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SHORT COMMUNICATIONS

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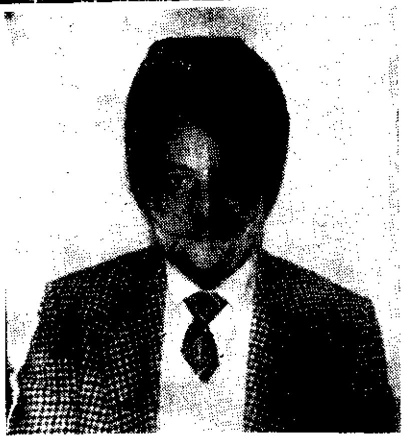
OBITUARY



Dr. K.S. Labana
(1930-1990)

Dr. Kuldeep Singh Labana, Senior Scientists (Oilseeds,)– and Head of the Department of Plant Breeding, Punjab Agricultural University, Ludhiana passed away in Ludhiana on October 17, 1990 following a heart attack. He was sixty. Dr. Labana had a long and significant innings in crop improvement especially oilseeds breeding.

He graduated in Agriculture in 1950 from Punjab University, Solan and subsequently obtained his M.Sc. (Ag.) degree in Genetics and Plant Breeding in 1952 from the same university. He secured his Ph.D. degree in 1969 from Punjab Agricultural University, Ludhiana.

He started his professional career as Research Assistant in 1951 and later rose to become Senior Scientist in 1978. Subsequently Dr. Labana worked as the Head of the Department of Plant Breeding, Punjab Agril. University, Ludhiana after a stint in the Ministry of Agriculture, New Delhi as Additional Agricultural Commissioner of Oilseeds Development.

His major contributions in oilseeds breeding include the development of as many as 23 high yielding varieties. Notable among them are RLM 619 and RL 1359 of Indian Mustard;TL 15 of *Toria*;GSL 1 of oilseed rape; M 13,M335 and SG 84 of Groundnut and TC 289 of sesamum,. His work on breeding hybrid mustard led to the development of some F_1 hybrids with every high yield potential. Dr. Labana was also associated with the refinement of Oilseed Production Technology, especially the development of *toria-gobhi sarson* (*Brassica napus*) intercropping and transplanting of *gobhi sarson*. During his distinguished career, Dr. Labana served in several positions of various professional bodies. He had to credit more than 300 publications.

He authored a comprehensive text book on Breeding of Oilseed *Brassica* which will be published very soon. He was a very popular teacher of plant breeding and guided the research work of around 18 post-graduate students.

Always forthcoming and kind hearted, Dr. Labana had a multi-facetted personality. His colleagues and friends will always miss his affection, hospitality and advice. In his death, the agricultural scientists in general and oilseed scientists in particular have lost a worthy colleague and the Indian Society of Oilseeds Research is deprived of one of its foremost and senior members. He is survived by his wife, a son and four daughters. The Indian society of Oilseeds Research conveys deep condolences to the bereaved family members. May his soul rest in peace.

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GENOTYPIC AND PHENOTYPIC ASSOCIATIONS AMONG NINE QUALITY TRAITS OF SEED AND OIL IN LINSEED (*LINUM USITATISSIMUM* L)

M. Rai, S.A. Kerkhi, S. Pandey, P.A. Naqvi and A.K. Vashistha
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ABSTRACT

Based on tne observations recorded at three locations, genotypc and phenotypic correlation coefficients among nine quality traits were worked out. Significant negative associations were obtained between oil content and protein content, iodine value, and stearic acid, iodine value and oleic acid and oleic acid and linolenic acid at all the locatons while only iodine value showed significant positive link with linoenic acid at each of the three locations under the study. Linoleic acid showed significant negative correlation with linolenic acid at Kanpur and Kangra locations. The rest of the significant correlation coefficients viz., moisture content with protein content (negative) oil content with iodine and linoleinic acid (positive), oil content with oleic acid (negative), protein content with oleic acid (positive) and with linolenic acid (negative), iodine with palmitic (negative) palmitic with linoleic and linolenic acids (negative) palmitic with oleic acid (negative) stearic with linolenic acid (negative) and oleic and with linoleic acid (negative), were observed at only one of the three locations.

Key words: Linseed, oil quality.

INTRODUCTION

In linseed, the quality of seed is primarily determined by its oil content and the oil quality is assessed on account of the degree of unsaturated fatty acids present in the oil. However, a part of the total oil produced is used for edible purpose. There is, therefore, an urgent need to have suitable varieties with predominantly low unsaturated fatty acids, as well. As linseed cake is widely used as cattle feed, protein content of the seed also merits consideration for improvement by attaining a happy genetic balance between oil and protein contents.

Manifestation of traits is a multiplicative interaction of varoious factors including environmental factors. It was, therefore, of interest to estimate genotypic and phenotypic correlation coefficients over environments to formulate selection strategies for the improvement of various components of seed and quality components of oil.

MATERIALS AND METHOD

The field experiment consisting of 35 promising linseed cultures varieties including the standard check was undertaken at Patna (Bihar) Kanpur (Uttar Pradesh) and Kangra (Himachal Pradesh) during 1984-85. The experiment was laid out with two replications at each of the 3 locations in a net plot size of 0.75m × 4.0m. The usual agronomic practices were followed during the crop period. After harvesting, replication wise seed samples of each entry were drawn. Crushing of the drawn samples were done by pestle

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TABLE 1. Genotypic (rg) and Phenotypic (rp) Correlations among nine characters in three different locations alongwith pooled estimates in Linseed

Character		Moisure content	Oil content	Protein content	Iodine calue	Palmitic acid	Stearic acid	Oleic acid	Linoleic acid	Linolenic acid
1		2	3	4	5	6	7	8	9	10
Moisture content	r_p L1		-0.001	0.047	-0.141	0.193	-0.224	0.229	0.013	-0.177
	L2		0.060	-0.894**	-0.007	-0.106	0.235	-0.024	-0.206	0.086
	L3		0.006	-0.082	-0.066	0.009	0.121	-0.035	-0.020	0.003
	r_g L1		0.012	0.025	-0.271	0.377	-0.388	0.465	-0.118	-0.299
	L2		0.224	-0.281	0.001	-0.151	0.428	-0.074	-0.281	0.120
	L3		0.142	-0.200	-0.083	-0.160	0.446	-0.035	-0.373	0.110
Oil content	r_p L1	0.088		-0.932**	0.162	-0.047	-0.144	-0.172	0.107	0.160
	L2			-0.956**	0.375*	0.133	0.101	-0.418*	-0.297	0.474*
	L3			-0.922**	0.265	0.011	-0.261	-0.107	-0.225	0.291
	r_g L1	1.185		-0.968	0.187	-0.092	-0.174	-0.195	0.141	0.177
	L2			-0.976	0.399	0.146	0.102	-0.439	-0.268	0.476
	L3			-0.957	0.276	0.177	-0.295	-0.173	-0.251	0.312
Protein content	r_p L1	-0.148	-0.943**	—	-0.188	0.084	0.151	0.165	-0.039	-0.204
	L2				-0.311	-0.052	-0.138	0.337*	0.262	-0.389*
	L3				-0.285	-0.009	0.242	0.148	0.214	-0.316
	r_g L1	-1.515	-1.005		-0.218	0.114	0.184	0.205	-0.060	-0.239
	L2				-0.333	-0.031	-0.155	0.360	0.229	-0.392
	L3				-0.316	-0.167	0.231	0.245	0.214	-0.342
Iodine value	r_p L1	0.143	0.201	0.205		-0.604**	-0.355*	-0.860**	0.268	0.901**
	L2					0.054	-0.399*	-0.851**	0.072	0.828**
	L3					-0.092	-0.329*	-0.785**	-0.137	0.894**
	r_g L1	0.917	0.241	-0.249		-0.650	-0.375	-0.876	0.273	0.907
	L2					-0.071	-0.397	-0.867	0.080	0.835
	L3					-0.193	-0.387	-0.843	-0.218	0.937
Palmitic acid	r_p L1	-0.033	-0.187	0.057	-0.128		0.007	0.469**	-0.099	-0.591**
	L2						-0.126	-0.273	-0.329*	0.237
	L3						-0.259	-0.036	-0.321	0.058
	r_g L1	-1.366	-0.684	0.172	-0.462		0.026	0.536	-0.084	-0.653
	L2						-0.097	-0.299	-0.343	0.277
	L3						-0.500	0.218	-0.523	0.062

Contd.

and mortar and the crushed materials in duplicate were taken for oil analysis by Soxhlet apparatus. Oil extracted cake was used for protein analysis by micro-kjeldohl method. Fatty acid composition was determined as per the trans-estrification and gas-liquid chromatographic procedures. After usual analysis of varience, correlation coefficients among the nine traits were worked out as suggested by Al-jibouri *et al.* (1958 .

RESULTS AND DISCUSSION

Genotypic and phenotypic correlation coefficients estimated for 3 different growing conditions among the nine characters under study are presented in Table-1. The significance of genotypic correlations could not be done as no suitable stastical test is available. However, genetic associations in general were simiqar in sign and slightly higher in magnitude than phenotypic correlations. Hence, the significant phenotypic associations may be used as a reliable indicators for directing selection to improve upon the qulaity traits.

As linseed oil is primarily an industrial oil, it is realised that such studies merit consideration (Das and Rai, 1973, Rai and Das, 1976, Rai, 1981) for understanding the association among various components of seed and oil and thereby outlining the strategies for improvement of the desired traits. Moisture content was significantly and negatively correlated with protein content only at Kanpur (L_2). Association among oil content and protein content showed highly significant negative values at all the three locations and on the pooled basis as well. The oil content showed significant and positive relations with iodine value and linolenic acid and negative association with oleic acid. This association is of practical utility as the linseed oil is preferred in paint and varnish industries. Hence, there is a distinct possibility of improving the oil content in the seed and enhancing industrial utility of the linseed oil, simultaneously. However, to increase the acceptability of linseed oil for edible purposes, there is a need to break the linkages between oil content of the seed and highly unsaturated linolenic acid content of the oil. A breeding programme with biparental or triple-test-cross mating design may be applied or a mutation breeding programme may be followed to achieve the objectives. Disruptive selection programme may also be of immense use for breaking such linkages.

Protein content was positively correlated with oleic acid while it was negatively associated with linolenic acid at Kanpur. Although the coefficient of correlation between these traits were not significant at other locations, the direction of association and the magnitude of the correlation was close to the level of significance . This indicates that the selection based on protein content may result in developing varieties with better quality linseed oil for edible use. Iodine value was significantly and negatively associated with most of the saturated fatty acids while the same showed positive link with linolenic acid, Such type of results were obtained by Naqvi *et al.* (1987). As such iodine value may be a good indicator of the degree of saturation/unsaturation of the acid composition in the linseed oil. Hence, iodine value may be used as an efficient trait for directing selections for evolving varieties for edible and technical grades, respectively.

Palmatic acid was negatively correlated with linolenic acid and linoleic acid at Patna and Kanpur locations respectively and was positively associated with oleic acid at Patna. Stearic acid showed negative association with linoleic acid at Kangra while oleic acid exhibited negative relationship with lienolenic acid at all the 3 locations.

The perusal of the data in general revealed that the manifestation of a number of quality components is widely influenced by change in environments. Hence, adequate caution under varying environments is necessary for achieving the desired results.

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Contd... (Table 1)

1	2	3	4	5	6	7	8	9	10
Stearic acid	-0.275	0.304	-0.202	-0.00	-0.025	rp L1	-0.001	-0.413*	-0.132
						L2	0.033	-0.229	-0.197
						L3	-0.110	0.158	-0.259
	-1.706	0.518	-0.397	-0.015	0.411	rg L1	0.042	-0.441	-0.141
						L2	0.054	-0.255	-0.197
						L3	-0.056	0.324	-0.312
Oleic acid	-0.021	-0.238	0.214	-0.832**	-0.060	-0.347*	rp L1	-0.329*	-0.833**
							L2	0.021	-0.842**
							L3	0.054	-0.771**
	-0.067	-0.312	0.299	-0.880	0.161	-0.406	rg L1	0.330	-0.844
							L2	0.026	-0.857
							L3	-0.019	-0.836
Linoleic acid	0.149	-0.102	0.178	-0.068	-0.137	-0.101	0.057	rp L1	-0.096
								L2	-0.434**
								L3	-0.489**
	0.340	-0.053	0.149	-0.080	-0.188	-0.089	-0.042	rg L1	-0.086
								L2	-0.425
								L3	-0.479
Linolenic acid	0.014	0.234	-0.261	0.852**	-0.025	0.112	-0.788**	-0.490**	rp
	0.268	0.254	-0.294	0.882	-0.158	0.208	-0.829	-0.485	rg

L 1 — Location I (Patna)
L 2 — Location II (Kanpur)
L 3 — Location III (Kangra)

* — Significant at P = .05

** — ,, ,, P = .01

Lower half diagonal values showed the pooled correlation

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VARIETAL PERFORMANCE, HERITABILITY AND GENETIC ADVANCE FOR SOME QUALITY COMPONENTS OF SEED AND OIL IN LINSEED (*LINUM USITATISSIMUM L.*)

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and
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ABSTRACT

Variability, broadsense heritability and genetic advance were estimated among 35 promising genotypes of linseed for moisture content, oil content, protein content and iodine value of the oil. Significant mean differences were obtained among the varieties for all the traits. Considerable variability in moisture content (3.25 to 5.20%), oil content (38.0 to 45.06%) protein content (13.55 to 17.86%) and iodine value (190.25 to 167.68) was observed. High heritability percentage with medium to low genetic advance was observed for all the traits except for moisture content.

Key words: Linseed, oil content, heritability, genetic advance

INTRODUCTION

Linseed seed is composed of oil, protein, moisture and fibre. Out of these oil and protein are the desirable traits. However, very little information on the genetic architecture of these traits are available (Rai *et al.* 1985). Similarly, genetic informations on the iodine value of the oil which determines the drying property of the oil which is an essential for paint and varnish indiustries, needs adequate attention. It was, therefore, of interest to assess the variability existing in the promising cultures of linseed and to estimate the genetic parameters to understand the possibility of improvement in these traits.

MATERIALS AND METHOD

The field experiment consisted of 35 promising linseed cultures including the standard check was undertaken at Patna (Bihar) Kanpur (Utter Pradesh) and Kangra (Himachal Pradesh) centres during 1984-85. The experiment was conducted in two replications at each of the three locations in a net plot size of 0.75m × 4.0m. The usual agronomic practices were adopted during the crop period. After harvesting, the replication wise seed samples of each entry were drawn. Crushing of the drawn samples was done by pestle and mortar and the crushed material in duplicate was taken for oil analysis by Soxhlet apparatus. Oil extracted cake was used for protein analysis by microkjeldohl method. Iodine value was worked out by AOAC (1962) procedure. Moisture content in the seed was recorded on oven dried basis. Standard stastical procedures were used to estimate variability among the varieties, heritability and genetic advance for moisture content, oil content, protein content and iodin value.

RESULTS AND DISCUSSION

Significant varietal differences were observed with regard to all the characters at all the 3 locations (Table - 1).

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TABLE 1. Mean performance of 35 vaieties for four characters ih linseed.

Sl. No.	Variety	Moisture content				Oil content			
		L1	L2	L3		L1	L2	L3	
		Moisture	Moisture	Moisture	Pooled	Oil content	Oil content	Oil content	Pooled
1	2	3	4	5	6	7	8	9	10
1.	LCK 8321	4.90	5.35	5.50	5.25	38.85	41.25	39.45	39.80
2.	RL 26-2	4.00	4.45	4.30	4.25	41.20	43.10	40.05	41.45
3.	RLC-19	5.40	4.90	4.80	5.03	38.10	38.85	41.25	39.40
4.	BAU 70	3.95	6.20	6.20	5.45	40.90	42.35	39.85	41.03
5.	T 397	4.75	4.05	4.35	4.38	42.25	43.65	42.25	42.71
6.	LCK 8324	5.10	4.95	5.15	5.06	39.40	41.60	42.10	41.03
7.	LCK 8326	4.80	4.20	4.50	4.50	38.65	42.90	44.80	42.11
8.	RL 6-10	4.90	4.00	4.15	4.35	40.20	40.40	34.45	38.35
9.	RL 8-13	4.80	5.00	5.00	4.93	42.60	46.20	37.05	41.75
10.	PCL-1	5.90	4.85	4.50	5.08	41.20	42.60	36.45	40.08
11.	LCK 8322	6.10	4.50	4.85	5.15	36.30	40.15	39.15	38.53
12.	RL 9-6	5.00	3.90	4.15	4.35	41.35	43.40	45.55	43.43
13.	LCK 8323	4.85	4.10	3.90	4.28	37.20	40.45	40.45	39.36
14.	RLC 18	6.20	3.25	3.90	4.45	40.05	38.65	40.15	39.61
15.	KL-1	5.90	3.90	3.25	4.35	39.65	40.85	44.10	41.53
16.	LCK 8325	4.80	4.80	3.80	4.46	37.75	22.05	41.25	40.35
17.	PBNL-2	5.50	4.00	4.80	4.76	43.05	44.55	42.45	42.35

Contd.

Table 1 (Contd...)

1	2	3	4	5	6	7	8	9	10
18.	LCK 8327	5.15	3.80	4.00	4.31	35.70	38.80	39.50	38.00
19.	LCM 84-746	5.85	4.65	4.75	5.08	39.40	44.70	44.40	42.83
20.	LCM 84-55	5.50	4.75	4.65	4.96	38.15	40.90	39.60	39.55
21.	Zonal check	6.05	4.80	5.50	5.45	44.65	41.70	42.90	43.08
22.	KL-31	5.00	5.55	4.80	5.11	46.65	42.50	44.25	44.46
23.	KL-32	5.35	5.30	3.95	4.86	36.85	41.30	38.95	39.03
24.	LCM-84-771	5.10	3.95	5.30	4.78	44.90	45.10	41.80	43.93
25.	LCM-84-89	5.45	4.55	4.20	4.73	42.45	43.90	42.25	42.86
26.	BAU-152	5.00	5.50	4.55	5.01	40.75	44.55	41.15	42.15
27.	RL 25-1	5.80	4.20	5.50	5.16	41.50	45.70	40.30	42.50
28.	BAU 62	5.15	4.90	5.10	5.05	39.05	40.55	43.50	41.03
29.	RL-28-1	4.30	5.10	4.26	4.53	41.65	44.50	43.60	43.25
30.	LCM 8437	5.60	4.40	5.15	5.05	41.25	43.65	45.20	43.36
31.	LCM 84259	5.60	5.15	5.20	5.31	44.15	44.80	46.25	45.06
32.	BAU 191	4.55	5.20	4.40	4.71	40.95	39.70	39.80	40.15
33.	BAU-95	4.15	5.25	4.40	4.60	40.95	41.70	42.45	41.70
34.	BAU 111-1	4.35	4.40	4.85	4.53	37.30	41.40	40.00	39.56
35.	BAU 160	5.40	4.85	5.25	5.16	40.00	40.50	42.00	40.83
	G.M·	5.1486	4.6486	4.6529	4.81	40.4286	42.2557	41.3914	41.35
	C.V·	11.9336	12.6028	12.7587	12.41	0.85766539	1.8191	1.7194	1.88
	S.E. if difference of two means	0.61440889	0.58584880	0.59364379	0.345	0.85766539	0.76868973	0.71166844	0.45
	C.D. 5%	1.25	1.19	1.20	0.68	1.74	1.55	1.44	0.89

Contd...

