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SHORT COMMUNICATIONS

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HCH RESIDUES IN FOLLOW UP GROUNDNUT AND SESAME CROPS

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ABSTRACT

Dusting Hexachloro-cyclohexane 10 D at 2.5 kg a.i./ha on groundnut crop 35 DAS and sesame 75 DAS resulted in 0.354 and 0.551 ppm total HCH in soil respectively a day after application which declined 93.4% and 97.4% respectively at harvest. The difference in the doses applied to the preceding cotton main crop did not influence the carry over of HCH residues in soils from the main crop to the follow up groundnut and sesame crops. At harvest the proportion of the individual isomers in soil of follow up crops was in the order of $\beta > \alpha > \gamma > \delta$. Application of HCH at 2.5 kg a.i./ha to groundnut 35 DAS resulted in residues of 0.460 ppm in haulms 0.916 ppm in husk and 0.266 ppm in groundnut kernels. Application of HCH at 2.5 kg a.i./ha to sesame crop 75 DAS resulted in 0.104 ppm in sesame seeds. Application of HCH to the preceding cotton crop at 5 or 10 kg a.i./ha did not influence the carry over of applied HCH from main crop to follow up groundnut kernels, haulms, husk and sesame seeds.

Key Words : Groundnut; Sesame; Follow up crop; HCH residues; HCH persistence.

Wide spread contamination of Hexachloro-cyclohexane (HCH) in oils and fats in Tamil Nadu was observed in the monitoring programme carried out by Krishnamoorthy and Regupathy (1990), Mercy and Regupathy (1989 a, b), Regupathy and Kuttalam (1989 a, b, c). Considering all these, the present study was carried out to know whether the build up of residues in oils was due to direct application or through cross contamination.

A supervised trial was laid out with MCU 5 cotton during winter 1986 (September 1986-February 1987). The entire field was divided into three plots of each 30 x 12 m to accommodate three treatments viz., 5 kg a.i./ha (recommended dose), 10 kg a.i./ha (double the recommended dose) and an untreated check. HCH 10% dust was incorporated into soil 30 days after sowing (Krishnamoorthy and Regupathy, 1992). Each plot of 30 x 12 m was divided into sub plots of 3.75 x 12 m to have the following varied combination in the follow up crops with two replications in randomised replicated design. JL groundnut with a duration of 105 days and Co 1 sesame with a duration of 90 days were sown with a spacing of 30 x 10 cm and 30 x 20 m respectively. The treatments included in the follow up crops were HCH 10% dust (Dosage a.i./ha).

1. Cotton untreated + groundnut untreated
2. Cotton untreated + groundnut treated at 2.5 kg, the recommended dose in practice against Red Hairy Caterpillar (*Amsacta albistriga* Wlk).
3. Cotton untreated + sesame untreated
4. Cotton untreated + sesame treated at 2.5 kg the recommended dose in practice against sesame pod bug *Elasmolomus sordidus* Fb.
5. Cotton treated with 5 kg (single dose - SD) + groundnut untreated

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6. Cotton treated with 5 kg (SD) + groundnut treated at 2.5 kg
7. Cotton treated with 5 kg (SD) + sesame untreated
8. Cotton treated with 5 kg (SD) + sesame treated at 2.5 kg
9. Cotton treated with 10 kg (double dose - DD) + groundnut untreated
10. Cotton treated with 10 kg (DD) + groundnut treated at 2.5 kg
11. Cotton treated with 10 kg (DD) + sesame untreated
12. Cotton treated with 10 kg (DD) + sesame treated at 2.5 kg

HCH 10 D calculated based on the plot size was dusted uniformly 35 days after sowing to groundnut and 15 days before harvest to sesame with the help of Aspee puff duster of 500 g capacity and using bamboo "thatties" to avoid cross contamination to the adjacent plots by drift and application was done in the early morning.

Representative soil samples were taken from individual treatments before application, a day after application and at harvest from 60 spots with the help of augur at 10 cm depth in each plot and pooled. Groundnut pods harvested from individual treatments were sun dried and hand decorticated. From this a representative sample of 500 g was taken. Similarly sesame seeds of 400 g was taken from the pooled extracted seeds obtained from the plants after curing. Groundnut haulms were collected from 20 plants from individual plots at the time of harvest, sun dried, chopped into pieces and a representative sample of 200 g was taken. Groundnut husk samples were obtained after decortication of the groundnut pods collected from individual plots and from this representative samples of 200 g was retained for residue estimation.

The method described in protocol prepared for the All India Coordinated Research Project - Pesticide Residues Scheme (Anon. 1985) was followed for residue estimation. Extraction from soil samples (50 g) was done with 100, 50 and 50 ml portions of n-hexane; acetone (1:1 v/v) and washed with 50 ml distilled water. Extraction from groundnut kernels (20 g), sesame seeds (15 g) was done by soxhlet apparatus using 200 ml n-hexane for 8 hours. After evaporation of hexane the soil content was weighed and re-dissolved in 50 ml hexane and partitioned into 100, 50 and 50 ml portions of n-hexane saturated acetonitrile by adding 600ml of 5% aqueous sodium chloride. Residues from groundnut haulms (10 g) were extracted by blending with 100, 50 and 50 ml portions of acetonitrile : water (2:1 v/v) and partitioned into n-hexane. Soxhlet extraction with 200 ml n-hexane for 4 hours was used for groundnut husk.

The final extracts of all samples were condensed to 10 ml before proceeding to final clean up by sulphuric acid digestion (Kapoor *et al.*, 1981).

Residues estimation was done on Chemito Model 3800 Gas Chromatograph equipped with 63 NI Electron Capture Detector (ECD) and 2.0 m long and 2 mm i.d. coiled glass column packed with 1.5% OV 17 + 1.95 % QF_1 with nitrogen at a flow rate of 30 ml/min. The temperature (°C) of column 180, injector 200, detector base 200 and detector source 246° were maintained.

Analysis of the soil of experimental field indicated 36.2% clay, 18.2% silt, 6.0% fine sand, 39.6% coarse sand, 0.87% organic matter, 8.4 pG, 0.3 EC (mmhos/cm), 18.9 total cation exchange capacity (m.e./100 g) and 3.0 mg/kg

available iron. The recovery from fortified samples at 0.2 ppm level was found satisfactory as indicated in Table 1.

Dusting groundnut 35 days after sowing DAS and sesame 15 days before harvest (75 DAS) with HCH at 2.5 kg a.i./ha resulted in initial level soil residues of 0.551 mg/kg HCH on day one after application. The residual level observed a day after application in the present investigation was in confirmity with the findings of Kathpal *et al.*, (1976, 1981a, 1981b).

At harvest, the residues in soil in the follow up groundnut and sesame declined by 93.0% in 65 days and 97.4% in 20 days respectively. The loss of HCH at such faster rate under tropical conditions of India had been reported by Srivastava and Yadav (1977), Yadav (1976), Yadav *et al.*, (1977), Agnihotri (1978), Kathpal *et al.*, (1981b) and Karanth *et al.*, (1982). Application of HCH to the preceding cotton main crop at 5 or 10 kg a.i./ha did not result in the carry over of HCH residues to the follow up crops, as the residue degradation of HCH applied to cotton was to the extent of 99.7% and 99.9% at 5 and 10 kg a.i./ha respectively (Krishnamoorthy and Regupathy, 1992).

The HCH 10% dust when analysed, contained 69.4% alpha, 7.9% beta, 13.2% gamma and 5.2% delta. On day one of application, the HCH residues had 51.2% alpha, 24.2% beta, 19.2% gamma, 5.4% delta in groundnut and 67.7% alpha, 11.6% beta,16.0% gamma, 4.72% delta in sesame. At harvest of groundnut and sesame the proportion of the isomers changed with the predominance of beta followed by alpha, gamma and delta. Similar observations on the predominance of beta at harvest have been observed in soil treated with HCH for controlling cotton stem weevil by Krishnamoorthy and Regupathy (1992), in vegetables like tomato, chilli, knol-khol, carrot, amaranthus, coriander raised soils treated with HCH at 5 and 10 kg a.i./ha by Karanth *et al.*, (1982) and in sandy loam soil in Nova Scotia after 15 years by Steward and Chrisholm (1971) and in Japanese soils by Tatsukawa *et al.*, (1972). The predominance of beta with the elapse of time might either be due to transisomerization in favour of beta or due to less or non degradable nature of beta. Deo *et al.*, (1980, 1981) have observed that all the four HCH isomers viz., alpha, beta, gamma and delta isomerize slowly and in small amounts, on dispersion in water at 25° C. Steinwandter (1978) and Steinwandter and Schlueter (1978) observed the interconversion of gamma HCH to HCB (hexachlorobenzene), alpha, HCH

Table 1. Per cent recovery of HCH isomers from fortified samples at 0.2 ppm level

Compound	Soil	Seed	Groundnut haulms	Groundnut husk	Oil
Alpha	80.7	90.7	86.5	82.5	80.9
Beta	99.2	110.0	93.2	80.0	98.3
Gamma	80.7	82.3	83.2	82.5	80.4
Delta	98.3	101.2	87.9	89.3	81.5
Total HCH	89.7	96.1	87.7	83.6	85.3

Table 2. Residues of HCH in soil - follow up groundnut crop (mg/kg)

Treatment	Cotton Untreated					Cotton treated 5 kg a.i./ha					Cotton treated 10 kg a.i./ha				
	Alpha	Beta	Gamma	Delta	Total HCH	Alpha	Beta	Gamma	Delta	Total HCH	Alpha	Beta	Gamma	Delta	Total HCH
ONE DAY AFTER TREATMENT															
Groundnut treated	0.182 (0.003)	0.086 (0.017)	0.088 (0.002)	0.019 (0.000)	0.355 (0.022)	0.204 (0.012)	0.125 (0.016)	0.070 (0.008)	0.028 (0.000)	0.427 (0.036)	0.085 (0.012)	0.119 (0.004)	0.025 (0.007)	0.007 (0.003)	0.236 (0.025)
Groundnut untreated	0.002 (0.002)	0.003 (0.009)	0.002 (0.001)	0.001 (0.001)	0.008 (0.013)	0.005 (0.009)	0.110 (0.027)	0.004 (0.005)	0.002 (0.001)	0.121 (0.042)	0.006 (0.010)	0.082 (0.004)	0.003 (0.007)	0.001 (0.001)	0.092 (0.022)
AT HARVEST (100 days)															
Groundnut treated	0.006	0.013	0.002	0.002	0.023	0.005	0.021	0.002	0.002	0.030	0.004	0.015	0.001	0.001	0.021
Groundnut untreated	0.003	0.002	0.001	0.001	0.007	0.002	0.004	0.001	0.000	0.007	0.004	0.007	0.002	0.000	0.013

Figures in parentheses indicate residues before application of HCH; Tr - Trace (< 0.001; mg/kg)

Table 3. Residues of HCH in soil - follow up sesame crop (mg/kg)

Treatment	Cotton untreated					Cotton treated 5 kg a.i./ha					Cotton treated 10 kg a.i./ha				
	Alpha	Beta	Gamma	Delta	Total HCH	Alpha	Beta	Gamma	Delta	Total HCH	Alpha	Beta	Gamma	Delta	Total HCH
ONE DAY AFTER TREATMENT															
Sesame treated	0.373 (0.008)	0.064 (0.032)	0.088 (0.003)	0.026 (0.002)	0.551 (0.045)	0.371 (0.010)	0.054 (0.019)	0.069 (0.002)	0.029 (0.001)	0.523 (0.032)	0.125 (0.014)	0.024 (0.061)	0.032 (0.003)	0.007 (0.001)	0.189 (0.079)
Sesame untreated	0.002 (0.003)	0.002 (0.002)	0.001 (0.001)	0.000 (0.000)	(0.005) (0.006)	0.004 (0.004)	0.042 (0.013)	0.001 (0.001)	0.001 (0.000)	0.048 (0.018)	0.004 (0.003)	0.086 (0.002)	0.001 (0.001)	0.000 (0.000)	0.091 (0.006)
HARVEST TIME															
Sesame treated	0.006	0.005	0.002	0.001	0.014	0.008	0.007	0.005	0.002	0.022	0.008	0.011	0.004	0.001	0.024
Sesame untreated	0.002	0.002	0.001	0.000	0.005	0.003	0.007	0.001	0.000	0.011	0.002	0.007	0.001	0.000	0.01

Figures in parenthesis indicate residues before application of HCH ; Tr - Traces (< 0.001 mg/kg)

Table 4. Residues of HCH in groundnut kernels and oil (mg/kg)

Main crop (Cotton) kg a.i. /ha	Follow up crop (Groundnut) kg a.i./ha	Kernal HCH Isomers				Total HCH	Oil HCH Isomers				Total HCH
		Alpha	Beta	Gamma	Delta		Alpha	Beta	Gamma	Delta	
-	-	0.010	0.013	0.007	0.007	0.037	0.023	0.031	0.015	0.017	0.086
-	2.5	0.053	0.203	0.009	0.001	0.266	0.121	0.464	0.021	0.002	0.608
5	-	0.028	0.055	0.005	0.001	0.089	0.073	0.144	0.011	0.002	0.230
5	2.5	0.057	0.206	0.006	0.004	0.273	0.132	0.480	0.013	0.010	0.635
10	-	0.030	0.060	0.007	0.002	0.099	0.077	0.150	0.019	0.004	0.250
10	2.5	0.106	0.168	0.014	0.004	0.292	0.239	0.376	0.322	0.008	0.945

Table 5 Residues of HCH in groundnut haulms and husk (mg/kg)

Main Crop (Cotton) kg a.i. /ha	Follow up cop (Groundnut) kg a.i./ha	Haulms HCH isomers				Total HCH	Husk HCH isomers				Total HCH
		Alpha	Beta	Gamma	Delta		Alpha	Beta	Gamma	Delta	
-	-	0.055	0.246	0.021	BDL	0.322	0.115	BDL	0.007	0.013	0.135
-	2.5	0.136	0.274	0.045	0.005	0.460	0.332	0.329	0.186	0.070	0.917
5	-	0.080	0.287	0.035	BDL	0.402	0.282	0.002	0.007	0.026	0.317
5	2.5	0.189	0.500	0.080	0.006	0.780	0.422	0.326	0.429	0.097	1.274
10	-	0.080	0.285	0.042	0.001	0.408	0.218	0.187	0.029	0.024	0.458
10	2.5	0.172	0.570	0.066	0.003	0.811	0.550	0.365	0.475	0.099	1.489

BDL - Below Detectable Limit.

Table 6 Residues of HCH in sesame seeds and oil (mg/kg)

Main crop (Cotton) kg a.i. /ha	Follow up crop (Sesame) kg a.i./ha	Seeds HCH isomers				Total HCH	Oil HCH isomers				Total HCH
		Alpha	Beta	Gamma	Delta		Alpha	Beta	Gamma	Delta	
-	-	0.004	0.015	0.003	0.002	0.024	0.006	0.026	0.004	0.003	0.039
-	2.5	0.027	0.064	0.010	0.003	0.104	0.053	0.125	0.019	0.005	0.202
5	-	0.012	0.025	0.007	0.002	0.046	0.029	0.059	0.016	0.004	0.108
5	2.5	0.036	0.072	0 .014	0.003	0.125	0.071	0.140	0.027	0.006	0.244
10	-	0.017	0.034	0.009	0.003	0.063	0.038	0.069	0.021	0.007	0.135
10	2.5	0.039	0.069	0.019	0.011	0.138	0.074	0.135	0.037	0.021	0.267

and beta HCH in laboratory studies. Formation of alpha HCH was much faster in sunlight than HCB and alpha HCH subsequently changed, in part, to beta HCH which was much faster under field conditions than in closed room (Steinwandter, 1976). Karanth (unpublished), Deo *et al.*, (1982) after incubating alpha HCH with an oxide enzyme preparation obtained form 10 day old tomato seedlings found the presence of gamma HCH, beta HCH and PCCH (Penta-chlorocyclohexane) at the end of incubation time by TLC analysis.

Dusting of HCH 10 D at 2.5 kg a.i./ha on groundnut 35 days after sowing recorded residues 0.265, 0.608, 0.459 and 0.916 mg/kg in groundnut kernel, oil, haulms and husk respectively. Dusting at the same dosage on sesame 75 days after sowing resulted in 0.104 and 0.201 mg/kg residues in seeds and oil respectively. Application of HCH to the preceding cotton crop at 5 and 10 kg did not have any carry over effect to the followup of groundnut and sesame crops.

The HCH residues observed were less in sesame oil despite shorter time interval between dusting and harvest of sesame when compared to that in groundnut which might be due to larger biomass of sesame than groundnut/ha leading to dilution of deposition of HCH dusted. Further the continuous contact of groundnut pods with contaminated HCH might be the reason for higher level of HCH in groundnut oil. Udean and Deshmukh (1971) reported 0.60 mg/kg HCH on kernel basis and 7.08 mg/kg HCH on oil basis in groundnut dusted with 2.5 kg a.i./ha at the time of sowing. Chopra *et al.*, (1973) reported BDL of HCH in groundnut kernels by spraying with 0.1 to 0.35 a.i./ha 15 days after sowing. Joia *et al.*, (1970) reported 0.093 mg/kg of HCH in groundnut oil by application of HCH at 2.5 kg a.i./ha at the time of sowing. Yadav and Yadava (1982) reported that soil application of HCH at 2.5, 5.0 and 10.0 kg a.i./ha, 0.35, 0.57 and 0.97 ppm of HCH residues in green vines respectively after 60 days of sowing and BDL in husks.

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PARTITIONING OF DRY MATTER IN FOLIAR DISEASE RESISTANT GENOTYPES OF GROUNDNUT (*Arachis hypogaea* L.)

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ABSTRACT

The relative efficiency of partitioning of dry matter in ten genotypes with varying reaction to foliar diseases susceptible, partial resistant and resistant were studied. The accumulation of dry matter in stem as well as root did not vary significantly among these genotypes. In the susceptible and partially resistant genotypes, the partitioning of dry matter to pod is more. Poor partitioning of assimilates and inadequate translocation from source to the sink may be the limiting factors for yield in the resistant genotypes.

Key Words : Dry matter; Partitioning; Foliar diseases; Resistant genotypes.

It has been reported that resistance to foliar diseases associated with low yield potential in groundnut (Williams *et al.*, 1984). Duncan *et al.*, (1978) has observed that potential growth rates were fairly constant whereas the yield differences between high yielding cultivars were attributed largely to the differences in partitioning. The present study was conducted to examine growth and partitioning in genotypes with variable reaction to foliar diseases.

MATERIALS AND METHODS

The genotypes were screened for foliar disease during *kharif* 1988 where the disease intensity was severe. Among the ten genotypes Co 2, JL 24, VRI 1 and VRI 2 recorded a mean grade of 8 in the 19 scale and hence grouped as susceptible. The genotypes ALG 33, DORG 18-10 and ICG (FDRS) 43 recorded a mean grade of 4 and designated as partially resistant. Whereas, the other genotypes viz., NCAC 17090, NCAC 17135 and ICG (FDRS) 10 were recorded a mean grade of 2 and hence considered as resistant. The above groups of genotypes were raised during summer 1989 season where the disease intensity is very meagre. The experiments were conducted in a Randomized Block Design with three replications under irrigated conditions. The other insect pests were controlled by spraying. Plant samples were collected at 30, 50, 70, 90 and 110 days after sowing coincide with five stages of crop growth i.e., peak flowering, peg formation, pod filling and harvesting. Ten plants from each genotypes were sampled at random in each replication. The plants were dug so as to get the entire root system. The sample plants were separated into roots, stem, leaf and pods and oven dried. The dry weight of individual parts were recorded. The yield data were recorded in a measured area of one square metre.

RESULTS AND DISCUSSION

The pattern of accumulation of DMP revealed that upto pod formation stage there are no differences among the genotypes (Fig. 1). During pod filling and maturing phases, partial resistant and resistant genotypes recorded linear increase in pod dry matter than the susceptible genotype. However, accumulation of pod dry matter was poor in resistant genotypes compared to susceptible and partial resistant genotypes.

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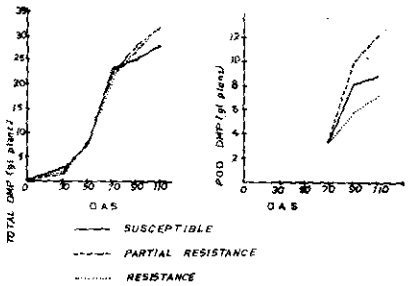

Fig 1. Dry matter partioning in different genotypes

Leaf dry matter increased linearly in the resistant types, whereas, a gradual increase upto pod formation followed by reduction was observed in susceptible types (Fig. 2). At maturity, the mean leaf dry weight was 5.72, 5.77 and 10.11 g/plant in susceptible, partial resistant and resistant genotypes, respectively.

The stem dry matter increased linearly in all the genotypes. However, the differences were not significant among the three categories. Similarly, the root weights also exhibited non significant differences.

A linear increase of pod dry matter was observed in all the categories of the genotypes, with maximum pod weights being 12.28 g, 8.91g and 7.17 g/plant at pod maturity in partial resistant, susceptible and resistant genotypes, respectively.

Although the total dry matter of genotypes did not vary much, the differences in kernel yield varied significantly due to genotypic differences in partitioning of dry matter to pods as observed by Duncan *et al.*, (1978).

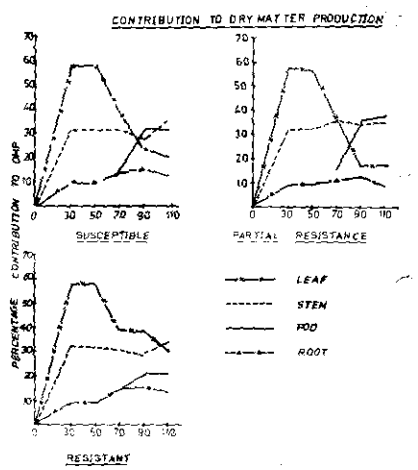

Fig. 2. Contribution to dry matter production

Table 1. **Leaf Area Ratio (LAR) at various growth stages in groundnut genotypes.**

Variety	LAR (cm^2/g)					Pod yield (g/m^2)	Shelling (%)	Kernel yield (g/m^2)
	S_1	S_2	S_3	S_4	S_5			
A. Susceptible								
Co 2	196.2	314.8	143.7	56.1	35.2	184	74.0	136
JL 24	266.3	294.2	106.1	77.9	69.7	182	73.5	134
VRI 1	323.0	328.9	129.4	47.8	40.1	177	74.5	132
VRI 2	388.7	299.6	83.7	53.9	30.6	193	74.0	143
Mean	293.6	309.4	115.8	58.9	43.9			
B. Partial resistant								
ALG 33	270.8	281.3	111.1	48.1	33.3	168	73.0	123
DORG 18-10	289.3	262.3	86.3	33.2	29.3	168	71.5	120
ICG (FDRS) 43	299.4	247.9	114.3	36.8	40.6	169	72.0	122
Mean	286.5	263.8	103.9	39.4	34.4			
C. Resistant								
ICG (FDRS) 10	281.0	259.9	111.8	55.8	51.4	176	65.5	155
NCAC 17135	255.5	257.5	125.8	49.6	43.7	152	64.0	97
NCAC 17090	279.6	200.8	127.4	78.2	74.7	176	64.5	114
Mean	272.0	239.4	121.7	61.2	56.6			
SE	[illegible]	8.2	5.7	7.5	17.3	2.2	0.6	1.2
CD	32.0	24.2	16.8	22.2	NS	6.5	1.8	3.5

The dry matter accumulation in stem and root did not vary significantly amongst genotypes. The leaf area in relation to total dry weight of plant (LAR) decreased markedly after the second phase, characterized by flowering (Table 1). LAR was higher in susceptible genotypes upto flowering, the value being 309.4 cm^2/g. But resistant genotypes registered higher values of LAR during pod formation, pod filling and maturity phase. The values of LAR for the above three phases are 121.70, 61.2 and 56.6 cm^2/g respectively. The leaf production and vegetative growth continued in the resistant genotypes, even in the later phases of crop growth, resulting in higher LAR. Hence, the translocation of assimilates from leaf to pod is lower in resistant cultivars as compared to the other two groups. Poor partitioning of dry matter to pod in the resistant group is a limiting factor for yield in this group. The role of partitioning by assimilates for realising higher yield in groundnut was reported by Watson (1971) and Wareing and Patrick (1975). The study also suggests the utility of partially resistant genotypes in tiding over the above situation.

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PHOSPHORUS UTILIZATION BY RAINFED CASTOR IN RED SANDY LOAM (*Chalka*) SOIL

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ABSTRACT

In a field experiment conducted on red sandy loam (*Chalka*) soil employing tracer techniques, castor crop responded to application of P. The dry matter yields and P uptake parameters recorded at 45 and 90 DAS showed significant influence of levels (20, 40 and 60 kg P_2O_5/ha) and source of phosphate (DAP and SSP). The mean phosphorus utilization values were 2.51 and 7.20 per cent at 45 and 90 DAS respectively. Soil P uptake was, however, not influenced at 45 DAS, while the effects of sources and levels were significant at 90 DAS. Between the two sources, DAP was superior to SSP in all respects. Application of P as DAP at 60 kg P_2O_5/ha was found beneficial to castor grown on red sandy loam (*Chalka*) soils under rainfed conditions.

Key words : Castor; Dry matter yield; Phosphorus utilization.

Castor (*Ricinus communis*) occupies an important place in country's vegetable oil economy. Despite phenomenal increase witnessed in the production and productivity of castor over the last ten years or so, there still exists wide regional disparities in per hectare yields of castor. Growing castor in submarginal and marginal lands under rainfed conditions with practically a little or no inputs, use of poor quality of seed etc., are some of the reasons identified for low yields

Application of phosphorus to oilseed crops has been found beneficial as it helps in increasing growth and yields particularly when they are grown on P deficient light soils such as the local red sandy loam. Responses of oilseed crops to P are particularly marked in red and yellow, coastal alluvial, alluvial, red loamy and laterite soils (Tandon, 1986). In general, the requirement of P by oilseed crops is quite high. Oilseeds remove 24 kg P_2O_5 from soil to produce one tonne of yield. Responses of groundnut, mustard and sunflower to applied P are more common than in other oilseed crops (Ankineedu *et al.*, 1983). Scanty information is available on responses of castor to P and it is particularly not available for castor grown on red sandy loam (*Chalka*) soils under rainfed conditions. Further, no attempt was made in the past to know the efficiency of utilization of P from different sources by this crop. Hence, an investigation was planned to find out the utilization of fertilizer P from different sources of castor grown on red sandy loam (*Chalka*) soil under rainfed conditions.

MATERIALS AND METHODS

A field experiment was conducted during *kharif*, 1988 at Student's Farm of the College of Agriculture, Rajendranagar, Hyderabad by growing castor (var. Aruna) on a medium available P (Olsen's P_2O_5 = 23.3 kg/ha) red sandy loam (*Chalka*) soil which was neutral (pH = 6.92), non saline (EC = 0.32 ds/m) with a clay content of 10.8 per cent. The experiment was laid out in a Randomized Block Design with seven treatments, each replicated thrice. The treatments consisted of combinations of two

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sources of P viz., Diammonium phosphate (DAP) and single superphosphate (SSP) applied at 3 levels of 20, 40 and 60 kg P_2O_5/ha. Besides these, a control treatment without P was also included. The experimental plot consisted of a main plot of 6.0 x 3. m size and a sub plot of 1.8 m x 3.0 m size both separated by a thin bund. While the former was maintained to record yields the latter served the purpose of collecting plant samples.

The castor crop received recommended doses of nitrogen as urea and potassium as muriate of potash. Nitrogen was applied at the rate of 80 kg N/ha in three splits viz., basal, at 40 and 80 days after sowing (DAS) while the potassium was applied at 30 kg K_2O/ha as basal. Phosphorus was applied to the central row of the crop in the sub plot in the form of ^{32}P labelled DAP and SSP (at a final specific activity of 0.3 mCi/g P_2O_5) while the rest of the rows in main plot received unlabelled fertilizers basally as per the treatments. Sulphur was applied to DAP plots as per the S - content supplied through SSP and the N content of DAP was taken into account while calculating the N dose for the crop. The crop was sown at a spacing of 60 cm x 30 cm and thinned to maintain single plant per hill.

Plant samples were collected at 45 and 90 DAS and dry matter yields were recorded. The samples were then analysed for P- content by Vando-molybdo phosphoric yellow colour method (Jackson, 1967). ^{32}P assaying was done by evaporating the extracts under infra red lamp. Counting measurements were carried using a G.M. counter (GCS 10 A of ECIL make) with a G.M. tube having a mica end window thickness of 2 mg/cm^2.

RESULTS AND DISCUSSION

Results of the investigation showing the effects of sources and levels of P on dry matter yield and P uptake parameters at 45 nd 90 days age of the castor crop are presented in Table 1.

The data at both the stages of crop growth showed that castor crop responded to phosphorus application as increases in dry matter yields were recorded with increase in level of P applied to castor. At 45 DAS, the increase in dry matter was significant upto 40 kg P_2O_5/ha but at 90 DAS, responses were observed even upto 60 kg P_2O_5/ha. The source of P also significantly influenced the dry matter yields of castor. Dry matter yields were higher with DAP than with SSP. The observed crop response to applied P are possible as the local red sandy loam *(chalka)* soil used for growing the castor was medium in available P and low in clay content with a moderate P fixing capacity of 31 per cent. Response of oilseed crops to applied phosphate were reported by Sachidanand *et al.*, (1980), Mandal *et al.*, (1983), Mallikarjuna Rao *et al.*, (1985) and Singh and Kamath (1988). Response of castor in terms of dry matter production were also reported by many workers (Goud Reddy *et al.*, 1975; Paida and Parmar, 1979 and Ankineedu *et al.*, 1983).

