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SHORT COMMUNICATIONS

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INFLUENCE OF WEED CONTROL PRACTICES AND LEVELS OF PHOSPHORUS ON GROUNDNUT (*ARACHIS HYPOGAEA L.*)

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ABSTRACT

Results of a field experiment conducted in a sandy loam soil of Division of Agronomy, Indian Agricultural Research Institute, New Delhi during two consecutive rainy seasons of 1983 and 1984 revealed that weed control efficiency of repeated weeding was the highest (95.0 per cent) followed by two weedings (83.7 per cent). By reducing weed competition, the cultural practices resulted in significant increase in the yield of groundnut. Pre-emergence application of oxadiazon at 1 kg a.i./ha also effectively controlled the weeds and increased yield over weedy check and post emergence application of Bentazone + Fluazifop-butyl in 1984 and in pooled data. Application of phosphorus at 40 kg P_2O_5/ha increased the groundnut yield by 21.9 per cent. Optimum dose of phosphorus was found to be 57.6 kg/ha.

Key words : Groundnut; Arachis hypogaea L.: Weed control; Phosphorus.

INTRODUCTION

Groundnut is very susceptible to weed competition at early stage due to slow growth and its low stature (Shanmugam, 1984). Loss in yield varies depending upon weed flora and fertility of the field. Reduction in groundnut yelid has been reported as high as 70 per cent (Yaduraju *et al.*, 1980). Effectiveness of herbicides in controlling weeds in groundnut has been reported by Chandra Singh *et al.* (1971) and Brar *et al.* (1980)'. But some of the new herbicides have not been tested under field conditions. The present experiment was, therefore, conducted to study the effect of various cultural practices and herbicide application in combination with levels of phosphorus on weed densities, weed control efficiency and yield of groundnut.

MATERIALS AND METHODS

An experiment was conducted during monsoon season of 1983 and 1984 at the farm of the Division of Agronomy, Indian Agricultural Research Institute, New Delhi.Treatments comprising six weed control practices (weedy check, weeding once at 30 days after sowing and weeding twice at 30 and 60 days after sowing, pre-emergence application of oxadiazon at 1kg a.i. / ha, post-emergence application of mixture of Bentazone at 2 l+Fluazifop-butyl 1 l/ha 30 days after sowing and repeated weeding) and three levels of phosphorus (0, 40 and 80 kg/ha) were tested in a factorial randomised block design with three replications. Pre-emergence herbicide was applied just after sowing in 1983 and 72 hours after sowing in 1984. Herbicides were sprayed with a spray volume of 1000 l water hectare. Four and five weedings at 15,33,49 and 76, and 18,31,48,67 and 93 days were given in repeated weeding plots in 1983 and 1984, respectively.

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Groundnut, cv, Kadiri-3 was sown on July 15 and June 23 in respective seasons. The soil of the field was sandy loam, low in available nitrogen (140 kg/ha) and phosphorus (9.6 kg P_2O_5/ha) and high in potassium (315 kg K_2O/ha) having pH 7.6 . The crop was sown at distance of 40 cm with a basal dose of 25 kg N/ha. Crop was harvested on December 13 and 10 in respective years. The crop of 1983 received no irrigations as the rains in this season continued untill second week of October. Two irrigations were given in 1984 as rains stopped in first week of September. Rainfall (Fig. 1) during both crop seasons were 783 and 520 mm respectively. In 1983 it was about 50% more than normal (515 mm) of the season. Weed control efficiency of each treatment was calculated by using the formula :

$$WCE = \frac{\text{Dry weed weight in unweeded check} - \text{Dry weed weight in treated plot}}{\text{Dry weed weight in unweeded check}} \times 100$$

RESULTS AND DISCUSSION

Studies on Weeds : *Trianthema monogyna* L., *Echinochloa colonum* L., *Digera arvensis* Forsk, *Phylanthus niruri* constituted the major weed species. Other species were *Cynodon dactylon* L. Pers and *Sorghum halepanse*. In weedy check plots *Echinochloa* and *Trianthema* respectively constituted 44 and 16 per cent of the total weeds at 60 days in 1983, 60 and 34 per cent at 30 days and 88 and 4 per cent at 60 days in 1984. Both, pre-emergence application of oxadiazon and post-emergence application of Bentazone × Fluazifop-butyl, suppressed the population of Echinochloa (monocot weed) in 1983 while in 1984 only oxadiazon wsa observed to be effective in suppressing the population of weeds in general and monocot weeds in particular.

The lowest population (Fig. 2) of weeds and the dry weight and the highest (91.8%) weed control efficiency (Table 1) was recorded in repeated weeding followed by weeding twice in 1983. Among the herbicides, post-emergence application of Bentazone+Fluazifop-butyl reduced the weed population and dry weight in this season. In 1984 weed population (Fig. 2) and dry weight (Table 1) at 30 days were reduced with pre-emergence application of oxadiazon and repeated weeding. At 60 days and at harvesting repeated weeding completely suppressed the weeds and gave the highest weed control efficiency (98.2%) followed by oxadiazon and weeding twice. Weeding once also significantly reduced weed population and dry weight at 60 days and at harvesting in 1984. Application of phospohrus, though suppressed the weed population, did not influence weeds dry weight. Significant reduction in population of weeds in general and monocot weeds in particular in 1984 was recorded with 80 kg P_2O_5/ha. Increase in the dry weight of groundnut (Flg. 3) and formation of more acids at higher doses of phosphorus might have suppressed the population of weeds.

Studies on groundnut

Dry matter accumulation at harvest (Fig,. 3) in 1983 was the highest in repeated weeding followed by weeding twice.

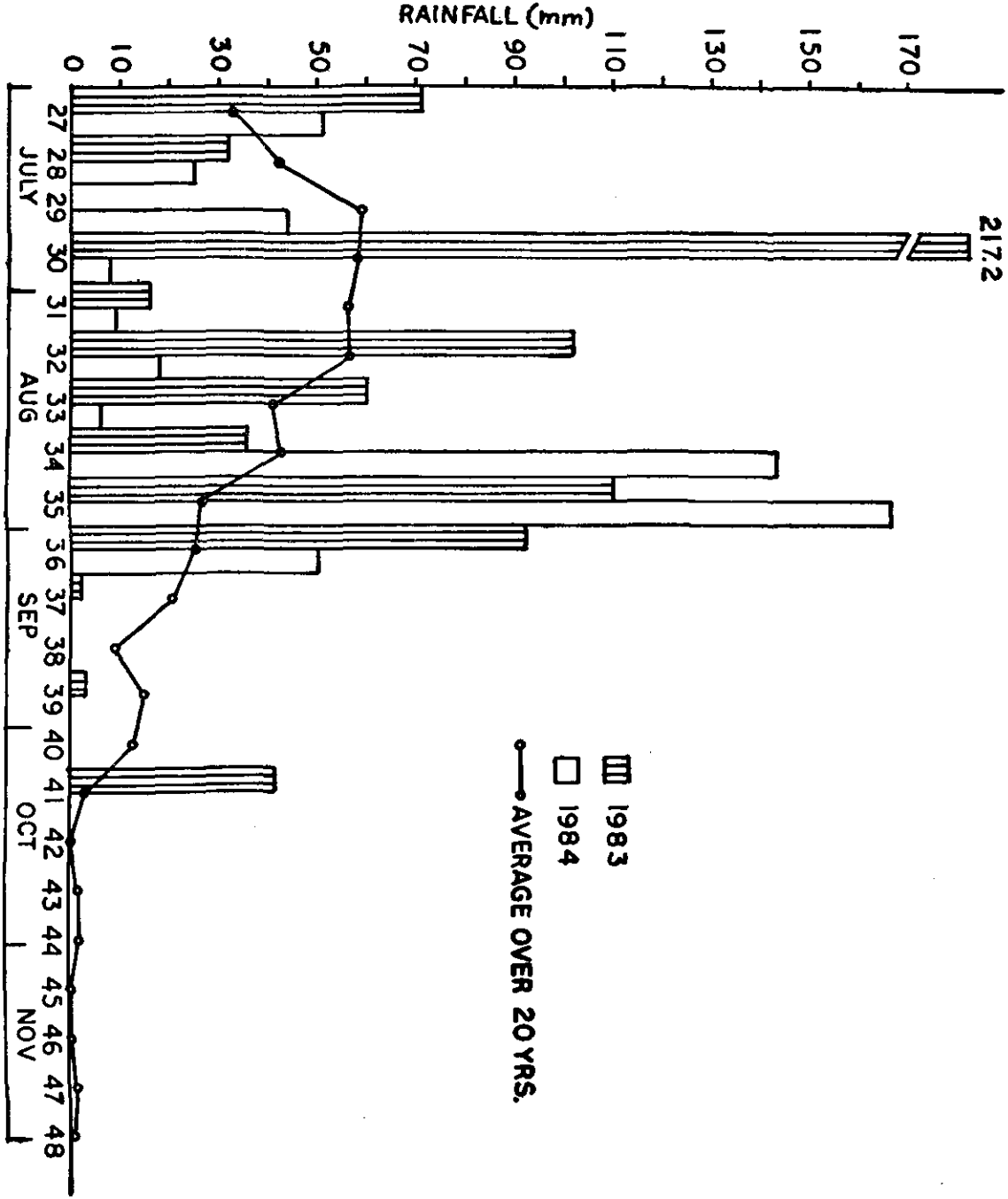

Fig. 1. Rainfall during Cropping Seasons

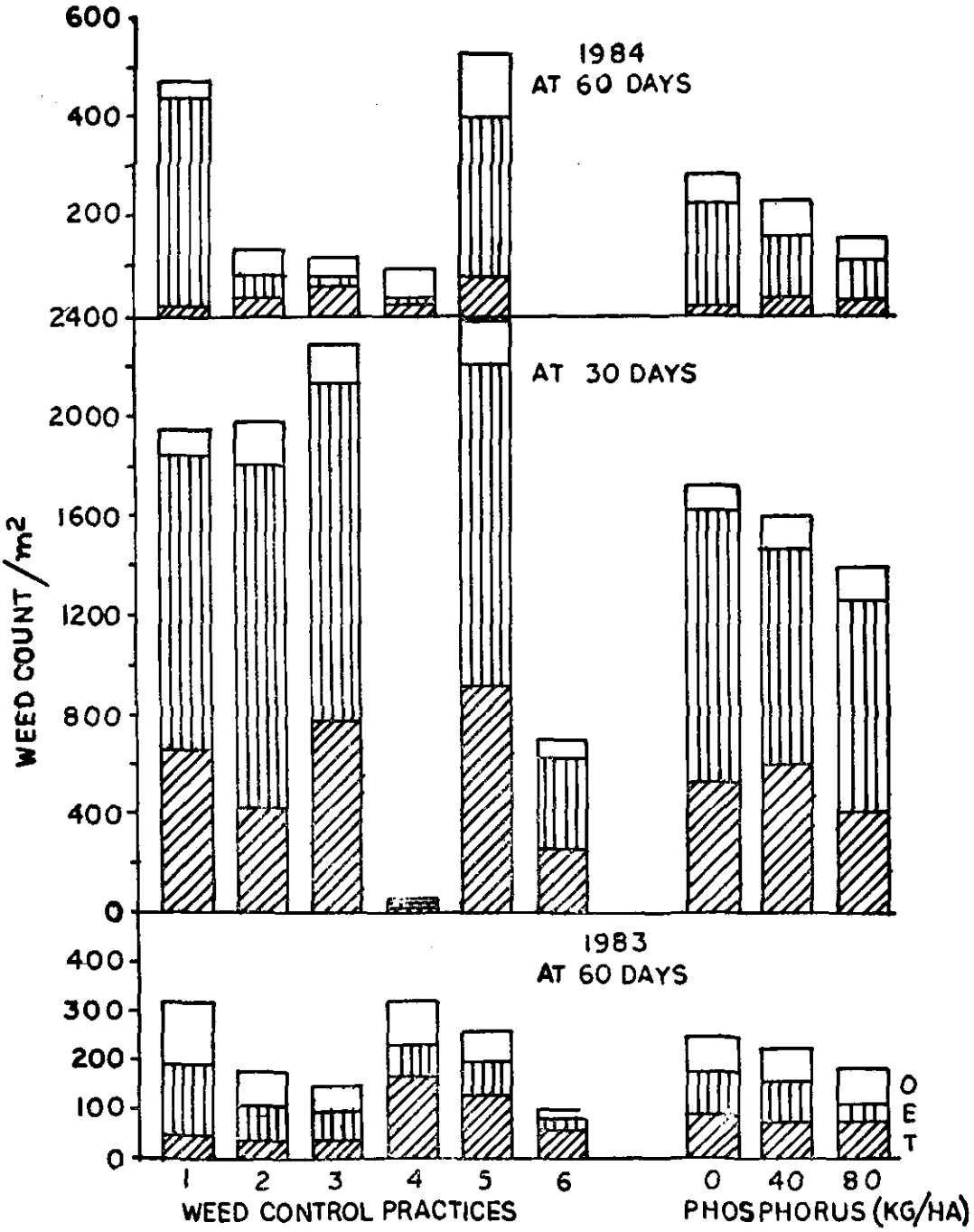

Fig. 2. Weeds count as influenced by weed control practices and levels of phosphorus.

1. Weedy check
2. Weeding once
3. Weeding twice
4. Herbicide pre-emergence
5. Herbicide post-emergence
6. Repeated weeding

T-Trianthma, E-Echinochola
O-Other weeds.

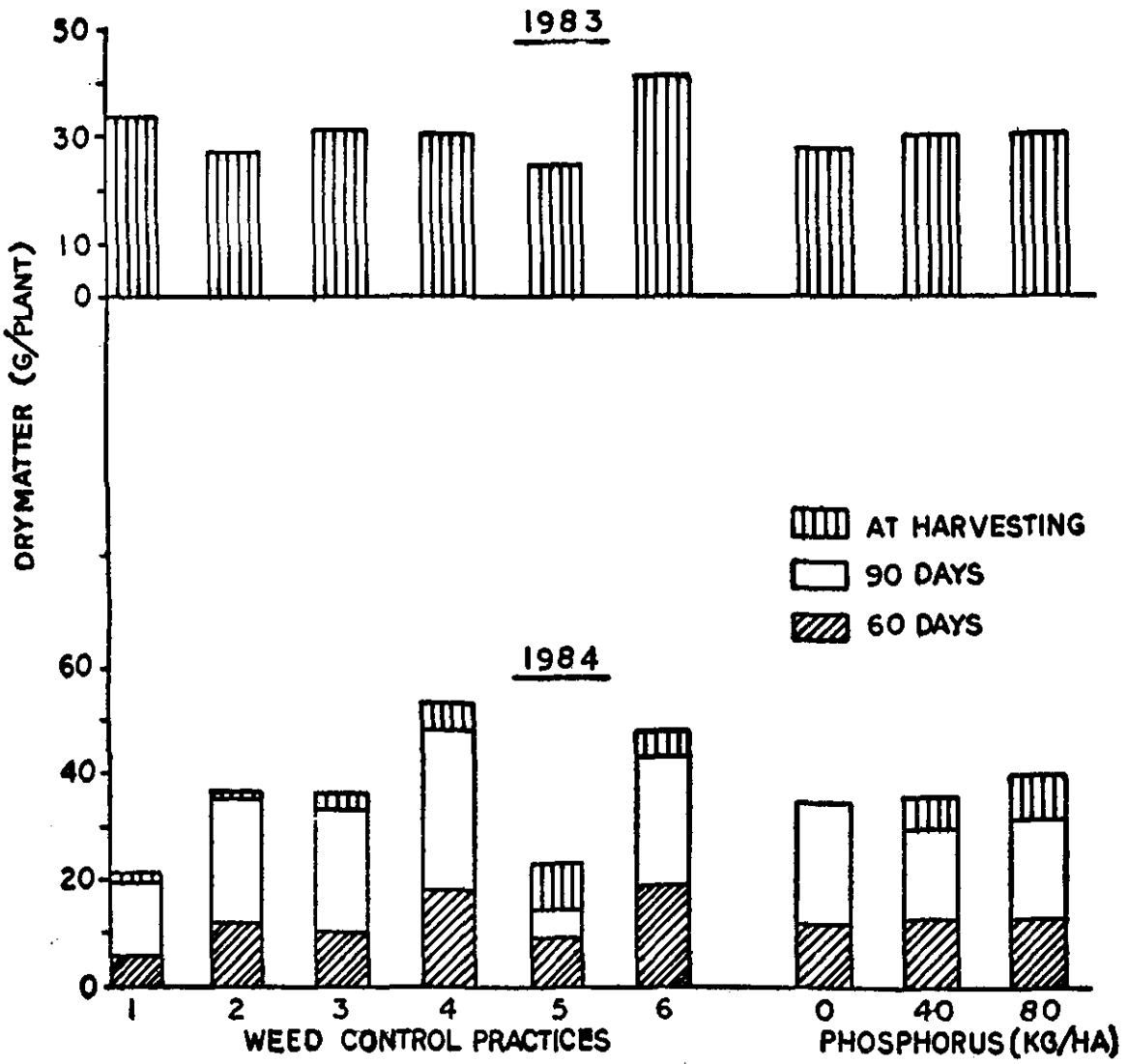

Fig. 3. Dry matter production of groundnut as influenced by weed control practices
1. Weedy check
2. Weeding once
3. Weeding twice
4. Herbicide pre-emergence
5. Herbicide post-emergence
6. Repeated weeding and levels of phosphorus

TABLE 1. Dry weight of weeds and weed control efficiency as influenced by weed control and levels of phosphorus

Weed control practices	Dry weight of weeds (kg/ha)					Weed control efficiency (%)			
	1983		1984			1983		1984	
	60 days	Harvest	30 days	60 days	Harvest	60 DAS	Harvest	60 DAS	Harvest
Weedy check	2204 4.5	1564 3.9	2175 4.5	2121 4.5	1760 4.2	0	0	0	0
Weeding once	410 1.8	1047 3.1	1840 4.1	342 2.0	409 2 0	81.4	33.1	83.9	76.8
Weeding twice	91 1.2	388 2.1	2286 4.6	310 1.8	137 1.2	95.9	75.2	85.4	92.2
Herbicide pre-emergence	1936 4.3	1897 4.2	98 1.1	273 1.7	188 1.4	12.2	21.3	87.1	89.3
Herbicide post-emergence	1098 3.0	930 3.0	2062 4.5	2026 4.5	1388 3.6	50.2	40.5	4.5	24.0
Repeated weeding	39 0.9	128 1.3	569 2.5	0 0.7	32 0.9	98.2	91.8	100.0	98.2
S.Em ±	0.29	0.29	0.29	0.20	0.18				
CD (P=0.05)	0.93	0.85	0.83	0.58	0.53				
Levels of phosphorus (kg/ha)									
0	886 2.6	908 2.8	1304 3.4	862 2.5	613 2.2				
40	947 2.5	956 2.9	1700 3.8	962 2.7	613 2.2				
80	1056 2.8	1111 3.1	1510 3.5	774 2.4	705 2.4				
S. Em ±	0.24	0.19	0.20	0.14	0.13				
CD (P=0 05)	N.S *	N.S *	N.S *	N.X *	N.S *				

N.S. Non-significant

* Transformed values

The Weed control practices influenced the number and weight of pods (Table2) however, differences were significant in 1984 only. All hand weeding practices whether once or repeated were equally effective in increasing the dry matter production at all the stages (Fig. 3) and pod yield of groundnut over weedy check. Pre-emergence application of oxadiazon also increased the dry matter production and number and weight of pods over weedy check. Test weight in 1983 with 40 kg P_2O_5/ha and shelling percentage in 1984 with 80 kg P_2O_5/ha was significantly higher than the control.

The pod yield (Table 3) obtained with one or two weedings were comparable with repeated weedings, which was significantly better than the weedy check. Pre-emergence application of oxadiazon also increased the pods yield, however, differences were significant only in 1984 and in pooled data. Data pooled over two years indicated that hand weeding twice increased the yield by 24.2% followed by weeding once (22.4%) or repeated (21.8%) and pre-emergence application of oxadiazon (15.8%).

Application of phosphorus influenced the pod yield of groundnut in both the years. In 1983, yield increased with increasing levels of phosphorus while in 1984 and in both the years together response was obtained only upto 40 kg.

Haulm yield of groundnut (Table 3) increased significantly with repeated weeding in both the years and with pre-emergence application of oxadiazon and weeding twice in 1984 only. Application of phosphorus did not influence haulm yield in either of the years. Various controlweed practices were more effective in 1984 than in 1983 because in 1984 crop was sown on 23 June, before onset of rains while in 1983 crop was sown in the mid July after onset of rains when weeds had established.

One weeding done at 30 days after sowing kept the weeds under control upto 60 days and was as effective as repeated weeding (Table 1). Two weedings at 30 and 60 days, though increased weed control efficiency upto harvesting, did not increase groundnut yield significantly over one weeding. This is because there was a critical period for weed free condition for groundnut. Weed free period upto 50 days for groundnut has been reported to be critical by Krishnamurthy *et al.* (1981). Pre-emergence application of oxadiazon effectively controlled the weeds and increased yield in 1984 only because low rain fall during early eight weeks was conducive for effective weed control. In 1983, oxadiazon might have got leached down as rains occured after 4-5 hours of spray reduced the efficacy of herbicide. Application of Bentazone+Fluazifop -butyl at 30 days did not increase yield in either of the years. Even 50 per cent weed control efficiency at 60 days in 1983 under this treatment could not increase the yield significantly. It indicated that efficiency of a treatment for controlling weeds at early stage of groundnut is more important.

The harvest index (Table 3) values were higher in 1984 than that of 1983. Early planting in 1984 and sub-normal rains at early stage of crop suppressed the vegetative growth and above normal rains at peg penetration and pod development stage encouraged pods yield which has resulted in higher harvest index.

TABLE 2. Yield attributes of groundnut as influenced by weed control and levels of phosphorus

Weed control practices	No. of pods/plant		Weight of pods/plants (g)		Shelling (%)		Test weight (g)	
	1983	1984	1983	1984	1983	1984	9183	1984
Weedy check	23.8	19.2	21.3	20.7	75.0	74.4	41.7	50.2
Weeding once	28.4	31.4	25.3	30.0	75.0	73.9	44.2	49.2
Weeding twice	33.3	40.9	29.9	38.2	74.2	74.5	41.1	47.4
Herbicide pre-emergence	31.0	34.8	27.2	32.6	73.9	74.0	43.7	49.5
Herbicide post-emergence	26.1	18.4	23.3	19.6	73.3	75.7	39.5	50.3
Repeated weeding	26.8	41.0	25.6	41.0	75.6	75.1	40.7	49.1
S.Em ±	2.6	3.6	2.5	3.5	0.7	1.0	1.4	0.7
CD (P=.05)	NS	10.4	NS	10.1	N.S.	N.S.	N.S.	N.S
Levels of phosphorus (kg/ha)								
0	27.2	31.9	24.7	29.0	74.7	74.1	41.7	50.1
40	30.1	31.7	26.5	31.3	74.7	73.4	43.6	49.0
80	27.4	29.3	25.0	28.8	74.0	76.3	40.2	48.8
S.Em ±	1.9	2.6	1.8	2.5	0.5	0.7	1.0	0.5
CD (P=0.05)	N.S.	N.S.	N.S.	N.S.	N.S.	2.1	2.8	N.S.

TABLE 3. Pod and haulm yield and harvest index of groundnut as influenced by weed control and levels of phosphorus

Weed control practices	Pods yield (kg/ha)			Haulm yield (kg/ha)		Harvest Index	
	1983	1984	Pooled	1983	1984	1983	1984
Weedy check	1975	2081	2028	3725	2250	34.6	48.0
Weeding once	2334	2627	2483	4400	2663	34.7	49.7
Weeding twice	2507	2530	2519	4462	3025	36.0	45.5
Herbicide pre-emergence	2239	2458	2349	4462	3713	33.4	39.8
Herbicide post-emergence	2210	2130	2170	3462	2488	39.0	46.1
Repeated weeding	2349	2591	2470	4837	3488	32.7	42.6
S.Em ±	104	114	78	263	184		
CD (P=0.05)	299	328	219	755	527		
Levels of phosphorus (kg/ha)							
0	1974	2087	2031	4212	2925	31.9	41.6
40	2304	2644	2475	4188	2875	35.5	47.9
80	2531	2477	2505	4262	3013	37.2	45.1
S.Em ±	74	81	55	186	130		
CD (P=0.05)	212	238	155	N.S.	N.S.		

The lowest harvest index values in pre-emergence application of oxadiazon and repeated weeding plots were due to more dry matter production (Fig. 2). It indicates that production of more haulm does not necessarily produce higher pods. In oxadiazon plots, weeds came up at later stages in 1983 and hence pod-yield was not significantly higher while in 1984 though weed control efficiency was more, it did not result in corresponding higher pod yield. In repeated weedings, weeding at 76 and 93 days would have disturbed peg penetration and pod development and as such resulted in a lower harvest index.

Application of phosphorus significantly increased the harvest index in both years. In 1983, the highest harvest index (37.2 per cent) was recorded with 80 kgs P_2O_5/ha while in 1984 application of 40 kg P_2O_5/ha gave the highest (47.9 per cent) harvest index. It indicates that phosphorus application encouraged the pod development and resulted in higher yield.

Response function and optimum dose

Response of groundnut to phosphorus was linear in 1983 and quadratic in 1984 and in pooled data (Table 4). The optimum dose of phosphorus was 47.7 kg/ and 57.6 kg/ha in 1984 and in pooled data, respectively (Table 4). In 1983 crop was sown after sorghum and mustard which might have exhausted the nutrients in the field. This could be the reason for linear response to applied phosphorus in 1983. In 1984 the experiment was repeated on a site where previous crop might have left some phosphorus to be utilized by subsequent crop. Under such conditions groundnut crop responded only upto 40 kg of applied phosphorus.

TABLE 4. Response equations and economic optimum dose

Year	Equation	Optimum dose of P_2O_5 (kg/ha)
1983	$Y = 1991 + 6.9625 \times$	
1984	$Y = 2087 + 22975\ x - 0.2263\ x^2$	47.7
Pooled	$Y = 2031 + 16.2750\ x - 0.1294\ x^2$	57.6

LITERATURE CITED

BRAR, L.S., GILL, H.S. and SINDHU, A.S. 1980. Efficacy of different herbicides for weed control in rainfed groundnut. Pesticides 14:24-27.

CHANDRA SINGH, D.J., HALL, V.L. and NARAYAN RAO 1975. Chemical weed control in groundnut. PANS 6:21-23.

KRISHNAMURTY, K., RAJU, B. REDDY and KANCHAIAH, K. 1981. Proc. 8th Asian Pacific Weed Sci. Soc. Conf. 1981. Vol. II:123-127.

SHANMUGAM, K.S. 1984. Weed control in groundnut. Pesticides 18:52.

YADURAJU, N.T., KULSHRESTHA, GITA and MANI, V.S. 1980. Herbicide studies in groundnut Indian J. Agron. 25:447-452.

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INHERITANCE OF SILIQUA CHARACTERS IN INDIAN COLZA (*BRASSICA CAMPESTRIS* L. VAR YELLOW *SARSON*)

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ABSTRACT

Six generations viz. P_1, P_2, F_1, F_2, B_1, and B_2 were a studied in four crosses of Indian Colza to study the inheritance pattern of siliqua charecters. Results indicated that both additive as well as non additive gene actions are important for expression of siliqua length, siliqua girth and siliqua beak length. Variation in gene action in different crosses suggested the importance of genetype involved in the cross. To get desirable segregants where additive gene action is important conventional breeding method like hybridization followed by pedigree method and when both additive as well as non additive gene action are important then population improvement following biparental matings or reciprocal recurrant selection are suggested.

Key words : *Brassica Campestris* L. Siliqua characters, gene action

INTRODUCTION

Siliqua is the important plant part in yellow sarson (Indian colza) which bears the seeds. Its length and girth is related with, the number of seeds/siliqua which is positively associated with economic yield in Indian colza (Ramanujam and Rai, 1963; Anand *et al*; 1975). Thus the genetic manipulation of siliqua length, girth and beak length may prove useful in breeding high yielding varieties in yellow sarson (*Brassica campestris L.* var. Yellow *Sarson*). But information on the inheritance of these characters is meagre in this important oilseed crop. The present investigation was undertaken to study the type of gene effects operative in the genetic control of siliqua length, siliqua girth and beak length.

MATERIALS AND METHODS

The materials for the present study comprised six generations (P_1,P_2,F_1,B_1 and B_2) for four crosses viz. RAUYS $_{-3}$XDYS $_{-1}$, RAUYS $_{-3}$. XPYS $_{-6}$, RAUYS $_{-2}$X, PYS $_{-6}$, 9Y × YSIK $_{-742}$, RAUYS $_{-3}$ and DYS $_{-1}$ are tetralocular with upright siliqua position having more siliqua girth and beak length whereas RAUYS $_{2-}$ is tetralomlar with pendent siliqua with more siliqua girth and beak length. While PYS $_{-6}$. $_{9}$Y and YSIK $_{-742}$ are bilocular, upright siliqua with small girth and beak. Different generations of four crosses were grown in a randomized block design with three replications at Tirhut College of Agriculture, Dholi, Bihar. Parents and F_1s are grown in a single row plot, B_1 and B_2 in 3 row plot and F_2 in 5 row plots. Row to row and plant to plant distances were maintained at 30×10 cm. Observations were recorded on 10 random plants from P_1, P_2 and F_1, 20 random plants from B_1 and B_2 and 50 random plants from F2 in each replication. The adequacy of 3 parameter models and 6 parameter model was tested with scaling tests given by Hayman and Mather (1955). In

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TABLE 1. Means for siliqua characters in Indian colza.

Generations	Siliqua length (cm)				Siliqua girth (cm)				Siliqua beak length (cm)			
	RAUYS-3 X DYS-1	RAUYS-3 X PYS-6	RAUYS-2 X PYS-6	9Y X YSIK-742	RAUYS-3 X DYS-1	RAUYS-3 X PYS-6	RAUYS-2 X PYS-6	9Y X YSIK-742	RAUYS-3 X DYS-1	RAUYS-3 X PYS-6	RAUYS-2 X PYS-6	9Y X YSIK-742
P_1	5.33±0.11	5.33±0.11	6.33±0.12	4.80±0.15	2.70±0.25	2.70±0.25	2.90±0.11	1.90±0.11	1.81±0.06	1.81±0.06	2.10±0.10	1.20±0.06
P_2	5.70±0.17	5.47±0.35	5.47±0.35	5.50±0.10	2.87±0.12	2.23±0.24	2.23±0.24	2.20±0.23	1.87±0.17	1.58±0.02	1.58±0.02	1.15±0.03
F_1	5.73±0.12	5.57±0.26	5.97±0.03	5.13±0.03	2.63±0.12	2.47±0.13	2.33±0.03	1.80±0.07	1.97±0.03	1.70±0.06	1.77±0.03	1.60±0.06
F_2	5.50±0.01	5.21±0.22	5.33±0.01	4.14±0.10	2.75±0.01	2.17±0.14	2.20±0.02	1.67±0.06	1.67±0.09	1.76±0.05	1.68±0.04	1.03±0.06
B^{C1}	5.20±0.13	4.73±0.19	6.05±0.03	3.95±0.05	2.70±0.06	1.97±0.09	2.93±0.25	1.68±0.04	1.80±0.07	1.35±0.12	2.03±0.04	1.15±0.06
B^{C2}	6.02±0.19	4.88±0.16	5.45±0.10	4.67±0.03	3.05±0.21	1.80±0.01	2.17±0.07	1.77±0.03	1.75±0.03	1.48±0.03	1.90±0.05	1.22±0.05

TABLE 2. Estimates of components of generation means on 3-parameter and 6-parameter model for siliqua characters in Indian colaza.

Cross	Mean (m)	Additive (d)	Dominance (h)	Add. × Add. (i)	Add. × Dom. (j)	Dom × Dom. (l)	Heterosis	Type of Epistasis	Degree of Dominance
				Siliqua length					
RAUYS-3 × DYS-1	5.507**	-0.817**	0.623	0.406	-1.267*	0.341	1.667	Complementary	
RAUYS-3 × PYS-6	5.213**	-0.150	-1.452**	-1.620**	-0.166	4.322**	0.401	Duplicate	
RAUYS-2 × PYS-6	5.330**	0.600**	1.747	1.680	0.334	-0.946**	-0.700	Duplicate	
9 Y × tYSIK-742	4.140	-0.717	0.657	0.674	-0.734	2.658	-0.367	Complementary	
				Siliqua girth					
RAUYS-3 × DYS-1	0.092	-0.194	0.021	—	—	—	—	—	-0.331
RAUYS-3 × PYS-6	2.173**	0.167	-2.157**	-2.158**	-1.133	2.488**	0.400	Duplicate	—
RAUYS-2 × PYS-6	2.200	0.766	1.167	1.400	0.865	0.199	-1.431	Complementary	—
9 Y × YSIK-742	0.070	0.002	-0.244	—	—	—	—	—	-11.260**
				Siliqua beak					
RAUYS-3 × DYS-1	0.033	0.024	-0.017	—	—	—	—	—	-0.837
RAUYS-3 × PYS-6	1.760**	-0.133	-1.374**	-1.374**	-0.500	2.508**	0.383	Duplicate	
RAUYS-2 × PYS-6	1.680**	0.133	1.072**	1.146	-0.251	-1.795	-0.082	Duplicate	—
9 Y × YSIK-742	1.027	-0.067	1.051	0.626	-0.184	0.090	0.484	Complementary	—

the absence of interactions. three parameter model (Mather, 1949)was used for estimation of genetic components. When, interactions were significant, six parameter model (Hayman, 1958) was utilised for estimation of genetic components. The genetic parameters estimated were mean (m), additive (d), dominance (h), additive × additive (i), additive × dominance (j), and dominance × dominance (l). Significance of these genetic components was tested with 't' value.

RESULTS AND DISCUSSIONS :

The generation means and estimates of genetic parameters by three and six parameter models for three characters are given in Table 1 and Table 2. The scaling tests indicated that interactions were not significant in two crosses for siliqua girth and in one cross for siliqua beak (Table 2). For these crosses simple addive-dominance model (3 parameter model) is adequate to explain the variation in generation means. For rest of the crosses one or other interaction was significant. Therefore, 6 parameter model was used to explain the variation.

Siliqua length :

The mean length of siliqua was more in F_1 for all crosses than mid parental value except 9Y × YSIK-$_{742}$. The F_1, means of two crosses were higher while lower in two crosses than the best parental value of the cross (Table 1). The F_2 means were lower than midparent values and repspective F_1 in all crosses. For this character, back crosses was more towards the mean of recurrent parent. The joint scaling test revealed the presence of non allelic interactions for this character in all crosses. The estimate of aditive gene component was highly significant for siliqua length for all crosses except RAUYS -$_3$ × PYS -$_6$ (Table 2). The dominance gene effect was significant only in RAUYS -$_2$ × PYS-$_6$ for this attribute. There is evidence of presence of epistatic gene action in all crosses. Additive × additive gene interaction is important in RAUYS -$_2$ × PYS-$_6$ while additive × dominance interaction plays important role in crosses RAUYS -$_3$ × DYS -$_1$ 9YX YSIK -$_{742}$—. Dominance × dominance interaction is important in RAUYS -$_3$ × PYS -$_6$ and 9Y × YSIK -$_{742}$ for siliqua length.

The parameters (h) and (i) on which the classicfication of epistasis depends were of opposite sign in RAUYS -$_3$ × PYS -$_6$ and RAUYS -$_2$ × PYS -$_6$ indicating the duplicate type of epistasis, whereas in RAUYS -$_3$ × DYS -$_1$ and 9YX YSIK -$_{742}$ were of same sign indicating therby the complementary type of espistasis. (Table 2)

Sliqua girth :

For siliqua girth, the mean of F_1, S were lower than mid parental value in three crosses except for RAUYS $_3$ × PYS -$_6$ where it was equal to midparental value indicating nonadditive nature in three crosses and additive gene action in later cross was important for this character. The mean of F_1s was lower in all crosses with respect to best parent for this character.

It seems that the genes governing the less siliqua girth are dominant (Table 1). The siliqua girth in F_2 generation was lower than F_1'S in three crosses while it was more in RAUYS $-_3 \times$ DYS $-_1$. similarly the F_2 means were lower than mid-parental value and none of the crosses exceeded the respective better parental mean in F_2 generation. The general trend of back crosses was more towards the recurrent parent (Table 1). The additive gene action was significant only in cross RAUYS $-_2 \times$ PYS $-_6$. However, dominance gene action was important in two crosses (Table 2). For siliqua girth in two crosses Viz RAUYS $-_3 \times$ DYS $-_1$ and $_9$YX YSIK $-_{742}$ simple additive-dominance model was adequate to explain the variation in crosses, while in other two crosses epistatic gene action was also important and 6- parameter model was used for these. Additive $\times$ additive gene action was important to explain the variation in two crosses viz RAUYS $-_3 \times$ PYS $-_6$ and RAUYS $-_2 \times$ PYS $-_6$. Additive $\times$ dominance and dominance $\times$ dominance interactions were important only in one cross i.e. RAUYS $-_3 \times$ PYS $-_6$. In the cross RAUYS $-_3 \times$ PYS $-_6$ duplicate epistasis and RAUYS $-_2 \times$ PYS $-_6$ complementary epistasis was important (Table 2).

Siliqua beak

The mean length of siliqua beak was more in F_1 for two crosses RAUYS $-_3 \times$ DYS $-_1$ and 9YX YSIK $-_{742}$ than mid parental value and the highest parent involved in the cross (Table 1). The mean F_1 of RAUYS $-_3 \times$ PYS $-_6$ was equal to mid parental value while it was less than the best parental value. In the cross RAUYS $-_2 \times$ PYS $-_6$ the F_1 mean was less than mid parental value and the best parent RAUYS $-_2$. The F_2 mean was lower than F_1 mean and mid parental value in all crosses except RAUYS $-_3 \times$ PYS $_6$. In this cross F_2 mean was at part with that of F_1, but it was less than the best parent RAUYS $-_3$ (Table-1). Epistasis did not play any role for expression of siliqua beak in RAUYS $-_3 \times$ DYS $-_1$. However, non-additive gene action was important in other three crosses (Table 2). Dominance (h)gene action was important in RAUYS $-_3 \times$ PYS $-_6$ and 9YX YSIK $-_{742}$ while both additive and dominance were important in RAUYS $-_2 \times$ PYS $-_6$. Additive $\times$ additive and dominance $\times$ dominance gene interaction with duplicate type of epistasis, were the major components for expression of siliqua beak in RAUYS $-_3 \times$ PYS $-_6$ and RAUYS $-_2 \times$ PYS $-_6$ while additive $\times$ additive gene action was major component in $_9$YX YSIK $-_{742}$ with complementary epistasis.

The results indicate that both additive as well as nonadditive gene action were important for all three siliqua characters in different crosses. The gene action variesd from cross to cross for different characters indicating the importance of genotype involved in cross combination . Additive (d) and additive $\times$ additive (i) gene effects could be exploited through selection. When 'i' component is positive and being a fixable component this may cause higher manifestation of the character in some of the segregants even in advance generation. It may therefore, be possible to exploit such crosses for developing superior lines. However such effects coupled with larger magnitude of and duplicate type of epistasis will slow down the improvement through selection. Similarly in crosses where negative additive $\times$ additive effects are important worthwhile improvement in the character may not be achieved through selection.

However, in such crosses where additive as well as non-additive gene effects are involved, breeding procedures involving multiple crosses, growing large size populations in each generation and of using biparental mating in early segregating generations may be resorted to. Comstock *et al* (1949) also suggested the use of reciprocal recurrent selection for effective utilization of both types of gene action. Siliqua being an important economic character which bears seed and its length and size may affect the seed number and size vis-a-vis seed yield, the genetic studies of these characters may help formulating a suitable breeding methodology to develop high yielding varieties in yellow sarson.

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REFERENCES

ANAND, I.J., J.N.SINGH and P.O. SHARMA (1975) Inter-relationship and diversity in Indian colza. Indian J. agric. Sci., 45:253-258.

COMSTOCK, R.E., H.F. ROBINSON and P.H. HARVEY (1949) A breeding procedure designed to make maximum use of both general and specific combining ability. Agron. J. 41:360-367.

HAYMAN, B.I. (1958) The separation of epistatic from additive and dominance variation in generation means. Heredity 12:371-390.

HAYMAN, B.I. and K. MATHER (1955) The description of genetic interaction in continuous variation. Biometrics 11:69-82.

MATHER, K. (1949) Biometrical Genetics. Dever publication Inc. New York.

RAMANUJAM, S. and B. RAI (1963) Analysis of yield components in *Brassica Campestris* Var yellow *sarson*. Indian J. genetics 23:312-319.

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INFLUENCE OF WEATHER FACTORS ON THE INCIDENCE OF LEAF MINER (*APROAEREMA MODICELLA* DEVENTER) ON GROUNDNUT

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ABSTRACT

Effects of meteorological factors on outbreak of leaf miner (*Aproaerema modicella* Deventer) on groundnut (*Arachis hypogaea* L.) cultivar 'Phule Pragati (JL-24)' were studied during kharif seasons of 1982, 1983 and 1984. A heavy precipitation followed by a break of monsoon and increase in sunshine hours were observed to be favourable for the multiplication of the pest. However continuous rainfall and lesser sunshine hours were not favourable for its build up. Significantly positive and negative correlations were observed between the pest incidence and sunshine hours and relative humidity respectively. Pooled analysis of three years data, revealed that,increases in the relative humidity, minimum temperature and intensity of rainfall are responsible for decrease in the population of leaf miner on groundnut (JL-24). However, the pest intensity increased due to the increase in the sunshine hours and maximum temparature.

Key words : *Arachis hypogaea* : Leaf miner; Weather factors

INTRODUCTION

Leaf miner (Aproaerema modicella Deventer) is a major pest of groundnut (*Arachis hypogaea* L.) by mining the leaves and feeding on green matter of epidermal parts. The larvae roll the leaves and feed inside, due to which there is reduction in dry pod yields. The attempts have been therefore, made to examine the effects of weather factors on occurence and the intensity of the pest on *kharif* groundnut under rainfed conditions.

MATERIALS AND METHODS

Five plots of 6×5 m in size were sown with groundnut cv. Phule Pragati on 13th, 8th and 23rd July of 1982, 1983 and 1984 respectively at the Agricultural School Farm, Jalgaon. The larval population of leaf miner was recorded by opening the mined and folded leaves on ten plants located serially in the centre of the plot at every meteorological week from the start of the pest infestation till the harvest of the crop. Weekly meteorological data on temperature, relative humidity, rainfall and bright sunshine hours were recorded for all the weeks of observations for three seasons and are depicted in Figures 1,2 and 3 respectively.

To study the influence of abiotic (meteorological) factors on pest incidence two approaches were made. In one case graphical super-imposition technique was

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used while in the other simple correlations were worked out between pest incidence and meteotological factors for the same period and the three years data was pooled statistically.

RESULTS AND DISCUSSION

The yearwise relationship between individual meteorological parameters (abiotic factors) viz. temperature, relative humidity, rainfal and sunshine hours and incidence of leaf miner on groundnut are presented below.

Population build - up of leaf miner on groundnut during Kharif 1982 :

Leaf miner incidence started during 33rd meteorological week due to decreasing intensity of rain fall during preceding two weeks (31st and 32nd) and increased evening humidity (i.e. 80%) during 33rd week. Rainfall of 63.7 mm received during 34th week might have influenced to cause complete decline of leaf miner during 35th week or the larvae might have gone in to pupal stage. Increase in sunshine hours (8.4 hrs) and maximum temperature (32.9°C) during 35th and 36th week respectively with no rainfall, resulted in maximum build up of leaf miner larvae (155/10 plants) in 36th meteorological week. Its population started declining from 37th week onwards because of rainfall (Table 1).

Population build-up of leaf miner on groundnut during kharif, 1983 :

The incidence of leaf miner was observed in 31st meteorological week and population increased reaching its peak in 38th week. Continuous rainfall, humid climate and less sunshine hours were responsible for less pest incidence on groundnut as compared to its incidence during Kharif 1982. The maximum population (20.5 larvae/10 palnts) was observed during 38th meteorological week, when there was increase in sunshine hours (7.5 hrs) and decrease in rainfall (26.6 mm) (Table 1).

Population build-up of leaf miner on groundnut during Kharif 1984

From Table 1 it could be seen that the pest incidence started from 32nd meteorological week and population build-up continued upto 35th week. However, it declined during 36th and 37th week, because of rainfal, increase in relative humidity and decrease in sunshine hours during 35th meteorological week.

The peak incidence of the pest was noticed during 39th week (29.3 larvae/10 plants). During this period, the maximum temperature and morning and evening humidity were 34.0°C and 82 and 53 per cent respectively with 7.1 hours of sunshine. Due to slight rainfall, the pest again attained its peak duriing 42nd week i.e. 49 larvae/10 plants.

TABLE 1. Weather parameters and leaf miner population during kharif sesons of 1982, 1983 and 1984

Met. : weeks	Kharif 1982							Kharif 1983							Kharif 1984						
	Temperature (°C)		Humidity (%)		Rainfall (mm)	Sunshine hours	Leaf miner population per 10 plants	Temperature (°C)		Humidity (%)		Rainfall (mm)	Sunshine hrs.	Leaf miner population per 10 plants	Temperature (°C)		Humidity (%)		Rainfall (mm)	Sunshine hrs.	Leaf miner population per 10 plants
	Max.	Min.	Morn.	Even.				Max.	Min.	Morn.	Even.				Max.	Min.	Morn.	Even.			
30	31.0	24.2	91	74	39.2	3.3	0.0	32.4	24.8	87	73	63.8	3.7	0.0	33.7	24.0	83	57	2.0	6.3	0.0
31	31.7	24.5	88	65	51.2	4.0	0.0	31.3	24.6	91	76	31.8	2.6	1.0	31.3	25.4	87	66	67.0	3.6	0.0
32	30.4	24.0	91	70	18.8	3.4	0.0	30.6	24.6	93	77.	91.6	3.0	1.5	29.2	23.2	92	79	44.6	2.4	0.3
33	29.6	23.7	92	80	55.2	1.6	7.3	29.6	24.5	94	82	106.2	1.9	0.5	30.4	23.2	92	82	29.2	3.6	1.7
34	29.3	23.4	91	83	63.7	2.1	31.0	31.6	23.7	88	64	1.6	7.1	2.2	31.0	22.7	88	69	8.0	4.8	6.7
35	31.8	23.7	87	58	0.0	8.4	0.0	29.1	23.8	90	82	83.0	3.1	2.7	29.6	20.0	89	77	24.0	2.4	17.3
36	32.9	22.9	85	50	0.0	7.5	155.0	29.7	23.8	94	76	64.4	1.1	4.3	30.2	21.8	81	66	1.8	4.7	4.0
37	32.7	23.7	86	56	0.4	6.8	47.3	31.1	24.0	88	75	65.0	5.1	12.0	34.7	22.3	84	58	8.8	7.5	2.0
38	34.8	22.9	81	47	32.0	8.4	28.5	32.7	25.9	90	63	26.6	7.5	20.5	34.7	21.8	81	41	0.0	9.8	22.3
39	34.3	22.3	83	47	0.0	9.4	6.0	32.0	23.5	91	70	20.2	6.1	2.5	34.0	22.7	82	53	13.6	7.1	29.3
40	36.6	19.9	67	42	0.0	9.9	3.7	33.0	23.4	90	57	38.2	8.5	3.0	37.0	22.8	74	35	14.1	8.6	21.0
41	37.3	19.3	68	39	0.0	9.8	0.0	31.2	23.4	89	54	12.2	5.8	0.0	31.7	21.4	88	43	32.6	7.3	4.0
42	35.7	21.5	76	43	1.0	10.1	0.0	33.1	17.6	75	33	0.0	10.3	0.0	34.8	18.2	65	23	0.0	10.5	49.0

TABLE 2. Correlation coefficients between different climatic factors and infestation of leaf miner on groundnut

Sr. No.	Meteorological parameters	Year	'r' value
1.	Maximum temperature (°C)	1982	-0.0614
		1983	0.2899
		1984	0.5244
		Pooled	0.152
2.	Minimum temperature (°C)	1982	0.0962
		1983	0.3626
		1984	-0.7092**
		Pooled	-0.096
3.	Morning humidity (%)	1982	0.1184
		1983	-0.8172**
		1984	-0.7863**
		Pooled	-0.157
4.	Evening humidity (%)	1982	-0.1265
		1983	-0.6138*
		1984	-0.6929**
		Pooled	-0.253
5.	Rainfall (mm)	1982	-0.1136
		1983	-0.2862
		1984	-0.4417
		Pooled	-0.232
6.	Sunshine hours	1982	0.4341
		1983	0.8397**
		1984	0.6508*
		Pooled	0.193

* Significant at 5 % level.