Sl. No.	Variety	Protein content				Iodine value			
		L1	L2	L3	Pooled	L1	L2	L3	Pooled
		Protein	Protein	Protein		Iodine value	Iodine value	Ioddine value	
1	2	11	12	13	14	15	16	17	18
1.	LCK 8321	17.45	16.15	16.95	16.85	181.20	176.15	177.55	178.30
2.	RL 26.2	17.20	15.15	16.80	16.38	184.75	180.75	183.20	182.90
3.	RLC-19	17.60	17.00	15.55	16.71	162.30	170.15	170.60	167.68
4.	BAU 70	16.15	15.00	16.90	16.01	191.75	182.00	181.00	184.91
5.	T 397	15.85	14.10	15.85	15.26	185.25	179.00	178.10	180.78
6.	LCK 8324	16.65	15.65	15.20	18.83	184.75	185.75	185.50	185.33
7.	LCK 8326	17.75	14.25	15.10	15.70	169.50	179.50	177.00	175.33
8.	RL 6-10	16.85	16.90	18.40	17.38	181.25	179.75	174.65	178.55
9.	RL 8-13	15.45	12.60	17.20	15.08	188.85	185.65	183.20	185.90
10.	PCL–1	16.65	15.25	17.90	16.60	167.65	190.15	180.10	179.30
11.	LCK 8322	18.70	16.75	17.40	17.61	189.75	181.40	180.55	180.90
12.	RL 9-6	16.60	14.50	14.50	15.20	174.90	184.25	185.60	181.58
13.	LCK 8323	19.00	16.70	16.90	17.53	181.50	182.05	179.65	181.06
14.	RLC-18	18.25	17.95	16.95	17.71	179.40	179.90	181.70	180.33]
15.	KL-1	16.95	16.60	14.95	16.16	178.00	185.75	185.20	182.98
16.	LCK-8325	18.05	15.70	16.30	16.68	182.00	183.50	182.95	182.81

Contd...

Contd. (Table 1)

1	2	11	12	13	14	15	16	17	18
17.	PBNL-2	14.85	13.85	15.15	14.61	197.80	192.25	180.70	190.25
18.	LCK-8327	18.70	17.90	17.00	17.86	177.45	179.25	180.45	179.05
19.	LCM 84-746	16.80	13.70	14.55	15.01	184.20	187.65	185.40	185.75
20.	LCM 84-55	18.20	16.30	15.70	16.73	177.00	189.65	187.95	184.86
21.	Zonal check	15.15	16.05	15.45	15.55	181.25	179.75	178.75	179.91
22.	KL 31	13.85	14.80	14.40	14.35	175.80	183.95	186.95	182.23
23.	KL 32	18.70	15.60	17.70	17.33	187.00	179.75	184.15	183.63
24.	LCM 84-771	14.25	12.80	15.90	14.31	172.40	171.25	168.05	170.56
25.	LCM 84-89	15.55	14.65	16.00	15.40	180.75	181.95	170.05	179.91
26.	BAU-152	16.40	13.90	16.40	15.56	184.75	181.00	183.20	182.98
27.	RL 25-1	16.10	13.05	16.90	15.35	176.80	189.00	187.55	184.45
28.	BAU 62	17.40	16.90	14.90	16.40	166.35	173.85	182.20	174.13
29.	RL 28-1	16.00	14.60	14.55	15.05	181.95	186.40	186.85	185.06
30.	LCM 8437	16.95	13.75	14.00	14.90	187.90	189.45	186.25	187.86
31.	LCM 84259	14.65	13.25	13.55	13.81	186.00	184.65	183.75	184.80
32.	BAU 191	16.05	16.95	16.55	16.55	182.05	181.00	179.55	180.86
33.	BAU 95	16.50	15.15	15.65	15.76	184.15	184.95	187.25	185.45
34.	BAU 111-1	18.45	16.20	17.00	17.21	177.10	186.75	183.15	182.33
35.	BAU 160	17.55	15.75	15.65	16.31	183.15	181.00	185.55	183.23
	G.M.	16.7786	15.2971	15.9986	16.02	180.5043	182.5486	181.7514	181.60
	C.V.	3.3560	3.7548	2.9111	3.34	0.4566	0.4744	0.5029	0.48
	S.E. if difference of two means	0.56308076	0.57438044	0.46573888	0.309	0.82426337	0.86602641	0.91394525	0.51
	C.D. 5%	1.142	1.165	0.94	0.61	1.670	1.759	1.859	1.009

On an average, moisture content of seed ranged from 3.25 to 6.20%. The oil content was in between 38.00 to 45.06% while protein percentage varied between 13.55 to 17.86. Differences in iodine value were in the range of 167.00 to 190.25.

The highest oil content was recorded in the variety LCM 84-259 (45.06%) while it was the lowest in LCK 8327 (38.00%). Varieties KL-31, LCM 84-771 and RL 9-6, the next highest oil containing varieties were also moderate in protein content. Among these varieties LCM 84-771 also exhibited the next lowest iodine value (170.56%). The highest iodine value (190.25%) was observed in the variety PBNL-2. This variety also possessed the high percentage of oil content. For simultaneous improvement of oil and protein contents in linseed, varieties LCM 84-259 and LCK 8327 may be considered for exploitation in various breeding programmes.

Genotypic and phenotypic coefficient of variability was the highest for moisture content followed by protein content and *oil content* at each of the locations. High heritability values were observed for all the characters. Such type of results were also observed by Rai *et al.* (1985). However, maximum heritability was recorded for iodine value. Genetic advance was also the highest for this trait, revealing that the emphasis may be given *more to this trait* for selecting the genotypes for technical and edible purpose *in linseed.*

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POSSIBILITIES OF INCREASING PRODUCTION OF OILSEEDS THROUGH INTERCROPPING SYSTEM

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ABSTRACT

The results of the experiments conducted in different agro-ecological conditions revealed that intercropping system is more profitable under dry land conditions. The yield advantage ranged from 12 to 76% and net profit from Rs. 467/ha in groundnut+sesame paired row system to Rs.5500/ha in Castor+green gram system. Possibilities of intercropping systems with oil seeds in different agro-ecological situations has been reviewed. Field experiments conducted at the University Farm revealed that yield advantages ranged from 81-85% in IG:2SF and 50-57% in groundnut + sunflower (2:1), 44-56% in Sesame + mung (2:1), 55% in IG:2W 32-35% in groundnut + wheat (2:1) and 72% in IG:2S 23-43% in groundnut + Sesame (2:1). Net profit ranged from Rs. 4230/ha to Rs. 7690/ha. Experiments on cultivator's field were conducted in saline tract with groundnut + chilli and laterite tract with groundnut + upland rice and it was observed that this system was remunerative as compared to sole crops.

Key words: Oilseeds, intercropping.

INTRODUCTION

There is an increasing demand of oilseeds and oils in India. The system of inter-cropping not only saves the crops against natural hazards but also helps in better utilization of farm resources. Results of experiments on intercropping system revealed that this practice is remunerative and gives yield advantage over sole crops provided it is properly planned and crops are not competetive to each other (Lingegowda *et al.*, 1972; Reddy and Willey 1981; Samui *et al.*, 1984 and Samui *et al.*, 1986).

MATERIALS AND METHODS

A series of experiments were conducted at the university farm of Bidhan Chandra Krishi Viswavidyalaya, West Bengal, during 1980 and 1981. The experiments were laid out in Randomized Block Design. There were six cropping system treatmnts as givenbelow

(1) One row of groundnut alternated with one row of sunflower (*kharif*)/sunflower (*Rabi*)/wheat/sesame (IG:1SF/W/S),
(2) Two rows of groundnut alternated with one row of sunflower (*kharif*)/sunflower (*rabi*)/wheat/sesame (26:1SF/W/S),
(3) One row of groundnut alternated with two rows of sunflower (*kharif*/sunflower (*rabi*)/*wheat*/*sesame* (1G:2SF/W/S).
(4) One row of groundnut alternated with three rows of sunflower (*kharif*)/sunflower (*rabi*)/wheat/sesame (1G-3SF/W/S).
(5) Sole groundnut (G).
(6) Sole sunflower (*kharif*)/sunflower (*rabi*)/wheat/sesame (SF (*kharif*/SF(*rabi*)/W/S).

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The soil of the experimental field was sandy loam having a pH 7.4, total N 0.07 percent available P_2O_5 36 kg/ha and available K_2O 112 kg/ha. Polachi-1 variety of groundnut, Morden variety of sunflower and B67 of sesame were used in *kharif* season, while sonalika of wheat, Morden of sunflower and J-11 for groundnut were used in-*rabi*. In *kharif* sunflower, groundnut and sesame were sown in middle of June, at 25 cm apart. Sunflower and sesame were harvested in September and groundnut was harvested in November. Wheat, sunflower (*Rabi*) and groundnut were sown in the middle of November and wheat and sunflower were harvested in February and groundnut in April. The crops received 60 kg N, 60 kg P_2O_5 and 40 kg K_2O/ha. Irrigation and other management practices were carried out as and when found necessary.

RESULTS AND DISCUSSION

Possibilities of intercropping systems with oilseeds in different agroecological situations in India has been reviewed and presented in Table 1. It is seen from the Table that yield advantages due to intercropping system ranged from - 12% with sorghum + sunflower to 76% with castor + green gram. Net profit ranged from Rs. 467/ha in groundnut + sesame to Rs. 5500 in castor + green gram system. Intercropping system was reported to be more profitable under stress condition.

It is seen from Table 2 that the combined yield of groundnut and sunflower was significantly influenced due to different cropping system. The highest seed + pod yield, stalk yield and oil yield were recorded when one row of groundnut was alternated with one row of sunflower (IG:1SF) in both *kharif* and *rabi* seasons and it was significantly higher over other intercropping systems. Combined yield was also significantly increased when two rows of groundnut was alternated with one row of *kharif* sunflower (2G:1SF) but in the case of *rabi* sunflower significantly higher combined yield was recorded when one row of groundnut was alternated with two rows of sunflower (IG:2SF).

The highest intercropping yield advantage (Table 3) was recorded when one row of groundnut was alternated with one row of sunflower (LER = 1.82 and 1.85 respectively in *kharif* and *rabi* seasons), followed by paired row of groundnut alternated with one row sunflower in kharif (LER 1.52) and one row of groundnut alternated with paired row of rabi sunflower (LER 1.57). The yield advantage was about 40% when one row of groundnut was alternated with two rows of *kharif* sunflower and the yield advantage was about 53% when two rows of groundnut was alternated with one row of *rabi* sunflower. Tarhalkar and Rao (1979) found 57% yield advantage in sorghum/groundnut intercropping system.

Combined yield of groundnut and wheat, groundnut and sesame was significantly influenced due to different cropping systems (Table 4). The highest combined yield of pod and seed, stalk and oil yield was recorded when one row of groundnut was alternated with one row or either wheat or one row of sesame (1G:IW/IS), followed by two rows of groundnut alternated with one row of wheat or sesame (IG:1W/I5). The highest yield advantages of 55% and 72% (LER 1.55 and 1.72) were observed when one row of groundnut was alternated with one row of wheat or one row of sesame respec-

TABLE 1. Possibilities of intercropping systems with oilseeds in different agroecological situations as reported by various workers.

Intercrops	Yield advantage (%)	Net Profit (Rs/ha)	Agroecological situation	Reported by
Sunflower + groundnut (EC 68415) 6:2 (BH8-18)	45–50	1446	Bangalore	Sindagi, 1989
Sunflower + groundnut (Morden) 6:2 (BH8-18)	45–52	2082	-do-	-do
Sorghum + groundnut	57	3221	Hyderabad	Tarhalkar & Rao, 1979
,, + castor	8	3530	-do-	-do-
,, + Sunflower	-12	—	-do-	-do-
Wheat + Linseed	16	1625	Ranchi	Chowdhury, 19
Barley + Mustard	7	2410	Agra	-do-
Pearl millet + groundnut	25–29	—	ICRISAT	Reddy et al. 1980
Sorghum + groundnut	5–26	—	-do-	Anon, 1977-78
Mustard + Lentil (R 75-2) 1:1 (Pusa Type 1)	20–30	—	Kanpur	Kushwaha, 1981
Safflower + gram paired row	35–43	4025	Jalgaon	Nikam et al. 1984
Safflower + Linseed paired row	,,	4149	-do-	-do-
Castor + greengram (Aurna) 1:2 (PS 16)	64–76	5500	Kota	Prasad & Ver 1986
Castor + Sesame (Aruna) 1:2 (Pratap)	31–39	3650	-do-	-do-
Castor + Sorghum (Aruna) 1:2 (CSH–5)	–11–15	2000	-do-	-do-
Sorghum + groundnut	11–16	3200	Indore	Singh&Jha, 1984
Wheat + Mustard (Sonalika) (Varuna) (1:1)	11–30	2795	Pantnagar	Sharma et al, 1986
1:1	8–27	2450	-do-	-do-
4:2	8–27	2450	-do-	-do-
10:2	11–29	3040	-do-	-do-
Groundnut + Sesame (JL 24/TMV2) 2:1 (Gouri)	—	467	Hyderabad	Sharma&Singh, 1987
Groundnut + Sunflower (EC 68414)	—	887	-do-	-do-

ABLE 2. *Effect of intercropping system on combined yield (q/ha) of groundnut and sunflower* (average of 1981 and 1982)

Intercropping system	Combined yield					
	Groundnut + sunflower (K)			Groundnut + sunflower (R)		
	Seed+pod yield	Stalk yield	Oil yield	Seed+Pod yield	Stalk yield	Oil yield
1G : 1SF	25.56	95.84	9.22	33.90	72.78	13.50
2G : 1SF	21.97	91.75	7.94	27.29	66.50	10.77
1G : 2SF	20.69	79.39	7.54	29.24	57.99	11.68
1G : 3SF	14.64	63.16	5.28	21.51	48.72	8.56
Sole G	15.13	72.49	5.37	16.74	43.45	6.48
Sole SF	13.41	55.10	5.04	19.34	47.22	7.82
S.Em±	0.24	1.34	0.16	0.55	1.12	0.18
C.D. 5%	0.67	3.75	0.45	1.54	3.14	0.50

G = Groundnut, SF = Sunflower, K = Kharif, R = Rabi

TABLE 3. Land equivalant ratio (LER) of Pod or Seed yield of groundnut and sunflower (average of 2 years)

Intercropping system	Partial LER of groundnut	Partial LER of sunflower (K)	Total LER	Partial LER of groundnut	Partial LER of sunflower (R)	Total LER
1G : 1SF	0.77	1.04	1.81	0.78	1.07	1.85
2G : 1SF	0.91	0.61	1.52	0.94	0.59	1.53
1G : 2SF	0.41	1.09	1.50	0.43	1.14	1.57
1G : 3SF	0.26	0.79	1.05	0.28	0.87	1.15
Sole G	1.00	—	1.00	1.00	—	1.00
Sole SF	—	1.00	1.00	—	1.00	1.00

TABLE 4. Effect of intercropping system on combined yield (q/ha) of groundnut and wheat and groundnut and sesame

(Average of 1980 and 1981)

Intercropping system	Groundnut + wheat		Groundnut + sesame		
	Combined yield	Combined stalk yield	Combined yield	Combined stalk yield	Combined oil yield
1G : 1 W/S	32.42	66.21	21.74	62.29	6.29
2G : 1 W/S	30.07	58.62	21.08	61.40	7.77
1G : 2 W/S	27.02	54.86	13.96	37.68	5.40
1G : 3 W/S	22.09	43.86	19.60	61.77	7.04
Sole G	22.19	47.49	—	—	—
Sole W/S	19.95	36.60	7.33	15.27	3.34
S.Em±	0.54	0.66	0.41	1.62	0.19
C.D. 5%	1.51	1.86	1.15	4.54	0.53

W = Wheat, S = Sesame

TABLE 5. Land Equivalent Ratio (LER) of Pod or Seed yield of groundnut and wheat/sesame (average of 2 years)

Intercropping system	Partial LER of groundnut	Partial LER of wheat	Total LER	Partial LER of groundnut	Partial LER of sesame	Total LER
1G : 1 W/S	0.84	0.71	1.55	0.73	0.99	1.72
2G : 1 W/S	0.93	0.39	1.32	0.87	0.56	1.43
1G : 2 W/S	0.44	0.91	1.35	0.39	0.84	1.23
1G : 3 W/S	0.28	0.83	1.11	0.25	0.75	1.00
Sole G	1.00	—	1.00	1.00	—	1.00
Sole W/S	—	1.00	1.00	—	1.00	1.00

TABLE 6. Economics of intercropping system*

Intercropping system G:SF (K)/SF(R)/W/S	Groundnut and sunflower (K)		Groundnut and sunflower (R)		Groundnut and wheat		Groundnut and sesame	
	Net return (Rs)	*Net profit* over sole cropping (Rs)	*Net return* (RS)	*Net profit* over sole cropping (Rs)	*Net return* (Rs)	*Net profit* over sole cropping (Rs)	*Net return* (Rs)	*Net profit* over sole croping (Rs)
1 : 1	12615	5529	16588	7690	11158	4230	12292	**4627**
2 : 1	11015	3663	13616	4784	10884	2846	12957	**3975**
1 : 2	10036	3217	14096	5133	7082	1263	**8276**	**1928**
1 : 3	7081	387	10345	1351	**5346**	**49**	**6138**	**410**
Sole G	**7868**		8705		**10192**		11539	
Sole SF(K)/ SF (R)/W/S	**6303**		*9090*		**3665**		**3791**	

* Local wholesale price basis (1982) : Groundnut Rs. 520/q, sunflower Rs. 470/q, wheat Rs 190/q and sesame Rs. 500/q.

tively (Table 5). There was 32% yield advantage in groundnut wheat intercropping system and 43% in groundunt sesame intercropping system when two rows of groundnut was alternated with either one row of wheat or one row of sesame (IG:IW/2G:IS). Around 35% and 23% yield advantages were recorded when one row of groundnut was alternated with two rows of wheat or two rows of sesame (1G:2W/2S). Reddy and Willey (1981) also reported the yield advantage of intercropping in groundnut and pearl millet.

The highest net profit of Rs. 5529/ha, Rs. 7690/ha, Rs. 4230/ha and Rs. 4627/ha were found when one row of groundnut was alternated with one row of sunflower/wheat/sesame (Table 6). When two rows of groundnut were alternated with one row of sunflower/wheat/sesame, the net profits were Rs. 3663/ha, 4784/ha Rs. 2846/ha and Rs. 3975/ha respectively. There were net profits of Rs. 3217/ha, Rs. 5133/ha, Rs. 1928/ha when one row of groundnut was alternated with two rows of sunflower/wheat/sesame respectively. Giri *et al.* (1980) reported pigeon pea to be remunerative when intercropped with groundnut in 1P:1G or 2P:1G ratios.

Experiments on cultivators field

Intercropping experiemnts of sunflower with chilli and groundnut with chilli were carried out on farmer's field at Sunderban area (coastal saline tract West Bengal) in winter season. The highest yield advantage was recorded when three rows of sunflower or groundnut was alternated with 3 rows of chilli (3S/3G:3C). There was also yield advantage when paired rows of sunflower/groundnut were alternated with paired rows of chilli (2S/2G:2C).

It may be concluded from the experiments that groundnut can profitably be cultivated in intercropping system with chilli, sunffower wheat, sesame in different seasons in West Bengal to increase oilseed production.

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"EFFECT OF IRRIGATION SCHEDULE AND NITROGEN LEVEL ON SEED YIELD, CONSUMPTIVE WATER USE AND WATER USE EFFICIENCY OF LINSEED"

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ABSTRACT

In a field experiment conducted on clay loam soils of Kota during winter season of 1984-85 and 1985-86 to study the effect of irrigation schedule and levels of nitrogen, the highest mean seed yield was recorded with scheduling of irrigation at branching + capsule formation and the lowest seed yield was recorded with the irrigation at IW/CPE = 0.2. The higher water supply resulted in increased consumptive water use, but water use efficiency was reduced. An irrigation at branching + capsule formation and application of 90 kg/N/ha increased seed yield. The maximum consumptive water use was observed when irrigations were scheduled at branching + capsule formation and combined with 90 kg N/ha. Water use efficiency and consumptive water use were higher with increasing levels of mitrogen.