Similar to dry matter yield, application of phosphate significantly influenced P content and other P uptake parameters. While several of these parameters showed an increase with increase in level of P, phosphorus utilization was however decreased. The P utilization by castor ranged from 1.76 to 3.55 and 5.00 to 9.96 per cent at 45 and 90 DAS respectively showing the highest values at lowest levels of 20 kg P_2O_5/ha through either of the P sources applied. This shows that the fertilizer P uptake by the crop was not in proportion to the dose applied. The values of all these P uptake parameters were higher with DAP than with SSP. Among the interaction effects the interaction between source and levels only showed significant in-

Treatment (kg P_2O_5 ha^{-1})	At 45 DAS				At 90 DAS			
	Dry matter (q ha^{-1})	P - content (%)	P - uptake (kg ha^{-1})	Pdff (%)	Dry matter (q ha^{-1})	P - content (%)	P - uptake (kg ha^{-1})	Pdff (%)
Control	3.04	0.262	0.80	-	13.54	0.237	3.21	-
DAP - 20	3.89	0.318	1.24	25.00	17.04	0.293	4.99	17.41
DAP - 40	4.11	0.351	1.44	33.18	18.61	0.334	6.22	23.37
DAP - 60	4.33	0.372	1.61	40.21	20.39	0.367	7.48	26.50
SSP - 20	3.72	0.314	1.17	18.72	15.33	0.283	4.34	13.17
SSP - 40	4.02	0.336	1.35	25.97	17.29	0.310	5.36	18.20
SSP - 60	4.09	0.353	1.44	31.75	18.24	0.338	6.17	21.28
Mean	3.89	0.329	1.28	29.14	17.21	0.309	5.32	20.07
CD (0.05)	0.23	0.020	0.11	3.93	1.55	0.010	0.54	2.17

DAP : Diammonium Phosphate
SSP : Single super Phosphate
Pdff : P derived from fertilizer

fluence on fertilizers P uptake by castor at 90 DAS.

The changes in dry matter yields and P uptake parameters with advancement in age of the castor crop are presented in Table 2. While all the parameters showed higher values at 90 DAS, the values of P content and % Pdff were higher at 45 DAS indicating the dilution effect of the dry matter produced at 90 DAS on these two parameters.

Table 2. Changes in yield and p uptake parameters of castor crop as influenced by age of crop

Particulars	45 DAS	90 DAS
Yield (q/ha)	3.89	17.21
P - content (%)	0.329	0.309
P - uptake (kg/ha)	1.28	5.32
Pdff (%)	29.14	20.07
Fert. P uptake (kg/ha0	0.41	1.20
P utilisation (%)	2.51	7.20
P uptake from soil (kg/ha)	0.94	4.37

The relative changes in uptake of soil and fertilizer P by castor at both the stages of growth are shown in Fig. 1. The uptake of native P at 45 DAS was not influenced significantly by sources and levels P applied while the effects were observed to be significant at 90 DAS. The soil P uptake at 45 DAS was more or less constant for the levels of P applied.

This can be attributed to the increased exploitation of soil by deep root system of castor besides the possible priming effect of applied P releasing more of native P for crop use.

The results also showed that DAP was superior to SSP as it increased the dry matter yield and P uptake parameters of castor at both stages of crop growth. The NH_4^+ ion associated with the phosphorus in the complex fertilizer DAP might have increased the P uptake by castor. The associated NH_4^+ decreases the soil pH which helps to increase P uptake by the crop. Rennie and Soper (1958) and Grunes (1959) recognised that rapidly absorbable NH_4^+ ion had beneficial affect on the uptake of anion such as $H_2PO_4^-$

Thus the results of the investigation showed that application of phosphate upto 60 kg P_2O_5/ha as DAP is beneficial to castor grown on red sandy loam (*Chalka*) soil under rainfed conditions.

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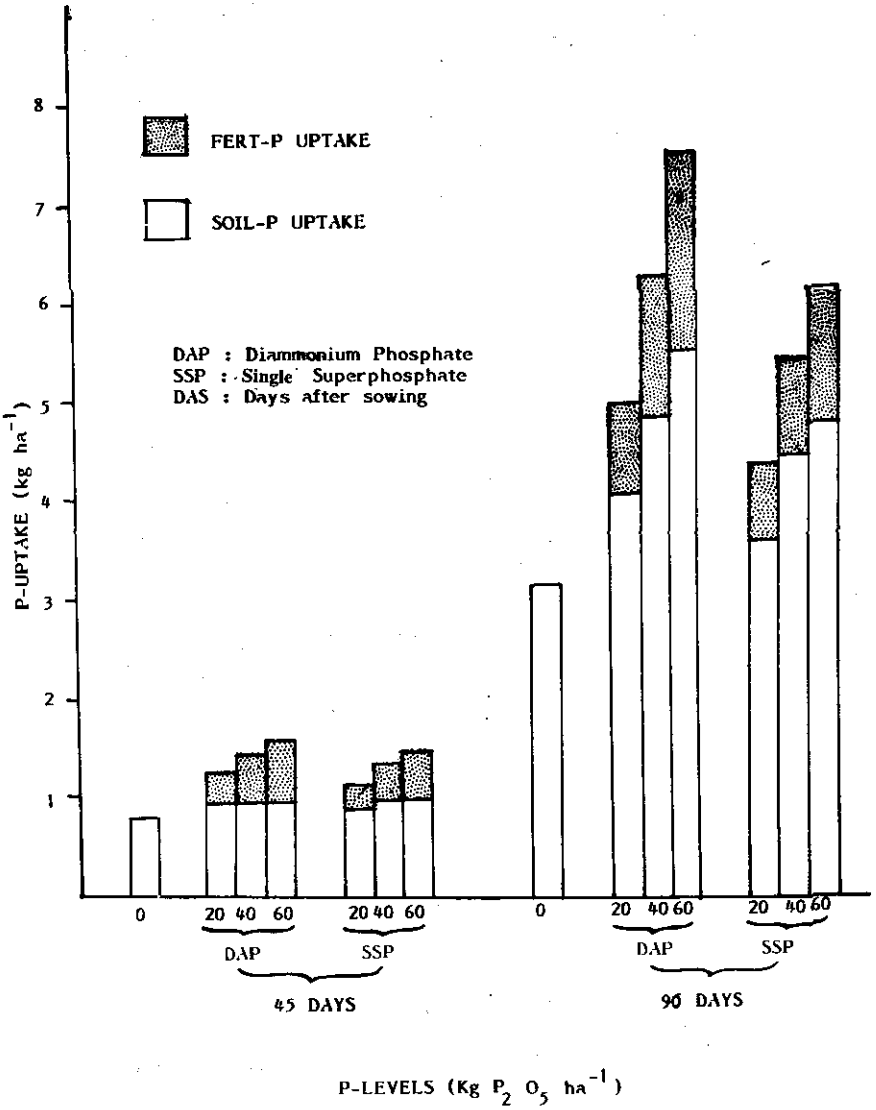

Fig 1. PHOSPHORUS UPTAKE (kg ha^{-1}) BY CASTOR

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STUDIES ON OCCURRENCE AND DISTRIBUTION OF GROUNDNUT (*Arachis hypogaea* L.) THRIPS*

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ABSTRACT

Experimental groundnut crop of variety MH-2 was surveyed for thrips fauna in *kharif* season of 1988. The crop was inhabited by different species of thrips, *Frankliniella sulphurea* Schmutz, *Megalurothrips usitatus* (Bagnall) and *Thrips palmi Karny* were floricolous thrips, whereas *Caliothrips indicus* (Bagnall) and *Scirtothrips* dorsalis Hood were found on foliage. On the basis of their relative duration of occurrence, they were designated as primary and secondary species. The distribution pattern of *C. indicus* was of a regular type.

Key Words : Groundnut; Floricolous thrips; *Caliothrips indicus*.

Many species of thrips infest groundnut crop. Seventeen species of thrips in the world have been reported feeding on groundnuts (Smith and Barfield, 1982). The major pests in India are *Scirtothrips dorsalis* Hood, *Caliothrips indicus* (Bagnall) and *Frankliniella sulphurea* (Trybom) (Amin, 1988). Miyazaki *et al.*, (1984) recorded *Megalurothrips usitatus* (Bagnall) as another floricolous thrips on mungbean and groundnut. Sakimura *et al.*, (1986) reported that *Thrips palmi Karny* attacks all plant parts on a variety of plants especially solonaceous crop (except tomato), cucurbits, legumes and ornamental plants. These thrips are known to cause direct and indirect loss by sucking the sap and as vectors respectively. As studies are lacking on the occurrence and distribution of various thrips infesting groundnut crop, a detailed study was undertaken to ascertain the thrips infesting groundnut crop from seedling to harvest stage.

MATERIALS AND METHODS

Field experiments were conducted during *kharif* season of 1988 at Water Technology Centre, I.A.R.I. New Delhi, to determine the occurrence of various foliage and floricolous thrips throughout the cropping season. The distribution of *Caliothrips indicus* (Bagnall) was undertaken on the groundnut field in detail on the plant. The test variety was MH-2. Weekly sampling was done in 50 randomly selected plants, starting 7 days after sowing and continued till harvest. Observations were also recorded on 50 flowers at random to find out the occurrence of various floricolous thrips. To work out the distribution of *C. indicus* within groundnut plant, 3 leaves from top, 4 leaves from middle and 3 leaves from bottom portion of each plant were sampled randomly. The care was taken to include the terminal leaves at the time of sampling top leaves as *Caliothrips* are known to inhabit terminal leaves. Collection of the plant samples was done in small plastic bag and enough care was taken to observe that thrips do not escape. Each plastic bag was numbered plant-wise and leaflet-wise accordingly. After collection from the field, the thrips were transferred with fine camel hair brush into homeopathic vials containing 70 per cent alcohol and little drop of Triton-X. Vials were labelled accordingly. After storing the thrips they were processed for microscopic study. The method described by Mound and Pitkin

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(1972) was followed in preparing the slides. The slides were examined under microscope for identification of different species. The species encountered during study were identified using keys to different workers, such as Palmer (1987) for *Megalurothrips usitatus* (Bagnall), Bhatti (1980) for *Thrips palmi* Karny, Faure (1962) and Wilson (1975) for *Caliothrips indicus* (Bagnall), Mound and Palmer (1981) for *Scirtothrips dorsalis* Hood and *S. oligochaetus* (Karny). After identification, the data were statistically analysed.

The mean variance and K (distribution parameter) were calculated (Bliss and Fisher, 1953), for the major thrips, *C. indicus* on foliage and *F. sulphurea* on flowers.

RESULTS AND DISCUSSION

Five different thrips were found to infest different plant parts of groundnut crop starting from seedling to harvest stage.

I. OCCURRENCE OF FOLIAGE THRIPS

Two thrips viz., *Caliothrips indicus* (Bagnall) and *Scirtothrips dorsalis* Hood were found mainly on groundnut foliage through out the crop growth. Other thrips found in small numbers on foliage were *Scirtothrips oligochaetus* (Karny), *Frankliniella sulphurea* Schmutz and *Thrips palmi* Karny.

I.1 *Caliothrips indicus* (Bagnall)

This thrips constituted the major thysanopteran infesting groundnut foliage from seedling to harvest stage. The adults were found feeding on the upper surface and caused white spots or white streaks in the beginning, but as the severity of infestation increased, the stippling of leaves and drying was observed later. Population started gradually building up from its first appearance and attained a peak of 244 thrips per 50 plants in the seventh week (Table 1). The population remained at a peak somewhat constantly from first to third week of September (i.e., 7th week to 9th week of crop growth). The population declined during the last two weeks of crop growth to 84 and 73 thrips per 50 plants. The males were less than females throughout the season. The sex ratio was 1:13 (Male:Female). This species constituted 95 per cent of the total thrips sampled on foliage.

Table 1. Occurrence of different thrips on groundnut foliage, *kharif* 1988.

Week	Number of thrips collected on 50 plants (weeks after sowing)	
	Caliothrips indicus	*Scirtothrips dorsalis*
1	61	-
2	161	6
3	235	8
4	206	5
5	42	-
6	205	16
7	244	14
8	243	19
9	240	23
10	181	8
11	191	-
12	192	-
13	152	-
14	143	-
15	84	-
16	73	-
Total	2553	103
Sex ratio	13:1	11:1

Sixty five other thrips includes *S. oligochaetus*, *F. sulphurea* and *T. palmi*

I.2 *Scirtothrips dorsalis* Hood

This thrips started infesting groundnut from the second to eleventh week of the crop growth. The maximum number was attained in the

tenth week (last week of September) with 23 thrips per 50 plants. The feeding by *Scirtothrips* produced yellowish green patches on the upper surface of leaves and necrotic area on the lower side of leaflets. At latter stages, the leaves were found to curl. The sex ratio (Male:Female) was 1:11. This thrips constituted nearly 4 per cent of the foliage thrips during *kharif* 1988 (Table 1).

II. OCCURRENCE OF FLOWER THRIPS

The data collected on floricolous thrips infesting groundnut are presented in Table 2. The various thrips encountered are as follows :

II.1 *Frankliniella sulphurea* Schmutz

The thrips appeared on flower buds and flowers, starting from flowering till last and were also found on foliage before flowering in relatively small numbers. They constituted 75 per cent of the flower thrips. The peak activity was seen in the last week of September with 79 female thrips per 50 flowers. The males were less than females. The sex ratio (males : females) was 1:28 (Table 2).

This species was also found on the foliage for a short period from 10th to 12th week.

Frankliniella schultzei Schmutz., a vector of TSMV (Sakimura, 1962) a disease of economic importance for several crops including groundnut, in which it causes Bud Necrosis Disease (Amin *et al.*, 1981; Amin and Reddy, 1983) was not found in survey of various thrips in the present experiment. However, *F. schultzei* is usually considered synonym of *F. sulphurea*, although the latter species seems to be distinct. In view of the differences in nomenclature (Bhatti *et al.*, 1989), it is not possible to ascertain the species on groundnut reported by Amin *et al.*, (1981). The experimental studies undertaken in Delhi, *F. schultzei* on groundnut was not observed although *F. sulphurea* was quite common.

II.2 *Megalurothrips usitatus* (Bagnall)

This species was found on flowers after *F. sulphurea*. A maximum of 17 females per 50 flowers were observed in the last week of September (8th week). Males were not encountered during the study. This species

Table 2. Occurrence of floricolous thrips on groundnut, *kharif* 1988

		Number of thrips collected (at weeks after sowing)										Total	Sex ratio
		3	4	5	6	7	8	9	10	11	12		
1.	*Frankliniella sulphurea*												
	Females	45	24	12	38	54	79	36	32	9	4	333	28:1
	Males	-	-	1	-	1	8	1	1	-	-	12	
2.	*Megalurothrips usitatus*												
	Females	-	4	3	13	8	17	11	11	5	2	74	
	Males	-	-	-	-	-	-	-	-	-	-	-	
3.	*Thrips palmi*												
	Females	17	12	2	-	1	3	-	-	-	-	35	9:1
	Males	-	2	1	-	1	-	-	-	-	-	4	
	Total	62	42	19	51	65	107	48	44	14	6	450	

Others include *S. oligochetus*, *F. sulphurea*, larvae and pupae

constituted 16 per cent of the flower thrips collected on groundnut.

II.3 *Thrips palmi Karny*

Another species, *T. palmi* was found on flowers from third to eighth week. A total of 35 females and 4 males were collected. The sex ratio (male : female) was 1:9. This species constituted 8 per cent of the thrips collected on flowers. This thrips is being reported from groundnut for the first time.

On the basis of their relative duration of occurrence on flowers and foliage, species of thrips have been designated as primary and secondary (Vishwanathan and Anantakrishnan, 1976). *F. sulphurea* is the primary species, being the first to appear within the flowers and occurring throughout the flowering season. *M. usitatus* and *T. palmi* represent the secondary species on the flowers, occurring comparatively in fewer numbers than the primary species. These secondary species occurred throughout the period of study but displayed considerable irregularity in their population trend. *C. indicus* is a major primary foliage infesting thrip, since it occurred throughout the season. *S. dorsalis* is a secondary thrips found on foliage since they were found to occur in much smaller numbers as compared to *C. indicus*.

Amin and Palmer (1985) reported *F. schultzei* from groundnut, whereas (Amin *et al.*, 1981) reported the transmission of Tomato spotted wilt virus (TSWV) by this thrips species, causing bud necrosis disease (BND). Amin and Palmer (1985), while reporting *F. schultzei* did not indicate whether they found the so-called yellow form (*sulphurea*) or the dark (*schultzei*) form. Sakimura's conclusive evidence on *sulphurea* and the non-specific report of *schultzei* by Amin and Palmer cast doubt on the identity of the species reported by them. However, they apparently had the true *schultzei* before them, which is known as vector of TSWV, since Amin *et al.*, (1981) found evidence of the transmission of this virus by what recorded as *F. schultzei*.

III. DISTRIBUTION OF *C. INDICUS* WITHIN GROUNDNUT PLANT

C. indicus specimens were collected on 3 leaflets from the top portion, 4 leaflets from the middle portion and 3 in the bottom portion at random in 50 plants to know their distribution within the plant, and the data are presented in Table 3.

The data was arranged in frequency table, and mean, variance and K values (distribution parameter) were worked out. It is clearly evident that a maximum mean of 3.38 thrips on top portion in sixth week, 1.84 in middle portion during fifth week, 1.06 in lower portion of leaves in fourth week, respectively were observed. As the variance calculated was less than the calculated mean and K values were minus in most of the cases, the data indicates that dispersion pattern of *C. indicus* is of regular type, as individuals are arranged at regular intervals.

T-test was employed to know which plant part is the most preferred and as there was no significant difference observed between top portion and middle portion of leaflets, it can be concluded that there is no difference in infestation level by *C. indicus* with reference to top and middle portion of the plant.

The data from Table 3 also indicate that population on top portion of the plant started building up from its occurrence till sixth week (except in fifth week, when it heavily rained) and afterwards slowly declined. In middle portion of the plant population was present throughout the plant and was not affected due to rainfall. There was significant difference between top and bottom portion, middle and bot-

Table 3. Distribution of *Caliothrips indicus* at various levels of groundnut foliage

Weeks after sowing	Top leaves			Middle leaves			Bottom leaves			Total
	Mean ($\bar{x}$)	variance (s)	K	Mean ($\bar{x}$)	Variance (s)	K	Mean ($\bar{x}$)	Variance (s)	K	
1.	0.70	0.21	-1.01	0.36	0.32	-2.3	0.08	0.07	-1.31	1.18
2.	0.82	0.52	-2.23	1.40	1.22	-11.17	0.50	0.62	-0.04	2.64
3.	1.98	0.75	-3.12	1.74	0.77	-3.11	0.42	0.49	2.40	4.30
4.	1.54	1.07	-5.04	1.32	0.55	-2.26	1.06	1.08	62.56	3.92
5.	0.20	0.16	-1.09	1.84	0.55	-2.01	0.10	0.09	-1.23	0.62
6.	3.38	2.36	-11.23	1.26	0.52	-2.15	0.64	0.52	-3.44	3.79
7.	2.34	0.92	-3.86	1.68	0.55	-2.49	0.50	0.42	-3.06	4.56
8.	2.14	0.78	-3.36	1.76	0.68	-2.86	0.46	0.29	-1.28	4.66
9.	2.36	1.01	-4.13	1.74	0.36	-2.19	0.48	0.42	-3.71	4.62
10.	1.38	0.69	-2.76	1.28	0.74	-3.01	0.60	0.45	-2.38	3.16
11.	1.66	0.60	-2.59	1.20	0.53	-2.15	1.00	0.98	-49.00	3.60
12.	1.56	0.70	-2.83	1.36	0.72	-2.91	0.76	0.55	-2.80	3.68
13.	1.68	2.39	4.00	1.06	0.67	-2.88	0.52	0.42	-2.65	3.02
14.	0.94	0.55	-2.25	1.18	0.72	-3.04	0.44	0.50	3.44	2.54
15.	0.74	0.28	-1.19	0.64	0.48	-2.56	0.24	0.18	-1.07	1.64
16.	0.72	0.37	-1.48	0.56	0.46	-3.00	0.04	0.03	-1.96	1.34

t value for top and middle = 1.017
t value for top and bottom = 4.516
t value for middle and bottom = 5.60
Significant at 0.01 level

top portion, indicating that leaflets of bottom portion of plant are not preferred by *C. indicus*.

The distribution pattern of *C. indicus* was of regular type. There was no difference in the preference and infestation by *C. indicus* on leaflets from top and middle portion of the plant. *C. indicus* population declined in top portion with heavy rains, but in middle portion the population remained at the same level even after good rainfall. The lower leaves were less infested and not preferred, probably due to maturity and yellowing of leaves. The distribution of *C. indicus* on newly emerging leaflets in top portion and leaflets from middle portion is in contrary to the findings of Amin and Palmer (1985) who reported that *C. indicus* inhabits older leaves by remaining on the upper surface.

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EFFECT OF DIFFERENT DOSES OF NITROGEN ON SOME TARAMIRA (*Eruca sativa* L.) VARIETIES

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ABSTRACT

The effect of four nitrogen levels (0, 15, 30 and 45 kg/ha) was studied on taramira varieties (T 27, RTM 2, Job-TC 1 and Job-TC 2) for two consecutive seasons at Agronomy Farm, SKN College of Agriculture, Jobner. Application of nitrogen at 45 kg, remaining at par with 30 kg N/ha, significantly increased the seed yield and ancillary characters such as test weight, siliquae per plant, seeds per siliqua, plant height and dry matter per plant and water use efficiency over control and 15 kg N/ha. Among the varieties, Job-TC 2 provided significantly more seed yield, test weight, siliquae per plant and seeds per siliqua over T 27. However, plant height, dry matter per plant and crop growth rate were significantly higher in variety Job-TC 1 over RTM 2.

Key words : *Eruca sativa* L.; Nitrogen levels; Yield.

Taramira is a hardy winter season oilseed crop, well adapted to poor sandy soils having limited moisture storage capacity. In drought years, it is a preferred late sown crop grown on residual soil moisture during the winter season. The crop has almost been neglected by the agricultural scientists and practically no work has been done to establish the optimum dose of nitrogen for different taramira varieties under dryland conditions.

MATERIALS AND METHODS

A field experiment was conducted in two winter seasons of 1987-88 and 1988-89 at SKN College of Agriculture, Jobner (Rajasthan). The soil of experimental field was loamy sand having adequate drainage with low water holding capacity, low organic carbon (0.21%), Available N (75.0 kg/ha) and P (17.0 kg P_2O_5/ha) and medium available K (150.0 kg K_2O/ha). The treatments comprising four nitrogen levels (0, 15, 30, and 45 kg/ha) and four varieties (T 27, RTM 2, Job-TC 1 and Job-TC 2) were replicated four times in Randomized Block Design. Varieties T 27, RTM 2, Job-TC 1 and Job- TC 2 mature in 150, 140, 146 and 143 days and contain 34.0, 33.6, 38.0 and 38.1 per cent oil, respectively. A basal dose of 20 kg P_2O_5/ha and nitrogen as per treatments was drilled at the time of sowing. The total rainfall received during 1987-88 and 1988-89 seasons was 24.5 and 27.0 mm, respectively. Besides a pre-sowing irrigation of 60.0 mm, one life saving irrigation of 45.0 mm was applied at flowering stage. The crop was sown in rows 30 cm apart with a seed rate of 5.0 kg/ha. The crop growth rate (CGR) was computed as per procedure outlined by Watson (1952) and the field water use efficiency was calculated by dividing the crop yield with water used in ha-mm.

RESULTS AND DISCUSSION

Effect of nitrogen

Application of nitrogen at 45 kg/ha remaining comparable to 30 kg N/ha significantly increased the seed yield over 0 and 15 kg N/ha during both the years. This was due to combined effect of the increased number of siliquae, number of seeds per siliqua and 1000 seed weight which resulted in higher seed yield

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Table 1. Effect of nitrogen on yield and yield attributes of taramira varieties

Treatments	Seed yield (kg/ha)			Test weight (g)			Siliquae/plant			Seeds/siliqua		
	1987-88	1988-89	Mean	1987-88	1988-89	Mean	1987-88	1988-89	Mean	1987-88	1988-89	Mean
Nitrogen (kg/ha)												
0	714	728	721	3.44	3.41	3.43	75	80	78	15.9	15.0	15.5
15	786	790	788	3.46	3.60	3.53	94	95	95	16.2	16.1	16.2
30	834	855	845	3.61	3.70	3.66	110	115	113	17.2	18.0	17.6
45	876	863	870	3.58	3.71	3.65	122	125	124	16.7	18.2	17.5
CD 5%	64	60	-	0.14	0.17	-	4.4	8.0	-	NS	1.9	-
Varieties												
T 27	775	780	778	3.40	3.50	3.45	99	98	99	16.5	16.4	16.5
RTM 2	806	812	809	3.54	3.62	3.58	100	107	104	15.2	16.9	16.1
Job-TC 1	760	763	762	3.51	3.63	3.57	96	94	95	16.9	15.5	16.4
Job-TC 2	869	880	875	3.66	3.67	3.67	106	116	111	18.1	18.3	18.2
CD 5%	64	60	-	0.14	0.17	-	4.4	8.0	-	1.7	1.9	-

Table 2. Effect of nitrogen on water use efficiency (WUE) and growth of taramira varieties

Treatments	WUE (kg/ha -mm)			Plant height (cm)			Dry matter/plant (g)			CGR (g/day) 60 -90 DAS		
	1987-88	1988-89	Mean	1987-88	1988-89	Mean	1987-88	1988-89	Mean	1987-88	1988-89	Mean
Nitrogen (kg/ha)												
0	6.87	6.93	6.90	74	78	76	14.5	16.8	15.7	0.15	0.16	0.16
15	7.49	7.52	7.51	81	83	82	18.0	18.2	18.1	0.17	0.19	0.18
30	7.94	8.14	8.04	83	89	86	18.6	19.7	19.2	0.23	0.25	0.24
45	8.34	8.22	8.28	83	90	87	19.4	20.0	19.7	0.25	0.24	0.25
CD 5%	0.44	0.55	-	5.5	6.0	-	1.9	1.8	-	0.02	0.03	-
Varieties												
T 27	7.38	7.43	7.41	82	88	85	18.6	18.2	18.4	0.22	0.21	0.22
RTM 2	7.68	7.73	7.71	78	83	81	15.5	17.9	16.7	0.20	0.22	0.21
Job-TC 1	7.23	7.27	7.25	82	91	87	18.8	20.0	19.4	0.24	0.23	0.24
Job-TC 2	8.28	8.30	8.29	78	81	80	17.7	18.6	18.2	0.14	0.20	0.17
CD 5%	0.44	0.55	-	NS	6.0	-	1.9	1.8	-	0.02	NS	-

under this treatment. These results corroborate the findings of Jat *et al.*, (1987) who found 30 kg N/ha as an optimum dose of nitrogen for taramira. The field water use efficiency, plant height, dry matter per plant and crop growth rate were also significantly higher under 45 kg N/ha when compared with control but it was closely followed by 30 kg N/ha. The response of taramira to nitrogen application in terms of improved growth, yield and water use efficiency could be supported by the fact that the soil of the experimental field was deficient in available nitrogen (75.0 kg/ha). The significant and positive correlations and linear relationships existed between seed yield and number of siliquae ($r = 0.50^*$; $y = 4.73 + 0.04 X$) and test weight ($r = 0.50^*$; $y = 7.30 + 4.35 X$) during 1987-88 also extended the support for higher seed yield with nitrogen application. similar results were also reported by other workers (Anon., 1984 and 1985).

Varieties

Among the varieties tested, variety Job-TC 2 offered the maximum seed yield (875 kg/ha), representing an increase of 113, 97 and 66 kg/ha in two year's average seed yield, respectively over Job-TC 1, T 27 and RTM 2. The higher seed yield obtained under variety Job-TC 2 was due to the cumulative effect of yield attributes such as number of siliquae, seeds per siliquae and test weight which were maximum under this variety during both the years. The differential behavior of taramira varieties could be explained by the variation in their genetic make up (Maliwal *et al.*,1984). Besides higher seed yield the variety Job-TC 2 also recorded the maximum field water use efficiently. Variety Job-TC 1, however proved to be significantly superior to RTM 2 with respect to plant height (during 1988-89) dry matter per plant and CGR during both the years.

Based on the results of two years, it could be inferred that variety Job-TC 2 fertilized with 30 kg N/ha proved to be important production factor for enhancing yields of taramira in light textured soils of Rajasthan.

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STABILITY ANALYSIS FOR SEED YIELD AND ITS COMPONENTS IN NIGER UNDER RAINFED CONDITIONS

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ABSTRACT

Ten genotypes of niger grown from 1987 through 1990 were evaluated for stability parameters with respect to seed yield and its components under rainfed conditions. Genotype-environment interaction was observed. Linear as well as non-linear components accounted for the interaction present, however, the former contributed to a greater part. CHH-3 was found to be stable and desirable genotype for all the traits studied under varied environmental conditions. Varieties CHH-1, CHH-2 and Ootacmund with high seed yield were also stable for most of the characters including seed yield.