** Significant at 1 % level.

Pooled analysis of three years data of population built up of leaf miner (1982 to 1984) :

Pooled results indicated that correlation coefficient studies between leaf miner population with all the environment factors was observed statistically non-significant. However, positive relationship was observed between the leaf miner population, and maximum temperature and the sunshine hours. With the increase in the sunshine hours and temperature, the leaf miner population also increased and it declined as the intensity of these two environmental factors was reduced. There was negative relationship of relative humidity, minimum temperature and rainfall with the intensity of leaf miner population.

From the present studies, it could be inferred that the increase in the relative humidity, minimum temperature and intensity of rainfall are responsible for decrease in the population of leaf of miner larvae on groundnut (Var. JL-24). However, the pest intensity increased due to the increase in the sunshine hours and the maximum temperature. Logiswaran *et al.* (1982) and Gujarati *et al.* (1973) reported the negative correlation between leaf miner incidence and morning relative humidity and positive correlation with sunshine hours. In the present studies, non-significant correlations were observed between pest infestation and rainfall and temperature. However, negative correlation between pest infestation and minimum temperature was observed during 1984. Logiswaran *et al.* (1982) reported negative correlation between pest incidence and maximum and minimum tepmerature, while Lewing *et al.* (1979) observed a positive correlation. Krishnanda and Kaiwar (1965) reported that heavy showers in the last week of July reduced the pest incidence. The present findings are in conformity with those reported by these workers.

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LITERATURE CITED

GUJARATI, J.P.; KAPOOR, K.N. and GANGARDE, G.A. 1973. Biology of soyabean leaf miner *Stomopteryx subsecivella* (Zell.) (Lepidoptera Gelechidae). Entomologist, 106 (1323):187-191

KRISHNANDA, N. and KAIWAR, S.R. 1965. A preliminary study on the control of leaf miner on groundnut. Indian Oilseed J. 9:180-183.

LEWIN, H.D.; SAROJA, R.; SANDARAJU, D. and PADMANABHAN, M.D. 1979. Influence of sowing time and weather on the incidence of groundnut leaf miner. Indian J. agric. Sci. 49(ii): 886-91.

LOGISWARAN, G.; RAO MADHAV, S.; VASUDEVAN, G. and KANNAN, V. 1982. Influence of time of sowing and weather factor on the infestation of leaf miner, *Aproaerema modicella* Deventer and yield in rainfed groundnut. Madras agric. J. 69(6): 359-363.

LOGISWARAN, G.; RAO, MADHAV, S.; VASUDEVAN, G. and KANNAN, V. 1982. Incidence of leaf miner *Aproaerema modicella* Deventer. (*Stomotpteryx subsecivella* Zell.) on grundnut in relation to time of sowing and weather factors. Madras agric. J. 69(8) : 491-497.

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PATH ANALYSIS FOR SEED YIELD IN SUNFLOWER

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ABSTRACT

Correlations and path coefficient analysis for ten quantitative characters were made in 75 sunflower genotypes comprising 74 newly developed hybrids and one presently cultivated BSH-1 hybrid. Of these, five characters viz., seed filling per cent, capitulum diameter, 100-seed weight, stem girth and seed oil content had significant correlation with seed yield per plant at genotypic level. Also the direct effects of these characters were studied by path analysis. It was found that seed filling per cent had maximum direct effect on seed yield in addition to its indirect effects through capitulum diameter, 100-seed weight and stem girth. Heowver, seed oil content showed negative direct effect even though it was significantly associated with seed yield. This clearly suggests that seed yield per plant in sunflower can be increased by increasing seed filling per cent capitulum diameter, 100-seed weight and stem girth.

Key words : Sunflower; Seed yield; Correlation Coefficient; Path coefficient

INTRODUCTION

Yield is a complex metric trait and is the end product of a number of factors often interrelated with each other. Correlation coefficients measure the association between any two characters. It is rather difficult to explain a system of correlations. as the indirect associations of charact.rs increase. Information through path analysis of a number of characters furnish a means of detecting the direct effects as well as indirect effects via other characters on the end product (seed yield). This paper presents information on the relative contribution of different characters towards seed yield.

MATERIALS AND METHODS

The material for the present study consisted of 75 genotypes comprising 74 newely developed hybrids and one presently cultivated BSH-1 hybrid. The hybrids were obtained by crossing a common female parent CMS-234 to 74 different new fertility restorer lines developed under All India Coordinated Research Project on Sunflower, G.K.V.K., UAS, Bangalore.

The experiment was laid out in RCBD with 3 replications during kharif season of 1983 and all recommended package of practices were followed. Data were recorded on five randomly chosen plants for the following ten characters.

1) Days to 50 per cent flowering
2) Plant height (cm)
3) Stem girth (cm)
4) Capitulum diameter (cm)
5) Days to maturity
6) Seed filling per cent
7) Seedyield/plant (g)
8) 100-seed weight (g)
9) Husk percentage
10) Seed oil content (%)

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The genotypic correlations among these ten characters, association of nine characters with seed yield and path co-efficient analysis were computed as per Dewey and Liu (1959).

RESULTS AND DISCUSSION

The genotypic correlations reveal that characters such as seed filling per cent, capitulum diameter, 100-seed weihgt, stem girth and seed oil content showed positive significant correlation with seed yield per plant.

The trend of direct and indirect effects of various component characters on seed yield were similar both at phenotypic and genotypic levels. However, the data at genotypic level only are presented (Table 1).

Days to 50 per cent flowering showed the maximum direct effect on seed yield (0.8938) followed by seed filling per cent (0.7529), capitulum diameter (0.3977) and 100-seed weight (0.3410) while days to maturity showed the maximum negative direct effect on the seed yield (-0.6534) followed by seed oil content (-0.5092) and plant height (-0.3019). It was also found that seed yield per plant was mainly influenced by other characters through seed filling, capitulum diameter, 100-seed weight and stem girth. Though the correlation between seed oil content and yield is positively significant the direct effect is negative.

Path coefficient analysis at genotypic level revealed that days to 50 per cent flowering exerted the greatest direct influence on seed yield, though its association with seed yield was significantly negative. This could be attributed to the fact that indirect influence of days to 50 per cent flowering through days to maturity on seed yield was highly negative. Seed filling per cent also exerted considerable direct effect on seed yield which is reflected in signifixant positive association. Other characters like capitulum diameter, 100-seed weight, stem girth and seed oil content which are positively and highly correlated with seed yield have their influence mostly through seed filling. Earlier workers (Varshney and Singh, 1977; Giriraj *et al.*, 1979; Lakshmanaiah, 1980 and Rao, 1983) have reported that seed filling per cent, capitulum diameter and 100-seed weight influenced the seed yield, both directly and indirectly. Days to maturity which had the greatest negative direct effect on seed yield also showed insignificant association with seed yield which revealed its unimportance in selection for high seed yield.

Simple correlation studies have clearly indicated singficant positive correlation between oil content and seed yield. However, through path coefficient analysis it may be seen that the direct effect of oil content on seed yield is negative but indirect effect through seed filling per cent, capitulum diameter days to 50 per cent flowering, 100-seed weight, stem girth and husk percentage are positive. This type of correlation and path coefficients clearly indicates that the selection pressure should not be merely on oil content but should be combined with seed filling per cent, 100-seed weight, capitulum diameter and stem girth. These results are in agreement with those of Varshney and

TABLE 1. Direct (diagonal) and indirect effects of different quantitative characters on seed yield (X_7) at genotypic level

	X_1	X_2	X_3	X_4	X_5	X_6	X_8	X_9	X_{10}	Genotypic correlation with yield
X1	**0.8938**	-0.1360	0.0300	0.0273	-0.5985	-0.1014	-0.1459	-0.0192	-0.1027	-0.5127*
X2	0.4026	**-0.3019**	0.0640	0.1096	-0.2434	0.1251	0.0150	0.0211	-0.0579	0.1342**
X3	0.2241	-0.1617	**0.1194**	0.2992	-0.1800	0.2097	0.0871	0.0857	-0.2810	0.4026**
X4	0.0614	-0.0832	0.0899	**0.3977**	-0.1104	0.5418	0.2111	0.0277	-0.2541	0.8819**
X5	0.8187	-0.1125	0.0329	0.0672	**-0.6534**	0.0230	-0.0282	-0.0458	-0.0633	0.0376
X6	**-0.1203**	-0.0502	0.0332	0.2861	-0.0200	**0.7529**	0.2695	-0.0171	-0.2188	0.9153**
X8	-0.3824	-0.0132	0.0305	0.2461	0.0540	0.5950	**0.3410**	-0.0345	-0.01541	0.6826**
X9	0.0978	0.0364	-0.0583	-0.0628	-0.1745	0.0737	0.0672	**-0.1754**	0.1671	-0.0285
X10	0.1802	-0.0343	0.0659	0.1984	-0.0812	0.3235	0.1032	0.0576	**-0.5092**	0.3062**

Residual = 0.0306

* $P \leq 0.05$
** $P \leq 0.01$

X1 : Days to 50 per cent flowering
X2 : Plant height
X3 : Stem girth
X4 : Capitulum diameter
X5 : Days to maturity
X6 : Seed filling per cent
X7 : Seed yield / plant
X8 : 100 - seed weight
X9 : Husk percentage
X10 : Seed oil content

Singh (1977) and Chandra and Anand (1977) who reported that direct effect of days to maturity on seed yield was negative which revealed the possibility of selection for earliness and high seed yield simultaneously. A close scrutiny of genotypic correlation and path coefficient clearly indicates that seed filling per cent, capitulum diameter 100-seed weight and stem girth contribute considrably to seed yield and selection for these characters would considerably improve the seed yield in sunflower.

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LITERATURE CITED

CHANDRA, S. and ANAND, I.J., 1977, Association of morphological and physiological characters with seed yield and grain filling in sunflower, *Crop Improvemet*, 4(2):170-176.

DEWEY, D.R. and LU, K.H., 1959. A correlation and path coefficient analysis of components of crested wheat grass. Seed production, *Agron. J.*, **51**:515-518.

GIRIRAJ, K., VIDYASHANKAR T.S. VENKATRAM, M.N, and SEETHARAM, A., 1979, Path Coefficient analysis of seed yield in sunflower . *Sunflower News Letter*, 3(4):10-12.

LAKSHMANAIAH, V.H., 1980, Genetic variability and association of morphological characters with seed yield and oil content in Sunflower (*Helianthus anuuus* L.), *Mysore J. Sci., agric.* **14**:259.

RAO, N.G.L., 1983, Studies on correlation and path coefficient analysis in sunflower (*Helianthus annuus* L.) M.Sc. Thesis abstract, UAS, Bangalore.

VARSHNEY S.K. and SINGH B , 1977, Correlation and path coefficient analysis in Sunflower *Helianthus annuus* L.) *Panthnagar J. Res.* **2**:147-149.

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EFFECT OF GROWTH STIMULATORS ON YIELD AND OIL CONTENT OF SOYBEAN

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ABSTRACT

An experiment was conducted for two seasons (Kharif 1984 and 1985) at R.A.K. College of Agriculture Farm, Sehore (M.P.) to know the effect of growth stimulators on yield and oil content of soybean. The maximum enhancement in growth and yield attributory characters and yield was obtained with Mixtalel sprayed at pre-flowering + fruit set stage of crop. The highest number of nodules per plant and their dry weight and oil content were recorded under Mixtalol sprayed at 4 leaf stage + preflowering + fruit set stage of soybean crop.

Key words : Growth stimulator, Soybean, Oil content.

INTRODUCTION

Madhya Pradseh has the credit of being declared as the soybean state amongst all the Indian States because about three-fourth of the soybean area of the countrv comes under this state only. During previous years constant efforts were made to improve the productivity of this economicallv important crop through various means including the appilcation of plant nutrients and agronomic practices, but studies on the improvement of plant efficiency for mobilization of absorbed nutrients, use of solar energy, fixation of Co_2 and modification of plant stature is lacking. Plant harmones may play an important role as an organic substance acting in very small amount, regulates plant physiological processes to hasten the production efflciency by many metabolic and physiological activities.

Keeping above in view the present investigation was undertaken with the objectives to know the effect of growth stimulators on growth, yield and oil content of soybean.

MATERIALS AND METHODS

An experiment was conducted on medium black soil of R.A.K. College of Agriculture farm, Sehore (M.P.) in Kharif 1984 and 1985. The experiment was laid out in a randomized block design with six replications and filling eight treatments *viz.*- control, Mixtalol at 4 leaf + preflow ring @ 312 ml/ha; -Mixtalol at 4 leaf + pre-flower ing + fruit set @ 312 ml/ha; mixtalal at pre-flowering + fruit set @ 312 ml./ha; Planofix at pre-ffowering @ 250 ml/ha; Miraculan 4 at leaf @ + pre-flowering at 200 ml/ha; Cycocel at preflowering @ 750 ml/ha and Cytozyme at 4 leaf + pre-flowering at 450 ml/ha. 20 N, 80 P_2O_5 and 20 K_2O was drilled below the seed at the timr of sowing. The required quantity of growth stimulators were diluted with water and uniformly sprayed by hand compression sprayer. Oil content in soybean flour was estimated by petroleum ether extracts as per A.O.A.C. 1960.

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RESULTS AND DISCUSSION

Growth and yield attributing characters :

The perusal of the data of Tables 1 and 2 reveal that Mixtalol (pre-flowering + fruit set) produced significantly higher number of branches, dry weight of plant, number of pods and grain yield/plant, number of seeds/pod and 100 seed weight as compared to control. The differences among all the treatments for number of branches and dry weight per plant, number of seeds per pod and 100 seed weight were not significant in 1984 and plant height in both the years. The possible explanation for the above findings may be that most of the growth stimulators enter into the plant system and improve the net photosynthetic rate by increasing Co_2 fixation and reducing the photoirespration. This harmonal interference at the molecular level is ultimately expressed in the form of alterations in the growth behaviour of various morphological components of the plant.

The number of root nodules and their dry weight were the highest under Mixtalol (4 leaves = pre-flowering + fruit set) and Mixtalol (4 leaves + pre-flowering) was second in order. It seems that initial treatment at 4 leaf stage gave a beneficial effect in increasing the root nodules and their dry weight.

Yield :

The data from the Table 3 revealed that the highest grain yield was obtained by the spray of Mixtalol at pre-flowering + fruit set which gave 9.5 and 22.4 per cent more yield over control in 1984 and 1985, respectively. The highest harvest index was recorded under Mixtalol (pre-flowering + fruit set) in both the years as compared to all the treatments.

The grain yield per plant showed positive and strong relationship with pods/plant, seeds/pod and seed index, while with the other characters like branches/plant and dry weight (g)/plant was proved to be non-significant (Table-4). This beneficial effect may be due to the important role played by the harmonal sprays in boosting all the growth and yield attributing characters. Vegetative growth of the plant is basically responsible for the manufacturing of food material and thereby directly or indirectly related with the crop yield, as production of friuts and seeds directly depends on the readily available supply of synthesised food material. Similar findings have been reported by Baptla (1981) and Maley (1982).

The lowest yield and almost all the growth and yield attributing characters was recorded under planofix as compared to other growth stimulators. It may be due to the fact that it is used for checking the flower and fruit drop which might not be a limiting factor owing to crop season.

Oil content

The oil content which is the most important quality character and for which soybean is cultivated was also affected significantly by growth stimulators. Usually

TABLE 1. Growth attributing characters as influenced by different growth stimulators

Treatments	Plant height (cm)		Branches per plant		No. of nodules per plant		Dry weight of nodules (g)/ plant		Dry weight of plant (g)	
	1984	1985	1984	1985	1984	1985	1984	1985	1984	1985
1. Control	44.9	49.9	4.2	2.9	65.7	59.7	0.19	0.21	6.6	5.9
2. Mixtalol (4 leaf + pre-flowrring)	47.2	51.0	4.0	2.4	78.6	81.0	0.21	0.35	7.0	7.8
3. Mixtalol (4 leaf + pre-flowering + fruit set)	45.5	50.8	4.3	3.5	80.9	83.5	0.24	0.36	6.8	7.3
4. Mixtalol (pre-flowering + fruit set)	48.5	53.7	4.6	3.9	66.5	71.2	0.24	0.30	8.0	8.5
5. Planofix (Pre-flowering)	48.5	52.7	3.9	2.7	65.8	51.8	0.21	0.23	6.8	6.5
6. Miraculan (4 leaf + pre-flowering)	47.1	51.6	3.6	3.2	61.2	52.9	0.16	0.18	6.8	7.4
7. Cycocel (pre-flowrring)	49.1	54.2	4.5	3.3	71.2	58.9	0.21	0.24	6.9	6.9
8. Cytozyme (4 leaf + pre-flowering)	46.6	51.0	3.7	2.9	72.2	59.9	0.17	0.18	6.9	6.8
S.Em ±	1.9	1.8	0.6	0.2	1.9	4.0	0.01	0.02	0.7	0.4
C.D. at 5%	N.S.	N.S.	N.S.	0.6	5.7	11.6	0.03	0.05	N.S.	1.3

TABLE 2. Yield attributing characters as influenced by different growth stimulators

Treatments	Number of pods/plant		Number of seeds/pod		Grain yield (g)/plant		100-grain weight (g)	
	1984	1985	1984	1985	1984	1985	1984	1985
1. Control	23.0	24.0	1.5	1.4	2.7	2.8	8.1	8.5
2. Mixtalol (4 leaf + pre-flowering	21.9	24.2	1.6	1.6	2.8	2.9	8.4	8.8
3. Mixtalol (4 leaf + pre flowering + fruit set)	23.4	26.6	1.7	1.8	2.8	3.0	8.5	8.9
4. Mixtalol (pre-flowering + fruit set)	26.7	28.7	1.7	1.8	3.5	3.6	9.0	9.2
5. Planofix (Pre-flowering)	22.9	23.6	1.6	1.6	3.0	3.1	8.2	8.4
6. Miraculan (4 leaf + pre-flowering)	22.2	22.9	1.6	1.7	2.8	2.9	8.3	8.5
7. Cycocel (Pre-flowering)	26.7	28.7	1.6	1.7	3.4	3.3	8.9	8.9
8. Cytozyme (4 leaf + pre-flowering)	23.5	25.3	1.7	1.7	3.2	3.2	8.8	8.9
S.Em ±	0.5	1.2	0.09	0.09	0.12	0.06	0.36	1.10
C.D. at 5%	1.6	3.5	N.S.	0.26	0.35	0.17	N.S.	0.31

TABLE 3. Effect of different growth stimulators on yield, harvest index and oil content of soybean.

Treatments	Yield (kg/ha)		Harvest Index		Oil percent	
	1984	1985	1984	1985	1984	1985
1. Control	1039	1036	40.1	40.0	17.97	17.68
2o Mixtalol (4 leaf + pre-flowering)	1050	1145	39.2	45.8	18.24	17.97
3. Mixtalol (4 leaf + pre-flowering + fruitset)	1089	1178	42.0	46.9	18.78	18.55
4. Mixtalol (pre-flowering + fruit set)	1138	1268	46.7	49.2	18.34	18.51
5. Planofix (Pre-flowering)	1010	1083	38.3	48.1	18.44	18.07
6. Miraculan (4 leaf + pre-flowering)	1039	1104	40.9	43.9	18.74	18.24
7. Cycocel (Pre-flowering)	1107	1194	45.3	47.3	18.42	18.35
8. Cytozyme (4 leaf + pre-flowering)	1107	1195	44.5	47.5	18.66	18.51
S.Em±	26	4	1.4	1.6	0.19	0.20
C.D. at 5%	76	13	4.3	4.9	0.55	0.58

TABLE 4. Correlation studies of yield with different yield attributing characters.

Seed yield (g/plant)	Characters	1984	1985
	Branches/Plant	0.4895	0.6430
	Dry weight (g)/Plant	0.6949	0.5264
	Pods/Plant	0.8888**	0.8034**
	seed/Pod	0.9906**	0.6527
	100 grain weight (g)	0.9007**	0.7478*

* Significant at 5%

** Significant at 1%

leaf cells are the seats of many vital metabolic activities of the plants and are implicated in important steps of nitrogen, carbohydrate and fat metabolism. The increased rate of carbon assimilation might have provided greater concentration of intermediate products acting as precursors in the synthesis of oil. Secondly, these growth stimulators might have enhanced the pace the vital activities going on within the plant cells and fat metabolism and thereby resulting in increasing the oil contents as has been by Ryan *et al.* (1982).

LITERATURE CITED REFERENCES

Baptla, A.P. (1981). Effect of mixtalol on tiller and grain number of paddy. *Hindustan Lever Res. Centre Report.* Bombay.

MALEY, S.R. (1982). Results of mixtalol at U.K. *Hindustan Lever Res. Centre Report*, 4-7, Bombay.

RYAN, J., SAGHIR, A.R., SHAFYUDDIN, M. and BARSUMIAN, A. (1982). Agronomic evaluation of cytozyme as a growth regulator. *Agron. J.* 74:144-6.

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COMBINING ABILITY AND HETEROSIS IN YELLOW SARSON

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ABSTRACT

The nature and magnitude of combining ability and heterosis was studied in a set of 7 × 7 diallel crosses (excluding reciprocals) of yellow sarson for yield, its components and oil content. Predominance of additive gene action was observed for yield, primary and secondary branches/plant, siliquae on main shoot, 1000-seed weight and oil content while it was non-additive for siliquae/plant. The Standard variety, YST 151, and PYS 6 were good general combiners for most of the characters except 1000-seed weight. The hybrids, PYS 3 xPYS 6 expressed the highest heterotic values for yield over better parent (82.13%) and the check (23.69%).

Key words : Yellow sarson, Combining ability, Heterosis, Gene action

INTRODUCTION

Combining ability and heterosis are used to assess the nicking ability of genotypes and, thus are likely to be successful to get desired segregants in hybridization programme. In yellow sarson very little work, has, been done to understand the nature and mag itued of gene action for yield and its components. Consequently, the progress in the development of new high yielding varieties has been quite slow as compared to other crops.

MATERIALS AND METHODS

Seven strains of yellow sarson (*Brassica campestris* var yellow sarson, Prain) viz PYS 408, DYS 1, PYS 3, PYS 148, PYS 6, PYS 25 and YST 151 were selected and crossed in all possible combinations excluding reciprocals. Twenty one F_1's and 7 parents were grown in a randomized block design with 3 replicators during 1983-84. Each plot consisted of 3 rows of 3 m long with a spacing of 30 cm betwee rows and 10 cm between plants. All the recommended package of practices were followed in raising the crop.

The observations on days to flowering and maturity, plant height, number of primary and secondary branches/plant, number of siliquae on the main shoot and siliquae/plant, number of seeds/siliqua, 1000-seed weight, seed yield/plant and oil content were recorded on 10 randomly selected competitive plants. The data were subjected to analysis of variance and combining ability analysis (Method 1, Model I of Griffing, 1956). Het rosis was computed as per cent increase (+) or decrease (—) of F_1's over mid parental value (relative heterosis), better parent (heterobeltiosis) and standard check (standard heterosis).

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RESULTS AND DISCUSSIONS

The significant mean squares due to general combining ability (GCA) and specific combining ability (SCA) for all the characters (Table 1), indicated the importance of both additive as well as non additive gene actions. The higher magnitude of GCA variance than that of SCA variance for all the characters except number of siliquae/plant revealed the pre-ponderance of additive effects in the expression of these traits. Similar results were reported by Yadav and Yadav (1985). However, Labana *et al.* (1978) reported greater role of non-additive gene action for seed yield and siliquae/plant. Presence of considerable amount of aditive genetic effects suggested that tremendous progress might be made with recurrent selection programme for seed yield and its components.

The GCA effects of parents and SCA effects of crosses for various quantitative characters are presented in Table 2 and 3, respectively. The results presented Table 2 revealed that YST 151 and PYS 6 were good general combiners for most of the charactters except 1000-seed weight for which both parents showed poor GCA. The standard variety, YST 151, was good general combiner for maturity, plant height, siliquae on main shoot, siliquae/plant and oil content. PYS 6 was good general combiner for flowering and maturity, plant height, primary and secondary branches/plant, siliquae/plant and seed yield/plant. PYs 3 and PYS 148 were marked as good or average general combiners for siliquae on main shoot, siliquae/plant, 1000-seed weight and oil content. DYS_1 showed good general combining ability for flowering and maturity, plant height and primary branches/plant. However, PYS 25 was good general combiner for primary branches/plant and 1000-seed weight.

Information on the best parent, best general combiner, best F_1 and best specific cross combination for various characters, presented in Table 4, revealed that the best performing parents were the best general combiners for most of the characters except plant height, siliquae on main shoot, seeds/siliqua, seed yield/plant and oil content. This suggested that the *per se* performance of the parents may be used as basis of selection for flowering and maturity, primary and secondary branches/plant and 1000-seed weight in combining out good general combiners.

The SCA effects and the mean performance of individual crosses revealed that the crosses having high mean did not always posses high SCA effects. This may be due to very poor performance of parents in comparison with their crosses. The cross combinations, DYS 1 × PYS 148, YST 151 × PYS 25 and PYS 3 × PYS 6 can be selected on the basis of *per se* performance for heterosis breeding. This, suggested that estimates of SCA effects may not always lead to the correct choice of cross combination. It is, therefore, suggested that emphasis on both, *per se* performance as well as SCA effects may be given in the selection of parents. The crosses having high SCA effects did not always involve the parents, which have high GCA effects, indicating the importance of epistasis. Involvement of both poor general combiners in the best specific crosses, revealed the imporance of epistasis for days to flowering and maturity. However, the

TABLE 1. Analysis of variance for combining ability for various quantitative characters

Source	d.f.	Flowering (days)	Maturity days)	Plant height (cm)	Primary branches/ plant (nos)	Secondasy branches/ plant (nos)	Siliquae on main shoot (nos)	Siliquae per plant (nos)	Seeds/ per siliqua (nos)	1000-seed weight (g)	Seed yield/ plant (g)	Oil content (%)
GCA	6	109.61**	750.17**	53.13**	1.62**	1.02**	44.21**	736.67**	30.67**	0.68**	5.06**	3.33**
SCA	21	7.53**	9.54**	64.63**	0.52**	0.18**	19.47**	751.87**	23.91**	0.17**	5.54**	1.46**
Error	54	1.40	1.66	2.74	0.04	0.01	0.51	18.88	0.29	0.01	0.09	0.11

** Significant at p = 0.01

TABLE 2. Estimates of general combining ability effects for various quantitative characters of the parents

Parents	Flowering (days)	Maturity (days)	Plant height (cm)	Primary branches/ plant (nos)	Secondary branches/ plant (nos)	Siliquae on main shoot	Siliquae/ plant (nos)	Seeds/Siliquae (nos)	1000-seed weight (g)	Seed yield plant (g)	Oil content (%)
PYS 408	-1.14**	-1.77**	-4.11**	-0.38**	-0.31**	2.73**	-17.62**	4.04**	-0.03	-0.10	-0.45**
DYS 1	-3.11**	-1.95**	-12.38**	0.50**	-0.01	-4.03**	-0.41	0.11	-0.24**	-0.38**	0.19
YST 151	-0.74	-1.07*	-1.92**	-0.23**	-0.21**	1.59**	7.56**	0.43**	-0.14**	0.57**	0.82**
PYS 3	1.86**	2.12**	6.55**	-0.44**	-0.27**	1.11*	0.84	-0.08	0.13**	-0.91**	0.42**
PYS 148	3.16**	2.23**	8.06**	-0.23**	-0.07*	0.46	0.69	-1.86**	0.49**	-0.48**	-0.15
PYS 25	4.89**	3.19**	12.16**	0.58**	0.04	-0.89	-1.95	-0.25	0.11**	-0.04	0.19
PYS 6	-4.92**	-2.77**	-8.36**	0.20*	0.68**	-0.98*	10.88**	-2.38**	-0.32**	1.35**	-1.02**
S.E. (gi)±	0.36	0.39	0.51	0.06	0.03	0.38	1.34	0.17	0.02	0.09	0.10
S.E. (gi-gj)±	0.39	0.61	0.78	0.09	0.04	0.58	2.05	0.26	0.02	0.14	1.43

* Significant at P = 0.05

** Significant at P = 0.01

TABLE 3. Estimates of specific combining effects for various quantitative characters

Crosses	Days to flowering	Days to maturity	Plant height (cm)	Primary branches/ plnat	Secondary branches/ plant	Siliquae on main raceme	Siliquae per plant	Seeds siliquae	1000 seed wt. (g)	Yield per plant (g)	Oil content (%)
1	2	3	4	5	6	7	8	9	10	11	12
PYS 408 × DYS 1	1.97	6.74**	-3.09*	0.61**	-0.22**	6.41**	0.37	4.43**	0.04	-0.89**	-1.39**
PYS 408 × YST 151	0.08	2.84*	-4.28**	-0.07	0.31**	-5.96**	6.88	-7.62**	0.44**	-1.74**	-0.36
PYS 408 × PYS 3	-1.83	-2.67*	-5.82**	-0.17	0.05	-7.37**	-11.68**	-1.68**	0.09*	0.19	1.05**
PYS 408 × PYS 148	-2.13*	-2.12	-2.82	0.33	-0.29**	5.92**	5.36	4.40**	-0.69**	2.66**	2.11**
PYS 408 × PYS 25	-1.87	-6.42	-8.12**	0.22	-0.27**	5.52**	2.69	6.79**	-0.10*	1.17**	-2.23**
PYS 408 × PYS 6	-0.95	3.88**	5.78**	-0.08	0.06	2.36*	-8.38**	-1.93**	-0.18**	0.48	0.99**
DYS 1 × YST 151	0.61	-1.98	4.57**	0.60**	0.31**	-1.29	11.09**	-4.27**	0.15**	0.46	-0.51
DYS 1 × PYS 3	-0.54	-1.41	-2.09	-0.33	0-.23**	-2.17	-21.15**	4.77**	0.53**	0.64**	-0.61*
DYS 1 × PYS 148	-3.49*	-2.94*	-13.01**	1.64**	-0.59**	-5.66	25.45**	-5.52**	-0.37**	1.14**	-0.36
DYS 1 × PYS 25	-2.24*	0.76	3.53*	-1.07**	0.21*	-0.11	-2.42	0.47	0.42**	0.87**	1.12**
DYS 1 × PYS 6	0.24	0.40	1.35	0.81**	0.33**	3.88**	-9.33*	-0.84	0.44**	-0.46	-0.16
YST 151 PYS 3	0.09	-1.37	0.01	-0.45*	-0.05	0.91	-42.18**	7.69**	0.07	-0.79**	0.27

contd..

Table 3 contd.

1	2	3	4	5	6	7	8	9	10	11	12
YST 151 PYS 148	-1.53	-0.16	1.37	-0.70**	-0.19**	1.51	27.92**	-0.51	0.30**	-1.07**	-0.16
YST 151 × PYS 25	-2.95*	-1.79	9.93**	-0.01	0.40**	4.06**	76.97**	-6.78**	-0.46**	-0.31	1.49**
YST 151 × PYS 6	3.54**	-1.16	4.69**	0.27	-0.73**	-0.40	-27.26**	-0.58	0.18**	-0.81**	-0.43
PYS 3 × PYS 148	-5.13**	2.65*	7.49**	0.70**	0.44**	0.16	14.64**	-4.11*	0.69**	1.38**	-1.42**
PYS 3 × PYS 25	2.14*	1.06	6.72*	-0.31	-0.30**	0.58	-9.20*	-8.29**	0.74-**	-1.52**	0-.10
PYS 3 × PYS 6	3.61**	3.66**	2.64	0.25	0.09	2.48**	45.86	-2.77**	-0.02	4.92**	-1.54**
PYS 148 × PYS 25	2.84*	1.26	10.01**	0.79**	0.38**	2.09	-12.27**	0.95	0.25**	1.33**	-0.85**
PYS 148 × PYS 6	0.98	-1.12	8.93**	-0.55**	0.08	0.73	-6.36	1.81**	0.26**	-0.34	-1.31**
PYS 25 × PYS 6	-0.76	2.59*	3.16*	0.29	0.99**	2.68*	-15.51**	5.24**	0.32**	2.97	1.34**
S.E. (Sij) ±	1.06	1.16	1.48	0.18	0.08	1.10	3.89	0.49	0.04	0.27	0.29
S.E. (Sij-Sik) ±	1.58	1.72	2.21	0.26	0.11	1.69	5.99	0.73	0.06	0.39	0.44
S.E. (Sij-Ski) ±	1.48	1.61	2.06	0.29	0.10	1.53	5.42	0.68	0.06	0.37	0.41

* Significant at 5 per cent probability level.

** Significant at 1 per cent probability level.

TABLE 4. Information on best parent, best F_1, best general combining and best specific cross combination for different characters.

Sl No.	Character	Best parent	Best F_1	Best general combiner	Best specific cross combinaion
1.	Days to flowering	PYS 6	DYS 1 × PYS 6	PYS 6	PYS 3 × PYS 148
2.	Days to maturity	PYS 6	YST 151 × PYS 6	PYS 6	PYS 408 × PYS 25
3.	Plant height	PYS 6	PYS 408 × DYS 1	DYS 1	DYS 1 × PYS 148
4.	Number of primary branches per plant	PYS 25	DYS 1 × PYS 148	PYS 25	DYS 1 × PYS 148
5.	Number of secondary branches per plant	PYS 6	YST 151 × PYS 6	PYS 6	PYS 3 × PYS 148
6.	Number of silique on main raceme	PYS 3	PYS 408 × PYS 148	PYS 408	PYS 408 × DYS 1
7.	Number of siliquae/plant	PYS 6	YST 151 × PYS 25	PYS 6	YST 151 × PYS 25
8.	Number of seeds/siliqua	YST 151	PYS 408 × PYS 25	PYS 408	YST 151 × PYS 3
9.	1000-seed weight	PYS 148	PYS 3 × PYS 148	PYS 148	PYS 3 × PYS 148
10.	Seed yield/plant	YST 151	PYS 3 × PYS 6	PYS 6	PYS 3 × PYS 6
11.	Oil content	PYS 3	YST 151 × PYS 25	YST 151	PYS 408 × PYS 148

TABLE : 5 Summory of per cent heterosis for various quantitation characters

Characters	No. of crosses sign fica-cantlv superior to better parent	Range	No. of crosses signifi-cantly superior to mid parent	Range	No. of crosses signifi-cantly superior to check (YST 151)	Range	Cross combination showing highest heterosis in desired direction over		
							Better parent	Mid parent	Check YST 151
1. Days to flowering	1	-8.42	10	-13.13 to - 4.24	4	-14.02 to - 5.34	PYS 3 × PYS 148	PYS 3 × PYS 148	DYS 1 × PYS 6
2. Days to maturity	—	—	1	·5 .27	3	- 3.85	—	PYS 408 × PYS 25	YST 151 × PYS 6
3. Plant height	—	—	2	-6.22 to 7.48	2	-4.74 to -4.87	—	DYS 1 × PYS 148	PYS 408 × DYS 1
4. No. of primary branches/plant	8	1.54 to 39.77	15	1.11 to 62.59	13	2.41 to 44.27	DYS 1 × PYS 148	DYS 1 × PYS 148	DYS 1 × PYS 148
5. No. of secondary branches/plant	2	13.00 to 31.13	5	16.00 to 119.54	9	74.00 to 574.00	YST 151 × PYS 6	YST 151 × PYS 6	YST 151 × PYS 6
6. No. of siliquae on main raceme	8	4.04 to 24.53	14	5.46 to 27.79	2	7.69 to 11.40	PYS 25 × PYS 6	PYS 408 × PYS 25	PYS 408 × PYS 148
7. No. of siliquae per plant	6	16.81 to 94.00	8	21.20 to 106.80	8	12.69 94.00	YST 151 × PYS 25	YST 151 × PYS 25	YST 151 × PYS 25
8. No. of seeds per siliquae	6	1.86 to 12.62	7	4.73 to 21.79	3	3.02 to 9.69	PYS 408 × PYS 25	PYS 408 × PYS 25	PYS 408 × PYS 25
9. 1000-seed weight	8	0.98 to 9.63	14	0.32 to 18.11	20	1.84 to 44.24	PYS 3 × PYS 148	PYS 3 × PYS 148	PYS 3 × PYS 148
10. Seed yield/plant	14	2.20 to 82.13	17	1.57 to 118.09	3	2.28 23.69	PYS 3 × PYS 6	PYS 3 × PYS 6	PYS 3 × PYS 6
11. Oil content	4	1.08 to 2.08	5	1.65 to 3.70	1	2.08	YST 151 × PYS 25	YST 151 × PYS 25	YST 151 × PYS 25

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COMBINING ABILITY FOR ECONOMIC TRAITS IN INDIAN MUSTARD

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ABSTRACT

A line x tester analysis of combining ability was carried out using 15 lines and 3 testers for 9 economic characters including seed yield in Indian mustard. Mean squares due to genotypes, parents, crosses, lines, testers and lines X testers were significant for most of the characters. Combining ability variances indicated the predominance of non-additive gene action for seed yield, primary branches, plant height and 1000-seed weight.

Among the testers, Kranti was the best general combiner whereas, Gonda-3, R-71-2, RC 7-2, RC 7-4 and Ferozpur-1 were the best lines exhibiting high gca values for seed yield and other traits. The use of atleast one good general combiner in a particular cross for the trait advocated. The use of crosses such as RC 7-4 × Varuna, No. 5422-2 × Kranti, R 71-2 × Varuna and Gonda-3 × Varuna, with high yield and sca effects, in multiple crossing programme followed by intermating, is also suggested.

Key words : Combining ability; Line × tester analysis; Indian mustard; *Brassicajuncea* L. *juncea* L. Czern and Coss.

INTRODUCTION

Combining ability analysis is useful in the selection of parents used in the formulation of a crossing plan for a plant breeding programme. Information of the relative size of general and specific combining abilities is also helpful in the analysis and interpretation of the genetic basis of the impcrtant traits. As gene action varies with the degree of diversity among parents, it is necessary to evaluate the parent for combining ability. With these objectives in view, a line × tester analysis was undertaken to identify better combiners and to study the nature and extent of heterosis in Indian mustard.

MATERIALS AND METHODS

Fifteen diverse and promising lines of Indian mustard (RH-1, RH 761, RLM-134, RK-10, Gonda-3, RLM-193, RC 14-1, RC 7-4, R 71-2, Ferozpur-2, Raya 10, RS 18, Ferozpur tripa-5, No. 5422-2, No. 5506) and three well adapted testers (Varuna, Kranti and RH-30) were selected on the basis of their phenotypic variability for different characters. These were crossed to produce 45 F_1 hybrids. These hybrids along with their parents were grown in a randomised block design, with three replications, during *rabi* 1983-84. Each genotype was accomodated in a single row of 3 meter length spaced 30 cm apart with a plant to plant distance of 10 cm. All the recommended agronomic practices were followed to raise the crop. Data on 5 randomly selected and competitive plants, were recorded on seed yield/plant, (g), primary branches/plant, secondary branches /plant, siliqua/plant, seeds/siliqua, plant height (cm), days to maturity, 1000-

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seed weight (g) and oil content (%). Oil content was estimated by nuclear magnetic resonance Spectrometry (Tiwari *et al.* 1974). Combining ability analysis was done as suggested by Kempthorne (1957).

RESULTS AND DISCUSSIONS

The mean squares due to treatments including parents and F_1's were significant for all the traits, indicating the presence of sufficient genotypic variability in the present material (Table-1). Similarly, mean squares due to parents, crosses and parents vs. crosses were significant for all the characters except the primary and secondary branches and seeds/siliqua. The range for mean values, was higher among the hybrids as compared to the parents for most of the traits suggesting thereby that considerable variability has been generated through hybridization in the present material.

Variances due to lines (L), testers (T), and lines X testers (L×T) were significant for all the character except days to maturity for lines, seeds/siliqua and oil content for testers and primary branches/plant, seeds/siliqua and days to maturity for line × tester. As observed in the present study, Singh (1973) and Chandra *et al.* (1985) also reported significant combining ability variations for various characters in Indian mustard. The magnitude of variances due to lines and testers in general, were higher than variances due to line × tester for most of characters (Table 1), indicating preponderance of additive variance, also reported by Badwal *et al.* (1976) and Chandra *et al.* (1985).

The estimates of general combining ability (gca) and specific combining ability (sca) variances revealed the importance of both additive and non-additive gene actions for all the traits except for seeds/siliqua and oil content (Table 1). The relative magnitude of gca and sca variances showed the predominance of additive and additive × additive gene action for siliqua/plant and days to maturity. Predominance of additive gene action for these traits in Indian mustard has also been reported by Singh (1973), Yadava *et al.* (1979), Rehman *et al.* (1977), Chauhan and Singh (1979) and Singh *et al.* (1986). For seed yield/plant, primary branches/plant, plant height and 1000-seed weight, non-additive type of gene action was more important. Similar results were obtained by Lal and Singh (1974), Labana *et al.* (1975). Badwal *et al.* (1976) and Labana *et al.* (1978).

Both additive and non-additive gene actions were equally operative for secondary branches/plant as observed by Singh (1977), Kanshi Ram *et al.* (1976), Gupta (1980) Labana *et al.* (1984) and Singh *et al.* (1986). In the present investigation, non-additive gene action played significant role in yield and its components. Under such a situation it would be worth while to resort to breeding mathodologies such as biparental mating, recurrent selection and diallel selective mating (Jenson, (1970); Frey, (1975) than to conventional pedigree or backcross techniques which would leave the unfixable components of genetic variances unexploited for yield and its components.

Gonda-3 exhibited the highest general combining ability (gca) effects for seed yield followed by R 71-2, Kranti and Ferozpur-2 (Table-2). Lines RC 7-2 and R 71-2

TABLE 1. Analysis of variance for combining ability for nine characters in Indian mustard

Source of variation	df	Seed yield/ plant	Primary branches/ plant	Secondary branches/ plant	Siliqua/ plant	Seeds/ siliqua	Plant height	Days to maturity	1000 seed weight	Oil content
Treatments	62	30.36**	0.74**	19.29**	9401.15**	2.54**	563.89**	61.54**	2.24**	4.41**
Parents	17	15.88**	0.45	17.13**	6821.69**	1.96	692.51**	35.61**	1.02**	3.59
Crosses	44	33.49**	0.87**	20.56**	10597.02**	2.18**	400.79**	39.40**	2.54**	4.56**
Parents vs. crosses	1	138.69*	0.01	0.00	628.00	28.18**	555.00**	131.20**	9.59**	11.25**
Females	14	47.16**	1.44**	24.68**	12970.64**	4.52**	438.66**	21.56	1.83**	5.37**
Males	2	45.24**	1.24*	143.69**	80279.00**	1.12	700.30**	453.20**	5.96**	2.58
Females × Males	28	25.74**	0.55	9.70**	4432.92**	1.08	360.46**	18.77	2.65**	4.30**
Errors (a)	88	5.62	0.36	2.81	2013.87	1.17	123.73	13.35	0.01	2.38
Error (b)	124	6.56	0.44	3.09	1747.96	1.27	118.91	13.87	0.03	2.32
2g c a		0.77	0.02	2.76	1562.66	0.06	7.74	8.09	0.04	-0.01
2s c a		6.72	0.06	2.30	806.35	-0.03	78.91	1.81	0.88	0.63
2sca/gca		8.73	3.00	0.83	0.52	—	10.19	0.22	22.0	—
Average degree of dominance		2.09	1.22	0.64	0.51	—	2.26	0.33	3.32	—

* Significant at 5% level

** Significant at 1% level

TABLE 2. Estimates of GCA effects and mean performance of eighteen parents in Indian mustard.

Parents	Seed yield/ plant (g) X1	Primary branches/ plant X2	Secondary branches/ plant X3	Siliqua/ plant X4	Seeds siliqua X5	Plant height (cm) X6	Days to maturity X7	1000-seed weight (g) X8	Oil content (%) X9
Testers (Males)	-0.65 (17.00)	-0.19* (4.60)	-1.66* (13.06)	-43.74* (252.80)	0.09 (12..0)	-4.54* (202.53)	-3.04* (159.00)	0.32* (4.27)	0.27 (43.13)
1. Varuna									
2. RH 30	-0.51 (12.34)	0.09 (4.93)	-0.23 (9.53)	-3.19 (272.53)	0.09 (12.60)	1.91 (207.46)	-0.24 (166.00)	-0.39* (4.44)	-0.10 (41.31)
3. Kranti	1.61* (16.80)	0.10 (5.46)	1.89* (9.20)	40.55* (230.20)	-0.18 (13.00)	2.63 (211.46)	3.28* (164.00)	(0.07) (3.96)	-0.17 (41.16)
SE (gi)	0.35	0.08	0.24	6.68	0.16	1.65	0.54	0.01	0.22
SE (gi-gi)	0.50	0.13	0.31	9.46	0.23	2.34	0.77	0.02	0.32
Lines (Females)	0.92	-3.39*	-2.51*	-17.27*	-0.81*	-5.63	-0.38	0.14*	0.76
4. RH 766	(13.73)	(4.33)	(10.33)	(275.53)	(11.60)	(211.13)	(162.00)	(4.67)	(43.46)
5. RH 75-1	-3.86* (11.25)	-0.53* (4.86)	-1.49* (8.96)	-55.23 (229.06)	-0.59 (13.00)	3.41 220.26	-3.68* (164.00)	0.84* (3.92)	-0.09 (43.40)
6. RLM-134	-1.35* (17.60)	-0.23 (4.93)	-1.48* (14.00)	-19.25 (366.06)	-1.36* (11.00)	-0.08 (232.80)	1.62 (168.00)	0.19* (5.94)	1.36* (40.30)
7. RK-10	-3.28* (13.26)	-0.51* (5.13)	-2.43* (10.03)	-75.27* (292.53)	0.95* (13.73)	-9.38* (222.40)	-2.38* (164.00)	-0.65* (4.75)	0.81 (41.46)
8. Gonda-3	4.87* (11.27)	0.21 (5.06)	-0.02 (15.90)	9.30 (377.66)	0.97* (12.80)	6.63* (250.66)	0.62 (170.00)	0.18* (3.78)	0.70 (42.33)

Contd.

Table 2. Contd....