Key words: Linseed, water use efficiency, consumptive use

INTRODUCTION

In linseed significant increase in seed yield due to one or two irrigations during growth period has been reported by several workers (Shekhawat *et al.* 1972 and Singh *et al.* 1974). However, scheduling irrigation based on critical stage and climatological approach has been of recent interest since it gives fairly good account of water requirement of crops. Tiwari *et al.* (1988) reported higher seed yield due to scheduling of iriga tions at IW/CPE = 0.8, Bhan and Khan (1982) did not observe any differences between these approaches while scheduling irrigation on aluvial loamy soils of Uttar Pradesh. Singh (1968) reported linear increase in yield due to application of 25, 50 and 75 Kg N/ha under rainfed conditions. The highest seed yield was reported by Tiwari *et al.* (1988) due to scheduling of irrigation at IW/CPE = 0.8. Yusuf *et al.* (1978) reported increase in consumptive use of water with one irrigation as compared to control (no irrigation). Water use efficiency has been reported to increase with increasing levels of nitrogen and decrease with supply of moisture (Veits, 1962). The information on scheduling of irrigation based on climatological approach, critical stage and nitrogen requirement affecting seed yield and water requirement of this important crop of the region is meagre, therefore, the present study was undertaken.

MATERIALS AND METHODS

Field experiments were conducted on the experimental farm of Agriculture Research Station, Borkhera, Kota of Rajasthan Agriculture University for two consecutive winter seasons of the year 1984-85 and 1985-86. 'Chambal' linseed was grown in winters (Rabi) of 1984-85 and 1985-86 on clay loam (Sand 21%; Silt 27% and Clay 57.8%) of PH 7.8 with EC of 0.2 mmhos/cm and infiltration rate of 0.3 cm/hr. The moisture holding capacity was 29%. The soil was low in organic matter (0.62%), avai-

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lable P_2O_5 (25 kg/ha) but was rich in nitrogen (211 kg/ha) and available K_2O (171.1 kg/ha).

Five irrigation regimes consisting of irrigating the crop at branching, at capsule formation stage, at branching + capsule formation, IW/CPE = 0.2, IW/CPE = 0.3 and three nitrogen levels consisting of 30, 60 and 90 kg N/ha were replicated 3 times in split plot design. The irrigation regimes were alloted to main plots and nitrogen levels to sub plots. The crop was sown on November 10, 1984 and October 10, 1985 and was harvested on March 10, 1985 and March, 17, 1986 respectively. Total quantity of fertilizer was applied as basal application by deep placement method. At each irrigation 60 mm of water was applied by Parshall Flume. The quantity of presowing irrigation applied was 100 mm. The moisture content values were computed by gravimetric method and consumptive water use was claculated by using the formula stated by Dastane (1972). The water use efficiency (WUE) was worked out by using the formual,

$$\text{WUE (kg/ha/mm)} = \frac{\text{Seed yield (kg/ha)}}{\text{Consumptive water use (mm)}}$$

RESULTS AND DISCUSSION

Seed Yield

Data presented in Table 1 reveal that seed yield did not differ significantly with the scheduling of errigation either at branching or at capsule development during both the years. However, significantly higher seed yield was observed when two irrigations were scheduled at branching + capsule development stage during 1985-86 years as compared to one irrigation scheduled at branching or at capsule formation. Irrigation scheduled at branching + capsule formation produced significantly higher yield than one irrigation at branching but was at par with one irrigation at capsule formation during 1984. Thus the highest seed yield of 11.03 q/ha was obtained with two irrigations scheduled at branching + capsule formation. These results corroborate the findings of Shekhawat *et al.* (1972). Irrigation scheduled on climatological approach exhibited significant results. Irrigation at IW/CPE = 0.3 gave significantly higher seed yield than at IW/CPE = 0.2 during both the years. However, there was no significant difference in seed yield when irrigation was scheduled either at branching + capsule development stage and IW/CPE = 0.3. Increase in seed yield due to scheduling of irrigations at branching + capsule development is obvious since this treatment involved two irrigations at physiologically critical stages. Similarly, the treatment IW/CPE = 0.3 also received two irrigations. The seed yield obtained under both of these treatments was at par since irrigations were scheduled almost on the same days after sowing. Scheduling of irrigation at IW/CPE = 0.8 resulted in the highest seed yield as compared to IW/CPE = 0.6 and 0.4 (Tiwari *et al*, 1988). However, Bhan and Khan (1980) did not observe any significant difference in seed yield of linseed while comparing the effects of irrigation regimes scheduled at critical stages or climatological approach. Increasing levels of nitrogen upto 90 kg/ha increased the seed yield significantly. Similar increase n seed yield was reported by Singh *et al.* (1974) and Tiwari *et al.* (1988).

Consumptive water use:

Scheduling of irrigation at branching + capsule development stage resulted in the highest consumptive use of water (Table 1). Consumptive use of water was 424 and 460 mm respectively during 1984-85 and 1985-86 with two irrigations given at above stages. The lower consumptive use was observed when irrigation was scheduled at branching stage. However, consumptive use of water increased with the increase in levels of nitrogen fertilization. The consumptive use of water increased progressively with the higher dose of fertilization and was highest at 90 kg N/ha. Yusuf *et al.* (1978) also reported increase in consumptive use of water due to additional irrigation over control.

TABLE 1. Effect of irrigation schedule and nitrogen levels on seed yield consumptive use and water use efficiency of linseed.

Treatments/ Irrigation regimes at	Seed yied (q/ha)			Consumptive water use (mm)		Water use efficiency (kg/ha/mm)	
	1984–85	1985–86	Mean	1984–85	1985–86	1984–85	1985–86
Branching	8.96	9.70	9.33	350	384	2.56	2.52
Capsule development	9.88	10.2	10.4	381	390	2.59	2.61
Branching + Capsule development	10.67	11.4	11.3	424	460	2.56	2.47
IW/CPE = 0.2	6.88	8.2	7.54	378	380	2.08	2.15
IW/CPE = 0.3	10.13	10.7	10.40	410	425	2.51	2.51
CD at 5%	1.07	1.05	—	—	—	—	—
Nitrogen levels (kg/ha)							
30	6.40	6.1	6.25	372	385	1.72	1.58
60	9.00	10.1	9.55	395	395	2.72	2.55
90	10.31	12.1	11.20	420	414	2.69	2.92
CD at 5%	0.46	0.64	—	—	—	—	—

Water use efficiency:

Water use efficiency which is a function of evapotranspiration of crop area (a constant) and crop yield, invariably increases with the moisture supply. In the present investigation also the water use efficiency decreased with two irrigations and was observed to be 2.56 and 2.47 kg/ha/mm respectively during 1984-85 and 1985-86 (Table 1). The increase in yield with increased water levels was less and hence WUE was less. Water use efficiency was found to increase progressively with increasing nitrogen levels and the highest WUE was obtained with nitrogen application at the rate of 90 kg N/ha. It confirmed the findings of Singh and Ramkrishna (1975).

Interaction of irrigation and nitrogen:

Interaction between irrigation and nitrogen rates was observed to be significant (Table 2). The highest seed yield of 12.92 and 13.9 q/ha was obtained when two irrigations at branching + capsule formation were combined with 90 kg N/ha during 1984-85 and 1985-86 respectively. Increased soil moisture content enhanced the uptake of nitrogen leading to increased yield due to more availability of nutrients. Tiwari *et al.* (1988) also repoerted interaction effcts in increasing seed yield of linseed due to irrigation and nitrogen fertilization.

TABLE 2. ***Interaction of irrigation schedule and nitrogen on seed yield of linseed (q/ha)***

Treatments	N LEVELS (kg/ha) Year 1984-85			Year 1985-86		
Irrigation regimes. at	30	60	90	30	60	90
Branching	6.0	9.42	11.36	6.9	11.5	11.8
Capsule development	6.51	10.53	12.61	7.9	10.4	12.5
Branching + Capsule development	7.20	11.63	12.92	8.7	11.8	13.9
IW/CPE = 0.2	5.54	6.51	8.59	6.6	8.8	9.6
IW/CPE = 0.3	6.65	7.48	10.25	8.1	9.5	11.2
CD at 5%	1.15	—	—	0.84	—	—

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EVALUATION OF EFFECTS OF SOIL FERTILITY VARIABLES ON THE YIELD OF LINSEED (*LINUM USITATISSIMUM* L.) IN VERTISOL

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ABSTRACT

Path coefficient analysis was a used to assess the direct and indirect effects contribution of sil fertiliy variable (N.P.K) on the yield of linseed (*Linum usitatissimum* L.) grown on Typic chromustert over two consecutive years. Direct effect of Soil-N, Soil-P, Soil-K, fertiliser-N an d fertiliser-P to the yield was significant while tne indirect effects were neglible except in fertiliser-N and fertiliser-P. Based on relative magnitude of mean, direct contribution the six soil fertility variables were screened and ranked in order: fertiliser N (88%)>fertiliser-P (71%)>Soil N (67%)> Soil-P (48%)>Soil-K (45%)>Fertiliser-K (44%).

Key words : Direct effect, Fertiliser-N, Fertiliser-P, Fertiliser-K, Indirect effect, Linseed, Path coefficient, Soil Nitrogen, Soil Phosphorus, Soil Potassium, Typic chromustert.

INTRODUCTION

In the modeling and optimisation studies the selection of optimal variable is a vital constraint. The prediction of dependent variable or yield are usually worked out in terms of a set of independent controllable factors, which are significantly related to the dependent factor. The contribution of soil fertility parameter to the yield is a sum of the direct and indirect contiibucions. The total correlation and the direct effect of that variable to the yield is considered for screening the soil fertility variables for model building. Such studies are few and untapped by pedologist. Thus, the present communication is a maiden endeavour to evaluate the direct and indirect effects on soil fertility variables (N.P.K) on linseed or flax plant (*Linum usitatissimum* L.) grown in moist sub humid bioclimate of central province of India.

MATERIALS AND METHODS

The field experiemnts were conducted in the years from 1984 to 1986, at the Research Farm, J.N. Agril. University, Jabalpur. The experimental soils belong to very fine, montmorilionitic hyper thermic family of Typic chromustert (Bhatterjee and Landey, 1983). It is clayey (Sand - 21.5% Silt - 23.5% and clay 65%) with pH 6.9 and medium nitrogen, low Olsen's and high available potassium. Field experimentation technique for soil test crop response correlation was developed by Rammoorthy and associates (1971). In this, the needed variation in soil fertility level for correla- ion was obtained by deliberately creating it in a given field in the season and conducting the main crop response trial in the same field in the subsequent season. The fertility gradient experiments were conducted on four fertility gradient strips created by applying graded doses of N.P and K fertilisrers, so as to get sufficient range in-

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their soil values. Maize as a prepatory crop was grown in the preceding season. The levels of P and K were fixed by taking into account P and K fixing capacity of soil i.e., 78 and 42 per cent, respectively. Complex experiments on linseed (*Linum usitatissimum* L.) were super imposed with variety R-17 on four fertility gradient strips of fractional factorial combination of 21 treatments ($5 \times 4 \times 3$ levels of N. P_2O_5 and K_2O) were alloted at random in each of the four strips with eight unfertilised plots ($3m \times 8m$). The fertiliser schedule consisted of 5 levels of N (O.25,50,75 and 100 kg/ha), 4 levels of P_2O_5 (O,20,40,60 kg/ha) and 3 levels of K_2O (O,20,30 kg/ha).

The correlation between the grain yield, and available soil nutrients and applied fertiliser nutrients were reckoned to assess the effect of soil fertility parameters on the grain yield. The regression of grain yield on soil and fertiliser nutrients, were calibrated to evaluate the direct and indirect effects of soil fertility parameters on the grain yield. (Singh and Choudhary, 1985).

RESULTS AND DISCUSSION

Table I indicates that the distribution of soil nutrients along with the grain yields in the fertilised plots varied from 975 to 1926 kg/ha in the first season (1984-85), 460 to 1900 kg/ha in the second season (1985-86). . The soil N varied from 167 to 392 kg/ha in the first season and 157 to 436 kg/ha in the second season. The soil P varied from 8.4 to 97.0 kg/ha in the first season and 4.6 to 81.3 kg/ha in the second season. The soil K varied from 179 to 694 kg/ha in the first season and 257 to 582 kg/ha in the second season. The mean yields were 1337 kg/ha and 662 kg/ha in the first season and the second season respectively. Similarly the mean soil fertility variable values for N,P and K were 257 kg/ha, 30 kg/ha and 394 kg/ha respectively in the first season.

TABLE 1. Distribution of linseed yield and soil nutrients

Variable		Range	Mean	C.V. (%)
Yield	A	975–1926	1337	43
(kg/ha)	B	460–900	662	41
Soil-N	A	167–392	257	43
	B	157–436	282	44
Soil-P	A	8.4–97.0	30	78
	B	4.6–81.3	44	70
Soil-K	A	179–694	394	54
	B	257–582	430	41

A — 1984-85

B — 1985-86

Significant at 5 level of significance

Whereas, the subsequent season accorded the mean values i.e. 282 kg N/ha, 44 kg Olsen's-P/ha and 430 kg-Ammonium Acetate-K/ha. The yield, soil-N and Olsen's-P were found to be non variant over seasons except Ammonium acetate extractable K.

The correlation between all pairs of soil fertility and fertiliser nutrients were worked out (Table 2). The positive and significant correlation of soil N with soil P and soil K were accorded which amounted to be 0.6456 and 0.5709 respectively. In the first season soil P had positive and significant relation with the soil K i.e. 0.4722 in the first season and 0.2624 in the second season. The soil N had a positive and significant (0.3013) relation with soil K in the second season. The correlation between all pairs of variables except soil N and fertiliser nutrients, soil P and fertiliser nutrients and soil K and fertiliser nutrients were found to be significant in the first season. The correlation between all the pairs of variables except soil N and soil P, soil N and fertiliser nutrient soil P and fertiliser nutrients, soil K and fertiliser nutrients, soil P and fertiliser nutrients, soil K and fertiliser nutrients, fertiliser N and fertiliser K were found to be significant in the second season. The correlation of yield with soil and fertiliser K were found to be significant in both the seasons.

TABLE-2. ***Coefficients of Correlation between linseed yield and soil and fertiliser nutrients***

Variable		Soil-N	Soil-P	Soil-K	Fert-N	Fert-P	Fert-K
Soil-N	A		0.6456*	0.5709*	–0.0493	0.0646	0.0245
	B		0.1787	0.3013*	–0.1077	–0.1254	0.1112
Soil-P	A			0.4722*	–0.0187	–0.1750	–0.0488
	B			0.2624*	0.2004	0.0589	–0.0525
Soil-K	A				–0.0483	–0.0497	–0.2315
	B				0.2136	0.1468	–0.2186
Fert-N	A					0.4547*	0.2069
	B					0.4771*	0.0289
Fert-P	A						0.2729*
	B						0.2504*
Yield	A	0.4800*	0.4264*	0.3566*	0.6247*	0.5133*	0.1427
	B	0.2952*	0.2725*	0.5365*	0.3030*	0.4132*	0.0517

A — 1984-85; B — 1985-86

* — Significance at 5% level

The linear regression of yield of soil and fertiliser nutrients were reckoned (Table 3). The coefficient of predictablity (R^2) was found to be high (0.78*) in the first season and poor (0.41*) in the second season. Based on 't' test values, out of six regressors, four were found to be significant in the first season while in the second season only regressor of soil K was found to contribute towards yield significantly. The magnitude of regression coefficient of soil and fertiliser variables varied over seasons.

TABLE 3. Multiple Regressions of linseed yield on scil and fertiliser nutrients

Year	Multiple Regression Equation	R^2
1984-85	Y = 144.9263 + 1.627* SN + 3.4691* SP + 0.2076 SK + 4.8786* FN + 6.3450* − 0.8724 FK	0.78*
1985–86	Y = 121.0465 + 0.4203 SN + 0.1509 SP + 0.6348* SK + 0.02726 FN + 2.6814 FP + 0.3998 FK	0.45*

*Significant at 0.05% level

The correlations between yield and each of the soil fertility variables together with the correlations among all the pairs of soil fertility variables, were partitioned into direct and indirect contributions and effect of soil fertility variables to the grain (Table 4). The direct effect of fertiliser nutrients were found to be invariant over two seasons and mean effects were found to be around 77 per cent, 71 per cent and 22 per cent for N, P and K nutrients, respectively. The direct effects of soil nutrients were found to be variant over seasons. and were of the order (%) - 65 and 69 for N, 59 and 38 for P and 26 and 64 for K over two seasons respectively. The higher contribution of soil nutrient was found to be compensated effect of a lower contribution of another soil nutrient *vice versa.*

The soil N was found to contribute to the yield indirectly through soil P (34%) and soil K (11%) in the 1st season and through soil P (6%) and soil K (35%) in the 2nd season. The mean indirect effect of soil N to the yield through soil P and soil K were approximately half that of its direct effect. The mean soil P was found to contribute yield indirectly through soil N (47%) and soil K (10%) in 1st season and through soil N (14%), soil K (33%), fertiliser N (22%) and fertiliser P (7%) in 2nd season. The soil K was found to contribute to yield indirectly through soil N (50%) and soil P (33%) in 1st season and soil N (12%), soil P (5%), fertiliser N, (12%) and fertiliser P (9%). The proportion of direct effect of soil P to its indirect effect through soil N and soil K were 1.6 times and 2.3 times, respectively. Similarly the proportion of direct effect of soil K to its indirect effect through soil N and soil K were 1.66 times and 2.33 times, respectively

The fertiliser P was found to contribute 26% to the yield indirectly through fertiliser N in 1st season. In the second season, the fertiliser P. soil K and soil P were found to contribute to the yield indirectly through fertiliser N which amounted, to 33 24 and 7 per cent, respectively. The fertiliser N was found to contribute (42%) to the yield indirectly through fertiliser P in the first season. While in the second season, the fertiliser N and Soil K were found to contribute 28 per cent and 12 per cent indirectly. The fertiliser P, fertiliser N and soil P were found to contribute indirectly through fertiliser K to yield, which amounted to be 70 per cent, 69 per cent and 9 per cent, respectively in the first season, . Whereas in the second season, indirect contribution of soil N was 43 per cent.

It is apparent that the fertiliser N and fertiliser P had directly contributed significantly to the linseed yield exception being fertiliser K. The fertiliser contribution through soil nutrients was negligible in both the seasons. All the three soil nutrients were found to contribute directly to the yield significantly. The indirect effects of soil N, soil P and soil K and fertiliser K were negligible in both the seasons. It is concluded that soil fertility variables were screened and ranked as fertiliser N (88%) followed by fertiliser P (71%), soil N (67%), soil P (48%), soil K (45%) and fertiliser K (44%).

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GROUNDNUT IN INTERCROPPING AND GROUNDNUT BASED CROPPING SYSTEMS

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ABSTRACT

The intercropping of groundnut as a measure of risk minimisation and higher income is prevalent in most of the major groundnut areas. Groundnut can be successfully intercropped with Sorghum, pigeon pea, sunflower, cotton, castor and tapioca in various agro-ecological situations. The plant population and geometry arrangement, fertiliser management and weed management have been highlighted in groundnut intercropping system. Groundnut is grown in Kharif and *rabi*/summer seasons involving various crops in sequences· Groundnut-maize, groundnut-wheat, groundnut-pulses, maize-groundnut are some of the profitable systems. Most of the *rabi*/summer groundnut is grown under paddy fallow system. The fertiliser management in groundnut-wheat sequence revealed that yield of groundnut after phosphorus applied to groundnut, or wheat or both crops in sequence was almost the same. Mustard yield after groundnut with 50 kg. P_2O_5/ha was higher than that of bajra with 60 kg. N/ha. Water management studies indicated that water used was more in rice-rice rotation than rice-groundnut sequence. Possibilities of growing groundnut as an intercrop in cassava, vegetables, spices, banana have been suggested along wih research priorities for increasing the productivity of groundnut both under rainfed and irrigated conditons.

Key Words: Groundnut: intercropping, cropping systems.

INTRODUCTION

The major states producing groundnut are Gujarat,Andhra Pradesh, Tamil Nadu, Karnataka, Maharashtra, Madhya Pradesh, Uttar Pradesh, Rajasthan, Punjab and Orissa. All these states grow groundnut in *Kharif* while Tamil Nadu, Andhra Pradesh, Karnataka, Maharashtra, Gujarat and Orissa also grow it in *rabi*/summer under irrigation. Area under *Kharif* groundnut is not likely to expand due to other competitive crops and as such it should find a place as an intercrop and sequential crop. Monocropping or intercropping during *Kharif* in rainfed and sequential cropping in irrigated situation is important in groundnut. Gangadharan *et al* (1985) reported that it can be successfully cultivated as intercrop in *Kharif* under dryland tracts and wheat is the most common *rabi* crop that follows groundnut in sequential system. They also projected the research needs and directions on groundnut based cropping system. In the present paper, an effort has been made to review the available information on groundnut intercropping as well as cropping system involving groundnut in India.