Key words : *Guizotia abyssinica* Cass.; Genotype x Environment interaction; Stability analysis

Marginal farmers generally grow niger under rainfed conditions. Fluctuation in yields affects therefore yield stability becomes a factor of prime importance. A precise knowledge of the nature and magnitude of genotype x environment interaction is very important in understanding the stability in yield of a particular variety before it is recommended for general cultivation. for the successful cultivation of niger. It is essential to identify the suitable genotype over varying environmental conditions. The present study was aimed at identifying such varieties.

MATERIALS AND METHODS

The experimental materials comprised ten genotypes of niger (namely CHH-1, CHH-2, CHH-3, Comp. II, Ootacmund, IGP-76, No. 71, GA-10, KEC-1 and RCR- 140) which were grow during kharif, 1987, 1988, 1989 and 1990 (making four environments) at Zonal Agricultural Research Station, Chhindwara (M.P.). The experiment was raised in a Randomized Block Design with four replications. Each plot comprised six rows of 5.0 m length with row to row spacing of 30 cm and plant to plant spacing of 10 cm. Data were collected on days to 50% flowering, days to maturity, plant height (cm), number of branches per plant, number of capsules per plant, seed yield per plant (g) and 1000-seed weight (g). Stability analysis was done following Eberhart and Russel (1966).

RESULTS AND DISCUSSION

Results of analysis of variance (Table 1) revealed that the mean squares due to genotypes and environments (when tested against both pooled error and deviation) showed highly significant differences for all the characters, suggesting presence of genetic variability in the material as well as among the environments for all the characters studied. Genotype x environment interactions were also found to be significant (when tested against pooled error) for all the characters. The mean square due to environment plus genotype-environment interaction were highly significant (when tested against both pooled error and deviation) for all the characters. The significant portion of these interactions was due to the linear component. Highly significant mean squares due to environments (linear) (when tested against both pooled error and deviation) for all the characters indicated differences between environments and their considerable influence on all the characters. The

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Table 1. Analysis of variance (mean squares) for stability of seed yield and its components in niger

Source of variance	df	Days to 50% flowering	Days to maturity	Plant height	No. of branches per plant	No. of capsules per plant	1000-seed weight	Seed yield per plant
Genotype	9	80.27++**	88.09++**	190.22+ **	3.81++**	38.99++**	0.06++**	0.78++**
Environment	3	303.69++**	374.44++**	2407.88++**	78.89++**	227.47++**	0.35++**	12.34++**
Genotype x Environment	27	2.30**	1.49**	103.07**	1.07**	10.06**	0.014**	0.19**
Env. + (Geno. x Env.)	30	32.44++**	38.70++**	333.55++**	8.85++**	31.80++**	0.05++**	1.40++**
Environment (linear)	1	911.08++**	1123.33++**	7223.65++**	236.67++**	682.40++**	1.04++**	37.01++**
Geno. x Env. (linear)	9	1.53**	1.39**	115.11**	1.75++**	10.87**	0.011*	0.33+ **
Pooled Deviation	20	2.42**	1.39**	87.22**	0.66**	8.69**	0.014**	0.10*
Pooled error	108	0.22	0.22	14.34	0.30	1.65	0.007	0.06
p($\bar{x}_i$ and b_i)		0.85**	0.17	0.39	0.26	0.12	-0.34	0.64*
p($\bar{x}_i$ and S^2_{di})		0.78*	0.24	0.73*	-0.44	-0.34	-0.43	-0.06
p(b_i and S^2_{di})		0.55	-0.19	0.50	-0.10	-0.47	0.18	-0.08

* P = 0.05 ; ** = 0.01 against pooled error
+ P = 0.05; ++ = 0.01 against pooled deviation

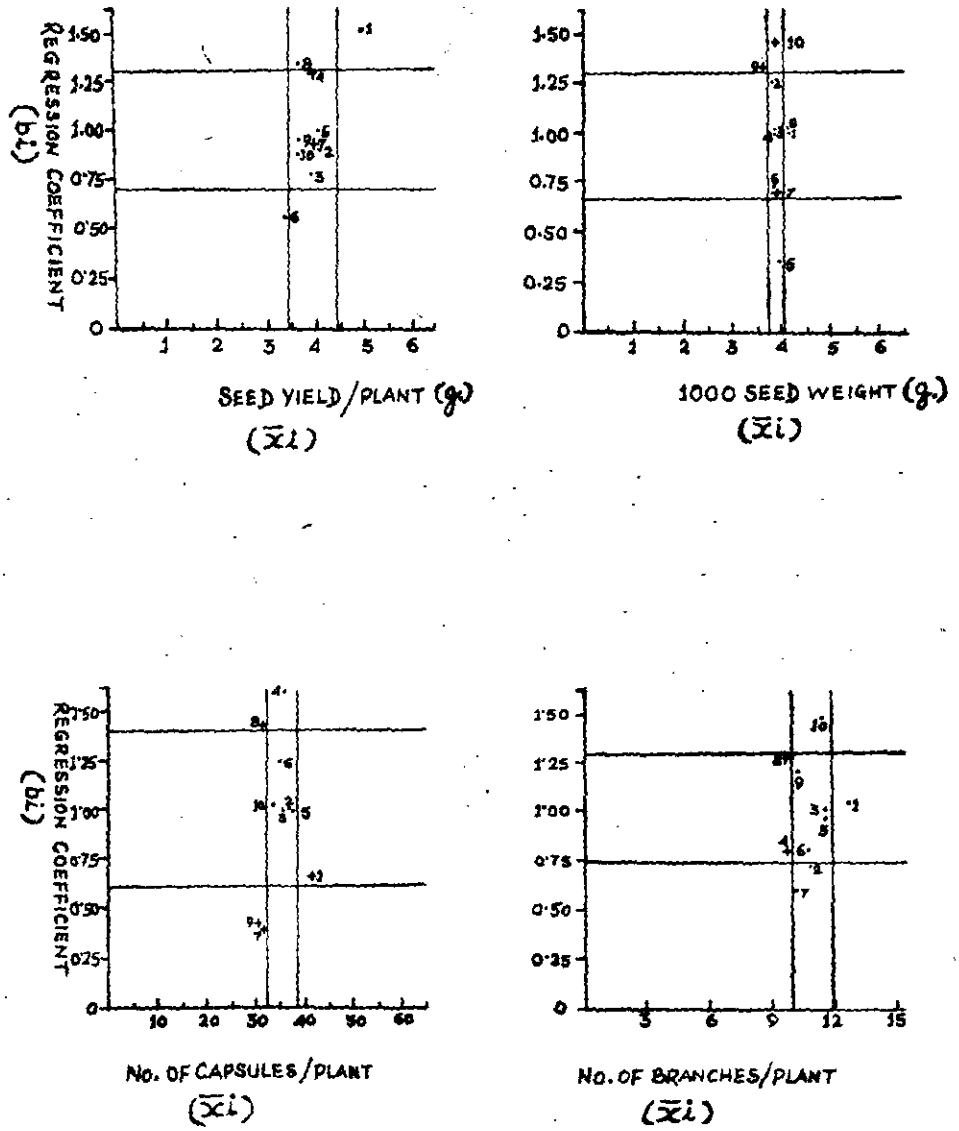

FIG.-1 : The relation of mean value (xi) and regression coefficient (bi) for different characters for stability of ten genotypes of niger. Estimates of S^2 di were significant (P=.05) only for those genotypes indicated by +.

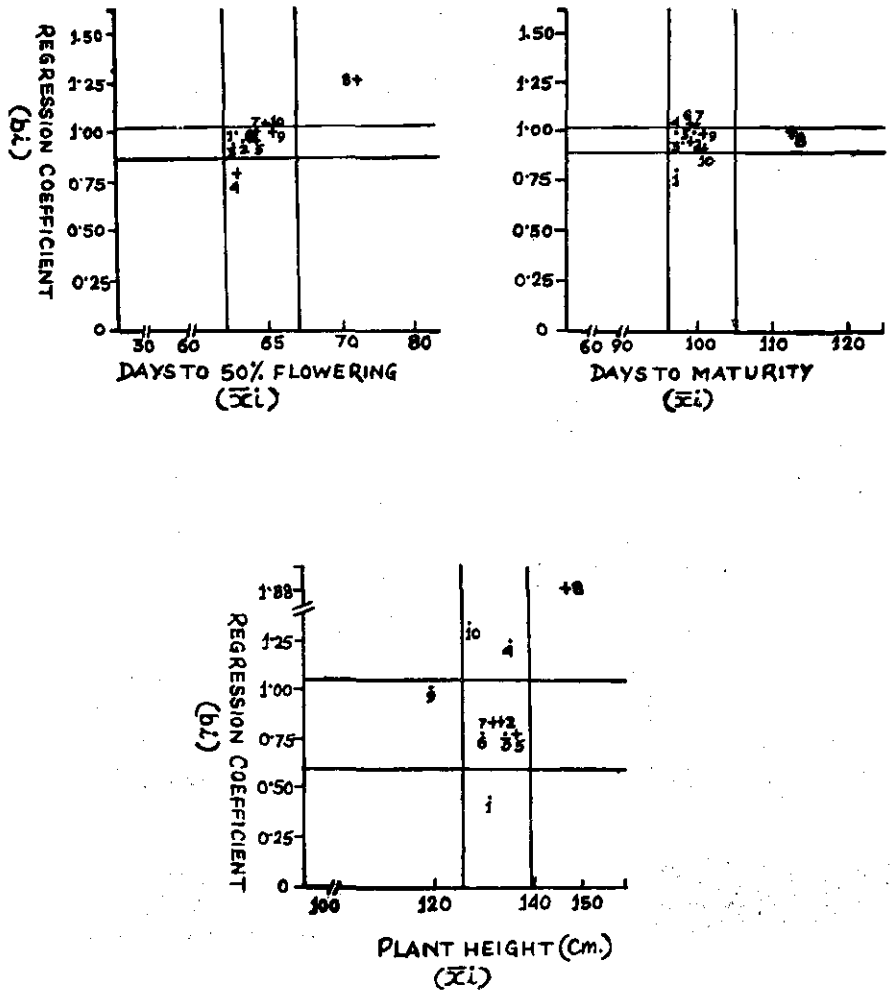

FIG.-2 : The relation of mean value (xi) and regression coefficient (bi) for different characters for stability of ten genotypes of niger. Estimates of S^2 di were significant (P=.05) only for those genotypes indicated by +.

mean squares due to genotype x environment (linear) were significant (when tested against pooled error) for all the characters indicating that linear component of genotype-environment interactions was present. This suggested that variation in the performance of varieties when grown over environments could be predicted. Such results were also reported by Varulkar and Upadhyay (1989) . However, the significant variances due to pooled deviatior for all the characters indicated that genotypes differed with respect to their stability suggesting that performance of varieties was predictable.

The stability performance of ten genotypes are presented graphically in Fig.1 and Fig.2. According to Eberhart and Russel (1966) an ideal genotype may be characterized as having high mean, a regression coefficient equal to unity and deviation from regression near to zero. They further pointed out that the varieties exhibiting high regression coefficient ($b_i > 1$) could be considered as below average stable varieties. Such varieties will perform well only in favourable environments while their performance will be poor in unfavourable environments. The varieties with low regression coefficient ($b_i < 1$) are above average stable and are adapted specifically to poor environments.

CHH-3 was found to be stable and desirable genotype for all the traits studied with average mean performance and average response under varied environmental conditions. Genotype CHH-1 with significant highest mean seed yield was below average stable for all the characters except number of capsules per plant and was found desirable under favourable environments only. While variety IGP-76 with lowest mean seed yield was above average stable for all traits except due to maturity and found desirable specifically under poor environments. Genotypes, CHH-2 and Ootacmund with mean seed yield at par with population mean were stable and also desirable for most of the traits except plant height. The other unstable trait in CHH-2 is days to maturity, while in Ootacmund it is days to 50% flowering. Variety No.71 with low mean seed yield was incidentally found to be the most unstable for all the traits except number of branches per plant hence undesirable under all the environments.

The significant correlation (Table 1) between $\bar{x}_i$ and b_i for days to 50% flowering and seed yield per plant and between $\bar{x}_i$ and S^2 di for days to 50% flowering and plant height suggested that simple use of mean values of these characters could be made to judge the stability of these genotypes. The lack of association between these parameters with respect to other characters indicate involvement of different genetic systems in the control of these characters.

It may be concluded that among the materials evaluated CHH-1, CHH-2, CHH-3 and Ootacmund with good yield potential, average plant height, medium maturity were found to be stable and desirable with respect to most of the traits studied. In addition, these genotypes can serve as useful parents in breeding programme.

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UNCONVENTIONAL OIL : PHYSICO-CHEMICAL AND NUTRITIONAL EVALUATION OF MESUA FERREA KERNEL OIL

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ABSTRACT

Mesua ferrea kernel oil contains unsaturated fatty acids with saturated fatty acids in the ratio of 73.6:26.4 and oleic acid being maximum (53%). While refined oil appeared less viscous, light in colour crude oil was thick and dark. Nutritional evaluation revealed that the refined oil was comparable to sunflower oil. On the contrary, crude oil showed growth retardation, alopeacia, higher lipid and cholesterol levels and abnormal histopathoology of the liver.

Key Words : Mesua ferrea kernel; Guttiferae; Mesuol; Body Nitrogen; Feed Efficiency ratio; Apparent digestibility; Cholesterol; Triglycerides; LDL and HDL cholesterol; Phospholipids.

Mesua ferrea trees belonging to family "Guttiferae" and species *M. ferrea* Linn and are commonly known as *Nagakesara/Nagachampakam* in regional language. They are mostly found in Himalayas, Nepal, North Eastern India, Deccan peninsula and Andaman Islands. The seeds measure 2.5 cm diameter and are dark brown in colour. Cotyledons are fleshy and oily. The seed contains a pale yellow lactone, Mesuol ($C_{23}H_{22}O_5$. m.p.154) to the extent of 1%. It is probably a 4 phenyl coumarine of complex nature. It also contains another phenolic compound Mesuone ($C_{29}H_{44}O_4$, m.p. 139) in much smaller concentration. Both showed antibacterial activity against many micro-organisms. The seed oil is used as an embrocation in rhematism and for skin diseases (Wealth of India, 1962). The kernels yield 45 per cent other extractives. The LD_{50} value of the crude oil has been reported as 0.6 g/kg body weight. On the other hand refined oil caused no death of animals even at a level of 25 g/kg body weight (Basu *et al.*, 1990). While some information on physico-chemical characteristics and pharmacological use was available, no studies have so far been reported on the nutritional quality of the oil. Hence this study was undertaken to evaluate the physico-chemical and nutritional quality of Mesua ferrea oil (both crude and refined) in comparison with sunflower oil.

MATERIALS AND METHODS

Crude and refined M. ferrea oil samples were obtained from the Director, National Botanical Research Institute, Lucknow, for the purpose of the study.

PHYSICO CHEMICAL CONSTANTS

Both the oil samples were analysed for physical and chemical constants like specific gravity, refractive index and viscosity, acid number, saponification value, Iodine value and unsaponifiable matter using AOAC methods (1984). The fatty acid composition was determined by Gas Liquid Chromatography of Varian Model 3700 using a 15% DEGS column and chromosorb W (45-60 mesh) with a flame ionisation detector, isothermally at 200°C.

Nutritional evaluation : Three groups of male weanling rats (9 in each group) of Wistar strain

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in the weight range of 35 ± 0.5 g were usde. They were fed with isocaloric diets containing 10% lipid and 10% protein, adequate in all vitamins and minerals in the following manner:

Group I - Diet containing refined sunflower oil (SFO- control)

Group II - Diet containing crude Mesua ferrea kernel oil (MEC - Experimental)

Group III - Diet containing refined Mesua ferrea kernel oil (MFR - Experimental)

Weekly body weights and food intakes of all animals were recorded nearest to 0.1 g for 12 weeks.

To study the effect of the experimental oil on protein utilisation of young animals, three rats from each group were sacrificed after 4 weeks feeding and body nitrogen was estimated using the method of Miller and Bender (1955). On the penultimate 12 weeks feeding apparent lipid digestibility in the animals was assessed. Finally on the last day, after overnight fast all the rats were sacrificed and blood and liver tissue were collected, suitably processed for lipid analysis and histopathological study. The total lipids for serum and liver (Fendley *et al.*, 1972); triglycerids (Foster and Dunn, 1973); phospholipids (Marinetti, 1972); total cholesterol (Carr and Drekter, 1956) and HDL cholesterol (Lopex *et al.*, 1977) were determined.Histopathological study was carried out using the standard techniques at Veterinary Biological Research Institute, Hyderabad. Statistical analysis for the data was done using the method of Snedcor and Cochron (1974).

RESULTS AND DISCUSSION

The data pertaining to the physico-chemical constants and nutritional evaluation are presented in Tables 1 to 6.

The physico-chemical parameters revealed that the Mesua ferrea refined oil was closer to sunflower oil. In contrast Mesua ferrea crude oil was dark in colour and indicated high acid value and unsap matter contents (Table 1). The fatty acid composition showed higher proportions of palmtic, stearic and oleic acids than the commonly used edible oils (Table 2).

Symptoms of poor nutrition like growth retardation, alopecia and yellow pigmentation of

Table 1. Physico- chemical characteristics of Mesua ferrea oil vs. edible oils

Characteristics	MFC	MFR	SFO	GNO
Colour	Rust	Yellow	Light yellow	Yellow
Odour	Stong turpentine	Light pungeni	Light yellow	Typical
Specific gravity	0.9167	0.9004	0.9001	-
Refractive Index	1.4690	1.4690	1.4659	-
Viscosity (poises)	43.50	95.2	-	1.72
Acid value	8.60	1.96	-	206.2
Saponification value	159.0	192.0	190.0	206.2
Iodine value	62.0	76.0	122.0	98.2
Unsap matter (%)	8.20	1.6	-	1.1

MFC - Mesua ferrea crude oil
MFR - Mesua ferrea refined oil
SFO - sunflower oil

Table 2. Fatty acid composition of Mesua ferrea oil vs. edible oils

Fatty acids	MFC	MFR	SFO	GNO
Palmitic (C 16:0)	19.0	19.8	5.5	14.3
Stearic (C 18:0)	7.4	6.9	4.7	3.1
Oleic (C 18:1)	53.0	53.8	19.5	42.6
Linoleic (C 18:2)	20.3	19.2	68.5	35.9
Linolenic (C 18:3)	0.3	0.3	0.1	-
Total saturated	26.4	26.7	10.2	17.4
Total unsaturated	73.6	73.3	88.1	78.5

1. Julie, M.J. (1989)
2. Rukmini, C. (1990)

the skin were observed markedly in rats fed with Mesua ferrea crude oil. Contrary to this, the growth performance in animals fed with Mesua ferrea oil was good and comparable to sunflower oil and other most commonly used oils. A similar trend was also observed in feed efficiency ratio (Table 3). Feeding the rats with diets containing either crude or refined Mesua ferrea oil did not indicate any difference in apparent digestibility.

The lipid profile in the serum (Table 4) indicated that feeding Mesua ferrea crude oil increased the total lipids, triglycerides and phospholipids contents. However, the levels of these components were lower in the serum of rats fed with Mesua ferrea refined oil. At the same time the values were comparable with sunflower oil (control).

Regarding the total cholesterol, the level in serum in the Mesua ferrea refined oil group was higher than that of Mesua ferrea oil. Though the level was higher it contained higher level of HDL cholosterol which is of nutritional importance in reducing the risk of cardio vascular diseases. This response was in contrast to those other conventional and unconventional oils like rubber seed oil, palm kernel oil and coconut oil wherein a decrease in HDL cholesterol has been reported(Nwokolo *et al.*, 1988).

The liver weights as per cent of body weight (Table 5) showed significant differences both in Mesua ferrea refined oil and Mesua ferrea crude oil. The levels of total lipids, total cholesterol and its fractions in liver also showed a similar trend as in serum (Table 5). Higher total lipid content in the liver confirmed the presence of fatty infiltration and necrotic changes on histopathological examination (Table 6).

Table 6. Clinical signs and histopathological changes in livers of rats fed with Mesua ferrea oils vs. sunflower oil

	Mesua ferrea kernel oil		
	MFC	MFR	SUNFLOWER
Clinical signs			
1-4 weeks	Signs of poor growth, Inactive, Mild alpaecia.	Healthy look satisfactory growth	Healthy, no outward clinical signs
5-8 weeks	40-50 per cent alopaecia. Yellow pigmentation of skin. Unhealthy look	Healthy, No clinical changes	Healthy and normal
9-12 weeks	Marked growth retardation, very inactive, 60-70 per cent alopaecia, severe yellow pigmentation on skin	Healthy. No apparent clinical changes	Healthy and normal
Histopathology	Normal size bright red colour very minimal fatty changes	Enlarged and pale look pykenotic and Necrotic changes	Normal size intact stucture bright red in colour

Table 3. Mean weight gain, feed efficiency and digestability of Mesua ferrea oil vs. sunflower oil.

Group	Body weights (g)								
	Initial	After 4 weeks	Gain	After 12 weeks	Gain	Food intake (12 weeks)	FER	Body N	Apparent digestibility (%)
MFC	34.9 ± 3.87	63.6 ± 3.65	28.7 ± 4.52 [b]	132.2 ± 18.75	99 ± 18.49 [b]	779 ± 55.19 [b]	0.13 ± 0.01 [b]	1.87 ± 0.32 [b]	97 [a]
MFR	34.9 ± 3.82	112.0 ± 16.62	77.1 ± 15.20 [a]	203.0 ± 13.99	170 ± 13.43 [a]	941 ± 72.22 [a]	0.18 ± 0.02 [a]	3.31 ± 0.61 [a]	98 [a]
SFO	34.5 ± 3.49	103.8 ± 6.08	69.3 ± 7.37 [a]	211.3 ± 22.08	179 ± 22.07 [a]	998 ± 52.77 [a]	0.18 ±0.02 [a]	3.02 ±0.14 [a]	98 [a]

- Figures carrying the same superscripts are not significantly different (P = 0.05)
- Values represent group averages

Table 4. Mean serum lipid profiles in rats fed with Mesua ferrea oil vs. sunflower oil (mg/dl)

Group	Total lipids	Triglycerides	Phospholipids	Total cholesterol	HDL - C*	LDL - C*	VLDL - C*
MFC	$499^{b+55.55}$ (+99.6)	$73^{b+2.33}$ (+40.4)	$129.3^{a+3.06}$ (+46.6)	$99.7^{a+1.69}$ (+3.5)	$20^{b+3.05}$ (-50.0)	65.1 (+41.8)	14.6
MFR	$183^{c+16.66}$ (-26.8)	$52^{a+17.44}$	$82.0^{a+3.14}$ (-8.7)	$104.7^{b+3.38}$ (+8.7)	$54^{c+3.05}$ (-3.5)	40.3 (-12.2)	10.4
SFO	$250^{a+27.83}$	$52^{a+6.42}$	88.2 + 3.51	$96.3^{a+1.69}$	$40^{a+1.53}$	45.9	10.4

1. * Lopex *et al.*, LDL - C = Total C - (TG/5 + HDL - C) 1977
2. ** VLDL - C = Total C - (HDL - C + LDL - C)

Figures carrying the same superscripts are not significantly different (P < 0.05)
Figures in parentheses represent per cent change from the reference

Table 5. Liver lipid profile in rats fed Mesua ferrea oil vs. sunflower oil (mg/g tissue)

Group	Liver weight (g)	Liver weight as % body weight	Total lipids	Triglycerides	Phospholipids	Total cholesterol
MFC	$7.8^{b+0.96}$ (+14.7)	5.8^{b} (+81.3)	$63.0^{b+1.00}$ (+64.4)	$20.5^{a+1.32}$ (+3.0)	$17.9^{b+5.97}$ (-38.3)	$4.5^{b+0.33}$ (+21.6)
MFR	$7.1^{a+1.20}$ (+4.4)	3.5^{a} (+9.4)	$52.2^{c+1.74}$ (+36.3)	$19.5^{a+1.39}$ (-2.0)	$23.6^{a+7.13}$ (-18.6)	$4.2^{b+0.33}$ (+13.5)
SFO	$6.8^{a+0.80}$	3.2^{a}	$38.3^{a+3.47}$	$19.9^{a+0.06}$	$29.0^{a+4.21}$	$3.7^{a+0.29}$

* Figures carrying the same superscripts are not significantly different ($P < 0.05$)

** Values represent group averages

*** Figures in parentheses represent per cent change with respect to the reference oil

The study therefore concludes that only Mesua ferrea refined oil could be safely recommended for use after conducting the multi-generation studies.

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PRE-SOWING WATER REQUIREMENT FOR FIELD EMERGENCE AND SEEDLING ESTABLISHMENT IN GROUNDNUT (*Arachis hypogaea* L.)

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ABSTRACT

A field experiment was conducted with three pre-sowing irrigation levels (20, 30 and 40 mm)and ten genotypes to assess the minimum rainfall requirement for sowing groundnut seeds to achieve good emergence and crop establishment. Genotypic variation in crop growth rates subsequent to moisture stress alleviation was also assessed. Minimum precipitation required to get about 85 per cent emergence under field conditions is 40 mm. Emergence, leaf area and dry matter accumulation (DMA) on 30 and 60th day after sowing (DAS) were increased with the amount of pre-sowing irrigation. Genotype ICG 7694 had higher leaf area and DMA on stress alleviation (60 th DAS). An attempt was made to relate the leaf expansion rate and dry matter accumulation during stress alleviation with leaf proline content at the end of stress. Proline content was increased with stress at the end of stress period (30 DAS), but it was not related to leaf expansion or DMA rates on stress alleviation across genotypes.

Key words : Groundnut; Pre-sowing; Water requirement; Crop emergence.

Rainfall pattern of southern Karnataka shows a bimodal trend with an average of 120 and 690 mm during pre-monsoon (from April to May) and regular monsoon (from July to November) periods respectively, with a rainfree period of four to five weeks between these periods. It has been observed that, advanced sowing during rainy season enhance the groundnut productivity (Reddy *et al.*, 1990). In such situations, the amount of rainfall required for sowing of crop to obtain good emergence and crop establishment, and faster crop recovery on stress alleviation (moisture stress alleviation after rainfree period of 4-5 weeks) are the major constraints for productivity. Keeping these aspects in view the field experiment was conducted during February-April,1986 (dry season) to asses the minimum amount of rainfall required for seed emergence and crop establishment during pre-monsoon period.

MATERIALS AND METHODS

The field experiment was conducted at GKVK farm, U.A.S., Bangalore on red loamy soils during February-April, 1986 as a split-plot design with three irrigation levels during the time of sowing (20, 30 and 40 mm) as main treatments and ten genotypes as sub treatments which were replicated thrice. Crops were raised following the appropriate package of practices for groundnut.

Irrigation schedule (Table 1) imposed for all the genotypes is as follows :

1. On the dry soil 5 mm irrigation was given to all plots a day before sowing of seeds.
2. Dry sowing was done and then on the same day, according to the treatment 10, 20 and 30 mm irrigation was given respectively.
3. On 5th day after sowing (DAS), 5 mm irrigation was given to all plots uniformly.
4. There was no rainfall or irrigation was given between 6 to 29 DAS and this was considered as stress period.
5. On 30th day and after all plots were irrigated to field capacity at 10 days interval

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and it was continued upto 60th DAS. The crop was continued only upto 60 DAS.

Each genotype was hand dibbled in rows with the spacing of 30 x 15 cm at the rate of one seed

Table 1. Irrigation schedule/ treatments

	Amount of irrigation (mm)						
	On Days after sowing (DAS)						
Trearments	-1	0*	5	30	40	50	60
1. 20 mm	5	10	5	FC	FC	FC	FC
2. 30 mm	5	20	5	FC	FC	FC	FC
3. 40 mm	5	30	5	FC	FC	FC	FC

* : Irrigation given after sowing the seeds
FC : Field capacity

per hill. Each replication consisted of three rows with 30 seeds per row. Each plot had an area of 1.8 m^2.

Data recorded upto 60 DAS only. Field emergence was recorded on 20th DAS in whole area of 1.8 m^2. Leaf area and dry matter accumulation (DMA) was recorded at the end of stress period (30 DAS) and one month after stress alleviation (60 DAS) in randomly selected five plants in each plot. Proline content (Bates *et al.*, 1973) and Relative water content (Barrs and Weatherly, 1962) were estimated in leaves at the end of stress period.

RESULTS AND DISCUSSION

Seedlings were established about 30 days after sowing (DAS). An increase in amount of irrigation during the time of sowing, significantly enhanced the emergence (Table 2). Similar to these results Sharma *et al.*, (1987) observed a decrease in emergence with increase in stress level under field conditions. Genotypic variation in field emergence is ranged from 65 to 78% at 30 mm and 75 to 94% at 40 mm except the genotype ICG 4501 which had below 69% even at 40 mm irrigation (Table 2). Genotypes GNP 225 and GNP 1020 had more than 91% field emergence and crop establishment at 40 mm irrigation. Genotypes ICG 2710, ICG 799 and DH-3-30 did not differ significantly between 30 and 40 mm suggests that 30 mm rainfall is sufficient to result in good emergence. However genotypes GNP 25 and GNP 1020 had 19% and 22% higher emergence respectively at 40 mm compared to 30 mm. This indicated that minimum of 40 mm rainfall in a single shower was sufficient to achieve higher field emergence of a genotype during pre-monsoon season.