Parents	X1	X2	X3	X4	X5	X6	X7	X8	X9
9. RLM 193	0.79 (11.88)	-0.12 (5.06)	0.41 (11.93)	24.16* (305.53)	0.03 (11.53)	8.25* (247.33)	0.29 (169.00)	-0.02 (4.41)	0.65 (41.36)
10. RC 14-1	-1.77* (16.06)	-0.33 (4.53)	-1.72 (12.40)	-9.72 (376.20)	0.45 (13.73)	-0.34 (227.33)	0.29 (172.00)	-0.03 (3.38)	-1.15 (42.70)
11. RC 7-4	0.66 (13.26)	0.72* (4.33)	2.91* (11.73)	64.05* (310.73)	0.73* (11.93)	-1.71 (215.73)	-1.71 (163.00)	-1.09* (3.99)	0.42 (43.26)
12. R71-2	3.74* (19.05)	0.68* (4.80)	0.91 (17.86)	24.37* (360.53)	-0.03 (11.33)	2.39 (243.86)	0.29 (169.00)	0.14* (4.53)	-0.44* (40.43)
13. Ferozpur-2	1.32 (15.80)	-0.06 (4.86)	0.64 (14.16)	-12.15 (354.60)	0.79* (13.13)	0.66 (238.13)	-0.04 (168.00)	0.01 (4.10)	-0.41 (43.00)
14. Raya-10	0.67 (13.30)	0.39 (5.73)	0.66 (12.06)	26.37* (279.33)	-0.21 (12.53)	8.70* (229.86)	-1.04 (165.00)	-0.23* (4.2)	-0.64 (43.50)
15. RS-18	-0.69 (15.85)	0.40* (5.60)	2.09* (10.90)	32.20* (33.80)	-0.66 (12.13)	-4.49 (247.40)	0.95 (167.00)	0.10* (3.64)	-1.09* (42.70)
16. Ferozpur Tripa-5	0.65 (14.26)	-0.09 (5.06)	1.55* (10.90)	11.61 (296.73)	-0.07 (12.13)	0.99 (236.93)	1.29* (164.00)	0.57 (3.55)	0.18 (44.10)
17. No. 5422-2	0.18 (16.73)	-0.08 (4.93)	0.66 (12.60)	-9.14 (350.60)	-0.57 (11.60)	-6.52* (245.60)	1.62 (170.00)	0.41* (4.26)	-0.87 (42.30)
18. No. 5506	0.16 (14.26)	0.05 (4.66)	1.12* (9.80)	36.99 (313.06)	0.39 (13.13)	10.36* (234.73)	1.95 (162.00)	-0.38* (4.71)	-1.17* (42.30)
SE (gi)	0.79	0.20	0.55	14.95	0.36	3.70	1.21	0.03	0.51
SE (gi-gi)	1.11	0.28	0.79	21.15	0.51	5.24	1.72	0.04	0.73

were good general combiners for primary branches/plant and RC 7-4, RS 18, Ferozpur. Tripa-5 and No. 5506 for secondary branches/plant.

Another line RH 75-1 recorded the highest significant negative gca effect for days to maturity closely followed by Varuna. These lines also showed significant positive gca effects for 1000-seed weight also. However, for oil content RLM. 134 exhibited the maximum gca effect followed by RK 10. R 71-2 was good combiner among lines for seed yield, siliqua number, 1000-seed weight and primary branches. Furthermore, RC 7-4 was the second best line showing high gca effects for primary and secondary branches, seeds/siliqua, plant height and 1000 seed. No significant association was observed between gca effects and *per se* performance of the parents for all the characters except seeds/siliqua (Table 3). Similar results were reported by Chandra *et al.* (1985). The *per se* performance as such, therefore, does not help in judging the combining ability of parents in Indian mustard (Yadava *et al.* 1981). So, both parental means and gca effects should be taken into account while selecting the parents for combining ability.

The crosses showing high sca effects involved good, average and poor general combining parents (Table 4). Six cross combinations *viz.*, Gonda 3 × Varuna, RC 7-4 × Varuna, RC 71-2 × Varuna, RLM 134 × Kranti, Ferozpur Tripa-5 × Kranti and No. 5422-2 × Kranti showed significant positive sca effects and fairly high seed yield/plant. Besides, other cross combinations like Ferozpur-2 × RH-30, Gonda 3 × RH 30, RC 7-4 × Varuna, Ferozpur-2 × RH 30, RS 18 × Kranti may also be used for exploiting sca effects through further breeding programme for producing superior types. It was observed that high and average general combiners usually showed high sca effects in cross combinations. The high sca effects of the crosses, involving both the parents as low general combiners and one low and one average general combiner, may be due to the presence of genetic diversity in the form of heterozygous loci for specific traits.

In general, there was little or no visible relationship between the direction and magnitude of sca effects of hybrids and their performance for yield and various other characters (Table 4). For instance, the cross RC 7-4 × Varuna exhibited the highest significant positive sca effect, nevertheless the maximum seed yield (23.8 g) was recorded for the cross Gonda-3 × Varuna ranking fourth in terms of sca magnitude. However, four out of five top yielding crosses showed high sca effects though with changed relative rankings.

These results indicated that almost all the promising hybrids were the result of at least one good combining parent with respect to the character concerned. Besides, none of the cross combinations in the present material was good for all the yield attributes simultaneously.

Hence it would be worthwhile to attempt multiple crosses using F_1's exhibiting high *perse* performance and sca effects. Multiple crossing programme initiated among RC 71-2 × Varuna, No. 5422-2 × Kranti and Ferozpur Tripa-5 × Kranti, followed by relative intermating approach should be most appropriate for best utilization

of the present material aimed at further improvement of the crop. Further more, at-least one, preferably both parents of these hybrids should be good general combiners. Such a programme is likely to be effective in bringing together the additive genes fixable through selection. In general, most heterotic and high yielding hybrids involved low and high oil containing parents and hence commercial exploitation of such combination would undoubtedly culminate in significant improvement in per hectare out put of oil.

TABLE 3. Degree of association between gca effects and *per se* performance of parents.

Character	'r' value
Seed yield/plant	0.130
Primary branches/plant	0.202
Secondary branches/plant	0.035
Siliqua/plant	0.173
Seeds/siliqua	0.620*
Days to maturity	0.331
Plant height	0.385
1000-seed weight	0.132
Oil content (%)	0.188

*Significant at P=0.05 level.

LITERATURE CITED REFERENCES

BADWAL, S.S.; SINGH, M.; LABANA, K.S. and CHAURASIA, B.D. 1976. General *versus* specific combining ability in raya (*Brassica juncea* L. Czern and Coss). *Journal of Research, P.A.U.* 13:319-323.

CHANDRA, JAGDISH; CHAUDHARY, M.S. and CHAUDARY, B.D. 1985. Identification of parents for hybridization through combining ability analysis in Indian mustard *J. Oilseeds Res.* 2(2):191-203.

CHAUHAN, Y.S. and SINGH, A.B. 1979. Genetic architecture of some quantitative characters in *Indian* mustard. *Indian J. Genet.* 39:255-262.

FREY, K.J. 1975. Breeding concepts and techniques for self pollinated crops. *Proc. Int. workshop on grain legumes, held at Hyderabad* India.

GUPTA, M.L. 1980. Genotype environment interaction and stability analysis in Indian mustard. (*Brassica juncea* L. Czer and Coss) Unpub. Ph.D. thesis, P.A.U. Ludhiana.

JENSEN, F. 1970. A diallel selective mating system for cereal breeding. *crop Sci.* 10:629-633.

KEMPTHORNE,O. 1957. An Introduction to genetical statistics. John Willey and sons. Inc., New York.

TABLE 4. Five top ranking cross combinations in terms of *per se* performance, sca effects and heterotic responses for various characters (crosses arranged in descending order)

Characters	Best five crosses on the basis of *per se* performance			Best five specific crosss combinations			Best five heterotic crosses								
							Mid-parents		Better parents		Best parents				
1.	2.			3.			4.		5.		6.				
Seed yield/ plant	1×8, (L×H)	1×12, (L×H)	2×8, (L×H)	1×11,	3×17,	1×12,	2×8,	1×8,	2×8,	2×9,	1×8,	1×12,			
	3×17, (A×L)	1×11 (L×L)		1×8,	3×16		2×9, 2×13	2×4,	2×4, 3×17	1×8,	2×8, 1×11	3×17,			
Primary branches/ plant	3×11, (L×H)	2×15, (L×A)	2×12, (L×H)	2×12,	2×15,	1×14,	2×11,	3×11,	1×11,	2×12	3×11,	2×15,			
	3×12, (L×H)	1×11 (L×H)		1×18,	3×11		2×12, 2×8	2×15,	3×7, 2×13	3×11	2×12, 1×11	3×12,			
Secondary branches/ plant	3×15, (A×H)	3×16, (A×A)	3×11, (A×H)	2×8,	3×15,	1×11,	3×15,	3×16,	3×15,	3×18,	3×15				
	3×18, (A×A)	1×11 (L×H)		2×13	3×17		3×18, 3×14	3×11,	3×16, 3×5	3×11,					
Siliqua/ plant	3×11, (H×H)	3×15, (H×A)	3×16, (H×L)	1×11,	2×13,	1×10	3×11,	3×16,	3×14,	3×11,	3×11,	3×15,			
	1×11, (L×H)	3×18 (H×A)		3×16,	2×4		3×14, 3×18	3×15,	3×16, 3×15,	3×5,	3×16, 3×18,	1×11,			
Seeds/ siliqua	1×8, (L×H)	3×7, (L×H)	1×13, (L×H)	3×7,	3×6	2×14	1×8.	1×13,	1×8,	1×11,	1×8,	3×7,			
	1×7, (L×H)	2×10 (L×A)		1×13,	2×17		1×12, 3×11	1×11,	1×13, 2×14	1×12,	1×13, 2×10	1×7,			
Plant height	3×8, (A×A)	2×5, (L×A)	2×18, (L×H)	2×17,	1×15,	2×4	2×5,	2×4,	2×4,	2×5,	—				
	3×14, (A×H)	2×9 (L×H)		2×5,	3×8		2×18, 3×5	3×14,	2×11, 3×14	3×4,	—				

Contd.

Table 4. Contd....

1.	2.			3.			4.		5.		6.	
Days to maturity	1×5, (H×H) 1×9, (H×L)	1×4, (H×A) 1×11, (H×A)	1×7 (H×H)	3×13, 1×5,	2×12, 1×6	1×4	2×10, 2×12, 1×10	1×5, 1×9,	1×10, 2×10, 1×6	1×9, 1×5,	1×5, 1×7	1×4,
1000-seed weight	2×5, (L×H) 1×6, (A×A)	3×4, (L×A) 1×17 (A×H)	1×8, (A×A)	2×5, 2×12,	3×4, 1×8	1×18,	2×5, 3×4, 3×15	1×8. 3×10,	2×5, 3×15, 3×4	1×5, 3×10,	2×5, 1×8	3×4,
Oil content (%)	1×9, (A×H) 1×8 (A×H)	3×6, (L×H) 3×7 (L×H)	1×4, (A×H)	2×18, 2×17,	1×9, 3×6	3×18,	3×6, 2×6, 3×7	1×9. 3×9,	3×6, 1×9, 3×7	3×9, 2×6,	1×9, 1×4, 3×7	3×6, 1×8,

1= Varuna, 2= RH30 3= Kranti, 4= RH 761, 5= RH 75-1, 6= RLM 134,
7= RK10, 8= Gonda-3, 9= RLM 193, 10= RC 14-1, 11= RC 7-4, 12= R 71-2,
13= Ferozpur-2, 14= Raya 10, 15= RS 18, (16= Ferozpur) tripa-5, 17= No. 5422-2,
18= No. 5506.

* Figures in brackets are combining ability of parents entering into crosses
(H= High, A= Average, L= Low).

LABANA, K.S.; BADWAL, S.S. and CHAURASIA, B.D. 1975. Heterosis and combining ability analysis in mustard (*Brassica juncea* L. Czern and Coss). *Crop Improv.* 2:46-51.

LABANA, K.S.; TIRATH RAM; BADWAL, S.S. and MEHAN, D.K. 1978. Combining ability analysis in Indian mustard. *Crop. Improv.* 11:58-60.

LABANA, K.S.; CHAURASIA, B.D. and SINGH, A.S. 1984. Inheritance for some yield components in Indian mistard. *Crop Improv.* 11:58-60.

RAM, K.; RAM KISHAN; CHAUHAN, Y.S. and KATIYAR, R.P. 1976. Partial diallel analysis in F_3 generation of Indian mustard. *Indian J. Agric. Sci.* 46:229-232.

REHMAN, N.S.; JOARDER, O.I. and EUNUS, A.M. 1977. Diallel analysis of some quantitative characters of *Brassica juncea* L. *Genetica agraria* 31:143-153.

SINGH, J.N.; SACHAN, RAM BHAJAN; BASUDEV SINGH and SINGH, S.P. 1986. Combining ability in Indian mustard *J. oilseeds Res.* 3(1):1-7.

TIWARI, P.N.; GHAMBIR, P.N. and RAJAN, T.S. 1974. Rapid and non-destructive determination of seed oil by Pulsed Nuclear Magnetic Resonance Technique. *Jour. Amer. Chem. Soc.* 51:104-109.

YADAVA, A.K.; YADAVA, T.P. and PRAKASH KUMAR. 1979. Combining ability studies by line × tester analysis in Indian mustard. *Crop. Improv.* 6:141-147.

YADAVA, T.P.; YADAVA, A.K.; and PRAKASH KUMAR. 1981. Genetic analysis for oil content in Indian mustard. *Indian J. Agric. Sci.* 51:371-373.

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CORRELATION AND PATH-ANALYSIS OF SEED QUALITY CHARACTERS IN SOYBEAN

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ABSTRACT

Correlation and path-analysis of seed quality characters was studied in 15 soybean cultivars. A great scope for improvement of seed quality was found to exist. The seed-vigour characters were found to exhibit positive correlation among themselves both at genotypic and phenotypic level but these did not show any association with oil and protein content. Oil content and seed weight had significant positive correlation at genotypic level but not at phenotypic level. Seed weight showed a significant negative correlation with germinability and early seedling growth both at genotypic and phenotypic levels. Path analysis revealed that hypocotyl length was the principal direct contributor towards total seedling length. Seed weight, germinability and root length were the other major components which had significant indirect effects via hypocotyl length. This clearly showed that increased hypocotyl length and small seed size could be reliable parameters in selection for seed vigour. It is suggested that seed size should not be increased for the sake of high yield to such an extent that it mars the emergence, stand and performance of soybean crop besides inflating its seed rate. Cultivars viz. Gujarat Soybean 1 and 2, JS 84-1, Sagar Selection 2, MACS-13 and JS80-21 were found to possess high germinability and desirable early seedling growth.

Key words : Correlation, Path analysis, Soybean.

Diagnostic analysis to decipher the constraints limiting the soybean productivity to an average of 7.54 quintals per hectare, has shown poor plant population to be a major factor (Motiramani, 1986). A plant stand of about 400,000 is imperative for optimum performance of soybean crop. Seed germinability is ascribable to inherent genetic potential of the variety along with several factors viz. soil type, date of planting and harvest, fertilizer application, use of pesticides, allelopathy of weeds etc. (Green and Pinnell, 1968; Mugnisjah and Nakamura, 1984 a and b; Tiwari *et. al* 1985; Yaklich *et al.* 1979). Further study is warranted to understand the scope of. improvement and inter-dependence of seed vigour and quality characters in soybean The present study was, hence, undertaken in regard to different seed quality characters using some recently evolved strains of soybean.

MATERIALS AND METHODS

Fifteen cultivars comprising advanced breeding lines and released varieties were grown during rainy season in a randomised block design with three replications at Junagadh (Gujarat, India). Seeds were stored for about six months after harvest. Seed vigour in the form of germinability and early seedling growth was studied under standard laboratory conditions at 30°C. Observations on germinability, root length, hypocotyl length and total seedling length were recorded on the fifth day using 100 seeds in each treatment combination.

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Oil content in seeds was estimated by nuclear magnetic resonance using NMR model Bruker Minispec PC 20 (West Germany). For estimation of crude protein content, seeds were subjected to dry-grinding and the powder was sieved (300 microns). The nitrogen (N_2) content was, then, determined by using Kjeltec Auto Analyser Model 1030 (Tecator, Sweden). Per cent protein was calculated as $N_2 \times 6.25$. Per cent values were transformed, wherever necessary, as arcsin angles before analysis of data by standard methods. Path-coefficients were worked out accordig to Dewey and Lu (1959).

RESULTS AND DISCUSSIONS

Mean values and estimates of variability, heritability and genetic advance for seven seed quality characters are given in Table-1. Varietal differences were found to be highly significant.Seed germinability, seed weight and oil content had very high heritability whereas protein content, root length, hypocotyl length and total seedling length had medium to high heritability. Germinability and root length had high genetic advance (around 75% of mean). Seed weight had relatively lower but still appreciable genetic advance (30% of mean). Oil content had the lowest genetic advance.

Genotypic, phenotypic and environmental correlation coefficients for different character-combinations are given in Table-2. The most striking association obtained was a consistent and highly significant negative genotypic correlation between seed weight and all the seed vigour characters, the latter comprising germinability, root length, hypocotyl length and total seedling length. Seed weight showed a significant negative correlation with seed vigour characters at phenotypic level also. Besides, all the four seed vigour characters were found to have significant positive correlation among themselves both at genotypic and phenotypic level but did not show any association with oil content and protein content. Oil content and seed weight, however gave a positive correlation coefficient which was just significant at genotypic level but non-significant at phenotypic level. Oil and protein content gave negative values of correlation coefficients as expected but these values were not significant. High values of genotypic covariances were obtained in general which indicated high co-heritability of the related characters.

Path-coefficient analysis revealed direct and indirect effects of seed quality characters on total seedling length, the ultimate stage of seed vigour in this study (Table -3). Hypocotyl length was found to have the highest direct positive effect on total seedling length. Seed weight, germinability and root length were the other major but indirect contributors affecting via hypocotyl length. Seed weight had a little direct effect but exhibited a significant negative indirect effect through hypocotyl length. Oil and protein content, wherever involved, showed the least direct and indirect effects. Residual effect of unknown factors was low (-0.122) indicating that major proportion of variability for total seedling length could be associated with the factors included in this study.

The present study points out towards a scope for the improvement of seed vigour in soybean and also identifies reliable selection criteria for this purpose. The

TABLE 1. Mean values and estimates of variability for seed quality characters in soybean

Statistical Parameter	Characters						
	100 seed weight (g)	Germinability –% (arcsin)	Root length (cm)	Hypocotyl length (cm)	Total seedling lenghth (cm)	Oil % (arcsin)	Protein %
Range	10.5–18.3	16.6–74.3	0.6–5.3	1.1–5.7	1.7–10.1	19.3–20.4	34.4–46.4
Mean	13.6	48.1	2.4	3.9	6.4	19.3	39.3
Standard error	0.54	3.97	0.49	0.55	0.85	0.07	1.17
F-ratio (varieties)	17.27**	23.57**	5.74**	4.84**	6.99**	13.93**	6.12**
Genotypic variance	4.77	355.19	1.13	1.18	4.31	0.065	6.96
Phenotypic variance	5.65	402.40	1.85	2.10	6.47	0.080	11.04
Heritability (%)	84.42	88.27	61.08	56.19	66.61	81.18	63.04
Genotypic coefficient of variation	16.01	39.21	44.29	27.50	32.64	0.96	6.72
Phenotypic coefficient of variation	17.43	41.73	56.67	36.69	39.99	1.06	8.46
Genetic advance (K = 2.06)	4.13	36.48	1.71	1.68	3.49	0.47	4.31
Genetic advance as percentage of mean	30.28	75.89	71.25	42.53	54.87	1.78	10.98

** Significant at 0.01 P.

TABLE 2. Genotypic (G), phenotypic (P) and environmental (E) correlation coefficients for seed quality characters in soybean

Characters		Germinability	Root length	Hypocotyl lenghth	oil content	Protein content	Total seedling length
Seed weight	G	-0.65**	-0.71**	-0.80**	0.51*	-0.17	-0.78**
	P	-0.54*	-0.52*	-0.55*	0.45	-0.06	-0.60*
	E	0.17	-0.02	0.04	0.24	0.24	-0.04
Germinability	G		0.80**	0.85**	0.19	0.27	0.85**
	P		0.54*	0.53*	0.18	0.23	0.59*
	E		-0.21	-0.30	0.10	0.15	0.34
Root length	G			0.84**	0.17	0.01	0.96**
	P			0.65**	0.02	0.08	0.91**
	E			0.39	-0.30	0.20	0.83**
Hypocotyl length	G				0.11	-0.15	0.96**
	P				0.10	-0.09	0.91**
	E				0.08	-0.01	0.83**
Oil content	G					-0.42	0.15
	P					0-.31	0.08
	B					-0.04	0.12
Protein content	G						-0.04
	P						-0.03
	E						-0.02

* = Significant at 0.05 P; ** = Significant at 0.01 P

TABLE 3. Direct and indirect eeffcts of different seed quality characters on total seedling length in soybean

Characters	Seed weight	Germinability	Root length	Hypocotyl lenghth	Oil content	Protein content	'r' with total seedling lenghth
Seed weight	**0.057**	0.484	–0.339	–1.022	0.115	–0.077	–0.78
Germinability	–0.037	**–0.745**	0.382	1.085	0.044	0.122	0.85
Root length	–0.040	–0.596	**0.477**	1.073	0.039	0.055	0.96
Hypocotyl length	–0.046	–0.633	0.401	**1.277**	0.025	–0.068	0.96
Oil content	–0.029	–0.142	0.081	0.140	**0.231**	–0.189	0.15
Protein content	–0.010	0.201	0.005	–0.192	–0.097	**0.451**	–0.04

Vvalues in thicker print represent direct effects

sample of advanced breeding lines and cultivars studied hereby exhibited high estimates of variability and heritability for seed germinability when compared with the earlier report (Green and Pinnell, 1968). Both field emergence and germinability, although dependent on sound and healthy nature of seeds, are established to be correlated in a positive manner in soybean (Green and Pinnell, 1968; Singh and Ram, 1985). The present results are, hence, reliable enough for seed quality improvement.

The correlation and path-analysis clearly revealed that hypocotyl length was the principal direct contributor towards total seedling length. Seed weight, germinability and root length were other components which had significant indirect effects via hypocotyl length. Since seed vigour characters are not easy to measure and one has to wait till the seeds are grown, the most feasible and easy selection criterion could be the seed weight. Seed weight was shown to have indirect but pronounced negative effect via hypocotyl length and its negative correlation with all the seed vigour characters was found to be highly significant and consistent in nature. It would be pertinent to point out here that most of the earlier reports excepting that of Paschal and Ellis (1978) regarding the effect of seed size on germing tion and other related characters (Edwards *et al.*, 1971; Singh *et al.* 1972) compared the seed grades (A, B etc) within genotypes and were based on limited number of varieties or isogenic lines of single variety leading to either in consistent or non-significant results. In the present study, however, the relationships were comprehensively tested accros the varities.

It is suggested that seed size, in view of its negative association with seed vigour, should not be increased by breeding efforts for the sake of high yield to such an extent that it mars the emergence, stand and performance of soybean crop in the field besides inflating the seed rate for sowing. On the other hand, since seed size was reportted to have a negative relationship with impermeable seed and ability to store well (Hill *et al.*, 1986), a strong selection in favour of small seeds could lead to impermeable or hard seeds. Moreover, soybean is important as a source of oil. Since seed size and oil content were found to have positive correlation, reducing the seed size indiscriminately for high germinability could result in low oil harvest. Plant breeders have, thus, to strike a balance between seed size and seed vigour. The present study also identified the advanced breeding lines and varities which have high germinability and desirable early seedling growth, viz. Gujarat Soybean 1 and 2, JS 84-1, Sagar Selection 2, MACS-13 and JS 80-21 which could be utilised for improvement in seed vigour.

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LITERATURE CITED REFERENCES

DEWEY, K.R. and LU, K.H. 1959. A correlation and path coefficient analysis of components of crested wheat grass seed production. Agronomy Journal, 51:515-518.

EDWARDS, C.J. JR. and HARTWIG, E.E. 1971. Effect of seed size upon rate of germination in soybeans. Agronomy Journal, 63:429-430.

GREEN, D.E. and PINNELL, E.L. 1968. Inheritance of soybean seed quality. I. Heritability of laboratory germination and field emergence . Crop Sci. 8:5-11.

HILL, H.J., WEST, S.H. and HINSON, K.1968. Soybean seed size influences expression of the impermeable seed coat trait. Crop. Sci. 26:634-637.

MOTIRAMANI, D.P. 1986. Soybean production trends-future research needs. In 'National Seminar and XVII Annual Workshop (AICRPS)' held at Pune. pp. 55-69. (Mimeo.).

MUGNISJAH, W.Q. and NAKAMURA, S. 1984a. Vigour of soybean seed produced from different nitrogen and phosphorous fertilizer application. Seed Sci. Technol. 12:475-482.

MUGNISJAH, W.Q. and NAKAMURA, S. 1948b. Vigour of soybean seed produced from different harvest date and phosporous fertilizer application. Seed Sci. Techol. 12:483-491.

PASCHAL, E.H. and ELLIS, M.A. 1978. Variation in seed quality characteristics of tropically grown Soybeans *Crop Sci*. 18;837-840

SINGH, J.N., TRIPATHI, S.K. and NEGI, P.S. 1972. Note on the effect of seed size on germination, growth and yield of soybean (*Glycine max* (L.) Merr.). Indian J. Agric. Sci. 42:83-86.

SINGH, R.K. and RAM, H.H. 1985. Screening techniques and selection parameters for germinability in soybean. Tropical Grain Legume Bulletin, 31:31-34.

TIWARI, S.P. BHADAURIA, S.S., VADDORIA, M.A. and DEVI DAYAL. 1985. Allelopathic effects of weeds in soybean, groundnut and green-gram Current Sci. 54:434-435.

YAKLICH, R.W., KULIK, M.M. and GARRISON, C.S. 1979. Evaluation of vigour in soybean seeds: Influence of date of planting and soil type on emergence, stand and yield. Crop Sci. 19:242-246

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ASSOCIATION AND PATH ANALYSIS OF YIELD COMPONENTS IN NIGER (*GUIZOTIA ABYSSINICA* CASS.) GROWN UNDER MID ALTITUDE, P-DEFICIRNT ACIDIC SOIL

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ABSTRACT

In a study involving 30 diverse genotypes of niger (*Guizotia abyssinica* Cass.) the interrelationships of seven quantitative characters and the influence of six characters on seed yield were assessed through correlation and path coefficient analysis. The geno type correlation coefficients between seed yield and days to 50 per cent flowering days to maturity, number of branches and capitula per plant were positive and significant. Path coefficient analysis revealed that days to maturity and number of capitula per plant were the direct components of seed yield, which also had substantial indirect effects via 1000 seed weight. The six characters cumulatively contributed 685 per cent of genetic gain towards seed yield per plant with a genetic advance of 2.36 grams. Selection index was workerd out for predicting the expected yield. The results suggested that days to maturity and number of capitula per plant might serve as criteria for selection in a breeding programme aimed at yield improvement as these characters have satisfied both the requirements of association and path analysis.

Key words : Niger, *Guizotia abyssinica*; correlation coefficient; path coefficient; selection index; discriminant function; genetic advance.

INTRODUCTION

Niger (*Guizotia abyssinica Cass.*) is an annual herb bearing axilliary yellow capitula with black achenes rich in oil (35-50%). The plant is cultivated as an oil crop in Ethiopia, Tanzania, Uganda, Sudan and India (Baagoe, 1974). It is occasionally reported as a weed from places remote from the area of cultivation, probably because of the use of niger seed in bird feed, as in United States (Mc Carty, 1980). Ethiopia was probably the area of domestication (Simmonds, 1976). India produces about 1,50,000 tonnes of niger seed per annum from an area of about 0.6 million hectares (Anon., 1985).

Seed yield is a complex metric trait which is the end result of a numebr of traits often interrelated with each otehr. The relative value of these traits in determining seed yield in a crop species is of importance in selection of superior genotypes. The knowledge of correlations helps in determining the component characters of a complex entity like seed yield but it does not give an exact picture of the relative importance of the direct and indirect effects of the various yield attributes. Path analysis proposed by Wright (1921) facilitates the partitioning of the correlation coefficients into direct and indirect effects of various characters on seed yield or any other attributes. It also permits to study the specifific forces acting to produce a given correlation in correlated variables. Studies on these aspects are meagre in niger espiecally under the present set of conditions under which it was grown. Therefore, the present study

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was conducted to have effective selection programme for plant improvement work in this crop.

MATERIALS AND METHODS

Thirty genotypes of niger from diverse sources were evaluated in a randomised block design with 3 replications at the I.C.A.R. Research Complex Experimental Farm at Barapani (1000m, msl, 26°N and 92°E) in an acidic soil (pH 5.0) with low phosphorus availability (3.92ppm) during the rainy season of 1985. Soil characteristics were determined by standard prodcedures (Jackson, 1967). Each plot consisted of 4 rows of 3m length spaced 30 cm between rows and 10 cm space between plants. Plant to plant distance of 10 cm was maintained by thinning when the seedlings were 15 days old. Basal doses of 30 kg N, 20 kg P_2O_5 and 20 kg K_2O were applied at sowing as ammonium sulphate, single superphosphate and muriate of potash, respectively. Data were recorded on five randomly selected competitive plants from each plot. The characters examined were days to 50 per cent flowering, days to maturity, plant height, number of capitula per plant, number of branches per plant, 1000 seed weight and seed yield per plant.

Genotype and phenotypic correlation coefficients were worked out according to Jhonson *et al.*, (1955). Path coefficient analysis as applied by Dewey and Lu (1959) was used to partition the genotypic correlation coefficient into direct and indirect effects. Discriminant function was used for working out the selection index (Smith, 1936).

RESULTS AND DISCUSSION

Correlations

The phenotypic and genotypic correlation coefficients of all pairs of characters are presented in Table 1. The magnitude of genotypic correlation coefficient was higher than the phenotypic correlation coeffiicents with respect to any character combination. In certain cases it was more than unity which may be attributed to a low estimate of genetic variance for the respective character. Genotypic correlation coefficients exceeding unity have also been reported by Williams *et al.*, (1965); Carlson and Moll (1962); and Chaudary and Anand (1985). Seed yield exhibited a significant positive correlation with days to 50 per cent flowering, days to maturity, number of branches per plant and number of capitula per plant. Days to 50 per cent flowering and days to mautrity were significantly and positively correlated between themselves showing that days to flowering was a fairy reliable index to maturity.—These two characters also had significant positive correlation with number of branches per plant and number of capitula per plant. However, they exhibited a significant negative correlation with 1000-seed weight. In fact, the association of 1000-seed weight with any other character was found to be negative. All other intercorrelations of various pairs of characters were positive. Therefore, simultaneous improvement of all the characters should be expected through the improvement of any one particular character except in

TABLE 1. Phenotypic (P) and genotypic (G) correlation coefficients among 7 characters in niger

Character		*Days to* maturity	Plant height	Branches per plant	Capitula per plant	1000-seed *weight*	Yield per plant
Days to 50% flowering	P	0.954	0.514**	0.607**	0.472**	-0.440*	0.420*
	G	0.958	0.732	0.954	1.222	-0.794	1.107
Days to maturity	P		0.572**	0.593**	0.433**	-0.443*	0.369*
	G		0.826	0.934	1.129	-0.819	0.936
Plant height	P			0.513**	0.477**	-0.331	0.343
	G			0.709	0.940	-0.953	0.734
Branches per plant	P				0.799**	-0.558**	0.563**
	G				1.152	-0.959	0.827
Capitula per plant	P					-0.354	0.697**
	G					-1.550	0.668
1000-seed weight	P						-0.164
	G						-0.906

* Significant at 5% level of significance.

** Significant at 1% level of significance.

1000-seed weight where a reduction in seed weight is likely as a result of its negative association with other characters. Adams (1967) has pointeed out that negative correlation could arise primarily from developmentally induced relationships such as two developing components competing for limited resources. It would be difficult to exercise simulataneous selection of characters which are negatively correlated between themselves, for the development of a variety (Nowell and Eberhart, 1961). In such a situation it would be desirable to seek an adjustment between the two attributes to find out acceptable level of both the characters under improvement.

Path coefficient analysis

Correlation measures only mutual association between two variables, but does not imply a cause-and-effect relationship, whereas the path coefficient analysis specifies the cause and measures their relative importance. The genotypic correlation coefficients were partitioned into direct and indirect effects by the addoption of path coefficient analysis to understand the relative importance of each of the causal factors on seed yield. The direct and indirect contribution of six characters on seed yield per plant are presented in Table 2. The direct genotypic effect of days to 50 per cent flowering (-2.182) and the indirect genotypic effect of days to maturity through days to 50 per cent flowering (-2.091) were both high and negative whereas the indirect effect of days to flowering via days to maturity (10.886) and the direct genotypic effect of days to maturity (11.360) were both very high and positive. This shows that late initiation of flowering might have a negative effect on seed yield, whereas early flowering may have a positive effect. The positive indirect effect of days to 50 per cent flowering via days to maturity indicated that even in late flowering types the seed yield was enhanced with the advancement of days to maturity, and the negative indirect effects of days to maturity via days to 50 per cent flowering showed that with a fixed maturity period the seed yield was adversely affected with the delay in the onset of flowering. This aspect shows that seed yield was mostly a function of flowering duration. The indirect path effects of plant height and branches per plant through days to 50 per cent flowering (-1.596 and -2.080 respectively) and days to maturity (9.380 and 10.609 respectively) were similar to the direct effects of the latter two characters indicating that the effect of plant height and number of branches on seed yield may be manifestations of the growth phase. These results also bring out that at a certain plant height or with a certain number of branches, seed yield was adversely affected by a delay in flowering and favourably influenced by an advancement in the maturity date. The direct genotypic effects of plant height and number of branches per plant were both negative and high. However, the two characters had positive correlation with seed yield which was mainly due to their positive indirect effects via days to maturity, number of capitula per plant and 1000-seed weight. Number of capitula per plant also showed a high direct genotypic effect on seed yield. Like days to maturity, this character had positive effect at genotypic as well as phonetypic levels, Besides, this character also contributed to seed yield through its indirect effects via days to maturity and 1000-seed weight. The direct effect of 1000-seed weight on seed yield was negative (-4.096) and its total correlation with seed yield was also negative and high (r=-0.906). This character had positive indirect genotypic effect via days to 50 per cent flowering, plant height and

TABLE 2. Direct (diagonal) and indirect effects of 6 characters on seed yield of niger

Character	Days to 50 per cent flowering	Days to maturity	Plant height	Branches per plant	Capitulam per plant	1000-seed weight	Genotypic correlation with seed yield
Days to 50% flowering	**-2.182**	10.886	-4.883	-12.046	6.081	3.251	1.107
Days to maturity	-2.091	**11.360**	-5.512	-11.798	5.622	3.354	0.936
Plant height	-1.596	9.380	**-6.675**	-8.957	4.678	3.904	0.734
Number of branches per plant	-2.080	10.609	-4.733	**-12.633**	5.735	3.929	0.827
Capitulam per plant	-2.665	12.830	-6.273	-14.553	**4.978**	6.349	0.668
1000-seed weight	1.731	-9.300	6.361	12.115	-7.716	**-4.096**	-0.906

number of branches per plant and its indirect effects via days to maturitv and number of capitula per plant also were negative (-9.300 and -7.716, respectively).

It is clear from the path coefficient analysis that days to matiruty and number of capitula per plant are the direct components of seed yield. The contribution of these characters to seed yield through their indirect effects via 1000-seed weight were also substantial. The results of the association analysis also revealed the importance of these characters as the major yield components. Therefore, adequate weights should be given to days to mtaurity and number of capitula per plant in individual plant selections aimed at improvement of seed yield in niger.

Selection based on the use of selection indices which give adequate weight to two or more characters of importance is more efficient than selection for one character at a time or several characters independently (Hazel and Lush, 1942). The selection index worked out for predicting the expected yield is given below :

$$Y = 0.47486\ X_1 - 0.35153\ X_2 + 0.00815\ X_3 + 0.03366\ X_4 - 0.01931\ X_5 - 0.19959\ X_6$$

Y = the expected seed yield of a strain
X_1 = Days to 50 per cent flowering; X_2 = Days to maturity;
X_3 = Plant height; X_4 = Number of branches per plant; X_5 = Number of capitula per plant; X_6 = 1000 seed weight,.

It was found that the six characters cumulatively contributed 685 per cent of genetic gain towards seed yield per plant with a genetic advance of 2.36 grams,

LITERATURE CITED

ADAMS, M.W. 1967. Basis of compensation in crop plants with special reference to field bean *Phaseolus vulgaris*. *Crop Sci.* 7, 505-510.

ANONYMOUS, 1985. Groundnut, Sesamum, Niger, Sunflower and Castor. Package of Practices for Increasing Production. *Extension Bulletin No.*2, Directorate of Oilseeds Research, Hyderabad, India, p. 55-61.

BAAGOE, J. 1974. The genus *Guizotia* (Compositae) - a taxonomic revision. *Bot. Tidsskrift.* 69, p. 1-29.

CARLSON, I.T. and MOLL, R.H. 1962. Phenotypic and genotypic variation in quantitative characters in strains of orchard grass. *Crop. Sci.* 2, 281-286.

CHAUDHARY, S.K. and ANAND, I.J. 1985. Influence of various characters on yield of sunflower *J. Oilseeds Res.* 2, 78-85.

DEWEY, D.R. and LU, K.H. 1959. A correlation and path-coefficient analysis of components of crested wheat grass seed production. *Agron. J.* 51, 515-518.

HAZEL, L.N. and LUSH, J.L. 1942. The efficiency of three methods of selection, *J. Hered.* 33, 393-402.

JOHNSON, H.W., ROBINSON, H.F. and COMSTOCK, R.E. 1955. Genotypic and phenotypic correlation in soybean and their implication in selection. *Agron. J.* 47, 477-483.

Mc. CARTY, M.K. 1980. Niger Seed. *Weeds Today.* 11, p. 21-22.

NEWELL, L.C. and EBERHART, S.A. 1961. Clone and progeny evaluation in the improvement of switch grass, *Pancium varigatum* L. *Crop Sci.* 1, 117-121.

SIMMONDS, N.W. 1976. *Evolution of Crop Plants.* Longman Inc. New York, U.S.A. p. 305.

SMITH, H. 1936. A discriminant function for plant selection. *Ann. Eng.* 7, 240-50.

WILLIAMS, J.C., PENNY, L.H. and SPRAGUE, G.F. 1965. Full-sib and half-sib estimates of genetic variance in an open-pollinated variety of corn (Zea mays L.), *Crop Sci.* 5, 125-129.

WRIGHT, S. 1921. Correlation and causation. *J. Agric. Res.* 20, 557-585.

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STUDIES ON CROP ASSOCIATION IN MUSTARD AND WHEAT WHEN GROWN UNDER DIFFERENT PROPORTIONS

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ABSTRACT

A field experiment on crop association in mustard and wheat, when grown under different proportions was conducted for 3 years during rabi 1979-80 to 1982-83 under irrigated conditions on clay loam soil at R.S. Pura (Jammu). The results indicated that it is not economically viable to replace wheat by mustard under such conditions. However, mustard can be grown profitably in inter and mixed cropping system by sowing 6 or 10 rows of wheat alternated with 2 rows of mustard or in the seed mixture of 83.7 per cent wheat + 16.3 per cent mustard respectively.

Key words : Crop association; Mustard; WHEAT.

INTRODUCTION

Mustard is predominantly grown in association with wheat in sub-tropical area both under irrigated and rainfed conditions. Growing of wheat and mustard as mixed and inter-crop have been reported to be successful and economically viable cropping system (Sawhney et al. 1983; Ganga Saran and Giri, 1985 and Malik et al. 1985). With this background the present investigation was carried out for 3 years on the crop association of wheat and mustard grown under different proportions both under inter and mixed cropping system, since no information is available under local *conditions on the most suitable proportion of wheat and mustard grown in assocaition.*

MATERIALS AND METHODS

A field experiment was conducted during rabi rabi 1979 - 80 to 1982-83 under irrigated condition on a clay loam soil of R.S. Pura (Jammu) representing sub-tropical climatic conditions. Treatments comprised different propotions of wheat and mustard seeds and different row ratios as shown in Table 1. These treatments were replicated four times in Randomised Block Design.

Wheat (*Triticum, aestivum*, L) variety HD 2009 and mustard (*Brassica Juncea*,L) variety *varuna* were sown in rows 20 cm and 30 cm apart in pure and intercropping systems. The recommended seed rate of wheat was 100 Kg/ha and that of mustard 5 kg/ha. In seed mixture and row ratio treatments, seed ratio was accordingly adjusted. Sowing of both the crops was done on 11th December, 10th December and 25th November in 1979, 1980 and 1981 respectively. All the treatments having wheat crop as pure, mixed or inter-cropping with mustard received 100 kg N, 50 kg P_2O_5 and 30 kg K_2O/ha. Pure mustard crop received 60 kg N, 40 kg P_2O_5 and 20 kg K_2 O/ha. The competitive ratio (CR) and monetary advantage were calculated by equation suggested by Willey (1979) and Rao (1980) respectively.

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TABLE 1. Yield and competitive ratio (CR) of wheat and mustard

Treatments	1979–80		1980–81		1981–82		Mean		Mean competitive ratio (CR)	
	Wheat	Mustard	Wheat	Mustard	Wheat	Mustard	Wheat	Mustard	Wheat	Mustard
Pure Wheat	35.31	—	28.77	—	32.67	—	32.25	—	—	—
Pure mustard	—	6.81	—	4.85	—	10.43	—	7.36	—	—
Seed ratio										
Wheat + Mustard 50% 50%	23.77	4.79	10.84	2.50	14.46	5.98	16.36	4.39	0.83	1.20
Wheat + Mustard 66.7% 33.3%	26.91	4.62	13.62	2.10	16.68	5.20	19.07	3.97	1.12	0.90
Wheat + Mustard 75% 25%	27.38	4.35	14.86	2.00	18.77	4.59	20.34	3.65	1.24	0.81
Wheat + Mustard 83.7% 16.3%	28.80	4.34	15.30	1.60	20.36	4.39	21.49	3.44	1.43	0.70
Row ratio										
Wheat + Mustard 1:1	—	—	10.08	2.47	12.65	5.03	11.37	3.75	0.74	1.35
Wheat + Mustard 4:2	23.80	4.19	14.94	2.20	20.93	3.89	19.89	3.43	1.27	0.79
Wheat + Mustard 6:2	25.85	5.02	15.92	1.83	22.38	3.73	21.38	3.53	1.35	0.74
Wheat + Mustard 10:2	27.84	4.10	19.53	1.60	24.19	2.36	23.85	2.69	1.87	0.53
SEm ±	0.80	0.42	0.70	0.05	0.90	0.30	0.80	0.26		
C.D. 5%	2.34	1.21	2.07	0.15	2.63	0.87	2.35	0.74		

$$\text{Monetary advantage} = \left.\begin{matrix}\text{Value of combined}\\ \text{inter crop yield}\end{matrix}\right\} \times \frac{(\text{LER-1})}{\text{LER}}$$

Competitive ratio (CR) =

$$\text{CR wheat} = \frac{\text{LER wheat}}{\text{LER mustard}}$$

$$\text{CR mustard} = \frac{\text{LER mustard}}{\text{LER wheat}}$$

Whereas, grain productivity (wheat equivalent) was calculated by multiplying the mustard yield by a wheat equivalent factor (3.82) which was taken as a ratio of the price per unit weight of mustard (Rs. 600/q) to the price per unit of wheat (Rs. 157/q).

RESULTS AND DISCUSSION

Seed yield :

Grain yield of wheat was the highest in pure stand while in intercroppings with mustard it decreased in all combinations. The competitive ratio (CR) of musard as suggested by Willey and Rao (1980), increased with its increasing population and lowest wheat yield was recorded at the highest mustard population. Comparing the yield index of wheat in wheat in mixed (50%+50%) ratio and inter-cropping system (1:1 ratio) at the same population of two crops on unit area basis, it was observed that, on an average wheat suffered more from intra-row competition of mustard recording CR 0.74 compared to C.R. of 0.82 under mixed cropping.

Mustard yield was also higher in pure crop stand, and in mixed cropping it decreased due to its lower plant population. Though the treatment 6:2 row ratio of wheat and mustard recorded higher mustard yield to 4:2 row ratio, it remained statistically at par confirming the trend in mixed cropping. The differential behaviour in mixed proportions and geometrical confirmation of two crops in the field may be due to their varying canopy heights. Wheat always had lower canopy than that of mustard in mixed stand, thus the advantage of incident solar energy utilization efficiency was more in latter as compared to former which was growing under canopy and suffered more.

Economics :

Average gross return (Rs. 7015/ha) was the highest when wheat was grown as sole crop and was statistically superior to sole mustard (Rs. 4416/ha) and wheat + mustard at 1:1 row ratio (Rs. 4744/ha) but remained at par with 10:2 row ratio

TABLE 2. Gross return Rs/ha, monetary advantage Rs/ha, grain productivity (q/ha) (Wheat equivalent) and LER

Treatments	Gross return (Rs/ha)			Mean	Mean monetary dvantage (Rs+ha) (q/ha)	Mean grain productivity (q/ha)	LER			Mean
	1979-80	1980-81	1981-82				1979-80	1980-81	1981-82	
Pure wheat	7599	6275	7171	7015	—	32.25	1.00	1.00	1.00	1.00
Pure mustard	4087	2895	6255	4416	—	28.14	1.00	1.00	1.00	1.00
Seed ratio										
Wheat + mustard 50% 50%	8042	3881	6684	6202	564	33.26	1.38	0.89	1.02	1.10
67.7% + 33.3%	8622	4250	6934	6602	707	34.26	1.44	0.91	1.01	1.12
75% + 25%	8623	4603	6871	6699	718	34.27	1.41	0.93	1.01	1.12
83.7% + 16.3%	8915	4333	7111	6786	727	34.65	1.45	0.86	1.04	1.12
Row ratio										
Wheat + mustard										
1:1	—	3688	5800	4744	—	25.70	—	0.86	0.87	0.86
4:2	7650	4582	6448	6227	514	32.99	1.29	0.97	1.01	1.09
6:2	8608	4575	7165	6783	885	34.86	1.47	0.93	1.04	1.15
10:2	8919	5218	6728	6955	745	34.12	1.39	1.01	0.97	1.12
SEm ±	309	170	271	250	—	—	—	—	—	—
CD 5%	901	495	786	728	—	—	—	—	—	—

(Rs. 6955/ha) seed ratio 83.7%+16.3% (Rs. 6786/ha) and 6:2 row ratio (Rs. 6783/ha). Similar findings have been reported by Sharma *et al.* (1985). Thus it is evident from these findings that any of the above systems (seed or row ratio) can be recommended to the farmers for increasing total production of oil seed from large area under wheat without affecting the gross returns that could be obtained by sole wheat. However, for operational convenience particularly harvesting, it would be better to sow 2 rows of mustard alternated with 6 or 10 rows of wheat.

From the equation for monetary advantage suggested by Willey (1979), it was ascertained that absolute value of yield advantage in intercropping systems due to the value of the additional production of land area ranges from Rs. 514 to Rs. 885, maximum being in the treatment wheat + mustard at 6:2 spatial ratio (Table 2). Total grain productivity (wheat equivalent) was higher in mixed and intercropping compared to that of pure wheat and pure musrtard treatments except in mixture of seed of wheat 50% + mustard 50% (Table 2). However, the land equilant ratio (LER) in the treatment wheat + mustard at 10:2 row ratio was 1:12 against 1.15 of wheat+ mustard in 6:2 row ratio, but the latter recorded lower gross return against higher yield advantages (15%) as predicted by LER. Similar drawback of LER was also reported by by Rehman *et al* (1982).

These results clearly indicated that the practical feasibility of intercropping wheat and mustard at the most suitable row ratio is 6 to 10 rows of wheat alternated with 2 rows of mustard under agro-ecological condition of R.S. Pura (Jammu). Hoewever, in the case of seed mixture, the most suitable proportion is 83.7% wheat+ 16.3% mustard.

LITERATURE CITED

GANGASARAN and GIRI, GAJENDRA (1985). Intercropping mustard with chick-pea, lentil and barley in dryland. Indian J. Agron 30(2):244-250.

MALIK, B.B. BATRA, M.L. and AGARWAL, M.C. Towards improvement in Farm Technology. Farm Journal 4(11):8-9.

REHMAN, A, SINHA, K.P.; SINGH Y.P., RAFEY, A; BHAGAT, A.K. and SINGH, R.K. (1982). Effect of intercropping pulses, Oilseeds and tuber crops in maize on yield and net return. Indian J. Agron 27(1) 1-6.

SAWHNEY, J.S.; NARANG, R.S.; MAHAJAN, V.P. and SINDHU M.S. 1983. Intercropping of *Brassica Juneca* (raya) with wheat. Agronomy 2000 AD, Looking ahead-Symposium, Feb 7-9 at Nagpur, India Soc. Agron.

SHARMA, K.C.; SINGH, Y; GUPTA, P.C.; TRIPATHI, S.K.; BHARDWAJ A.K; and SINGH, S.P. (1986). Plant population and spatial arrangement in wheat-mustard intercropping. Indian J. Agron. 31(2) 154-157.

WILLEY, R.W. (1979). Intercropping - its importance and research needs Part-I. Competition and yield advantages. Field crops Abst. 32(1):1-10.