I. *Groundnut and intercropping:*

The guiding principle in intercropping, irrespective of crops and varieties, hitherto is distribution of risk arising out of aberrant weather and other factors beyond control. Of late, the concept of intercropping has witnessed a sea change, wherein

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production is prime and supreme. It makes use of the scientific approach to maximise a system's productivity.

Kharif groundnut is normally grown as an intercrop along with other crops. In India, groundnut is commonly intercropped with sorghum and pigeon pea. In general, sorghum depresses groundnut yield. A reduction up to 50% was reported by John *et al.* (1943). Despite the reduction in groundnut yield, overall yield advantage has been noticed. Two rows of sorghum and eight rows of groundnut gave higher total yield than raising either of the pure crops. Yield advantages as high as 53% (Tarhalkar and Rao, 1975) and 78% (Rao and Willey, 1980). have been reported. Studies conducted at Navasari (Gujarat) and Akola (Maharashtra) showed that grundnut formed a compatible intercrop with sorghum (Singh 1981). Pearlmillet + groundnut intercropping has been studied in detail at ICRISAT. One row each of pearlmillet and groundnut gave yield advantage of 26% over sole crop. In both the systems, yield of groundnut per plant was similar and the two systems were not different with respect to light interception, but the solar radiation was more efficiently converted dry matter due to intercropping. Maize also depresssed the groundnut yield in intercropping system but maize yield was not reduced (Azab, 1968). The work done at New Delhi by Singh *et al.* (1982) reported that maize yield increased by 4-5 q/ha in association with groundnut and net profit index (19-62%) was higher than pure maize as well as maize + soybean intercropping system. Groundnut can go well as an intercrop with finger millet and rice. Rao *et al.* (1982) reported that rice + groundnut gave yield of 38 and 12% respectively.

Among the legumes, pigeonpea + groundnut is the most prevalent in drylands. Since groundnut makes rapid canopy coverage of the ground and uses the resources more effectively, in semi-arid areas of India, groundnut is the major component with 5-6 rows to one row of pigeonpea. In such situations, almost full yield of groundnut and 30% of the pigeonpea was obtained (Appadurai and Selvaraj, 1974). Average yield advantage up to 67% was obtained at ICRISAT, Hyderabad in 5:1 groundnut + pigeonpea inter-cropping (Willey *et al.*, 1981). Trials conducted under All India Pulse Improvement Project (1974-80) at various locations indicated the success of groundnut pigeonpea intercropping system. The yield of intercropped groundnut was the highest (29.7 q/ha) at Ludhiana followed by that at Ranchi (16.5 q/ha), Hyderabad (12.8 q/ha) and Badnapur (10.5 q/ha). The trial conducted at Tindivanum revealed the profitability of intercropping of groundnut with black gram (Rajah *et al.*, 1978)

At Rajkot (Gujarat), a four year study revealed that groundnut intercropped with castor or pigeonpea have higher LER (Singh and Das, 1984). Among the oilseed crops, a variety of sunflower (Morden) opened up new vistas and made the intercropping system in Saurashtra region a profitable possibility. Large scale demonstration trials conducted on farmers' field's over years by the Research Programme of Vanaspati Manufacturers Association proved beyond doubt the economic viability ofthe system. Sindagi (1982) reported that combined yield of groundnut + sunflower over two years was higher by 18% over pure crop of groundnut. Trials conducted at Akola, Bangalore and Coimbatore (Table 1) showed yield advantage up to 36% with groundnut + sunflower (6:2) intercropping system (Ankineedu *et al.* 1983). Sesame

(B-67) established in June was alternated with two rows of groundnut, (AK-12.24) and the production per unit area increased appreciably (Maiti, 1984). Intercropping of niger with groundnut has also been found remunerative (Chatterjee, 1984). Castor, a long duration oilseed crop, being slow growing in initial stage provides both space and time for raising as an intercrop. Improvement in castor yield was reported when grown in association with groundnut (Reddy *et al.*, 1965; Tarhalkar and Rao, 1975). Two rows of groundnut with castor recorded the higher Land Equivalent Ratio (1.20) under alluvial soil conditions of Delhi (Al-Bakry and Gangasaran, 1985).

TABLE 1 Intercropping of groundnut with sunflower

System	Akola		Coimbatore		Bangalore	
	Y	R	Y	R	Y	R
Sole groundnut	7.4	3345	4.5	1808	17.5	4307
Sunflower	9.6	3708	14.3	464	8.3	2650
Groundnut + Sunflower (6:2)	5.4+4.3	4077	3.3+9.1	4267	10.2+3.5	3977
LER	0.72		0.72		0.58	
	0.45		0.64		0.43	
LER total	1.17		01.36		1.01	

Y = Yield (q/ha), R = Gross return (Rs./ha)

Source : Ankineedu *et.al.* (1983)

Raising 2-3 rows of groundnut in between cotton rows spaced 2m apart has been reported to give higher income than raising either of them alone (Joshi and Joshi, 1965). Groundnut+cotton intercropping was also profitable at Junagadh.

Groundnut has been successfully grown as an intercrop with tapioca (Table 2) Mandal *et al.* (1972) reported that at Trivandrum (Kerala) and Dandakaranya (Orissa) tapioca+groundnut system gave yield advantage of the order of 55% and 33% respectively at both the locations (Table 2). Trials conducted on farmer's field in Kerala showed that intercropping of groundnut with tapioca gave groundnut yield of about 12 q/ha in addition to full yield of tapioca (Potti and Thomas, 1978). Remunerative intercropping systems have been identified by the All India Coordinated Research Project on Oilseeds (Table 3).

Plant population and geometry in intercropping:

The yield advantage of the intercropping system depends on the plant population of the component crops and geometric arrangement in the intercropping system. Plant population indicates the number of plants/unit-area while-geometry considers proportion of area allotted to each component crop.

TABLE 2. **Yield and economics of intercropping in tapioca over 2 years**

Treatment	Yield (q/ha) Tapioca	Intercrop	% increase in income
	Trivandrum		
Tapioca	305	—	—
Tapioca + Cowpea	334	4.1	7.6
Tapioca + Coleus	285	34.3	+13.3
Tapioca + *Bhindi*	336	6.2	+19.7
Tapioca + Groundnut	275	22.5	+55.3
	Dandakaranaya (Orissa)		
Tapioca	190	—	—
Tapioca + Sunflower	154	14.9	+0.8
Tapioca + Blackgram	188	12.6	+32.1
Tapioca + Groundnut	204	6.5	+33.1
Tapioca + *ragi*	74	12.8	-44.2

Soutce: Mandal *et al.* (1972)

TABLE 3. **Remunerative intercropping systems**

Locations	Crops	Ratio	Monetary returns (Rs./ha)
Junagadh (Gujarat)	Groundnut + Castor	2:1	3181
Dharwar (Karnataka)	,, + Hybrid *jowar*	3:1	6947
Jalgaon (Maharashtra)	,, + Sunflower	4:2	1704
Aliyarnagar (TN)	,, + Pigeonpea	3:1	3411
Tindivanum (TN)	,, + Blackgram	3:1	1518

Source: AICORPO trials

Nikam *et al.* (1984) reported intercropping of sunflower with groundnut in different row ratios and observed that two skip rows + five rows of groundnut (1:5), one skip row+three rows of groundnut (1:3) and paired rows of sunflower+two rows of groundnut gave more or less the same returns. The LER was higher where three rows of groundnut were replaced by one row of sunflower.

Singh and Das (1984) reported that three rows of groundnut alternated with one row of castor/pigeon pea gave higher yield advantage than other systems viz. sole cropping or 6:1 combination.

Umrani *et al.* (1984) tested the sorghum groundnut intercropping in different planting patterns and found that planting patterns did not influence the yield of either component crops. (Table 4).

TABLE 4. Effect of planting geometry in sorghum + groundnut intercropping system.

Planting geometry	Yield of component crops (q/ha)	
	Sorghum	Groundnut
Solid (45 × 15cm)	27	4.4
Paired (30/60 cm)	25	4.2
Skipped (90 cm)	24	4.0

Source: Umrani *et al.* (1984)

Intercropping and fertiliser management:

Groundnut, being a legume fixes a considerable quantum of nitrogen and thus may reduce nitrogen application to succeeding crop or may help to reduce nitrogen requirement of associated cereal in a system. The work done at ICRISAT, Hyderabad indicated that there was no transfer of fixed nitrogen to maize, when it was intercropped with groundnut. The relative yield advantage of intercropping was 44% as compared to sole cropping of maize at no nitrogen level but this decreased as the level of nitrogen increased.

Intercropping and weed management:

At ICRISAT, Hyderabad, one row of pearlmillet alternated with three rows of groundnut provided not only the highest yield advantage but weed control as well. Reddy *et al.* (1985) reported that pendimethalin @ 1 kg. ai/ha controlled the weeds in groundnut intercropped with sunflower, sorghum and pigeonpea. Maximum monetery returns were obtained in groundnut + pigeonpea intercropping system with pendimethalin @ 1 kg. ai/ha as pre-emergence application next to weed free treatment.

II. Groundnut based crop sequences:

Generally, *Kharif* groundnut is sown year after year on the same piece of land under rainfed conditions and consequently yields are low. A decade's study (1945-46 to 1954-55) at Tindivanum showed that sorghum and *bajra* after groundnut gave consistently higher yield over their pure cropping. Subsequent trial conducted by Rajah *et al.* (1978) at Tindivanum revealed that the groundnut-black gram was the most profitable sequence. The increase in profit was more by 102% over the single crop of groundnut. Under rainfed conditions of Tirupati (Andhra Pradesh) Sankara Reddy *et al.*(1981) reported that sequence cropping of green-gram, cowpea, vegetable cluster bean after first crop of groundnut was successful. Higher monetary returns were obtained from greengram and cowpea. In northern states viz. Punjab, Haryana, Uttar Pradesh and also in central part of India (Gujarat, Madhya Pradesh and Maharashtra) wheat is the most comon crop that follows groundnut in *rabi* season. Studies indicate that wheat yields are increased by 3.4 q/ha if grown after groundnut (Table 5). Considerable economy in nitrogen use to wheat was realised when wheat was grown after groundnut over other legumes (Prasad and Bhardwaj, 1984). According to Giri and De, (1980) prec-ceding groundnut increased the yield of *bajra* in a monocropping system on dryland by 22.8% and yield advantage was equivalent to 60 kg. N/ha. Singh and Sahasra-budhe (1957) observed a beneficial effect of groundnut on cotton as compared to Sorghum and pigeonpea in the preceding season. Cotton yields increased by 21% due to receding groundnut than either owing to sorghum or pigeonpea. In recent years, due to frequent shortage of water supply in command areas, rice-groundnut sequence has gained paramount importance. Mandal *et al.* (1975) reported that rice-rice sequence required higher water than rice-groundnut sequence at Cuttack. Similarly, Sundararajan, and Subramaniam (1981) advocated the groundnut-rice sequential system over rice-rice sequence both from monetary returns and water requirement point of view in Periyar Vagai command aeas of Tamil Nadu and viewed that water so saved could be utilised for expanding area under command. In residual moisture conditions of coastal areas of Karnataka, Tamil Nadu, Andhra Pradesh and Orissa, rice-groundnut sequence was found to be more remunerative

TABLE 5. Grain and fodder yield from groundnutbased multiple cropping systems

Cropping system	Mean over two years	
	Grain (q/ha)	Fodder (q/ha)
Maze	29.7	62.5
Wheat	25.5	41.4
Groundnut	17.7*	45.9
System total	72.9	149.5
Groundnut	16.8*	11.8
Wheat	29.2	47.1
Maize	12.4	90.2
System total	58.4	149.1

* Dry groundnut pods

Source: Patil *et al.* (1979)

Cropping systems and fertiliser management:

In view of the efficient and economic fertilisers use system approach to fertilizer use is emphasised in recent years. Giri and De (1980) reported that the uptake of nitrogen by *bajra* was higher after groundnut than after mung, cowpea and pigeon pea. Seed yield of mustard after groundnut with 50 kg.'P_2O_5/ha as higher than that after *bajra* with 60 kg. N/ha pigeonpea with 30 kg. N+40 kg. P_2O_5/ha (Singh and Rao, 1983). According to Chatterjee (1984) mustard yield (13 q/ha) was more after groundnut than after rice (8.7 q/ha), maize (8.6 q/ha), Jute (10.2 q/ha) or black gram (11.8 q/ha). Umrani *et al.* (1984) reported that out of the recommended dose (120+60+60) of NPK fertiliser, only 50% was enough after groundnut to produce the same yield (26 q/ha) of sorghum. Pasricha (1984) reported that groundnut yield after phosphorus applied to groundnut, to wheat or both crops in groundnut wheat rotations was almost the same (Table 6). Groundnut can meet its phosphorus requirement from residual fertiliser.

TABLE 6. Effect of phosphorus applied in three phases on groundnut yield (q/ha) in groundnut-wheat rotations (Average of 5 yrs., 1976-80)

P given to	P_2O_5 Kg./ha			
	0	30	60	90
Groundnut	—	18.10 (22.9)	19.10 (23.80)	19.06 (22.90)
Wheat	—	18.42 (24.55)	19.17 (22.50)	18.42 (22.88)
Both crops	—	18.64 (22.70)	17.80 (22.02)	17.96 (22.96)
No Crop	16.61 (21.73)			

Figures in parenthesis are for groundnut sown on 20 July and the other on 6 July.

Source : Pasricha (1984).

Future line of work:

Groundnut occupies an important place both as an edible oil and as a legume, as such monocropping by and large is the dominant system. There is a need for critical analysis of monocropping systems in relation to edaphic, environmental, ecological and socio-economic situations with an ultimate object of determining efficient groundnut zones at micro level.

Although, inter/mixed cropping systems have been vogue since time immemorial, quantitative estimates on ameliorative impact on long and short term studies call for research attention.

Studies on plant geometry involving wide range of crops, adjustment in sowing time and efficient fertiliser use in intercrops need to be carried out on priority basis.

Groundnut as an intercrop in plantation crops, vegetables, banana, spices like pepper, ginger and turmeric needs research attention. Since most of the *rabi*/summer area is confined to rice fallows, special soil moisture management techniques need to be identified. Investigation on tillage requirement under paddy fallow system is a priority area of research.

Only meagre information on integrated fertiliser, water and weed management is available, Therefore, there is a need to initiate research work on these aspects involving sequential/inter cropping systems on priority basis. In the case of fertiliser management, emphasis should be on groundnut's quantitative nitrog n contribution to an associated or succeeding non-legume.

Both fundamental and applied studies on induction and acceleration of root nodules especially in sequential and intercropping systems is highly desirable.

The role of groundnut as a base crop in different cropping systems should be studied with a view to intercepting pests and disease. The manurial value of groundnut shell has hardly been paid any attention. Similarly, the possib lities of using haulms as a measure ro restore soil fertility need to be studied.

In order to popularise the *rabi*/summer groundnut cultivation in North Indian conditions there is a need to have groundnut varieties which can withstand low tempeatures and mature before hot summer (May). Varieties should find acceptability for *kharif* conditions without affecting timely sowing of proposed crops like wheat.

The practice of growing groundnut continuously over long period of time in relation to soil and crop productivity calls for investigation.

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AN ANALYSIS OF MECHANICAL OIL EXPELLER OPERATION

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ABSTRACT

About 90% of edible oilseed is crushed in oil expelling machines. The mecha-mechanical oil expellers crush the oilseeds, rupture oilcell walls, carry the crushed maerial to high pressure zone and separate oil from two phase solid liquid system under the dynamic compression process. These expellers work on the principle of pressure differential applied to the feed material versus that applied to the discharged end material i.e. cake. The experience of working with Rosedown Mini 40 Screw press (oil expeller) has been used for analying the process of oil expression in the present article. Also the state of art of available expellers has been briefly presented.

Key Words Expression, Compression ratio, Counter-current

INTRODUCTION

India produces about 12 million tonnes of oilseeds from about 16 million hectares of land annually (Anonymous, 1986) Oilseeds occupy the second largest place among the agrocultural commodities. They value about 24 thousand million rupees. Of 12 million tonnes, about 9.70 million tonnes are edible oilseeds About 3 million tonnes of edible oils are produced annually from edible oilseeds

These oilseeds are crushed in a variety of oil expelling machineries. About 90% of edible oilseeds are crushed in screw expellers (Singh and Bargale 1985). Understanding about these mechanical expellers is desirable prior to improving the existing designs to reduce the demand and supply gap of edible oils. In the present article, efforts have been made to dsicuss the principles, the design aspects and various other considerations relating the screw expellers.

PRINCIPLES OF MECHANICAL OIL EXPRESSION

The oil is stored at differenet places in the oilseed in the form of oil globules surrounded by tough membrane (Fig. 1). There are two steps involved in the expulsion of oil from oilseeds through the expellers - (a) disintegration and (b) the pressing. Under the disintegration process oil globules that form into oilseed are separated. The tough membrane surrounding the oil droplet is exposed and brusted under pressure enabling the oil to ooze out.

Expellers work on the principle of a pressure differential applied to incoming oilseeds versus that applied to the discharged material. It may be termed as compression ratio which is defined as ratio of the volume displaced per revolution of the shaft at feed section to the volume displaced per revolution of the shaft near end of the plug section. The radial pressure is generated due to volumetric compression along the screw barrel. Literature reveals that maximum radial pressure is generated at the feed

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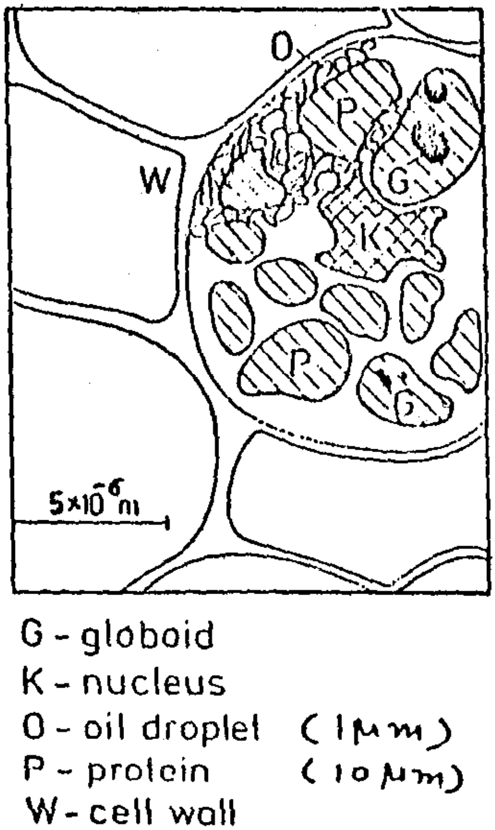
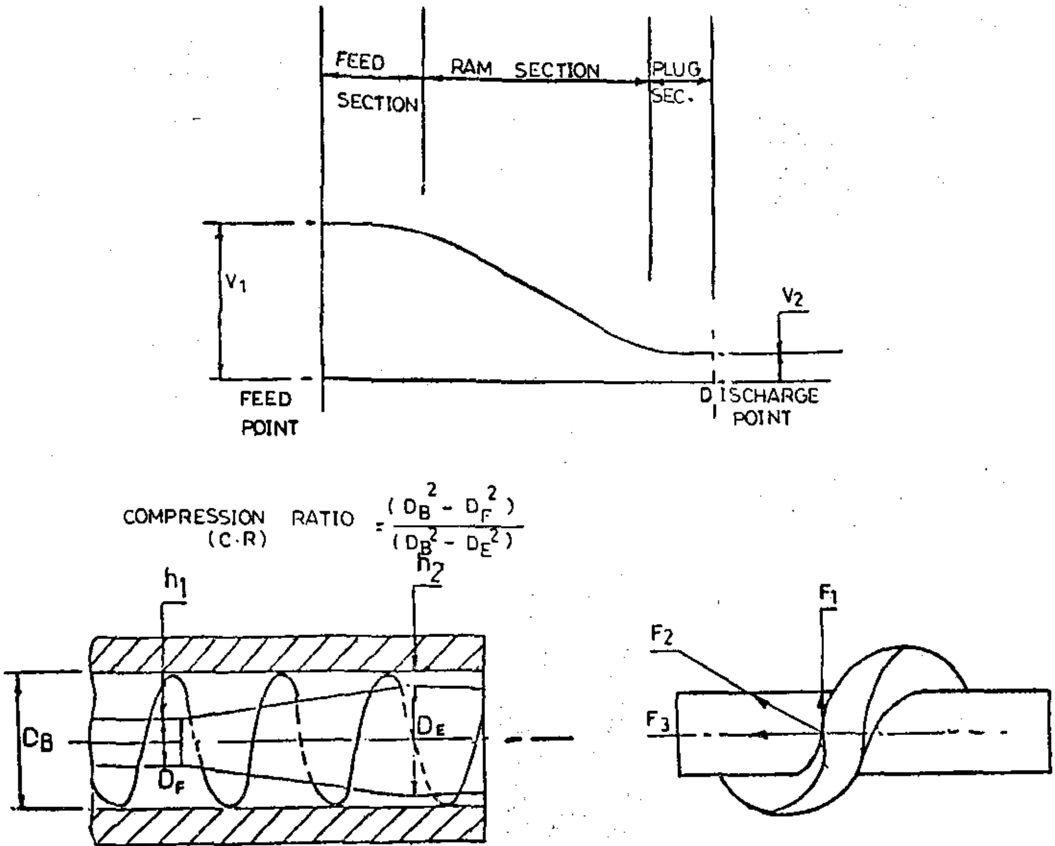


FIG. 1: MICRO - SECTION OF RAPESEED

end. It is also reported that axial pressure follows the similar trend of radial pressure. Under ideal conditions, flow of material along the worm shaft should be purely axial and compression ratio should be quite low. Singh and Agrawal (1986) reported that screw presses are mostly for high oil content having higher compression ratio of 10:1 while low oil content seeds require low compression ratio. Morever, prepatory operations of the oilseeds also play profound role in oil expression. It coagulates proteins inside the seeds causing coalescence of oil droplets and makes the seed permeable to the flow of oil. The pretreatments also decrease the affinity of oil for the solid surface of the seed so that better yield of oil is obtained on their subsequent pressing.