The productivity of pre-monsoon sown crop depends on its survival during the rainfree period and recovery rate subsequent to stress alleviation. Present results showed that, leaf area and DMA were significantly more in crops raised with higher levels of irrigation during the time of sowing (Tables 3 and 4). Similar results were shown by Black *et al.*, (1985) under field conditions. Genotypes differed significantly for leaf area and DMA during the end of stress period and also on 30 days after stress alleviation. During the end of stress period, genotype GNP 225 had accumulated highest leaf area and dry matter at 40 mm irrigation. But on stress alleviation for 30 days at 40 mm irrigation, genotypes ICG 4501 and ICG 7694 showed highest leaf area and DMA and highest rate of leaf area development (672 and 775%) and DMA (1019 and 1002%) respectively. This suggests that, genotype ICG 7694 was better suited for pre-monsoon sowing because of its fairly good emergence (81%) and higher recovery rate subsequent to stress alleviation.

The growth rates after stress alleviation have to be associated with intrinsic drought tolerance mechanisms such as high matabolic growth rates under stress, osmoregulation etc. The proline accumulation as an osmoticum under

Table 2. Effect of pre-sowing irrigation on emergence at 20th DAS

Genotypes	Irrigation levels (mm)			
	20	30	40	Mean
ICG 2710	24.6 (29.7)*	74.1 (59.4)	75.4 (58.9)	57.6 (49.4)
ICG 1697	40.0 (39.2)	71.7 (57.8)	85.5 (67.5)	66.9 (54.8)
GNP 225	43.1(41.1)	76.7 (61.1)	91.4 (72.9)	72.5 (58.4)
ICG 799	36.6 (37.3)	77.4 (61.6)	79.1 (61.9)	65.2 (53.8)
GNP 1158	44.8 (42.0)	75.6 (60.4)	87.8 (69.6)	70.8 (57.3)
ICG 4507	32.2 (34.6)	67.6 (55.3)	77.6 (62.8)	60.2 (50.9)
GNP 1020	46.1 (42.7)	77.6 (61.7)	94.4 (76.3)	75.3 (60.3)
DH - 3 - 30	32.1 (34.5)	77.6 (61.7)	86.1 (68.0)	66.7 (54.8)
ICG 4501	18.6 (25.5)	52.3 (46.3)	66.7 (55.8)	45.7 (42.5)
ICG 7694	45.4 (42.4)	64.6 (53.5)	81.2 (64.3)	64.5 (53.4)
Mean	36.0 (36.9)	71.7 (57.9)	83.3 (65.9)	-

CD (p = 0.05) for the mean values
Irrigations (I) = (6.44)
Genotypes (G) = (6.36)
* values in parenthesis are angular transformed values

moisture stress conditions have been well documented by Low *et al.*, (1985) and Sharma *et al.*, (1990). In the present study, proline levels were increased with intensity of stress. Significant differences between genotypes were also observed (Table 5). Genotype ICG 7694 accumulated highest leaf proline content at the end of stress period and this also had higher leaf expansion and DMA rates on stress alleviation at 20 mm irrigation. Proline accumulation was significantly and positively related with leaf expansion and DMA rates when treatment means were considered for the computation. However, absence of this relationship at all irrigation levels and in all genotypes (Table 6) indicated that, the crop growth rates on stress alleviation are not necessarily be related to leaf proline content during stress period. Relative water content (RWC) did not differ significantly due to treatments (Table 5). However, higher irrigation level at the time of sowing had higher RWC (Umar *et al.*, 1991).

Table 6. Correlation co-efficients between proline accumulation at the end of stress period and other parameters

Characters	"r" - value
I. When treatment means were used for computation	
1. Proline vs irrigation levels	-0.99 **
2. Proline vs Leaf expansion rate	0.97 **
3. Proline vs DMA rates	0.99 **
II. Amongst genotypes	
1. Proline vs leaf expansion rate at	
20 mm	0.37 NS
30 mm	0.18 NS
40 mm	-0.18 NS
2. Proline vs DMA rates at	
20 mm	0.20 NS
30 mm	0.06 NS
40 mm	-0.10 NS

Note : Leaf expansion and DMA rates were measured on 30 days after stress alleviation
** - Significant at 1 % level
NS - Non - significant

Table 3. Effect of pre-sowing irrigation on leaf area (cm2/plant) at the end of stress period from 6th to 29 DAS and 30 after stress alleviation

Genotypes	At the end of stress period				After stress alleviation			
	Irrigation levels (mm)				Irrigation levels (mm)			
	20	30	40	Mean	20	30	40	Mean
ICG 2710	37.2	68.9	76.6	60.9	363	358	539	420
ICG 1697	32.8	55.9	89.1	59.3	285	353	595	411
GNP 225	39.3	53.3	105.3	65.9	353	455	560	456
ICG 799	36.3	53.0	91.3	60.2	325	451	577	451
GNP 1158	33.2	55.9	75.6	54.9	313	444	503	420
ICG 4507	36.9	58.6	83.1	59.5	425	518	528	490
GNP 1020	30.8	57.9	67.8	52.2	247	360	465	357
DH - 3 - 30	28.4	47.8	67.6	47.9	149	330	366	282
ICG 4501	29.8	63.4	82.3	58.5	242	391	636	423
ICG 7694	32.2	63.2	82.8	59.7	429	576	724	576
Mean	33.8	57.8	82.1	-	313	423	549	-
CD (P = 0.05)								
Irrigation (I)		2.25				11.7		
Genotypes (G)		4.51				19.8		
I x G		7.82				34.3		

Table 4. Effect of pre-sowing irrigation on dry matter accumulation (g/plant) at the end of stress period from 6th to 29 DAS and 30 after stress alleviation

Genotypes	At the end of stress period				After stress alleviation			
	Irrigation levels (mm)				Irrigation levels (mm)			
	20	30	40	Mean	20	30	40	Mean
ICG 2710	0.53	0.88	0.95	0.79	4.55	4.44	7.13	5.37
ICG 1697	0.43	0.64	0.76	0.61	3.22	4.59	7.42	5.11
GNP 225	0.50	0.53	1.01	0.68	4.77	6.73	6.75	6.08
ICG 799	0.32	0.47	0.93	0.57	4.13	6.29	7.06	5.83
GNP 1158	0.32	0.53	0.73	0.52	3.52	6.18	6.12	5.27
ICG 4507	0.30	0.60	0.79	0.56	4.90	6.79	6.88	6.19
GNP 1020	0.25	0.49	0.81	0.51	3.11	4.99	5.32	4.47
DH - 3 - 30	0.20	0.47	0.57	0.41	1.94	3.84	4.53	3.44
ICG 4501	0.40	0.55	0.75	0.57	2.80	5.04	8.36	5.40
ICG 7694	0.39	0.70	0.80	0.63	5.94	8.41	8.77	7.71
Mean	0.37	0.59	0.81	-	3.90	5.73	6.84	-
CD (P = 0.05)								
Irrigation (I)		0.014				0.44		
Genotypes (G)		0.020				0.57		
I x G		0.035				0.76		

Table 5. Effect of pre-sowing irrigation on proline content and relative water content measured at the end of stress period (6th to 29 DAS)

Genotypes	Proline content (Ug/g fr.wt)				Relative water content (%)			
	Irrigation levels (mm)				Irrigation levels (mm)			
	20	30	40	Mean	20	30	40	Mean
ICG 2710	270	218	159	216	59.2	66.1	72.3	66.0
ICG 1697	275	225	184	228	58.5	65.5	61.7	62.0
GNP 225	543	391	140	358	59.0	67.1	64.1	63.4
ICG 799	186	147	103	145	68.9	69.7	64.5	67.7
GNP 1158	227	152	99	159	66.7	65.1	62.2	65.0
ICG 4507	234	196	133	188	67.4	62.6	64.0	64.7
GNP 1020	265	229	138	211	58.7	64.9	64.9	63.2
DH - 3 - 30	391	307	140	279	57.6	71.8	69.6	66.5
ICG 4501	328	210	116	218	68.2	67.3	71.0	68.6
ICG 7694	792	314	121	409	68.8	65.2	70.2	65.9
Mean	351	239	113	-	62.9	66.5	66.7	-
CD (P = 0.05)								
Irrigation (I)		42				NS		
Genotypes (G)		45				NS		
I x G		79				NS		

This study indicated that crop emergence and establishment is a serious problem in groundnut particularly during monsoon season. Identifying genotypes which can withstand to moisture stress to certain extent during emergence and seedling establishment and incorporating this property in high yielding lines will goalong way in increasing productivity

The minimum moisture requirement for crop emergence and establishment varies with soil type and other environmental factors prevailing during emergence. A survey of minimum moisture requirement for different agro-climatic conditions will help in sowing groundnut at proper moisture conditions to achieve maximum emergence and establishment.

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EFFECT OF IRRIGATION REGIMES AND WEED CONTROL TREATMENTS ON NUTRIENT UPTAKE AND QUALITY OF SUNFLOWER

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ABSTRACT

Field experiments were conducted on sunflower variety Co-2 during *Kharif* and *rabi* summer seasons of 1989 and 1990, respectively at Tamil Nadu Agricultural University, Coimbatore. The experiments were conducted in clay loam soils with three irrigation regimes viz., 0.5, 0.75 and 1.0 IW/CPE ratio based on climatological approach and weed control treatments. The maximum uptake of nutrient by crop was observed in high moisture regime which was comparable with medium moisture regime. The *kharif* sunflower gave higher oil yield than the *rabi* summer crop. The oil content was high in medium moisture regime which was 38.9% and 33.5% during *kharif* and *rabi* summer respectively. The protein content was maximum in high moisture followed by medium moisture regime. The oil content varied significantly among weed control treatments. The minimum oil content of 37.2% in kharif and 30.4% during *rabi* summer were recorded in unweeded check. Highest net return and B:C ratio of Rs 3,938 and Rs 2.31 during *kharif* and 4713 and 2.62 during *rabi* summer were obtained in the high moisture combined with flurochloridone 0.5 kg a.i.ha^{-1} + 1 HW treatment.

Key words : *Helianthus annuus* L; Nutrient uptake; Oil content; Protein content; Herbicide.

Sunflower being a widely spaced crop with slow initial growth allows the weeds to compete easily at early growth stages. The nutrient availability and their uptake by plants are largely controlled by the soil moisture status and hence it has a greater role in the crop-weed competition. Control of weeds is important to increase the efficiency of the applied fertilizers. Yadav *et al.*, (1986) reported that the nutrient availability to crop can be increased by timely and effective control of weeds. The present study was conducted to assess the influence of irrigation regimes and weed control treatments on nutrient uptake, seed oil and protein content in sunflower.

MATERIALS AND METHODS

Two field experiments were conducted on clay loam soils at Tamil Nadu Agricultural University, Coimbatore. Three moisture regimes based on climatological approach viz., 0.5, 0.75 and 1.0 IW/CPE ratio combined with seven weed control treatments viz., flurochloridone (fc) 0.5 kg, a.i. ha^{-1}, flurochloridone 0.5 kg a.i. ha^{-1} + 1 HW (40 DAS), pendimethalin (pm) 1.0 kg. a.i. ha^{-1}, Pendimethalin 1.0 kg a.i. ha^{-1} + 1 HW (40 DAS), tank mixture of flurochloridone 0.25 kg a.i. ha^{-1} + pendimethalin 0.5 kg a.i. ha^{-1} + 1 HW (40 DAS), Hand weeding twice (20, 40 DAS) and unweeded check were evaluated during *kharif* season. An additional treatment of tank mixture of flurochloridone 0.25 kg a.i. ha^{-1} + pendimethalin 0.5 kg a.i. ha^{-1} was included in *rabi*/summer experiment. The herbicides were applied as per-emergence spray on third day after sowing. The initial soil samples were analysed using standard procedures. The protein content of the oil free meal was estimated colorimatrically at 600 nm using Spectronic Photoelectric Colorimeter, type 101. The estimation of oil content was done by Nuclear Magnetic Resonance (NMR) spectrometer. (Bruker Minispe p^{20} model) against the standard reference sample. The nutrient content in soil such as available N (Subbiah and Asija, 1956), available P (Olsen *et al.*, 1954) and avail-

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able K (Standard and English, 1949) and in plant such as total N (Humpries, 1956), total P (Jackson, 1973), total K (Jackson, 1973), seed protein, (Alikhan, and Youngs, 1973) and oil content (Granlund and Zimmerman, 1975) were estimated.

RESULTS AND DISCUSSION

The soil was clay loam in texture with low (156.8, 169.4, kg ha^{-1}) nitrogen, medium (12.5, 13.8 kg ha^{-1}) phosphorus and high (477.5, 530 kg ha^{-1}) potassium content respectively for *kharif* and *rabi*/ summer crop. The nutrient removal by sunflower crop and the quality of sunflower seeds are given in Table 1 and 2.

The nutrient removal by sunflower crop was significantly influenced by the moisture regimes and weed control treatments. The nitrogen, phosphorus and potassium uptake was maximum in the high moisture regime which was on par with medium moisture regime but significantly higher than low moisture regime. On the contrary, plants in the limited moisture supply recorded reduced uptake of nutrients due to reduction in dry matter accumulation. This was in agreement with the findings of Somasundaram (1970) and Panchanathan (1987).

All the weed control treatments recorded increased nutrient uptake which was significantly superior to unweeded check. The plants in the unweeded check recorded the least uptake of nutrient in both the seasons due to faster growth of weeds in the unweeded check and causing severe competition for available nutrients between crop and weeds. The treatments combined with one late hand weeding at 40 DAS viz.,flurochloridone 0.5 kg a.i. ha^{-1} + 1 HW, pendimethalin 1.0 kg a.i. ha^{-1} + 1 HW, tank mixture of flurochloridone 0.25 kg + pendimethalin 0.5 kg ai ha^{-1} + 1 HW and hand weeding twice (20, 40 DAS) recorded higher nutrient uptake irrespective of the seasons and found significantly superior to rest of the treatments. The nutrient removal was minimum in the unweeded check.

As regards the seed oil content, the medium moisture treatment recorded higher oil content. The reduction in oil percentage in the low moisture regime was to the tune of 4.5% during *kharif* and 11.1% during *rabi*/summer crop. The lowest oil percentage at low moisture regime was due to improper filling of seeds for want of moisture. The reduction of oil due to low moisture regime has been reported by Somasundaram (1979). Relatively small but significant reduction of oil content in the high moisture regime over medium moisture regime was observed which accounted for 3.3% during *kharif* and 4.0% during *rabi*/summer seasons. This might be due to delayed maturity of plants at high moisture treatment. Ramesh (1989) reported delayed maturity of soybean crop under high moisture level. However, this aspect needs further investigation. The seed oil content was reduced by 2.3% during *kharif* and 5.9% during *rabi*/summer season in the unweeded check over weeded treatment. This might be due to competition of weeds for the growth factors which affected the proper seed filling. The reduction in oil content due to weed competition was also reported by Jayakumar *et al.*, (1988) and Girijesh and Patil (1989).

The medium and high moisture treatments were on par with regard to protein content. The lowest protein content in the low moisture regime was due to low N recovery in seeds as a consequence of improper filling of seeds cased by limited partitioning of assimilated to the reproductive structure. Somasundaram (1979) obtained higher crude protein content in sunflower seeds at a higher moisture regime. All the weed control treatments recorded increased protein content over unweeded con-

Table 1. Nutrient removal and seed quality of sunflower during *kharif* season

Treatments		Nitrogen uptake (kg ha^{-1} 60 DAS)	Phosphorus uptake (kg ha^{-1} 60 DAS)	Potassium uptake (kg ha^{-1} 60 DAS)	Seed oil (per cent)	Seed protein (per cent)
Moisture regime						
I_1	0.50 IW/CPE ratio	107.16	13.67	49.88	37.31	20.10
I_2	0.75 IW/CPE ratio	130.42	15.71	60.71	38.97	24.15
I_3	1.00 IW/CPE ratio	134.36	16.28	64.67	37.72	24.28
	SEd	5.89	0.74	2.17	0.18	0.40
	CD (P = 0.05)	16.35	2.04	6.02	0.50	1.10
Weed control practices						
W_1	fc 0.5 kg a.i. ha^{-1}	121.08	15.42	58.19	38.74	22.87
W_2	W_1 + HW (40 DAS)	133.12	16.44	63.08	38.40	23.18
W_3	pm 1.0 kg a.i. ha^{-1}	188.30	14.55	56.72	37.48	24.10
W_4	W_3 + HW (40 DAS)	130.14	16.12	62.03	38.23	23.71
W_5	fc 0.25 kg + pm 0.5 kg a.i. ha^{-1} + one HW (40 DAS)	131.27	15.91	60.39	38.68	23.10
W_6	HW (20 and 40 DAS)	133.00	16.46	61.82	37.89	23.83
W_7	Unweeded control	100.93	11.62	46.72	37.27	19.11
	SEd	5.38	0.83	2.16	0.36	0.47
	CD (P = 0.05)	10.91	1.68	4.26	0.73	0.95

Interaction effect : Non significant

fc = Flurochloridone; pm = Pendimethalin; HW = Hand weeding

Table 2. Nutrient removal and seed quality of sunflower during *rabi* - summer season

Treatments		Nitrogen uptake (kg ha^{-1} 60 DAS)	Phosphorus uptake (kg ha^{-1} 60 DAS)	Potassium uptake (kg ha^{-1} 60 DAS)	Seed oil (per cent)	Seed protein (per cent)
Moisture regime						
I_1	0.50 IW/CPE ratio	89.00	18.44	63.64	30.20	25.97
I_2	0.75 IW/CPE ratio	118.44	20.84	76.57	33.56	29.39
I_3	1.00 IW/CPE ratio	138.07	23.53	83.04	32.27	29.87
	SEd	7.65	0.66	1.99	0.39	0.40
	CD (P = 0.05)	21.25	1.83	5.51	1.09	1.11
Weed control practices						
W_1	fc 0.5 kg a.i. ha^{-1}	118.26	20.31	76.22	33.02	28.33
W_2	W_1 + HW (40 DAS)	127.36	21.69	82.50	33.03	28.43
W_3	pm 1.0 kg a.i. ha^{-1}	111.13	21.09	75.44	31.90	29.36
W_4	W_3 + HW (40 DAS)	118.95	21.13	75.61	32.31	29.77
W_5	fc 0.25 kg + pm 0.5 kg a.i. ha^{-1}	107.51	20.17	69.52	32.02	28.28
W_6	W5 + HW (40 DAS)	117.36	21.96	75.70	31.65	28.62
W_7	HW (20 and 40 DAS)	136.21	25.40	83.08	31.68	29.28
W_8	Unweeded control	84.56	15.74	56.25	30.43	25.12
	SEd	7.70	1.30	3.51	0.55	0.40
	CD (P = 0.05)	15.54	2.61	7.08	1.11	0.81

Interaction effect : Non significant

fc = Flurochloridone; pm = Pendimethalin; HW = Hand weeding

Table 3. Economics and monetary return of sunflower (ha^{-1}) under irrigation regimes and weed control treatments during *kharif* season

Treatment		Cost of weeding (Rs./ha)	Total cost of cultivation (Rs./ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)	BC ratio (Rs.)
0.5 IW/CPE						
W_1	Flurochloridone 0.5 kg a.i./ha	355*	2748	5244	2496	1.91
W_2	W_1 + 1 HW (40 DAS)	515	2908	5844	2936	2.00
W_3	Pendimethalin 1.0 kg a.i./ha	541	2934	5100	2166	1.75
W_4	W_3 + 1 HW (40 DAS)	701	3094	5812	2718	1.88
W_5	Flurochloridone 0.25 kg + Pendimethalin 0.5 kg a.i./ha + 1 HW (40 DAS)	608	3001	5576	2575	1.86
W_6	Hand weeding twice (20 & 40 DAS)	800	3193	5640	2447	1.77
W_7	Unweeded control	-	2393	3628	1235	1.52
0.75 IW/CPE						
W_1	Flurochloridone 0.5 kg a.i./ha	355*	2784	6272	3488	2.25
W_2	W_1 + 1 HW (40 DAS	515	2944	6684	3740	2.27
W_3	Pendimethalin 1.0 kg a.i./ha	541	2970	6212	3242	2.09
W_4	W_3 + 1 HW (40 DAS	701	3130	6640	3510	2.12
W_5	Flurochloridone 0.25 kg + Pendimethalin 0.5 kg a.i./ha + 1 HW (40 DAS)	608	3037	6612	3575	2.18
W_6	Hand weeding twice (20 and 40 DAS)	800	3229	6568	3339	2.03
W_7	Unweeded control	-	2429	4084	1655	1.68
1.0 IW/CPE						
W_1	Flurochloridone 0.5 kg a.i./ha	355*	2838	6416	3578	2.26
W_2	W_1 + 1 HW (40 DAS)	515	2998	6936	3938	2.31
W_3	Pendimethalin 1.0 kg a.i./ha	541	3024	6324	3300	2.09
W_4	W_3 + 1 HW (40 DAS	701	3184	6760	3576	2.12
W_5	Flurochloridone 0.25 kg + Pendimethalin 0.5 kg a.i./ha + 1 HW (40 DAS)	608	3091	6804	3713	2.20
W_6	Hand weeding twice (20 and 40 DAS)	800	3283	6804	3521	2.07
W_7	Unweeded control	-	2483	4124	1641	1.66

* Cost of chemical was not yet fixed, hence the cost was assumed as the cost of pendimethalin.

Cost of herbicide application - Rs. 75.00

Cost of chemicals : Flurochloridone (0.5 kg) - Rs. 280.0 ; Pendimethalin (1.0kg) - Rs. 466.00

Cost of Irrigation : 0.5 IW/CPE - Rs. 126; 0.75 IW/CPE - Rs. 161; 1.0 IW/CPE - Rs. 216

Value of sunflower seed - Rs. 4.0 kg^{-1}

Table 4. Economics and monetary return of sunflower (ha^{-1}) under different irrigation regimes and weed control treatments during *rabi*-summer season

Treatment		Cost of weeding (Rs./ha)	Total cost of cultivation (Rs./ha)	Gross returns (Rs./ha)	Net returns (Rs./ha)	BC ratio (Rs.)
0.5 IW/CPE						
W_1	Flurochloridone 0.5 kg a.i./ha	355*	2675	5760	3085	2.15
W_2	W_1 + 1 HW (40 DAS)	515	2835	6212	3317	2.19
W_3	Pendimethalin 1.0 kg a.i./ha	541	2861	5668	2807	1.98
W_4	W_3 + 1 HW (40 DAS)	701	3021	6180	3159	2.05
W_5	Flurochloridone 0.25 kg + Pendimethalin 0.5 kg a.i./ha + 1 HW (40 DAS)	448	2768	5660	2892	2.05
W_6	W_5 + 1 HW (40 DAS)	608	2928	6176	3248	2.11
W_7	Hand weeding twice (20 and 40 DAS)	800	3120	6256	3136	2.00
W_8	Unweeded control	-	2320	4400	2080	1.90
0.75 IW/CPE						
W_1	Flurochloridone 0.5 kg a.i./ha	355*	2711	6908	4197	2.55
W_2	W_1 + 1 HW (40 DAS)	515	2871	7364	4493	2.57
W_3	Pendimethalin 1.0 kg a.i./ha	541	2897	6900	4003	2.38
W_4	W_3 + 1 HW (40 DAS	701	3057	7300	4243	2.39
W_5	Flurochloridone 0.25 kg + Pendimethalin 0.5 kg a.i./ha + 1 HW (40 DAS)	448	2804	6876	4072	2.45
W_6	W_5 + 1 HW (40 DAS)	608	2964	7276	4312	2.46
W_7	Hand weeding twice (20 and 40 DAS)	800	3156	7324	4168	2.32
W_8	Unweeded control	-	2356	4800	2444	2.04
1.0 IW/CPE						
W_1	Flurochloridone 0.5 kg a.i./ha	355*	2747	7116	4369	2.59
W_2	W_1 + 1 HW (40 DAS)	515	2907	7620	4713	2.62
W_3	Pendimethalin 1.0 kg a.i./ha	541	2933	7092	4159	2.42
W_4	W_3 + 1 HW (40 DAS	701	3093	7652	4559	2.47
W_5	Flurochloridone 0.25 kg + Pendimethalin 0.5 kg a.i./ha + 1 HW (40 DAS)	448	2840	7136	4296	2.51
W_6	W_5 + 1 HW (40 DAS)	608	3000	7568	4568	2.52
W_7	Hand weeding twice (20 and 40 DAS)	800	3192	7632	4440	2.39
W_8	Unweeded control	-	2392	4828	2436	2.02

* Cost of chemical was not yet fixed and hence the cost was assumed as cost of pendimethalin

Cost of herbicide application Rs. 75.00

Cost of chemical : Flurochloridone (05 kg) - Rs. 280.00; Pendimethalin (1.0 kg) - Rs. 466.00

Value of sunflower seed - Rs. 4.0 kg^{-1}

Cost of irrigation : 0.5 IE/CPE - Rs. 90; 0.75 IW/CPE - Rs. 1236; 1.00 IW/CPE - Rs. 162

trol. Similar reduction in crude protein content in the unweeded treatment was reported by Jayakumar *et al.*, (1988).

ECONOMICS

Higher net return and B:C ratio of Rs 3,938 and Rs 2.3% during *kharif* and 4,713 and 2.62 during *rabi* /summer were obtained in the high moisture regime combined with flurochloridone 0.5 kg a.i. ha^{-1} + 1 HW treatment (Table 3 and 4).

The net return realised from medium moisture regime was Rs. 3, 221 during *kharif* and Rs 3,992 during *rabi* / summer season which was comparable to high moisture regime. The net return was considerably reduced under low moisture regime.

Though herbicide + one hand weeding and hand weeding twice treatment recorded comparable gross return, the net return was highest in flurochloridone + one hand weeding because of its efficiency in controlling weeds at low doses. Pendimethalin + 1 HW, herbicide mixture + 1 HW recorded reduction in monetary benefit than flurochloridone + 1 HW because of the high dose of pendimethalin required to get adequate control of weeds. Hand weeding twice registered lesser monetary benefit than flurochloridone + 1 HW due to high cost of weeding.

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COMPARATIVE PERFORMANCE OF TWO SMALL SCREW TYPE OIL EXPELLERS FOR SUNFLOWER (*Helianthus annuus* L.)

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ABSTRACT

Studies were conducted for extraction of oil from sunflower seed using two small capacity screw type oil expellers, Model I and Model II. The paper presents the comparative performance of these two expellers in terms of capacity and oil extraction efficiency as affected by different seed pre-treatments viz., instant water addition, mixing calculated amount of water 24 hours earlier to expression and size reduction. The effective capacity of two expellers was found to be 7.2 and 10.0 kg of seed/hour for Model I and II, respectively. The extraction efficiency varied between 48.9 to 85.2% for Model I and from 64.2 to 91.9 for Model II depending on seed pre- treatment on two pass basis. The economics for the use of these two expellers in terms of net profit/day, break-even-point, pay back period, return-on-investment etc., was also worked out. The economic analysis reveals that both the expellers seems to be economically viable giving a net profit of Rs 72.0 and Rs 152.0 per day and return-on investment of 54 and 114% in the case of Model I and II, respectively.

Key words : Sunflower; Expellers; Pre-treatment; Extraction efficiency; Capacity.

Sunflower (*Helianthus annuus* L.), a robust oilseed crop has been adopted as a potential crop for drought-prone areas of India. The seed contains about 20% protein and 40-50% oil which has mild taste, pleasant flavour, good keeping quality with appreciable amounts of vitamin E (Campbell, 1983). Though the sunflower seed could be expressed in ghanies, rotary mills, oil expellers as well as solvent extraction plants, the use of screw expellers is being advocated for higher economic returns with less capital investment per kg of oilseed crushed. In Indian conditions, land productivity and overall production of sunflower seed is low, hence use of small capacity screw type oil expellers may be preferred to other oil milling equipment provided 6-8% or less oil is left out in the cake.

A number of small capacity oil expellers have been developed in India and abroad. These includes mini oil expellers, baby oil expellers, table oil expeller etc. The oil expression from sunflower seeds using such expellers has been studied by Prinsloo and Huge (1981), Thompson and Peterson (1982) and Jacobson and Baker (1986). These studies included the effects of different operating parameters and pre-treatment of seeds prior to expelling on oil recovery as well as performance of small oil expellers.

Studies conducted by Prinsloo and Huge (1981) for expelling of sunflower seed with small expeller, showed that varying the choke setting of a expeller has changed the barrel temperature, oil extraction efficiency, the cake thickness and power consumption. Thompson and Peterson (1982) tested pre-heating effects on oil extraction with a Cecoco Hander expeller for sunflower seed and reported that oil output decreased with an increase in pre-heating temperature of seeds. Jacobson and baker (1986) tested a hander vegetable oil expeller for oil expression from sunflower. Pre- heating of seeds had such a dramatic impact on expeller performance that the capacity and oil output doubled. It was recommended that if

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high capacity and oil output from low moisture content sunflower seeds are desired, pre-heating would be necessary. However, if high efficiency is desired, low moisture content sunflower seeds and high expeller pressures are recommended.