WILLEY, R.W. and RAO, M.R. (1980). A competitive ratio for quantifying competition between intercrops. Expl. Agric 16:117-125.

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NUTRITIONAL STUDIES WITH *MADHUCA BUTYRACEA* FAT (Phulwara butter)

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ABSTRACT

Growth, digestibility, serum and liver lipid composition on feeding *Madhuca butyracea* fat (Phulwara butter) at 10 per cent level in the diet to growing albino rats were studied and compared with hydrogenated vegetable and groundnut oils. *Madhuca butyracea* fat promoted growth comparable to the control diets.

The true digestibility of this fat (92%) was almost close to hydrogenated vegetable oil (94%). Total lipids, ester cholesterol, free cholesterol, triglycerides in serum and liver were found to be within normal limits. Histopathological examination of various organs did not reveal any abnormalities.

Key words : *Madhuca butyracea* fat nutrition.

INTRODUCTION

The widening gap between demand and supply of oils and fats necessitated the need for exploration of unconventional sources of oils. *Madhuca butyracea* is a natural fat of tree origin belonging to family *Sapotaceae*. The fat content in the seed was reported as 60 per cent (Benerji *et al.* 1984)

The physico chemical-characteristics and fatty acid composition of the fat were reported (Shah *et al* 1983). The information on nutritional quality of the fat was not reported earlier. Hence this study was undertaken.

MATERIALS AND METHODS :

Madhuca butyracea fat in the present study was supplied by National Botanical Research Institute, Lucknow. Refined groundnut oil and hydrogeneted vegetable oil were purchased from the local market. The three fats viz., *Madhuca butyracea* fat, hydrogenated vegetable oil and groundnut oil were incorporated in a semi synthetic diet at 10 per cent level. The composition of the experimental diets was given in Table 1.

Albino rats of the Wistar strain, weighing between 40-60 g (8 in each group) were alloted to three groups in a randomized block design. The rats were kept in individual cages and fed ad lib with one of the above diets for 24 weeks. Records of food intake and gain in weight were maintained. During the experimental period, the animals were watched carefully for appearance of any abnormal symptoms.

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TABLE 1. Per cent composition of the diets used in rat feeding

Ingredients	Madhuca butyracea fat	Hydrogenated vegetable oil	Groundnut oil
Wheat flour	60	60	60
Green gram dhal flour	25	25	25
Madhuca butyracea fat	9	—	—
Hydrogenated vegetable oil	—	9	—
Groundnut oil	—	—	9
Salt mixture*	4	4	4
Water soluble vitamin* mixture	1	1	1
Fat soluble vitamin* mixture	1	1	1

* ISI — 7481 (1974)

At the end of the experimental period, the blood was collected from the neck by decapitation. The blood was allowed to clot, centrifuged and serum was separated. The livers, kidneys and heart were removed quickly, blotted free of blood and weighed. One centimeter from right lobe of the liver and other organs were fixed in 10 per cent neutral formalin for the histopathological examination.

The feed efficiency ratio (FER) was computed from the data on food intake and weight gain. The true digestibility of the fat was determined at 23 weeks of feeding from the fat intake and fat excreted through the faeces after making corrections for metabolic fat.

The serum and liver tissues were estimated for total lipids (Polch *et al* 1957), total and free cholesterol (Zak *et al* 1954) and triglycerides (Vanhandel and Zilversmit 1957).

RESULTS AND DISCUSSION:

The results of the food intake, gain in body weight and feed efficiency ratio of rats fed control and experimental diets are presented in Table 2.

The F.E.R. of *Madhuca butyracea* fat was similar to groundnut oil. The true digestibility of this fat was less than that of groundnut oil and was seen close to hydrogenated vegetable oil as indicated by the coefficient digestibility in Table 2. This lower digestibility of the experimental fat could be due to higher melting point (Crocket and Deuel 1947).

TABLE 2. F.E.R. & Digestibility of control and experimental rats

Group	F.E.R.	Digestibility (%)
Madhuca butyracea fat	0.27	92
Hydrogenated vegetable oil	0.25	94
Groundnut oil	0.27	97

TABLE 3. Weights of organs in experimental and control rats

Parameters	Madhuca butyracea fat	Hydrogenated vegatable oil	Groundnut oil
Final body weight (g)	197.9	270.4	198.1
Liver weight (g)	$4.31^{b} \pm 0.90$	$6.12^{a} \pm 1.49$	$4.04^{b} \pm 1.16$
As per cent body weight	2.2 ± 0.13	2.26 ± 0.16	2.02 ± 0.21
Kidney weight (g)	$0.92^{b} \pm 0.09$	$1.3^{a} \pm 0.29$	$0.91^{b} \pm 0.17$
As per cent of body weight	0.46 ± 0.12	0.48 ± 0.05	0.47 ± 0.07
Heart weight (g)	$0.58^{a} \pm 0.09$	$0.65^{a} \pm 0.11$	$0.52^{a} \pm 0.11$
As per cent body weight	0.30 ± 0.03	0.24 ± 0.02	0.26 ± 0.02

($\pm$) Standard deviation

Figures with the same superscript are not significantly different ($P<0.05$).

The weight of liver, kidney and heart sacrificed at the end of feeding did not reveal any significant difference when expressed as per cent of body weight. Histopathological examination of the tissues, liver, heart and kidney did not reveal any abnormalities.

The total lipid and lipid components in serum of rats is given in Table 4.

TABLE 4. Lipid components in serum

Parameters	Madhuca butyracea fat	Hydrogenated vegetable oil	Groundnut oil
Total lipids (g/100 ml)	$0.46^{a} \pm 0.50$	$0.44^{a} \pm 0.049$	$0.49^{a} \pm 0.046$
Total cholesterol (mg/100 ml)	$89.6^{ab} \pm 7.14$	$86.5^{b} \pm 5.2$	$96.3^{a} \pm 5.99$
Ester cholesterol (mg/100 ml)	$66.9^{ab} \pm 4.7$	$65.3^{a} \pm 3.7$	$70.6^{a} \pm 4.7$
Free cholesterol (mg/100 ml)	$22.7^{b} \pm 2.8$	$21.3^{b} \pm 2.4$	$25.6^{a} \pm 2.5$
Triglycerides (mg/100 ml)	$160^{a} \pm 37.4$	$141.7^{a} \pm 34.8$	$171.3^{a} \pm 28.00$

$\pm$ Standard deviation

Figures with same superscript are not significantly different (/0.05)

The lipid components in serum of rats fed with the experimental fat, hydrogenated vegetable oil and groundnut oil were found close to each other. The free cholesterol concentration in serum of rats fed Madhuca butyracea fat was significantly lower than groundnut oil fed groups. This difference was not significant when compared with the group fed hydrogenated vegetable oil.

Data on the lipid components in liver of rats is shown in Table 5.

TABLE 5 : Lipid components in liver

Parameters	Madhuca butyracea fat	Hydrogenated vegetable oil	Groundnut oil
Total lipids (g/100 ml)	$7.25^a \pm 0.34$	$6.2^b \pm 0.82$	$6.88^a \pm 0.61$
Total cholesterol (mg/g)	$7.8^a \pm 0.78$	$7.3^a \pm 0.61$	$7.5^a \pm 0.88$
Ester cholesterol (mg/g)	$5.4^a \pm 0.50$	$5.1^a \pm 0.37$	$5.2^a \pm 0.67$
Free cholesterol (mg/g)	$2.4^a \pm 0.31$	$2.2^a \pm 0.29$	$2.3^a \pm 0.26$
Triglycerides (mg/g)	$42^a \pm 2.66$	$37.2^b \pm 3.68$	$40^a \pm 2.06$

± Standard deviation

Figures with same superscript are not significantly different ($P < 0.06$)

The total lipid and triglyceride levels in liver of rats fed *Madhuca butyracea* fat were significantly higher than hydrogenated vegetable oil fed group, but the other lipid components like total cholesterol, esteral cholesterol and free cholesterol were almost close to both controls fed hydrogenated vegetable oil and groundnut oil.

Thus from the above observations it can be concluded that the *Madhuca butyracea* fat does not cause any adverse effect on growth and tissue lipid composition. Hence it could be suggested as substitute for hydrogenated vegetable oil and for a variety of culinary purposes.

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LITERATURE CITED

BANERJI, R., M.O. NAINAN., G. MISRA and S.K. NIGAM. (1984) Chemurgy of Madhuca butyracea Macbride. Oil seeds and their utilisation. Rohini Publishing house. India p.3

CROCKETT, M.E. and H.J. JR. DEUEL. (1947). A comparison of the coefficient of digestibility and the rate of absorption of several natural and artificial fats as influenced by melting point. J. Nutr. 33 (2):187-189.

POLCH, J.M., K.M. LEES and G.H.S. STANLEY. (1957). A simple method for the isolation and purification of total lipids from animal tissues. J. Biol. Chem. 226 (1): 497-509.

SHAH, S.G., V.V.R. SUBRAHMANYAM and D.V. REGE. (1983). Composition and characteristics of four non traditional indigenous hard fats, J. Oil. tech. Assn. India. (2) : 19-22.

VANHANDEL, E. and D.B. ZILVERSMIT. (1957). Micro method for direct determination of serum triglycerides. J. Lab. Clini-Med. 50 : 152.

ZAK, B., R.C. DICKENMAN, E.G. WHITE, M. BURNETT and P.J. CHERNEY. (1954). Estimation of free and total cholesterol. Am. J. Clin. Pathol. 24 : 1307-1310.

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LEAF ANATOMICAL FEATURES OF SOME INTERSPECIFIC HYBRIDS AND POLYPLOIDS IN THE GENUS *ARACHIS* L.

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ABSTRACT

Leaf anatomy of four cultivars, three interspecific hybrids and eight hybrid derivatives of *Arachis* belonging to different ploidy levels was studied. Data on 13 wild species is used from the previous report for comparison. The diploid wild species possessed longer hairs in higher frequences and thicker lamina with thicker palisade than their tetraploid counterparts. Among the hybrids, the characters such as length of hairs, thickness of palisade, diameter of palisade, thickness of spongy parenchyma and lamina thickness showed a gradual increase with the increase in the ploidy level; but all these characters deviated at the 'tetraploid' level in the opposite direction; the order being represented as 4X<3X<5X<6X.

Key words : *Leaf anatomy*, Groundnut, Interspecific hybrids, Polyploids.

INTRODUCTION

Information on the leaf anatomy of *Arachis* is not very extensive, and is confined to a few earlier reports. (Reed 1924, Hemingway 1957, Yarborough 1957, D' Cruz and Upadhyaya 1961, Pallas 1980 and Surya Kumari *et al.* 1983).

Among the other genera of the family, in alfalfa, four ploidy levels were distinguished using stomatal chloroplast number (Bingham 1968). The present study is undertaken to examine the leaf anatomical characters associated with different ploidy levels in the genus *Arachis*.

MATERIALS AND METHODS

Three triploids, four tetraploids, one pentaploid and six hexaploids obtained as hybrids and hybrid derivatives of the crosses between diploid wild species of section *Archis* and the cultivars (4n) (Murthy *et al* 1981); four cultivars (4n) viz., 'chico', 'Gangapuri', 'Kadiri' and 'U.S.-52' of *A. hypogoea* are studied. Data on seven diploid and six tetraploid wild species is used for comparison from the previous report (Surya Kumari *et al* 1983).

The studies were made from the epidermal peelings as well as from transections of lamina. Mature leaves fixed in F.A.A. were used for both peelings and sections. Epidermal peelings were obtained by scraping with a razor blade (Metcalfe and Chalk 1950) and were stained with 1 per cent aqueous safran in and mounted in glycerine. Slides were sealed with canada balsam. For transections, leaves were cut

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TABLE 1. ***Mean values in respect of leaf anatomical characters of some cultivars and interspecific hybrids at different levels of ploidy - Epidermis.***

			Number of epidermal cells mm-2	Number of hairs mm-2	Length of hairs u	Number of stomata mm-2	Length of stomata u
Cultivars							
U.S. - 52	4n	Ab	326 ± 18	13 ± 2	134 ± 11	189 ± 28	25.9 ± 3.1
		Ad	364 ± 23	5 ± 1		200 ± 19	23.2 ± 0.7
Kadiri	4n	Ab	404 ± 25	15 ± 1	124 ± 10	212 ± 10	27.4 ± 0.8
		Ad	418 ± 25	5 ± 1		225 ± 11	22.9 ± 0.4
Gangapuri	4n	Ab	354 ± 12	11 ± 3	235 ± 32	152 ± 16	27.1 ± 1.4
		Ad	406 ± 38	3 ±		207 ± 19	22.6 ± 1.4
Chico	4n	Ab	406 ± 59	13 ± 2	215 ± 18	174 ± 20	27.7 ± 2.4
		Ad	389 ± 14	3 ± 1		180 ± 15	23.9 ± 1.4
Interspecific hybrids							
TMV_2 × *A. chacoense*	3x	Ab	571 ± 39	33 ± 8	189 ± 20	187 ± 26	21.2 ± 2.0
		Ad	509 ± 34	14 ± 4		244 ± 36	17.6 ± 1.5
M_{13} × *A. chacoense*	3x	Ab	447 ± 70	22 ± 7	269 ± 67	132 ± 25	23.3 ± 1.6
		Ad	417 ± 42	16 ± 7		191 ± 65	18.1 ± 2.0

		Number of epidermal cells mm-2	Number of hairs mm-2	Length of hairs u	Number of stomata mm-2	Length of stomata u
Acholiwhite × *A. chacoense*	Ab	353 ± 20	22 ± 9	239 ± 62	154 ± 32	24.6 ± 1.9
	Ad	331 ± 63	17 ± 10		147 ± 20	22.2 ± 2.5
Hybrid Derivatives						
TMV_2 × *A. chacoensa* 4X	Ab	456 ± 32	15 ± 7	156 ±	191 ± 46	23.2 ± 3.1
	Ad	435 ± 72	12 ± 4		173 ± 37	21.3 ± 2.5
TMV_2 *A. correntina* 4X	Ab	468 ± 49	9 ± 5	119 ± 18	268 ± 44	19.6 ± 2.1
	Ad	479 ± 32	28 ± 10		211 ± 26	22.6 ± 1.2
M_{13} × *A. villose* 4X	Ab	376 ± 48	3 ± 2	137 ± 23	206 ± 23	20.6 ± 2.3
	Ad	391 ± 60	17 ± 10		166 ± 36	25.0 ± 1.8
Florunner × *A. chacoense* 4X	Ab	582 ± 52	25 ± 7	104 ± 14	186 ± 56	23.8 ± 1.4
	Ad	516 ± 34	8 ± 5		266 ± 16	19.8 ± 2.2
GDM × *A. chacoense* 5X	Ab	389 ± 92	27 ± 9	284 ± 65	112 ± 12	27.0 ± 2.3
	Ad	340 ± 22	1 ± 1		167 ± 15	24.0 ± 2.1
TMV_2 × *A. chacoense* 6X	Ab	358 ± 43	22 ± 7	264 ± 49	114 ± 22	27.2 ± 2.0
	Ad	354 ± 30	9 ± 6		150 ± 25	24.5 ± 2.2
Acholiwhite × *A. chacoense* 6X	Ab	306 ± 23	16 ± 6	365 ± 50	101 ± 18	28.7 ± 2.1
	Ad	278 ± 32	4 ± 3		143 ± 23	25.3 ± 2.2
GDM × *A. chacoense* 6X	Ab	371 ± 32	17 ± 5	418 ± 59	114 ± 20	28.2 ± 1.0
	Ad	326 ± 28	3 ± 1		148 ±28	24.8 ± 1.6

TABLE 2. Mean Values in respect of leaf anatomical characters of some cultivars and interspecific hybrids at different levels of ploidy-T.S. Lamina.

Variety / hybrid		Lamina thickness u	Thickness of epidermis Ab/Ad u	Thickness of palisade u	Diameter of palisade u	Thickness of spongy parenchyma u	Thickness of water storage tissue u
Cultivars							
U.S. - 52	(4n)	195.1 ± 32.6	13.0 ± 1.4 / 17.7 ± 0.9	91.7 ± 15.9	10.1 ± 0.7	41.9 ± 7.3	35.7 ± 2.5
Kadiri	(4n)	193.4 ± 16.6	13.5 ± 2.0 / 15.5 ± 1.7	91.4 ± 11.2	11.4 ± 0.3	36.5 ± 3.2	36.8 ± 2.0
Gangapuri	(4n)	209.5 ± 11.7	16.5 ± 0.9 / 18.4 ± 3.0	100.3 ± 8.2	9.4 ± 0.4	37.4 ± 3.1	36.0 ± 1.0
Chico	(4n)	194.6 ± 17.2	13.9 ± 0.9 / 16.3 ± 1.4	84.9 ± 11.8	8.6 ± 0.7	43.1 ± 4.4	36.4 ± 6.3
Interspecific hybrids							
TMV_2 × *A. chacoense*	(3X)	206.2 ± 15.1	14.8 ± 1.9 / 15.0 ± 2.1	90.0 ± 6.8	9.6 ± 1.8	46.4 ± 8.7	42.8 ± 7.8
M_{13} × *A. chacoense*	(3X)	173.2 ± 7.0	13.2 ± 2.7 / 12.8 ± 3.1	84.0 ± 5.9	10.4 ± 2.0	32.0 ± 6.8	31.2 ± 3.1
Acholiwhite × *A. chacoense*	(3X)	181.6 ± 16.2	14.4 ± 2.8 / 16.4 ± 3.9	82.0 ± 8.0	11.2 ± 1.7	42.0 ± 7.1	24.4 ± 7.1

Table 2. Contd...

Variety / hybrid	Lamina thickness u	Thickness of epidermis Ab/Ad u	Thickness of palisade u	Diameter of palisade u	Thickness of spongy parenchyma u	Thickness of water storage tissue u
TMV_2 × *A. correntina* (4X)	209.8 ± 13.0	12.8 ± 2.5 / 17.0 ± 5.0	96.0 ± 9.9	10.4 ± 1.8	37.6 ± 6.3	46.4 ± 6.8
M_{13} × *A. villosa* (4X)	212.0 ± 9.8	13.6 ± 2.8 / 16.8 ± 1.7	92.0 × 4.2	11.8 ± 2.7	44.8 ± 8.2	44.8 ± 10.1
Florunner × *A. chacoense* (4X)	144.4 ± 17.6	11.6 ± 2.9 / 15.2 ± 4.1	70.8 ± 9.4	8.0 ± 1.3	26.8 ± 4.6	20.0 ± 1.3
GDM × *A. chacoense* (5X)	222.2 ± 18.2	14.2 ± 4.2 / 19.6 ± 2.9	98.0 ± 8.0	12.0 ± 1.0	42.8 ± 7.3	53.2 ± 13.3
TMV_2 × *A. chacoense* (6X)	230.1 ± 13.3	12.7 ± 2.8 / 16.7 ± 3.0	114.5 ± 6.5	13.4 ± 1.9	51.2 ± 11.2	33.6 ± 12.0
Acholiwhite × *A. chacoense* (6X)	210.7 ± 8.5	12.6 ± 4.0 / 18.1 ± 2.6	96.2 ± 6.2	11.1 ± 0.8	43.8 ± 5.2	40.0 ± 9.1
GDM × *A. chacoense* (6X)	244.8 ± 9.4	13.6 ± 2.0 / 21.6 ± 6.0	104.0 ± 10.0	11.2 ± 0.8	42.4 ± 7.1	53.2 ± 6.5

into small bits vertically and the bits of the middle region were taken and processed through the conventional methods of dehydration, infiltration and embedding.

Sections were cut with a Spencer microtome at 8-10u thickness, stained with safranin fast green double stain and mounted in D.P.X. mountani. Length of stomata and thickness of different tissue layers in transections were measured with an ocular micrometer. Number of stomata and epidermal cells etc. were counted under a field area of 0.08 mm^2.

RESULTS AND DISCUSSION

The mean values in respect of eleven anatomical characters in the different plants studied are presented in Tables 1 and 2 and a comparison of these characters in different groups under Table 3.

From the present study, it is observed that, the adaxial leaf surface in ground nut is characterized by - (i) higher number of stomata and (ii) lower frequency of hairs, compared to the abaxial surface. Pallas (1980) observed an abnormally higher cooductance from the adaxial side of the leaf in groundnut than from the abaxial surface. The differences observed in the present study lend support to such a finding.

The diploid species showed higher values than the Tetraploid species for the parameters such as: (i) frequency and length of hairs, (ii) frequency of stomata; (iii) lamina thickness and (iv) thickness and diameter of palisade. The difference in the palisade thickness between the diploid and tetraploid species is statistically significant ('t' = 4.11 $p>0.01$). Thicker palisade in the diploids than the tetraploids has earlier been reported in *Gossypium*. (Tutayuk and Sadykhova 1969) though the lamina was thicker in the tetraploids.

Leaf anatomical characters such as longer epidermal hairs and smaller size of stomata are found to be useful in making the plant resistant to various insects and diseases (Hemingway 1957; D' cruz and Upadhyaya 1961 and Webster *et al* 1957). In *Arachis*, the features such as decreased size of epidermal cells, higher frequency of epidermal hairs, strongly developed palisade and higher percentage of water sortage tissue were found to be associated with drought resistance (Surya Kumari 1984).

It is evident from the present study, that the 'triploid' hybrids with intermediate values; of their parents i.e. the cultivars and the diploid wild species of the section '*Arachis*' are a valuable source for further genetic engineering (Table 3).

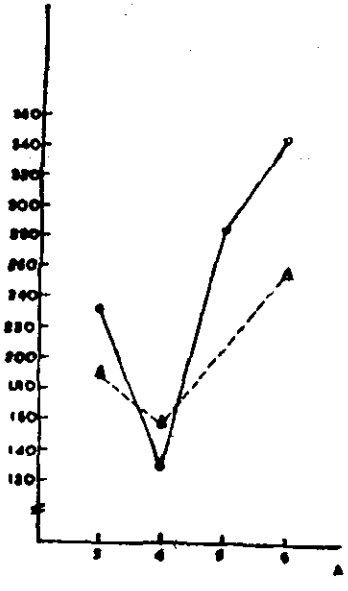
Among the triploid, tetraploid and hexaploid Hybrids between $TM''_3 \times$ A *Chancoense*, characters such as (i) length of hairs, (ii) thickness of palisade, (iii) diameter of palisade, (iv) thickness of spongy parenchyma and (v) lamina thickness showed a gradual increase with the ploidy level with the exception of the tetraploid level, the sequence being $4x>3x>5x>6x$. A similar trend was observed even when the data for all the hybrids is pooled (Fig. 1 A - D).

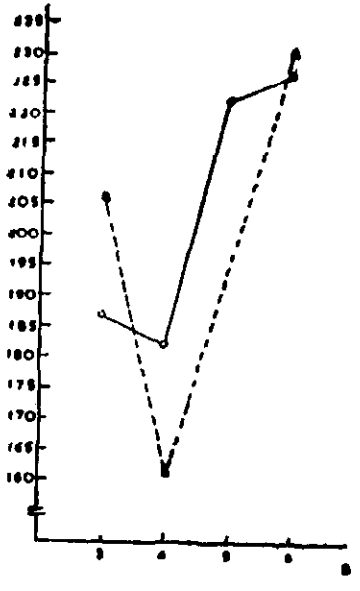
TABLE 3. Comparison of leaf anatomical characters in different groups studied.

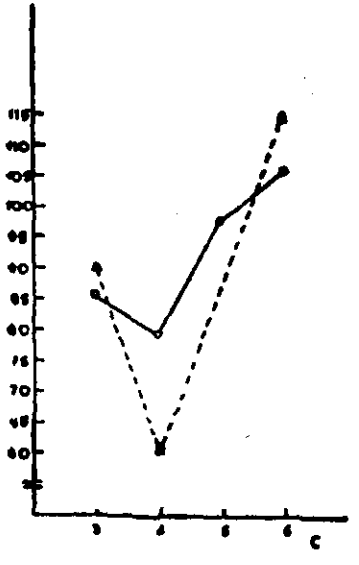
		Wild species			Cultivars 4n	Interspecific hybrids 3X	Derivatives of 3x hybrids		
		2n	4n	2nd sps of section Arachis			4X	5X	6X
Epidermis									
Number of epidermal cells mm^{-2}	Ab	654.0	676.0	620.0	372.0	457.0	370.0	389.0	345.0
	Ad	637.0	709.0	571.0	394.0	419.0	455.0	340.0	3190
Number of hairs mm^{-2}	Ab	63.0	38.3	52.6	13.0	25.6	13.0	27.0	18.3
	Ad	40.8	15.5	32.6	4.0	15.6	13.7	1.0	5.3
Length of hairs (u)		270.3	120.5	271.8	177.0	232.3	129.0	284.0	349.0
Number of stomata mm^{-2}	Ab	298.0	251.0	308.0	182.0	157.6	212.7	112.0	109.6
	Ad	326.0	285.0	345.0	203.0	194.0	204.0	167.0	147.0
Length of stomata (u)	Ab	15.0	13.9	15.2	27.0	23.0	21.8	27.0	28.0
	Ad	13.5	13.6	13.5	23.1	19.3	22.1	24.0	24.8

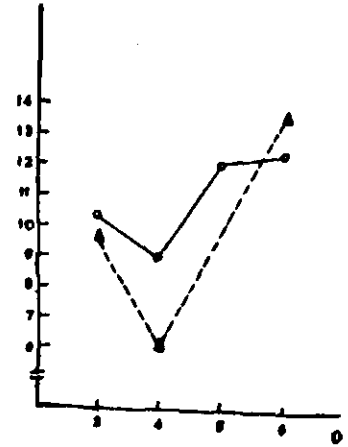
Table 3. Contd...

		Wild species			Cultivars	Interspecific hybrids	Derivatives of 3X hybrids		
		2n	4n	2nd sps of section Arachis	4n	3x	4x	5x	6x
T.S. Lamina									
Lamina thickness (*u*)		173.7	149.3	165.5	198.1	187.0	181.9	222.2	228.5
Thickness of epidermis (*u*)	Ab	12.4	15.5	12.5	14.2	14.1	12.0	14.2	12.9
	Ad	15.1	16.3	15.2	16.9	14.7	15.2	19.6	18.8
Thickness of palisade (*u*)		83.6	56.3	78.9	92.0	85.3	79.7	98.0	104.9
Diameter of palisade (*a*)		8.1	7.8	8.2	9.8	10.4	9.0	12.0	11.9
Thickness of spongy parenchyma (*u*)		31.8	26.8	31.2	39.7	40.1	36.0	42.8	45.8
Thickness of water storage tissue (*u*)		30.8	34.4	27.7	36.2	32.8	39.4	53.2	42.2









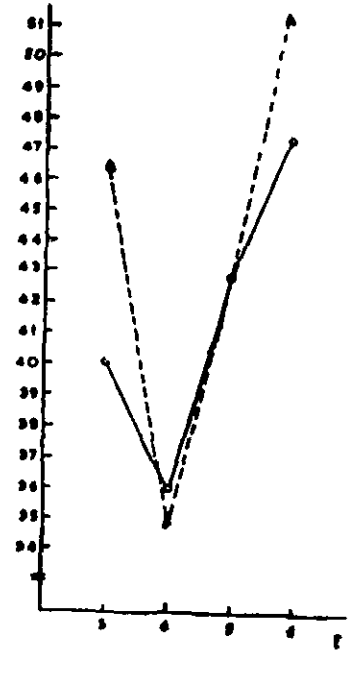


FIG. I. A–E PLOIDY LEVEL Vs LEAF ANATOMICAL CHARACTERS

A — Length of hairs in μ

B — Lamina thickness in μ

C — Total thickness of Palisade in U

D — Diameter of Palisade in μ

E — Thickness of spongy parenchyma in μ

o—o Average of all hybrids

Δ—Δ TM V_3/A. Cheesense.

Though a gradual increase or decrease of a particular anatomical feature with increasing ploidy is not uncommon (Rajendra *et al* 1978) and Tutayuk and Sadykhova 1969), the deviation encountered at the tetraploid level in the present study could not be ascribed to any specific reason at this stage.

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LITERATURE CITED **REFERENCES**

BINGHAM, E.T. (1968).Stomatal chloroplasts in Alfalfa at four ploidy levels. *Crop. Sci.* **8**:509-510.

D'CRUZ, R. and UPADHYAYA, B.R. (1961). Stem and leaf anatomy of *Arachis*. *Indian Oil Seeds Journal* **5**(4), 239-244.

HEMINGWAY, J.S. (1957). The resistance of groundnuts to Cerospora leaf spots. *Empire Journ of Exper. Agric.* **25**(97), 60-68.

METCALFE, C.R. and CHALK, L. (1950). Anatomy of the Dicotyledons Vol.I Oxford at the Clarendon Press.

MURTHY, U.R., BHARATHI, M. KIRTI, P.B. and JAHNAVI, M.R. (1981). Some problems and prospects in the interspecific Hybridization in *Arachis Hypogaea* L. with special reference to alien incorporation. Technical Bulletin No.2 National Fellow Project on Sorghum and groundnut, IARI, Regional Station, Hyderabad, India.

PALLAS, JAMES E. JR. (1980). An apparent anomaly in peanut leaf Conductance. Plant Physiol. **65**, 848-851.

RAJENDRA, B.R., MUJEEB, A.A. and BATES, L.S. (1978). Relationships between 2x Hordeum sp. 2x secale sp. and 2x, 4x, 6x Triticum sp. for stomatal frequency, size and distribution. *Environmental and Experimental Botany* **18**:33-37.

REED, E.L. (1924). Anatomy, Embryology and Ecology of Arachis Hypogaea. *Bot. Gaz.* **78**,: 289-310.

SURYAKUMARI, D., SESHAVATHARAM, V. and MURTHY, U.R. (1983). Comparative leaf anatomy of the wild species and cultivated varieties of the genus *Arachis*. *Oleagineux* **38**, 27-40

SURYAKUMARI, D. (1984). Leaf anatomical and embroyological studies in the genus Arachis L. Ph.D. thesis, Andhra University, Visakhapatnam.

TUTAYUK, V.Kh. and SADYKHOVA, L.D. (1969). Anatomical examination of the leaf structure of varied chromosomal forms of the cotton plant *Gossypium* L. *Izy. Akad. Nauk, Azerb, SSR, ser. Bid. Nauk*, **1**:3-9.

WEBSTER, J.A., SMITH, D.H. JR., RATHKE, E. and CRESS, C.E. (1975). Resistance to cereal leaf beetle in wheat: and length of leaf-surface pubescence in four wheat lines. *Crop. Sci.* 15.

YARBROUGH, J.A. (1957). *Arachis hypogaea*. The seedling, its epicotyl and foliar organs. *Am. J. Bot.* **44**, 19-30.

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STUDIES ON THE EMBRYOLOGY OF THE GENUS *ARACHIS* L

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ABSTRACT

Structure and development of the ovule, embryo sac, endosperm, embryo and seed coat were studied in 4 wild species and a cultivar of *Arachis*. The archesporium is hypodermal and cuts off a parietal cell. Development of the embryo sac conforms to the Polygonum type. Aerial pegs contain two celled embryo with four nucleate endosperm. Endosperm development is *ab initio* Nuclear. Endosperm nodules are observed at the globular embryo stage in the cultivar. Embrayogeny conforms to the solanad type. Seed coat consists (1) a single layered outer palisade, (ii) 20-25 middle layers and (iii) a single layer of isodiametric cells.

Key words : *Arachis*, **embryology, seed coat.**

INTRODUCTION

Arachis is a South American genus having about 40 to 70 species, belonging to the subtribe '*Stylosanthineae*' tribe Hedysareae, subfamily Papilionoideae and family Leguminosae (Taubert 1894). Most of the species of the genus are diploids (2n = 20) and only a few are tetraploids (2n=40). Gregory *et al* (1973) included the species of *Arachis* in seven different sections. Among the tetraploid species only *A. hypogaea* L. is of major economic importance. Earlier information on the embryology of the genus is based entirely on the cultivated species, *A. hypogaea* of section *Arachis* (Reed 1924; Patel and Narayana 1935; Shibuya 1935; Banerji 1938; Smith 1946; 1956a, 1956b; Conagin 1957; Raman and Nagarajan 1958; Gerassimova Navashina 1959 and Sudha Prakash 1960). Bharathi (1981) studied the embryological events in three wild species viz. *A. chacoense* Krap. et. Grey. nom. rand of section *Arachis*, *A. hagenbeckii* Harm and *A. glabrata* Benth of section *rhizomatosae*. The development of seed coat was not studied in *A. hypogaea* so far. The structure and development of the ovule, embryo sac, endosperm and embryo in four wild species and the development of endosperm, embryo and seed coat in a cultivar of *A. hypogaea* are presented here.

MATERIALS AND METHODS

The species investigated were *A. duranesis* sp. Nov. and *A. monticola* Krap et. Rig. of Section *Arachis*; *A. marginata* Gardn. of Section Extranervosae and *A. pusilla* Benth of section *Triseminale* and a cultivar N.S. 5 of *A. hypogaea* L. of section *Arachis*. The plants were grown during the *rabi* season of 1981 at the regional research station IARI, Rajendranagar, Hyderabad. Flower buds, flowers, aerial and subterranean pegs were fixed in F.A.A. and were processed through the conventional methods

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of dehydration, infiltration and embedding. Sections were cut at 8-12*u* thickness and stained in Delafield's haematoxylin.

RESULTS

I. Ovule, Megasporogenesis and Female gametophyte :

The ovules are anatropous crassinucellate and bitegmic. The micropyle is formed by both the integuments and the path is zigzag. The vascular supply to the ovule ends near the chalaza. The archesporium in the ovule is hypodermal and is represented by a single cell in all the species, it cuts off a parietal cell (Fig. 1) which by further divisions gives rise to a parietal tissue of 2-3 layers above the megaspore mother cell. Two megaspore mother cells have been observed occasionally in *A. pusilla* (Fig.2). The megaspore mother cell undergoes usual meiotic divisions resulting in a linear tetrad of megaspores (Fig. 3). In *A. pusilla* the megaspore mother cell undergoes a meiotic division and forms a dyad. Out of the two resulting cells, only the cell towards the chalaza divides further resulting in a triad(Fig. 4). The mature embryo sac is eight nucleate and consists of an egg apparatus, two polar nuclei and three antipodals. The antipodals are ephemeral and degneerate prior to fertilization in all the species (Fig. 5). Starch grains are seen even from the 4-uncleate stage of embryo sac in *A. marginate* (Fig. 6).

Most of the ovules in the aerial pegs are found to have a 2-celled embryo with a 4-nucleate endosperm. Further development of the embryo and endosperm take place after the pegs penetrate the soil.

2. Endosperm :

Endosprem development is *ab initio* nuclear. The fertilized embryosac contains starch grains in abundance during its early development. In the wild species, the starch grains are mostly digested when the endosperm shows 16 nuclei; and the embryo is in its octant stage; while in the cultivar N.S. -5 they persist upto the globular stage of the embryo (Fig. 10). Free nuclear divisions in the endosperm continue until the embryo reaches early dicotyledonous stage. In *A. hypogaea* N.S.-5 a higher number of endosperm nuclei occur at this stage (Fig. 8) whereas in the wild species their number is much less. Wall formation is initiated at the micropylar region when the embryo is at the early dicotyledonous stage in *A. monticola* (Fig. 7); but it is delayed upto the formation of a late dictoyledonous embryo in the cultivar N.S. -5 (Fig. 9). Endosperm nodules enclosing 4-5 nuclei are frequently encountered at the globular stage of the embryo (Fig. II) in the cultivar N.S. -5.

3. Embryo :

The developmental stages in the embryogeny of the cultivar and the wild species studied presently (Figs. 12-19) conform to the Solanad type of Johansen (1950) or fall under period I Series C and megarchetype V according to Soueges system (see-

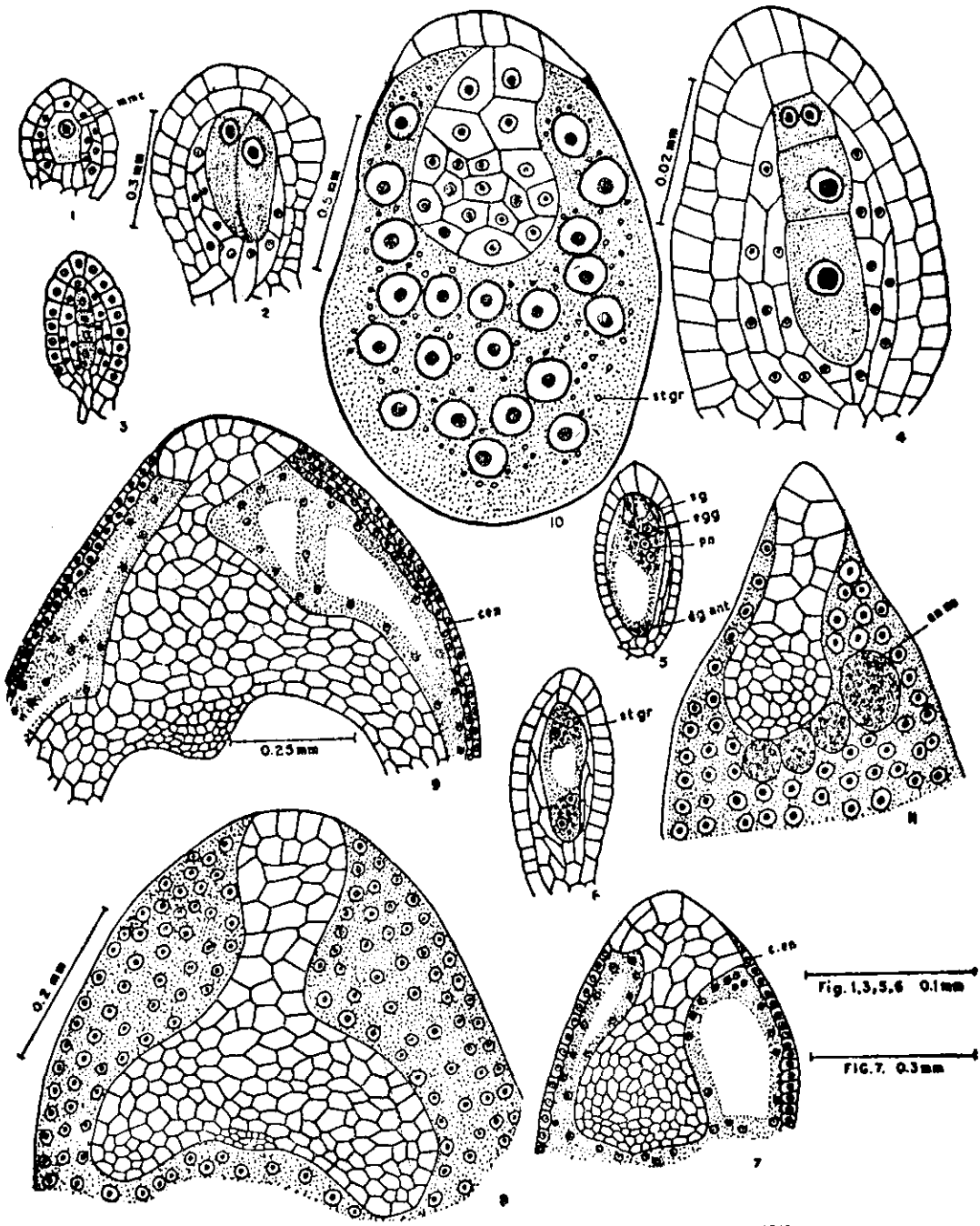

FIG. 1–11. STAGES IN THE DEVELOPMENT OF EMBRYOSAC AND ENDOSPERM.

Fig. 1. *A. monticola.* Megaspore mother cell Fig. 2. *A. pusilla.* Twin megaspore mother cells
Fig. 3. *A. marginata.* Megaspore tetrad Fig. 4. *A. pusilla.* Megaspore triad
Fig. 5. *A. duranensis.* Mature embryo sac Fig. 6. *A. marginata.* Four nucleate emryo sac
Fig. 7. *A. monticola.* Early dicotyledonous embryo
Fig. 8. *A. hypogaea.* N.S.- 5 early dicotyledonous embryo
Fig. 9. *A. hypogaea.* N.S. - 5 Late dicotyledonous embryo
Fig. 10. *A. hypogaea.* N.S. - 5 Globular embryo Fig. 11. *A. hypogaea.* N.S.-5 Globular embryo
(Note the presence of endosperm nodules mmc = megaspore mother cell st gr = starch grains, c en = cellular endosperm, sg = synergid, pn = polar nucleus, dg ant = degenerating antipodals; en no = endosperm nodules)

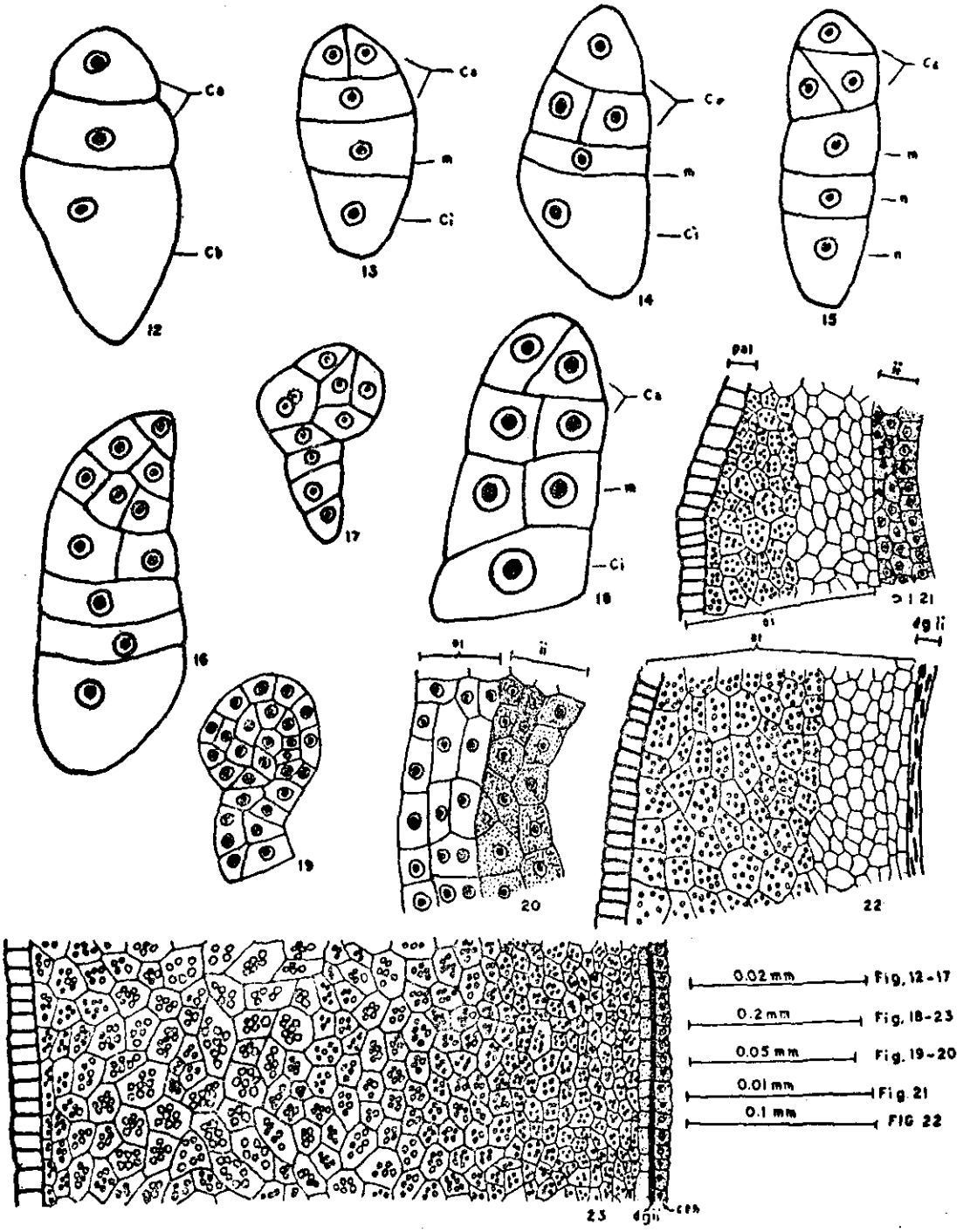

FIG. 12-23 STAGES IN THE DEVELOPMENT OF EMBRYO AND SEED COAT

Figs. 12-17. *A. pusilla* stages in the development of embryo
Fig. 18. *A. duranensis*. Linear proembryo
Fig. 19. *A. duranesis*. Globular embryo
Figs. 20-23. A. Hypogaea N.S. - 5 Stages in the development of seed soat
ca = apical cell, cb = basal cell ii = innerintegument, oi = outer integument, pal = palisade, dg ii = degenerating inner integument, c en = celluar endosperm)

Crete 1963). The sequence of divisions during early embryogeny are similar to those reported earlier (Feed 1924, Smith 1946 and Bharathi 1981).

4. Seed Coat :

The development of seed coat has been studied in N.S. -5 of *A. hypogaea*. Initially, the both the outer and inner integuments are two layered only. Both the integuments become three layered, each due to the periclinal divisions in the inner layer of the outer integument and the outer layer of the inner integument. Further pericliinal divisions occur in the derivative layers of the outer integument only. When the wall is about 11-13 layers thick, the cells of the outermost layer become columnar, with thick walls and constitutes the outer palisade (Fig. 21). Concurrent with these changes, the inner integument gradually disintegrates (Fig. 22) and is completely obliterated in the mature seed. Further divisions in the outer integument continue and in the mature seed it is represented by 23-27 layers. The mature seed coat consists of (1) uniseriate outer palisade of columnar cells, (ii) 20-25 middle layers of parenchymatous cells containing starch grains, whose size gradually decreases towards the embryo side and (iii) a single layer of isodiametric cells which represented the innermost layer of the outer integument (Fig. 23).

DISCUSSION

No significant differences could be recorded in the developmental morphology of the different species belonging to the different sections of the genus, either in the present study or from the earlier available reports. Multiple archesporium recorded presently was also recorded earlier in *Desmodium paniculatum* and *Lespedeza stuevei* (Rembert 1969) and *Oogeinia oojeinensis* (Seshavatharam 1969), belonging to the tribe Hedysareae.

With the exception of *A. pusilla* a linear tetrad of megaspores was reported in all the investigated species viz., *A. hypogaea* (Sec: *Arachis*) (Benerji 1938), *A. chacoense* (Sec. *Arachis*) and *A. hagenbeckii* and *A. glabrata* (section *Rhizomatosae*) (Bharati 1981) In addition to the linear tetrads Bharathi (1981) reported 'T' shaped tetrads in *A. hagenbeckii*. In the present study only a triad was observed in *A. pusilla* (Section *Triseminale*). A similar condition has earlier been recorded in *Ougeinia oojeinensis* belonging to the same tribe by Seshavatharam (1969).

Embryo sac development is uniformly of the Polygonum type in all the species of *Arachis* studied. Abundance of starch grains in the mature emryo sac of *Arachis* reported presently was also recorded by several earlier workers in *A. hypogaea* (Reed 1924; Gerassimova Navashina 1959 and Sudha Prakash 960). However, in *A. marginata* of section *Extranervosae* starch grains appear in the embryo sac even from its 4-uncleate stage of development.

In the present study it was observed that wall formation in the endosperm was initiated only after the dicotyled onous embryo was well adavnced in its growth in the cultivar

N.S. - 5 of *A. hypogaea*. A similar feature has also been reported in *A. hypogaea* by Sudha Prakash (1960). However, among the wild species, wall formation is initiated in *A. monticola* (Section: *Arachis*) just before the differentiation of the early dicotyledonous stage of embryo. Endosperm nodules reported presently in the cultivar N.S. - 5 were not recorded earlier in any other species of *Arachis* though they have been reported in the family Leguminosae in *Tephrosia villosa* by Johri and Garg (1959).

Wild and cultivated species show variation in some fruit characters, the wild species being characterised by, low pod set, smaller size of pod and kernel, catenate pods and a thinner shell. The smaller size of the kernel, in the wild species could be attributed to the comparatively lesser number of endosperm nuclei which results in the poor nutrition of the embryo. The other differences in fruit characters might have evolved during domestication, due to genetic factors and do not have any embryological basis.