The Barrel

The barrel consists of a heavy craddle type into which flat steel bars are set edgewise around the periphery parallel to the worm shat. The cress section of the bars is slighlty trapezoidal hence placement needs adequate consideration such that free outflow of oil takes place during the process of milling. In the recent developments barrels are also made of cast iron rings spaced apart with spacers (washers). In order to obtain optimum oil drianage, barrel rings are assembled in the machine. facing in the same direction. The problem with these barrels is that with long use, the wear and tear in the rings and washer leads to choking as well as outflow of foots from slits. However, the barrel should be strong enough to with-stand very high pressure (about 100 kg/cm2) in all the directions



COMPONENTS OF FORCES IN EXPELLER BARREL

1 Feed Section
2 Ram Section
3 Plug Section

V_1 Feed Volume
V_2 Volume of Cake after Primary Compression

D_B Barrel Section
D_F Root DIA of Screw feed at feed section
D_E Root DIA of screw at start of plug section
h_1 Clearance between the Barrel and Screw root at feed end
h_2 Clearance between the Barrel and Screw root at start of plug section

F_1 Component of process Causing Rotation
F_2 Force Generated by worm
F_3 Component of Force Along Barrel

FIG. 2: SCHEMATIC CROSS SECTION OF SCREW AND BARREL

The Worm

The worm consists of a shaft and flight (Fig. 2). It revolves inside the barrel. In most of the cases, it could be seen that over the length of screw lead volume decreases towards the discharge end. The expeller worm length is considered of three sections (Ward, 1976) - (a) feed section (b) ram section and (c) plug section. Under feed section the seed is simply transported to the ram section under which as compression increases transport of the seed is maintained owing to the fact that friction of the material is greater on the cage than on the screw surface. It is probably due to slightly staggered cage bars or the oil outlets. This also prevents the material from rotating with the screw and generates the axial movent. The material now passes to the plug section wherein a column or plug of the compressed meal is formed along discharge end of the barrel. It is probably due to the fact that discharge end is provided with a pressure cone in most of the commercial expellers as a restriction.

The Choke

The basic function of the choke is to permit adjustment of pressure, capacity of the expeller and thickness of cake in order to secure the lowest possible content in the cake. If the cake thickness remains more due to improper adjustment, it causes loss of oil. It also helps reducing the choking problem. On the soft seeds discharge end has wide-spaced worm whereas a hard seed should have close spaced worm. This decides the compression desirability for the material being crushed. For hard seeds the existing designs, therefore, appear to be inadequate.

Movement of the Material during Expression Process

Ideally the material inside the barrel should move axially forward towards the discharge end and the expelled oil through the horizontal slots. But it has been experienced that some of the expelled oil flows counter current to the meal along the pressure gradient, (Singh et al, 1987). The movement of the material is explained as under:

(a) Drag flow (Qd): It takes place because the meal inside the barrel and worm adheres both to the barrel, and to the rotating screw. The drag flow is proportional to the speed of the screw

(b) Pressure Back (Qp): It arises because a pressure cone creates restriction at the discharge end of expeller which gives rise to the pressure gradient in the gap between screw and the barrel and also because the lead volume decreases towards the discharge end. Therefore,

Pressure backflow $= f(\Delta p, \mu m, c)$

Where,

Δp = Pressure gradient

\

μm = Viscosity of meal and oil mixture

c = Clearance between barrel and worm.

(c) Actual flow (Q): It is the resultant of drag flow and pressure back flow. In other words it is the net flow of meal in the axial direction inside the barrel of expeller.

$$Q = Qd - Qp$$

The application of pressure causes the fibrous capillaries (oil globules) to be reduced in volume and the oil to be expelled. The decrease in lead volume causes increase in pressure and density of the material. The volume at discharge end is reduced compared to the volume at the inlet.

i.e. $\vee$ output $\vee$ input

$\vee$ net = $\vee$ input - $\vee$ output

Input(Q) = *(Discharge through slits* + *(Discharge* ***through)*** *barrel end.*

= Output (Q)

= $Q_1 + Q_2$

= $K_1 = \wedge P_1/\mu_1 + K_2 = \frac{\wedge P_2}{\mu_2}$

Where K_1 = $Wh_3/12\ L_1$ } **Geometric constants**

K_2 = $\pi R4/8\ L_2$

Q = Discharge

$\wedge p_1$ = Pressure drop across cage slots

$\wedge p_2$ = Pressure drop across discharge end

L_1 = Length of dlscharge slot

L_2 = Length of discharge end

W = Width of slot

h = Height of slot

R = Radius at discharge end, $\mu 1,2$=Visnosity at respective outlets.

Therefore, Q $= \frac{Wh_3}{12 L_1} \frac{\wedge P_2}{\mu_1} + \frac{\pi R^4}{8 L_2} \frac{\wedge P_2}{\mu_2}$

This speaks of the fact that to maintain proper outflow at related discharge points the design of slots, length of barrel, pressure drop as well as the viscosity of the material play significant role. Earlier attempts were also made by Koo (1942) and Baskerville et al:(1947)to establish correlation between oil recovery from various oilseeds such as pressure, pressing time and viscosity. They reported that output is greatly influenced by the pressing time and also that of viscosity of oil but the constraints involved were not mentioned. From practical point of view, however it is worth mentioning that pressure gradient towards feed end is troublesome, because expelled oil would flow counter current to meal along this gradient resulting in higher oil content of crushed meal than that of raw material being fed into the expeller. Such problem was obserevd while working on Rosedown mini 40 screw press (oil expeller) with high oil bearing seeds like groundnut, rapeseed and linseed. But this problem did not appear with low content seed like soybean. In case of high oil content seeds this also created the problem of choking. In case of soybean also choking was observed due to lack of biting on the meal and forwarding it to the ram and plug sections. Therefore, design of feed section has to be in a manner where back pressure dissipates to overcome back flow and choking problems and oil is insured rapid out-flow through the drainage area. Also to reduce the tendency of the partially crushed material to rotate with the screw a low friction shaft need to be used in conjunction with higher friction bars.

When oilcake crosses the discharge end, it is released of the pressure and gains moisture immediately. The heat balance around the discharge end (assuming adiabatic process) is considered to be as

$$\dot{m}\ cp\ (T_1 - T_2) = \dot{m}\ (M_1 - M_2)\lambda$$

$$\text{or } M_2 = M_1 - c\rho\ (T_1 - T_2)\lambda$$

Where, $\dot{m}$ = mass rate of flow of material

$c\rho$ = Specific heat

λ = Latent heat of vaporization at ambient pressure.

M_1 = M.C. of material before it is out of discharge end at temperature T_1 of cake

M_2 = M.C. of material after it is thrown out of discharge end at temperature T_2 of cake

BRIEF DISCUSSION ON AVAILABLE MECHANICAL EXPELLERS

There are many types of screw expellers. In its simplest form some of the expellers consist of an interrupted helical thread and some continuous helical thread revolving concentrically within a stationary cylindrical barrel which usually has axially arranged slots through which expelled oil flows out. These slots are formed by a series of axially placed steel bars spaced apart by shims to provide narrow axial slots as mentioned earlier. These are so built that they stand a pressure of about 4.33 kg/mm^2. The opening between the bars are arranged from 0.141 cm to 0.013 cm depending upon the materials to be crushed. Except for some of the small capacity expellers, barrel is generally made in two halves held together by a clamping frame to aollw the expeller to be cleared in case of choking or overloading. The rotating scrw or worem assembly are of two kinds - (i) a series of hard faced worm sections spaced apart by hardened distance pieces or by separate pieces bored and keywayed to fit the wormshaft, (ii) in some cases it is manufactured in one piece only and subsequently handfaced. Either a screw of constant diameter operates in a slotted barrel which narrows down progressively towards the exit end for low pressure high capacity or the surrounding slotted barrel is cylindrical whilst diameter of the screw worm shaft increase towards exit end. Latter one is the most common. In both cases, the action of screw causes increasing pressure on meal as it passes through the expeller and maintains pressure gradient towards both the ends of the worm as mentioned earlier.

Classification of Mechanical Expellers:

Broadly, types of screw expellers depend on following factors:

i) Power applied per kg of material being crushed: As a general classification on oilseeds expellers which have upto 1.12 kw, 1.12-1.90 kw and above 1.9 kW per tonne of input material handled per day are low pressure, medium pressure and high pressure expellers respectively. The present upper limit of high pressure expellers is around 3.75 kW per tonne of input material handled per day.

ii) The type of barrel: Whether the expeller has constant diameter barrel or stepped diameter barrel.

iii) The form of expeller's feed end: Whether it has an auxialliary feeding means such as a high speed feedworm (vertical, inclined or horizontal) or twin inter meshing screws etc.

iv) The form of choke section: Whether it is of moving cone, moving sleeve, chuck or fixed type. It can increase load on the screw press but also the load on screw is controlled by the feed rate of the expeller.

v) The type and configuration of the connection between cooker and expeller, whether it is worm taped or free fall type or an open feed from a variable speed screw conveyor etc

Some information on oil expellers manufactured by a number of manufacturers in and outside India is presented in Table 1 and 2. Only a limited response from manufacturers was received. The list covers a wide range of expellers, and gives good general information on these expellers for advantage of the processors. Various features of these expellers when correlated revealed the fact that there are no standard

TABLE 1. List of various oil expellers manufactured outside India (Tindale 1976)

Sl. No.	Manufacturers	Model	KW	Capacity (kg/day)	Total Wt. (Kg.)
1.	Andersion, IBEC, U.S.A.	Red Lion	15	5,000	4,000
		Model 33	60	40,000	10,000
		Model 55	93.25	50,000	11,500
		11-66	—	—	—
2.	Dammon-Croes,	SP 50	104.4	65,000	18,500
	Belgium	PP 125	104.4	160,000	20,000
3.	Krupp Machine	LP	9.3	46,000	11,500
	Fabriken, West Germany	SVP	134.3	190,000	10,250
4.	Simon-Rosedown,	M.K. 2A	37.3	20,000	7,700
	England	M.K. 3A	56	33,000	8,400
		E type	149.2	80,000	13,400
		G type	179	190,000	13,100
		Mini-40	2.24	320	
5.	Speichim, France	301	29.84	22,000	7,000
		400	55.95	38,500	12,000
		500	93.25	143,000	17,500
		500 L	112	175,000	21,000
6.	Stork Amsterdam, Netherlands	R 400	29.84	45,000	4,250
7.	The French Oil	F 44	55.95	22,000	9,500
	Mill Mach. Co., USA	F 44 (2×11 in ext.)	93.25	42,000	11,000
		F 66	93.25	36,000	10,500
		F 77	93.25	42,000	12,000
		F 88	93.25	42,000	13,500
		D 66	149.20	42,000	13,000
		D 77	149.20	50,000	15,000
		D 88	149.20	65,000	17,000
		C 3300	223.80	110,000	21,000
		B 1500	74.6	100,000	15,000
		B 2100	149.2	170,000	18,000
		H2 6600	447.60	460,000	21,250

TABLE 2. List of some of the oil expellers manufactured in India.

Sl. No.	Manufacturers	Model	KW	Capacity (kg/day)	Total wt(kg)
1.	Ballaji Roll, Shut &	30 B	22.38	2,368	NA
	Engg. Works	40 B	37.3	3,334	—
	Hyderabad, India.	60 B	44.76	4,920	—
		70 B	59.70	6,304	—
		90 B	74.6	7,650	—
		120 B	112	9,040	—
2.	Manjit Engg. Co., Ghaziabad, India	Solar S.B.	5.22	480	1,000
		Solar D.G.	11.19	576	2,400
3.	S.P. Engg. Corp., Kanpur, India	Super T.O.E.	2.24	240	203
		Duplex T.O.E.	2.24	320	208
		Delux T.O.E.	3.73	400	230
		Super Delux T.O.E.	3.73	440	255
		Super B.O.E.	8.95	1,336	2,000
		No. 1 B.O.E.	7.46	6,664	1,488
		No. 2 B.O.E.	55.95	448	1.000
		4 B I.O.E.	3.73	320	440
		Young	14.92	1,500	2,500
		Standard	—	—	5,000
4.	Bharat Industrial Corp., Bombay	Bharat Super 'A'	44.76	20,000	—
		Bharat 'A'	37.30	10,000	—
		Bharat 'B'	22.38	5,000	—
		Bharat 'C'	14.92	2,500	—
5.	United Engg. Corpn. BRB Bose Road, Calcutta, India.	Tiger	7.46	1,050	2,000
		Exceoir	11.19	5,000	
6.	Guruteg Engg. Co., Millar *Ganj, Ludhiana, India*	Guruteg	22.38	9,000	4,400
7.	*United Oil Mill* Machinery & Spares Pvt. Ltd., New Delhi, India.	*Ashoka*	22.38	10,000	—
8.	Alfa Engg. Works,	Alfa Auto	11.19	7,000	3,600
	Bombay, India	Alfa Gient	22.38	12,000	3,800
		Alfa Super 20	55.95	22,000	—
		Alfa Baby No.1	5.97	4,000	2,000
		Alfa Baby	3.73		1,000

design patterns which are followed through. For instance, the capacity, kilowatt, worm size and weight of one expeller do not have similar proportionality with any of the other expellers

During the operation of mechanical oil expeller the major problems of oil back flow, choking and hence the reduction in the output occur mainly due to improper pressure gradient towards the feed end. The design of feed section, therefore needs improvement in order to create better suction and pushing forward the crushed material. Preferably for groundnut, rapeseed, linseed and other soft seeds, the discharge end or plug section worm should have wide spaced worm compared to hard seeds like soybean. The compression ratio for hard seed should be preferably less than 10:1. Analysis of data on available oil expellers indicated that there is no co-relation among the power input, capacity and the weight of the oil expeller,. Thus, it would be worth while to develop a standard design criteria and an improved expeller both for hard and soft oils seeds separately.

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"EFFECT OF INSECTICIDES AND A CHITIN INHIBITOR ON DEVELOPMENT OF THREE PARASITOIDS OF THE COCONUT BLACK HEADED CATERPILLAR OPISINA ARENOSELLA WALKER (LEP: XYLORYCTIDAE)"

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ABSTRACT

Paralysed host larvae of *Corcyra cephalonica* Staint (Lep: Pyralidae) wtih different developmental stages of two ecto parasitoids *Goniozus nephantidis* (Muesbeck) (Hym: Bethylidae)and *Bracon brevcoirnis* (Hym; Braconidae) and pupae parasitized by *Trichospilus pupivora* Ferr, (Hym: Eulophidae) were sprayed with 8 chemicals at field concentrations, under Potter s Tower. Compounds tested were endosulfan, fenvalcrate, permethrin, cypermethrin, carbaryl, chloropyriphos, monocrotophos and diflubenzuron (chitin inhibitor). On the basis of per cent emergence from treated host, endosulfan was found to be the safest to all the three parasitoids at all stages of development followed by fenvalerate. Monocrotophos and chlorpyriphos were highly toxic to all stages of the parasitoids. Egg stage was more sensitive and tolerance of the paraistoids to test chemicals increased with their age·

Key Words *Goniozus nephantidis, Bracon brevicornis, Trichospilus pupivora, Opisina arenosella* toxicity, insecticides, diflubenzuron.

INTRODUCTION

The need for more studies on the toxicity responses of predators and parasitoids to insecticides has been emphasized by Craft (1972) and Newson (1974). The mortality caused directly by contact of natural enemy with a toxicant has been documented in terms of the degree of parasitism which followed insecticide application in the field. Such data are helpful in evaluating the general effects of insecticides but it is impossible to distinguish between direct toxic effects and indirect effects caused by destruction of hosts, competitors or alternate food source of natural enemy population.

Coconut black headed caterpillar *Opisina arenosella* Walker has assumed major status in recent years in all the coconut growing areas in South India. Its management has been said to be feasible with an array of natural enemies (21 parasitoids and 7 Predators) supressing the pest at various developmental stages (Mohamed *et al.*, 1982). A large number of insecticides as dusts or sprays or through stem injection have been found to be effective in the control of the pest. (Nirula, 1951; Sathiamma and Kurien 1971; Nadarajan and Channabasavanna, 1981; Kapadia, 1982; Patil, 1984). However, the toxic effects of these chemicals to biocontrol agents and their developmental stages is overlooked.

Sundermurthy (1980) and Patil (1984) reported that sprays of diflubenzuron will reduce the emergence of *Goniozus nephantidis* (Muesbeck)), in field and laboratory,

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respectively. Bartlett (1965), Lingreen and Ridgway (1967), Lingappa *et al.* (1972) and Patil (1984) observed the tolerance of larval and pupal stages of various parasitoids to different insecticides. Emergence of *Trichogramma chilonis* Ishi was unaffected by spraying endosulfan, monocrotophes and phosalane on parasitized eggs of *Erias vitella* (Fabricius) (Santharam and Kumarswamy, (1985).

In th light of the importance of conserving natural enemies, while pesticides are being used for control of *O. arenosella*, basic studies on the hazards of chemicals to developmental stages of three potential parasitoids was under taken.

MATERIALS AND METHODS

The study was undertaken on two potential larval ectoparasitoids, *Goniozus nephantidis* and *Bracon brevicornis* Wesmael, and a pupul endoparasite' *Trichospilus pupivora* Ferr., of *O. arenosella*. The larval parasitoids were cultured on laboratory host, *Corcyra cephalonica* Staint (Lep; Gelleridae) larvae (final instar) and pupae were given to a pair of individual parasitoids separately for parasitization. The paralysed larvae of *C. cephalonica* with different developmental stages of parasitoids viz., 1,3,7,9 days old parasitoids in the case of *G. nephantidis* and 1,3,5 and 7 days in the case of *B. brevicornis* were transferred to excised coconut leafbits to simulate natural condition. The parasitized larvae were covered with webbing from galleries made by *O. arenosella* on coconut and sprayed with one ml of different insecticides under potter's tower at 6.81 kgs pressure per 6.25 cm^2. The test was conducted adopting completely randoinized design with 5 replications of 10 immature parasitoils in each replication. Seven insecticides and a chitin inhibitor at field concentration are listed in table 1. Per cent emergence of parasitoids was transferred to degree of an angle and analysed for varience.