This paper reports the comparative performance of two small capacity oil expellers, viz.,Model I and II used for expression of sunflower seeds in terms of capacity and extraction efficiency as affected by different seed pre-treatments. Based on the performance of study, the economics of use of these two oil expellers has also been worked out.

MATERIALS AND METHODS

The two oil expellers used for extraction of oil from sunflower seeds (Fig 1 and 2) consist of feed hopper, three major assemblies namely worm shaft and operating screw, feed barrel and choke and main frame-drive. Power is transmitted with the help of a chain drive mechanism. The details of worm shaft of both the expellers are shown in Fig 3 and 4, while Table1 gives the other relevant details of these expellers. Model I is reported to be suitable for rapeseed, linseed, sunflower and palm kernels and Model II is recommended for mustard and groundnut.

The sunflower seeds (Variety, Morden) were procured and cleaned to remove the impurities like trashes, dirt, dust etc. The oil content of sunflower seed was determined using soxhlet extraction method. A weighed amount of dry sample was taken into a thimble and plugged with cotton, placed in soxhlet apparatus and extracted with anhydrous hexane for about 16 hours (Raghuramulu, 1983). The oil content of the seed was found as 40.5 per cent.

The following pre-treatments were given to the seed for expression of oil.

i instant addition of water to raise the moisture content.

ii) addition of calculated amount of water to the seed 24 hours earlier to expression and putting the sample in air tight polyethylene bags to attain uniform moisture.

iii) size reduction of whole seeds in a multipurpose mini-grain mill (pulverization) and instant water addition.

The size of the sunflower kernel along the length was reduced in the range of 3.3 to 4.1 mm from the average size of the kernel i.e., 5.4 mm. Hot air oven maintained at 40°C temperature below initial level of 6.5 per cent. The moisture content of seed in each case was determined by standard hot-air-oven method by placing a sample of 25-30 g in the hot air oven at 100° C for 72 hours (Hall, 1957). The sample was then cooled in a desiccator, weighed and the moisture content of seeds was determined. The barrel clearance was adjusted by using the handle provided in both the expellers and time taken for crushing the seed in each pass was observed by using a stop watch (least count 0.1 sec.). Both the expellers were operated under maximum pressing, i.e., the clearance between the barrel and screw was maintained at minimum (4mm) during all the experiments. The following methods were used for the calculation of capacity, extraction efficiency and oil content in the cake

$$\text{Capacity of expeller (kg/ha)} = \frac{\textit{Quantity of sample} \times 60}{\textit{time required in crushing the sample in minutes}}$$

$$\text{Extraction of efficiency of expeller (\%)} = \frac{\textit{quantity of oil} \times 100 \textit{ expelled}}{\textit{amount of oil available in sample}}$$

Oil content in the cake was determined using soxhlet extraction method explained earlier.

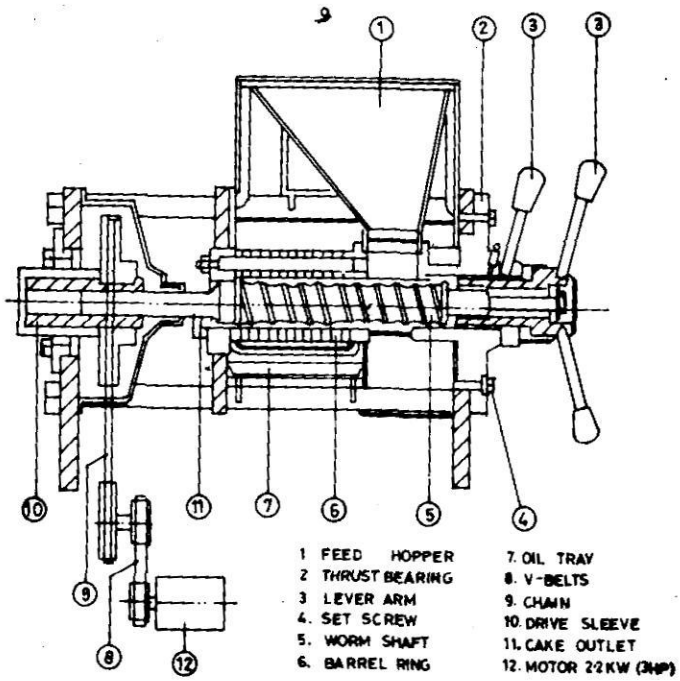


Fig. 1. Sectional view of Model-I oil expeller

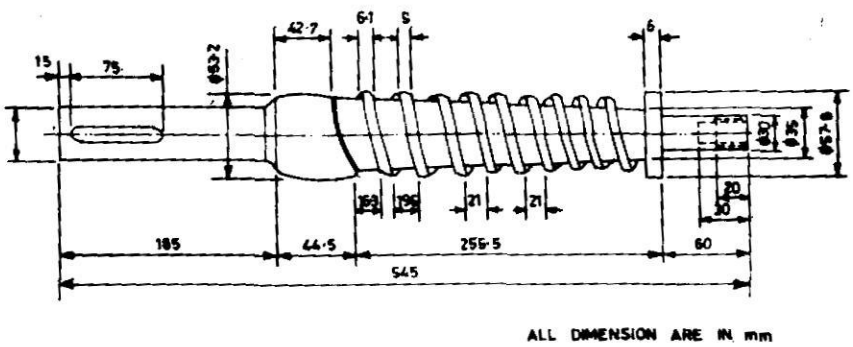
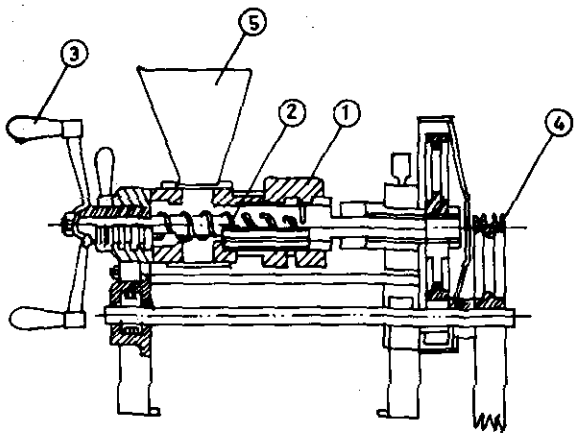
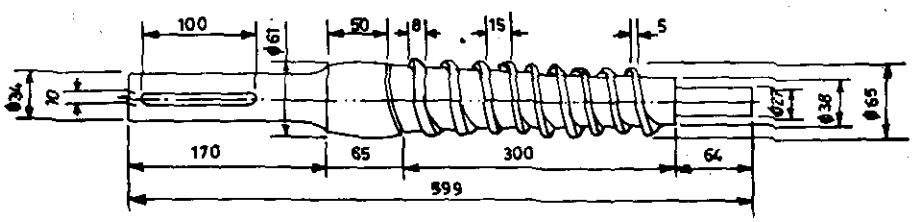


Fig. 2. Detail of worm shaft of Model-I oil expeller



1. DRUM
2. WARM SHAFT
3. HANDLE
4. PULLEY
5. HOPPER

Fig. 3. Sectional view of Model-II oil expeller



ALL DIMENSIONS IN mm

Fig. 4. Worm shaft of Model-II oil expeller

For the calculation of various economic parameters, viz., depreciation in expeller value, break-even-point, pay back period and return-on-investment etc., the following expression were used :

Depreciation per year

$$= \frac{\textit{Initial cost of expeller} - \textit{June value}^{*}}{\textit{Life of the expeller}}$$

*June value for expeller was assumed 10% of the initial cost. Break-even-point in terms quantity handled, q/y = B x Weighted capacity of expeller per hour

Where 'B' is calculated using the equation,

Fixed cost + Hourly variable cost x B = Per hour sales revenue x B

Pay-Back period, y

$$= \frac{\textit{Capital investment}}{\textit{Net profit per year} + \textit{Depreciation}}$$

Return-on-Investment

$$= \frac{\textit{Net profit per year x 100}}{\textit{Capital investment}}$$

RESULTS AND DISCUSSION

During preliminary trials with the two expellers, it was noted that very little (less than 2%) oil was recovered in the third pass while the effective capacity was seriously affected hence, third pressing of seed has not been included for determination of capacity and extraction efficiency of the expellers. Table 2 shows that effect of different seed pre-treatments on capacity, extraction, efficiency and oil left in cake (2 pass basis). In case of Model I, the extraction efficiency increased from 48.9 to 82.7% when the moisture content of seed was increased from 4.1 to 8.7%. Further, increase in moisture content by instant water addition to 12.9% decreased the extraction efficiency. Similarly in Model II, an extraction efficiency of 64.2% was observed at seed moisture content of 4.1% which increased upto 91.9% at seed moisture level of 8.7%. In this case also further increase in moisture content reduced the extraction efficiency.

In case of seed which was treated by mixing of water 24 hours prior to expelling, maximum extraction efficiency of 85.2% at seed moisture content of 6.5% and 91.4% at seed moisture content of 8.7% was obtained in Model I and Model II, respectively. Further increase in seed moisture decreased the extraction efficiency in both the expellers (Fig.5 and 6). size reduction, i.e., pulverization and instant water addition helped in more oil recovery in case of Model II as compared with Model I. At seed moisture content of 6.4%, maximum extraction efficiency of 92.6% was obtained in Model II whereas, Model I could extract only 77.8% oil. However, statistical analysis revealed that variation in extraction efficiency was found significant (S.D. + 6.67) within the seed moisture content of 6-9% among all the seed pre-treatments. The effective capacity corresponding to maximum extraction efficiency of both the expeller i.e., Model I and II was found as 7.2 kg seed/h and 10 kg seed/h, respectively. Average energy consumption was observed as 0.15 kwh and 0.18 kwh per kg of seed crushed in Model I and II, respectively. Based on their use has been worked out (Table 3). However, the following assumptions were made for the economic analysis :

(a) The expellers will be used for sunflower for 90 days/year, 8 hours/day and their useful life is 10 years.

(b) The cost of each expeller is Rs 10, 000

(c) Drying of seed if required will be done by sun drying.

The economic analysis revealed that both the expellers seem to be economically viable. The important economic parameters viz., net

Table 1. Comparative description of small screw oil expellers used for sunflower seed

Parameter	Model I	Model II
Overall dimensions mm x mm x mm	100 x 650x 560	1060 x 530 x 890
Power requirement, hp	3	3
Labour requirement	2	2
Rated capacity, kg seed/ha (first pass basis)	40	30
Suitability for oilseeds	Rapeseed, Linseed, Sunflower Palm kernel	Mustard and Groundnut
Developed at	M/s. Simon Rose Downs Ltd. England	M/s. SP Engineering Corporation Kannur, India

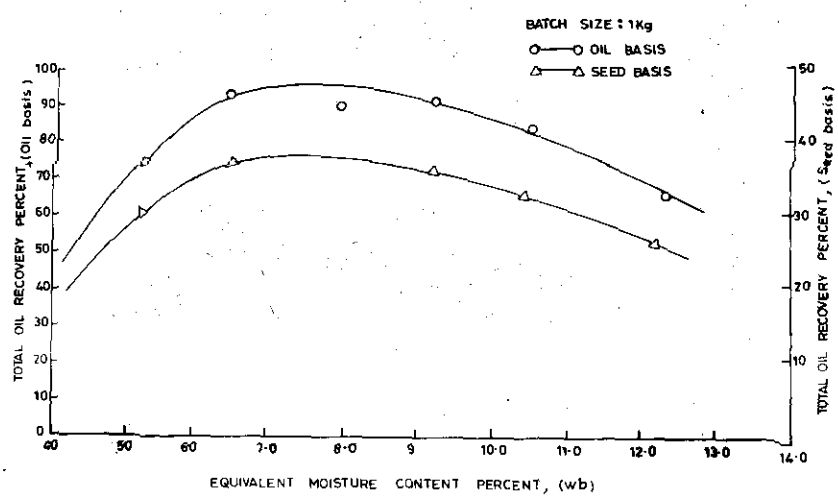


Fig. 5 Effect of equivalent moisture content on recovery of oil from undecorticated sunflower seed (For Model-I oil expeller)

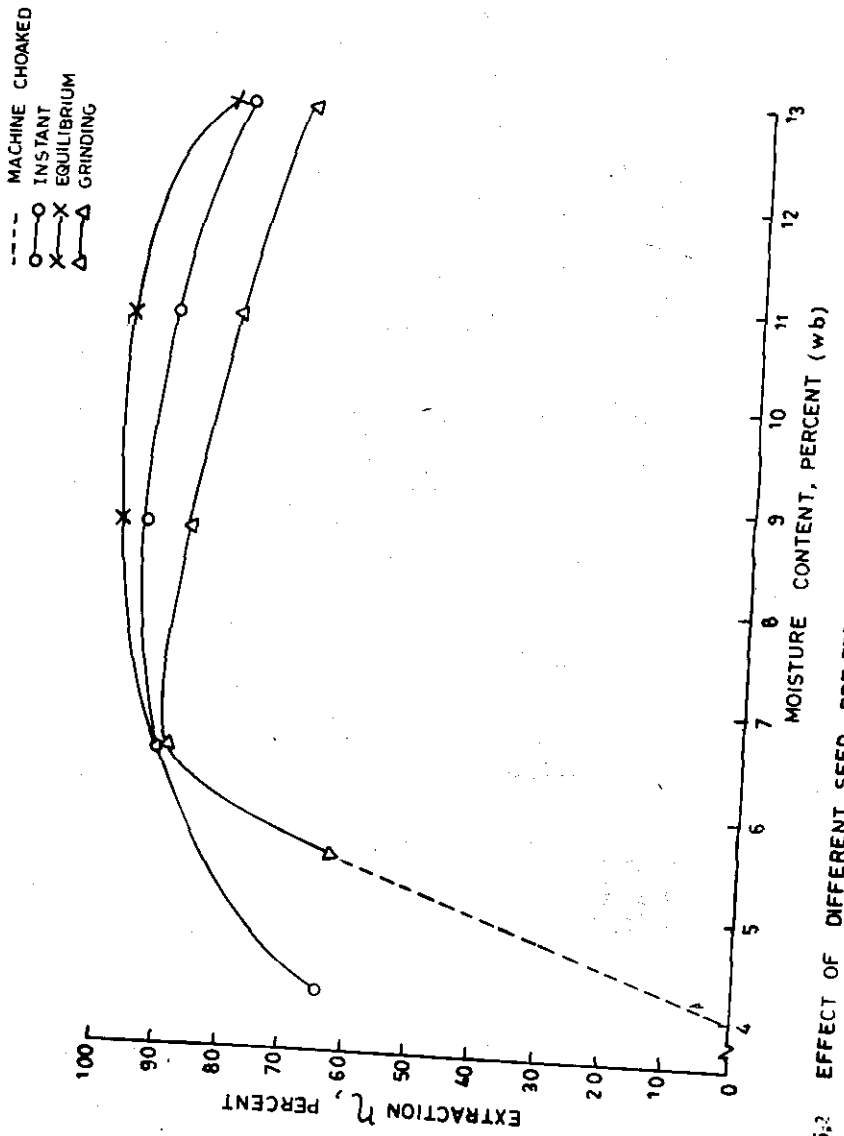


FIG.6.2 EFFECT OF DIFFERENT SEED PRE TREATMENTS ON EXTRACTION EFFICIENCY FOR MODEL-II OIL EXPELLER

Table 2. Comparative performance of oil expellers for sunflower seed (2 pass basis)

Expeller/Seed treatment		M.C. of seed %(Wb)	Extraction efficiency (%)	Capacity (kg/h)	Oil output kg/h	Oil left in cake (%)
1.	**Model I expeller**					
a	No treatment	4.2	48.9	5.80	1.15	25.8
b	Instant water addition	5.6	68.0	12.00	3.31	17.9
		7.7	82.7	12.00	4.02	10.5
		10.3	77.5	15.32	4.81	13.3
		12.9	45.2	6.50	1.19	27.2
c	Mixing Calculated amount of water 24 h prior to expression	6.5	85.2	7.19	2.46	9.6*
		7.9	80.9	11.80	3.87	11.5
		9.5	80.5	10.75	3.50	11.7
		10.5	1.5	11.61	3.83	11.2
		12.4	26.7	6.50	0.67	33.6
d	Pulverization and instant water addition	4.1	61.7	12.00	3.00	15.5
		6.4	77.8	12.00	3.78	9.0
II	**Model II expeller**					
a	No treatment	4.1	64.2	10.90	2.25	19.6
		6.4	91.4	6.67	2.47	5.6*
b	Instant water addition	8.7	91.9	10.00	3.84	3.3
		10.8	83.9	6.67	2.27	9.9
		12.8	81.7	2.40	0.59	20.7
c	Mixing calculated amount of water 24 h prior to expression	6.4	91.4	6.67	2.47	5.6*
		8.7	92.1	10.00	3.99	3.3
		10.8	83.9	8.67	2.91	9.9
		12.8	81.5	6.57	2.20	11.2
d	Pulverization and instant water addition	6.4	92.6	10.00	3.75	4.8*
		8.7	81.5	10.00	3.30	11.2
		10.8	81.5	6.00	1.98	11.2
		12.8	71.6	6.00	1.74	16.2
	S.D		± 16.63	± 2.97	± 1.14	± 7.55

* best performance of expellers

Table 3. Comparative economic analysis of two expellers

	Description	Model I	Model II
1.	**Fixed capital**		
(a)	Cost of expeller with accessories, Rs.	10,000	10,000
(b)	Installation charges, Rs.	2,000	2,000
	Sub Total	12,000	12,000
2.	**Fixed charges Rs./h**		
(a)	Interest at the rate of 15%, Rs.	2.50	2.50
(b)	Depreciation, Rs.	1.50	1.50
(c)	Repairs and maintenance at the rate of 2% of fixed capital	0.33	0.33
(d)	Housing charges, Rs. 50/month	0.21	0.21
	Sub Total	4.54	4.54
3.	**Operating expenditure, Rs./h**		
(a)	Labour charges for two persons, Rs. 25/d	6.25	6.25
(b)	Power charges, Rs. 1.0/kwh	2.00	2.00
(c)	Cost of raw material, (Rs.6/kg)	43.20	60.00
	Sub Total	51.45	68.25
4.	**Cost of production, Rs.**		
(a)	Fixed charges, Rs.	4.54	4.54
(b)	Operating charges, Rs.	51.45	68.25
	Sub Total	55.99	72.79
5.	Capacity, kg/h	7.20	10.00
6.	Oil output, kg/h	2.50	3.99
7.	Oil cake output, kg/h	4.68	6.00
8.	Cost of oil produced, Rs./h at the rate of Rs. 20/kg	50.00	79.80
9.	Cost of cake produced, Rs./h at the rate of Rs. 2/kg	15.00	12.00
10.	Profit, Rs/h (8 + 9-4)	9.00	19.01
11.	Profit, Rs./day	72.00	152.00
12.	Total income, Rs./h	65.00	91.80
13.	Break-even-point, q/year	63.76	50.95
14.	Pay back period, years	1.60	0.82
15.	Return-on investment, %	54.00	114.00
16.	Employment generated per unit, man-days/year	180.00	180.00

profit, break-even-point and return-on-investment for Model I were worked out as Rs 72.0 per day, 63.76 q/year and 54%, respectively, whereas for Model II these were Rs. 152.0 per day, 5.95 q/year and 114% respectively. However, Model II would give better returns in comparison with Model I (Table 3). These expellers would also be used for expelling other oilseeds and small scale oilseeds processing enterprises could be established at rural level to generate additional employment and value addition.

CONCLUSIONS

Based on the present study, the following conclusions could be drawn :

i) The per cent oil recovery from sunflower seed increases with increase in moisture content in the range from 4.2 to 8.7 per cent. Further increase in moisture content, however, decreased the oil recovery. The maximum oil recovery in both the expellers were obtained at seed moisture content of 6- 9%.

ii) On two pass basis the Model I has a capacity of 7.2 kg seed input/h and its extraction efficiency varied from 48.9 to 85.2% whereas, Model II expeller has a capacity of 10 kg seed input/n and its extraction efficiency varies from 64.2 to 91.9% depending upon seed treatment prior to expelling.

iii) The method of attaining desired moisture content by mixing of calculated amount of water with seeds 24 hours earlier to expression gives better oil recovery as compared with instant water addition either to the seed or after size reduction.

iv) Both the expellers are suitable and economically viable for oil expression from sunflower. However, economic analysis reveal that Model II expeller is preferable to Model I expeller

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EFFECT OF NITROGEN FERTILIZATION AND PLANT POPULATION ON FATTY ACID COMPOSITION OF SELECT MUSTARD (*Brassica juncea* L. Czern and Coss) CULTIVARS

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ABSTRACT

Investigation carried out for two years indicated that different cultivars, plant population and N rates significantly affected the fatty acid composition of mustard oil. Mustard variety T-59 recorded increase in erucic acid by 3.9% and a decrease in oleic acid content by 4.11% of oil over that of variety RL-18. Narrow row spacing of 30 cm resulted in 1.16% increase in oleic acid content over wider row spacing of 45 cm. Similarly, plant spacing of 10 cm within row increased mean oleic acid content by 1.19% over 15 cm plant spacing. Increasing levels of nitrogen from 0 to 120 kg/ha decreased the linoleic acid application of nitrogen upto 120 kg/ha significantly increased the total unsaturated fatty acid composition of mustard oil over control.

Key Words : Nitrogen; Fertilization; Plant population; Fatty acid composition.

Quantity and quality of fat fed to human beings has a great dietary relevance as mustard oil constitute an important source of fat supply in the Indian diet. Looking to the important role of fatty acids in nutrition it becomes necessary to study whether, use of improved varieties and cultural practices, like N fertilization, plant geometry and consequent high yield have any impact on saturated and unsaturated fatty acid composition of mustard oil. Variation in fatty acid composition of oilseeds due to differences in season, nitrogen application and plant densities have been reported (Hilditch and Williams, 1964; Appelqvist, *et al.*, 1968; Ahuja *et al.*, 1971; Debowski, 1973; Bobrzeeka *et al.*, 1975; Gupta and Friend, 1975). The present experiment was to study the effect of nitrogen fertilization and plant population on fatty acids composition of select cultivars of mustard T-59 and RL-18 was conducted at the Agronomy farm of the Rajasthan college of Agriculture, Udaipur during *rabi* seasons of 1978-79 and 1979-80.

MATERIALS AND METHODS

The experiment was set-up in a split plot design with the combinations of two mustard cultivars (T-59 and RL-18), two inter row spacings (30 and 45 cm), two intra row spacings (10 and 15 cm) in the main plots and four levels of nitrogen (0,40,80 and 120 kg/ha) in the sub-plots. The treatments were replicated three times and the plot size of 5.4 x 3.6 metres was used. The soil of experimental field was clay loam in texture, well supplied with available phosphorus (47 kg/ha) and potassium (180 kg/ha) but had moderate supply of nitrogen (0.084%), pH of the soil was 8.4. A basal application of phosphorus @ 40 kg P_2O_5/ha was made just before sowing. Fatty acid methyl esters were determined by using the method given by Graig and Murthy (1959) with the help of dual column gas liquid chromotograph "Shimadzu" model "GC-4BPTF". Oil determination was made as per method of analysis of A.O.A.C (1960) as ether extract. Nitrogen was determined by colorimetric method given by Linder

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(1944),while that of sulphur by Terbidometric method of Tabatabai and Bremner (1970).

RESULTS AND DISCUSSION

(a) *Effect of varieties* : Data (Table 1) show that varieties significantly affected fatty acid content of mustard oil. Variety T-59 recorded a significant increase in erucic acid and decrease in oleic acid content over that of variety RL-18. Corresponding per cent increase in erucic acid and mean decrease in oleic acid was 3.1 and 4.11 per cent respectively. This seems to be a varietal character. Moreover, in the light of findings of Lee *et al.*, (1974) that a high oil content of rape seed varieties were correlated with low oleic and high erucic acid contents, it bears ample testimony to the fact that mustard T-59 is superior to RL-18 in having significantly higher oil content (Table 2). Variation in fatty acid contents of mustard oil due to varieties have also been reported by Ahuja *et al.*, (1984) and Ghosh and Chatterjee (1988).

(b) Effect of spacings : It was found that significant increase in oleic acid content due to narrow inter row spacings (Table 1). Narrow row spacing resulted in 1.16 per cent mean increase in oleic acid content over wider row spacings. Similarly, narrow plant spacing with in rows increased mean oleic acid content by 1.19 per cent over the wider plant spacing. Linoleic acid content was affected significantly by inter row spacing only. Row spacing of 30 cm recorded a mean decrease in linoleic acid by 1.01 per cent when compared with 45 cm row spacing. Linoleic acid content was affected by intra row spacing only. 10 cm plant spacing decreased mean linoleic acid content by 1.27 per cent when compared with 15 cm plant spacing. There seems to be a stimulatory effect of closer row spacing and plant spacing on desaturation system of oleic acid, as a result of which, content of oleic acid under closer spacings increased. While decrease in content of linoleic acid under closer row spacings and that of linoleic acid under closer row spacing seems to be a function of inhibitory effect of closer spacing on desaturation system of linoleic and linolenic acid. These observations imply that plant spacings had bearing on fatty acid make up of mustard oil. Variation in fatty acid composition of sesame oil due to differences in inter and intra row spacings have also been reported by Ahuja *et al.*, (1971).

(c) *Effect of nitrogen levels* : Increasing levels of nitrogen from 0 to 120 kg/ha increased the stearic and palmatic acid and decreased the oleic acid and linoleic acid content of oil significantly (Table 1).

Higher uptake of plant nutrients, in particular that of sulphur by mustard seed under the influence of increasing levels of nitrogen and its increased concentration in seed at harvest (Table 2) which alone or in combination with nitrogen in seed might have some adverse effect on desaturation system of oleic acid and linoleic acid as a result of which the content of these unsaturated fatty acids decreased and that of saturated acids increased. These results are in close conformity with the findings of Bobrzeeka *et al.*, (1975) who reported that increased nitrogen and sulphur content of seed was associated with decreased oleic and linoleic acid content of rape seed oil. An increase in total saturated fatty acids with increase in nitrogen application has also been reported by Gupta and Friend (1975). Higher contents of erucic acid during 1979-80 and that of linolenic and eicosenoic acid during the year 1978-79 in all the treatments might be due to the prevailed climatic conditions during seed formation and maturity stages. Variation in fatty acid composition of sesame oil due to seasonal differences and of mustard oil due to different dates of sowing has also been reported by Ahuja *et al.*, (1971) and Ghosh and Chatterjee (1988).

Table 1. Effect of varieties, spacings and nitrogen levels on fatty acid composition (per cent) of mustard oil

Treatments	Stearic acid			Palmatic acid			Erucic acid			Oleic acid			Linoleic acid		
	'78-79	'79-80	Mean	'78-79	'79-80	Mean	'78-79	'79-80	Mean	'78-79	'79-80	Mean	'78-79	'79-80	Mean
Varieties															
T-59	2.41	2.43	2.42	3.73	3.71	3.72	45.27	47.22	46.20	12.79	12.77	12.78	14.54	14.54	14.54
RL-18	2.48	2.48	2.48	3.51	3.51	3.51	41.27	43.31	42.29	16.89	16.87	16.89	14.50	14.49	14.50
CD at 5%	NS	NS		0.201	0.186		0.366	0.104		0.254	0.303		NS	NS	
Row spacings															
30	2.45	2.47	2.46	3.63	3.60	3.62	43.22	45.27	44.25	15.42	15.41	15.42	14.02	14.01	14.02
45	2.44	2.44	2.44	3.62	3.62	3.62	43.22	45.22	44.24	14.26	14.25	14.26	15.03	15.02	15.03
CD at 5%	NS	NS		NS	NS		NS	NS		0.254	0.303		0.200	0.195	
Plant spacings															
10	2.47	2.48	2.48	3.60	3.58	3.59	43.22	45.27	44.25	15.44	15.42	15.43	14.52	14.52	14.52
15	2.42	2.43	2.43	3.65	3.64	3.65	43.22	45.27	44.25	14.24	14.24	14.24	14.53	14.52	14.53
CD at 5%	NS	NS		NS	NS		NS	NS		0.254	0.303		NS	NS	
Nitrogen levels															
0	2.12	2.14	2.13	3.31	3.27	3.29	42.97	45.04	44.00	15.17	15.16	15.17	14.96	14.95	14.96
40	2.44	2.43	2.44	3.60	3.61	3.61	43.19	45.25	44.22	14.86	14.83	14.85	14.58	14.57	14.58
80	2.58	2.60	2.59	3.75	3.73	3.74	43.32	45.35	44.34	14.71	14.70	14.71	14.30	14.30	14.30
120	2.64	2.65	2.65	3.82	3.82	3.82	43.31	45.43	44.41	14.64	14.63	14.63	14.26	14.25	14.26
CD at 5%	0.216	0.219		0.239	0.269		NS	NS	NS		0.322		0.363	0.316	

Continued...