Though the seed coat in *A. hypogaea* is derived entirely from the outer integument as in many other legumes, the hour glass cells which are characteristic of the leguminous seeds (Corner 1976) are absent.

Embryological data do not lend any support for the taxonomic treatment of the genus into several sections.

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LITERATURE CITED

BANERJI, I. A note on the embryology of groundnut *Arachis hypogaea* L. *J. Bombay Nat.Hist. Soc.* **40**: 539-543 (1938).

BHARATHI, M. Cytogenetics studies in *Arachis* L. Ph.D. Thesis Osmania University, Hyderabad (1981).

CONAGIN, C.H.T.M. Cytology and seed development in the peanut plant. *Bragantia* **22**, 125-129. (1957).

CORNER, E.J.H. *The seeds of Dicotyledons.* Vol. I pp. 161. Cambridge University Press (1976)

CRETE, P. EMBRYO. In MAHESWARI, P. (Ed.) "Recent Advances in the embryology of Angiosperms" (1963).

GERASSIMOVA NAVASHINA. Embryological observations on *Arachis hypogaea. Bot. Zhur.*, **44.**

GREGORY, W.C., M.Ph. GREGORY, A. KRAPOVICKAS, B.W. SMITH and J.A. YARBROUGH· Structure and genetic resources of peanuts. In: Peanut culture and uses, pp. 47-133 (1973).

JOHANSEN, D.A. : Plant Embryology, Walthan, Mass (1950).

JOHRI, B.M. and S. GARG. Development of endosperm haustoria in some Leguminosae. *Phytomorphology* **9**, 34-46 (1959).

PATEL, J.S. and G.V. NARAYANA. A rare instance of polyembryony in *Arachis hypogaea. Curr. Sci.*, **4**, 32-33 (1935).

RAMAN, V.S. and S.S. NAGARAJAN. Studies in the genus *Arachis* III Polyembryony in the groundnut (*Arachis hypogaea* L.) *Indian Oil Seeds Jour.* **11**(2), 74 (1958).

REED, E.L. Anatomy, Embryology and Ecology of *Arachis hypogaea L. Bot. Gaz.* **78**, 289-310 (1924).

REMBERT, D.H. Comparative megasporogenesis in Papilionaceae. *Am. J. Bot.* **56**, 584-591 (1969).

SESHAVATHARAM, V. "A contribution to the embryology of the Papilionoideae and the Caesalpinioideae", Ph.D. thesis, Andhra University, Waltair (1969).

SHIBUYA, T. Morphological and physiological studies on the frutification of peanut. *Taihoku Imperial Univ. Fac. Sci. and Agri. Memoris*, **17**, 120 (1935).

SMITH, B.W. Macrosporogenesis and embryogeny in *Arachis* hypogaea :L. as related to seed failure. *Am. J. Bot.* **33**, 826 (1946).

SMITH, B.W. *Arachis hypogaea* L. Normal megasporogenesis and SYNGAMY WITH OCCASIONAL SINGLE FERTILISATION. *Am. J. Bot.* **43**, 81-89 (1956a).

SMITH, B.W. *Arachis hypogaea* L. Embryogeny and the effect of peg elongation upon embryo and endosperm growth. *Am. J. Bot.* **43**, 233-240 (1956b).

SUDHA PRAKASH. The endosperm of *Arachis hypogaea* L. *Phyto morphology*, **10**, 60-64 (1960).

TAUBERT, P. Leguminosae. In: A Engler and K. Prantl (ed.) Die naturlichen Pflanzen familien III Teil Abt. 3 (*Arachis*) **322**, 324-325 (1894).

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COMBINING ABILITY AND GENETIC ARCHITECTURE OF OIL CONTENT IN CASTOR (*RICINUS COMMUNIS* L.)

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ABSTRACT

A set of twelve diverse castor genotypes was studied in a partial diallel cross to investigate heterosis, general and specific combining ability and mode of inheritance for oil content in seeds. Considerable degree of heterosis was observed for this quality character. Variances due to *gca* and *sca* revealed that additive as well as non-additive gene action was involved in the inheritance of seed oil content with predominant role of non-additive gene action. The parents viz; TMV-5 JM-3 and 240 exhibited significant positive *gca* effects and high *per se* performance suggesting that parents were good general combiners. The crosses 2-73-11 × SH-38 and SH-15 × 2-73-11 showed high *sca* and heterotic effects eventhough both parents of the crosses poor for *per se* peroprmance and *gca* effects, indicating the presence of non-additive gene action. The results suggested that exploitation of heterosis for oil seed content in castor would be possible by selecting specific combinations.

Key Words : *Combining ability, genetic architecture, Ricinus Communis L.*

INTRODUCTION

Castor (*Ricinus Communis* L.) being an important oilseed crop the ultimate of productivity is the oil yield, which depends on seed yield and oil content. Efforts are being made to increase seed yield, but little attention has been paid for oil content. Therefore, presnet study was attempted to look into the genetic architecture of oil content which would facilitate the choice of superior parents and in the formulation of an effective breeding methodology suited for castor.

MATERIALS AND METHODS

Twelve genotypes of castor viz; VP-1, 240, 48-1, HC-8, SH-57, SPS-35-9B, SH-15, TMV-5, 2-73-11, SH-38, SH-49 and JM-3 differing in morphological characters were crossed in all possible combinations excluding reciprocals . All the parents and their 66 F hybrids were grown in randomized block design with three replications at Regional Research Station, GAU, Sardarkrushinagar during 1985-86. Each plot consisted of 15 plants having an inter and intra - row spacing of 90 cm. X 60 cm. The bulk seed sample of each progeny collected at the time of harvesting from all the replications was used for analysis of oil content. The analysis of general and specific combining ability variances and effects was done according to Griffing's (1956) method 2 and model 1.

RESULTS AND DISCUSSIONS

Analysis of variance revealed that the variances due to parents, hybrids and parents vs. hybrids were highly significant (Table-1). Results suggested the presence

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TABLE 1. Analysis of variance for randomized block design.

Source	D.f.	M.S.
Treatment	77	10.22^{xx}
Parents	11	12.85^{xx}
Hybrids	65	9.84^{xx}
Parents Vs. hybrids	1	5.59^{xx}
Error	154	0.22

XX Significant at P = 0.01.

of sufficient amount of genetic variability for oil content in seeds among the progenies under study. Out of sixty six crosses studied, nineteen exhibited positive and significant heterosis and eight crosses showed positive and significant heterobelteosis. The values of positive heterosis and heterobelteosis varied from 2.38 to 7.83 and 1.95 to 5.91 per cent respectively (Table - 2). Thus, considerable amount of heterosis was observed for this trait.

TABLE 2. Some selected crosses showing significant positive heterosis for oil content

Sr. No.	Crosses	% Heterosis	% Heterobeltieosis
1	240 × HC - 8	3.61	3.37
2	SH - 57 × SH - 38	4.68	4.18
3	SH - 15 × 2-73-11	5.92	5.37
4	SH - 15 × SH - 38	6.26	3.84
5	SH - 15 × SH - 49	2.38	2.13
6	2-73-11 × SH - 38	7.83	5.91
7	2-73-11 × SH - 49	4.17	3.38
8	SH - 38 × JM - 13	7.29	1.95

The mean sum of squares due to general and specific combining ability were highly significant (Table - 3). Since the mean squares due to general and specific combining ability do not provide the clear picture regarding the relative magnitude of additive and non-additive genetic components, the unbiased variance due to both general (σ^2 g) and specific (σ^2s) combining abilities alongwith the ratio σ^2/σ^2g were calculated. The results indicated the presence of both additive and non-additive genetic components. But the magnitude of σ^2s was approximately five times higher than the corresponding σ^2g suggesting that oil content in seeds appeared to be predominantly under the control of non-additive gene action.

TABLE 3. Analysis of variance for combining ability for oil content in castor

Source	d.f.	Mean sum of squares
General combining ability	11	6.84**
Specific combning ability	66	2.83**
Error	154	0.07

o^2 gca	0.48
o^2 sca	2.76
o^2 sca / o^2 gca	5.75

** Significant at P = 0.01

The estimation of general and specific combining ability with respect to parents and F_1 crosses respectively would be of immense use for the characterisation of genetic material (Table-3). The parent TMV-5 exhibited the highest gca effect followed by JM-3 and 240 for oil content. A positive association of gca effects and *per se* performance was observed for these parents. It is therefore, suggested that the above good general combining parents could be used extensively in future breeding programme for the development of high oil content varieties.

An analysis of sca revealed that out of 66 crosses studied 27 crosses exhibited significant positive sca effects for oil content. The cross 240x HC-8 possessed the highest sca effect (2.93) whereas the minimum sca effect was recorded for a cross VP-1xSH-57 (0.55). Rest of the crosses possessing desirable sca effects were mid-way between these two extremes. Among the above 27 promising cross combinations, 14 crosses resulted from at least one good general combiner. Results revealed that the additive x dominance type of gene interaction was important in these crosses. The remaining 13 crosses involving low x low general combiners showed good sca effects, indicating epistatic type of gene action which may be due to genetic diversity in the form of heterozygous loci.

The combining ability and genetic components analysis have shown the preponderance of non-additive genetic variance towards the inheritance of oil content in castor. Under this situation expoitation of hybrid vigour is the best method for oil improvement as pistillate lines are available in this crop. The importance of additive genetic variance can not be ruled out. In such a condition maintenance of certain degree of heterozygosity will be desirable. The most suitable breeding methodology for improving oil content in castor would be one which mops up the additive genetic variance and at the same time maintains heterozygosity for exploiting the dominance effect. Therefore, to practice recurrent selection by way of intermating the most desirable segregants alternately with selection appears to facilitate exploitation of the additive and nonadditive gene effects, simultaneously.

TABLE 4. General (Diagnol) and Specifc (off diagnol) combining ability for oil content in castor

	VP - 1	240	48-1	HC-8	SH-57	SPS-35-9	SH-15	TMV-5	2-73-11	SH-38	SH-49	JM-3
VP - 1	0.05	1.12^{xx}	0.46	1.71^{xx}	0.55^{x}	-0.56^{xx}	-1.21^{xx}	-1.65^{xx}	-1.70^{xx}	-0.28	-1.33^{xx}	0.02
240		0.60^{xx}	-0.23	2.93^{xx}	2.63^{xx}	-1.78^{xx}	0.57^{xx}	-1.93^{xx}	-0.59^{x}	-1.23^{xx}	0.62^{x}	-2.59^{xx}
48 - 1			-0.33^{xx}	1.80^{xx}	1.43^{xx}	-0.84^{xx}	-1.23^{xx}	-0.10	-0.18	-2.30^{xx}	-1.68^{xx}	-2.09^{xx}
HC - 8				-3.09^{xx}	0.22	-0.45	-4.64^{xx}	-0.38	-1.60^{xx}	-1.18^{xx}	-1.13^{xx}	-1.27^{xx}
SH - 57					-1.22^{xx}	-4.38^{xx}	0.63^{xx}	1.69xx	-2.73^{xx}	0.66^{xx}	0.01	1.00^{xx}
SPS - 35 - 9B						-0.18^{xx}	0.79^{xx}	-0.25	0.33	1.72^{xx}	0.30	-0.11
SH - 15							-0.23^{xx}	-0.50^{x}	2.31^{xx}	1.80^{xx}	0.75^{xx}	1.14^{xx}
TMV - 5								1.31^{xx}	1.01^{xx}	0.73	1.74^{xx}	-0.93^{xx}
2 - 73 - 11									-0.14^{x}	2.17^{xx}	1.26^{xx}	1.48^{xx}
SH - 38										-0.36^{xx}	-0.29	2.47^{xx}
SH - 49											-0.14^{x}	0.95^{xx}
JM - 3												1.14^{xx}

SE (gi) ± 0.07 SE (sij) ± 0.25 x P = 0.05

SE (gi-gj) ± 0.10 SE (sij-skl) ± 0.36 xx P = 0.01

REFERENCES

FATTEH, U.G., DANGARIA, C.J., DOBARIYA, K.L. and PATEL, V.J. 1987. Combining ability for seed characters in Castor. J. Oilseeds Res. **4**:54-58.

GIRIRAJ, K., MENSINKAI, S.W. and SINDAGI, S.S. 1974. Components of genetic variation for yield and its attributes in 6×6 diallel crosses of Castor. Indian J. Agric. Sci. **44**:132-36.

GRIFFING, B. 1956. Concept of general and specific combining ability in relation to diallel crossing system. Aust. J. Biol. Sci. **9**:469-493.

HOOKS, J.A., WILLIAMS, J.H. and GARDNER, C.O. 1971. Estimate of heterosis from diallel cross of inbred lines of Castor. Crop. Sci. **11**:651-655.

MATHER, K. and JINKS, J.L. 1971. Biometrical Genetics. 2nd Edition, Chapman and Hall Ltd. London.

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GENETIC ANALYSIS OF CHARACTERS ASSOCIATED WITH DROUGHT TOLERANCE IN INDIAN MUSTARD[1]

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ABSTRACT

Combining ability analysis was carried out for three physiological characters related with drought tolerance in Indian mustard. The characters studiedwere leaf water potential, relative water content and number of stomata per unit leaf area. Twenty three parents 60 F_1S and 60 F_2S generated by line × tester mating design were studied during rabi 1984-85. Mean squares due to genotypes were significant for all the three traits in both F_1 and F_2 generations. The study indicated the preponderance of non-additive gene effects in the expression of these traits. In general, RH 7827, RK 1418 CSR 212 and V10 were good general combiners. Among the cross combinations, several crosses exhibited consistency in performance with genearation advancement for all the traits Most of the crosses were the resultant of at least one good combining parent. The results have been discussed in relation to breeding methodologies in Indian mustard.
Key Words :-Indian mustard, drought tolerance, genetic analysis.

INTRODUCTION

Indian mustard (*Brassica juncea* L. (Zern. and Coss.) is reckoned as the most important oilseed among the *Brassica* group because of its high production potential. But under Indian conditions, it is generally grown on soils with limited water storage capacity as a rainfed crop. Even under conditions of limited irrigation it has been found to suffer from moisture stress at one or other stages of crop growth, depending upon the winter rains or availability of irrigation water.

Different breeding strategies for the development of higher yielding genotypes with drought tolerance are currently receiving considerable attention. Theses different approaches are based more on the physiological mechanisms influencing yield under drought. By and large, the studies in Indian mustard have been conducted under normal conditions of irrigations and very little is known about the extent of variability of physiological characters under limited moisture environments. Therefore an attempt was made to study the genetic architecture of some physiological characters responsible for drought tolerance in Indian mustard to enable a breeder to persue a systematic breeding programme.

MATERIALS AND METHODS

Twenty widely diverse female lines of Indian mustard selected at random were hybridized with three moderately drought tolerant, broad based male testers (KRV tall, KRV 24 and RH 7827) during *rabi* 1983-84. All the 23 parents, their 60 F_1S and 60 F_2S (generated during *Kharif*, 1984 in Kashmir) were grown in Randomised Block Design with three replications during rabi 1984-85 under moisture scarcity conditions at Kanpur. The genotypes were sown in a three row plot at a spacing of 50 cms. and 15

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cms. between and within rows, respectively. A single non-experimental row was grown all around the experimental area. The parents, their F_1S and F_2S were studied for leaf water potential using Plant water Status Console, Relative Water content (Weathrly and Slatyer, 1957) and number of stomata per unit leaf. area. Observations on these characters were recorded on five plants selected at random among those of each parent and hybrid, and ten plants from F_2 populations. Leaf water potential was determined on the fourth leaf from the base and other two characters from five randomly selected leaves of each selected plant. The data was then averaged to a single basis. Thecombining ability analysis was carried out using the methodology of Kempthorne (1957).

RESULTS AND DISCUSSIONS

The mean squares due to genotypes (Table 1) were highly significant for all the three characters in both F_1 and F_2 generations indicating thereby presence of considerable variation in the material. The interaction mean squares due to line x tester were also significant for all the characters in both the generations.

TABLE 1. Analysis of variance for combining ability with respect to three physiological characters in Indian mustard.

Source	D.F.	Leaf water potential		Relative water content		No. of Stomata per unit leaf area	
		F1	F2	F1	F2	F1	F2
Replications	2	1.03**	0.72**	14.26**	5.56**	0.16	0.13
Genotypes	59	5.47**	7.04**	140.27**	101.33**	30.11**	34.37**
Lines	19	5.96	6.62	135.35	81.09	26.02	25.38
Testers	2	8.37	13.35	206.56	43.28	13.49	20.08
Line × tester	38	5.07**	7.02**	138.95**	114.50**	33.02**	39.62**
Error	118	0.11	0.12	0.80	0.75	0.15	0.11
ó gca (M&F)		0.06	0.57	0.94	1.51	0.38	0.49
ó sca		1.65	2.30	46.05	37.91	10.96	13.17

P* = 0.05 **P = 0.01

The analysis of variance for combining ability revealed predominance of specific combining ability for all the characters. The non-additive variance component tended to increase in the F_2 generation. Among the testers, RH 7827 exhibited significant and positive gca effect for number of stomata per unit leaf area in both the generations

TABLE 2. Estimates of gca effects with respect to three physological characters in Indian mustard

S. No.	Parent Males	Leaf water potential		Relative water content		No. of Stomata unit per leaf area	
		F1	F2	F1	F2	F1	F2
1.	KRV tall	0.39**	-0.49**	1.86**	-0.76**	-0.32**	-0.39**
2.	KRV 24	-0.35**	0.17**	-0.02	-0.15	-0.23**	-0.27**
3.	RH 7827	-0.03	0.32**	-1.85**	-0.92**	0.55**	0.66**
4.	S.E. (gim) ± Females	0.04	0.04	0.12	0.11	0.05	0.04
4.	K1	0.16	0.91**	-1.38**	3.57**	1.30**	-2.74**
5.	A 11	0.05	-2.09**	1.50**	-5.30**	-0.08	2.19**
6.	Laha-101	-0.47**	-0.83**	-3.35**	-2.24**	2.04**	0.43**
7.	RK 8201	-0.51**	0.55**	-1.77**	1.98**	0.65**	-0.74**
8.	RK 8202	-0.26**	-0.29**	-3.22**	-1.58**	2.54**	0.61**
9.	KR 5610	0.52**	-0.33**	1.92**	0.77**	-0.07	-0.06
10.	Varuna	1.28**	-0.50**	5.63**	-3.12**	-2.08**	1.31**
11.	KRV 47	0.70**	-0.25**	3.09**	-6.45**	-1.06**	3.93**
12.	RK 1418	0.75**	0.46**	2.55**	1.06**	-0.38**	-1.04**
13.	CSR 975	-0.64**	0.57**	-1.32**	1.80**	-0.18**	-0.80
14.	CSR 212	0.60**	1.71**	2.04**	6.42**	-1.82**	-2.09**
15.	RK 8204	-0.43**	-0.54**	4.89**	-2.44**	-0.29**	0.32**
16.	V 10	0.50**	0.94**	0.72**	2.06**	-0.92**	-0.92**
17.	B 85	0.99**	0.88**	5.44**	2.02**	-3.55**	-0.67**
18.	RLM 608	-0.06**	0.16	-3.47**	-1.12**	0.28*	2.65**
19.	RH 30	-1.52**	-0.97	-4.55**	0.39	1.25**	0.62**
20.	T 5909	-0.32**	0.71**	-3.04**	0.11	0.87**	0.40**
21.	B 30	1.29**	0.14	5.64**	1.45**	-2.55**	0.71**
22.	RLM 82	-1.32**	-0.43**	-7.74**	1.83**	3.76**	-2.22**
23.	PR 18	-1.00**	0.04	-3.59**	0.35**	0.90**	-0.97**
	SE (gif) ±	0.11	0.12	0.30	0.29	0.13	0.11

(Table-2). The lines which showed significant and positive gca effects in both the F_1 and F_2 generations were RK 1418, CSR 212 and V10 for leaf water potential, RK 1418 CSR 212, V10, B85 and B30 for relative water content and Laha 101, RK 8202, RLM 608 RH 30 and T 5909 for number of stomata per unit leaf area. Considering the level and consistency of gca estimates of F_1 and F_2 generations, these parents appear to be superior combiners and can be used as suitable donors for various physiological characters. Exceptional generation dependant combining ability effects of these parental materials could be attributed to either genotype x environment interaction effect or non-additive inter-all lic interaction. Considering the fact that the materials under study contained significant genetic component for, hither to unknown, physiological characters, it would be feasible to involve them in an appropriate breeding programme which could exploit comparatively more non-additive genetic component than the additive one.

In respect of specific combining ability effects, high sca effects for all the three physiological characters was observed in several crosses. In both the generations the cross combinations involving parents with positive and negative gca effects exhibited positive or negative sca effects. On the other hand, combinations where parents had negative gca effects manifested positive sca effects. In general, it could be suggested that sca effects of any cross combination does not necessarily depend on the level of gca effect of the parents involved. Similar inference has been made from the study of other traits (Yadav *et al*; 1974, Labala *et al*; 1975 and Badwal *et al*; 1976).

The inconsistancy in the sca effects observed in different generations could be attributed either to dominance x dominante interaction. This could also result due to either complementary epistatic interactions or large amount of non-allelic interactions governing the expression of a particular character. However, some crosses did retain their supreior performance even in later generations to a considerable extent, indicating that additive gene effects were also important in the inheritance of these characters. The crosses which retained superior performance in both the generations were eight in number for water potential, ten for relative water content and eight for number of stomata per unit leaf area (Table-3). This parallel behaviour of the parents for gca effects and different crosses for sca effects for the three physiological characters studied was of significance.

Considerable progress has been made in the understanding of physiological changes brought about by water stress and effects of these changes on crop growth and yield. Drought resistance is the result of many frequently independent physiological characteristics whose interaction has not yet been fully elucidated. Most of these characters are under polygenic control and probably exhibit considerable genotype x environment interaction. It is little wonder, therefore, that plant breeders have not succeeded much in breeding speicifically for drought resistance through selection based on physiological processes. However, the present study should make a breeder's job considerably easier. It is possible to use the good general combiners as donors in an appropriate breeding programme. It is also possible to use cross combinations with superior performance for selecting desirable segregates in advanced generations.

TABLE 3. Selected crosses with significant sca effects both in F_1 and F_2 generations in Indian mustard

S.No.	Leaf water potential	Relative water content	No. of stomata per unit leaf area
1.	5×1	5×1	15×1
2.	16×1	8×1	17×1
3.	22×1	16×1	22×1
4.	11×2	11×2	23×1
5.	15×2	15×2	6×2
6.	23×2	18×2	13×2
7.	20×3	23×2	16×3
8.	22×3	20×3	18×3
9.	—	21×3	—
10.	—	22×3	—

Note :- The parents involved in the crosses are serially numbered in table - 2

LITERATURE CITED

BADWAL, S.S., SINGH, M., LABANA, K.S. and CHAURASIA, B.D. 1976. General vesus specific combining ability in raya (*Brassica juncea* L.(Zern and coss). *J. Res. Punjab Agricultural Universirty*, Ludhiana **13**:319-23.

KEMPTHORNE, O—. 1957. An introduction to Genetical Statistics pp. 458-71. John Wiley & Sons, Inc., New York.

LABANA, K.S., BADWAL, S.S. and CHAURASIA, B.D. 1975. Heterosis and combining ability analysis in *Brassica juncea* (L) Zern and Coss. *Crop Improv.* **2**:46-51.

WEATHERLY P.E. and SLATYER R.O. 1957 Relationship between relative turgidity and diffusion pressure deficits in leaves. *Nature* **179**:1085-1086.

YADAV, T.P., SINGH., H., GUPTA, V.P., and RANA R.L., 1974. Heterosis and combining ability in raya for yield and its components . *Ind. J. Genet.* 34A:684-95.

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PERFORMANCE OF SOME LINSEED VARIETIES ON DIFFERENT DATES OF SOWING UNDER RAINFED CONDITION

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ABSTRACT

Sowing of six varieties of linseed (RLC-1, RLC-3, RLC-7 R-1156, R-552 & J-23-10) on four dates of sowing (30 Oct, 9 Nov, 21 Nov, & 30 Nov. 1986 and 16 Oct, 27 Oct, 6 Nov,. & 16 Nov. 1987), showed that the highest yield of 11.01 Q/ha was recorded from the earliest date of sowing which was significantly superior to the second, third and fourth dates of sowing. The growth parameters like plant height, number of primary and secondary branches and yield attribute characters viz., Number of capsules, grains per capsules, grain and straw yield per plant, test weight and harvest index were the highest in the first date of sowing. However, the differences in harvest index were not significant in 1985-86.

Variety RLC-3 gave the highest grain yeild (1236.0 kg/ha) followed by J-23-10 (1043 08kg/ha). The growth and yield attributes showed maximum expression in the variety RLC-3.

Key words: Linseed, Date of sowing, varieties,

INTRODUCTION

Bundelkhand region of Madyha Pradesh has about 60 per cent irrigated area out of which about 50 per cent fall in clay-loam soils. Soybean-wheat, Jowar-wheat/gram/ Linseed is the common crop rotation followed. At present only local varieties are being grown which are very low yielding. Therefore there is a need for high yielding varieties suitable to the climatic conditions prevailing here for early as well as delayed sowings Although work on this aspect has been done elsewhere in M.P. by Shrivas *et al.* (1976) and Jakhmola *et al.* (1973), information on this aspect is lacking for this region. Therefore the present work was undertaken and the results obtained are reported here.

MATERIALS AND METHODS

A field experiment was conducted at the Regional Agricultural Research station, Tikamgarh during Rabi 1985-86 and 1986-87 in split plot design with dates of sowing as main treatment and varieties as sub treatment replicated thrice. The soil of experimental site was clay loam with 7.5pH and 307,330, & 20 kg/ha of available N,P_2O_5 & K_2O respectively. Six varieties (RLC-1, RLC-3, RLC-7, R-1156, R-552, & J-23-10) were sown on four dates of sowing (30th Oct, 9th Nov.21st Nov., 30th Nov., 1985-86 and 16th Oct., 27th Oct., 6th Nov., ; 16th Nov., 1986-87). The plot size was 5x3 sq.m. with a row spacing of 25 cm. At uniform basal dose of NPK @ 40:20:10 kg/ha in the form of Urea, single super phosphate and Muriate of Potash respectively.

Days to flowering, maturity, plant height number of primary and Secondary branches, number of capsules, number of grains per capsules, test weight, grain and

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straw yield per plant and per hectare were recorded and the harvest index was calculated.

RESULTS AND DISCUSSION

Effect of dates of sowing :

Crop duration :- The flowering in October sown crop (D1) started in 44.8 days which was 52.7 days in the late sown crop (D4) (Table-1). The total maturity period was only 119.3 days in late sown crop (D4) but the maturity (135 days) was delayed in the early sown crop. This indicates that the reproductive phase of the early sowing Crop (D1) was 90 days as against only 66 days in the late (D4) sown crop. This factor ultimately influenced the grain yield.

Growth components :- The data in Table-2 show that the maximium plant height (50.88 cm.) the number of primary branches (4.91) and Secondary branches (15.45) were recorded in the early sown crop (D1) and there was a significant reduction in the late sown crop (D3 and D4). The plant height, number of primary and secondary branches and days to maturity reduced and the vegetative phase increased with delayed sowings.

Yield Attributes :- The maximum number (54.48) of capsules, number of grains (9.04) per capsule, grain (2.75) and straw (6.03 gms.) per plant and test weight (8.04 gms.) were recorded in the earliest sown crop (D1) followed by the later (D2) sown crop . There was a gradual reduction in respect of these attributes in D3 and D4. (Table-2).

The harvest index was significantly higher in D1 and D2 than D3 and D4 during both the years but it was statistically significant in 1986-87 only. (Table-3).

Grain yield :- Data (Table-3) indicated that crop sown at the earliest (D-1) gave higher grain and straw yield than the crop sown on later dates during both the years. Every ten days delay in sowing reduced grain yield by 9.29, 20.94, and 33.8, per cent during 1985-86 and 8.77, 19.34 and 30.80 per cent in 1986-87. Significant reduction was observed in grain yield with successive delays in sowing, due to unfavourable conditions of temperature and humidity, particularly during grain filling and development.

These results are confirmatory with Ghamrawy (1959) Shrivas *et al.* (1976) Jakhmola *et al.* (1973) and Anonymous (1985) who also found significantly higher yield in early sowings.

Response of Varieties

Crop duration:- The initiation of flowering occured in 47.5 and 41.1 days in RLC-7, 58.5, and 50.1 days in RLC-3 during 1985-86 and 1986-87 respectively while maturity period ranged from 127.5 and 118.5 days in RLC-7 and 133.5 and 125.6 days in RLC-1 in 1985-86 and 1986-87 respectively. The duration of flowering and total maturity period differed significantly among the varieties (Table-1).

TABLE 1. Effect dates of sowing and varieties on the crop duration and growth components of Linseed at Tikamgarh

Treatments	Days to flower			Days to maturity			Height (cm)			Primary branches			Secondary branches		
	1986	1987	Mean	1986	1987	Mean	1986	1987	Mean	1986	1987	Mean	1986	1987	Mean
D1	48.7	40.90	44.80	140.9	129.0	134.0	45.50	54.67	50.88	4.21	5.61	4.91	8.76	22.15	15.45
D2	47.5	43.04	45.27	135.3	123.0	129.2	46.26	53.15	49.70	4.16	5.00	4.58	8.42	20.56	14.49
D3	52.5	44.54	48.52	126.3	119.0	122.2	42.83	50.52	46.67	3.37	4.67	4.02	7.40	19.20	13.30
D4	55.6	49.83	52.71	122.6	115.9	119.2	40.42	47.47	43.92	2.43	4.27	3.35	6.62	17.50	12.09
S.E (m) ±	0.15	0.22	—	0.33	0.26	—	0.28	0.30	—	0.18	0.16	—	0.18	0.15	—
C.D. (5%)	0.48	0.72	—	1.33	0.83	—	0.89	0.93	—	0.42	0.51	—	0.53	0.53	—
RLC-1	49.62	44.56	47.09	133.5	125.6	129.5	49.50	62.54	56.04	3.62	5.30	4.47	7.28	20.66	13.97
RLC-3	58.50	50.18	54.34	130.4	123.4	126.9	42.50	46.46	44.48	4.35	5.73	5.04	9.82	23.70	16.76
RLC-7	47.50	41.12	44.31	127.4	118.5	122.9	36.00	35.33	35.79	2.58	4.06	3.32	5.31	16.70	10.78
R-1156	48.75	42.73	45.62	133.8	121.0	127.4	44.18	53.18	48.68	3.45	4.62	4.03	7.11	18.95	13.03
R-552	48.87	43.06	49.96	132.5	119.43	125.9	41.67	51.98	46.82	3.14	4.45	3.79	7.94	17.49	12.71
J-23-10	53.00	46.25	49.82	128.5	122.5	125.5	48.67	58.85	53.76	4.11	5.11	4.61	9.72	22.17	15.94
S.E (m) ±	0.21	0.38	—	0.45	0.31	—	0.41	0.37	—	0.11	0.08	—	0.19	0.15	—
C.D. (5%)	0.58	1.07	—	1.06	0.87	—	1.61	1.05	—	0.33	0.23	—	0.5	0.44	—

TABLE 2. Effect of dates of sowing and varieties on the yield attributes of linseed at Tikamgarh

Treatments	No. of capsules			No. of grains/capsule			Grain weight/plant			Straw yield/plant			Test weight (gms)		
	1986	1987	Mean	1986	1987	Mean	1986	1987	Mean	1986	1987	Mean	1986	1987	Mean
D1	26.77	82.20	54.48	9.08	9.01	9.04	1.84	3.67	2.75	4.28	7.78	6.03	7.4	8.68	8.04
D2	25.02	68.22	46.62	9.35	8.67	9.01	1.62	2.90	2.26	3.67	6.95	5.31	7.7	7.49	7.59
D3	23.47	61.51	42.49	9.21	8.45	8.83	1.46	2.44	1.95	3.58	5.80	4.69	6.5	7.03	6.76
D4	20.42	55.53	37.97	7.71	8.07	7.89	1.11	2.13	1.62	3.47	4.64	4.05	5.9	6.66	6.28
S.E. (m) ±	0.52	0.50	—	0.18	0.05	—	0.08	0.06	—	0.26	0.18	—	0.11	0.06	—
C.D. (%5)	1.66	1.62	—	0.58	0.16	—	0.26	0.19	—	NS	0.58	—	0.35	0.20	—
RLC-1	26.72	69.66	48.19	9.01	8.82	8.91	1.64	2.85	2.24	3.98	6.55	5.26	7.4	8.04	7.72
RLC-3	30.15	85.96	73.13	9.12	9.33	9.22	1.84	3.48	2.66	4.28	8.95	6.61	8.4	9.00	8.70
RLC-7	20.18	55.39	37.78	7.54	7.85	7.69	1.26	2.14	1.70	2.85	3.56	3.20	5.4	6.27	5.83
R-1156	21.49	64.51	43.00	8.78	8.10	8.44	1.65	2.48	2.06	3.75	5.64	4.69	7.3	6.83	7.06
R-552	13.82	56.25	35.05	8.78	8.18	8.48	1.09	2.65	1.87	3.44	6.30	4.87	5.1	7.22	6.16
J-23-10	28.29	69.41	48.85	9.63	9.01	9.32	1.58	3.10	2.34	4.16	8.76	5.46	7.5	7.41	7.45
S.E. (m) ±	0.44	0.57	—	0.13	0.04	—	0.06	0.07	—	0.17	0.17	—	0.14	0.06	—
C.D. (5%)	1.22	1.63	—	0.36	0.11	—	0.17	0.20	—	0.47	0.48	—	0.39	0.18	—

TABLE 3. Effect of dates of sowing and varieties on the grain yield, straw yield and harvest index of linseed at Tikamgarh

Treatments	Grain yield kg/ha			Straw yield kg/ha			Harvest index		
	1986	1987	Mean	1986	1987	Mean	1986	1987	Mean
D1	925.00	1277.00	1101.00	1870	2940	2405	33.1	30.0	31.55
D2	839.58	1165.00	1002.29	1462	2630	2046	33.0	30.0	31.5
D3	731.25	1030.00	880.62	1321	2810	1966	32.7	27.0	29.8
D4	618.00	890.00	754.00	1229	2490	1859	32.8	27.0	29.9
S.E. (m) ±	10.2	15.1	—	32	18.72	—	0.9	0.26	—
C.D. (5%)	46.9	48.7	—	100	59.48	—	NS	0.83	—
RLC-1	787.50	1148.00	967.25	1525	3030	2277	32.8	27.0	29.9
RLC-3	1018.15	1454.00	1236.07	1712	3550	2631	39.2	28.0	33.6
RLC-7	628.15	846.00	737.07	1343	1940	1641	28.8	30.0	29.4
R-1156	764.87	1057.00	910.93	1459	2980	2219	32.6	32.0	32.3
R-552	518.25	890.00	704.12	1256	2300	1778	32.2	27.0	29.6
J-23-10	909.37	1177.00	1043.18	1587	3180	2385	34.2	26.0	30.1
S.E. (m) ±	22.9	18.3	—	24	18.9	—	00.4	0.39	—
C.D. (5%)	86.1	46.3	—	70	53.48	—	1.0	1.01	—

Growth compoments :- Significant differences were observed in the growth components i.e. plant height, Primary and Secondary bracnhes in different varieties during both the years. The plant height ranged from 35.7 in RLC-7 to 56.04 cm. in RLC-1 showing significant differences between the varieties. More number of primary (5.04) as well as secondary branches (16.70) per palnt were observed in RLC-3 (Table-1)

Yield Attributes :- The total number of capsules, grain and straw weight per plant and test weight was higher in RLC-3 during both the years. Number of grains per capsules was significantly higher in RLC-3 during 1986-87. However, number of grains during 1985-86 were significantly higher in J-23-10 (Table-2).

Variety RLC-3 superseeded significantly all the other varieties in both the years with respect to straw yield (Table-3). Harvest index was significantly higher in RLC-3 in 1985-86 and R-1156 in 1986-87. The harvest index of RLC-1 RLC- 3and R-552 was significantly higher than variety J-23-10 but without significant differences among the first three in 1986-87'. (Table-3).

Grain yield :- The varieties differed markedly in grain yield in both the years (Table-3). Variety RLC-3 gave significantly higher grain yield than all the other varieties in both the years. Variety J-23-10 was the next best on the basis of Yield during both the years. Varieties RLC-1 and RLC-1156 (1985-86) were at par but were significantly superior to varieties RLC-7 and R-552. Varieties RLC-1 and J-23-10 (1986-87) were at par but, showed significantly higher yield than varieties RLC-7 and R-552. Significant varietal differences in relation to grain yield has already been reported by Tomar (1984). The probable reason for the maximum yield in RLC-3 may be due to cumulative effect of growth and yield attributes and its genetic constituents suitable for the local climatic condition.

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LITERATURE CITED

ANONYMOUS (1985) Oilseed research at Pant Nagar Expt. stn. tech. bul. **111**:81-82.

GHAMRAWY, A.K. (1959). Effect of delayed planting on yield of flax and formation of oil and iodin value. Field, crop Abst. **12** (2) : 861.

JAKHMOLA S.S. KAUSHIK U.K. and P.K. KAUSHAL (1973). Note on the effect of dates of sowing and nitrogen levels on the infestation of linseed gall fly. Indian J. Agril. Sci. **43** (6) 623-624.

SHRIVAS S.R., KAUSHAL P.K. and JAKHMOLA S.S. (1976). Effect of delayed planting on oil linseed. Food Farm. and Agril. VIII (6) 15-16.

TOMAR R.K.S. (1984). Comparative performance of linseed varieties under different dates of sowing. M.Sc. (Ag) thesis, College of Agriculture, Gwalior.

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GENE EFFECTS FOR THE INHERITANCE OF FLOWERING AND MATURITY PERIOD IN LINSEED *LINUM USITATISSIMUM* L.

G.M. TAK

A B S T R A C T

The variations among generation means of three linseed (*Linum usitatissimum* L) crosses for flowering and maturity period was partioned. Various scaling tests indicated the presence of digenic and trigenic interactions for these developmental traits and inadequacy of the trigenic interaction model, which may be due to linkage or higher order interactions. Estimates of genic effects revealed that both additive and dominance effects together with additive × additive and dominance × dominance with their trigenic interactions were present in the three crosses for days to maturity while additive and dominance alongwith some of the digenie and trigenic non-allelic interations were significant for days to flowering. The type of epistasis was in general complementary. Implying that there was a good scope of selections for these two characters.

Key words : Gene effects, Linseed

INTRODUCTION

Linseed being one of the important oilseed crops, the suitability of generation means technique in understanding the role of epistatic interaction in the expression of developmental traits viz. flowering and maturity period has not been adequately tested in the genetic improvement of linseed (*Linum usitatissimum* L). Therefore, an attempt was made to partition the generation means of 18 generations including parents of the three linseed crosses for the afore-mentioned traits.

MATERIALS AND METHODS :

The experimental material comprised the three crosses, Himalinixflake-I, KL-43 LHCK-69 and Neelam x Aoyogi, th parent were of both seed and flax type with diverse origin. From these three crosses 18 generations viz $F_1, F_2, F_3, B_1, B_2, B_{11}, B_{21}, B_{22}$ $F_1, F_2, FP_{21}, FP_{22}$ and $B_1, F_1, B_2F_1, B_1S, B_2S$ including the parents were developed, in each cross and this marterial was grown for evaluation in a compact family block at Kangra (HP) during rabi 1986. Each plot consisted of a single row of 30 cms. Data were recorded on ten randomly selected plants from each generation, however, 30 plants were taken in case of F_2 and F_3 for the two traits under study. The data collected were analysed for each generation block-wise on individual plant basis and lat r pooled over blocks with respect to mean and standard error. The generation means with their standard rerror were further utilized for detection of non-allelic interaction and estimates of various genic effects using the proceedure of Mather and Jinks (1982).

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S.E. (m) ±	10.2	15.1	—	32	18.72	—	0.9	0.26	—
C.D. (5%)	46.9	48.7	—	100	59.48	—	NS	0.83	—
RLC-1	787.50	1148.00	967.25	1525	3030	2277	32.8	27.0	29.9
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LITERATURE CITED

ANONYMOUS (1985) Oilseed research at Pant Nagar Expt. stn. tech. bul. **111**:81-82.

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TOMAR R.K.S. (1984). Comparative performance of linseed varieties under different dates of sowing. M.Sc. (Ag) thesis, College of Agriculture, Gwalior.

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G.M. TAK

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RESULTS AND DISCUSSIONS :

The estimates of scaling tests and the genic effects for the two developmental traits are presented in Tables 1 and 2 and discussed as under :

DAYS TO MATURITY :

The phenological trait days to maturity is impotrant in this crop as this trait has been found invariably to be associated with higher seed yield. The digenic and trigenic interactions were found to be significant for this trait, in the three crosses under study, and also the presence of linkage. From the perusal of the data the estimates of genic effects revealed that both additive and dominance genic effects were found to be present and most of the genic effects were also present in cross I and cross II, while in cross III, dominance × dominance (lab), additive × dominance × dominance (ja/bc) and dominance × dominance × dominance (labc) were absent. Similar signs of h and I revealed the presence of complementary type of gene interaction associated with significant additive genic effects which imply that there was a good scope of selection for the character. Additive genic effects for the character were also found by Rai and Das (1974), Kumar and Chawhan (1980) and Rao and Singh (1985), while non-additive genic effects found in this study were supported by the findings of Chu *et al.* (1976). Thakur and Rana (1987) and Satpathi *et al* 1987, Negative heterosis although low in magnitude over the mid parent in all the three crosses was observed which implies that F_1 had lower value than its lower parent, and therefore is of practical utility for selection of early maturity,. In all the three crosses the inadequacy of trigenic interaction model revealed the presence of linkage or higher order interactions involving four or more number of genes at any loci.

DAYS TO FLOWERING :

Significant scaling tests both digenic and trigenic revealed the presence of non-allelic interaction in the three crosses under study for days to flowering. Estimates of genic affects revealed the presence of additive, dominance, additive dominance × dominance and additve × additive × dominance type of digenic and trigenic interactions for cross I and II. Similar findings were also reported by Chu *et al* (1976). Badwal and Bains (1974) Rai and Dass (1974), Kansal and Gupta (1981) and Rao and Singh (1985). Additive gene effects were higher than dominance effects in all the three crosses as also observed by Kansal and Gupta (1981), fitting of trigenic interacting model has indicated the inadequacy of this model in the three crosses, which appears to be due to the presence of either differential fertility or linkage among interacting genes or higher order interactions at four or more gene loci in 3 crosses.

On the basis of sign of h and I, the type of interaction was predominantly complement type in cross I and II,. The presence of complementary type of epistatis would expose the detectable genetic variance in the population and the probability of obtaining recombinants that are earlier than a early flowering, would be increased considerably. For developing high yielding and early flowering cultivars from the population of this type,

TABLE 1. Estimates of scaling tests with respect to the three crosses studied for flowering and maturity period

Trait	Flowering period			Maturity period		
Scaling test/cross	I	II	III	I	II	III
A	5.72* ± 1.21	-0.32* ± 1.05	1.47* ± 4.86	1.29* ± 0.61	0.10* ± 2.45	6.96* ± 3.10
B	13.43* ± 2.18	11.42* ± 2.38	-0.51 ± 3.86	10.11* ± 5.81	3.94* ± 2.25	2.33 ± 2.26
C	20.16* ± 4.76	-16.05* ± 4.05	16.29* ± 0.95	5.34* ± 2.51	9.60* ± 3.72	-14.20* ± 7.04
D	-18.50* ± 5.10	9.31* ± 3.86	-14.23* ± 6.35	1.72 ± 2.87	3.54* ± 1.77	9.80* ± 5.39
X	11.17* ± 3.86	3.36 ± 2.01	-15.15* ± 4.27	6.11 ± 4.34	-5.76* ± 2.14	5.23* ± 2.71
Y	17.61* ± 8.02	-1.96 ± 2.36	7.18* ± 4.53	7.91* ± 3.42	-1.56 ± 2.20	-11.09* ± 3.13
Z	18.50* ± 5.11	12.55* ± 4.79	-17.52* ± 6.82	6.50* ± 3.24	-0.05 ± 2.18	0.33 ± 4.08

10 parameter Genetic model was used.

TABLE 2. Estimates of various genic effects with respect to three crosses studied for flowering and maturity period in linseed

Trait	Flowering period			Maturity period		
Genic effects/cross	I	II	III	I	II	III
1. m	89.88* ± 1.16	85.40* ± 2.59	91.43* ± 20.57	151.82* ± 12.55	144.52* ± 32.50	15.45* ± 2.31
2. d	59.26* ± 7.81	-14.86* ± 7.67	36.62* ± 14.53	-52.04* ± 8.59	-105.96* ± 6.11	-24.95* ± 7.57
3. h	7.21* ± 0.66	1.53* ± 0.46	3.98* ± 0.81	9.67* ± 0.31	15.07* ± 3.22	22.30* ± 6.56
4. iab	-8.68 ± 5.15	-9.45 ± 4.41	-15.53 ± 11.53	-16.88* ± 7.39	-50.28* ± 5.04	14.96 ± 6.97
5. jab	-101.16* ± 21.44	-32.75 ± 24.59	30.15 ± 44.73	-27.06 ± 20.18	-106.82* ± 12.99	37.21* ± 13.90
6. lab	50.96* ± 11.73	12.55 ± 7.14	5.04 ± 13.39	27.26* ± 6.26	130.82* ± 9.05	0.48 ± 1.21
7. labc	71.82* ± 14.03	32.49* ± 13.56	55.63* ± 4.84	91 41* ± 15.46	157.76* ± 10.50	38.36* ± 13.25
8. jab/c	165.86* ± 23.17	96.14 ± 22.05	61.27 ± 30.43	121.58* ± 15.85	155.30* ± 17.44	125.60* ± 21.41
9. jab/bc	174.37* ± 42.75	87.79 ± 45.86	11.95 ± 13.08	128.89* ± 34.70	104.46* ± 27.90	-40.69 ± 43.51
10. labc	45.16* ± 10.99	2.13 ± 7.04	-1.85 ± 12.06	-7.13* ± 5.89	101.79* ± 8.26	2.71* ± 11.17
X^2value	30.18*	104.31*	57.48*	25.81*	306.66*	57.56*
Df	8	8	8	8	8	8

it would be worthwhile to use a breeding proceedure such as bi-parental cross approach which would break the undesirable linkages following recombination.

REFERENCES

BADWAL, S.S. and BAINS, K.S. 1974. Genetic analysis in Linum top crosses, Genet Agrara. **28** (2) : 136-41.

CHU, H.T. and BOTHAM, R.E. 1976, Comparison of F5 genotypes with parents F1 and F3 bulked hybrids of flax Journal of Agril. Association of China, 71 : 29-40 (Pl. breed. Abs,. 42 : Abs No. 1056:1121).

KANSAL, K.K. and GUPTA, S.C. 1981. Gene action on Linseed. Ind. J. Agric. Sci,. **51** (19) : 684-37

KUMAR, S. and CHAUHAN, B.P.S. 1980. Combining ability in Linseed, Ind. J. Agril. Sci. **52** (11) 723-27.

MATHER, K. and JINKS, J.L. 1982. Biometerical genetics 3rd Edn. B. chapman and Hall Ltd. 11 New, Fetter Lane London.

RAO, S.K. and SINGH, S.P. 1985. Relationship of maturity with seed characteristics and their implication in Linseed Journal of Oilseed Research **2** (1) -: 86-92.

RAI, M. and DAS, K. 1974. *Combining ability for components of yield in Linseed* **Ind.** J. Genet and Pl,. breed. **34** (3) : 371-374.

SATPATHI, D and MISRA, R.C. and PANDA, B.S. 1987, Variability correlations and path-coefficient analysis in Linseed. Journal of oilseed Research **4**:28-34.

TH KUR., M.L. and RANA, N.D. 1987, Combining ability in Linseed. Ind. J. Agric. Sci. **57** (5): 303-8.

it would be worthwhile to use a breeding proceedure such as bi-parental cross approach which would break the undesirable linkages following recombination.