For pupul parasite 1,5,10,15 days old parasitised pupae were treated as explained above. There were 5 replications., with approximately 100 immature parasitoids for each replication. Unlike in the larval ectoparasitoids, it is difficult to know the number of eggs laid in the pupae. However preliminary research indicated that the fecundity ranged from 40-60 with an average of 50 per pupa.

RESULTS AND DISCUSSION

The data presented in table 1 indicate that effectiveness of chemicals varied with developmental stages of *B. brevicornis* and innate toxicity of the compound. Endosulfan allowed significantly highest number of parasitoids to emerge followed by fenvalarate, diflubenzuron, permethrin, carbaryl and cypermethrin. However, when compared to water spray (untreated check), endosulfan did lower the parasite emergence by 7.5%. Both chlorpyriphos and monocrotophos caused near total mortality of parasitoids. Diflubenzuron, a chitin inhibitor, restricted the development in 74.16% of the population. Differances in parasitoid emergence were significant between chemicals and age of the parasitoids. Survival of parasitoids increased with increase in time gap between parasitization and insecticidal treatment. Thus, tolerance capacity of the developmental stage of the parasitoid to insecticidal action increased with increase in their age.

TABLE 1. Percent* emergence of adult *B. brevicornis* from the parasitized *O. arenosella* larvae treated with insecticides

Insecticides	Concentration (%)	Number of days from parasitism to spraying				Mean
		1 day	3 days	5 days	7 days	
Untreated check (water spray)	—	99.1	80.74	99.10	99.10	94.51
Endosulfan	0.035	99.1	68.85	66.14	80.74	78.71
Diflubenzuron	0.05	33.21	63.93	78.03	80.74	63.97
Fenvalerate	0.01	43.07	68.85	78.03	78.03	66.99
Carbaryl	0.02	21.44	43.07	63.93	73.10	50.31
Permethrin	0.01	28.77	66.14	68.85	87.21	62.74
Cypermethrin	0.01	00.99	12.62	15.33	43.07	18.00
Monocrotophos	0.02	0.99	0.99	0.99	15.33	4.57
Chlorpyriphos	0.04	0.99	0.99	0.99	12.62	3.89
	Mean	36.67	45.13	52.37	63.32	
		Duration	Insecticide		Insecticide × duration	
S.E.		1.93	2.9		5.80	
LSD (P = 0.05)		3.79	5.69		11.36	

*Percentages transformed into degrees of an angle.

The results given in table 2 reveal adverse effects of insecticides on survival of developmental stages of *G. nephantidis*. The toxicity of chemicals and susceptibility of developmental stages of parasitoids differed significantly. As noticed from parasitoid emergence, excepting for monocrotophos, all other chemical exerted higher toxicity to developmental stages of *G. nephantidis* than to *B. brevicornis*. As fenvalerate chlorpyriphos once again proved to be highly lethal to immature parasitoids. Endosulfan which was nealry non toxic to *B. breveiornis* was fairly toxic and was on par with permithrin. Diflubenzuron killed 67.50% of the parasitoids before reaching adult stage.

The parasitoid emergence was least when egg stage (one day after parasitization) was exposed to chemical treatment, and increased gradually with advance in stage of the parasitoid· When pupal stage (9 days after parasitization) was sprayed, slightly more than half of the population emerged in to adults suggesting increased tolerance of pupae to insecticidal action. At the egg stage, monocrotophos, chlorpyriphos, carbaryl and cypermethrin caused total mortality of parasitoids. while fenvalerate allowed significantly higher emergence followed by endosulfan, permethrin and diflubenzuron.

TABLE 2. Per cent* emergence of adult *G. nephantidis* from the parasitised *O. arenosella* larvae treated with insecticides

Insecticides	Concentration (%)	Number of days from parasitism to spraying				Mean
		1 day	3 days	6 days	9 days	
Untreated check (water spray)	—	99.10	99.10	89.92	99.10	96.80
Endosulfan	0.035	26.50	46.92	56.79	59.00	47.32
Fenvalerate	0.01	30.99	59.00	63.39	68.85	55.69
Permethrin	0.01	23.85	43.07	57.00	63.93	46.96
Diflubenzuron	0.05	15.33	26.56	30.99	59.00	32.97
Cypermethrin	0.01	00.99	00.99	39.23	45.00	21.55
Carbaryl	0.02	00.99	33.21	35.21	37.22	26.56
Monocrotophos	0.02	00.99	33.21	33.21	35.21	25.65
Chlorpyriphos	0.04	00.99	00.99	00.99	12.62	03.89
Mean		22.19	38.11	45.25	53.32	
		Duration	Insecticide		Duration × Insecticide	
S.E.		0.95	1.42		2.84	
LSD (P = 0.05)		1.86	2.78		5 57	

*Percentage transformed into degrees of an angle.

To the early instar grubs (3 days after parasitization), similar trend in the toxicity was noticed with higher percent adult emergence excepting carbaryl and monocrotophos where substantial increase in emergence was recorded over previous srage. A similar situation prevailed when mid-late larval stage (6 days after parasitization) and pupal cocoons were exposed to treatments with the exception of cypermethrin. The interaction between developmental stage and insecticide was also significant.

Observations on the safety of chemicals to pupal parasitoid *T. pupivora* indicate that all the chemicals were highly detirmental to the parasitoid development when sprayed a day after parasitization (table 3). None of the chemicals spared any parasitoid in contrast to 94.66% emegence in untreated check. However, on the fifth day after parasitization, a strikingly high per centage of emergence was recorded in all treatments except monocrotophos and chlorpyriphos. It was interesting to note that enhancement in the per cent emergence of parasitoids from 1 day to 5 days after parasitization was 55%, however further lapse of similar duration, did not result in increased emergence of parasitoid. On the basis of mean parasitoid emergence, endosulfan, permethrin and diflubenzuron significantly safer to the developing parasitoids fallowed by fenvalerate, cypermethrin and carbaryl. Monocrotophos and chlorpyriphos were highly toxic to the pupal parasite.

TABLE 3. *Per cent* emergence of adult T. pupivora* from parasitized pupae of *O. arenosella* treated with indsecticides

Treatments (insecticides)	Concentration (%)	Number of days from parasitism to spraying				Mean
		1 day	5 days	10 days	15 days	
Untreated check (Water spray)	—	77.08	77.08	72.47	84.17	77.70
Endosulfan	0.035	00.99	68.67	69.09	72.77	52.88
Carbaryl	0.02	00.99	60.34	56.26	60.00	44.40
Fenvalerate	0.01	00.99	63.99	66.15	64.98	49.03
Permethrin	0.01	00.99	68.62	66.16	70.97	51.68
Cypermethrin	0.01	00.99	59.84	62.59	63.96	46.85
Monocrotophos	0.02	00.99	00.99	00.99	29.77	08.18
Chlorpyriphos	0.04	00.99	00.99	00.99	00.99	00.99
Diflubenzuron	0.05	00.99	72.17	67.30	68.05	53.20
	Mean	09.44	52.55	51.33	57.29	

	Duration	Insecticide	Interaction
SE	0.96	1.45	2.90
LSD (P = 0.05)	1.90	2.85	5.70

*Percentages transformed into degrees of an angle.

From the foregoing results it is evident that two organophosphates, monocrotophos and chlorpyriphos were highly toxic and endosulfan was safest to the developing stages of all the three parasitoid species, while toxicity of others varied with the species.

Pesticides as they destroy the target species, do knock off the parasites. Conservation of natural enemies of pest species has been considered as a vital component in formulating the integrated control strategies. The consensus has been that such system would be fairly stable and lead to the reduction in the pesticide load in the environment. If selection of pesticides which are less toxic to adult parasitoids is considered as one approach, assessment of pesticide effect on the development of parasite should be regarded as an equally important one. Hence, study was aimed to ascertain the hazardous effects of pesticides to the immature stages of three parasitoids when sprayed at different developmental stages.

A number of workers (Bartlett, 1964; Lingreen and Reidgway, 1967; Lingappa *et al.*, 1972; Robertson, 1972; Wilkinson *et al.*, 1975; Babrikova, 1979 and Niemezyk *et al.*, 1981) have expressed that generally larval and pupal stages of perasitoids are more tolerant than adult stage. In the present study also., larval and pupal stages were found to be less susceptable than the egg stage. The increased susceptibility of egg stage, as observed in the study, has also been the findings of Lingappa *et al.* (1972) in *Lysiphlebus testaceipes* and Robertson (1972) in *Iloplectis behrensid.* Death of green bugs has been attributed as the cause for failure of *L. testaceipes* emergence when one day old parasitized green bugs were sprayed with insecticides. Apart from high intrensic toxicity of insecticides to parasitoid eggs, another possible explanation for low adult emergence when parasitoid eggs were treated could be death of host before parasitoids had completed larval development. The reduced susceptability of egg stage as generalised by Bartlett (1965), is contrary to the present findings. However, his observation of larval stages being less susceptable than later ones is in support of the present study.

Similarly higher toxicity of chlorpyriphos to *G. nephantidis* is supported by the findings of Fitzpatrick and Dowell (1981), who opined that high toxicity of this chemical is due to its low water solubility. Diflubenzuron, a chitin inhibitor, was also observed to be detrimental to the parasotoid development. Sundermutrhy (1980), recorded 57 to 83 per cent mortality of the parasitoid spray with diflubenzuron in field condition as against mortality ranging from 26.67 to 90 per cent noticed in he laboratory in the present study. The parasite emergence gradually incrased with advance in age at treatment confirming the decreased susceptability of larval and pupalstages. This may be due to the greater glycogen and fat resources in the later stages of development according to Hamilton and Kieckhefer (1969). This postulate is similar to that of Hoffman and Grosch (1971) who proposed a detoxificative function for the fat body of *Habrabracon jungalandis.*

Total failure of parasitoid *T. pupivora* emergence from host pupae in all the treatments sprayed at one day after parasitization was noticed. Similarly no emergence of internal parasite of *Scheizaphis graminum* (Rondani), was noticed when sprayed a day after parasitization with disulfoton and parathion by Lingappa *et al.* (1972). Grosch and Hoffman(1973)reported a marked increase in the death of embreoys in eggs deposited in the paralysed larvae of *Ephistia kuhniella* Zell, fallowing the spray with three derivatives of carbamate insecticides. High mortality of *T. pupivora* at this stage may be due to the death of host pupae before parasitioid completed larval development as has been contemplated by Lingappa *et al.* (1972) or increased susceptability of parasitoid in the early stages. Conversely siginificant increase in parasitoid emergence on the fifth day after parasitization suggest that the parasitoids do complete their development even after the death of host or the stages were tolerant to the action of insecticides. The O.P. compounds were highly toxic to immature stages up to first 15 days. Possibly owing to their penctration through pupal cuticle and increased susceptibility of early stages of parasitoids in contrast to other insecticides. Finally from the available facts it may be concluded that endosulfon diflubenzuron and permethrin could be selected as suitable chemicals to integrate chemical and biological control methods in the management of black headed caterpillar.

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"SELF RELIANCE IN VEGETABLE OILS — A MYTH OR REALITY"

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Next to food grains oilseeds are the largest of crops for a sizeable portion of the total cultivated are a (=21 m.ha/130 m.ha).Despite their envious position in the National Agricultural Economy (=10.5% of the value of gross national output) and the multiplicity of crops and *crop growing situations,* the country's indigenous output of oilseeds has been lagging far behind our actual *requirements:* Never *in* the past, the aggrgate output of oilseeds has crossed the level of 12 to 13 m. tonnes even under the most favourable seasonal conditions. As a result of this widening demand-supply gap wnich soared close to 18 to 19 lakh tonnes by 1987-88 the country has been until recently resorting to huge imports: worth Rs. 1100 to 1320 crores foreign exchange equivalent which is a serious drain on the latters *already precarious* foreign exchange reserves.

Interestingly, China with about 85% of India's acreage under oilseeds produces annually over 24 *m.tons which is in* fact, nearly twice our highest ever recorded output in the pre-mission era (*Table*-1).

The above continued paradoxical situation on the indigenous oilseeds front has only strengthen further the belief of those who have been advocating imports as the only ultimate nanacea to keep pace with the growing demands for vegetable oils.

According to the available estimates the country requires 26 m. tonnes of oilseeds equivalent to 71 lakh tonnes of vegetable oils by the turn of this century. This would mean that the country has to nearly double the existing production within the next 10 years or so. Considering the past dismal record of the counttry on vegetable oilseeds front there is no surprise that several people harbour serious reservations and doubts on the technological potentials and capabilities of the farmers to achieve such a tall order that too wihtin a short span of 10 years. Infact, many a eyebrows were raised at the ultimate task the mission has set for itself to phase out imports of vegetable oils totally by 2000 AD through a Process of self-reliance and the target of 16.5 m. tonnes laid down for the terminal year of VII Plan considered too aimbitious to achieve.

Notwithstanding the extensive and massive research network the country has through the chain of 77 research centres under its fold besides, the Directorate of Oilseeds Research and the two National Resesrach centres one for groundnut and the other for soybean and the whole range of high yielding varieties and hybrids of specific/multi regional importance (total released todate since 70's = 233; hybrids released identified in 80's alone=162), production and protection technologies and the multi-

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TABLE 1. Oilseeds Scenario in India and China - A comparison

CROP	INDIA			CHINA			WORLD		
	Area Lakh ha	Prod. Lakh Tons	Yield Kg/ha	Area Lakh ha	Prod. Lakh Tons	Yield Kg/ha	Area Lakh ha	Prod. Lakh Tons	Yield Kg/ha
Soybean	16.55	15.01	910	81.11	109.18	1346	546.5	423.3	1690
Groundnut	84.30	95.44	1132	33.16	58.55	1766	195.4	227.5	1165
Castor	6.35	4.17	656	2.70	3.10	1148	13.6	8.9	654
Sunflower	10.52	3.97	377	9.30	11.50	1237	154.6	209.5	1355
Rapeseed	48.65	44.12	907	47.00	50 40	1072	170.3	217.6	1277
Sesame	21.50	5.00	233	10.01	5.31	530	66.9	22.5	336
Linseed	11.82	3.49	296	1.42	1.37	965	43.4	20.0	462
Safflower	7.82	4.29	549	—	—	—	15.6	3.7	560
Cotton Seed	75.00	29.70	396	55.00	84.00	1527	340.6	354.3	1040
Niger	6.07	1.73	285	—	—	—	—	—	—
All nine annual oilseeds	207.51	177.20	—	184.69	239.41	—	1206.3	1638.0	—
All nine annual oilseeds including cotton	282.51	206.92	—	239.69	323.41	—	1546.9	1992.3	1288

Source: India: Final Estimates of 1988-89, Dirc. of Econ & Statistics, New Delhi

China: FAO Production Year Book, data for 1988 plicity of remunerative and fesabile cropping systems involving oilseeds as sole, seqential, relay and Inter cropping with other crops developed so far the oilseeds researchers in the country have done precious little to either demonstrate the superior production potentials, implementability and viability of the specific technologies they have so far been advocating vis-a-vis farmers traditional practices under real farm situations and/ or convince the developmental personnel, administrations, policy makers of the veracity of their claims and dispel misgivings in the minds of developmental personnel, administrators policy makers on the new technologies and their potentials and relevance. Prior to 1987 the country's oilseeds research workers had little or no opportunity to obtain feed back so essential from the ultimate end user namely the farmers on the new technologies advocated for different crops and crop growing situations, their specific merits and demerits, location specific corrections if any needed to improve their relevance and applicability. No wonder, they lacked the required confidence so essential to backup their own recommendations which are drawn based on micro plot experiments. The result, is bulk of the improved technologies generated by the country's oilseed research network over the last two decades or so largely remained confined to the four walls of the research laboratories.

The introduction of a special cess fund supported programme in 1988 for the frontline demonstrations in oilseeds greatly removed this bottleneck and provided an unique opportunity to oilseed workers in the country to test the performance of their latest varieties, production and protection technologies vis-a-vis prevailing farmers practices in different regions. During the last two years alone the oilseeds project in collaboration with State Agricultural Universities and the transfer of technology programmes of ICAR has successfully carried out thousands of demonstrations in the nine oilseed crops covering diverse crop-growing seasons and situations. The wealth of valuable data generated under the project since 1988-89 crop season dispels all reservations and misconception about the technological potentials the country has to stage breakthroughs in oilseeds output in the immediate fututre.

As compared to the corresponding prevailing state average yields in different oilseeds crops, plots that received full recommended package of improved technologies on an average, registered extra yields to the tune of 49 to 211% in groundnut, 42 to 211% in repeseed-mustard, 69 to 414% in soybean, 95 to 192% in safflower and 20 to 290% in sesame, 80-345% in castor and 108-150% in linseed even under purely rainfed conditions. Wherever, farmers could apply one or two limited irrigations at sensitive/crucial stages of crop growth during periods of moisture stress, the general yield level from demonstration plots touched as much as 1645-3500 kg/ha in rapeseed-mustard (Mean: 1737 kg/ha), 2140 kg/ha in safflower (Mean: 1362 kg/ha), 563-2100 kg/ha in inseed (Mean: 903 kg/ha) and 630-900 kg (Mean: 554 kg/ha) in rabi/summer sesame. Under conditions of full irrigation, castor, kharif and rabi/summer groundnut registered highest yields to the tune of 3000 to 5010 kg/ha (Mean: 2488 kg/ha) 1825 to 3250 kg/ha (Mean: 1848 kg/ha) and 1900 to 3750 kg/ha (Mean: 2170 kg/ha) respectively. Interestingly, the highest per hectare yields recorded from improved plots were 1.5 to 8 times more than the corresponding State/district average yields realised presently in different crops.

Undoubtedly, even with the technologies that are currently available in different crops there exist a wide untapped yield reservoir. Without exception in all crops, the yield gap between the improved plots and the corresponding state/district average is much wider if one considers the highest yields recorded from demonstration plots.