Table 1. Continued

Treatment	Linolenic acid			Ecosenoic acid			Total S.F.A*			Total U.S.F.A**		
	'78-79	'79-80	Mean	'78-79	'79-80	Mean	'78-79	'79-80	Mean	'78-79	'79-80	Mean
Varieties												
T-59	9.82	8.82	9.32	10.74	9.86	10.30	6.15	6.16	6.16	93.07	93.22	93.15
RL-18	9.97	8.96	9.47	10.89	9.87	10.38	5.99	5.98	5.99	93.44	93.55	93.50
CD at 5%	NS	NS	-	NS	NS	-	NS	NS	-	NS	NS	-
Row spacings												
30	9.86	8.85	9.36	10.81	9.92	10.37	6.09	6.05	6.07	93.31	93.48	93.40
45	9.93	8.93	9.43	10.82	9.81	10.32	6.06	6.09	6.08	93.19	93.29	93.24
CD at 5%	NS	NS	-	NS	NS	-	NS	NS	-	NS	NS	-
Plant spacings												
10	9.26	8.26	8.76	10.81	9.80	10.31	6.08	6.04	6.06	93.23	93.28	93.26
15	10.53	9.52	10.03	10.82	9.93	10.38	6.07	6.10	6.09	93.27	93.49	93.38
CD at 5%	0.306	0.388	-	NS	NS	-	NS	NS	-	NS	NS	-
Nitrogen levels												
0	9.88	8.88	9.38	11.14	10.13	10.63	5.43	5.46	5.45	94.06	94.17	94.12
40	9.90	8.90	9.40	10.36	9.84	10.35	6.04	6.04	6.04	93.35	93.41	93.38
80	9.39	8.89	9.39	10.18	9.80	10.24	6.34	6.37	6.36	92.89	93.05	92.97
120	9.91	8.89	9.40	10.38	9.70	10.14	6.47	6.40	6.44	92.71	92.92	92.82
CD at 5%	NS	NS	-	NS	NS	-	0.290	0.412	-	0.799	0.690	-

* S.F.A. Saturated Fatty Acid ; ** U.S.F.A. Unsaturated Saturated Fatty Acid

Table 2. Effect of varieties, spacings and nitrogen levels on oil, nitrogen and sulphur contents of seed

Treatments	Oil content (%)			N content (%)			S content (%)		
	'78-79	'79-80	Mean	'78-79	'79-80	Mean	'78-79	'79-80	Mean
Varieties									
T-59	38.3	37.1	37.7	3.18	3.11	3.15	0.781	0.775	0.778
RL-18	37.6	36.4	37.0	3.21	3.15	3.18	0.790	0.787	0.789
CD at 5%	0.33	0.31	-	NS	NS	-	0.008	0.009	-
Row spacings (cm)									
30	38.0	36.9	37.5	3.17	3.10	3.14	0.781	0.775	0.778
45	37.8	36.6	37.2	3.23	3.16	3.20	0.790	0.786	0.778
CD at 5%	NS	NS	-	NS	NS	-	0.008	0.009	-
Plant spacings (cm)									
10	38.0	36.9	37.4	3.16	3.10	3.13	0.786	0.780	0.783
15	37.8	36.7	37.3	3.23	3.16	3.20	0.785	0.782	0.784
CD at 5%	NS	NS	-	NS	NS	-	NS	NS	-
N levels (kg/ha)									
0	38.9	37.9	38.4	2.55	2.55	2.55	0.744	0.744	0.744
40	38.8	37.5	38.2	3.04	2.96	3.00	0.765	0.750	0.757
80	37.8	36.2	37.0	3.57	3.45	3.51	0.812	0.806	0.809
120	36.5	35.5	36.0	3.64	3.56	3.60	0.822	0.824	0.823
CD at 5%	0.30	0.28	-	0.065	0.60	-	0.010	0.013	-

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EFFECT OF WEED MANAGEMENT PRACTICES AND NITROGEN ON MUSTARD YIELD AND NUTRIENT LOSSES THROUGH WEEDS

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ABSTRACT

Field studies carried out during 1989-90 and 1990-91 at Navsari (Gujarat) revealed that maintaining weed free condition or two hand weedings done at 25 and 45 days after sowing were most effective in reducing dry weight of weeds and removal of nitrogen, phosphorus and potash through weeds and increased seed yield of mustard and net returns. Increased application of nitrogen from 60 to 90 kg/ha increased the total weed biomass, uptake of nutrients by weeds, seed yield of mustard and net realization. Uncontrolled weeds on an average took up 15.1 kg N, 4.1 kg P_2O_5 and 18.6 kg K_2O/ha.

Key Words : Mustard; NPK; Nutrient losses; Weed management; Yield.

Weeds utilize considerable amounts of nutrients. About 30-40 per cent of the applied nutrients are reported to be utilized by weeds for their growth and development (Dryden and Krishnamoorthy, 1977). Effective weed management practices increase the uptake of nutrients by crop and decrease the removal through weeds (patel, 1990). Information on the extent of nutrient losses caused by weeds in clayey soils of South Gujarat is lacking, hence, this study was undertaken to find out the losses of nitrogen, phosphorus and potassium through weeds in mustard crop.

MATERIALS AND METHODS

A field experiment was conducted at Agricultural College Farm, Gujarat Agricultural University, Navsari during 1989-90 and 1990-91. The study involved ten weed management practices viz., pre-emergence application of pendimethalin at 1.0 kg/ha, pre-emergence application of pendimethalin at 1.0 kg/ha plus one hand weeding at 45 days after sowing, pre-emergence application of alachlor at 1.0 kg/ha, pre-emergence application of alachlor at 1.0 kg/ha plus one hand weeding at 45 days after sowing, two hand weedings at 25 and 45 days after sowing, one interculture at 25 days after, sowing, one hand weeding at 45 days after sowing, one interculture at 25 days after sowing and one hand weeding at 45 days after sowing, weed free condition (hand weedings at 25, 45 and 65 days after sowing) and unweeded control in main plots and three levels of nitrogen i.e., 60, 75 and 90 kg/ha in sub-plots, replicated three times in a split-plot design. Half dose of N and 50 kg P_2O_5/ha were applied at sowing and the remaining half dose of N was top dressed at 30 days after sowing. Mustard variety 'Varuna' was sown with a row spacing of 60 cm in November and was harvested in March in both the years. The soil of experimental field was clayey, low in total N (0.050-0.042%), medium in available P (20.50-12.88 kg/ha) and high in available K (270.24-278.09 kg/ha) with pH 7.7-7.9.

The dry weight of weeds was recorded before harvest of mustard crop and weed samples were analysed for N, P_2O_5 and K_2O content following modified Kjeldahl's method, Vanado-molybdo phosphoric acid yellow colour method and flame photometric method, respectively.

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RESULTS AND DISCUSSION

Weed flora

The dominant weeds observed in mustard field were *Echinochlea colonum* (L.) Link, *Digera arvensis* Forsk, *Convolvulus arvensis* L., *Trianthema monogyna* L. and *Cyperus rotundus* L.

Effect of weed management practices

Dry weight of weeds at harvest in mustard was reduced appreciably in all the weed management practices as compared to unweeded control. Significantly, lower dry weight of weeds was recorded under weed free condition and two hand weedings at 25 and 45 DAS, followed by herbicidal treatments as compared to weedy check and H.W. at 45 DAS or I.C. at 25 DAS or both I.C. at 25 DAS and H.W. at 45 DAS. this might be due to rapid growth of the mustard crop as indicated by taller plants and more number of branches/plant, which did not allow the weeds to grow vigorously due to smothering effect. Patel (1990) and Tomar and Namdeo (1991) also observed the similar trend. These treatments also recorded higher weed control efficiency as compared to interculture at 25 DAS, hand weeding at 45 DAS and interculture at 25 DAS plus HW at 45 DAS indicating their superiority. The results are in conformity with those of Pandey and Kumar (1984) and Patel (1990). Crop-weed competition resulted in reduction of seed yield by 44.48 per cent. Weed caused severe competition with crop plants from the very beginning of the crop growth. However, two hand weedings at 25 and 45 DAS, pendimethalin 1 kg a.i./ha along with one hand weeding at 45 DAS and pendimethalin alone at 1 kg a.i./ha were found to offer better weed control seed yield and higher net returns (Table 1). The results is in line with the findings of Ghosh and Mukopadhyaya (1981).

Pooled data showed that the highest seed yield of mustard was obtained under weed free condition which was comparable with two hand weedings at 25 and 45 DAS, pendimethalin kg a.i./ha along with one hand weeding at 45 DAS and pendimethalin alone; the increase in seed yield being 80, 69, 62 and 51 per cent respectively over unweeded control. Similar results were reported by Bhimani (1988) and Tomar and Namdeo (1991). The seed yield is a cumulative effect of different growth and yield attributing characters. Moreover, the yield reflected in these treatments show the effectiveness to control the weeds at important growth stage with substantial reduction in uptake of nutrients by the weeds (Table 2).

Economic analysis of different weed management practices revealed that the highest net realization of Rs. 4485/ha was obtained with weed free conditions, followed by two hand weedings at 25 and 45 DAS(Rs. 4216/ha), as against the lowest net realization of Rs. 1546/ha obtained in unweeded control (Table 1).

The lowest removal in nutrients by weeds were observed in weed free condition and two hand weedings treatments due to their effective weed control efficiency. Unweeded control recorded the highest uptake of N, P_2O_5 and K_2O by weeds, closely followed by one interculture at 25 DAS and one hand weeding at 45 DAS which was due to vigorous growth of weeds and more weed biomass production. Dashora *et al.*, (1990) and Patel (1990) also reported the highest removal of nutrients through weeds in unweeded control and lower in pendimethalin and cultural treatments.

Effect of nitrogen

The dry weight of weeds was significantly enhanced with increase in the rate of nitrogen upto 90 kg/ha during both the years which was due to vigorous growth and higher nutrient uptake by weeds. There was increase in the weed biomass at harvest due to 90 and 75 N/ha

Table 1. Dry weight of weeds, seed yield of mustard, weed control efficiency, weed competition index and net returns as effected by weed management practices and nitrogen levels

Treatment	Dose (kg a.i/ha)	Dry weight of weeds (kg/ha)*			Seed yield of mustard (kg/ha)			Weed control efficiency (%)	Weed competition index (%)	Net returns (Rs/ha)
		1989-90	1990-91	Mean	1989-90	1990-91	Mean			
Weed management practices										
Pendimethalin	1.0	11.11	11.31	11.21	1055	1445	1250	84.39	**16.38**	**3441**
Pendimethalin + One H.W. (45 DAS)	1.0	10.69	10.72	10.67	1101	1580	1341	85.84	10.30	**3687**
Alachlor	1.0	12.57	12.66	12.61	1004	1264	1134	80.32	24.15	**3024**
Alachlor + One H.W. (45 DAS)	1.0	11.74	11.81	11.78	1034	1332	1183	82.81	20.87	**3026**
Two hand weedings (25,45 DAS)	-	9.24	9.37	9.31	1134	1665	1400	89.24	6.35	**4216**
One interculture (25 DAS)	-	17.45	17.73	17.60	934	1035	985	61.68	34.11	2328
One hand weeding (45 DAS)	-	16.81	16.90	16.85	967	1174	1071	64.90	28.36	2617
One interculture + H.W. (25+45 DAS)	-	15.80	15.91	15.85	978	1208	1093	68.97	26.89	2662
Weedfree condition H.W. at (25,45,65 DAS)	-	8.27	8.42	8.35	1195	1795	1495	91.31	-	4485
Unweeded control	-	28.41	28.38	28.39	835	824	**830**	-	44.48	1546
CD at 5%		1.78	0.18	0.87	182	142	308	-	-	-
Nitrogen (kg/ha)										
60		13.74	14.19	13.97	936	1201	1069	-	-	2568
75		14.19	14.33	14.26	1062	1321	1192	-	-	3181
90		14.68	14.44	14.56	1073	1475	1274	-	-	3560
CD at 5%		0.40	0.12	NS	85	38	113	-	-	-

* Square root transformed values

Table 2. Uptake of nitrogen, phosphorus and potash by weeds (kg/ha) at harvest

Treatment	Dose (kg a.i./ha)	Uptake of N (kg/ha)			Uptake of P_2O_5 (kg/ha)			Uptake of K_2O (kg/ha)		
		1989-90	1990-91	Mean	1989-90	1990-91	Mean	1989-90	1990-91	Mean
Weed management practices										
Pendimethalin	1.0	1.55	2.03	1.79	0.41	0.48	0.45	2.61	2.70	2.66
Pendimethalin + One H.W. (45 DAS)	1.0	1.39	1.76	1.58	0.30	0.39	0.35	2.32	2.41	2.37
Alachlor	1.0	2.18	2.67	2.43	0.58	0.63	0.61	3.37	3.42	3.39
Alachlor + One H.W. (45 DAS)	1.0	1.77	2.25	2.01	0.47	0.53	0.50	2.91	2.97	2.94
Two hand weedings (25,45 DAS)	-	1.05	1.29	1.17	0.21	0.29	0.25	1.74	1.77	1.76
One interculture (25 DAS)	-	4.97	6.05	5.51	1.47	1.46	1.47	6.73	6.84	6.79
One hand weeding (45 DAS)	-	4.59	5.27	4.93	1.23	1.29	1.26	6.15	6.18	6.16
One interculture + H.W. (25+45 DAS)	-	4.05	4.52	4.29	1.01	1.07	1.04	5.40	5.43	5.42
Weed free condition H.W. at (25,45,65 DAS)	-	0.77	1.00	0.88	0.15	0.23	0.19	1.37	1.43	1.40
Unweeded control	-	14.35	15.94	15.15	4.26	3.87	4.07	18.78	18.46	18.62
CD at 5%		0.87	0.63	0.52	0.21	0.11	0.23	1.16	0.16	0.57
Nitrogen (kg/ha)										
60	-	3.13	4.05	3.59	0.87	0.95	0.91	4.66	5.00	4.83
75		3.63	4.30	3.97	0.99	1.02	1.01	5.05	5.18	5.11
90		4.23	4.49	4.36	1.17	1.09	1.13	5.70	5.31	5.51
CD at 5%		0.43	0.05	NS	0.11	0.03	NS	0.51	0.09	NS

was of the order of 10 and 4 per cent over 60 kg N/ha, respectively. Application of 90 kg N/ha remaining comparable to 75 kg N/ha produced substantially higher seed yield than 60 kg N/ha; the per cent increase being 19 and 12, respectively. This response might be due to lower available nitrogen content of the soil. The findings are in accordance with those obtained by Vasvelia (1988) and Patel (1989).

Application of graded doses of nitrogen upto 90 kg/ha progressively increased the net realization per hectare. The highest net realization of Rs. 3560/ha was obtained with 90 kg N/ha, closely followed by 75 kg N/ha (Rs. 3181/ha) and 60 kg N/ha (Rs. 2568/ha).

Though there was substantial increase in uptake of N, P and K by weeds with every increment of nitrogen, the enhancement, however, was not discernible when pooled data were considered (Table 2).

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INHERITANCE OF SEED COAT COLOUR IN OILSEED *Brassica* *

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ABSTRACT

Inheritance of seed coat colour was studied in two crosses of *Brassica juncea* x *Brassica carinata* and an inter varietal cross of *B. juncea* involving yellow, dull yellow and brown seeded parents. The study revealed presence of three factors controlling seed coat colour but the digenic pattern observed by us and many workers may be due to segregation in only two gene pairs. Maternal control and intergenomic complementation were also indicated. Thus, the yellow seeded digenomic *Brassica* sp. must have genes for yellow seed coat in both the genomes

Key Words : *Brassica*; Seed coat colour; Inheritance.

Most of the available cultivar of digenomic *Brassica* are brown seeded, but lines with yellow seed coat are available in germplasm resources. Efforts have been made in several *Brassica* growing countries to breed yellow seeded types, because of the fact that yellow seeds possess a thinner seed coat with smaller cell size than that of dark seeds resulting in higher oil, protein content and lower crude fibre (Woods, 1980; Abraham and Bhatia, 1986). Thus, understanding of the inheritance pattern is an important requisite for efficient breeding of yellow seeded digenomic *Brassica*. This paper presents the results of crosses at both interspecific and intraspecific levels.

MATERIALS AND METHODS

Investigation was undertaken in two *B. juncea* x *B. carinata* interspecific crosses and one intervarietal cross of *B. juncea*, made during 1988-89 *rabi* season. This work involved two *B. juncea* cultivars, yellow seeded "DIRA- 313", brown seeded "Pusa Barani" and two *B. carinata* cultivars viz., brown seeded "DLC-1" and dull yellow seeded "DLC-2". All the materials were true breeding lines. F_1s were raised during 1989-90 rabi season and seed colour of individual F_1 plants were recorded. During the winter 1990-91, F_2 generation was grown in four rows of five metres long in each of the crosses. Frequency of plants with different seed coat colour was noted. The Chi-square was used to verify the goodness of fit into genetic ratio.

RESULTS AND DISCUSSION

In all the three crosses (Table 1), F_1 seed colour resembled selfed seed colour of respective mother parents. This observation indicated that maternal parents exclusively controlled the immediate pigment development of seeds borne on it, irrespective of genetic constitution of pollens. This is in conformity with the previous reports of Vaughen (1956) and Anand *et al.*, (1985).

The seed coat colour of F_1 in DIRA-313 x DLC-1 and Pusa Barani x DIRA - 313 crosses (Table 1) was brown irrespective of parental or F_1 seed colour indicating dominance of brown over yellow. In both, the crosses F_2 distribution showed a segregation of 15 brown : 1 yellow ratio with high probability (0.8 - 0.9 in 1st and 0.5 - 0.7 in 2nd cross). On the contrary, the cross DIRA-313 x DLC-2 involving yellow *juncea* and dull yellow *carinata* also gave brown

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Table 1. Mode of inheritance of seed coat colour in two *juncea* x *carinata* and one intervarietal *juncea* cross

Cross	Seed colour		No. of plants with seed colour in F_2				Ratio	χ^2 Value	P - range
	F_0	F_1	Brown	Dull yellow	Yellow	Total			
DIRA-313 (yellow) x DLC-1 (Brown)	Yellow	Brown	111	-	7	118	15:1	0.023	0.80-0.90
DIRA-313 (yellow) x DLC-2 (Dull yellow)	Yellow	Brown	66	33	40	139	9:3:4	4.536	0.10-0.20
Pusa Barani (Brown) x DIRA-313 (yellow)	Brown	Brown	150	-	8	158	15:1	0.389	0.50-0.70

* Colour of parents is indicated in parentheses

seeded F_1 indicating complementation. The F_2 segregation pattern of 9 brown : 3 dull yellow : 4 yellow with P-range of 0.1 to 0.2. This indicated the same digenic case with recessive epistatic interaction in contrast to duplicate interaction in the above two crosses.

In both the interspecific crosses, DIRA-313 x DLC-1 and DIRA-313 x DLC-2, female parent was common but the difference in male parent with different seed colour changed the segregation pattern. It is presumed that DLC-2 (dull yellow) must have some extra factor, which interacts with other seed colour genes giving different ratio. Presence of an epistatic factor E-e was assumed in addition to principal seed coat colour genes Y-y and Br-br. The gene E, when homozygous recessive interacts with only Br gene in the absence of Y resulting in dull yellow seed colour. Both Y and Br genes (for brown colour) are completely dominant over y, br (for yellow colour). Both y and br must be recessive homozygous irrespective of constitution of E-gene for yellowness. Presence of either the dominant gene or both results in brown colour. The ratio 9:3:4 may be due to segregation of E and Br genes with assumption of y-locus in recessive homozygous state in both DLC-2 and DIRA-313. Similarly, 15:1 ratio obtained in our crosses may be explained assuming E-gene in homozygous state in both the parents involved. The proposed genotypes of parents and segregating population are given in Table 2. However, confirmation from Back cross and F_3 progenies is required.

Duplicate digenic control with complete dominance was reported by Anand *et al.*, (1985) and Rawat (1989), whereas Pal and Singh (1990) proposed digenic pattern with incomplete dominance of *B. juncea*. Both monogenic and digenic inheritance in *B. carinata* (Getinet *et al.*, 1987 and Yousuf, 1982) and trigenic case in *B. napus* (Shirzadegan, 1986) have been reported. Incomplete dominance was not evidenced from the study. However, change in interaction pattern cannot be ruled out in interspecific background. It is thus reasonable to postulate the epistatic factor for explaining variation in seed colour and also true breeding nature of dull yellow cultivar.

Table 2. Proposed genotypic constitution of parents and interspecific derivatives

Population	Genotype	Phenotype
Pusa Barani	YY Br Br EE	Brown
DLC - 1	YY Br Br EE	Brown
DLC - 2	yy Br Br ee	Dull yellow
DIRA - 313	yy br br EE	Yellow
Segregating population		
	Y - Br - E - Y - Br - ee Y - br br E - yy Br - EE	Brown
	yy Br - ee	Dull yellow
	yy br br E - yy br br ee	Yellow

The brown colour of F_1 and 9/16 of F_2 population in yellow x dull yellow cross may be the result of intergenomic complementation as suggested by Chen *et al.*, (1988). This might be due to intergenomic homology with regards to pigmentation system, which would be expected from the established view that *Brassica* genomes A, B, C evolved from a common archetype (Prakash and Hinata, 1980).

Thus, it is clear that due to prevalence of intergenomic complementation, if it requires to breed digenomic yellow seeded *Brassica*, it must have genes for yellow seed coat in both the genomes. However, the yellow seeded characters found in *juncea* and *carinata* germplasm resources can be easily transferred to adaptable varieties by backcross breeding methodology because of simple mode inheritance. But further investigation is required on diverse material for detailed information in view of the report of multiple allelic series (Schwetka, 1982) and involvement of modifiers (Stringham, 1980).

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SEROLOGICAL DETECTION OF MLO IN PHYLLODY INFECTED SESAME, SUNN HEMP AND IN LEAFHOPPER *Orosius albicinctus*

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ABSTRACT

Antiserum for the sesasme phyllody disease (SPD) MLO has been developed. The SPD MLO was detected in infected sesame and sunn hemp by employing slide agglutination test and capillary tube precipitin test. Among the four forms of ELISA methods viz., DAC-ELISA, DAS-ELISA, INDIRECT-ELISA and PAC-ELISA tested, the indirect form and protein a coating form of ELISA were sensitive in detecting SPD MLO in sesame. The SPD MLO was also detected in leafhopper vector, *Orosius albicinctus* using alkaline based indirect form of ELISA.

Key Words : Sesame phyllody disease; Serological technique; ELISA.

In recent years serological methods are widely adopted in detection and identification of plant viruses and MLO's. The MLO infection in different plant species has been detected using different serological tests by several workers; aster yellows in aster (Sinha and Benhamon, 1983), paulownia witches broom (Zhu *et al.*, 1986), Eastern aster yellows, western aster yellows, potato witches broom and clover proliferation in *Catharanthus roseus* (De Rocha *et al.*, 1986).

This paper reports the sensitivity of serological test for the SPD MLO in sesame, sunn hemp and its leafhopper vector *Orosius albicinctus*.

MATERIALS AND METHODS

Seasme (*Sesamum indicum* L.) plants showing symptoms of phyllody infection were marked in the fields of Oilseed Breeding Station, Tamil Nadu Agricultural University, Coimbatore. Transmission of SPD MLO was made by using insect vector *O. albicinctus* to healthy sesame (TMV 3) and sunn hemp (Co 1) plants. Plants showing typical phyllody symptoms were used in the study.

a)*Preparation of immunogen*

SPD MLO culture was maintained on sunn hemp plants through vector transmission, as slimy nature of sesame plant tissue was found to be interfere during MLO purification process. Stem tissue with phyllod flowers from 60 days old sunn hemp (Co 1) were used in the partial purification of the SPD MLO following the method of De Rocha *et al.*, (1986).

b) *Antisera production*

Procedure was adopted following Hobbs *et al.*, (1987) with some modifications. A New Zealand white inbred rabbit was injected intramuscularly in the hind legs at two to three sites, with an emulsion of partially purified MLO preparation and Freunds incomplete adjuvant. The rabbit was bled three times at interval of 10 days, starting 1 week after the booster injection. The gama globulins (IgG) were extracted from antisera using sodium sulphate. For cross absorption the antibodies were incubated at 35°C with an equal volume of a preparation from healthy sunn hemp tissue processed in the same way as the phyllody

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MLO preparation. Precipitate was removed by centrifugation at 5000 rpm for 15 min. The supernuatant (antiserum) was collected and used for detection of SPD MLO infection by the following serological methods :

c) *Serological methods*

i) *Slide agglutination test*

Equal quantities of antiserum and antigen were placed in the depression of cavity slide and incubated at 25°C for 90 min. and observed at 15 min. interval. The time taken for precipitation and the intensity of precipitate were recorded. Fifteen samples each from healthy and infected plants were tested.

ii) *Glass capillary tube precipitation test*

The glass capillary tubes (10 cm length) with 0.5 and 1.0 mm internal diameter were dipped in the antiserum. The antiserum was allowed to be sucked upto 2.0 cm in tube. The tube was then dipped in the saps from healthy and phyllody MLO infected plants separately which was also allowed to be sucked in upto 2.0 cm and the tubes were fixed on microscopic slides by means of a drop of fevicol. The tubes were incubated at 25°C for 90 min. and examined at 15 min. interval against a dark back ground for the formation of the precipitate. Fifteen samples each from healthy and infected plants were tested.

iii) ELISA

Four different ELISA procedures using alkaline phosphates as a label were compared for their sensitivity in detecting SPD MLO. The r-globulins produced in rabbits/anti rabbit-FC specific globulins produced in goats(Cappel Laboratories Inc. West Chester, USA) were conjugated with alkaline phosphatase (Sigma Chemical Co. St. Louis, USA) (2 mg enzyme for each 1 mg of r- globulins). Top most stem tissues with phylloid flowers from 60 days old sesame plants were employed to detect phyllody ML by forms of ELISA procedures using polystyrene ELISA plates with flat bottom 96 wells (Dynatech Lab. Inc. Alexandria VA 22134). The corresponding tissues from healthy plants served as control. For each set 16 samples were tested. The four forms of ELISA namely Direct antigen coating form of ELISA (DAC-ELISA), Double antibody sandwitch form of ELISA (DAS-ELISA), Indirect form of ELISA (I- ELISA), Protein A coating form of ELISA (PAC-ELISA) were compared for their sensitivity in detecting SPD MLO, by measuring the absorbance values at 405 nm with a Bio-Rad microplate ELISA reader MR 3550.

Detection of SPD MLO in leafhopper vectors

Second instar nymphs of *O. albicinctus* were given an inoculation access on source plant for 24 h and were then caged on 25 days old healthy sesame (TMV 3) plants to complete latent period. After a period of 30 days, these leafhoppers were tested for the presence of SPD MLO by indirect form of ELISA. The leafhoppers were homogenized with aliquots of 250 ml of antigen buffer. Samples of one, three and five insects were tested. The alkaline phosphates based indirect form of ELISA was adopted with 1:500 and 1:1000 dilutions of SPD MLO antibodies and alkaline phosphates conjugated anti-rabbit and FC specific antibodies produced in goat respectively. Comparable non-inoculative, MLO free leafhoppers served as control. Absorbance values were read at 405 nm with ELISA reader.

RESULTS

Slide agglutination test and glass capillary tube precipitin test could detect the SPD MLO infected plants, by forming a precipitate. In slide agglutination test, sesame phyllody antigen

Table 1. Slide agglutination test for diagnosing phyllody infection in sesame and sunn hemp

Source	Antigen	Time taken for precipotation (min)*					
		15	30	45	60	75	90
Sesame	Healthy	-	-	-	-	-	-
	Infected	-	+ +	+ + +	+ + +	+ + +	+ + +
Sunn hemp	Healthy	-	-	-	-	-	-
	Infected	-	-	+	+ +	+ +	+ +

* Observations based on 15 plants each

- : No precipitation
+ : Low precipitation
+ + : Moderate precipitation
+ + + : High precipitation

from sesamum plants formed a precipitate with antiserum with 30 min. whereas the sesame phyllody antigen from infected sunn hemp also formed a precipitate but only after 45 min (Table 1).

In glass capillary tube precipitin test, the amount of precipitate formed and time taken for precipitation varied with the diameter of capillary tubes and the antigen source used (Table 2). The precipitate formed in 1.0 cm capillary tube was clearly visible since it was distributed in greater volumes of liquid phase. The other interesting finding was that in both the tests, the antigen from infected sesame formed more precipitate in minimum time than antigen from infected sunn hemp, indicating the MLO concentration may be higher in sesame than in sunn hemp. Among the four forms of ELISA's employed with various antibody dilutions for detecting SPD MLO at 10^{-1} dilution the DAC-ELISA and DAS-ELISA were not sensitive in detecting phyllody MLO as the absorbance values obtained at 405 nm for healthy and phyllody infected plants sap did not exhibit much variation at all dilutions of antibodies tested (Fig. 1).

The indirect form of ELISA was well as protein - A coating form of ELISA were found to be be more sensitive in detecting the phyllody of MLO in sesame plants (Table 3). With antisera dilution upto 1:500 gave absorbance values between 0.149 to 0.156 for healthy and between 0.407 and 0.419 for infected samples. The two procedures were able to detect phyllody MLO even upto to 1:1000 antisera dilution tested. The indirect form of ELISA and protein-A coating form of ELISA could detect the phyllody MLO in plant sap upto 10^{-4} dilution with 1:500 antisera dilution.

Different number of leafhoppers viz., one, three and five were used for detecting SPD MLO by indirect form of ELISA. The difference in absorbance values between extracts of inoculative (0.179) and healthy (0.137) was appreciable, only when groups of five leafhoppers were tested. No distinct difference in absorbance values were noted when groups of two and single leafhoppers were used for testing (Table 4). This study indicated that presence of SPD could be detected using samples of five or more number of leafhoppers.