REFERENCES

BADWAL, S.S. and BAINS, K.S. 1974. *Genetic analysis in Linum top crosses*, Genet Agrara. **28** (2) : 136-41.

CHU, H.T. and BOTHAM, R.E. 1976, Comparison of F5 genotypes with parents F1 and F3 bulked hybrids of flax Journal of Agril. Association of China, 71 : 29-40 (Pl. breed. Abs,. 42 : Abs No. 1056:1121).

KANSAL, K.K. and GUPTA, S.C. 1981. Gene action on Linseed. Ind. J. Agric. Sci,. **51** (19) : 684-37

KUMAR, S. and CHAUHAN, B.P.S. 1980. Combining ability in Linseed, Ind. J. Agril. Sci. **52** (11) 723-27.

MATHER, K. and JINKS, J.L. 1982. Biometerical genetics 3rd Edn. B. chapman and Hall Ltd. 11 New, Fetter Lane London.

RAO, S.K. and SINGH, S.P. 1985. *Relationship of maturity with seed characteristics and their implication* in Linseed Journal of Oilseed Research **2** (1) -: 86-92.

RAI, M. and DAS, K. 1974. Combining ability for components of yield in Linseed Ind. J. Genet and Pl,. breed. **34** (3) : 371-374.

SATPATHI, D and MISRA, R.C. and PANDA, B.S. 1987, Variability correlations and path-coefficient analysis in Linseed. Journal of oilseed Research **4**:28-34.

TH KUR., M.L. and RANA, N.D. 1987, Combining ability in Linseed. Ind. J. Agric. Sci. 57 (5): 303-8.

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STUDIES ON INTERCROPPING IN CASTOR

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A B S T R A C T

Castor being a long duration crop, the possibility of taking up an intercrop in between the rows, thereby increasing and stabilizing the returns has been explored in Aruna, GAUC-1 and GAUCH-1 under rainfed conditions. Three short duration crops namely groundnut, cowpea and sesamum were selected as intercrops. Among the cultivars GAUCH-1 produced highest yields both as pure crop and in combination with all three intercrops. In general intercropping reduced castor yields as much as 24.4% in 1983-84 and 41.7% in 1984-85. However, differential production potentials of castor and intercrops over the years confirmed the advantage of enhancing and stabilizing the returns from intercropping. Among Intercrops, cowpea produced higher yields than groundnut as well as sesame. The same in combination with GAUCH-1 recorded the highest gross returns of Rs. 5821/ ha compared to Rs. 3581/ha from sole crop of hybrid. Despite considerable reduction in production potentials of castor, intercropping cowpea and groundnut proved to give higher and stable returns than crop of the varie·ies as well as the hybrid.

Key words : Intercropping, castor.

INTRODUCTION

The beneficial effects of intercropping in increasing and stabilizing the returns per unit area are well known (Saraf *et al.* 1975 and Rahaman *et al.* 1982). Since the inter-row spacing is wide enough and currently available castor cultivars take about 60-70 days to cover the land, considerable scope exists for taking a short duration crop in between the rows. In that it is an attempt to assess the overall performance of intercrop combinations involving popular castor cultivars and three other prominent crops of the region in semi-arid tract of Gujarat.

MATERIALS AND METHODS

The experiment comprising three castor cultivars viz., Aruna, GAUCH-1 and GAUC-1, intercropped with groundnut and cowpea in 1:2 row proportion and sesame in 1:1 row proportion was laid out during rainy season in 1983-84 and 1984-85 at Castor Research Station, Gujarat Agricultural University, Sardar Krushinagar Campus representing semi-arid climate. Sole crop of three castor cultivars, three intercrops and resulting nine intercrop combinations were grown in Randomised Block Design with three replications under rainfed conditions. An inter-row spacing of 90 cm and intra-row spacing of 20cm was adopted in all the plots. Two rows of groundnut and cowpea at 30 cm distance and one row of sesame at 45 cm distance were placed in between two rows of castor. The fertilizer was applied as per recommended dose for different crops. Need based plant protection measures were taken to save all the crops from the attack of insects and diseases. The yield of all the crops were calculated on hectare basis and the monetary return was worked out on the basis of prevailing

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prices during corresponding year. Land equivalent ratio (LER) was worked out with the help of formulae suggested by Rahman *et al.* (1982).

RESULTS AND DISCUSSION

Seed yield

A perusal of the data presented in Table-1 indicated the yield superiority of GAUCH-1 in pure stand and in combination with intercrops. The seed yields of all three cultivars were adversely affected by imposition of intercrop. The seed yields of GAUCH-1 and Aruna were considerably high during the first year as compared to the second year and the reverse was true for intercrops, probably due to prolonged monsoon with **32** rainy days and **509 mm** rainfall in 1983-84 compared to **25** rainy days and **525 cm** total rainfall during 1984-85. Further, short duration intercrops got benefited from condensed monsoon in 1984-85 and long duration basecrop of castor availed of prolonged monsoon during 1983-84, possibly due to internal competition for nutrients and water. Reddy *et al.* (1965) reported considerably lower yields of castor in mixtured stands as than those of pure crop. The average yield data of two years showed that the inclusion of cowpea as an intercrop with all the castor cultivars increased the total production than castor cultivars grown as a sole crop. The highest total production of seed (1420 kg/ha) was achieved with GAUCH-1 + cowpea (1:2) combination, followed by Aruna + cowpea (1:2) and GAUC-1 + cowpea (1:2). In a similar study Desai and Goyal (1980) reported the highest seed yields with the intercrop combination of castor and sesame in 1:1 ratio.

ECONOMICS

Economics of production is ultimate criterion for selecting the best crop combination. In the present study, GAUCH-1 and cowpea combination in 1:2 row proportion gave significantly higher gross monetary returns during both the years of experimentation (Table-2). The highest gross returns (Rs. 5821/ha) were achieved with GAUCH-1 cowpea + combination which were significantly higher than all the other *treatments except GAUCH-1 + sesame, Aruna + cowpea and GAUCH-1 + groundnut* However, intercropping of cowpea, sesame and groundnut in castor cultivars has resulted in considerably higher returns than those of corresponding pure stands. Among the cultivars, GAUCH-1 proved highly productive. All the intercrop combinations with GAUCH-1 were more profitable than the intercrop combinations of the other two cultivars. The additional returns accrued from intercropping cowpea, sesame and groundnut in GAUCH-1 over the pure crop were Rs. 2240, Rs. 1474 and Rs. 1038/ha respectively. Prasad and Varma (1986) reported that intercropping green gram and black gram in castor has resulted in significantly higher net returns than pure crop of castor.

LAND EQUIVALENT RATIO (LER)

The land equivalent ratio (LER) is an indicator of efficient land utilization for intercropping systems (Jha and Chandra, 1982). In 1983-84 the values of LER

TABLE 1. Production potentials of castor cultivars as influenced by imposition of selected grain legumes as intercrop.

S.No.	Sole and intercrop combinations	Seed yield (kg/ha)					
		1983-84		1984–85		Mean	
		Base crop	Companion crops	Base crop	Companion crops	Base crop	Companion crops
1.	Aruna	1010	—	571	—	791	—
2.	Aruna+G'nut (2)	360	417 (2253)	239	306 (3395)	300	362 (2824)
3.	Aruna+Sesame	503	235	145	470	324	353
4.	Aruna+cowpea	576	559 (679)	241	1036 (2818)	409	788 (1349)
5.	GAUCH-1	1087	—	531	—	509	—
6.	GAUCH-1+G'nut (2)	538	319 (1667)	254	431 (3704)	396	375 (2688)
7.	GAUCH-1+sesame	691	293	238	478	465	386
8.	GAUCH-1+cowpea	873	501 (540)	330	1144 (1900)	597	823 (1270)
9.	GAUC-1	669	—	712	—	691	—
10.	GAUC. 1+G'nut	232	285 (1775)	279	327 (3758)	256	306 (2767)
11.	GAUC.1+sesame	521	216	338	455	430	336
12.	GAUC.1+cowpea	483	384 (594)	201	1190 (1801)	342	787 (1198)
13.	Groundnut (GAUC.1)	—	404 (2423)	—	540 (3488)	—	427 (2956)
14.	Sesame (GT.1)	—	218	—	545	—	432
15.	Cowpea (Pusa Falguni)	—	547 (679)	—	1220 (2168)	—	884 (1424)

Figures in parenthesis indicate fodder yield.

TABLE 2. *Land equivalent ratio and monetary returns from different intercrop combinations.*

S.No.	Sole and inter crop combinations	LER			Total monetary return		
		1983-84	1984–85	Mean	1983–84	1984–85	Pooled *Rs/ha*
1.	Aruna	1.00	1.00	1.00	5050	1856	3453
2.	Aruna+Groundnut	1.39	1.10	1.25	4561	3228	3945
3.	Aruna+Sesame	1.58	0.98	1.28	4124	4237	4181
4.	Aruna+cowpea	1.56	1.27	1.42	4589	5072	4830
5.	GAUCH-1	1.00	1.00	1.00	5436	1725	3581
6.	GAUCH-1+Groundnut	1.28	1.44	1.36	5143	4095	4619
7.	GAUCH.1+Sesame	1.98	1.19	1.59	5510	4600	5055
8.	GAUCH.1+cowpea	1.72	1.56	1.64	5900	5741	5821
9.	GAUC-1	1.00	1.00	1.00	3345	2312	2829
10.	GAUC.1+Groundnut	1.86	1.12	1.89	3122	3671	3397
11.	GAUC.1+Sesame	1.77	1.17	1.47	4121	4740	4431
12.	GAUC.1+cowpea	1.42	1.26	1.34	3567	5473	4528
13.	Groundnut sole (GAUC-1)	1.00	1.00	1.00	2748	3296	3022
14.	Sesame (GT.1)	1.00	1.00	1.00	1523	5161	3342
15.	Cowpea (Pusa Falguni)	1.00	1.00	1.00	1674	5009	3342
	S.Em ±				731	458	431
	C.D. (0.05)				2118	1327	1222

Market rates (Rs./q)

	1983–84	1984–85
Castor seed	500	325
Groundnut pod	500	500
Groundnut fodder	30	30
Sesame seed	700	800
Cowpea seed	275	375
Cowpea fodder	25	20

were higher for castor + sesame than those for castor + cowpea as well as castor + groundnut. However, in 1984-85 higher values of LER were recorded for castor + cowpea as compared to castor + sesame and casor + groundnut. Across seasons GAUCH-1 + cowpea registered highest LER (1.64) followed bp GAUCH-1 + Sesame (1.59).

LITERATURE CITED

DESAI, N.D. and GOYAL, S.N. (1980). Intercropping of sesame with other oilseed crops. Indian J. Agric. Sci. **50** (8) : 603-605.

JHA, K.P. and CHANDRA, D. (1982). Parallel multiple cropping with rice. Indian J. Agron. **27** (1) : 97-98.

PRASAD, S.N. and VARMA, B. (1986). Effect of intercropping castor with green gram, black gram sesame and sorghum on yield and net return. Indian J. Agron. **31** (1) : 21-25.

REDDY, G.P., RAO, C.S. and REDDY, P.R. (1965). Mixed cropping in castor. Indian oilseeds J. **9** (4) : 310-316.

SARAF, C.S., SINGH, A. and AHLAWAR, I.P.S. (1975). Studies in intercropping of compatible crops with Pigeonpea. Indian J. Agron. **20** (2) : 127-130.

RAHAMAN, A.; SINHA, K.P., SINGH, Y.P., RATEY, A., BHAGAT, A.K. and SINGH, R.K. (1982). Effect of intercropping pulses, oilseeds and tuber crops in maize on yield and net return. Indian J. Agron. **27** (1) : 1-6.

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EFFICACY OF FUNGICIDES IN CONTROLLING LEAF SPOT OF SAFFLOWER CAUSED BY *RAMULARIA CARTHAMI*

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ABSTRACT

In vitro evaluation, ten fungicides with six concentrations were tested for their efficacy in inhibition of spore germination of *Ramularia carthami*. Dithane M-45 and Dithane flovable gave 100 per cent inhibition of spore germination even at 250 ppm. Daconil was found to be next best chemical while Bavistin and RH 2161 were less effective. Out of six fungicides tested in *in vivo*, three sprays of Dithane M-45 (0.2%) and Bavistin (0.05%) given at an interval of 15 days starting from 55th day of sowing gave maximum control.

INTRODUCTION

Leaf spot of safflower (*Carthamus tinctorius* Linn.) caused by *Ramularia carthami* Zaprometov has been causing considerable damage to the crop. Rathaiah and Pavagi (1970) tested six fungicides in *in vitro* against *R. carthami*. A ureofungin was most effective followed by Hexaferb, Dithane M-45, Bordeaux mixture, Dithane- Z-78 and Blue-copper. Sharma *et al.*, (1974) evaluated 11 fungicides in *in vitro* and found that Compogran m° completely checked spore germination and also spore formation followed by Dithane-M-45, Dithane Z-78 and captan. Hence, as a preliminary step to recommend an effective control schedule, few fungicides were evaluated in *in vitro* and *in vivo* conditions.

MATERIAL AND METHODS

The agar plate spore germination method for testing fungicides as suggested by Gattani (1954) was followed to determine the efficacy of different fungicides against *R. carthami*.

Ten fungicides viz., Captan, Mancozeb, Tridemefon, Fenapanil, Dithane flovable, Copper-oxy-chloride, Sulphur Chlorotha-lonil, Carbendazim and Biloxozole were used in this method at six concentrations viz., 50, 100, 250, 500, 1,000 and 2,000 ppm. Required quantities of fungicidal suspensions were added to three per cent water agar to obtain different concentrations. On solidifying one cm discs were cut and three such discs were placed on glass slide which served as three replications. A freshly prepared spore suspension of 100 spores of *R. carthami* was placed on the disc. The slides were kept in moist chamber and incubated at room temperature (27±1°C) for 18 hours. Appropriate control was maintained.

Six fungicides found to be effective in *in vitro* study were tried in the field under irrigated conditions. These fungicides were compared with unsprayed control in

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TABLE 1. Effect of fungicides at different concentrations on inhibition of spore germination of *Ramularia carthami*

Sl. No.	Fungicides	Per cent inhibition					
		Concentration in ppm					
		50 ppm	100 ppm	250 ppm	500 ppm	1000 ppm	2000 ppm
1.	Captan	26.84 (31.20)	12.20 (20.43)	17.65 (24.78)	17.19 (24.48)	15.94 (23.46)	(17.32 (24.57)
2.	Dithane M-45	86.67 (68.62)	97.50 (82.15)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)
3.	Bayletan	11.00 (19.35)	9.56 (17.96)	16.42 (23.85)	10.26 (18.68)	71.81 (57.93)	76.83 (61.25)
4.	RH-2161	28.67 (32.35)	37.80 (37.94)	25.20 (30.13)	29.20 (32.70)	30.94 (33.79)	69.77 (56.84)
5.	Dithane flovable	91.95 (73.60)	98.48 (82.97)	100.00 (90.00)	100.00 (90.00)	100 00 (90.00)	100.00 (90.00)
6.	Blitox	30.35 (33.41)	49.60 (44.77)	93.67 (75.49)	100.00 (90.00)	100.00 (90.00)	100.00 (90.00)
7.	Micronised sulphur	65.60 (54.09)	94.70 (76.77)	98.64 (83.55)	97.10 (80.33)	99.50 (86.73)	100.00 (90.;00)
8.	Daconil	97.83 (81.56)	97.65 (81.22)	96.90 (80.09)	99.09 (84.46)	100.00 (90.00)	100.00 (90.00)
9.	Bavistin	10.22 (18.63)	68.25 (55.71)	38.80 (38.52)	59.63 (50.55)	78.31 (62.71)	76.95 (61.30)
10.	Baycor	89.78 (71.35)	31.75 (34.27)	50.88 (45.49)	40.37 (39.44)	21.29 (27.45)	23.50 (28.99)
11.	Control	8.59 (17.01)	8.59 (17.01)	8.59 (17.01)	8.59 (17.01)	8.59 (17.01)	8.59 (17.10
	S.Em.±	0.42	0.32	0.48	0.30	0.40	7.81
	C.D. at 1%	1.75	1.30	1.93	1.19	1.62	31.40

Figures in parentheses indicate Arc sine transformed value.

TABLE 2. Effect of different fungicides in control of *Ramularia* leaf spot of saflower under irrigated conditions

Sl. No.	Fungicides	Concentration (%)	Per cent disease incidence	Yield (kg/ha)	weight of 100 capsules (g)	Weight of seed per 100 capsules (g)
1.	Dithane M-45	0.2	1.53 (6.89)	2156.0	201.0	106.0
2.	RH-2161	0.1	70.88 (57.46)	1967.0	123.6	78.3
3.	Baycor	0.1	5.88 (12.48)	2117.0	166.3	103.0
4.	Bavistin	0.05	2.88 (7.75)	2170.0	208.3	120.3
5.	Wet-sulf	.3	15.98 (23.41)	2010.0	176.3	95.3
6.	Blitox	0.2	10.85 (19.00)	2105.0	144.6	92.0
7.	Control	—	83.36 (66.03)	1792.0	118.6	66.0
	F – Test significant at 5 per cent					
	S.Em. ±		10.09	24.50	5.83	2.82
	C.D. at 5%		31.11	75.89	17.97	8.69

Figures in the parentheses indicate arc sine transformed values.

Randomised Block Design with three replications. The Gross size maintained was 3.2×2.3 m and net plot size was 2.25×1.95 m with 45 cm row to row and 15 cm plant to plant spacing. The A-1 variety of safflower was sown on 25th October 1982. Three sprays of each fungicide were given. First spray was given on 55th day after sowing and subsequent sprays were given at 15 days interval. Observations were recorded on 125th day after sowing. Five plants were selected at random in each treatment to record the per cent disease index, data on grain yield were also recorded.

RESULTS AND DISCUSSIONS

Efficacy of ten fungicides at six concentrations were tested by spore germination technique and per cent inhibition of spore germination was calculated (Table 1). The maximum per cent inhibition (more than 95%) of spore germiniation was obtained with Dithane M-45, Dithane flovable and Micronised sulphur at 100 ppm concentration and above but in case of Deconil, it was at 50 ppm onwards, whereas, in case of Blitox it was 500 ppm onwards. Comparatively, Captan, RH 2161, Bayletan, Bavistin and Baycor were least effective even at 2000 ppm concentration.

All the fungicides tested except RH 2161 were found to be significantly effective in reducing per cent Disease Incidence. The least per cent Disease Incidence was obtained in Dithane M-45 (1.53). However, it was par with Bavistin, Blitox and wet sulf. There was no significant difference between RH 2161 and the control (Table 2).

All the fungicides significantly increased the grain yield over control. Maximum seed yield was observed in Bavistin (2170.0 kg/ha) followed by Dithane M-45 (2156.00 kg/ha), Baycor (2117.0 kg/ha) and Blitox (2105.0 kg/ha) which were on par. RH 2161 (1967.0 kg/ha) and wet Sulf. (2010.0 kg/ha) were found to be less effective.

In general *in vitro* evaluation is used to select the effective fungicide to be tried under field condition. In some cases the fungicides which proved less effective under laboratory condition proved efficient under field condition. Dithane M-45, which was very effective and Bavistin which was less effective *in vitro* evaluation were found to be superior in reducing per cent disease index and increasing the grain yield under field conditions.

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LITERATURE CITED

GATTANI, M.L., 1954, The agar plate spore germination method for testing fungicides. *Phytopathology*, **44**:113-115.

RATHAIAH, Y. and PAVAGI, M.S. 1970., Evaluation of fungicides against some leaf spot fungi parasitising oil seed crops. *Hindustan Antibiotics Bulletin, Vol.* 13, No. 1 and 2, Aug.-Nov. 1970

SHARMA, O.P., KULAKARNI, S.N., ANAMICO TIWARI and JAIN, A.C., 1974, Evaluation of some fungicides on sporulation and spore germination of *Ramularia carthami*. *Pesticide*, **8** (1):43.

ZAPROMETOV, N.G., 1926, Brown leaf spot of safflower. *Morbi plantarum*, Leningrad, XV (3): 141-142.

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VARIABILITY FOR FATTY ACID PROFILES IN LINSEED (*LINUM USITATISSIMUM L.*)

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ABSTRACT

Variability broad sense, heritability and genetic advance were estimated in 35 promising cultures of linseed at three different locations (Patna, Kanpur and Kangra) for Palmitic, stearic, oleic, linoleic and linolenic acids. Significant mean differences were observed among the genotypes for all the characters. Considerable variability with regard to linolenic acid (45.75 to 56.58%), oleic acid (16.53 to 27.10%), linoleic acid (12.96 to 19.16), stearic acid (4.6 to 7.06%) and palmitic acid (5.4 to 6.91%) were observed. Maximum fluctuations were observed in oleic and stearic acids. Medium to high heritability was recorded for all the fatty acids at all the locations except palmitic acid at Kangra. Low expected genetic gain was noted for all the fatty acids at all the locations.

INTRODUCTION

The utility of vegetable oil broadly depends on its suitability as a source of digestible energy and as a raw material for industries. Linseed oil is largely used in agro based industries for the manufacture of paint and varnish, pad and printing ink, and oil cloth linoleum etc. About 20% of the oil produced is used for direct human consumption is used for direct human consumption. Suitability of linseed oil for these two uses, however depends on the profile of saturated and unsaturated fatty acids in the oil. Therefore, it is imperative that equal attention be given on the yield and quality of the oil.

MATERIALS AND METHOD

Field experiments using 35 promising linseed cultures (source LCK-CSAUA&T, Kanpur, LCM-Mauranipur, RL-Kota., BAU-Kanke, RLC-Raipur, PBNL-Parbhani, PCL-PC Unit Kanpur and KL-Kangra) including T 397 and LHCK-21 as the standard check were carried out during 1984-85 at Patna (Bihar), Kanpur (Uttar Pradesh) and Kangra (Himachal Pradesh). These locations come under two highly distinct linseed growing zones in the country. The experiment at each location was laid out with two replications in Randomized complete Block design with a net plot size of 0.75m × 4.00m. The usual agronomic practices were followed. Treatment wise seed samples from each replication were extracted for their oil using Soxhlet apparatus. Duplicate oil samples were used for determining the composition of five fatty acids viz; Palmitic, Stearic, oleic, Linoleic and Linolenic acids following trans-esterification and gas liquid Chromatographic procedures (GLC Method). Results were statistically analysed to work out the variability, heritability and genetic advance.

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TABLE 1. Mean performance (Pooled basis) of 35 varieties for fatty acid profiles in linseed.

S.No.	Variety	Palmatic acid	Stearic acid	Oleic acid	Linoleic acid	Linolenic acid	Oil content (%)
1.	LCK 8321	5.90	5.96	21.95	13.41	52.76	39.85
2.	RL 26-2	5.41	7.06	18.36	16.23	52.91	41.45
3.	RLC-19	5.81	5.95	27.10	14.55	45.78	39.40
4.	BAU-70	5.73	5.95	18.95	17.03	53.13	41.03
5.	T 397 (National check)	5.50	5.36	20.83	15.68	52.61	42.71
6.	LCK 8324	5.90	5.43	20.35	13.68	54.63	41.03
7.	LCK 8326	6.01	6.80	22.01	16.05	49.11	42.11
8.	RL 6-10	5.93	6.55	20.26	16.40	50.85	38.35
9.	RL 8-13	6.50	5.73	16.53	15.41	55.98	41.95
10.	PCL-1	6.30	4.98	22.98	15.65	50.01	40.08
11.	LCK 8322	5.90	5.10	20.63	19.16	49.20	38.53
12.	RL-9-6	6.15	7.00	17.96	13.75	55.11	43.43
13.	LCK 8323	5.58	6.21	20.83	16.20	51.16	39.36
14.	RLC 18	5.75	5.45	20.36	18.25	50.18	39.61
15.	KL-1	5.75	4.95	21.05	16.03	52.21	41.53
16.	LCK 8325	6.91	5.53	18.40	16.26	52.88	40.35
17.	PBNL-2	6.05	4.90	17.46	14.90	56.68	43.35
18.	LCK 8327	6.56	4.60	23.05	12.96	52.83	38.00
19.	LCM 84-746	5.40	6.41	18.15	15.13	54.90	42.83
20.	LCM 84-55	5.86	5.90	17.65	16.58	54.01	39.55

Table 1. Contd...

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
21.	Zonal check (LHCK-21)	5.26	5.16	21.45	15.36	51.75	43.08
22.	KL 31	5.43	4.70	22.05	17.78	50.03	44.46
23.	KL 32	5.55	5.83	19.71	14.50	54.40	39.03
24.	LCM 84-771	6.78	6.88	23.65	15.81	46.86	43.93
25.	LCM 84.89	5.50	5.11	20.90	16.76	51.71	42.86
26.	BAU 152	5.46	6.06	21.20	13.01	54.25	42.15
27.	RL 25-1	5.85	5.71	19.71	18.08	54.61	42.50
28.	BAU 62	6.53	63.71	23.05	13.95	50.15	41.03
29.	RL 28-1	5.95	5.63	18.70	14.78	55.00	43.25
30.	LCM 8437	5.95	5.48	17.11	15.21	56.23	45.36
31.	LCM 84-259	5.75	6.88	17.33	15.31	54.71	45.06
32.	BAU 191	6.01	6.48	19.70	14.18	53.61	40.15
33.	BAU 95	5.70	5.80	18.35	14.75	55.40	41.70
34.	BAU 111-1	5.76	6.56	19.06	15.76	52.83	39.50
35.	BAU 160	5.70	5.21	20.53	16.43	52.13	40.83
	G.M.	5.92	5.28	20.21	15.45	52.59	40.83
	C.V.	6.97	8.08	3.05	4.15	1.19	
	S.Em±	0.23	0.27	0.35	0.37	0.36	41.35
	C.D. 5%	0.45	0.53	0.69	0.73	0.71	

TABLE 2. **Estimates of genetic parameters for fatty acid in linseed**

Characters	GCV			PCV			Heritability (%)			Genetic advance		
	L_1	L_2	L_3	L_1	L_2	L_3	L_1	L_2	L_3	L_1	L_2	L_3
Palmitic acid	12.12	10.08	6.36	13.23	11.40	11.47	83.9	78.2	30.7	1.37	1.09	0.42
Stearic acid	20.88	16.44	11.72	22.65	17.63	14.52	84.9	86.9	65.1	2.33	1.71	1.20
Oleic acid	15.43	12.64	10.92	15.70	12.79	11.64	96.5	97.7	87.9	6.55	5.18	4.12
Linoleic acid	13.08	10.04	8.27	13.46	10.48	10.08	94.4	91.8	67.2	4.01	3.73	2.14
Linolenic acid	6.85	5.43	4.87	6.92	5.52	5.09	98.0	96.6	91.4	7.24	5.80	5.10

GCV Genotypic coefficient of variability

PCV Phenotypic coefficient of variability

L1 Patna location

L2 Kanpur ,,

L3 Kanpur ,,

RESULTS AND DISCUSSION

Significant differences among the genotypes with regards to all the five fatty acids were observed (Table-1). Oil yield is also given in Table 1 to see the comparative performance of the genotypes.

Proportions of Linolenic acid (range 56.58-45.75%) and Oleic acid (16.53-27. 10%) were the highest followed by Linoleic acid (12.96-1916), Stearic acid (4.6-7.06) and Palmitic acid (5.4-6.91) in that order. Higher amount of Linolenic acid in the oil makes it suitable for practical uses particularly in paint and varnish industries due to its higher drying property. Linseed oil could be utilized in human diet if the proportion of Linolenic acid is reduced to 6-8%. Four of the cultures (RLC-19, LCK 8326, LCK 8322, LCM-84-771) evaluated had less than 50% Linolenic acid content. Variety RLC-19 also had the highest percentage of Oleic acid (27.10%) which is a favourable point for the use of this variety in breeding programmes to improve the oil quality for edible purpose. Varieties LCK-84-771 followed by LCK-8326, appeared promising with regard to the levels of saturated fatty acids. Variety PBNL-2 had the highest level of linolenic acid and medium to low levels of other fatty acids. This variety may therefore be useful in breeding programmes aiming at improvement of oil quality for industrial use.

The genotypic and phenotypic coefficients of variability were maximum for stearic acid (Table -2) followed by oleic acid at all the locations. Maximum variability for stearic acid was also recorded by Rai *et al.* (1985). Minimum variability was noted for linolenic acid at each of the three locations. High heritability percentage was recorded for all the fatty acids at Patna and Kanpur except for palmitic acid at Kanpur in which medium heritability was observed. However, maximum heritability was noted for linolenic acid followed by oleic acid at all the 3 locations. Medium heritability was recorded for stearic and linoleic acids while low heritability was observed ony for palmitic acid at Kangra.

The estimates of heritability in conjunction with the genetic gain may be considered as a pointer for bringing an improvement in a particular trait by adopting appropriate breeding procedures. In the present investigation, expectedlow genetic gain was recorded for all the traits at all the locations. However, maximum genetic gain attainable was reflected for linoleic acid followed by oleic acid at each of the 3 locations. These two traits also exhibited the highest heritability values. It was observed that for the improvement of linseed oil for edible purposes, emphasis should be given to oleic acid. However for improvement in oil for technical purpose, selection pressure may be put upon linolenic acid.

REFERENCES

RAI, M., VASISHTHA, A.K. and NAQVI, P.A. 1985. Estimates heritability and genetic advances in seed and oil components of linseed. *J. Oilseeds Res.* : 240-245.

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Short Communications

EFFECTIVENESS OF HERBICIDES AND CULTURAL METHODS FOR THE CONTROL OF WEEDS IN SPANISH AD VIRGINIA HABIT GROUPS OF GROUNDNUT (*ARACHIS HYPOGAEA* L.)

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Large number of groundnut varieties belonging to different habit groups with a wide range of growth habit are in cultivation. These varieties seem to offer varying degrees of resistance to the weeds present in the field. At the same time, some of the crop varieties have shown differential response for herbicides. This type of work has not been done so far in groundnut. Keeping these points in view, an experiment was conducted to study the varietal response of groundnut by selecting one variety each from *Spanish* and *Virginia* habit groups on yield and yield attributes as influenced by different herbicides along with cultural methods.

Field experiment was conducted during the rainy season of 1983-'84 at the Agricultural College Farm, Rajendranagar, Hyderabad on red sandy loam soil. Two groundnut habit groups (Spanish variety JL-24 and Virginia variety Kadiri-3) and seven weed control treatments (Hand weeding twice on 15 and 35 DAS, no weeding fluazifopbutyl 0.25 and 0.50 kg a.i./ha), oxyflurofen 0.25 kg a.i./ha, pendimethalin 1.5 kg a.i./ha, oxadiazon 1.25 kg a.i./ha were laid out in a factorial randomised block design with four replications. Fluazifopbutyl was applied as post - emergence (20 DAS) while oxyflurofen, oxadiazon and pendimethalin were applied as pre-emergence (24 hours after sowing). A uniform dose of 20 kg N and 40 kg P_2O_5 per hectare was applied as basal in the form of urea and single superphosphate respectively. The crop was sown on 26th June, 1983 and was harvested on 13th October and 22nd October, 1983 for Spanish and Virginia groups of groundnut respectively. The total rainfall was more than the normal and was distributed uniformly throughout the crop growth period.

The predominant weeds observed in the experimental field were *Commelina benghalensis* Linn. *Cynodon dactylon* Pers; *Cyperus rotundus* Linn., *Dactyloctenium aegyptium* Beauv., *Digitaria sanquinalis* Scop., and *Panicum repens*, Linn (among monocots) *Acanthospermum hispidum* D.C., *Amaranthus viridis* Linn., *Celosia arqentea* Linn., *Lagasca mollis* Cav., *Euphorbia hirta* Linn and *Tridax procumbens* Linn (among dicots).

Drymatter production of weeds (Table 2) was significantly affected on 90th day after sowing. Spanish group variety JL-24 recorded 27.4 per cent more dry weight of weeds over virginia group variety Kadiri-3. Fluazifopbutyl 0.5 kg a.i./ha. (45.19 g/m^2)

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TABLE 1. Yield and yield attributing characters of groundnut varietal groups as influenced by weed control treatments.

Treatments	Number of primary branches 60 days	Number of mature pods per plant	Number of seeds per plant	100 pod weight (g)	1000 kernel weight (g)
A. Varietal groups					
1. Virginia (K-3)	5.96	10.27	20.40	51.84	37.03
2. Spanish (JL-24)	5.18	8.46	17.11	50.08	34.93
B. Weed Control treatments					
1. Hand weeding twice (15 and 35 DAS)	6.19	12.60	25.60	54.11	39.45
2. Fluazifopbutyl o.25 kg a.i./ha	5.63	8.85	17.50	51.29	26.56
3. Fluazifopbutyl 0.50 kg a.i./ha	6.02	10.80	21.70	53.40	38.44
4. Oxyflurofen 0.25 kg a.i./ha	5.60	8.85	17.55	51.93	37.01
6. Pendimethalin 1.50 kg a.i./ha	6.15	11.20	22.55	53.57	38.65
6. Oxadiazon 1.25 kg a.i./ha	5.67	8.85	17.50	52.80	37.70
7. No weeding	3.63	4.46	8.90	39.60	24.05
S.Ed ± V	0.28	0.61	1.50	1.42	0.44
W	0.53	1.16	2 80	2.65	1.25
V × W	0.74	1.64	3.97	3.76	1.61
C.D. (0.05) V	0.57	1.25	3.03	—	0.88
W	1.07	2.34	5.67	5.37	2.53
V × W	—	3.31	—	—	—

V = Varieties W = Weed Control treatments.

TABLE 2. Pod yield (q/ha), weed index and weed drymatter as influenced by groundnut genotypes and weed control treatments

Treatments	Pod yield (q/ha)		Weed index (%)		Drymatter of weeds at 90 days after sowing (g)	
	Virginia (Kadiri-3)	Spanish (JL-24)	Virginia (Kadiri-3)	Spanish (JL-24)	Virginia (Kadiri-3)	Spanish (JL-24)
1. Hand weeding twice (15 and 35 DAS)	18.04	16.06	—	—	45.64	56.08
2. Fluazifopbutyl 0.25 kg a.i./ha	12.38	10.30	31.31	35.87	59.63	65.63
3. Fluazifopbutyl 0.50 kg a.i./ha	15.92	12.92	11.73	29.51	40.40	49.98
4. Oxyfluorfen 0.25 kg a.i./ha	13.00	10.00	27.90	37.73	75.25	88.70
5. Pendimethalin 1.50 kg a.i./ha	16.51	13.49	8.48	16.00	50.70	61.20
6. Oxadiazon 1.25 kg a.i./ha	12.56	10.80	30.34	32.76	91.20	100.00
7. No weeding	6.07	2.40	66.35	85.05	159.53	244.50
Mean	13.50	10.85	25.16	32.41	74.62	95.23
S.Ed ± V		0.54		0.92		4.85
W		1.01		1.73		9.08
V × W		1.43		2.44		12.84
C.D. (0.05) V		1.09		1.86		9.82
W		2.04		3.49		18.37
V × W		—		4.93		25.98

V = Varieties and W = Weed control treatments

followed by hand weeding twice (50.86 gm^2) and Pendimethalin 1.5 kg a.i./ha (55.95 g/m^2) recorded 77.6, 74.8 and 72.3 per cent less dry weight weeds respectively over weedy check.

Groundnut pod yields (Table 2) in *Virginia* variety Kadiri-3 (13.50 q/ha) was significantly higher than that recorded in Spanish variety JL-24 (10.85 q/ha). This might be because the variety Kadiri-3 with more number of branches which might have covered the ground completely and offered more resistance to weeds and resulted in less percentage reduction in yield. Kondap *et al.* (1980) were also of the opinion that the Kadiri-3 (Virginia) which is of more spreading habit is more tolerant to weeds as compared to JL-24 (Spanish). All the chemical weed control and hand weeding treatments registered significantly higher pod yields over weedy check in both the groups of varieties. Hand weeding twice at 15 and 35 DAS followed by Pendimethalin 1.5 kg a.i./ha, fluazifopbutyl 0.5 kg a.i./ha, oxyflurofen 0.25 kg a.i./ha, fluazifopbutyl 0.25 kg a.i./ha, and oxadiazon 1.25 kg ai.i./ha recorded 302.1, 253.8, 238.0, 175.5, and 167.5 per cent increased yield over weedy check treatment. There was 75.7 per cent reduction in yield in weedy check as compared to hand weeding twice at 15 and 35 DAS.

Weed index (Table 2) which represents the overall percentage reduction in yield was more in Spanish variety JL-24. This clearly shows that the yield reduction due to weed was more in JL-24 (32.41%) than that in Kadiri-3 (25.16%). Pendimethalin 1.5 kg a.i./ha (12.24%) followed by fluazifopbutyl 0.5 kg a.i./ha (15.62%) recorded significantly lesser weed index over oxyfluo fen 0.25 kg a.i./ha, oxadiazon 1.25 kg a.i./ha, fluazifopbutyl 0.25 kg a.i./ha and weedy check treatments.

Yield components (Table 1) such as number of mature pods per plant, number of seeds per plant, 100 pod weight and 100 kernel weight were more in Kadiri-3 variety (Virginia). However, it cannot be said that it is exclusively due to its suppressing ability of weeds as the interaction effects were not significant. All the yield components were more in hand weeding at 15 and 35 DAS followed by Pendimethalin 1.5 kg a.i./ha and fluazifopbutyl 0.5 kg a.i./ha which also recorded higher pod yields . Narasimha Murthy (1982) and Yadav *et al.* (1983) also obtained higher yield in Pendimethalin due to improvement in all the yield components. However, Kulandaivelu and Sankaran (1981) reported that the number of pods per plant decreased in Pendimethalin treatments.

Thus the present study indicated that fluazifopbutyl 0.5 kg a.i./ha and pendi methalin 1.5. kg a.i./ha which were used as post emergence (20 DAS) and pre-emergence (24 hours after sowing) respectively showed equal performance with hand weeding twice at 15 and 35 DAS and were found better in controlling of grassy weeds in groundnut.

LITERATURE CITED

KONDAP, S.M., M.R. REDDY, K. RAMAKRISHNA and N. GOPAL NAIDU 1980. Effect of different weed groups on 5 groundnut varieties. Annual Conference of Indian Society of weed science 21-23, July 1980. Bhubaneswar (Abstracts of papers) Orissa University of Agriculture and Technology, Bhubaneswar.

KULANDAIVELU, R. and S. SANKARAN, 1981. Effect of weed management on growth and yield of groundnut. Annual Conference of Indian Society of Weed Science 25th November, 1981 (Abstracts of papers 24), University of Agricultural Sciences, Bangalore.

NARASIMHA MURTHY, Y.V. 1982. Studies on weed control efficacy of certain herbicides on a groundnut under different phosphorus levels. M. Sc. (Ag.) thesis, Department of Agronomy APAU, Hyderabad.

YADAV, S.K., S.P. SINGH and V.M. BHAN, 1933. performance of herbicides for weed control in groundnut. Indian J. Weed Sci,. **15** (1) : 58-61.

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PHOSPHATE UTILIZATION FROM FULL BASAL, SPLIT AND FOLIAR APPLICATION BY MUSTARD (*BRASSICA JUNCEA* L.)

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Application of full dose of P at the time of sowing is the general recommendation for most crops. Some interest has arisen in recent years with regard to split or delayed application of P, in case where initial supply of the nutrient is insufficient to meet the growth requirement of the crop. Foliar application, though less frequently used for P, spray application of P not only economises the quantity of the nutrient as compared to soil application, but also overcomes the fixation of the phoshpates in the soil. But the information on such attempts of P application to mustard, an important oilseeds crop of India is lacking. Therefore, the present investigation was undertaken to evaluate some method of P application in relation to P utilization by mustard.

Green house experiments were conducted on alluvial soil (Typic, Ustochrept) of IARI Farm, New Delhi for two rabi seasons (1982-83 and 1983-84) using mustard (*Var*,. Pusa Bold) as the test crop. The important soil properties varied as organic carbon: 0.43-0.47 per cent; available p: 7.8-8.6 kg/ha; P fixing capacity; 31.2-32.6 per cent; clay:13.6-14.5 and pH: 7.8. The treatments comprised mainly three methods of application viz., basal, split and foliar application. Four levels of P (15,30,45 and 60 kg P_2O_5/ha) were applied basally with one control treatment (no phosphate) while 30 and 60 kg P_2O_5/ha levels were chosen for split application. For which, half the amount of P_2O_5 was applied basally and the balance was top-dressed 25 days after sowing the crop. Foliar application either in two (7.5 kg P_2O_5/each) or three sprays (5 kg P_2O_5 each) was made with 15 kg P_2O_5/ha dose only by the method as detailed by Dutta and Vyas (1967). All the treatments were replicated thrice in a completely randomized design. The crop was sown in pots with 4 kg soil each in the first week of November each year. Five plants were allowed to grow till flowering. The crop also received a uniform dose of 50 kg N and 40 kgK_2O/ha through urea and muriate of potash respectively, while labelled single superphosphate (Sp. act. 0.4 *m*Ci/g P_2O_5) was used as the source for P. Crop was harvested at flowering stage (approx. height 55-60 cm), washed thoroughly and dried in hot air oven at 70° c for drymatter yield. Phosphorus content was determined by Vanado-molybdate method (Koenig and Johnson, 1942) and radio assaying for ^{32}p was done by Double Precipitation method (Mackenzie and Dean, 1984). Counting was done using a G.M. Counter.

Application of phosphate brought about significant increase in drymatter yield as well as total P uptake by mustard over control. The drymatter yields obtained in spray treatments (2 or 3 sprays) were lower than that of the basal application. However, a marginal increase in total P uptake was observed with both the spray treatments over basal application at 15kg P_2O_5/ha level. The split application of P proved

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beneficial to mustard crop. The drymatter production as well as total P uptake recorded at 60 kg P_2O_5/ha level were significantly higher with split application as compared to basal application. The high response of mustard to phosphate application were due to low initial available P status of the soil as also reported by many investigators (Vir and Verma, 1979; Singh *et al.*, 1988).

A steady and significant increase in per cent Pdff values was noticed with increasing levels of basally applied phosphate up to 60 kg P_2O_5/ha. Foliar application of P in 2 or 3 sprays being at par with respect to per cent Pdff values but both were inferior to soil application when compared on equivalent level of phosphate (15 kg P_2O_5/ha). Similar types of results were also reported by Raju and Kamath (1982) due to foliar application on *rabi* cereals. Split application (Half as basally applied and half as topdressed 25 days after sowing) proved superior to full basal application as judged by the much higher per cent Pdff values obtained for the former in comparison to the latter. The beneficial effect of split application on mustard might be attributed to the fact that first split of fertilizer dose (applied as basal) helped the seedlings to get established quickly due to its 'starter effect' and thus took care of P requirement of the crop in the initial stage of growth till 25 days growth. Thereafter possibly a good deal of root proliferation derived P from fresh supply through second split which was topdressed 25 days after sowing. While such was not the case with full basal application where the pho phate was added only once at the time of sowing. Similar findings exist for barley and wheat crops (Raju and Kamath, 1984; Hamid and Sarwar, 1977).

The data on alternate tagging technique (Table 1) conclusively indicated that mustard crop derived relatively more P from the basally apllied fertilizer as compared to topdressed one. The low per cent Pdff values from topdressed fertilizer may be ascribed to a reduction in the rate of P uptake by older or suberized roots. Bhat and Nye (1974) from auto radiographic studies on rape roots reported increased P flux for the first 8 days and after that P was absorbed at a reduced rate.

TABLE 1. Effect of different treatments on drymatter yield and P uptake parameters in mustard

(Mean of two years)

P levels (kg P_2O_5/ha)	Method of application	Drymatter (g//pot)	Total P uptake (mg/pot)	Pdff (%)	Pdff (%) from each split (by alternate tagging-technique)	
					Basal* application	Topdressing*
0	Control	6.96	14.7	—	—	—
15	FB	8.15	19.2	33.4	—	—
30	FB	8.55	19.6	41.0	—	—
45	FB	7.58	17.0	49.8	—	—
60	FB	7.63	21.1	56.4	—	—
15	FA (2 sprays)	7.71	20.5	26.2	—	—
15	FA(3 sprays)	7.64	20.5	30.5	—	—
30	Split	8.65	19.3	68.1	39.9	28.2
60	Split	9.59	25.7	79.5	47.0	32.5
	S.Em (±)	0.21	0.45	1.98	*At 50% of P level	
	C.D. (5%)	0.63	1.36	6.00		

FB: Full basal

Split: Half as basal and half as topdressed

FA: Foliar application.

BHAT, K.K. and NYE, P.H. 1974.
Pl. Soil **41** : 365-382.

DUTTA, N.P. and VYAS, K.K. 1967.
Proc. Inter. Sym. Isotopes in Plant Nutrition and Physiology, FAO/IAEA, VIENNA P. 371-376.

HAMID, A. and SARWAR, G. 1977.
Expl. Agric. **13** : 337-340.

KOENIG, H.A. and JOHNSON, G.R. 1942.
Indus. Eng. Chem. (Anal.) **14** : 155-156.

MACKENZIE, A.J. and DEAN, L.A. 1948.
Anal. Chem. **20** : 559-560.

RAJU, A.S. and KAMATH, M.B. 1982.
J. Nuclear Agric. Biol. **11** -: 115-118.

RAJU, A.S., KAMATH, M.B. and GOSWAMI, N.N. 1984.
J. Nuclear Agric. Biol. **13** : 115-118..

SINGH, S., KAMATH, M.B. and CHATTERJEE, R.K. 1988.
Fertil. News **33** : 33-37.

VIR. P. and VERMA, B.S. 1979.
Indian J. Agric. Sci., **36** : 100-104.

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EVALUATION OF INSECTICIDES AGAINST THE SAFFLOWER APHID, *UROLECON COMPOSITAE* (APHIDIDAE:HEMIPTERA)

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Safflower aphid, *Urolecon compositae* theobold is considered to be the most destructive pest throughout India and the yield losses ranging 35 to 56 per cent have been reported (Khan and Hussain, 1958; Bindra and Vaishampayan, 1965) in Andhra Pradesh and Madhya Pradesh. A number of effective insecticides have been reported against this aphid by several workers (Bindra and Vaishampayan, 1965; Bindra and Rathore, 1967; Bhumannavar and Thontadarya, 1979) based on the field trials. The present study was made to determine the effective aphicide under Chhattisgarh, Madhya Pradesh condidtions.

Nine insecticides replicated four times were evaluated for their efficiency against the safflower aphid under field condition in a randomised block design. Safflower variety Eb7 was sown during the second week of December in both the years after the harvest of paddy. Two sprays, first when the crop was 55 days old, followed by second spary 25 days later were given. Pre-treatment aphid count was recorded 24 hours prior to treatment and post treatment observations were recorded on average aphid survival upto 10 days by counting the aphid population in 10 cm central twig on 10 plants in each plot. Yield data was recorded at harvest and benefit cost ratio was worked out.

Among the insecticides evaluated methyl demeton spray applied @ 1000 ml/ha proved to be the best in reducing the aphid incidence followed by monocrotophos, dimethoate and phosphamidon which were at par. On the contrary Bindra and Vaishampayan (1965) and Bhumannavar and Thontadarya (1979) found phosphamidon 0.05 per cent to be most effective where as Sarup *et al.* (1964) and Basavangoud *et al.* (1983) observed phosphamidon 0.05 per cent second to phorate and pirimicarb 50 DP respectively. Endosulfan, Chlorpyriphos, Fenvalerate and Fenitrothion were less effective in controlling the aphid and were at par with the untreated control. Similar trend was observed in the second spray. After 10 days of the second spray aphid population showed a declining trend and completely disappeared within a week.

Highest yield was recorded in the methyl demeton treatment (14.43 q/ha) followed by phosphamidon (11.77 q/ha) and monocrotophos (11.50 q/ha). Dimethoate al o gave higher yield (10.04 q/ha), whereas endosulfan, fenvalerate, chlorpyriphos and fenitrothion did not perform well and their yield being at par with control. The benefit cost ratio was also the highest in methyl demeton (9.9) followed by phosphamidon (7.4) and dimethoate (5.7).