Contrary to the widespread belief the suggested improved technologies for oil seed crops are not only high yielding but require only marginal additional investments over and above what the farmers otherwise incur on their own traditional practices. (Table-2)

TABLE 2. Economics of improved Technologies in various annual oilseeds under real farm situations*

Crop	Additional investment (Rs/ha) on improved technology over farmers practice		Incremental benefit cost ratio	
	Rainfed	Irrigated	Rainfed	Irrigated
Groundnut Kharif	420–2080 (1237)	58–2083 (1362)	2.46	9.72
Rabi/summer	—	668–1998 (911)	—	4.15
Sesame Kharif	225–1048 (612)	—	4.15	—
Rabi/summer	—	561–1075 (733)	—	2.87
Soybean	512–1815 (973)	—	4.67	—
Castor	276–966 (824)	403–1561 (726)	2.66	3.14
Niger	399–803 (588)	—	2.15	—
Sunflower	—	300–2400 (1152)	—	3.82
Rapeseed-Mustard	215–1523 (1010)	132–1092 (555)	3.18	5.94
Linseed	455–1063 (570)	606–2200 (1251)	2.77	2.61
Safflower	396–1344 (852)	177–685 (459)	2.69	8.21

* Figures in parenthesis refer to corresponding mean

When compared to the extra amount they spent towards cash inputs such as fertilizer, plant protection, farmers reaped on an average, extra monetary returns to the extent of 2.5 to 9.7 in groundnut; 3.2 to 5.9 in Rapeseed-mustard, 2.7 to 8.2 in safflower and 2 to 5 in others. The above results should no doubt, help allay all fears and mis. givings about the improved technologies that they are input intensive and less attractive

TABLE 3. Additional output of nine annual oilseeds anticipated through improvements in per hectare yields *per se*

Crop	Existing* National Avergae Kg/ha	Mean Realizable yield with improved Technology Kg/ha	Realizable yield gap Kg/ha	Current area in lakh ha	Current production in lakh tonnes	*Additional Prouoction possible at*** 100% of realizable yield gap with IT Lakh T	75% Lakh T	50% Lakh T	25% Lakh T
Rabi/summer groundnut	1467	2172	705	14.07	20.35	9.92	7.44	4.96	2.48
Kharif groundnut	870	1276	406	72.48	59.81	29.43	22.07	14.71	7.36
Rapeseed-Mustard	844	1326	482	49.40	43.41	23.81	17.86	11.91	5.95
Safflower	488	781	293	8.60	4.10	2.52	1.89	1.26	0.63
Castor (irri.)	1266	2488	1222	2.93	3.70	3.58	2.68	1.79	0.90
Castor (rainfed)	295	1213	918	4.36	1.24	4.00	3.00	2.00	1.00
Castor Total	—	—	—	7.29	4.94	7.58	5.68	3.79	1.90
Sesame	272	614	342	24.23	5.55	8.29	6.21	4.14	2.07
Linseed	310	582	272	12.03	3.52	3.27	2.45	1.64	0.82
Niger	281	409	128	6.15	1.71	0.79	0.59	0.39	0.20
Soybean	774	1850	1076	22.11	18.42	23.79	17.84	11.89	5.95
Sunflower (R/s)	464	1551	1087	6.15	3.88	6.68	5.01	3.34	1.67
Sunflower (kharif)	425	800	375	5.40	2.78	2.03	1.52	1.01	0.51
Total:				227.9	168.47	118.11	94.24	62.83	29.54

* based on data from 1987-90

** at 100%, 75%, 50% and 25% realisation of the available exploitable yield gap under real farmers situations

Even if one considers for the purpose of computation only 50% and 75% of the mean unrealised yield reservior otherwise available for different crops and regions/states in relation to the corresponding state/district averages the country should be able to add another 63 to 94 lakh tonnes to the oilseeds basket from out of existing 21 m and odd hactare alone just through improvements in per hactare yields *per se* by resorting to all suggested improved technologies (Table-3)

The potentials would in fact, be much higher than the above estimates which are conservative if one takes into consideration the maximum unrealised yield gap at the current level of technology. Added to this, there is a whole range of other viable and feasible technological opportunities open for bringing up more and more areas under oilseeds cultivation and thereby augment their aggregate output: these interalia include (1) positive crop shifts to more efficient and remunerative oilseed crop as for e.g. sunflower in place of low yielding millets; safflower in place of *herbaceum* cottons, coriander, chickpea in vertisols; *rabi*/summer groundnut in place of paddy; soybean in place of other millets and rape-seed-mustard in place of wheat etc., (2) introduction of oilseeds as inter-crops with various other conventional crops by successfully capitalising on various synergistic crop combinations to enhance aggregate returns from traditional farmers' systems in drylands as for instance safflower with gram, coriander, linseed, wheat in rainfed vertisols, as for instance sunflower with groundnut; castor with sesame and niger; mustard with wheat and potato (irrigated); soybean with maize and sorghum and a host other plantation crops etc., (3) popularisation of oilseeds as sequence/relay/catch crops before and/or after main crops (cereals, oilseds, legumes etc.) under irrigation as well as in drylands with assured rainfall and/or moisture and thereby double/triple the existing cropping intensity (4) Extension of oilseeds to irrigated areas in place of more water intensive crops such as rice, wheat to harness the superior potentials of oilseeds particulalrly under limited irrigations and thereby step up returns per unit area and water applied viz., rapeseed-mustard in place of wheat in the Indo-gangetic plains, safflower in place of wheat in the vertisols of Deccan, groundnut in place of paddy in southren parts and in Chattisgarh region of Madhya Pradesh.

Judging from the counrty's rich natural endowments for year round culture, multitude of crops comprising 9 annual oilseeds, host of non-conventional oil bearing species of plant origin such as rice (potential=7 lakh tonnes), cotton (pottential=4-6 lakh tonnes) and various other minor oilseeds of tree and forest origin (potential = 11 lakh tonnes) and the whole panorama of opportunities the available technologies offer, self-reliance in vegetable oils is no longer a myth or mirage. There is, therefore, no cause for either dispair or dillusionment on the vegetable oilseeds front. Given the current tempo of development, determination, mission mode approach, integrated policies and measures and above all the pricing climate which is exceptionally favourable for oilseeds, the country is no doubt, destined to emerge as one of the leading producers of vegetable oils in the coming few years. The remarkable manner in which the country could manage to maintain oilseeds output at 12 to 13m. tonnes even in one of the worst drought years in 1987-88 and push up the aggregate output close to 18 m. tonnes in 1988-89 over the previous record of 13m. tonnes rules out any such lingering doubts in the latter's potentials and capabilities to accomplish the ultimate goal of self-reliance. Simple practices which require little or no cash investments such as choice of appropriate crops and varieties, cropping systems, use of quality seed treated with chemical protectants to minimise stand losses from seed borne diseases, timely seeding, adoption of recommended seeding rates and devices, scientific crop rotation, maintenance of weed free conditions during the first 25-30 days of crop growth in conjuction with application of recommended fertilizers including correction of micronutrient deficieneies wherever noticed, need based plant protection against major insect pests and diseases play a crucial role in the realisation of the full potentials of the suggested new technologies. Major thrust should, therefore, be on the dissemination and spread of all such viable and implementable techniologies rather than look for some wonder varieties or miracle technologies which are not available right now.

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Short Communication

COMBINING ABILITY FOR-YIELD AND ITS ATTRIBUTES IN SUNFLOWER

The present study was undertaken to assess the utility of inbred lines as parents in the heterosis breeding in sunflower by adopting Line × Tester analysis.

Four male sterile lines (CMS-234, CMS-290, CMS-302 and CMS-308) were crossed with six testers in all possible combinations. The resultant 24 hybrids along with ten parents were planted in randomised block design with four replications during rainy season of 1984. Each genotype was sown in a single row of 5 metre length with spacing of 60×30 cm, Observations were recorded on nine quantitative characters from five competitive plants selected randomly. Oil content was estimated using NMR-Spectrometer (Model 20 Pi). The mean values of each genotype were subjected to combining ability analysis (Kempthorne, 1957). Average hecterosis was calculated as difference between F1 mean and parental mean expressed in percentage.

Analysis of variance indicated wide genetic variability in the selected inbred lines for all the characters studied (Table 1). The magnitude of SCA in relation to GCA variance was higher in respect of all the characters except LAI and 100-seed weight showing thereby that only LAI and seed weight were governed by additive gene action while seed yield, days to flowering, plant height, number of leaves per plant, head diameter, harvest index and oil content were predominantly under the control of non-additive gene action. The results obtained are at variance with the earlier report of Putt (1966). He reported additive gene action for days to flowering, seed yield and oil content. Non-additive gene action for flowering, head diameter and seed yield obtained in the present study are in agreement with the earlier reports of Setty and Singh (1977 and Kadkol *et al.* (1984). As in the present study Sudhakar *et al.* (1984) also reported non-additive gene action for 100-seed weight.

The general combining ability (gca) effects of inbreds presented in Table 2 showed that amongst lines, CMS-234 was the most desirable female parent in heterosis breeding as it recorded significant and positive gca effects for majority of characters (viz., seed yield, oil content, 100-seed weight, number of leaves and LAI). Incidently, it is the female parent of the presently cultivated BSH-1 sunflower hybrid. Amongst testers, considering the overall values of gca effects, PR-1 and RHA-801 appear to be desirable parents for seed yield and component characters. Although none of the lines and testers recorded significant positive gca effect for oil content, CMS-302, CMS-234, RHA-801 and PR-7 may be used as parents for improving oil conetnt in hybrid cultivars.

The results of sca effects of 24 crosses revealed that CMS-308×RHA-801 and CMS-234×PR-1 were the top ranking crosses for seed yield (Rudranaik, 1984). These

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TABLE 1. Analysis of variance and combining ability analysis for seed yield and component characters in sunflower

Source	df	Days to flowering	Plant height	No. of leaves per plant	Leaf area index	Head diameter	Seed yield per plant	Harvest index	100-seed weight	Oil content
Lines	3	133.93**	2160.33**	138.50**	2.04**	3.10**	765.13**	114.52**	0.76**	57.48**
Testes	5	103.42**	3333.12**	8.49**	0.54**	15.69**	81.21**	111.61**	1.33**	11.81**
Line × Testers	15	20.13**	882.64**	12.58**	0.53**	14.68**	70.52**	59.76**	0.62**	8.49
Error	99	5.12	271.76	2.55	0.07	1.15	5.41	12.26	0.08	5.04
GCA	9	0.62	13.23	0.29	3.78	0.02	1.82	0.35	3.30	0.14
SCA	23	19.35	445.76	12.27	0.24	2.52	71.79	20.29	0.20	5.04
GCA/SCA	—	0.03	0.03	0.02	15.75	0.01	0.02	0.02	16.50	0.03

** Significant

TABLE 2. General combining ability effects for female and male parets

Parents	Days to 50% flowering	Plant height	No. of leaves/ plant	Leaf area index	Head diameter	Yield for plant	Harvest index	100 seed weight	Oil content
Lines									
CMS. 234	-1.22*	13.61**	3.55**	0.34**	0.01	8.05**	2.60**	0.22**	0.89
CMS. 290	-2.05**	-9.06*	-1.60*	0.14*	0.42	-0.23	99	00.06	-0.64
CMS. 302	-0.05	-4.28	-1.45**	-0.27**	0.02	-4.15**	-2.07**	-0.14*	1.60*
CMS. 308	3.32**	0.35	-0.48	-0.22**	0.46	-3.67**	-1.52**	-0.15*	-1.85**
CD at 5%	0.95	6.94	0.67	0.11	0.45	0.98	1.48	0.12	0.50
CD at 1%	1.29	9.39	0.91	0.15	0.61	1.33	1.99	0.16	1.26
Testers									
PR-1	1.34*	13.18**	0.13	0.11	0.90**	3.09**	0.97	0.09	-1.42*
PR-3	-0.41	0.96	0.45	0.05	-0.77**	-3.15**	-2.75**	-0.17*	-0.62
PR-6	0.28	-8.73*	0.31	-0.22**	-0.52	-1.70**	1.55	-0.43**	0.42
PR-7	3.91**	21.00**	-1.47**	0.22**	1.43**	1.74**	-3.92**	0.44**	0.44
RHA. 274	-1.59**	-13.83**	0.26	-0.24**	0.06	-0.15	2.18*	-0.01	0.26
RHA. 801	-3.53**	-12.60**	0.32	0.08	-1.10**	0.17	1.96*	0.08	0.93
CD at 5%	1.17	8.51	0.82	0.13	0.56	1.20	1.81	0.15	1.16
CD at 1%	1.58	11.53	1.11	0.18	0.75	1.62	2.44	0.19	1.57

* Significant at 5% ** Significant at 1%

two crosses also had the highest sca effects for component characters like number of leaves LAI and 100-seed weight. Besides, CMS-234×PR-1 and CMS-308×RHA-801 recorded relatively higher magnitude of sca effect for oil content. These two crosses showing high sca effects for seed yield, component characters and oil content involve parents with high×low and high × high combining parents in their cross combinations. It further substantiated the operation of non-additive gene action for seed yield and oil content.

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A NOTE ON INHERITANCE OF SEED COLOUR, SIZE AND SEED SHAPE IN INDIAN MUSTARD

In new germplasm collections of Indian mustard (*Brassica juncea* L. Czern & Coss) there is considerable variability for seed colour, seed size and seed shape. Bold seed and yellow coat colour are desirable attributes from agronomic point of view as a cultivar possessing such atributes fetches more premium in the market. Variation for seed shape is a new character whose importance is yet to be established. In the present study efforts were made to analyse inheritance of these seed characteristics. The information could be useful in evolving the high yielding genotypes possessing such important seed attributes.

The inheritance of seed coat colour and seed size was worked out in F_2 and back cross generations of the cross Varuna × EC-126743 Prakash × EC-126743 was studied for the inheritance of colour size and seed shape. EC-126743 is a new intro duction from U.S.S.R. which possessess yellow, elipitical and small seed characteristics. Varuna is bold and brown seeded cultivar whereas Prakash has medium sized brown colour seeds. There were marked differences among the parents for these attributes. The crosses in their F_2 and back cross generations were grown in large plots during the year, 1983-84 at Haryana Agricultureal University, Hisar. At harvest, individual plant observations were recorded for seed colour, seed size and seed shape. Seed colour and seed shape were visually observed whereas seed size was expressed as small, medium and bold based on 1000-seed weight.

The seeds were categories into visibly distinct classes of dark brown, brown, brownish, yellowish brown and yellow seed colour; bold medium and small seed size and round and eliptical seed shape.

The data in different categorised were analysed by X^2 analysis. The results presented in Table 1 foı seed colour in F2 indicated perfect fit into the ration of 1:4: 6:4:1. This indicated that the seed colour was under the control of two genes with incomplete dominance. The test cross ratio of 1:2:1 further confirmed its inheritance as digenic with incomplete dominance. It indicated the simple inheritance of this charcter for incorporation into high yielding background of brown seed colour cultivars. Yellow seed colour may also be desirable because of its low fibre and high oil content.

Inheritance of seed size was analyzed in the crosses Varuna × EC-126743. The results for F2 and test cross generations presented in Table 2 indicated that there was good fit of the ratio 1:2:1 in F2 which envisaged that there is monogenic inheritance with incomplete dominance. The test cross ratio of 1:1 also supplemented the F2 observations. Bold seed is a desirable character, As evident from its inheritance, it may be possible to introgress the bold seed size into the agronomically superior genotypes by back cross method.

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TABLE 1. Calculation of X^2 for classification for seed colour in F_2 and test cross Populations of Indian Mustard cross Varuna × EC-126743

A. For F_2

Genotype	Frequency		O.E.	(O-E)2 / E
	Observed (O)	Expected (E)		
Dark brown	27	21.25	5.750	1.556
Brown	83	85.00	-2.000	0.047
Brownisn	140	127.5	12.50	1.225
Yellowish	73	85.00	-12.00	1.694
Yellow	17	21.25	-4.250	0.850
Total	340	340	X2 = 5.372	N.S.

Table value: X^2 at 5% = 2.490
(4 d.f.)

B. For Test Cross

Phenotype	Frequency		O.E.	$(O-E^2)$ / E
	Observed (O)	Expected (E)		
Dark brown	34	31	3	0.290
Brownish	62	62	0	0.000
Yellow	28	31	-3	0.290
Total	124	124		0.580 N.S.

Table value: X^2 at 5% = 5.990
(2 d.f.) i

TABLE 2. Calculation of X^2 for classification for seed size in F_2 and test cross populations in cross Varuna × EC 126743 of Indian Mustard,

A. For F_2

Phenotype	Frequency		O-E	(O-E)2 / E
	Observed	Expected		
Small	94	85	9	0.9529
Intermediate	149	170	-21	2.594
Bold	97	85	12	1 694
Total	340	340	X^2 = 5.241	N.S.

Table value: X^2 at 5% = 5.99
2 d.F.

B. **For Test cross**

Phenotype	Frequency		O-E	$\frac{(O-E)^2}{E}$
	Observed	Expected		
Intermediate	48	45	3	0.200
Small	42	45	–3	0.200
Total	90	90	$X^2 = 0.400$ N.S.	

Table value: X^2 at 5% = 3.841

1 d.f.

TABLE 3(a) : Calculation of X^2 for classification for *seed shape* in F_2 and test cross population in cross population in cross Varuna EC 126743 of Indian Mustard.

A. **For F_2**

Phenotype	Frequency		O-E	$\frac{(O-E)^2}{E}$
	Observed	Expected		
Round	256	255	1	.0040
Eliptical	84	84	–1	.0040
Total	340		$X^2 = .0080$ N.S.	

Table value: X^2 at 5% = 3.841

1 d.f.

B. **For Test cross**

Phenotype	Frequency		O.E.	$\frac{(O-E)^2}{E}$
	Observed	Expected		
Round	58	56	2	0.0710
Eliptical	54	56	–2	0.0710
Total	112	112	X^2 =	0.1420 N.S.

Table value- X^2 at 5% = 3.841

1 d.f.

TABLE : 3(b) Calculation of X^2 for classification for *seed shape* in F_2 and test cross population in cross Prakash × EC 126743 of Indian Mustard.

A. For F2

Phenotype	Frequency		O-E	(O-E)2 / E
	Observed	Expected		
Round	292	306	-14	0.6405
Eliptical	116	102	14	0.6405
Total	408	408		X^2 = 1.281 N.S

Table value: X^2 at 5% = 3.841

1 d.f.

B. For Test cross

Phenotype	Frequency		O-E	$(O-E)^2$ / E
	Observed	Expected		
Round	98	95	3	0.0947
Eliptical	92	95	-3	0.0947
Total	190		X2 =	1.1895 N.S

Table value: X^2 at 5% 3.841

1 d.f.

Eliptical seed shape is a contrasting character found in exotic genotype EC. 126743. Its inheritance in both the crosses i.e. Varuna × EC 126743 and Prakash × EC 126743 was studied in their F2 and test cross generations. The data presented in Table 3 (a) and 3(b) indicated that the round seed shape was dominant over eliptical. The round seed was controlled by a single dominant gene in both the crosses. This was further verified from the test cross ratio which was largely in agreement of 1:1 ratio. This supplemented the F2 segregating pattern of monogenic control with complete dominance for this character.

The inheritance studies of seed attributes indicated their control by major genes with simple inheritance. It could, therefore, be possible to incorporate these charcters in breeding programmes.

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GROWTH RATE OF GROUNDNUT IN MAHARASHTRA

It is believed that the process of agricultural development has pronounced effect on productivity of agjiculture resulting thereby in a higher level of agricultural production per unit of available resources. The agricultural development would be visualised through the relative changes in area, production and productivity of crops over a period of time. Groundnut is an important oilseed crop in Maharashtra. The area under groundnut in the state was 6.17 lakh hectares, 8.40 per cent of the total area of country and production of groundnut in the state was 4 19 lakh tonnes, 7.55 per cent of the total production .of country during 1982-83 In this context, the compound growth rates for area, production and productivity of groundnut in Maharashtra have been computed for the period of 24 years from 1959 - 60 to 1982 - 83

The study was conducted with the following specific objective:

To estimate the regionwise trends in area, Production and Productivity of groundnut in the state of Maharashtra

The growth rates of area, production and productivity have been estimated by using exponential trend equations.

$$Y = ab^t$$

Where : Y = Area/Production/Productivity

a = Constant

b = $(1 + r)$ = trend value

t = time variable in years.

The sfgnificance of compound growth rates were tested with Student 't' test.

The regionwise growth rates in area, production and productivity of groundnut in Maharashtra are presented in Table-1. The growth rates in area and production of groundnut in the state during the entire period of 24 years were significantly negative to the extent of 2.20 and 2.01 percent, respectively, though the productivity showed marginal increase of 0.91 percent. The similar trend in area, production and productivity of groundnut was observed for the Western Maharashtra. The growth rates in area, production and productivity groundnut for Marathwada were significantly negative while the area under the crop continuously declined during the period under review which ultimately affected the production. The study concludes that the groundnut is generally grown under conditions of scanty and uncertain rainfall and not much of the irrigated area is diverted to this crop The prevailing inefficient oilseed processing and marketing

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system also adversely affect the area and production of the crop. The productivity showed slight increase because of the introduction of new high yielding varieties and increasing use of inorganic fertilizers during the entire period.

TABLE 1. Regionwise Compound Growth Rates in Area, Production and Productivity of Groundnut in Maharashtra State (1959-60 to 1982-83)

Regions	Compound Growth Rates in		
	Area	Production	Productivity
Western Maharashtra Region	–1.66***	–1.35	0.32
Marathwada Region	–5.54***	–6.56***	–1.08
Vidarbha Region	0.75**	1.61	0.85
Maharashtra State	–2.20***	–2.01***	0.91

** Significant at 5 per cent level.

*** Significant at 1 per cent level

To overcome the increasing demand for oilseeds such as groundnut, the irrigated area should be diverted to this crop Easy credit system, efficient processing and marketing, fair price are the other factors enhance the area as well as production of the crop

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COMBINING ABILITY STUDIES IN SESAME

The seed yield potential of seasame is remained static over decades, even though it is known to be the most ancient and important oil yielding crop in India. The slow improvement in sesame is owing to the arbitrary choice of parents and inadequate information about the nature of gene action in the materials used. It is thus desirable to isolate high combining lines from the germplasm. Hence an experiment was conducted using line × tester analysis to study the relative magnitudes of general and specific combining ability effects and the nature of gene action underlying the yield and component characters of sesame.