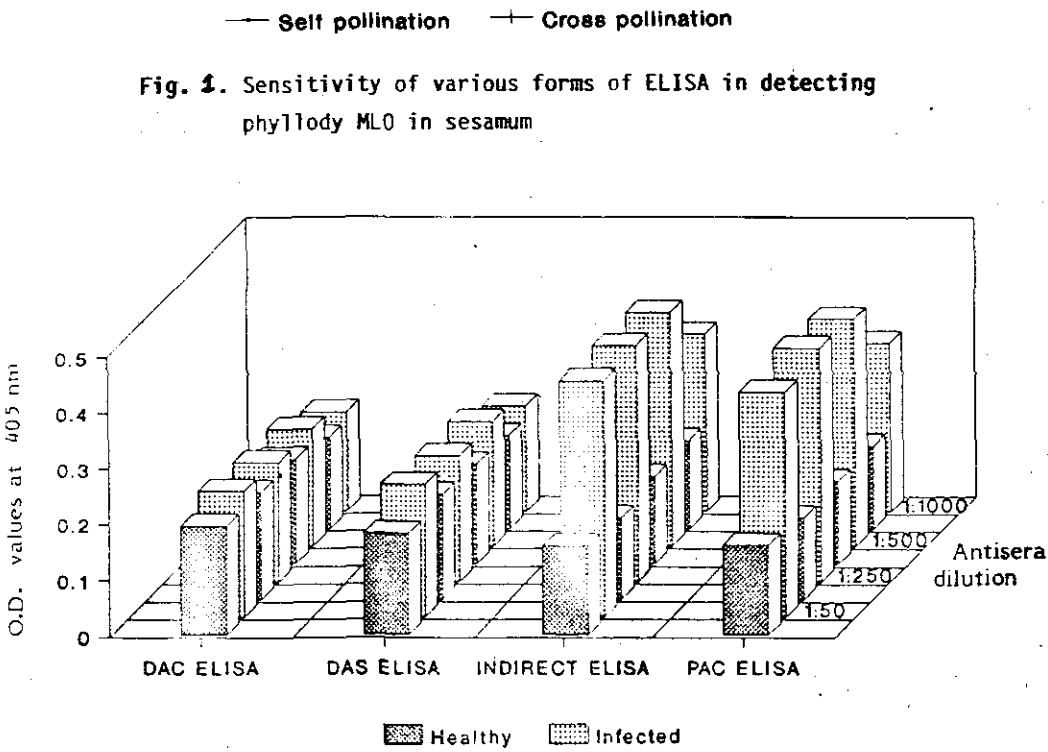

Fig. 1. Sensitivity of various forms of ELISA in detecting phyllody MLO in sesamum

DISCUSSION

Detection of the MLO infections using serological tests is considered to be more rapid, sensitive and reliable because of the specificity of the reactions between the pathogen and specific antibodies induced by the pathogen. The present investigations were taken up to explore the possibility of selecting sensitive serological test for the detection of phyllody infection.

In glass capillary tube precipitin test, the amount of precipitate formed and the time taken for precipitation varied with the diameter of capillary tubes and the antigen source used. The precipitate formed in 1.0 mm capillary tube was clearly visible since it was distributed in greater volumes of liquid phase. The other interesting finding was that in both the tests, the antigen from infected sesame formed more precipitate in minimum time than antigen from infected sunn hemp indicating the MLO concentration may be higher in sesame that in sunn hemp. The MLO infection in different plant species has been detected using different serological tests by several workers; aster yellows in aster (Sinha and Benhamou, 1983), paulownia witches than broom (Zhu *et al.*,1986), Eastern aster yellows, Western aster yellows, potato witches broom and clover proliferation in *Catharanthus roseus* (De Rocha *et al.*, 1986). Spiroplasma citri (Fletcher and Slack, 1986). The present study also revealed the sensitivity of serological tests which provide the results rapidly.

Among the four forms of ELISA'S employed with various antibody dilutions for detecting SPD MLO at 10^{-1} dilution. The indirect form of ELISA as well as protein - A coating form of ELISA were found to be equally sensitive in detecting the phyllody MLO in sesame plants even upto 10^{-4} antigen dilution (Fig 1; Table 3). Peanut witches broom MLO also was detected using indirect form of ELISA by Hobbs *et al.*,

Table 2. **Glass capillary tube test for diagnosing phyllody infection in sesame and sunn hemp**

Source	Antigen	Internal diameter of capillary tubes											
		Time taken for precipitation (min)*						Time taken for precipitation (min)*					
		15	30	45	60	75	90	15	30	45	60	75	90
Sesame	Healthy	-	-	-	-	-	-	-	-	-	-	-	-
	Infected	-	-	++	++	++	+	-	++	+++	+++	+++	+++
Sunn hemp	Healthy	-	-	-	-	-	-	-	-	-	-	-	-
	Infected	-	-	-	-	-	-	-	-		++	++	++

* Observations based on 15 plants each

- : No precipitation
- + : Low precipitation
- ++ : Moderate precipitation
- +++ : High precipitation

Table 3. Sensitivity of indirect form and PAC form of ELISA techniques in detecting sesame phyllody

Antigen dilutions	Forms of ELISA* (P.D. values at 405 nm)			
	Indirect form		PAC form	
	Healthy	Infected	Healthy	Infected
10^{-1}	0.145	0.434	0.147	0.431
10^{-2}	0.135	0.385	0.143	0.392
10^{-3}	0.132	0.356	0.141	0.368
10^{-4}	0.131	0.197	0.137	0.201

* Dilutions used

Rabbit antibody : 1 : 500
Enzyme linked anti rabbit Fc specific antibodies produced in goat : 1 : 100
Protein A : 1 ng/ml

Table 4. Detection of SPD MLO in *Orosius albicinctus* by indirect form ELISA**

Number of leafhoppers (in 250 ul)	Absorbance values at 405 nm* Leafhoppers	
	Healthy	Inoculative
1	0.121	0.123
3	0.121	0.137
5	0.132	0.179

** ELISA system with alkaline phosphatase labelled rabbit Fc specific antibodies produced in goat at 1 : 1000 dilution used

* Represent the mean of five replicate wells

(1987). The present studies indicated that considering the cost of protein A and longer time (1 h.) required for PAC-ELISA indirect form of ELISA could be used as a routine method for detecting phyllody MLO in sesame.

Sesame phyllody MLO was detected in leafhopper vectors using ALP based indirect form of ELISA (Table 4). Using ELISA the transitory yellowing virus in *Nephotettix nigropictus* (Takahashi *et al.*, 1988) and in potato leaf roll virus (Tamada and Harrison, 1981) and Barley yellow dwarf (Torrance, 1987) in *Myzus persicae* and *Rhopalosiphon maidis* aphid vectors respectively using sandwich ELISA and PLRV in *Myzus persicae* using cock tail ELISA (Vanden Heuvel and Peters, 1989) were successfully detected. The ALP based indirect form of ELISA was used for detecting SPD MLO in *Orosius albicinctus*. Vector indexing based on ELISA may lead to rapid estimation of population of inoculative leafhoppers present at various periods of sampling. Such information may provide *point d' appui* to plan effective disease management system.

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PERFORMANCE OF *RABI* / SUMMER GROUNDNUT IN AN AGROFORESTRY SYSTEM AS INFLUENCED BY MANAGEMENT OF EUCALYPTUS TREE ROWS

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ABSTRACT

A field experiment was conducted at the Regional Research Station, Raichur, Karnataka, to study the influence of management practices like tree felling, trenching and increasing distance from tree line in an agroforestry system. Eucalyptus trees were planted in strips spaced at 20 m in north-south direction during 1983. Management practices were imposed during 1990. Groundnut was raised as an intercrop between eucalyptus tree rows during *rabi*/summer season of 1990-91 and 1991-92. Significant reduction in pod yield of groundnut was noticed when trees were not felled. Average pod yield with tree felling (1692 kg/ha) was 118 per cent higher than that of no felling (774 kg/ha). The pod yield recorded with open trench and trench covered with polythene were on par but significantly superior over no trench in both the years. The pod yield was more at 4.5 -9.0 m distance compared to 0-4.5 m away from tree line.

Key Words : Eucalyptus; Agroforestry system; Groundnut.

Agroforestry combines woody perennials with agricultural crops or pasture plants in a variety of arrangements. Studies conducted on eucalyptus based agroforestry systems reveal eucalyptus reduce the yield of field crops (Itnal, 1987; Nadagouda, 1990). It is obvious that it consumes more water but it produces more biomass per unit of water consumed than other tree species (Chaturvedi, 1984). Proper management of eucalyptus through pruning, topping, trenching etc., enable the farmers to include eucalyptus in agroforestry systems. However, information on the management practices to be followed to reduce the deleterious effects of the tree component in an agroforestry system is lacking. Considering this studies were undertaken with different management practices and their reponse on groundnut grown in association with eucalyptus.

MATERIALS AND METHODS

A field experiment was laid out under irrigated conditions in red soils of Regional Research station, Raichur, Karnataka. The saplings of eucalyptus hybrid were planted in north-south direction inlines at 20 m apart on 20th August,. 1983. Within a line, a spacing of 1 m was maintained between two saplings. The trees were allowed to grow and their effect on associated crops was studied for seven years. When trees attained seven years of age, management practices for eucalyptus tree rows were introduced. There were 12 treatment combinations consisting of two levels of tree felling (felling and no felling), three levels of trenching (no trench, open trench and trench covered with polythene and two distances from tree line in units of 4.5 m (0 - 4.5 m and 4.5 - 9.0 m). The trenches of 0.45m width and 0.60 m depth were dug on either side of tree rows. The experiment was laid out in split-split-plot design with felling treatments as main plot, trenching treatments as sub plot and distance from tree line as sub-sub plot. The treatments were replicated eight times (considering each direction of a tree lines as one replication). Groundnut was grown in between two eucalyptus lines following all the recommended cultivation practices during *rabi*/summer 1990 -91 and 1991 - 92 seasons.

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Pod yield per plot was recorded after harvest during both the years.

RESULTS AND DISCUSSION

The pod yield of groundnut as influenced by different management practices followed in eucalyptus tree rows and distance from tree lines during *rabi*/summer 1990-91 and 1991-92 are presented in Table 1 and 2. The pod yield of groundnut differed significantly due to tree felling, trenching and distance from tree lines. During both the years, the pod yields of groundnut recorded with tree felling (1712 and 1672 kg/ha during 1990-91 and 1991-92, respectively) were significantly higher than that of without felling (782 and 766 kg/ha during 1990-91 and 1991-92, respectively). During 1990-91, open trench recorded significantly higher pod yield (1409 kg/ha) compared to no trench (951 kg/ha) and was on par with trench covered with polythene (1381 kg/ha) treatments. But in 1991-92, trench covered with polythene recorded highest pod yield (1358 kg/ha) and was on par with open trench (1334 kg/ha) and both were significantly superior to no trench treatment (965 kg/ha). The increased yields with felling and trenching over no felling and no trench were mainly due to reduced effect of shade and root competition. On the contrary, the reduction in yield with no felling and no trench treatments was mainly due to shade and root effect of well grown eucalyptus trees. Mathur *et al.*, (1984) observed no adverse effect of eucalyptus planted on field bunds in the earlier stages, but reduction in grain yield of paddy from 40.0 to 37.5 q/ha and in wheat for 35.0 to 32.8 q/ha was observed with eucalyptus of 8-10 years old. Reduction in crop yields in association with eucalyptus were observed in agroforestry experiments conducted at Bangalore (Anon. 1987). Similar results suggesting adverse effects of tree species at 8 -10 years of age on associated field crops were reported by Srivastava and Ramamohan Rao (1988); Vinaya Rai and Suresh (1988) and Itnal *et al.*, (1989) and Ramshe (1989).

Pod yield recorded between 4.5 - 9.0 m distance from tree line was significantly higher than that of 0-4.5 m distance during both years (Table 1). Depressing effect of eucalyptus on the yield of associated crops near the tree line were reported by Chandrasekhariah (1986) and Itnal *et al.*, (1991).

Interaction effects of tree felling and trenching were significant during both the years. In general, the yields were higher with open trench and trench with polythene whether the

Table 1. ***Pod yield of groundnut (kg/ha) as influenced by eucalyptus tree row management practices during rabi/summer 1990 - 91***

	Trenches				Distance from tree line		
	No trench	Open trench	Trench with polythene	Mean	0 - 4.5 m	4.5 - 9.0 m	Mean
Tree felling	1327	1942	1867	1712	1531	1893	1712
No tree felling	575	876	895	782	707	857	782
Mean	951	1409	1381		1119	1375	

Source	CD at 5%
Tree felling	118
Trenches	144
Distance from tree line	114
Tree felling x Trenches	203
Tree felling x Distance from tree line	NS

Table 2. Pod yield of groundnut (kg/ha) as influenced by eucalyptus tree row management practices during *rabi* / summer 1991-92.

	Trenches				Distances from tree line		
	No trench	Open trench	Trench with polythene	Mean	0 - 4.5 m	4.5 - 9.0 m	Mean
Tree felling	1350	1790	1876	1672	1552	1792	1672
No tree felling	580	878	840	766	706	826	766
Mean	965	1334	1358		1129	1308	

Source	CD at 5%
Tree felling	123
Trenches	80
Distance from tree line	61
Tree felling x Trenches	113
Tree felling x Distance from tree line	86

trees were felled or not. However, trenching without tree felling has a very limited effect in reducing the deleterious effect of tree rows on groundnut crop (Table 1 and 2). Interaction effect of tree felling and distance from tree lines was significant only during 1991-92 (Table 2). significantly higher pod yield (1792 kg/ha) was recorded at 4.5 - 9.0 m distance when the tree was felled compared to all other interactions. The variations in pod yield due to other interactions such as trenches x distance from tree line; tree felling x trenches x distance from tree line were found non- significant during both the years. However,. the pod yields were higher at 4.5 - 9.0 m compared at 0 -4.5 m distance from tree line, in all the trenching treatments during both the years.

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PHYSICAL CONSTITUENTS AND SOME ENGINEERING PROPERTIES OF PEANUT POD

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ABSTRACT

Experiments were carried out to determine proportion of physical constituents and properties such as, spatial dimensions, projected area, weight, volume, specific gravity, terminal velocity, coefficient of external friction and angle of repose of peanut pods (variety : JL - 24). These properties were found for five distinct categories of peanut pods, classified according to their shape and number of kernels inside the pods. Results showed that proportion of hull, skin and cotyledons on pod basis varied between 21.51-24.13%, 1.24-2.57% and 73.49-75.92%, respectively. In case of physical properties, length, thickness and width of peanut pods of all the types varied between 14.50-48.65 mm, 8.75- 14.40 mm and 8.05-15.45 mm, respectively. Whereas, projected area, specific gravity, terminal velocity, coefficient of external friction and angle of repose varied between 430-2,054 mm ^{2}, 0.226-0.840, 7.32-14.87 m/s, 0.567-0.598 and 29.5°-30.5°, respectively. Lot of variation in properties was observed for pods belonging to different categories as well as for pods belonging to same category. Terminal velocity of hull and kernel varied between 2.25- 3.50 m/s and velocity 10.76-15.39 m/s respectively.

Key Words : Physical constituents; physical properties; peanut pods.

Peanut (*Arachis hypogaea*)pods go through various processes such as, stripping, cleaning, grading, drying and decortication before they are used for seed, table purposes and/or oil extraction. To design and develop processes and equipments for these unit operations, physical constituents and engineering properties of peanut pod need to be determined.

Some studies have been reported on physical properties of peanut kernels of Adhaoo *et al.*, (1976) and peanut pod geometry by Agrawal *et al.*, (1983). The effect of uniform maturity of peanut pods on grader design has been studied by Maraviya and Chandra (1982) and based on this study, a pneumatic type peanut pod grader was developed by Chandra *et al.*, (1985). However, there is lack of information on physical constituents and properties of peanut pods vis-a-vis the existance of great variation of these properties within a lot. It was thus, felt necessary to investigate the proportion and moisture content of physical constituents and some important properties such as, spatial dimensions, projected area, weight, volume, specific, gravity, terminal velocity, coefficient of external friction and angle of repose of peanut pods in order to use them for development of a peanut pod grader. It was also thought to determine terminal velocities of different physical constituents, viz., hull (half, quarter and bits) and kernel of peanut pods.

MATERIALS AND METHODS

Peanut stock (JL-24) was obtained from Madhya Pradesh Seed and Farm Development Corporation. The lot was first cleaned to remove the impurities, viz., trash, dirt and dust. To determine moisture content of peanut pods, five samples each weighing between 25-30 g were placed in a hot air oven at 100°C for 72h. The samples were then cooled in a dessicator, weighed and their moisture content determined.

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For this study peanut pods comprising single and double kernel were classified into four following distinct types (Agrawal *et al.*, 1973) for the purpose of predicting their cross- sectional area, projected area, surface area and volume.

Type 1 : Single kernel ellipsoid

Type 2 : Double kernel ellipsoid

Type 3 : Paired ellipsoids or double kernel, pod that appear to have two ellipsoids or spheroids paired to form a single pod

Type 4 : Cassinoids, which are double kernel pods similar in shape to a cassinoid where a cassinoid is a solid of revolution of the ovals of cassini.

However, a visual analysis of peanut sample procured revealed that it contained triple kernel pods too. A triple kernel pod generally comprises a single kernel ellipsoid and a double kernel ellipsoids category of pods was classified as Type 5. The whole lot was thus, divided into five categories as shown in Fig 1. Twenty five pods from each category were selected by hand picking and their physical constituents and properties determined.

A dial micrometer, having least count of 0.005 mm, was used to determine spatial dimensions, viz., thickness and width, in case of ellipsoid, major axis (a), minor axis (b) and transverse axis (c) which denote length, thickness and width of peanut pods, respectively were determined (Fig 1). For cassinoids, length and thickness of pods were determined (Agrawal *et al.*, 1973). Specific gravity was determined by using the following expression (Mohsenin, 1980).

Specific gravity :

$$\frac{\textit{Weight of pod in air x Specific gravity of liquid used}}{\textit{Weight of displaced liquid}}$$

Individual pod weight was taken with the help of an electronic balance having least count of 0.0001 g. Individual pod volume was determined by liquid displacement method (Mohsenin, 1980) using a general purpose reagant i.e., toluene rectified having specific gravity of 0.866. It was visually seen that peanut pods being lighter, did not sink in the toluene. Therefore, each pod was tied to a sinker with the help of a string and was dipped in toluene to find the change in volume.

Coefficient of external friction was measured with reference to mild steel surface. The set-up was mainly consisted of a frictionless pulley fitted on a frame and a sample holder connected to the weight pan (Sreenarayana *et al.*, 1985).

The angle of repose was determined by allowing peanut pods to form a pile a mild steel surface (Mohsein, 1980).

Terminal velocity of individual pods, hull (half, quarter and bits) and kernel in air was determined by using a vertical air tunnel (Mohsein, 1980) and an electronic digital anemometer having velocity range from 0.20 - 25.0 m/s.

Proportion of physical constituents was determined by separating individual pods into hull, skin and cotyledons. Individual constituents so obtained were weighed and their moisture content determined.

RESULTS AND DISCUSSION

The results of the experiments conducted for determining the various physical properties of peanut pod are given in Tables 1 and 2. It can be seen from Table 1 that length of peanut pods varied between 14.50-48.65 mm whereas corresponding thickness and width of pods varied between 8.75-14.40 mm and 8.05-15.45 mm, respectively for all types of pods.

Table 1. Spatial dimensions of peanut pod at 10.3 % (db) moisture content

Dimensions	Type				
	1	2	3	4	5
Length					
Min.	14.50	22.50	29.40	22.70	35.85
Max.	21.65	30.75	37.10	33.25	48.65
Avg.	18.25	27.17	33.61	28.09	42.15
SD	1.69	2.28	2.37	2.58	3.30
Thickness					
a) Types 1, 2 and 4 only					
Min.	10.60	9.65	-	9.20	-
Max.	14.15	13.35	-	13.80	-
Avg.	12.55	11.47	-	11.15	-
SD..	0.80	1.20	-	1.06	-
b) Types 3 and 5 only					
(i) First ellipsoid (Fig. 1)					
Min.	-	10.20	-	8.75	-
Max.	-	13.40	-	14.40	-
Avg.	-	12.28	-	11.99	-
SD	-	0.79	-	1.37	-
(ii) Second ellipsoid (Fig. 1)					
Min.	-	10.20	-	9.00	-
Max.	-	13.65	-	13.05	-
Avg.	-	12.01	-	11.49	-
SD	-	2.26	-	0.86	-
Width					
a) Types 1 and 2 only					
Min.	9.75	10.90	-	-	-
Max.	13.05	15.45	-	-	-
Avg.	11.53	12.61	-	-	-
SD	0.87	1.00	-	-	-
b) Types 3 and 5 only					
(i) First ellipsoid (Fig. 1)					
Min.	-	-	9.20	-	8.85
Max.	-	-	12.70	-	13.35
Avg.	-	-	11.22	-	11.28
SD	-	-	0.96	-	1.05
(ii) Second ellipsoid (Fig. 1)					
Min.	-	-	8.05	-	10.95
Max.	-	-	12.80	-	14.40
Avg.	-	-	11.52	-	12.65
SD	-	-	0.96	-	0.88

Table 2. Specific gravity, Coefficient of external friction, projected area and terminal velocity of peanut pods at 10.3 % (db) moisture content

Dimensions	Type				
	1	2	3	4	5
Specific gravity					
Min.	0..373	0.362	0.316	0.281	0.226
Max.	0.840	0.687	0.751	0.717	0.666
Avg.	0.605	0.563	0.534	0.551	0.549
SD	0.11	0.09	0.11	0.11	0.09
Coefficient of external friction (mild steel surface)	0.598	0.567	0.574	0.595	0.571
Projected area mm^2					
Min	430.00	714.20	882.80	760.00	878.50
Max.	751.40	1273.70	1437.10	1288.50	2054.20
Avg.	616.30	1009.30	1110.30	1019.90	1434.20
SD	0.86	1.34	1.46	1.49	2.72
Terminal velocity m/s					
Pod					
Min.	8.94	9.70	8.16	7.32	9.81
Max.	14.60	14.24	13.01	12.53	14.87
Avg.	12.56	12.19	10.99	10.94	12.92
SD	1.32	1.08	1.42	1.32	1.27
Hull					
Half	(7.18)	3.50		For all types	
Quarter	(6.28)	3.37		For all types	
Bits	(8.16)	2.25		For all types	
kernel	(4.39)	10.76 - 15.39		For all types	

* The values in parenthesis denote moisture content % (db)

Table 3. Proportion of physical constituents of peanut pod at 7.76 % (db) moisture content

Constituent	Type				
	1	2	3	4	5
Hull					
Avg.	21.51	22.84	23.76	24.13	23.18
SD	2.43	2.28	2.78	7.17	6.38
Skin					
Avg.	2.57	1.24	2.16	2.38	1.96
SD	0.67	0.46	0.87	0.56	0.47
Cotyledons					
Avg.	75.92	75.92	74.08	73.49	74.86
SD	2.72	2.35	3.28	7.49	6.61

Table 4. Moisture content of physical constituents % (db)

Type	Pod	Hull	Skin	Cotyledons
1	7.64	6.89	5.70	5.84
2	7.58	6.78	5.62	5.89
3	6.82	5.98	4.88	5.27
4	8.99	8.42	7.06	7.23
5	7.54	6.94	5.79	5.99

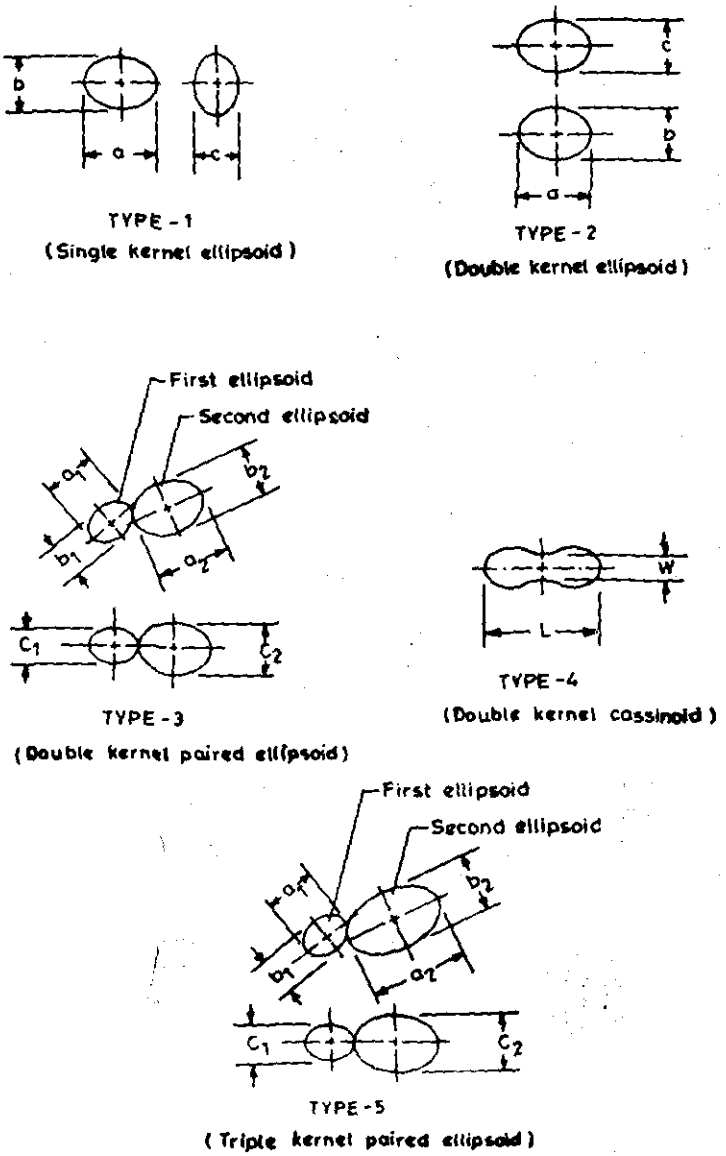

Fig.1. Schematic of peanut types en masse

Table 2 shows that specific gravity and coefficient of external friction of peanut pods varied between 0.226-0.840 and 0.567- 0.598 respectively, whereas, projected area and terminal velocity varied between 430.00 - 2,054.20 mm^2 and 7.32-14.87 m/s, respectively. Also, terminal velocity of hull and kernel varied between 2.25-3.5 m/s and 10.76-15.39 m/s, respectively for all types of pods. Angle of repose of peanut pods varied between 29.5°-30.5°. Proportion of physical constituents of peanut pods are shown in Table 3. It can be seen from Table 3 that hull, skin and cotyledons proportion on pod basis varied between 21.51- 24.13 %, 1.24-2.57% and 73.49-75.92%, respectively. However, in case of Type 4 and Type 5, there was considerable difference among physical constituents of different pods due to presence of immature kernels inside the pods.

Table 4 shows the moisture content of different constituents of peanut pod. It can be seen that there is considerable difference between moisture content of pod and its various constituents (Table 4). The reason can be that pods for moisture determination cannot be used for finding its physical constituents. Each constituent, viz., hull, skin and cotyledons do get exposed to environment immediately after breaking the pod. Moreover, the air pocket between kernel and hull doses also play an important role in moisture migration and acts as a barrier between kernel and hull.

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PROBLEMS WITH DEFINING SEED DORMANCY CHARACTERISTICS OF GROUNDNUT GENOTYPES

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ABSTRACT

The influence of maturity status, variation among seeds within and between plants of the same genotype and length of storage on dormancy in groundnut was evaluated in a two-part study. The first part was conducted from 1989 to 1991, with virginia genotypes, known for their fresh-seed dormancy for upto 70 days. Plant samples were harvested at various days, after emergence and stored for various lengths of time. Germination was observed for the apical seeds and corresponding basal seeds separately. The results showed that aging of seeds in storage broke dormancy faster than aging in plants. However, in the relatively early, virginia genotypes there was a sudden break in dormancy after a certain stage of maturity even when the pods were in the plants. Basal seeds in general, showed less germination than the apical seeds. In the second part of the study with four virginia and two non-dormant spanish genotypes plant-to-plant variation in the germination within a genotype was studied. Substantial range of germination percentage among the plants of each genotype, including the spanish ones was observed. It was concluded that defining dormancy characteristics of groundnut genotypes exactly, might be difficult and more so in the segregating generations.

Key words : Groundnut; Genotypes; Seed dormancy.

Fresh seed dormancy in groundnut (*Arachis hypogaea* L.) is desirable in the spanish (*ssp. fastigiata var. vulgaris*) and valencia (*ssp. fatigiata var. fastigiata*) types of cultivars, but generally is not available in them. The virginia (*ssp. hypogaea var. hypogaea*) type of genotypes have dormancy between 40 and 70 days (Zade *et al.*, 1986). Groundnut in general and virginia types specially are indeterminate in nature and so even the pods of the same plants vary highly in maturity. Toole *et al.*, (1964) reported that maturity status and seed position in pod influence dormancy in groundnut. In addition aging in storage may also affect dormancy. Therefore clear cut determination of the dormancy characteristics of a genotype may be difficult. The work reported here was carried out to understand the relationships between the variation in seed maturity, position and storage on dormancy of some groundnut genotypes. The idea was to get an indication whether it would be possible to identify dormant genotypes in the segregating generations especially when genotypes of wide duration differences were used as parents.