The data based on two years study clearly revealed that methyl demeton 25 EC when sprayed twice at 55 and 80 days after sowing gave the best protection against safflower aphid and yielded highest benefit cost ratio.

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TABLE 1. Efficacy of insecticides against safflower aphid during rabi 1983 and 1984.

S. No.	Treatment Dose ml/ha)	24 hrs. before treat-mant	55 days after sowing: Average number of aphids/plant (in 10 cm central twig) Days after spray treatment						24 hrs. before treat-ment	80 days after sowing: Average number of Aphids/plant (in 10 cm central twig) Days after spray treatment					
			1 day	2 day	3 days	4 days	7 days	10 days		1 day	2 days	3 days	4 days	7 days	10 day
1.	Methyl demeton (1000)	33.5	0 35 (0.89)	0 23 (0.83)	0.32 (0 89)	0.14 (0.80)	0.60 (1.02)	2 45 (1.56)	19.5	0.02 (0.72)	0.00 (0.71)	0 02 (0.72)	0 09 (0.77)	0.12 (0.78)	2.05) (1.65)
2.	Phosphamidon (300)	31.2	0.15 (0.81)	0.17 (0.84)	0.40 (0.95)	0.63 (1.02)	1.12 (1.25)	4.05 (1.99)	20.0	0.13 (0.79)	0.04 (0.73)	0 06 (0.76)	0 13 (0.79)	0.43 (0.95)	4.50 (2.09
3.	Dimethoate (625)	31.2	0.84 (1.03)	0.28 (0.88)	0.94 (1.11)	0.36 (0.90)	0.92 (0.66)	2.98 (2.04)	20.2	0.24 (0.84)	0 05 (0.74)	0.08 (0.77)	0.16 (0.80)	0 44 (0.95)	4 40 (2.07)
4.	Formothion (1000)	34.7	2.22 (1.30)	0.92 (1.14)	1.04 (1.06)	1.45 (1.36)	2.66 (1.68)	8.20 (2.86)	18.7	0.34 (0.91)	0 27 (0.87)	0.15 (0.81)	0.68 (0.82)	1.11 (1.25)	5 05 (2.22)
5.	Fenitrothion (1000)	34.6	0.74 (0.98)	0.87 (1.12)	1.83 (1.23)	2.62 (1.65)	7.18 (2.62)	19.5 (4.35)	19.1	0 58 (1.101)	0 29 (0.85)	0 25 (0.86)	0.30 (0.89)	2.45 (1.60)	4.83 (2.17)
6.	Monocrotophos (750)	30.8	0.44 (0.96)	0 42 (0.88)	0.63 (1.02)	1.28 (1.02)	2.56 (1.63)	6.88 (2.59)	20.1	0.18 (0.82)	0 09 (0.77)	0 09 (0.77)	0 21 (0.82)	0 45 (0.96)	3.70 (1.88)
7.	Chlorpyriphos (1000)	37.2	3.54 (1.90)	1.99 (1.54)	2.47 (1.70)	3 05 (1.80)	5.05 (2.30)	16.2 (4.02)	21.6	2.15 (1.26)	1.59 (2.08)	1.26 (1.29)	0.56 (1.14)	3 83 (2.00)	6.60 (2.55)
8.	Fenvalerate (300)	35.7	7.30 (2.38)	1.83 (1.49)	2.54 (1.67)	1.93 (1.55)	3.77 (2.05)	12.1 (3.47)	19.3	1.02 (1.30)	0.68 (0.07)	0.98 (1.18)	0.97 (1.19)	2.28 (1.62)	6.45 (2.56)
9.	Endosulphan (1000)	36.4	10.8 (3.12)	4.10 (2.00)	4 72 2.18)	5 00 (2.28)	8.47 (2.88)	22.65 (4.75)	20.1	1.79 (1.51)	1.96 (1.55)	1.12 (1.24)	1.39 (1.35)	6.76 (2.69)	8.48 (2.90)
10.	Untreated control	33.1	29.84 (5.50)	26.75 (5.22)	24.26 (4.97)	25 91 (5.14)	24.72 (4.48)	23.00 (4.80)	25.3	17.3 (4.18)	20.07 (4.51)	19.74 (4.50)	18.32 (4.83)	16.83 (4.49)	9 03 (3.00)
	S.E (d)	N.S.	0.41	0.21	0.22	0.25	0.32	0.50	N.S.	0.14	0.21	0.09	0.09	0.15	0.21
	C.D. at 5%		0.84	0.44	0.45	0.51	0.66	1.03		0.29	0.44	0.19	0.20	0.29	0.44

Note : (1) Figures in parenthesis indicate transformed values.
(2) Average of 10 plants each from four replications.
(3) The data based on means of the two years.

TABLE 2. Effect of various insecticides on the yield and its economics (Based on means of 1983 and 1984)

S. No.	Insecticides	Concentration dose ml/ha	Grain yield q/ha	Values of increased grain (in Rs/ha)	Cost of insecticides and application (in Rs/ha)	Benefit cost ratio
1	Methyl demeton 25 EC	1000	14.43	2639.10	266.00	9.9
2	Phosphamidon 85 EC	300	11.77	1881.00	252.80	7.4
3	Dimethoate 30 EC	625	10.04	1387.95	244.38	5.7
4	Formothion 25 EC	1000	7.17	570.00	240.00	2.48
5	Fenitrothion 50 EC	1000	7.19	575.70	240.00	2.4
6	Monocrotophos 40 EC	750	11.50	1804.05	335.00	5.4
7	Chlorpyriphos 20 EC	1000	7.08	544.35	280.00	1.9
8	Fenvalerate 25 EC	300	6.32	327.75	268.00	1.2
9	Endosulphon 35 EC	1000	6.21	296.40	288.00	1.03
10	Untreated control		5.17	—	—	—
	SE (d)		.22			
	C.D. at 5%		2.49			

BASAVANGOUD, K; KULKARNI, K.A. and THONTADARYA, T.S. (1981) Efficiency of insecticides against the safflower aphid *Dactynotus compositae* Theobald. *Oilseeds J.* XI : 42-44.

BHUMANNAVAR, B.S. and THONTADARYA, T.S. 1979. Effectiveness of different insecticides aginst safflower aphid, *Dactynotus comopsitae* Theobald (Hemptera : Aphididae) on safflower in Karnataka. *Pesticides*, 9 : 28-30.

BINDRA, O.S. and RATHORE, Y.S. 1967. Investigation on the biology and control of the safflower aphid at Jabalpur. *JNKVV Res. J.* 1 : 60-63.

BINDRA, O.S. and VAISHAMPAYANA, S.M. 1965—. Studies on the chemical control of safflower aphid, *Dactynotus compositae* Theo. *Indian Oilseeds J.* 9 : 113-118.

KHAN, M.Q. and HUSSAIN, M. 1958. Prodceedings of 45th Indian Science Congress, 3 : 463-464

PRAKASH SARUP, DAYA SHANKER SINGH AND RATTAN LAL 1964. Testing of pesticides against safflower aphid, *Dactynotus carthami* H.R.L. (Aphididae : Homoptera). *Indian J.* Ent.; 26 : 300 309.

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GENETIC VARIANCE STUDIES IN LINSEED

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Among the oilseed crops, linseed *Linum usitatissimum* L has considerable industrial importance as its oil is used in the manufacture of varnishes, paints, linoleum, oil cloth etc. Moreover, the lineseed oil is used for edible purposes to a limited extent. Besides, the linseed fibre is also used in the manufacture of twines, strings, woven into canvas used in the making of linen cloth, hose pipes, high grade paper etc. The presentinvestigation was undertaken for assessing the relative importance of additive and dominance genetic variances for these three traits of this crop.

The material comprised three crosses viz. Himalini × Flake-1, KL-134 × LHCK-69, Neelam × Aoyogi. The parents were both of seed and flax types with diverse origin, Flake-I and Aoyogi were the flax type while the rest were seed types. From these three crosses, 18 generations including the parents viz. F_1, F_2, F_3, BC_1, BC_2, BC_{11}, BC_{12}, BC_{22}, BC_{21}, F_1F_2, F_2P_1, F_2P_2, B_1F_1, B_2F_1, B_1S and B_2S were developed for each cross and these generations alongwith their parents were evaluated in a compact family block design at Kangra (HP) during Rabi 1986-87. One row plot of 3 meter length was planted with a row to row space of 30 cms. Individual plant data was collected on 10 random plants, however 30 plants were taken for F_2 and F_3.

The estimates of additive (D) and dominance (H) components of variance alongwith non-heritable components of variance viz. E_1 the non-heritable variance of individuals and E_2, the non-heritable variance of family means were estimated by recourse to second degree statistics. The various statistics namely V_1F_2, V_1F_3, W_1F_{23}, V_2F_3 and E_1 and E_2 were estimated from the available population of P_1, P_2, F_1,F_2 and F_3 with respect to seed yield, oil content and fibre yield. From these statistics, the estimates of genetic components of variance D and H and the environmental components of variation E_1 and E_2 were estimated using the procedure of un-weighted least squre analysis described in detail by Mather and Jinks (1982). The average degree of dominance was calculated by the formula (H/D) 1/2 and the narrow sense heritability was calculated as—

$$\frac{D}{D + H + E_1 + E_2}$$

The results obtained on genetic components of variance for seed yield, oil content and the fibre content are presented in Table-1 the perusal of which reveals that

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TABLE 1. Estimates of genetic components of variance with respect to three crosses studied for seed yield per plant.

Cross/ Genetic Component	Crosses I	II	III
D	7.49* ± 4.19	71.39* ± 10.12	13.88* ± 1.78
H	57.06* ± 23.98	60.02* ± 51.58	40.31* ± 5.71
E_1	3.41 ± 2.04	18.53* ± 4.38	5.025* ± 0.48
E_2	1.29 ± 2.05	1.47 ± 4.41	3.17* ± 0.49
Estimates of components of genetic variance with respect to three crosses studied for oil content			
D	0.55* ± 0.28	2.27* ± 1.33	2.81* ± 0.68
H	0.04* ± 1.23	7.95* ± 4.28	6.57* ± 2.18
E_1	0.21* ± 0.10	0.26 ± 0.36	1.14* ± 0.18
E_2	0.55* ± 0.10	0.38 ± 0.28	0.56* ± 0.18
Estimates of component of genetic variance with respect to three crosses studied for fibre weight.			
D	2.89* ± 1.50	0.45 ± 3.24	0.82 ± 1.10
H	1.58 ± 4.96	3.67* ± 1.07	2.72 ± 3.36
E_1	2.84* ± 0.42	0.28* ± 0.08	1.38 ± 0.28
E_2	0.36 ± 0.42	0.87 ± 0.09	1.16* ± 0.28

* Significant at 5%.

the additive (D) and dominance (H) variance were significant for seed yield and oil content in the three crosses under investigation while only additive (D) component was significant in cross I for fibre weight, and dominance component was non-significant in all three crosses for this trait. However, E_1 the environmental variation component between individuals was significant in cross II and III for seed yield, for oil content in

cross I and II and for all these three crosses for fibre weight in cross I and II. E_2 was significant in cross III for seed yield, in cross I and III for oil content and cross II and III for fibre weight. The relative magnitude of dominance component of genetic variance was higher than the additive component with the expression of over-dominance for the first two traits while partial dominance was observed for fibre weight. The heritability estimates in narrow sense were in general low for these traits.

The presence of additive type of genetic variation for these character is apparent from the present investigation. A considerbale amount of additive genetic variance alongwith significant dominance genetic variability observed for these traits as also reported by Badwal and Bains (1970). Similar were the findings of Murty and Anand (1966), Anand and Murty (1969). For the trait fibre yield, only additive variance was significant while dominance was non-significant. Presence of additive variance gives and indication that a breeder can plan his work systematically for the transgressive segregates in the segregating generations. The presence of additive genetic and dominance variation for the seed yield and other components in the present investigation suggested that it will be more desirable to exploit both types of gene actions simultaneously, through the recurrent selections procedure involving intermating of the potential segregates alternately with the selection would accumulate the favourable additive genetic variability and also leads to the exploitation of dominance genetic and epistatic effects.

From the present study it is suggested that for developing dual purpose varieties for higher seed yield and fibre content in linseed, cross I, (Himalini × Flak-I) followed by (Neelam × Aoyogi) may be exploited through recurrent selection procedure.

ANAND, I.J. and MURTHY B.R., 1969. Serial analysis of combining ability in linseed. Theort Appl. Genet, 39 : 88-94.

BADWAL, S.S. and BAINS K.S., 1970. Genetic analysis in Linum top crosses. Genetic Agraria 28 : (2) 136-141.

MATHER, K. and JINKS, J.L., 1982. Biometrical genetics 3rd Edn. Chapman and Hall Ltd. 11 New Fetter Lane London.

MURTY, B.R. and ANAND, I.J., 1966. Combining ability and genetic diversity in some varieties of *Linum usitatissimum* L Ind. J. Genet 26 : 21-26.

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INTERCROPPING OF MUSTARD WITH CHICKPEA UNDER RAINFED CULTIVATION

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Growing of mustard with chickpea, wheat or linseed is common practice. However, the precise scientific information on planting pattern in rainfed cropping of musard with chickpea is not available. The present studies are planned to assess the total production and economic return per unit area and time through row adjustment of mustard with chickpea under rainfed situation. Six treatment combinations consisting of pure chickpea, pure mustard and mustard in 3:1, 4:1 row rations with paired row planting (30/60) of chickpea + one row of mustard in 60 cm space and farmer's practice (chickpea in row 45 cm apart and mustard broadcasted) were tested in randomized block desigh in three replications at Oilseed Research Farm, Kalianpur, Kanpur during 1984-85 and 1985-86. The recommended dose of 40 kg N and 20 kg P_2O_5/ha to mustard, while 15 kg N and 45 kg P_2O_5/ha to chickpea was applied on row basis at seeding stage in each plot except in farmers' practice where 15 kg N+45 kg P_2O_5/ha was applied as basal only. Varieties 'Varuna' and 'Awarodhi of mustard and chickpea respectively were used in the experiment.

The atmospheric conditions during 1985-86 were more conducive for the occurance of Alternaria and White rust in mustard.

Crop Yield :- The data on crop yields (Table 1) revealed that the weather conditions during both the years were more conducive to achieve normal yield of chickpea with an average of 31-21 q/ha in pure cropping system. However, the yield of mustard was drastically reduced particularly during 1985-86 due to severe incidence of *Alternaria* and White rust diseases in this crop. An average yield of 9.43 q/ha of mustard was recorded in its pure stand. It was observed that 69.7%, 83.4%, 57.6% and 57.7% grain yield of chickpea and 60.9%, 56.2%, 71.4% and 56.0% seed yield of mustard of the either of the pure crop were contributed by 3:1, 4:1, paired row planting and farmer's practices respectively. There was reduction in the yield of chickpea, under intercropping system, but in the farmer's practice and paired row planting system of chickpea and adjustment of one row of mustard led to the drastic reduction in the productivity of chickpea against pure cropping. This seems to be largely due to shading effect of mustard on chickpea. Garse and Nikam (1984) also reported the adverse effect of main crop on intercrop under inter-cropping system.

Monetary return :- A perusal of data (Table 2) revealed that there were wide variations among different cropping systems with regards to the gross monetary returns. However the maximum net profit (Rs. 10339/ha) was recorded when one row of mustard was planted after every four rows of chickpea. It was 47.6% higher than the farmer's practice and 8% higher than the pure cropping of chickpea and much

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TABLE 1: Crop yield (q/ha) as influenced by different cropping systems.

Cropping systems	1984–85		1985–86		Mean	
	Chickpea	Mustard	Chickpea	Mustard	Chickpea	Mustard
Pure cropping						
Chickpea	32.16 (30.2)	—	30.26 (31.31)	—	31.21 (30.7)	—
Mustard	—	11.17 (40.2)	—	7.68 (22.6)	—	9.43 (31.4)
Chickpea + mustard						
3:1	19.90 (20.1)	7.16 (20.2)	23.57 (23.0)	4.31 (12.5)	21.74 (21.6)	5.74 (16.3)
4:1	25.32 (25.0)	6.79 (18.0)	26.75 (27.2)	3.8 (10.8)	26.04 (28.1)	5.30 (14.4)
Pair planting (2:1) (30/60)	18.36 (19.4)	8.58 (25.1)	17.60 (17.1)	4 88 (13.9)	17.98 (18.2)	6.73 (19.5)
Farmers' practice	16.73 (16.7)	7.77 (24.0)	18.68 (18.3)	4.15 (12.4)	17.71 (17.5)	5.96 (18.2)

Figures in parenthesis are the yield of Bhusa/sticks (q/ha).

higher than the pure cropping of mustard. It is evident from the bebefit cost ratio (Table-2) that with the investment of every one rupee, the maximum return of Rs. 2.97 was received with the intercropping of chickpea with mustard in 4:1 rows ratio followed by the pure cropping of chickpea where a return of Rs. 2.83 was obtained with the investment of every rupee. The beneficial effects of intercropping have been reported by several workers (Verma and Taneja, 1980; Rathore and Misra 1985, and Verma and Srivastava 1987).

Considering the agro-climatic conditions, crop yield and monetary return of different cropping systems, it is evident that the raising of one row of mustard after every four rows of chickpea is the most profitable.

GARSE T.L. and NIKAM, S.M. 1985. *J. Oilseeds Res.* 1 : 216-220.

RATHORE, R.S. and MISRA G.L. 1985. *J. Oilseeds Res.* 2 : 115-116.

VERMA, K.P. and SRIVASTAVA A.N. 1987. *J. Oilseeds Res.* 2 : 230-233.

VERMA, R.S. and TANEJA, S.K. 1980. *Indian J. Agron.* 25 (1) : 92-96.

TABLE 2. Total monetary return, net profit and cost benefit ratio as influenced by different cropping systems.

Cropping systems	Gross monetary return			Net profit (Rs/ha)			Cost benefit ratio		
	1984–85	1985–86	Mean	1984–85	1985–86	Mean	1984–85	1985–85	Mena
Pure cropping									
Chickpea	14261	11675	12968	10961	8175	9568	3.32	2.34	2.83
Mustard	6636	4563	5599	3036	563	1799	0.84	0.14	0.49
Chickpea + mustard									
3:1	12998	11632	12315	9548	87982	8765	2.77	2.19	2.48
4:1	15117	12561	13867	11717	8961	10339	3.45	2.49	2.97
Pair planting (30/60) 2:1	13166	9654	11410	9316	5404	7360	2.42	1.27	1.58 1.85
Farmer's practice	11959	9650	10804	8309	5700	7005	2.28	1.44	1.86
C.D. at 5%	1180	879	—	—	—	—	—	—	—
C.V. %	8.9	9.4	—	—	—	—		—	—

Prevailing market rates (Rs/q)

		84–85	85–85
Chickpea	grain	420.00	360.00
	Bhusa	25.00	25.00
Mustard	seed	550.00	550.00
	Sticks	10.0	15.0

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STUDIES ON THE USE OF SOME STRAINS OF *RHIZOBIUM* TO IMPROVE GROUNDNUT YIELD UNDER RAINFED CONDITIONS

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In India groundnut yield is relatively low although grown over a large area. The use of nitrogenous fertilizers is limited as the crop is usually grown on drylands. Henec *Rhizobium* is the alternate source of nitrogen supply to meet the crop nitrogen requirement. Groundnut being nonspecific to different types of *Rhizobia*, inoculation of right strains possessing competitive advantage over the native strains as pointed by Gaur *et al* (1974), may be necessary. According to Date (1976) the ability of an introduced Rhizobial strain to successfully compete with the native strains in soil is the foremost consideration in selecting a suitable strain.

Groundnut cultivars JL. 24, VRI. 1 and Co. 2 were used in this investigation. Four Rhizobium cultures viz., IGR 40 (Supplied by NRCG, Junagadh), Nc. 92, 5a/70 (supplied by ICRISAT, Hyderabad) and TNAU. 14 (supplied by TNAU, Coimbatore-3) were evaluated in this field experiment. Uninoculated control plot was also maintained for all the cultivars.

At Regional Research Station, Vridhachalam, a field experiment was conducted (during Kharif 1987) under rainfed conditions in split plot design with three replications. Groundnut Seeds were treated with Mancozeb @ 4g/kg of seed. After 24 hours of seed treatment with fungicide, the seeds were inoculated with peat based cultures using rice gruel, as sticker and dried in shade for 30 minutes and sown,. Uninoculated seeds were sown as control. Other cultural practices viz. weeding, Gypsum application and earthing up and plant protection measures were also taken up. After 45 days and 70 days, random samples were taken from each plot for recording nodule numbers and plant dry weight. The crop was harvested at maturity and the yield data were recorded.

All the test strains increased the nodulation in all the varieties (Table 1).

All the test Rhizobium cultures increased the growth of the plants except IGR. 40 on 45th day in JL. 24 and in VRI. 1 groundnut, over the uninoculated control (Table 2).

The varieties VRI. 1 and Co. 2 registered the highest yield of 1783 kg/ha and 1744 kg/ha when inoculated with TNAU. 14 Rhizobium cultures which were significantly superior to the respective controls (Table 3).

The variety JL. 24 registered the highest yield of 1811 kg when inoculated with Nc. 92 Rhizobium culture which is significantly superior to control (1655 kg/ha).

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TABLE 1. Effect of inoculating groundnut cultivars with different strains of *Rhizobium* under field coditions on the nodulation of groundnut.

Varieties	JL.24		VRI.1 (Nodule numbers/plant)		CO.2	
	45th day	70th day	45th day	70th day	45th day	70th day
Rhizobium cultures						
IGR:40	33.5	45.3	28.5	45.8	31.3	47.2
NC.92	36.0	53.0	27.7	47.7	33.3	46.0
5 a/70	32.7	46.3	28.5	45.0	32.8	45.5
TNAU 14	32.0	45.8	30.0	51.7	36.3	50.8
control (Uninoculated)	29.3	45.7	26.3	43.2	30.5	43.2

	45th day		70th day
SE		SE	
Varieties	0.59	Varieties	0.46
Rhizobium cultures	0.26	Rhizobium cultures	0.44
Varieties × cultures	0.65	Varieties × cultures	1.19
CD		CD	
Varieties	1.86*	Varieties	1.44*
Cultures	0.74*	Rhizobium	1.38*
Varieties × cultures	2.05*	Varieties × cultures	3.39*

* Significant (p=0.05)

TABLE 2. Effect of inoculating groundnut cultivars with different strains of Rhizobium under field conditions on the growth of groundnut.

	JL.24		VRI.1 (Plant dry weight g/plant)		Co.2	
	45th day	70th day	45th day	70th day	45th day	70th day
IGR.40	5.92	10.67	6.58	10.83	6.00	10.50
NC.92	6.50	11.75	6.42	11.08	6.00	10.08
5a/70	6.25	10.67	7.08	11.67	6.42	10.42
TNAU.14	6.25	10.17	7.83	12.67	6.92	10.58
Control (Uninoculated)	6.00	9.83	6.67	16.92	5.83	10.00

	4th day		70th day
SE		SE	
Varieties	0.11	Varieties	0.23
Rhizobium cultures	0.10	Rhizobium cultures	0.15
Variety × cultures	0.24	Varieties × cultures	0.36
CD		CD	
Varieties	0.35*	Varieties	0.73*
Rhizobium cultures	0.28*	Rhizobium cultures	0.42*
Varieties × cultures	0.68*	Varieties × cultures	1.03*

* Significant (p=0.05)

TABLE 3. **Effect of inoculating groundnut cultivars with different strains of *Rhizobium* under field conditions on the yield of groundnut.**

Cultivars / Rhizobium	JL.24		VRI.1		CO.2	
	Kg/ha	% over control	Kg/ha	% over control	Kg/ha	% over control
IGR.40	1750	5.7	1728	13.0	1678	7.5
NC.92	1811	9.4	1655	8.3	1661	6.4
5a/70	1661	0.3	1567	2.6	1683	7.8
TNAU.14	1705	3.0	1783	16.7	1744	11.7
Control (Uninoculated)	1655	—	1528	—	1561	—

SE	
Varieties	25.0
Rhizobium cultures	11.7
Varieties × cultures	33.3
CD	
Varieties	81.7*
Rhizobium cultures	33.3*
Varieties × cultures	90.0*

* Significant (p=0.05)

The fungicide treatment did not have any deleterious effect in any of the varieties tested. Manickasundaram and Ramabadran (1976) also reported the non-injurious nature of fungicides on nodulation.

Poi and Kabi (1983) also found that efficient *Rhizobium* strains should be used for groundnut for improving groundnut production under rainfed conditions. Therefore from the above study it understood that suitable Rhizobium culture is necessary for groundnut cultivars to increase the yield under rainfed conditions.

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GAUR, Y.D., SEN, A.N. and SUBBA RAO, N.S. 1974. Proc. Indian Nat. Sci. Acad,. B. 40 : 562

DATE, R.A. 1976. In symbiotic nitrogen fixation in plants, Ed. P.S. NUTMAN, Cambridge University Press, Cambridge: 137.

MANICKASUNDARAM, G. and RAMABADRAN, R. 1976. Madras Agric. J. 63 (11) : 644.

POI., S.C. and KABI, M.C. 1983, Trop. grain legume bulletin : 20.

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STABILITY OF PERFORMANCE OF SOME VARIETIES OF INDIAN RAPE, (*BRASSICA CAMPESTRIS* L.)

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Due to self-incompatibility mechanism toria type of Indian rape (*Brassica campestris* L.) maintains high degree of heterozygosity. There is considerable acerage of rape seed types in the country owing to its shorter duration and suitability to multiple cropping systems. A study was therefore conducted to evaluate seven promising rape seed varieties in comparison with M-27, a predominent variety of the country in order to identify suitable variety in place of the existing ones.

Varieties like T-9, PT-30, PT-303, PT-501-13 and YSB-9, were tested against M-27 and a local variety at Regional Research Station, G. Udayagiri during 1984-85 and 1985-86 under five different dates of sowing representing five environments. The trails were laid out in a Randomised Block Design during all the dates of sowings. Three replications having a net plot size of 6 m × 1.4 m was adopted. The spacing of 20 cm from line to line was followed during all the dates of sowing. The stability parameters for days to 50% flowering and yield were computed using the Eberhart and Russel (1966) model.

The analysis of variance revealed the presence of genetic variability in the materials under investigation for both the traits (Table 1). Variety X environment (linear) interactions were highly significant for both the traits indicating the differences among the regression coefficients pertaining to various varieties on the environmental means were real and the prediction of the varieties based on it appeared to be feasible. The variances due to pooled deviations were also highly significant. These confirmed that the linear regression and the deviations from linearity were the two major components for differences in stability for the flowering and seed yield among the varieties. It also suggested that these varieties differed from each other with respect to their stability.

M-27 was found to be earliest in flowering but none of them considered to be stable for this character as the days to 50% flowering fluctuates depending on the temperature. All the improved cultivars showed higher mean performance than the local variety and the average performance of PT-30 was the highest. But its performance cannot be predicted as both the regression and deviation from regression were significant. Recently introduced varieties were found superior to the older variety, M-27. Among all the varieties tested, T-9 can be considered the stable variety because of its regression value was arround one and deviation from regression was not significant. YS-B-9 is having above average stability and its yield can be improved under favourable condition.

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TABLE 1 Pooled analysis of variance (MSS) for flowering and yield of some rape seed varieties

Source	df	Yield	50% flowering
Genotypes	6	6338.2657 **	28.28 ** ++
Env + (Gent Var. × Env.)	28	39096.707 ** ++	5.52
Env. (Linear)	1	861372.28 ** ++	101.3
G X E (Linear)	6	11345.948 **	4.673 ** ++
Pooled deviation	21	7869.5157 **	1.202 **
Pooled Error	70	470.20933	0.171

** P 0.01 (Against pooled error)

++ P 0.01 (Against pooled deviation)

All the varieties excepting T-9 and M-27 possessed below average stability and hence may be better adapted to favourable environments whereas M-27 and the local variety could be suitable for unfavourable conditions as their average performance was negative, deviation from regression was significant and regression value was less than one. Similar conclusions were also drawn by Ram (1970) in another set of rape seed varieties and by Kumar *et al* (1986) in mustard varieties.

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EBERHART, S.A. and RUSSEL, W.A. 1966. Crop. Sci. 6 (1) : 36-40.

KUMAR, R., GUPTA, V.P. and GUPTA, M.L. 1986. J. Oilseeds Res. 3 : 251-54.

RAM, J. 1970. India J. Genet. 30 (1) 116-25.

TABLE 2. Stability of some rape seed varieties for yield and days to flowering.

Varieties	Yield				Days to 50% flowering			
	Mean yield kg/ha	Percentage over grand mean	b2	S^2d	Mean	Percentage over grand mean	b2	S^2d
1. Local	526.178	87.375	0.6939279	1205.575	33.04	92.49	1.769*	.469*
2. T-9	576.178	95.678	0.800605	128.09733	36.18	101.28	0.808	0.932**
3. YSB-9	619.833	102.928	0.7987085	15136.943**	35.36	98.99	0.453**	0.059
4. PT-30	660.702	109.971	1.4353091*	1492.2307**	37.78	105.76	0.185**	0.002
5. PT–303	619.035	102.795	1.2891906	24951.424**	34.64	96.97	1.569	0.725*
6. M–27	595.071	98.816	0.7609136	5966.452**	33.38	93.44	1.203	0.799**
7. PT-501-13	618.250	102.665	1.2213408	3170.384**	39.66	111.03	1.031	4.235**

*, ** Significant at 5% and 1% levels of probability.

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REFINED CROSSING METHOD FOR NIGER (*GUIZOTIA ABYSSINICA* CASS)

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Niger (Guizotia abyssinica Cass.) is a highly cross pollinated crop due to self-incompatability and protandry. The crop by virtue of the enormous variability it presents for various characters of economic importance offers tremendous scope for improvement through re-combination breeding. The currently adopted emasculation procedures which involve straight and repeated pollination from selected source in the case of ray florets which are pistillate (Chavan, 1961) and hand emasculation and their pollination in the case of disc florets are not only cumbersome and time consuming but result in very poor seed set (Table-1). The paper in question highlights the results of investigations carried out at the Directorate of Oilseeds Research to evolve less tedious, simple and rapid emasculation method than the presently followed ones and therby improve seed set in artificial hybridization programmes.

The capitulum in niger is heteromorphic with both ray and disc florets. The latter accounts for 80-85% of the total number of florets. Although the ray florets being pistillate do not require emasculation, seldom result in more than 33 to 35% seed set even with repeated pollinations presumably because of presence of variable degree of sterility (Anonymous, 1982; Weiss, 1983). The disc florets, therfore, form a better choice for obtaining higher seed set per unit time and input spent on artificial crosses.

The stamens in niger are epipetalous and syngenesious. At the time of opening (around 8 AM on a cloudless, clear sunny day) disc florets appear swollen and turn yellow : The anther column becomes more conspicuous with white tip. This is the right stage for emasculation. In the conventional method, the disc florets are emasculated individually by splitting the anther tube from the base upwards and removing syngenesious anthers. On an average, one with good skill can emasculate 50 to 55 capitula per hour (average number of disc florets per capitulum = 5 to 10) i.e., 8.636 florets per minute/man hour with the above method. The revised method on the other hand, involves no splitting of anther column which is time consuming. In the latter case, hold the white tip of anther column with a fine tweezers and pull it out with a quick jerk. The syngenesious anther tube comes off quickly and without any damage to stigmatic surface as the latter is at a lower level than the anther tube. (Figs. 1 and 2).

As compared to conventional method (8.636 florets per minute) one can easily emasculate 19.2 to 20.2 disc florets per minute (Table-1).

The relative efficacy of the three methods as assessed in terms of seed set and output per man hour is also given in Table-1: Thus as against a crossed seed set of 42% in capitula emasculated by usual method and pollinated by pollen from other

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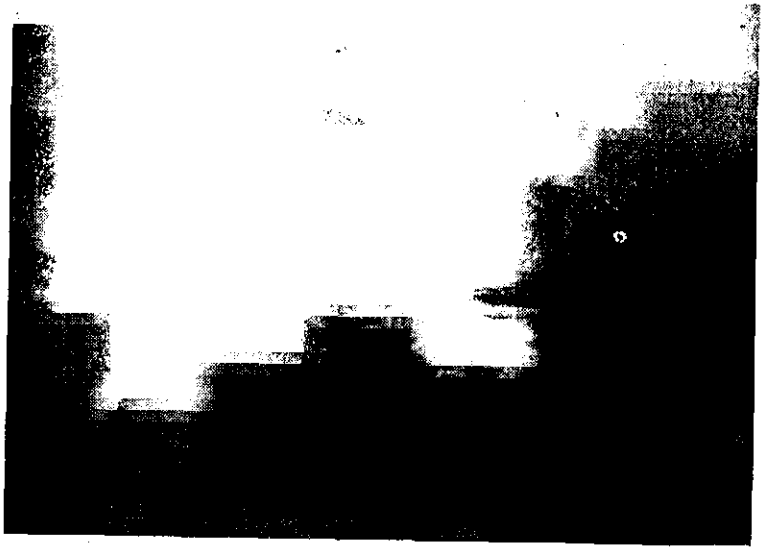

Fig. 1

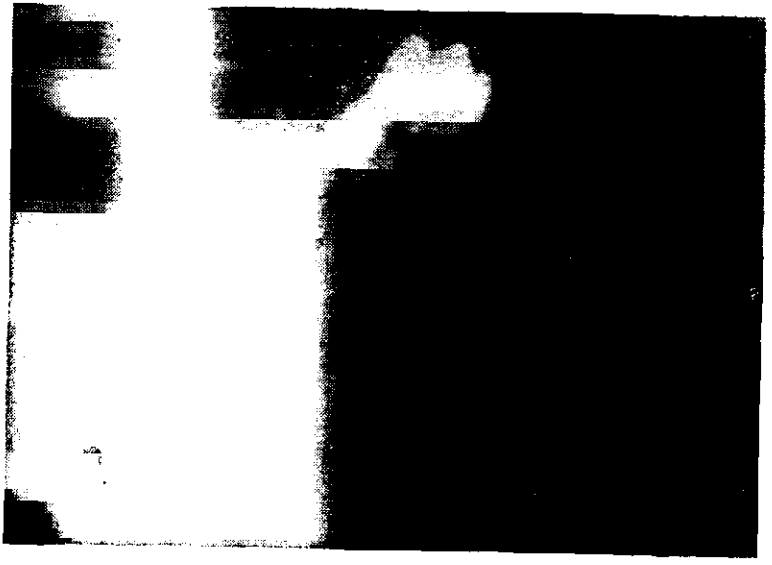

Fig. 2

TABLE 1. Extent of seed set as influenced by method of emasculation in niger (*Guizotia abyssinica* cass)

S. No.	Type of floret used for pollination	Mode of pollination	No. of capitula handled	No. of florets handled	Seeds obtained	% of seed set	Efficacy of the new method of emasculation: No. of capitula emasculated per min	No. of florets obtained per min.	Seeds set per min of Emasculation	Success % over conventional method
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1.	Ray florets	Removing all disc. florets & leaving only the ray florets and cross pollinating.	28	224	73	32.6 (-22.4)	1.727	12	3.912	+07
2.	Ray florets	Pollinated twice with pollen from another plant at half hourly intervals.	12	96	36	37.5 (-10.8)	1.727	12	4.5	+23
3.	Ray florets and Disc florets (No emasculation).	Capitulum dusted (3-4 days after opening) with pollen from another plant and bagged	16	256	156	61.00 (+45)	—	—	—	—
4.	Disc florets	Conventional emasculation of disc florets.	19	171	72	42.10 —	0.909	8.636	3.635	—
5.	Disc florets	Improved method of emasculation of disc florets	58	447	341	76.3 (+81)	1.55	19.15	14.61	+302

No. 1 and 3 are traditional methods.
No. 5 is the new method recommended.

*Figures in parenthesis indicate the percent increase or decrease in seed set over conventional method.

sources the improved method registered 81% more seed set (actual=76.3%) and in terms of relative efficacy is four times the conventional method. The next best method in terms of seed set is the straight dusting of the capitulum 3-4 days after its opening with pollen from male parent (Shrivastava and Shomwanshi 1974). Though needs no emasculation and results in higher seed set (61%) than the hand emasculation, it is cumbersome and may result in contamination. The reasons for enhanced seed set in the revised method over the usual crossing method could be due to (1) full exposure of stigmatic surfaces early in the day and thus allowing more time for pollination and (2) minimal mutilation injury. The revised system is not only simple, rapid but also more efficient in terms of seed set per unit time and man power. A switch over to the improved method should obviously prove more paying in terms of number of crosses to be handled per unit time as well as seed set.

ANONYMOUS, 1982 Agricultural plants Ed,. R.H.H. Langer and G.D. Hill P. 162 163.

CHAVANI, 1961 Monograph on niger and safflower : Indian Central Oilseeds Committee.

SHRIVASTAVA, P.S. and SHOMWANSHI, K.P.S. 1974. Investigations on the extent of cross pollination and selfing and crossing technique in niger (*Guizotia abyssinica*. Cass.) JNKVV, Res. J. 8 : 110-112.

WEISS, 1983. Oilseed Crops. Longman, London.

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LEAF AREA ESTIMATION BY LINEAR MEASUREMENTS IN NIGER (*GUIZOTIA ABYSSINICA* L.)

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Classical growth analysis studies, research on the interception of solar radiation by the crop canopy and finally the productivity require the non-destructive measurement of leaf very frequently. In the present study, effort has been made to findout a leaf factor so that area of the leaf can be measured by linear method.

Twenty one varieties of niger were grown following all the recommended packages in *kharif* season of 1988 at Regional research Station, Raichur in randomised design with three replications. At the time of peak flowering, fifty well developed green leaves were collected randomly from different heights of the plants from each treatments. They were dipped in distilled water for one hour. After removing the adhering moisture, their maximum length and width were recorded. From these leaves one hundred discs were (radius = 0.5 cms.) taken using a leaf punch, for estimated of leaf area by gravi=metric method. Care was taken to avoid midrib. These discs and the rest of the leaves were oven dried at 80°C and their weight was recorded. Leaf factor was worked out for all the varieties following the method of Ashely *et al* (1963) by dividing the actual leaf area with the product of maximum length and width of the leaf (appearent leaf area) and was fixed to third decimal. Estimated leaf area was computed by multiplying the apparent leaf area with its factor. The data so collected was subjected to statistical analysis and coefficient of correlation was worked out for actual leaf area with apparent and estimated leaf area.

The actual apparent and estimated leaf area varied from 18.54 to 29.80 cm^2; 29.94 to 49.12 cm^2; and 18.55 to 29.80 cm^2; respectively. (Table - 1) The leaf factor showed a range from 0.567 to 0.668. All these parameters did not show statistical variation among the varieties. The coefficient of correlation worked out revealed strong positive relationship between actual and apparent leaf area ($r=0.918$) and between actual and estimated leaf area ($r=0.999$) which indicate that the leaf factors worked out are accurate to the nearest point. It can be concluded that the leaf factor 0.613 (mean of all varieties) can be used in general for the easy estimation of leaf area in niger irrespective of varieties adopting the formula $A=L\times W\times 0.613$.

ASHLEY, D.A., DOSS, B.D. and BENNET, O.L., 1963. *Agron. J.* **55** : 584-585.

TABLE 1 : Apparent, actual estimated leaf area in niger varieties

Sl. No.	Variety	Leaf area per leaf (cm^2)			Leaf factor
		Apparent	Actual	Estimated	
1	RCR-64	34.62	21.00	20.99	0.606
2	RCR-140	41.14	25.53	25.52	0.622
3.	RCR-238	29.94	19.64	19.63	0.655
4	RCR-290	32.99	21.13	21.13	0.634
5	RCR-317	37.24	23.53	23.53	0.631
6	No-71	35.38	20.30	20.30	0.575
7	N-35	37.72	22.06	22.05	0.584
8	N-73-13	34.99	19.94	19.99	0.574
9	UN-4	40.74	24.23	24.24	0.599
10	ONS-6	49.12	29.80	29.80	0.603
11	CHH-1	42.79	24.21	24.21	0.567
12	CHH-2	33.32	21.01	21.01	0.631
13	CHH-3	30.25	18.54	18.55	0.614
14	GA-1	39.78	25.25	25.19	0.637
15	COMP-II	34.48	21.48	21.47	0.626
16	Phule-4	43.82	26.16	26.28	0.600
17	Goudeguda	39.53	21.71	21.71	0.608
18	REC-1	41.48	25.80	25.80	0.623
19	REC-2	40.84	25.83	25.82	0.634
20	BNS-120	39.41	22.98	22.99	0.586
21	Raichur local	35.38	23.61	23.62	0.668
	Mean	37.85	23.03	23.04	0.613
	SEm ±	3.30	2.05	2.06	0.022
	C.D. 5%	NS	NS	NS	NS

Co-efficient of correlation for :

Actual leaf area and Apparent leaf area = 0.918

Actual leaf area and estimated leaf area = 0.999

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CHEMICAL CONTROL OF CASTOR SEMILOOPER, *ACHOEA JANATA* LINN.

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The castor semilooper, *Achoea janata* is one of the most important regular spets on castor, causing serious damage to the crop. Effective control of the castor semilooper, *A. janata* has been achieved with several available insecticides like methyl parathion+DDT, carbaryl and dimethoate (Kushwaha and Pal, 1977), phosalone leptophos and phethoate (Deshmukh *et al* 1979) carbaryl and dicrotophos (Pal, 1977) and deltamethrin, indothrin, flucythrinate, cyfluthrin, permethrin, fenvalerate, cypermethrin and quinalphos (Dalaya *et al*,. 1983). Diflubenzuron, a chitin inhibitor was studied for its comparative efficacy, individually and as mixture with four other insecticides, belonging to different groups of insecticides, against castor semilooper under field conditions during the present investigations.

The studies were conducted on the Agricultural College Farm, Rajendranagar during *kharif*, 1986, in three replicated randomised block design (RBD) with nine treatments,fenvalerate (0..02%), endosulfan (0.07%), carbryl (0.1%), phosalone (0.07%), diflubenzuron (0..25%0 and diflubenzuron as mixture with the other four insecticides (Table 1). The plot size was 5×4m and the castor variety used was Aruna.

The insecticidal treatments were given only once at 50 days after sowing and the data was recorded with regard to the number of semilooper larvae on five randomly selected and tagged plants/treatment. Larval counts were taken one day prior to spraying and at two and seven days after spraying. The percentage reduction in the larval population was calculated with the help of the formula given by Fleming and Retnakaran, 1985.

$$\%\text{population reduction} = \left\{ 1 - \left| \frac{\text{post treatment population in treatment}}{\text{pretreatment population in treatment}} \times \frac{\text{pretreatment population in control}}{\text{post treatment population in control}} \right| \right\} \times 100$$

The percentages were transformed into angular values for statistical analysis.

The perusal of the data presented in the table suggest that at two days after spraying fenvalerate (0.02%) was the most effective with 82.94 per cent mean reduction in the larval population, while diflubenzuron (0.025%) was the least effective with 19.03 per cent mean reduction. The treatments followed fenvalerate in the order of efficacy, were endosulfan (0.07%), carbaryl (0.1%) and phosalone (0.07%) with

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TABLE 1. Efficacy of chemical treatments on castor semilooper A. janata

Treatments	Conc. %	Mean larval No. per 5 plants			Mean % reduction	
		Before treatment	2 days after treatment	7 days after treatment	2 days after treatment	7 days after treatment
Fenvalerate	0.02	9.33	1.67	1.00	82.94 (65.85)	87.99 (69.72)
Endosulfan	0.07	12.33	5.00	5.33	60.92 (51.39)	57.73 (45.99)
Carbaryl	0.10	11.00	5.00	5.33	56.69 (48.87)	45.90 (42.64)
Phosalone	0.07	15.00	7.67	7.00	50.48 (45.32)	47.96 (43.83)
Diflubenzuron	0.0250	11.00	9.33	3.33	19.03 (25.74)	65.97 (54.38)
Diflubenzuron + Fenvalerate	0.0125 0.0100	12.33	8.00	1.67	38.17 (38.11)	84.69 (67.26)
Diflubenzuron × Endosulfan	0.0125 0.0350	13.00	9.67	3.67	29.66 (32.83)	68.41 (55.87)
Diflubenzuron + Carbaryl	0.0125 0.0350	10.67	8.67	3.33	22.87 (28.53)	65.22 (53.88)
Diflubenzuron + Phosalone	0.0125 0.0500	13.67	10.33	4.00	27.26 (30.86)	66.99 (55.09)
Control		12.67	13.33	10.67	1.73 (5.60)	5.81 (23.29)
S.ED					4.89	2.80
CD					10.29 *	5.88 *

Figures in parantheses are angular transformed values

* Significant 0.05 probability level.

60.92, 56.69 and 50.48 per cent mean reductions of the larvae, respectively. The mixtures of the insecticides with diflubenzuron, although better than diflubenzuron alone, proved less effective than the individual treatments with 38.17 (diflubenzuron 0.0125+ fenvalerate 0.01%), 29.66 (diflubenzuron 0.0125% + endosulfan 0.035%), 27.26 (diflubenzuron 0.0125%+carbaryl 0.05%) and 22.87 (diflubenzuron 0.0125%+ phosalone 0.035%) per cent mean reductions of larval population. However all the treatments were significantly superior to control which recorded 1.75 peer cent mean reduction of the larvae.

At seven days afetr spraying, it was found that fenvalerate (0.02%), was the most effective treatment followed by diflubenzuron (0.0125%) + fenvalerate (0.01%) with 87.99 and 84.69 per cent mean reductions of castor semilooper larvae, respectively. The other treatments followed in the order of efficacy were diflubenzuron (0.0125%) + endosulfan(0.035%), diflubenzuron(0.0125%)+carbaryl(0.05%), diflubenzuron (0.0125%) and diflubenzuron (0.0125%)+phosalone (0.035%) with 68.41, 66.99, 65.97 and 65.22 per cent mean reductions of larvae, respectively. The synthetic organic insecticides, endosulfan(0.07%), phosalone(0.07%) and carbaryl (0.1%) individually were found less effective. However, all the treatments were significantly superior to control (5.81%) in bringing down the larval population at seven days after spraying also.

The perusal of the data at two and seven days after spraying suggest that fenvalelate (0.02%) was the most effective chemical among the treatments with larval population reduction of more than 82 per cent and its toxicity remained upto seven days. The efficacy of endosulfan, phosalone, and carbaryl was slightly higher at two days with larval population reduction ranging from 50 to 60 per cent with decreased at seven days after spraying. On the other hand diflubenzuron and the mixtures of insecticides with diflubenzuron were less effective intially with larval population reduction of about 19 to 38 per cent. Subsequently toxicities of these treatments increased with larval population reduction of about 65 to 85 per cent at seven days afetr spraying. Diflubenzuron appears to act few days after application synchronizing with the next moult (Vinod Kumar, 1986 and Arjuna Rao, 1984 unpublished) and this can be attributed to the fact that diflubenzuron and its mixtures were less effective initially, but the efficacy inreased by seventh day after application. Futrher since, diflubenzuron interferes with moulting and deposition of new cuticle (mulder and Gijswijt, 1973) it probably lead to the increased penetrability of other insecticides through the cuticle and made the incsects more susceptible even at lower concentrations. Thus the present findings would be very useful in the present pest management strategies, since diflubenzuron is environmentally safe and effective control of castor semilooper can be achieved by applying insecticides at far lower doses in combination with diflubenzuron.

REFERENCES

ARJUNA RAO, P. (1984). Effect of diflubenzuron on some physical properties of insec cuticle. Ph.D thesis, Division of Entomology, Indian Agril. Res,. Institute, New Delhi.

DALAYA, V.P., RAJPUT, S.G., AWATE, B.G. and MOHITE, B.B. (1983). Chemical control of castor semilooper, *Achaea janata* (Linn.). Indian J. Plant Prot., 11 (1/2) : 136-137.

DESHMUKH, S.D., AKHARE, M.O. and BORLE, M.N. (1979). Insecticidal control of insect pests of castor. Ind. J. Plant Prot. 7 (1) : 66-68.