The experiment consisted of three ovule parents viz., 'TMV 3', 'TMV 4' and 'Co 1' and five pollen parents viz., 'si o3-1', Si 08-4','SVPR 43', 'Si 2316', and 'Si 1761× The crosses were effected during Rabi '84 and the F_1s were evaluated duirng early kharif sesason 1985 (April-May) at Cotton Research Station (TNAU, Srivilliputtur. The 15 F_1s along with their eight parents were sown in a Randomised Block Design replicated twice. Observations were recorded on five randomly selected plants of each replication at harvest for seed yield per plant, number of branches per plant and number of capsuls per plant. The data were subjected to combining ability analysis following the method proposed by Kempthrone (1957).

The analysis of variance showed that the hybrids differed significantly for all the seed yield attributes. The mean squares due to males for all the three traits were larger, when compared to females indicating greater variability among he pollen parents (Table 1). The sca variance was greater than that of gca variance for all the traits

TABLE 1. Variance for different characters

Source	Seed yield per plant	Number of branches per plant	Number of capsules per plant
Hybrid	35.71**	4.13**	1405.76**
Female	1.38	7.17	48.17
Male	28.03**	12.90**	1176.65**
Female × Male	2.37	209.07**	30.82
Error	1.10	1.49	28.40
gca	0.38	0.034	9.16
sca	13.72	1.000	602.33
gca : sca	0.028	0.034	0.015

*P = 0.05

** P = 0.01

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viz., seed yield per plant, number of branches per plant and number of capsules per plant indicating preponderance of non-additive gene action. The characters controlled by non-additive gene action hold promise for the exploitation of heterosis. These results are in agreement with the findings of Reddi *et al.* (1982) and Krishnadoss (1984) for seed yield per plant and number of capsules per plant and Singh *et al.* (1983) for number of branches per plant. Hence, the improvement of these traits might be possible by the bi-parental mating followed by recurrent selection.

The gca effects indicates that none of the parents was found to be promising for all the yield attributes. Among the ovule parents, 'TMV 3' is a good combiner for seed yield per plant and number of branches per plant. 'Si 03-1' is a good combiner for all the yield traits among the pollen parents (Table 2). In the evaluation of hybrids, the cross combinations 'TMV 3' × 'Si 08-4' and 'Co 1 × 'SVPR 43' showed significant positive sca effects for seed yield per plant, number of capsules per plant and positive sca effects for number of branches per plant which are the principal components of seed yield (Singh, 1983). High sca effects were noticed for the different attributes in different crosses such as 'TMV 3' × 'Si 08-4' and 'Co 1' × 'SVPR 43' showed high sca effect for seed yield per plant, 'TMV 3' × 'Si 1761' and 'Co 1' × 'Si 03-1' for number of branches per plant, 'TMV 3' × 'Si 08-4' and ,Co 1' × 'SVPR 43' for number of capsules per plant.

TABLE 2. General combination ability effects

Parents	Seed yield per plant	Number of branches per plant	Number of capsules per plant
Female			
'TMV 3'	2.75**	0.80**	-13.57**
'TMV 4'	-1.93**	-0.70	13.13**
'Co 1'	-0.82*	-0.10	0.43
Male			
'Si 03-1'	2.08**	0.47	17.67**
'Si 08-4'	2.74.**	-0.20	15.00**
'SVPR 43'	-3.521**	0.97	-19.00**
'Si 2316'	-1.08*	-1.37*	-1.83
'Si 1761'	-0.21	0.13	-11.83**
S.E. (gca for female)	0.33	0.39	1.69
S.E. (gca for male)	0.43	0.50	2.18

*P = 0.05

**P = 0.01

TABLE 3. Specific combining ability effects

Hybrid	Seed yield per plant	Number of branches per plant	Number of capsules per plant
'TMV 3' × 'Si 03-1'	0.95	0.03	-7.27
'TMV 3' × 'Si 08-4'	3.75**	0.20	28.90**
'TMV 3' × 'SVPR 43'	-4.71***	-1.47	-0.00
'TMV 3' × 'Si 2316'	0.32	0.37	1.23
'TMV 3' × 'Si 1761'	-0.31	0.87	-22.27**
'TMV 4' × 'Si 03-1'	0.30	-1.47	4.03
'TMV 4' × 'Si 08-4'	2.43*	1.20	7.70
'TMV 4' × 'SVPR 43'	-0.26	0.53	-29.80**
'TMV 4' × 'Si 2316	-1.12	-0.63	4.03
'TMV 4' × 'Si 1761'	-1.35	0.37	14.03**
'Co 1' × 'Si 03-1'	-1.25	1.43	3.23
'Co 1' × 'Si 08-4'	-6.18**	-1.40	-36.60**
'Co 1' × 'SVPR 43'	4.96**	0.93	30.40**
'Co 1' × 'Si 2316'	0.81	0.27	-5.27
'Co 1' × 'Si 1761'	1.66	-1.23	8.23
SE (sca)	0.74	0.86	3.77

*P=0.05

**P=0.01

Thus, the combining ability analysis indicated the predominant role of non-additive gene action for all the yield attributes. Improvement of these parameters would be possible the exploitation of non-additive genetic components. Hence, bi-parental mating followed by recurrent selection may hasten the rate of genetic improvement of these traits in sesame.

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PERFORMANCE OF SOME GROUNDNUT VARIETIES IN TRIPURA

Groundnut (*Arachis hypohaea* L.) is the third most important oilseed crop of Tripura with an area of approximately 1500 ha. Traditionally the *Kharif* crop is grown in uplands locally known as *tilla* land while the *rabi* crop is in river bed areas and mid uplands with irrigation. Half of the total area is under *rabi* season. The topography of Tripura is highly undulating with uplands (*tilla*) interspersed with valleys (*lunga*). Sixty percent of the cultivated area in Tripura is *tilla* lands which are utilised only for 5-6 months in a year (May-Sept./Oct.) and these lands remain fallow for the rest of year.

Tripura receives an annual rainfall of more than 2000mm Rainfall of above of 50 mm is available during 8 months of the year in the state. Rainfall during November, December, January and February is 40.11, 9.2, 5.5 and 28.1mm respectively. The temperature during this season ususally ranges from 5-32°C. Morever the *tilla* land soils are deep, and sandy and as such groundnut is one such crop which can be exploited under such situation

A trial comprising 18 ICRISAT groudnnut lines and a local variety was laid out in a randomized block design having 2 replications in the *tilla* land of Tripura during December, 1988. An inter and intra row spacing of 33 and 30 cm respectively were provided in 3 sq.m. plot. Two seeds were dibbled at each point. Fertilizer was applied at the rate of 20:40:40 kg NPK/ha Half of the nitrogen was applied as top dressing about one amont after sowing. Irrigation in *tilla* condition is difficult. However, whenever the plants showed symptoms of extreme moisture stress light irri gations were given to save the crop. Thus total of six such irrigations were given during the crop season. Thrips were the only serious pest noticed. Two sprays of 0.5% democron at an interval of 14 days were given to control this pest. Observations were recorded on plot yield. shelling % and days to maturity.

The data on yield, shelling % and maturity presented in Table 1 reveal that groundnut can be grown successfully in *tilla* lands during *rabi* season. The anlysis of data revealed significant difference for yield among the lines. The highest yield was recorded by the line ICGV 87138 followed by ICGV 87119, ICGV 87120 and ICGV 87129 in order, all the 4 lines being superior to the local entry. Shelling % varied from 56.80 - 74.24%. Local entry had highest shelling%. Moderately good shelling out turn was observed in case of the lines ICGV 87138, ICGV 87120 and ICGV 87129. Hence these varities need to be further explored as *rabi* groundnut varieties in the *tilla* lands. Eventhough all the varieties are of longer duration (150-154 days) overall performance of the varieties was good. Thus having proved the feasibility of growing groundnut as *rabi* crop in *tilla* lands it would be useful to try come early maturing genotypes which can be sown during the second week of December (after the December showers.)

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TABLE 1. Mean data on yield, shelling % and maturity of some groundnut varieties in *tilla* lands during *rabi* season

Varieties	Yield, kg/ha.	Shelling %	Maturity (days)
ICGV 87190	2024.50	73.32	153.5
ICGV 87128	2133.00	69.05	153.5
ICGV 87123	2133.00	68.33	153.5
ICGV 87138	3188.00	67.55	153.0
ICGV 87146	1716.00	60.56	154.0
ICGV 87114	2116.00	62.20	153.0
ICGV 87130	2033.00	70.71	153.0
ICGV 87149*	858.00	66.66	154.0
ICGV 87143*	450.00	58.34	153.0
ICGV 87122	1374.50	65.41	154.0
ICGV 87124	1916.00	63.90	153.0
ICGV 87133	1049.00	64.58	150.00
ICGV 87120	2566.50	65.58	153.0
ICGV 87121	2066.50	65.33	153.0
ICGV 87119	2666.50	56.81	153.0
ICGV 87171	2433.00	63.92	153.00
ICGV 87187	2266.00	61.59	153.0
ICGV 87129	2466.50	67.93	153.0
Local	2333.00	74.24	152.0
Range	450.3183	56.81–74.24	150–154.0
Mean	1988.66	65.58	153.03
S.E.	388.65		
CV%	19%		

*Less plant population

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PRELIMINARY SCREENING OF NATIONAL VARIETIES OF BRASSICA JUNCEA (L.) CZERN AND COSS., AGAINST MUSTARD APHID, *LIPAPHIS ERYSIMI* (KALT)

Lipaphis erysimi (Kalt.) is the most serious pest of *Brassica* Spp in India. This pest alone has been reported to inflict upto 96 per cent yield losses in these crops (Phadke, 1980). Use of systemic insecticides has been advocated for the control of mustard aphid (Singh *et al.*, 1987). But the regular and injudicious use of insecticides is not advisable in oleiferous crops as it may lead to serious problem of residue in oil and cake. Besides, it also leads to the destruction of natural enemies of pests and consequent environmental pollution. Use of resistant/tolerant varieties in an integrated management will overcome these problems upto a great extent. Van Emden (1987) emphasised that presence of small level of pest resistance in avariety can result in reduction of more than one third concentration of insecticides to achieve the equivalent kill of the pest on the susceptible variety.

Eighteen national varieties (Table-1) of *Brassica juncea* developed by various oilseeds reserach centres in India were screened against the mustard aphid under field condition. The varieties were grown at Hisar, using 80 kg N and 40 kg P2 O5/ha in a plot of 10 rows × 5m each and replicated thrice. Sowing was done, in first week of November. Inter-row and interplant spacing was maintained at 30 cm and 10-15 cm. One pre-sowing irrigation and another at 50 days after sowing were given..

Randomly selected 150 central shoots of each of the test varieties were critically observed for aphid population. Based upon average number of aphids per central shoot and per cent shoot infeststaion at full bloom stage of the crop varieties RL-18 and RLM-198 were observed to be resistant. Four varieties, i.e. RLM-514, Vardan RH-819 and RH-7859 were observed to be tolerant, and three varieties, namely Vaibhav, B-85 and RH-8113 were observed to be moderately susceptible All the other varieties showed their susceptibility to mustard aphid RL-18 and RLM-198 had significantly minimum aphid population per central shoot, i.e., 8 and 9, respectively, and minimum number of shoot infestation, i.e., 18.33 and 25.0 per cent, respectively (Table-1).

Per cent shoot infestation bymustard aphid on various mustard varieties was positively and significantly correlated ($r = +0.8476$) with number of aphids per central shoot. This suggested that the varieties having more shoot infestation also harbour more aphid population. Two varieties i.e. RL-18 and RLM-198 are late blooming and hence this factor might have contributed towards their escape from heavy aphid infestation. Earlier, Bakhetia and Sandhu (1973) and Bakhetia and Bindra (1977) had also indicated the tolerance of RL-18 and RLM-198 varieties against mustard aphid.

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TABLE 1. **Response of some *Brassica juncea* varieties to mustard aphid**

Variety	Released for cultivation in given region	Per cent shoot infestation by mustard aphid	Average number of aphids per cental shoot	Reaction to aphid infestation
Varuna	All India	43.33 (41.16)*	26.17 (5.32)**	Susceptible
Kranti	,,	56.67 (48.82)	27.63 (5.38)	Susceptible
Krishna	,,	48.33 (44.04)	29.70 (5.53)	Suscsptible
RLM-198	,,	25.00 (30.00)	9.13 (3.20)	Resistant
RLM-619	,,	38.33 (38.26)	(29.70 (5.62))	Susceptible
RLM-514	,,	25.00 (30.00)	15.10 (3.82)	Tolerant
RL-18	,,	18.33 (25.34)	8.10 (3.12)	Resistant
Vardan	Central zone	33.33 (35.25)	12.90 (3.69)	Tolerant
Vaibhav	,,	30.00 (33.17)	15.60 (4.15)	Moderately susceptible
Rohini	,,	43.33 (41.15)	24.27 (5.12)	Susceptible
Pusa bold	Eastern zone	46.67 (43.08)	26.53 (5.27)	-do-
Sarma	,,	46.67 (43.08)	27.07 (5.40)	-do-
RH-781	,,	45.00 (42.13)	24.60 (5.09)	-do-
B-85	,,	40.50 (38.88)	14.97 (4.04)	Moderately susceptible
RH-30	Eastern & North-Western zone	35.00 (36.25)	23.17 (5.01)	Susceptible
RH-8113	North Western Zone	31.63 (34.22)	14.53 (4.01)	Moderately susceptible
RH-819	,,	33.63 (35.27)	13.20 (3.73)	Tolerant
RH-7859	,,	28.33 (32.15)	(13.01 (3.59)	Tolerant
C.D. at 5 per cent		(2.05)	(3.69)	

* Figures in parentheses are angular values.

** Figures in parentheses are $\sqrt{N+1}$ values.

On the basis on these preliminary studies it is suggested that the cultivation of varieties viz; RL-18, RLM-198, RLM-514, Vardan, RH-819, RH-7859, Vaibhav, B-85 and RH-8113 should be encouraged in the appropriate areas. These varieties will be helpful in the integrated management of aphids.

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A NOTE ON THE AERIAL POD BEARING VARIANT OF GROUNDNUT *ARACHIS HYPOGAEA L.*

Among all the legumes, the genus *Arachis* alone is characterised by subterranean pod bearing. Despite the development of large number of gynophores in the cultivated groundnut, only a small proportion of them penetrate into the soil to develop into mature pods. The aerial pegs which remain without developing into pods seem to represent drain on the reproductive efficiency of groundnut plant. Therefore, identification of an aerial podding groundnut genotype would be a significant step in the dierction of enhancing the reproductive efficient of groundnut, thereby paving the way to breaking yiled barriers in this important leguminous crop. Prasad (1985) has identified an aerial podding mutant types of Brazalian groundnut variety 'Tatu'. The five mutants reported by him, exhibited large proportion of the aerial pods, with good seed development. However, there is no record of occurrency of aerial pod bearing segregant.

In the F_2 population of a cross involving MH2 BC 28, a mutant of MH 2-(*Valencia*) for enhanced canopy development (Prasad, 1988) an ICG (C) 8 and inter specific derivative of *valencia* form of *Arachis hypogaea* L. × A. *cardinasii* obtained from ICRISAT revealed a segregant with 18 aerial pods with good seed development. The F_2 plant was characterized by sequential branching with six thick primary branches and four secondaries, with 3 to 4 stout elongated pegs at each node. The aerial pods were confined to 3rd and other subsequent nodes. The aerial pods were purple in colour before maturity and possessed 2-3 well developed seeds with purple seed coat. The dry matter of the plant at maturity was 165.20g. In addition to aerial pods the plant also produced 30 subterranean pods which were also 2-3 seeded. The seeds in respect of subterranean pods, weighed 2.452 g per 10 seeds, while those of aerial pods weighed 2.485 g per 10 seeds.

Considering the importance of the aerial podding attribute, the above segregant could be of significant importance in groundnut breeding. It is note-worthy that none of the parents involved in the cross exhibited aerial podding attribute. In the F_1 generation also aerial podding attribute was not observed. It could be presumed that the expression of aerial poddihg character in the segregant could be due to complementary genic interaction.

Wynne and Gregory (1981) suggested that greater adaptive contingency in groundnut plant could be attained by enhancing the fruit sites, which could be achieved through the development of aerial pod bearing genotypes. It could also be interesting

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to explore the genetic nature of the above aerial podding segregant, as well as its genetic relationship with the aerial pod bearing mutants reported by Prasad (1985).

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RECORD OF INSECT PESTS ON NIGER (*GUIZOTIA ABYSSINICA*)

Niger is one of the oilseed crops cultivated in India in an area of over 6 lakhs ha with annual production of 1.75 lakhs tons. Niger crop is generally grown under marginal and submarginal drylands. The information on insect pest complex of niger and yield losses are not systamatically documented, except a mention of safflower caterpillar *Perigea capenisis* (Guenee) and safflower aphid *Dactynotus carthami* (Hille Ris Lambers) (Narayanan 1961). A detailed study was undertaken to record the incidence of various insect pests on niger at the Directorate of Oilseeds Research, Hyderabad during Kharif 1988-90. Observations on the insect pests causing damage to niger crop were recorded at weekly interval starting from seedling stage till harvest. The insect pests collected were sent to C.A.B. International Institute of Entomology, London for identification. The detailed list of insect pests of niger are presented inTable 1. In addition to studies conducted at the Directorate of Oilseeds Research, Hyderabad a field survey was carried out in major niger growing areas of Maharashtra and Madhya Pradesh. Apart from major insect pests reported in Table 1, Bihar hairy caterpillar (*Spilosoma obliqua* walker) in Maharashtra and cut worm (*Agrotis* sp.) in Madhya Pradesh were found to cause severe damage to niger crop. The incidence of spittle bug was also common in both the states.

Apart from recording insect pest complex of niger, a detail study on the population dynamics of major pests and assessment of yield losses due to insect pests is in progress.

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TABLE 1. Insect pests of niger (*Guizotia abyssinica*)

S.No.	Common Name	Scientific Name	Systematic position		Economic status of pests
1.	Niger green bug	*Taylorilygus pallidulus* (Blanchard)	Hemiptera	: Miridae	Major
2.	Niger caterpillar	*Condica conducta* (Walker)	Lepidoptera	: Noctuidae	Major
3.	Green semilooper	*Thysanoptusia orichalcea* (Fabricius)	Lepidoptera	: Noctuidae	Major
4.	Tobacco caterpillar	*Spodoptera litura* (Fabricius)	Lepidoptera	: Noctuidae	Major
5.	Gram pod borer	*Heliothis armigera* (Hubner)	Lepidoptera	: Noctuidae	Major
6.	Niger grain fly	*Dixyna sororcu*(Wedemann)	Diptera	: Tephritidae	Major
7.	Safflower aphid	*Uroleucon carthami* Theobald	Hemiptera	: Aphididae	Minor
8.	Lucern caterpillar	*Spodoptera exigua* (Hubner)	Lepidoptera	: Noctuidae	Minor
9.	Jassid	*Amrasca biguttula* (Ishida)	Hemiptera	: Cicadellidae	Minor
10.	Grass hopper	*Pyrgomorpha bispinosa - conica*	Orthoptera	: Prygomorphidae	Minor
11.	Surface grass hopper	*Chrotogonus trachpterus* Blanch	Orthoptera	: Acriididae	Minor
12.	Pentatomid bug	*Nezara viridula* Linn	Hemiptera	: Pentatomidae	Minor
13.	Termite	*Odontotermes obesus* Ramp	Isoptera	: Termitidae	Minor
14.	Chafer beetle	*Gametis versicolor* (Fabricius)	Coloeptera	: Scarabaeidae	Minor
15.	Whitefly	*Bemisia tabacii* (Gennadius)	Hemiptera	: Aleyrodidae	Minor

INFORMATION FOR CONTRIBUTORS

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