FLEMMING, R. and RETNAKARAN, A. (1985). Evaluating single treatment data using Abbot's formula with reference to insecticides. J. Econ. Entomol. 78 : 1179-81.

KUSHWAHA, K.S. and PAL, S.K. (1977). Effectiveness of some insecticides against castor semilooper, *A. janata* Linn. Indian J. Ent. 39 (2) : 193-196.

MULDER, R. and GIJSWIJT, M.I. (1973). The laboratory evaluation of two promising new insecticides which interfere with cuticle deposition. Pestic. Sci., 4 : 737:-745.

PAL, S.K. (1977). Relative effectiveness of some chemical insecticides and bacterial insecticides against castor semilooper, *Achea janata*. Indian J. Plant Prot. 5 (2) : 195-198.

VINOD KUMAR, C.P. (1986). Studies on the effect of diflubenzuron against larva and pupa of *Chilo partellus* Swinhoe. M.Sc. (Ag.) thesis, Department of Entomology, College of Agriculture, Rajendranagar, A.P.A.U., Hyderabad.

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EFFECT OF DATES OF SOWING AND PLANT POPULATION ON YIELD OF TORIA

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The farmers of Bundelkhand region of Madyha Pradesh leave fields fallow during kharif and grow wheat late in the month of December. Under such conditions Toria may be a good mid season crop. Toria is reported to give yield of about 1289 kg/ha (Rai and Kumar 1980). However, there is a need to assess the performance of this crop in Bundelkhand region of Madhya Pradesh. Therefore, an experiment was conducted at J.N.K.V.V. research station, Tikamgarh and results of the same are reported here.

A field experiment was conducted on clay soil with 7.5 H, available Nitrogen 325 kg/ha, P_2O_5 21 kg/ha and K_2O 320 kg/ha during rabi 1986-87 at Regional Agricultural reesarch station, Tikamgarh, The experiment was laid out four times replicated in split plot design with plot size 5×3 sqm. The treatment consisted of three dates of sowing (20th Sept., 30th Sep., and 10th Oct.,) and four levels of plant density (3.33, 2.66 2.22 lakh/ha). The plant density was maintained by thinning to maintain the plant to plant distance 10, 12.5 and 15 cm. alongwith a check treatment without thinning with 30 cm row spacing. The variety was T-9. The fertilizer dose of 40 kg N, 40 kg P and 20 k/ha was applied at the time of sowing and 40 kg N/ha was applied as top dressing at first irrigation, at 20 Days after sowing (DAS). Rest of the irrigation were given at 40 & 60 DAS. One weeding was carried at 25 DAS. Aphid control was done by one spray of Dimecron (0.03%) at flowering stage.

The data indicated that (Table-1) the date of sowing had significant effect on seed yield. The seed yield was higher (846.58 kg/ha) under first date of sowing, but did not differ significantly from 2nd date of sowing. The decrease in yield in 2nd and 3rd dates of sowing was to the tune of 7.00 and 40.89 per cent respectively. Similar results were reported earlier (Anonymous 1985).

Oil percent, plant height, primary and secondary abranches per plant, Siliquae per plant, Number of grains per siliquae and test weight were also maximum under first date of sowing. There was a progressive reduction in the expression of all these characters in 2nd and 3rd date of sowing.

The plant density also significantly influenced the seed yield. The grain yield was the highest (980 kg/ha) at plant population of 2.22 lakh/ha, however there was reduction in yield with increase in plant population. The lowest yield (50 kg/ha) was obtained from higher plant population in control.

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TABLE 1. Effect of sowing dates and plant population on the yield, Oil % Growth and yield attributes

Treatments Sowing dates	Yield kg/ha	Oil %	Plant height	Primary branches/plant	Secondary branches/plant	Siliquae/ plant	Number of grain/Siliquae	1000 seed weight
20th Sep.	846.58	43.81	101.80	8.81	10.33	189.50	30.31	2.84
30th Sep.	791.13	42.60	92.50	6.67	6.59	123.75	27.37	2.62
10th Oct.	600.86	42.40	82.43	5.23	4.33	101.50	20.37	2.40
S.E. (m) ±	22.94	0.07	1.27	0.05	0.13	9.70	15.90	0.003
C.D. (5%)	76.94	0.25	4.42	0.17	0.46	33.57	NS	0.013
Plant population levels Control	508.50	42.21	95.83	6.02	6.18	109.50	23.83	2.56
3.33 lakh/ha	691.28	42.66	92.08	6.50	7.13	134.57	26.58	2.58
2.66 lakh/ha	804.90	42.76	90.91	7.51	7.23	138.75	30.83	2.61
2.22 lakh/ha	980.40	43.86	90.16	7.95	7.66	162.00	35.85	2.78
S.E. (m) ±	29.40	0.08	2.23	0.04	0.05	4.63	1.64	0.027
C.D. (5%)	85.10	0.24	NS	0.14	0.16	13.66	4.77	0.059

The oil per cent was significantly the highest at plant population of 2.22 lakh/h. This is in conformity with results of Gangwar and Kumar (1986). The higher plant density invariably had lower values of growth and yield contributing characters (Kumar and Rehman 1978). The seed yield under higher plant density reduced significantly because of decrease in primary and secondary branches and siliquae per plant, number of grains per siliquae and test weight.

LITERATURE CITED

ANONYMOUS (1985). Oilseed research at Pantnagar Expt. Stn. Tech. Bull 111 : 81-82.

GANGWAR K.S. and ARVIND KUMAR (1986). Nitrogen fertilizer and plant density levels in relation to yield, its attributes and quality of toria. J. Oilseeds Res. 3 : 151-157.

KUMAR, A. and REHMAN, A. (1970). Response of promising Toria at varying levels of plant density and Nitrogen rates. Annual Research Report, Expt. Stn. G.B. Pant Univ. Agril. and Tech., Pantnagar.

RAI, B. and KUMAR A. (1980). Research efforts for Boosting toria production. Oilseed Journal 1 to 4 (x) 14-18.

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STABILITY ANALYSIS IN CERTAIN VIRGINIA GROUNDNUT GENOTYPES

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The productivity of groundnut varies widely as it is grown predominantly under rainfed conditions. Hence, stability in yield performance over a wide range of agro-climatic conditions, is an important factor determining the productivity of this crop. A genotype which withstands the fluctuating weather conditions is the most ideal variety in this context. In groundnut reports on GXE interactions were made by Singh *et al.* (1975). Yadav and Kumar (1978) and Habib *et al*,. (1986) Eberhart and Russell (1966) suggested a model which provides three statistical parameters for stability, namely, mean performance, linear response (regression) of a varitey to the environments and the deviation from linear response.

A study was under-taken at the Agricultural Research Station, Aliyarnagar with a view to obtaining information on the stability parameters of pod yield, shelling outturn and kernel weight and to identify the best genotype in a group of *virginia* bunch and runner cultures.

The groundnut cultures comprising five each in virginia bunch and runner (Table - 2) were studied for productivity and stability during three rainfed seasons viz. Kharif '84, Kharif '85 and Kharif '86'. The trial was laid out in a randomised block design with a plot size of 5×3.5 m and three replications. Dry yield was computed as kg/ha. Besides, shelling percentage and hundred kernel weight were also recorded by standard procedures. Thr method outlined by Eberhart and Russell (1966) was applied to bring out information on stability parameters for the above three characters.

The analysis of variance for the three characters studied, are presented in Table 1. The data showed that the mean sum of squares due to genotype X environment interaction were significant only for pod yield and kernel size. This indicated that there was G×E interaction only for these two characters. Hence further analysis was not done in respect of shelling percentage. Among the two characters, pod yield and hundred kernel weight, the linear of G×E interaction was significant only for pod yield. Hence it appeared meaningful to carry out the stability analysis only for pod yield in as much there was no linear response for hundred kernel weight. The absence of linear response for shelling outturn and kernel weight could be due to the fact that shelling percentage and kernel size would not change beyond a certain limit of favourable environment.

The mean performance ($\overline{X}$), the regression coefficient (b), the deviation (S^2d) from mean square for pod yield are presented in table 2.

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TABLE 1. Anova for genotype stability for yield and quality characters in groundnut.

Source	df	Mean sum of squares		
		Dry pod yield	Shelling Percentage.	100 kernel weight.
Genotype (G)	9	139636.91**	24.50*	66.21**
Genotype × environment	20	182061.79**	6.48	74.56**
Environment (E) linear	1	2368444.27**	15.49	1201.69**
Genotype × Environment (linear)	9	127100.84**	6.95	21.02
Pooled Deviation	10	12888.38	5.16**	10.03**
Pooled Error	60	7704.92	0.14	0.27

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

TABLE 2. Stability parameters for pod yield in groundnut.

Genotypes	Mean	b	S^2d
1. ICG 2271	1582*	1.19	25282.1
2. JSP 1	1349	1.54*	– 2069.4
3. JSP 6	1649	2.57*	– 761.2
4. C 354	1349	1.45	– 4453.3
5. M 13	1179	0.90	10393.7
6. MA 16	1302	0.91	3393.2
7. C 263	1164	0.29*	– 3578.0
8. C 266	1132	0.35*	37333.5*
9. R.33-1	910	0.10*	– 6686.8
10. TMV 10	1273	0.71	– 7018.9
Mean	1288	1.0	
SE	80	0.23	
CD	238		

Among the genotypes, JSP 6 (1649 kg/ha) and ICG 2271 (1582 kg/ha) have recorded significantly higher yields than the check TMV 10 (1273 kg/ha). Out of the two, JSP 6 recorded a regression coefficient of 2.57 which was significantly higher than unity. This suggests that this genotype is adapted only to favourable environment. The next best variety ICG 2272 had a regression coefficient of 1.19 which was equal to unity. This also possesses a non significant S^2d. Hence, this variety satisfied all the three requirements of a stable genotype. The other genotypeas C 354, MA 16, TMV 10 and M 13 were also found to be stable performers. However, their mean yield is not comparable to ICG 2271.

Thus it may be seen that ICG 2271 was the most stable genotype identified from the study. The other advantages of this culture namely, tolerance to jassids, thrips and leafminer have been reported elsewhere (P.Vindhiya Varman *et al.* 1988). Based on these merits, this culture is presently under multilocation testing in Tamilnadu.

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EBERHART, S.A., and RUSSELL. 1966. *Crop Sci.* 6:35-40.

HABIB, A.F., H.L. NADAF; G.K. KULKARNI and S.D. NADIGER. 1986. *J. Oilseeds Res.* 3:46-50.

SINGH, M., S.S. BADWAL and S.V. JASWAL. 1975. *Indian J. Genet.* 35 : 26-28.

YADAV, T.P. and P. KUMAR 1978. *Indian J. agric. Res.* 12:1-4.

VINDHIYA VARMAN, P., R. BALAGURUNATHAN, T.S. RAVEENDRAN and F.J.S. KENEDY 1988. *Madras Agric. J.* (In press)

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A NOTE ON SENSITIVITY OF SOYBEAN VARIETIES TO SHATTERING AFTER MATURITY

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Soybean is a major kharif of central Narmada Valley . This crop is very sensitive to shattering if it is delayed in harvesting, which is a common feature due to scarcity of labour and nonavailabitity of proper mechanical harvesters. It is therefore necessary to develop and identify the varieties with lesser shattering, thus allowing some time for harvest after maturity.

Present study embodies the work done at J.N. Krishi Vishwa Vidyalaya, Zonal Agricultural Research Station, Powarkheda (Hoshangabad M.P.) during *kharif* 1986 on identification of such varieties which are less vulnerable to shattering.

For the study, four varieties of soybean (Punjab-1 and J.S. 72-44-both yellow seeded; J.S. 76-205 and Black local-both black seeded) which cover large area in the tract were sown on 8th July, 1986 and grown with recommended package of practices. The varieties were evaluated for their performance in respect of shattering with reference to five periods of harvesting, *viz.*, at maturity, 5,10,15 and 20 days after maturity.

As per the harvesting treatments, eighteen plants of each variety were uprooted randomly at the time of harvesting and observations on number of intact pods, shattered pods as well as grain yield of intact pods were recorded. From these data, grain yield per plant of shattered pods and losses in grain yield due to shattering were computed which are presented in Table 1.

As obvious from the data in Table 1, there was no loss of grain yield due to shattering in all the varieties except local black soybean though harvested at right time of maturity. The local black soybean sustained 0.8 per cent grain loss due to shattering.

The grain losses due to shattering were 78.69% in J.S. 76-205 followed by 20.3%, 6.93%, and 1.59% in case of local black, Punjab-1 and J.S. 72-44 respectively, when they were harvested 5 days after maturity. Further delay in harvesting by 5-10 days resulted more losses due to shattering in all the varieties but a minimum loss was observed in J.S. 72-44 (-9-17 per cent) while other varieties showed more than 50% losses.

A twenty days delay in harvesting after maturity resulted in tremondous loss of grain yield, ranging from 46 to 94% with the minimum and maximum values recorded in case of J.S. 72-44 and J.S. 76-205 respectively.

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TABLE 1. **Observations of total pods, intact pods, shattered pods, grain yield and Shattering losses per plant (Average of 18 plants).**

Harvesting time	Varieties	Harvesting (DAS)	Total pods/ plant (no)	Intact pods/ plant (no)	Shattered pods/plant (no)	Grain yield per plant from intact Pods (g)	Estimated grain yield of shattered pods (g)	Total grain yield per plant (g)	Losses in grain yield due to shattering (per cent)
At maturity	Punjab-1	93	44.44	44.44	—	6.80	—	6.80	NIl
	J.S.72–44	103	46.80	46.80	—	8.23	—	8.23	Nil
	J.S.76–205	96	49.33	49.33	—	8.58	—	8.58	Nil
	Black Local	112	69.38	68.77	0.61	10.88	0.09	10.97	0.82
5 days after maturity	Punjab-1	98	31.05	28.83	2.22	3.88	0.29	4.17	6.95
	J.S.72–44	108	41.22	40.50	0.72	6.15	0.10	6.25	1.60
	J.S.76–205	101	46.33	9.94	36.39	0.85	3.14	3.99	78.70
	Black Local	117	56.66	45.11	11.55	7.21	1.18	8.39	14.06

10 days after maturity	Punjab-1	103	34.77	24.66	10.11	2.90	1.19	4.09	29.09
	J.S.72-44	113	47.27	42.83	4.44	5.33	0.55	5.88	9.35
	J.S.76-205	106	50.16	9.94	40.22	1.68	6.82	8.50	80.23
	Black Local	122	70.11	46.44	23.67	7.97	4.06	12.03	33.75
15 days after maturity	Punjab-1	108	37.88	16.72	21.16	1.72	2.17	3.89	55.78
	J.S.72-44	118	38.55	32.00	6.55	4.29	0.87	5.16	16.86
	J.S.76-205	111	46.33	3.61	42.72	0.60	7.15	7.75	92.23
	Black Local	127	54.16	22.50	31.66	3.76	5.29	9.05	58.45
20 days after maturity	Punjab-1	113	39.66	10.11	29.55	1.32	3.87	5.19	74.57
	J.S.72-44	123	38.61	20.83	17.77	1.91	1.63	3.54	46.05
	J.S.76-205	116	37.77	1.94	35.83	0.32	5.99	6.31	94.93
	Black Local	132	53.00	12.16	40.83	1.96	6.60	8.56	77.10

DAS = Days after sowing.

The result indicate that the yellow seeded soybeen varieties, viz., J.S. 72-74 and Punjab-1, in respective order, should be preferred over black seed and J. S, 76-205 soybean varieties to minimise the shattering losses. The losses in grain yield due to shattering may be reduced considerably if the crop is harvested with in a week after maturity.

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EFFECT OF IRRIGATION LEVELS ON SAFFLOWFR YIELD IN LATERITE SOIL OF WEST BENGAL

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Safflower (*Carthamus tinctorius* L) is known for its drought resistance (Weiss 1971), but responds to limited irrigation. It holds considerable promise, under limited water supply in drought prone lateritic tract of West Bengal where, at present, monocropping by and large is the rule in this region. The crop being a recent introduction in this region, no information is available in respect of agronomic management. Hence the present investigation was carried out to select a suitable variety of safflower and its critical stages of water requirement in laterite soils of West Bengal.

A field experiment was conducted in split-plot design with three replications comprising four levels of irrigation viz: unirrigated control, one irrigation at branching, two irrigations one each at branching and flowering and three irrigations one each at branching, flowering and seed development stages and three varieties viz. A 300, 116-4-5 and 340092 of safflower assigning irrigation to main plots and varieties to sub-plots during *rabi* seasons of 1982-83 and 1983-84 at the Regional Research Farm of Bidhan Chandra Viswavidyalaya located at Jhargram in the district of Midnapore. The soil contains 0.32 per cent organic carbon 31 lkg, available P_2O_5 and 110 kg exchangable K_2O/ha with low nutrient retention, moisture holding and cation exchange capacity. The soils are sandy-loam in texture, oxisols in order and acidic in reaction having soil pH 5.7 at a depth of 0.30 cm layer. The crop was sown on 10th and 28th October in 1982 and 1983-84, respectively at a spacing of 50×20 cm using 20 kg/ha seed rate. The crop was fertilised with 120 kg N, 40 kg P_2O_5 and 40 kg K_20/ha in the form of urea, single super phosphate and muriate of potash, respectively at the time of sowing and irrigation was given in accordance with the treatment with a depth of 75 mm each. As the treatment combinations consisted of unirrigated control, entire nitrogen was aplied as basal. One weeding and necessary thinning to maintain uniform plant population were done within 35 days after sowing and the crop was harvested at about 160 days maturity.

The results presented in tables 2 revealed that the levels of irrigation significantly increased the seed yireld of safflower varieties. Highest mean yield of 1111 kg/ha was obtained with three irrigations one each at branching, flowering and seed development stages corresponding to 40, 100 and 130 days after sowing respectively. The increment in seed yield was in order of 19.58, 56.24, and 113.24, per cent due to one, two and three irrigations over unirrigated control indicating that seed development and flowering stages were most critical for the application of irrigation water. Rajput, *et al.*, (1981) also suggested similar combination of growth stages for irrigation. The cultivar A. 300 gave higher seed yield than other two cultivars. The interactions

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TABLE 1. Seed yield (kg/ha) of safflower varieties as influenced by irrigation levels.

Irrigation levels*	1982–83 Variety				1983–84 Variety			
	A 300	116-4-5	340092	Mean	A 300	116-4-5	340092	Mean
No	794	550	283	542	708	528	264	500
One	919	697	350	655	853	619	300	591
Two	1278	872	447	866	1250	700	336	762
Three	1900	1022	514	1145	1839	1001	389	1076
Mean	1223	785	399		1163	712	322	
		S Em (±)	CD P0.05)		S Em (±)	CD (0.05)		
Variety (V)		6.70	26.31		7.59	29.81		
Irrigation I))		12.07	35.86		8.03	23.86		
'V' for same 'I'		18.72	58.97		13.19	41.56		
'I' for same 'V'		20.91	62.12		13.91	41.33		

* As per description in text.

between levels of irrigation and varieties were also significant. The cultivar, A. 300 produced highest seed yield of 1870 kg/ha with three irrigations cross seasons.

MAHAPATRA, I.C., and SINGH, N.P., 1975. Indian Fmg., 25 (2) : 13.

RAJPUT, R.K., SINGH, S.N. YADAV, J.S.P. and SHARMA, B.M. 1981. *Indian J. Agric. Sci* 51 (5) : 316-320.

WEISS, E.A., CASTOR, Sesamum and Saflower 1971 Leonard-Hill Books, London pp 529-746.

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SAMPLING OF *UROLEUCON COMPOSITAE* THEOBALD (HOMOPTERA: APHIDIDAE) ON SAFFLOWER

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The safflower aphid, *Uroleucon Compositae* Theobald is a serious pest of safflower in Karnataka and other safflower growing tracts of India causing an yield loss upto 72 percent (Basavana Goud, 1979). The methodology of sampling of this aphid on safflower is lacking although Basavana Goud (1979) assessed the intensity by counting their number on leaves, unit stem length and capsules wihtout any comparative evaluation of these methods. Several sampling methods viz, sampling of leaves from different plant strata (Thomson and Jacob, 1943; Neilson, 1957); Sampling of plant portions of definite area/length (Otake, 1958; Amman, 1967); categorisation of aphid density from very less to very high (Banks, 1954); counting the colony numbers (Swirski, 1954); sampling from only tender shoots (Hull and Grimm, 1983) have been reported for several aphids. Time dependent aphid intensity was estimated for potato aphid by Holling (1958) by weekly sampling of 3 leaves from 50 plants. The present study was undertaken to arrive at a satisfactory sampling scheme for estimating aphid intensity in safflower crop so that it help sampling the aphids in the studies of economic threshold, population dynamics and chemical control programme.

In the present investigations the saffiower aphid was sampled first on 30 day old crop followed by flower bud formation stage on the safflower crop at Agricultural College Farm, Dharwad during Rabi, 1984. Leaf with highest aphid density, mature leaves with lowest aphid density, total leaf area, central shoot, main stem, total of all the above for younger crop stage and flower heads and branches in adition to all the above have been sampled for aphids on 50 plants and the data were subjected to analysis of standard diviation and coefficient of variation for evaluating the various sampled portions.

Sharp differences in coefficient of variation among various samplings done during pre-flowering stage have been observed and central shoot appears to be the most suitable portion for aphid sampling with least coefficient of variation (C.V.) at 29.4. Highest C.V. value of 69.2 for main stems reveals the unsuitability of this plant part for assessing aphid population density. Leaf with highest aphid density is also a suitable portion for sampling as C.V. Value was 32.0, close to the value recorded for central shoot. Although aphid population correspond ing to the total of all parts and total leaf area have C.V. values of 30.5 and 34.2 respectively, it is tedious to carry out such countings.

Analysis of aphid populations sampled during flowering stage indicated that the heads with highest aphid density was superior to all other parts excepting central shoot (C.V. 27.20); total branches was poorest with a C.V. of 86.6; total heads was in-

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ferior to central shoot, leaf (CV=49.90) and head (CV=42.3) with highest aphid density.

The comparison of various parts samples based on C.V. values during younger and flowering stages showed that central shoot is most valid in assessing aphid density followed by leaf and head with highest aphid density in the above respective stages. The other parts are either cumbersome to carry out aphid counting or have highly variable aphid density hence not to be considered for sampling this pest.

REFERENCES

AMMAN, G.D., 1967, Effect of minus 29°F on over wintering populations of the balsom wooly aphid in North Carolina, J. *Econ. Ent.*, 1965-1966.

BANKS, C.J., 1954, A method for estimating populations and counting large numbers of *Aphis fabae* Scop, *Bull. Ent. Res.*, **45** 751-756.

BASAVANA GOUD, K., 1979, Estimation of safflower crop loss due to the aphid *Dactynotus compositae* Theobald and reaction of varieties and insecticides to it. Master's thesis, Univ. Agri. Sci., Bangalore. pp. 80.

HOLLING, M., 1958. The measurement of aphid activity in relation to spread of potato viruses. *Proc. 3rd Conf. Potato virus diseases Liasse-Wagenengen*, 1957 85-89.

HULL, L.A., GRIMM, J.M., 1983, Sampling schemes for estimating populations of the apple aphid *Aphis pomi* (Homoptera : Aphididae) on apple. *Envt. Ent*, **12** : 1581-86.

NEILSON, M.W., 1967, Sampling technique studies on the spotted alfalfa aphid. *J. Econ Ent.*, **60** : 388-389.

OTAKE, 1958, The population growth of *Macrosiphum granarium Kirby* influenced by its papasites. *Japanese J. Ecol*; **8** : 62-68.

SWIRSKI, E., 1954, Fruit tree aphids of *Israel*. *Bull. Ent Res.*, **45** : 623-638.

THOMAS, I and JACOB, F.H., 1943, Ecology of the potato aphids in North Wales. *Ann. Appl. Biol.*, **30** : 97-101.

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STUDIES ON THE DRYING REQUIREMENT OF SESAMUM SEEDS

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Sesamum (*Sesamum indicum* L.) is the third most important oilseed crop of India occupying an area of 2.4 million ha with an annual production of 4.77 lakh tonnes of seed (Sharma and Reddy, 1983; Rai *et al.*, 1984). This is raised as the major catch crop in the rice fallows of Kerala during the summer season (January-February to March-April), utilizing the residual soil moisture after the harvest of rabi paddy.

The use of low quality seed is the major constraint to uniform stand establishement of the crop. The usual practice of the farmer is to dry the seeds even upto eitght days after threshing. The present experiment was taken up in 1985 to find out the optimum drying requirement of seasmum for ensuring the maximum viability of seeds.

Seven kilograms each of Sesamum seeds of the improved varieties Kayamkulam I and Thilothama were dried for one day and their moisture content noted at the end of drying. One kilogram from the major lot was stored separately in an air tight tin container which constituted the first treatment.

The remaining six kilograms of seeds were dried on the second day and their moisture content recorded at the end. One kilogram from this lot was stored again separately in an air tight container and this constituted the second treatment. The remaining five kilograms of seed were dried on the third day and one kilogram of seed stored. The procedure was repeated upto the seventh day. The seven samples thus stored in seven containers formed the treatments.

Drying was done foı six hours in direct sun light from 10 am to 4 pm spreading the seeds uniformly and stirring occasionally.

From the Table 1 it can be seen that there was no reduction in weight of the samples after the third day of sun drying showing that the moisture content of seeds has attained a constant level by the third day and that further drying was unnecessary.

The viability of seeds in the seven samples was tested at a regular interval of one month for a total period of one year and the germination percenatge is as shown in Table 2.

The germination percentage was above 90 per cent in all the treatments up to nine months. In the first ans second treatments there was a rapid reduction in germination after nine months of storage whereas in all the other treatments where the seeds were dried for three days or more, good germination could be maintained for one year.

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TABLE 1. Weight of sesamum varieties Kayamkulam 1 and Thilothama after sun drying for seven consecutive days.

Days of drying	Weight in kg of seven samples													
	Kayamkulam - I Samples							*Thilothama Samples*						
	1st	2nd	3rd	4th	5th	6th	7th	1st	2nd	3rd	4th	5th	6th	7th
1st day drying	0.960	0.961	0.960	0.958	0.958	0.965	0.962	0.955	0.955	0.958	0.953	0.962	0.958	0.957
2nd day drying		0.950	0.945	0.950	0.950	0.955	0.955		0.950	0.940	0.945	0.958	0.949	0.948
3rd day drying			0.945	0.945	0.950	0.950	0.950			0.940	0.945	0.950	0.949	0.945
4th day drying				0.945	0.950	0.950	0.950				0.945	0.950	0.949	0.945
5th day drying					0.950	0.950	0.950					0.950	0.949	0.945
6th day drying						0.950	0.950						0.949	0.945
7th day drying							0.950							0.945

Initial weight of each sample – 1 kg.

TABLE 2. Germination percentage of sesamum seeds

Months	Germination percentage													
	Kayamkulam - I Sample							*Thilothama Sample*						
	1st	2nd	3rd	4th	5th	6th	7th	1st	2nd	3rd	4th	5th	6th	7th
June	94	94	94	95	98	96	97	93	89	94	99	96	96	97
July	95	94	96	98	98	98	97	94	95	98	99	96	96	99
August	94	94	97	99	97	98	98	95	95	96	98	99	98	98
September	95	94	97	100	98	97	98	94	95	96	96	97	98	100
October	95	94	95	97	97	98	97	93	95	94	96	99	96	98
November	95	94	95	97	100	98	100	93	95	94	97	97	96	97
December	93	93	95	96	98	98	98	92	94	93	96	98	96	97
January	92	93	95	96	98	97	97	92	93	94	96	96	95	96
February	90	92	95	96	96	97	97	90	93	94	94	96	95	96
March	88	90	94	94	93	94	95	89	90	90	92	94	95	94
April	84	84	90	94	93	94	94	86	88	90	93	92	94	94
May	84	82	90	92	92	92	92	84	86	90	91	92	92	93

From this study, it is concluded that three days of sun drying is necessary for maintaining the viability of the seeds at a satisfactory level.

REFERENCES

RAI, B., SHARMA, N.N. and THAKUR, H.C., 1984. New Vistas in Sesamum production. Ind. Farming. 33(10) 3-4.

SHARMA, S.M. and REDDY, B.N., 1983. Research on Sesamum makes Headway. Ind. Farming 32(12) : 3-13.

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INFLUENCE OF SEASON AND SEED POSITION ON FATTY ACID COMPOSITION OF POLAR AND NON-POLAR LIPID FRACTIONS OF DEVELOPING SEEDS OF SUNFLOWER (HELIANTHUS ANNUUS L.)

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In sunflower oil oleic and linoleic acids are the major fatty acids. Their desired ratio is possible by genetic manipulations (Putt *et al.*, 1969). However, the degree of unsaturation also depends largely upon environment (Harris *et al.*, 1978; Goyne *et al.*, 1979; Robertson and Green, 1981). Even the position of the seeds within sunflower head (Zimmerman and Fick, 1973), shape and size of the head (Afzalpurkar and Lakshminarayana, 1980) and lipid classes (polar and non-polar lipids) have also been shown to affect the fatty acid composition (Grewal *et al.*, 1978). Appelqvist (1975) has reported that polar lipid fraction which forms the minor fraction at maturity constitutes the major fraction of total lipids at initial stage of seed development. In northern parts of India, the temperature difference between the two major seasons i.e. winter and summer are considerable. Therefore, the present study was designed to examine the effect of variables such as season (winter and summer) and position of the seeds within sunflower head on the fatty acid composition of polar and non-polar lipid fractions of developing seeds of sunflower at a single location.

Sunflower variety EC 68415 was raised under field conditions both under winter and summer seasons. About 200 plants were tagged at initiation of flowering. Generally the opening of disc florets started from periphery towards centre and two to three rows opened up each day. Sunflower heads were clipped at 7 day intervals till 42 days after flowering (DAF). According to Zimmerman and Fick (1973) the heads were divided into three concentric zones at each stage, namely peripheral, middle and central. Each zone was sampled for six adjoining seeds from 3,6,9 and 12 O'clock position. In winter during first sampling (7 DAF), seed initiation had advanced only up to the peripheral zone, therefore, the samples were taken only from the periphery whereas during summer the seed initiation had advanced upto the middle zone and hence the samples were taken from peripheral as well as the middle zone. After manually taking out the seeds from each zone, the pericarp (hull) was removed. The total lipids were extracted (Folch *et al.*, 1957) and separated into two polar and non-polar fractions by solvent partition method (Nichols, 1964). Fatty acid methyl esters were prepared and further separated in a Hewlett Packard Model No. 5730 A gas chromatograph (Luddy *et al.*, 1968).

The maximum temperature at the time of sampling during development of seeds in the winter ranged from 18.9°C to 26.5°C and minimum from 7.4°C to 11.5°C, while in case of summer these ranged from 41.7°C to 44.5°C and from 23.9°C to 30.6°C respectively. Data in Table-1 and 2 revealed that during seed development at different

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positions non-polar lipids increased steadily while polar lipids decreased in both the seasons. At initial stage the major portion of the total lipids was polar lipids. This fraction, however, decreased drastically to represent only about 2 per cent of the total lipids towards maturity. During seed development at different positions, the palmitic acid content of polar and non-polar lipid fractions was maximum at 7 DAF, decreased upto 21 DAF and then levelled off until maturity during both the seasons. Stearic acid concentration in winter was minimum at 7 DAF and reached the maximum level at 14 DAF followed by a gradual decrease till maturity while in summer, it decreased from the maximum level at 7 DAF till development. Oleic and linoleic acids were the major fatty acids. In winter, oleic acid accumulated rapidly at first but at the mid-point of seed development it was overtaken by linoleic acid which became the major component thereafter in both the fractions. However, in summer, oleic acid was observed to accumulate rapidly at first and then declined at a very slow rate but was never overtaken by linoleic acid and thus remained the major component upto maturity in non-polar fraction whereas in the polar fraction lionleic acid overtook the oleic acid at later stages of development. A similar trend was observed with respect to position of the seeds. Our results are in agreement with those of Grewal *et al.*, (1978) and Robertson *et al.*, (1978). They, however, conducted such studies during single season .

Positional effect showed that non-polar lipids decreased from periphery towards centre whereas a reverse trend was observed in case of polar lipids upto 14 DAF after this stage the amount of both the fractions was almost similar in all the positions during both seasons. The levels of palmitic and stearic acids at 7 and 14 DAF increased from periphery towards the centre followed by somewhat erratic behaviour at later stages in both the seasons and fractions. Of the major acids oleic decreased while linoleic increased from periphery towards centre consistently at all the stages of seed development during both the seasons and fractions. These results reflect on the variations which are taking place within the plant which might be due to environment since the seed formation initiated at the periphery of the head and then progressed towards the centre, therefore, individual seed may have developed and matured under somewhat different climatic conditions. Zimmerman and Fick (1973) observed similar positional effcet in matured sunflower seeds.

Polar and non-polar lipid fractions differed appreciably in amounts of fatty acids during seed development in both the seasons. Except at 7 DAF the level of palmitic acid at other stages of development was almost two folds in polar fraction than what was in non-polar fraction during winter as well as in summer and even in the seeds of different positions. Stearic acid, however, was marginally higher in non-polar than in the polar fraction during development in both the seasons. In winter, as well as in summer the oleic acid content during seed development was higher in non-polar fraction while linoleic acid was higher in polar fraction. This was also true in case of position of the seeds. Such quantitative differences in fatty acid composition of polar and non-polar lipid fractions have also been reported by Grewal *et al.*, (1978) in maturing sunflower seed during winter seasons.

TABLE 1. Fatty acid composition (per cent) of non-polar lipids fraction of developing seeds of sunflower as affected by position of the seeds within head and season.

DAF	Position	Non-polar lipids (% total lipids)		Fatty acids									
				Palmitic		Palmitoleic		Stearic		Oleic		Linoleic	
		W	S	W	S	W	S	W	S	W	S	W	S
7	P	45.10	44.64	19.06	16.03	0.86	0.42	2.20	7.76	25.71	49.51	43.96	23.01
	M	—	50.61	—	18.81	—	0.51	—	6.05	—	36.75	—	33.89
	C	—	—	—	—	—	—	—	—	—	—	—	—
14	P	84.34	92.65	8.41	5.53	t	t	8.01	4.56	65.59	79.20	16.99	10.71
	M	81.61	89.94	9.08	5.71	t	t	10.24	4.29	59.90	81.6	19.62	8.45
	C	79.33	86.43	11.55	6.52	t	tt	9.90	6.12	54.85	77.53	22.44	9.51
21	P	94.68	95.30	5.31	2.67	a	t	5.13	3.42	64.10	80.14	25.46	13.97
	M	93.74	95.42	6.79	4.79	a	tt	5.46	3.87	61.59	78.08	26.16	13.89
	C	93.65	94.81	7.41	6.21	a	t	7.02	4.23	56.73	74.68	28.85	14.89
28	P	96.13	97.78	7.02	2.49	0.56	t	3.75	3.59	41.24	77.35	47.43	16.57
	M	95.51	96.61	7.56	4.73	0.63	t	3.65	3.02	35.14	75.63	53.00	16.62
	C	94.50	96.51	7.57	4.92	0.46	t	3.44	3.42	32.11	73.22	56.42	18.44
35	P	96.50	96.73	5.73	4.55	0.46	0.26	3.59	3.79	42.40	73.72	47.82	17.68
	M	97.34	97.13	7.23	4.64	0.48	0.22	4.14	2.96	38.05	69.10	50.10	23.08
	C	95.56	96.62	6.58	5.57	0.51	0.23	3.08	2.71	36.26	69.05	53.60	22.44
42	P	96.47	97.41	7.05	3.85	0.45	0.30	3.16	3.65	38.21	70.56	51.13	21.64
	M	96.43	97.07	7.42	4.26	0.51	0.27	3.19	2.76	35.53	67.38	53.35	25.93
	C	95.44	96.74	7.58	4.78	0.52	0.32	3.14	2.71	33.66	64.43	55.10	27.76

DAF: Days after flowering; P=Peripheral; M= Middle; C= Central; W= Winter; S= Summer; a=absent; t= traces; —=No seed initiattion.

Lower fatty acids appeared only at 7 DAF and ranged from 0.62 to 1.52 per cent while linolenic acid appeared only at 7 DAF and 14 DAF and ranged from 2.65 to 6.59 and 1.00 to 1.26 per cent respectively, depending upon season and position of the seeds.

TABLE 2. Fatty acid composition (Per cent) of polar lipids fraction of developing seeds of sunflower as affected by position of the seeds within head and season.

DAF	Position	Polar lipids (% total lipids)		Fatty acids: Palmitic		Palmitoleic		Stearic		Oleic		Linoleic	
		W	S	W	S	W	S	W	W	S	W	W	S
7	P	54.21	54.05	22.36	21.15	a	a	1.31	6.19	32.10	41.29	38.09	27.29
	M	—	49.10	—	25.80	—	a	—	3.03	—	31.64	—	34.27
	C	—	—	—	—	—	—	—	—	—	—	—	—
14	P	12.59	5.76	12.62	10.20	a	a	7.65	5.47	58.00	55.48	20.08	28.35
	M	14.38	6.73	17.98	12.36	a	a	6.07	5.46	49.21	60.92	24.74	21.36
	C	18.25	8.23	18.79	13.16		a	5.39	5.70	50.24	55.04	22.01	26.10
21	P	3.68	3.04	13.35	9.84	t	a	3.03	3.13	36.41	60.18	47.21	26.85
	M	3.82	3.29	16.10	9.26	t	a	2.57	2.96	30.52	55.16	50.82	32.63
	C	3.33	3.39	15.37	9.94	t	a	4.01	2.20	26.28	50.10	53.33	37.33
28	P	2.26	1.79	11.68	9.04	0.45	t	2.69	2.58	31.11	51.22	54.09	37.16
	M	2.20	1.89	13.34	1.48	0.40	t	2.49	1.94	24.91	47.00	58.85	39.58
	C	2.18	2.08	13.80	12.25	0.40	t	2.91	1.85	265.6	45.15	56.33	40.75
35	P	2.68	2.05	13.27	11.66	0.65	0.40	3.04	13.02	27.21	39.08	55.82	45.85
	M	2.88	2.00	13.22	11.14	0.60	0.35	2.83	3.12	26.65	37.62	56.71	47.69
	[illegible]	2.7[illegible]	2.1[illegible]	14.0[illegible]	11.78	0.55	0.42	2.73	2.45	24.50	36.16	58.23	49.19
42	P	2.47	2.10	12.73	11.76	0.70	0.38	2.56	3.26	25.15	27.15	58.8	47.15
	M	2.58	2.07	13.1[illegible]	12.01	0.56	0.40	2.95	3.02	24.75	35.76	58.62	48.81
	C	2.86	2.16	12.86	12.85	0.60	0.40	2.75	2.25	21.60	35.00	60.20	49.60

DAF = Days after flowering; P=Peripheral; M=Middle; C=Central; W=Winter; S=Summer; a=absent; t=Traces, —=No seed initiation.

Lower fatty acids appeared only at 7 DAF and ranged from 0.84 to 1.06 per cent while linolenic acid appeared only at 7 DAF and 14 DAF and ranged from 3.14 to 4.93 and 0.46 to 3.25 per cent, respectively depending upon season and position of seeds.

Seasonal effect revealed that non-polar lipids were higher in summer while polar lipids were higher in winter at all the stages of seed development. However, the effect of season was very severe on oleic and linoleic acids while palmitic and stearic were affected to a smaller extent. In both the fractions palmitic acid was considerably higher in winter than in summer during seed development. At 7 DAF stearic acid was appreciably higher in summer as compared to winter. However, at 14 DAF it was higher in winter, thereafter, the seasonal effect was negligible. The higher temperature (summer) favoured the accumulation of oleic acid while lower temperature (winter) favoured linoleic acid. The effect of the temperature could be judged in a better way from the ratios of oleic acid to linoleic acid at maturity irrespective of the seed position. In non-polar fraction, the ratio of these two acids in winter was 1:1.25 while in summer it was 3:1. In the polar fractions, the ratio was 1:2.5 in winter and 1:1.3 in summer. These results suggest a positive relationship between temperature and oleic acid and a negative relationship between temperature and linoleic acid. It further suggests that by merely selecting the season of the year, a desired oleic to linoleic acid ratio of sunflower seed oil could be obtained. The decrease in linoleic acid at high temperature and an increase at low tempetarture may be attributed to the regulation of desaturase enzyme (Oleyl-Co A desaturase) which is responsible for converting oleic to linoleic acid. The synthesis or the activity of this enzyme is enhanced at the low temperature which results in an increase in linoleic acid (Tremoliers *et al.*, 1982).

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REFERENCES

AFZALPURKAR, A.B. and LAKSHMINARAYANA, A.G. 1980. Variation in oil content and fatty acid composition with sunflower head size and shape. J. Amer. Oil Chem. Soc. 57:105-106.

APPELQVIST, L.A. 1975. Biochemical and structural aspects of storage and membrane lipids in developing oilseeds. In Recent Advances in Chemistry and Biochemistry of Plant Lipids. T. Galliard and E.I. Mercer. Academic Press, New York. p. 251.

FOLCH, J., LEES, M. and STANLEY, G.H.S. 1957. A simple method for the isolation and purification of total lipids from animal tissues. J. Biol. Chem. 226:497-509.

GOYNE, P.J., SIMPSON, B.W., WOODRUFF, D.R. and CHURCHETT, J.D. 1979. Environmental influence on sunflower achene growth, oil content and oil quality. Aust. J. exp. Agric. Anim. Husb. 19:82-88.

GREWAL, S.S., SUKHIJA, P.S. and BHATIA, I.S. 1978. Polar lipid composition during sunflower seed development. Biochem. Physiol. Pflanzen, 173:11-16.

HARRIS, H.C., McWILLIAM, J.R. and MASON, W.K. 1978. Influence of temperature on oil content and composition of sunflower seed. Aust. J. agric. Res. 29:1203-1212.

LUDDY, F.E., BARFORD, R.A., HERB, S.F. and PAUL, M. 1968. A rapid quantitative procedure fo the preparation of methyl esters of butter fat and other fats. J. Amer. Oil Chem. Soc. 45: 549-552.

NICHOLS, B.W. 1964. New Biochemical Separations. Eds. A.J. James and L.J. Morris. Van Nostrand Co., London. pp, 321.

PUTT, E.D., CRAIG, B.M. and CARSUH, R.B. 1969. Variation in composititon of sunflower oil from composite samples and single seeds of varieties and inbred lines J. Amer. Oil Chem. Soc. 46 : 126-129.

ROBERTSON, J.A., CHAPMAN, G.W. and WILSON, R.L. 1978. Relation of days after flowering to chemical composition and physiological maturity of sunflower seeds. J. Amer. Oil Chem, Soc. 55 : 266-269.

ROBERTSON, J.A. and GREEN, V.E. Jr. 1981. Effect of planting date on sunflower seed oil content, fatty acid composition and yield in Florida. J. Amer. Oil Chem. Soc. 58:698-701.

TREMOLIERS, A., DUBACQ, J.P. and DRAPIER, D. 1982. Unsaturated fatty acids in maturing seeds of sunflower and rape. Regulation by temperature and light intensity. Phytochemistry 24 : 41-45.

ZIMMERMAN, D.C. and FICK G.N. 1973. Fatty acid composition of sunflower oil as influenced by seed position. J. Amer. Oil Cnem. Soc. 50 : 273-275.

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SHORT COMMUNICATIONS

INDIAN SOCIETY OF OILSEEDS RESEARCH

DIRECTORATE OF OILSEEDS RESEARCH

Rajendranagar, Hyderabad-500 030.

HRDF AWARDS FOR OUTSTANDING OILSEEDS RESEARCH

Background of awards

Indian Society of Oilseeds Research founded in 1983 is a registered society of individuals and organizations/institutions engaged in oilseeds research and development and vegetable oil technology in India. The forempst amongst its objectives is the promotion of research in various aspects of oilseeds production. The society firmly believes that the initiative and dedication on the part of the scientific community is the prime driving force to accelerate the pace of oilseeds research in the country. In our endeavour to recognise outstanding research contributions in various disciplines of oilseeds research and to provide some incentive to the scientists it has been decided to institute fifteen awards, through the kind courtesy of Hexamar Agricultural Research and Development Foundation. The awards are named HRDF AWARDS FOR OUTSTANDING OILSEEDS RESEARCH.

Nature of awards

Cash awards of Rs. 3,000/- each and citation in the following disciplines of oillseeds research :

i) Four awards for varietal improvement of groundnut, rapeseed-mustard, sesame safflower, sunflower, soybean, castor, linseed and niger.

ii) Five awards for insect pest management. Of these one each is earmarked for groundnut and rapeseed-mustard and the rest for sesame. safflower, sunflower, soybean, castor, linseed and niger.

iii) Four awards for diseases management. Of these one each is earmarked for groundnut and rapeseed- mustard and the rest for sesame, safflower, sunflower, soybean, castor, linseed and niger.

iv) Two awards, for chemical weed control one each in groundnut and soybean.

Eligibility for awards

i) All scientists essentially members of Indian Society of Oilseeds Research (for atleast three consecutive years preceding the year of award) and working in research centers or departments or laboratories of universities, research institutes, directorates and national research centres under ICAR, CSIR, BARC etc. in India.

ii) Oroginal research work carried out during 5 years preceding the year of award which has bearing on finding solution to any important problem in the disciplines and crops specified.

iii) Outstanding basic research leading to inventions or discoveries in the disciplines concerned duly supported by publications in journals of repute.

iv) Results of routine experiments and the research work alreday submitted or to be submitted for award of any degree or diploma are not considered.

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i) Awards will be presented at Annual General Body Meeting of Indian Society of Oilseeds Research.

ii) Hexamar Agricultural Research and Development Foundation will pay TA and DA for recepients of awards as per their entitlement.

iii) Indian Society of Oilseeds Research reserves the right to publish the results of research works selected for the awards and/or submitted for the awards in Journal of Oilseeds Research.

Guidelines for submitting proposals for the awards

i) Nominations for the award may be made by the Directors of Research Institutes, Vice-Chancellors of Agricultural Universities and Presidents of recognised Scientific Societies. The nominations should invariably be accompnied by eight typewritten copies of proposals containing

a) bio-data giving full name, designation, office address date of birth, academic qualification starting from bachelor's degree and experience.

b) an abstract of research contribution not exceeding 500 words

c) certificate stating the research work submitted for HRDF award is the original contribution of investigator (s) duly authenticated by the head of the institution where it was carried out, and

d) detailed technical report in the enclosed proforma. as per Proforma given below.

ii) Nominations should reach the General Secretary, Indian Society of Oilseeds Research, Directorate of Oilseeds Research, Rajendranagar., Hyderabad-500 030 by January 30, 1990. January 1990

Judging Committee

i) Consists of (a) (President of Indian Society of Oilseeds Research or his representative from Executive Committee, (b) Director of HRDF or his representative and (c) three experts in each discipline nominated by the President of Executive Committee of ISOR.

ii) In all matters relating to the awards, the decision of the Judging Committee is final and no correspondence on this account shall be entertained.

PROFORMA FOR TECHNICAL REPORT OF THE WORK TO BE SUBMITTED FOR HRDF AWARDS

1. Title of the Project/ResearchProgramme
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3. Investigator (s) with proportion of contribution of each
4. Year of initiation
5. Year of completion
6. Brief background of the project indicating the importance of the research project/programmes.
7. Objectives
8. Description of the work done
9. Pooled results
10. Implications of the research work
11. Publications in the journal of repute based on results of research work
12. Signature of the investigator(s)
13. Signature of the Head of the Institute.

CORRECTIONS

1. The Presidential Address on "Non-Conventional Area, Season, Crop and Technology Approach to meet the Vegetable Oil Shortage in India" by Dr. M.V. Rao, published in Volume 5(2) on pages 1-6 was delivered at *PATNA* on 22-4-1988, and not at Hyderabad as printed.

2. The article entitled "Role of Amino Acids in Relation to Aphid (*Lipaphis eryzimi* kalt) Resistance in Cruciferous Species" by R.S Mallik was printed twice in Vol. 5 (2) , by mistake. The material printed on pages 185-191 may be treated as cancelled.

INFORMATION FOR CONTRIBUTORS

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