MATERIALS AND METHODS

The study consisted of two parts. The first was conducted for three years viz.,1989, 1990 and 1991. In 1989 four cultivars namely, GAUG 10, Punjab 1, ICGS 11 and Kadiri 3 were studied. In 1990 and 1991, GAUG 10, ICGS 11, ICGS 44 and Kadiri 2 were studied. GAUG 10, Punjab 1 and Kadiri 2 are of the virginia type. The first two mature in 130 days and the third in 110 days. ICGS 11 and ICGS 44 are classified as spanish because they bear flowers on the main axis but they are virtually same in all respects to Kadiri 3, from which they were derived. They mature in about 110 days. Every year the cultivars were grown in the rainy season (*kharif*) in unreplicated plots under standard agronomic practices. A sample of 200 plants of each genotype was harvested at various num-

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Table 1. **Germination percentage of apical and basal seeds of groundnut at various days to harvest and periods of storage (values are means over genotypes)**

1989				1990				1991			
H	Sto	GP		H	Sto	GP		H	Sto	GP	
		A	B			A	B			A	B
90	95	3	2	100	105	12	9	100	105	10	6
	104	11	14		130	73	70		120	51	23
	113	43	36		155	75	87		130	75	73
	130	84	79		-	-	-		150	98	86
	153	93	92		-	-	-		-	-	-
105	110	43	3	110	115	10	2	105	115	7	2
	120	29	33		130	57	54		130	71	94
	135	79	74		155	82	81		145	98	82
	159	79	89		175	99	92		-	-	-
112	117	16	16	115	120	7	3	115	120	16	3
	132	52	45		130	65	47		145	85	79
	157	92	93		159	81	79		155	98	93
	-	-	-		178	97	89		-	-	-
125	130	10	5	120	125	25	9	120	125	25	10
	150	54	10		140	97	85		145	76	75
	175	93	96		-	-	-		155	54	52
	-	-	-		-	-	-		166	98	97
	-	-	-	125	130	0	0	125	130	64	49
	-	-	-		155	6	3		145	72	74
	-	-	-		175	98	89		155	86	85
	-	-	-		-	-	-		170	95	93
	-	-	-	133	138	0	0	130	135	65	52
	-	-	-		155	5	1		145	78	70
	-	-	-		173	70	64		160	84	80
	-	-	-		-	-	-		170	99	95

H = days to harvest (DAE) ; Sto = H + days of storage ; GP = germination percent ; A = apical seed ; B = basal seed ; DAE = days after emergenc

Table 2. Germination percentage of the apical and basal seeds of four genotypes of groundnut harvested in *Kharif* 1981 at different days after emergence and stored for different periods

Harvest (DAE)		100				105			115		
Storage (days)		5	20	30	50	10	25	40	5	30	40
Genotypes											
GAUG 10	A	4	3	15	98	0	11	98	11	50	98
	B	2	3	5	85	0	6	82	0	34	93
Kadiri 3	A	15	93	91	-	8	77	-	26	95	-
	B	1	38	94	-	0	83	-	3	88	-
ICGS 11	A	11	35	95	-	10	83	-	18	98	-
	B	11	8	98	-	6	93	-	3	98	-
ICGS 44	A	8	72	98	-	12	95	-	9	98	-
	B	0	41	95	-	3	95	-	6	95	-
Mean	A	9	51	75	98	7	71	98	16	85	98
	B	6	23	73	85	2	94	82	3	79	93

Contd..

Harvest (DAE)		120				125				130			
Storage (days)		5	25	35	46	5	20	30	45	5	15	30	40
Genotypes													
G A U G 10	A	3	13	54	98	0	39	58	95	0	15	47	98
	B	1	11	52	97	0	15	50	93	0	3	38	95
Kadiri 3	A	50	97	-	-	86	98	95	-	83	99	98	-
	B	13	98	-	-	60	87	98	-	43	97	98	-
ICGS 11	A	33	99	-	-	86	95	94	-	95	99	95	-
	B	18	96	-	-	73	75	95	-	77	97	95	-
ICGS 44	A	14	96	-	-	83	97	97	-	82	98	95	-
	B	7	95	-	-	63	99	98	-	87	86	90	-
Mean	A	25	76	54	98	64	72	86	95	65	78	84	99
	B	9	75	52	97	49	79	85	93	52	71	80	95

A = apical seed ; B = basal seed ; DAE = days after emergence

ber of days after emergence (DAE) of the seedlings. Pods obtained from each harvest were sun dried to 5-6% moisture content and stored in cotton bags at ambient laboratory conditions(40-60% RH and 20-36° C temperature) for various lengths of time. The details on the days to harvest and storage are given in Table 1. After each period of storage the pods were shelled and the apical and the basal seeds were grouped separately. Germination of seeds were then tested following the standard procedures of the Association of Official Seed Analysts (Copeland, 1978). The sample size for germination test of each group was 150 seeds.

The second part of the study was conducted in the year 1991. Four of the above mentioned cultivars viz., GAUG 10, Kadiri 3, ICGS 11 and ICGS 44 and two spanish cultivars with no dormancy viz., GG 2 and JL 24 were studied. They were grown as described above. A sample of 10 plants of each genotype was harvested twice viz., 112 DAE and 130 DAE. The seed from each sampled plant was tested for germination separately, following standard procedure mentioned above.

RESULTS AND DISCUSSION

Dormancy was found to be dependent on not only the genotype but also the maturity status of the genotype at harvest and the length of its storage. Aging of pods during storage appeared to break the dormancy at a faster rate than their aging in plants. For example, when the plants were harvested in 1989 at 90 DAE and stored for 23 days (cumulative 113 DAE), the mean germination percentage was 43 for the apical and 36 for the basal seeds. When the plants were harvested at 105 DAE and stored for 15 days (cumulative 120 DAE) the germination percentages were 29 and 33 for the apical and basal seeds, respectively (Table 1). Similarly, in 1991, when the plants harvested at 100 DAE and stored 30 days (cumulative 130 DAE) the germination percentages for the apical and basal seeds were 75 and 73 respectively, but when the plants were harvested at 125 DAE and stored for five days the germination percentages at the same cumulative DAE were 64 and 49 respectively. This general trend was evident in all the cases of harvest and storage. The trend was more clear when the detailed variety-wise results were studied (Table 2). For example, the cultivar GAUG 10, which matures later than other three genotypes and had longer period of dormancy, showed no dormancy when harvested at only 100 DAE but stored for 50 days. Whereas when it was harvested at 130 DAE and stored for 30 days it showed germination percentages of only 47 for the apical and 38 for the basal seeds.

The dependence of dormancy on maturity was more evident in 1991 (Table 2). It appeared that in the process of maturity, there was a gradual reduction in dormancy. The findings of Toole *et al.*, (1964) are similar. But after a certain stage of maturity there was a sudden break down of dormancy even when the pods were on the plants. This was more evident with respect to the cultivars maturing relatively early viz., Kadiri 3, ICGS 11 and ICGS 44. For example, germination percentage in Kadiri 3 moved with a little fluctuation, upto 50 for the apical and 13 for the basal seeds at 120 DAE and five days of storage. Then after the harvest at 125 DAE and storage for five days the germination percentage shot up to 86 and 60, respectively (Table 2). This trend was not evident in the cultivar GAUG 10, possibly because it is a long duration cultivar.

Variation in dormancy among the seeds of the same genotypes and even of the same plants was clearly evident when germination was observed plant-wise. Most striking was the range of germination percentage among the ten plants of ICGS 44 which when harvested at 112

Table 3. Range and mean of germination percentage of seeds of individual plants of five groundnut genotypes

Genotypes	Harvest (DAE)			
	112		130	
	Range	Mean	Range	Mean
GG 2	78-100	91	-	-
JL 24	89-100	99	-	-
ICGS 11	0-33	12	33-100	60
ICGS 44	0-50	25	0-100	55
Kadiri 3	0-38	17	40-100	70
GAUG 10	0	0	0	0

DAE = days after emergence

DAE showed the range of 0 to 50 and when harvested at 130 DAE showed the range of 40 to 100 (Table 3). Between the two harvests overlapping of the ranges of germination percentage was also found. Even in the non- dormant genotypes like GG 2 the rang of germination percentages was 78 to 100. An important component of the variation in germination of seeds of a plant was that due to the difference between the apical and basal seeds of the same pod. But for a few exceptions, if apical seeds had higher germination percentage than the corresponding basal seeds, irrespective of the harvest time and storage period. Difference in dormancy might be a possible reason for this difference in germination percentage. Toole *et al.*, (1964) also reported such difference. Table 4 lists the cases where the germination percentage of basal seeds were higher than the apical seeds. Except in cases number 1 and 30, in all other cases higher percentage of germination for the basal seeds was found only when the germination percentage was about 80. It would possibly mean that only when dormancy broke, the basal seeds might show a higher germination percentage. But it could be asked why even the dormancy had broken down (80 per cent or more germination taken as an indication of breaking of dormancy)basal seeds showed less percentage of germination than the apical ones in the majority of the cases. The difference in germination between apical and basal seeds remained even after treatment with gibberelic acid which is known to break dormancy. It is thus possible that dormancy may not be the only reason for the lower germination percentage of the basal seeds.

This study showed that the degree of maturity, position of seed and storage period had a confounding influence on seed dormancy. Therefore, it may be difficult to exactly define dormancy characteristics of even a fixed genotype. In a segregating population where the plants differ not only in dormancy but also in duration, defining a plant as dormant or otherwise might be extremely difficult and so

Table 4. Cases where the germination of the basal seeds were higher than the apical seeds

Case No.	Year	Genotype	Harvest (DAE)	Storage (days)	Germination %	
					A	B
1	1989	ICGS 11	90	14	34	43
2			105	15	72	82
3			105	54	97	99
4			112	45	98	99
5		Punjab 1	90	63	91	99
6			112	45	89	99
7			125	50	89	94
8		GAUG 10	112	45	81	82
9	1990	GAUG 10	100	55	75	87
10		Kadiri 3	110	45	97	98
11		ICGS 11	110	20	86	90
12			110	45	98	99
13		ICGS 44	100	5	11	18
14	1991	Kadiri 3	100	30	91	94
15			120	25	97	98
16			125	30	95	98
17		ICGS 11	100	30	95	98
18			105	25	83	93
19		ICGS 44	100	30	98	95
20			125	20	97	99
21			125	30	97	98
22			130	5	82	87

A = apical seed; B = basal seed; DAE = days after emergence

will be the selection for dormancy in early generations.

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ERADICATION OF WILT FUNGUS (*Fusarium oxysporum* f. sp. *carthami*) FROM HEAVILY INFECTED SAFFLOWER SEED

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ABSTRACT

Studies were undertaken to develop more suitable physical and chemical methods to eliminate wilt fungus from bulk seed lots of safflower collected from severely affected areas of the endemic tracts in Maharashtra.Hot water treatment at 55°C for 10 minutes was found to reduce the infection. Among the chemical treatments, wet formulations were found to be more suitable than dry formulations.Alternatively, in order to avoid the cumbersome process of soaking, a new seed dressing formulation of fine particled carbendazim with a sticker at 0.1% or higher dosage was found very effective.

Key Words: *Fusarium oxysporum* f.sp. *carthami* ; Hot water treatment; Seed dressing fungicide.

Klisiewicz (1963) described safflower wilt caused by *Fusarium oxysporum* f. sp. *carthami* as seed transmitted. Since then, several workers have shown that seed treatments with ceresan, thiram, benomyl and carbendazim reduce the fungal infection in the seed (Anil Kumar and Padaganur,1978; Chakrabarti and Basuchaudhary,1979; Bhatti *et al.,* 1985 and Pedgoankar and Mayee,1991). Heavy infections of the wilt fungus (10 to 40%) were detected in safflower seed harvested from wilt affected endemic areas of Buldana and Marathwada districts of Maharashtra (AICORPO, 1991). In view of such heavily infected seed lots and increased disease expression at the seedling stage itself, studies were undertaken at the Directorate of Oilseeds Research to develop more suitable physical and chemical methods to eliminate this fungus from bulk seed lots.

MATERIALS AND METHODS

Seeds from infected plots of farmers' fields in the endemic areas were taken and bulked. A minimum of 400 seeds were used for each treatment (ISTA, 1976). The seeds were put into muslin cloth bags and soaked in water at room temperature overnight.Then the bags were transferred to a hot water bath and treated at 45, 50, 55 and 60°C for 5 and 10 minutes at each temperature. The bags were subsequently transferred to cold water bath followed by drying at 35°C for 12 hours. In case of chemicals, the fungicides (Table 2) were tested at 2g/kg seed (dry treatment) and 2g/l of water(for soaking). In case of wet seed treatment, seeds were soaked in fungicide solutions for 12 hours and air-dried overnight at room temperature. Treated seeds were tested for *Fusarium oxysporum* by placing ten seeds per plate on modified Czapek-Dox agar (Sharma and Singh,1973).Three replicates were maintained for each treatment. The per cent germination of treated seeds was determined by the rolled paper towel test (ISTA,1976).Data on germination included per cent germinated seeds, per cent germinated seeds but killed or abnormal due to fungal attack and per cent ungerminated seeds. The effect on pre - and post emergence survival of seedlings was determined by sowing in sterilised soil and observing the mortality due to *Fusarium oxysporum* f.sp. *carthami* for three weeks. The pots were kept in an incubation chamber at 24°C with 12 hours alternate light and dark periods.

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The sensitivity of wilt fungus to a new seed dressing (S.D.) formulation of carbendazim was also tested by using the modified filter paper disk assay (Jeffery *et al.*,1985). Sterilised filter paper disks of 0.5mm diameter were dipped in different concentrations of fungicide solution and four such disks were placed on Czapek-Dox medium.Four replicates were used for each concentration of the fungicide. A 0.4 mm disk of a two week old *Fusarium oxysporum* f.sp. *carthami* culture was cut and placed on each disk for incubation under 12 hour alternate light and dark periods. After four days of incubation, the area colonized by the fungus on each disk was estimated.

RESULTS AND DISCUSSION

Data in Table 1 show that the hot water treatment at 55° C and above could eliminate the infection by *Fusarium oxysporum* f.sp. *carthami*. However, the seed viability was found to decrease as the temperature increased.The seed treatment at a temperature of 55°C for 10 minutes was considered optimum for reducing infection by the wilt fungus without any physiological damage to the seed. Daniels (1983) has reported elimination of *Fusarium moniliforme* from maize seed by hot water treatment at 60°C for 5 minutes while Zazzerini *et al* (1982) found that hot water treatment at 50° C for 30 minutes was effective for removal of *Alternaria* spp. from safflower seeds.Physical methods such as hot water treatment may thus be useful in bulk seed treatments with minimum cost and where chemical treatments are to be avoided.

Since in a pilot trial benzimidazole fungicides were found to be more efficient than other conventional fungicides like mancozeb, captan etc., in reducing the seed infections, seeds were treated with various formulations of benzimidazole fungicides. Table 2 shows the effect of these formulations on the growth of *Fusarium oxysporum* f. sp. *carthami* colonies singly or in conjunction with pathogenic fungi like *Alternaria* spp., *Curvularia* spp.etc, It was seen that treatments other than dry seed formulations of carbendazim or benomyl 50% W.P. were more effective in controlling the fungal colonies and also resulted in better survival of the seedlings (Table 2). However, use of higher dosage of carbendazim S.D.showed lower seed viability. Excellent control of wilt fungus with carbendazim and benomyl at 0.2 to 0.3% dosage has been reported in several crops including safflower(Haware *et al.*,1983; Pedgoankar and Mayee 1991). However , very often benomyl powder may not adhere to smooth seeds like safflower resulting in lower fungitoxic action(Chakrabarti and Basuchaudhary,1979).In addition, the hard thick coat may be impermeable to the chemical. This may be the reason for lack of complete control of fungus especially when present in the seed and at higher inoculum level. It may be thus necessary to use soak treatments for a more effective performance. The results also indicate the promise of seed dressing formulations of carbendazim which have some quantity of stickers and are also fine particled in nature.Table 3 shows the lower dose of 0.1% was as effective as the conventional dosages of 0.2% and 0.25% in reducing the fungal growth.

Results of this study show the promise of a physical method like hot water treatment at 55° C for 10 minutes to reduce infection by the wilt pathogen on safflower seed with no adverse effect on its physiology. Among chemical formulations, benzimidazole fungicides in soak treatments were more effective than dry treatments. Alternatively, in order to avoid the cumbersome process of soaking, drying, etc., seed dressing formulations of carbendazim at 0.1% or 0.2% dosage may be used for effectively managing the disease.

Table 1. Effect of hot water treatment on *Fusarium** infected safflower seed

Treatment	Blotter				In pot culture		
	Per cent germination				Per cent germination		
	Per cent seeds showing *Fusarium* infection	Normal germinated seed	Germinated but abnormal and killed	Ungerminated	Pre-germination	Post emergence survival	Post emergence mortality
45^0 C							
5 min	14.3 (22.22)	60 (50.77)	34 (35.67)	6 (14.18)	66 (54.33)	84.84 (66.74)	15.16 (22.87)
10 min	14.3 (22.24)	65 (53.73)	26 (30.66)	8 (16.43)	70 (56.79)	100 (90.00)	0 (1.81)
50^0 C							
5 min	13.3 (21.39)	50 (45.00)	42 (40.40)	2 (8.13)	76 (60.67)	100 (90.00)	0 (1.81)
10 min	14.3 (22.22)	74 (58.97)	18 (25.10)	8 (16.43)	86 (68.03)	90.69 (72.15)	9.31 (17.76)
55^0 C							
5 min	13.3 (21.39)	88 (69.73)	10 (18.44)	2 (8.13)	82 (64.90)	77 (61.34)	23 (28.66)
10 min	0.7 (4.80)	90 (71.56)	2 (8.13)	8 (16.43)	86 (68.03)	100 (90.00)	0 (1.81)
60^0 C							
5 min	2.7 (9.46)	84 (66.42)	8 (16.43)	8 (16.43)	82 (64.90)	100 (90.00)	0 (1.81)
10 min	1.0 (5.74)	76 (60.67)	0 (1.81)	24 (29.33)	42 (40.40)	100 (90.00)	0 (1.810
Untr. Control	38.7 (38.47)	54 (47.29)	6 (14.18)	18 (25.10)	50 (50.77)	66 (54.33)	34 (35.67)
CD at 5%	6.0 (14.10)	5.55 (13.56)	4.00 (11.54)	3.88 (11.24)	5.3 (10.47)	5.54 (13.55)	5.31 (10.40)

Figures in parentheses indicate are sine values.
* *Fusarium oxysporum* f. sp. *carthami*

Table 2. **Effect of various benzimadazole formulations on *Fusarium** infected seed**

Treatment	Blotter Per cent germination				In pot culture Per cent germination		
	Per cent seeds showing *Fusarium* infection	Normal germinated seed	Germinated but abnormal and killed	Ungerminated	Pre-germination	Post emergence survival	Post emergence mortality
Carbendazim (Bavistin 50% WP) @ 0.2%	15.84 (23.42)	81.00 (64.16)	2.50 (9.10)	16.50 (23.97)	91.00 (72.54)	86.00 (68.03)	14.00 (21.97)
Benomyl (Benlate 50% WP) @ 0.2%	10.67 (19.00)	81.40 (63.72)	3.00 (9.98)	15.60 (23.26)	94.00 (75.82)	84.00 (66.42)	16.00 (23.58)
Carbendazim Soak @ 0.2%	6.73 (15.00)	90.00 (71.56)	1.30 (6.55)	8.70 (68.87)	99.00 (84.26)	95.00 (77.08)	5.00 (12.92)
Benomyl thiram (Benlate thiram) @ 0.3%	4.1 (11.68)	95.00 (77.08)	0.00 (1.81)	5.00 (12.92)	99.00 (84.26)	94.00 (75.82)	6.00 (14.18)
Carbendazim (Bavistin 25 S.D.) @ 0.1%	1.83 (6.02)	98.00 (81.87)	0.00 (1.81)	2.00 (8.13)	99.00 (84.26)	100.00 (90.00)	0.00 (1.81)
Carbendazim (Bavistin 25 S.D.) @ 0.2%	3.16 (10.14)	90.00 (71.56)	1.00 (5.74)	9.00 (17.46)	94.00 (75.82)	90.00 (71.56)	10.00 (18.44)
Control	48 (43.91)	67.00 (54.94)	18 (22.79)	15.00 (53.13)	64.00 (56.79)	70.00 (56.79)	30.00 (33.21)
CD at 5%	5.24 (13.18)	4.50 (12.25)	2.60 (9.28)	4.31 (11.97)	5.34 (13.18)	5.00 (12.92)	4.80 (12.66)

Figures in parentheses indicate are sine values.

* *Fusarium oxysporum* f. sp. *carthami*

Table 3. Effect of various concentrations of carbendazim (S.D.) on the growth of *Fusarium oxysporum* (by filter paper disk assay)

Dosage of carbendazim 25 S.D.	Area of colony (Sq. mm)
0.05%	1497.50[b]
0.10%	612.25[a]
0.20%	317.50[a]
0.25%	250.00[a]
Control	4980.00[c]
CD at 5% value	884.25

* Mean of four replications

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EVALUATION OF GERMPLASM COLLECTIONS OF SAFFLOWER IN INDIA FOR MORPHOLOGICAL CHARACTERS AND ITS ASSOCIATION WITH REACTION TO ALTERNARIA LEAF SPOT

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ABSTRACT

Morphological characters of safflower were significantly associated with reaction to Alternaria leaf spot. Appressed and erect plant types were showing more degree of tolerance than bush and cone shaped plant types. Fleshy texture of upper stem leaves and oblong and lanceolate shape of upper stem leaves were associated with better tolerance to the disease than normal and leathery leaves or ovate shape of upper stem leaves. Non-spiny and semi-spiny accessions were more tolerant to the disease. Plants with more tolerance had higher mean seed yield and capitula per plant than the less tolerant ones and susceptible ones. Plant types maturing late showed better disease tolerance than the early maturing ones. It is concluded that these morphological types may be of use in selection of resistant or tolerant plants.

Key Words : Safflower; Germplasm; Alternaria leaf spot; Morphological characters.

Safflower (*Carthamus tinctorius* Linn) is one of the major annual oilseeds grown throughout the world and India has the largest crop area. The crop affected by a number of diseases. The leaf blight of safflower caused by *Alternaria carthami* Chowdhury is one the major diseases. It is seed borne or air borne and produces large irregular lesions on the foliage, stem and flower bracts (Chowdhury, 1944 and Irwin 1975, 1976) and finally the leaf sports lead to blight symptoms (Ray and Basu Chaudhary, 1984). India is known for its rich genetic resource in safflower which form a bulk of world's collection. In order to exploit the potentials of the genetic materials of this crop, evaluation of a number of economically important characters are being carried out systematically on the germplasm materials at the Germplasm Management Units, Mahatma Phule Agricultural University, Solapur in selection of plant type (GMU) for better performance. The present study analyses the results of evaluation of a set of 1136 accessions during 1987-88 for their reaction to Alternaria leaf spot and its association with morphological characters of importance.

MATERIALS AND METHODS

The germplasm material was raised in GMU, Solapur (Longitude - 17° 14' N and Latitude 75° 56'E and Elevation 483.6 m MSL) in single rows of 6 m length spaced at 45 cm between rows and 30 cm within rows using augmentated block design with 13 standard checks of Indian origin. Reaction to Alternaria leaf spot was scored on a 1-5 scale, indicating a score of 1 'resistant' (0-20% incidence); 2 'moderately resistant' (21-40% incidence); 3 'tolerant' (41-60% incidence); 4 'susceptible' (61-80% incidence, and 5 'highly susceptible' (more than 80% incidence). Morphological characters taken in this study were as per the catalogue of the germplasm materials (Ghorpade *et al.*, 1991). Relevant combinations of disease reaction and a morphological character were taken and two-way contingency tables were prepared

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to study the character association. In case of quantitative characters like seed yield, number of capitula and days to physiological maturity, one way analysis of variance performed to study the effect of the disease incidence on these characters.

RESULTS AND DISCUSSION

The frequencies of disease scores for some of the source countries is given in Table 1. Only three accessions (EC-191790 from Australia; EC-191791 and EC-181913 from India) were found to be 'resistant' (0- 20% incidence (for the disease. However, 266 accessions were found to be moderately resistant to the disease. A sizeable number of accessions were found to be tolerant (41-60% incidence).

The four plant types or growth habits showed different types of reaction to the disease (Table 2). Bushy and cone shaped plant types were more susceptible (a score of 4-5) to the disease as compared to appressed and erect types. The latter two types had a larger proportion of moderately tolerant plants compared to the former two types. Combining the first three disease scores (tolerant types), it is seen that appressed and erect types were more tolerant than bushy and cone shaped (the ratios being 70:30 and 60:40 to tolerant to susceptible). The differences in the reaction of these plant types were statistically significant.

Plant types with different texture of upper leaves also exhibited varying patterns of disease reaction. Plants with fleshy upper leaves were found to be less susceptible to the disease than those with normal and leathery leaves. The former had more proportion of tolerant plants than the latter two and the ratio of tolerant to susceptible in fleshy leaf types was 83:17 as compared to 64:36 in normal and leathery types (combining the first two columns).

Different shapes of upper stem leaves also showed varying patterns in the disease reaction. The differences were statistically significant. About 28% of plants with lanceolate and oblong leaf shapes were susceptible to the disease whereas 40% plants were susceptible in the case of plants with ovate upper stem

Table 1. Varied reaction of safflower germplasm to Alternaria leaf spot disease

Country	No. of entries	Per cent frequency in diffeent categories				
		Cat - 1	Cat - 2	Cat - 3	Cat - 4	Cat - 5
India	546	0.2	20.0	37.2	24.3	18.3
U.S.A	144	0.0	29.2	46.5	19.4	4.9
Turkey	64	0.0	29.7	46.9	12.5	10.9
Pakistan	53	0.0	33.9	49.1	11.3	5.7
Iran	51	0.0	21.6	58.8	15.7	3.9
Egypt	27	0.0	22.2	44.5	22.2	11.1
Portugal	20	0.0	30.0	40.0	25.0	5.0
Australia	18	11.1	16.7	22.2	33.3	16.7
Israel	18	0.0	27.8	55.6	11.1	5.5
Total (frequency)	1136*	3	266.0	470.0	245.0	152.0

* including all other countries with lesser number of entries.

Cat-1 to Cat-5 indicate classifications based on disease incidence of 0-20%, 21-40%, 41-60%, 61-80% respectively.

Table 2. Morphological types and their association with Alternaria leaf spot.

Morphological types	Disease incidence			Total	χ^2 value
	Tolerant group	Moderate group	suceptible group		
	≤ 40%	40-60%	> 60%		
Growth habit					
Bushy	27.7	32.2	40.1	202	
Cone shaped	20.0	39.6	40.4	374	23.04**
Appressed	18.1	51.8	30.1	83	
Erect	25.8	44.9	29.3	477	
Texture of upper leaves					
Fleshy	28.6	55.0	16.7	60	9.63*
Normal	23.7	40.4	35.9	768	
Leathery	22.7	41.2	36.0	308	
Shape of upper stem leaves					
Ovate	19.9	40.0	40.1	633	20.31**
Lanceolate	29.4	42.6	28.0	68	
Oblong	28.3	43.2	28.5	435	
Spines on upper stem leaves					
No spines	26.0	52.0	22.0	50	12.73*
Few spines	26.2	44.8	29.0	328	
Intermediate/Many	22.4	39.1	38.4	758	

The cell frequencies are expressed as percentage of corresponding row totals

* and ** contingency χ^2 significant at 5% and 1% respectively

leaves. In addition, the former two types had nearly 30% tolerant entries (score of 1-2) as compared to 20% tolerant entries in the ovate type. In all the three types of plants, about 40-43% plants exhibited moderate tolerance (a score of 3).

Non-spiny and few-spined upper stem leaves were associated with less susceptible reaction to the disease than intermediate or many spined leaves. The former two types had 22% and 29% susceptible lines compared to 38.4% in the case of latter. Though the differences in proportion of tolerant types (1-2 scores) were not high, the less spiny types had larger proportion of moderately tolerant ones (a score of 3). Similar results have been reported by Kolte (1985).

Apart from studying the relationships between the morphological characters and the reaction to *Alternaria*, one-way analysis of variance was done to study the effect of the degree of disease incidence on seed yield per plant, number of capitula per plant and days to physiological maturity (Table 3). The mean values were significantly different. The mean seed yield was 14.7 g for resistant/moderately resistant types. The mean seed yield for the other categories was in the range of 11.0-11.7 and the difference was not perceptible. The mean number of capitula for the plant types with a disease score

Table 3. Effect of Alternaria leaf spot on yield components and days to maturity in safflower

Disease per cent	Seed yield (gms) ± SE	Capitula/ plant ± SE	Days to maturity ± SE	No. of cases
0-40%	14.7 ± 0.57	33 ± 1.1	130 ± 0.5	26
41-60%	10.9 ± 0.43	30 ± 0.8	129 ± 0.3	470
61-80%	11.7 ± 0.60	30 ± 1.1	126 ± 0.5	245
> 80%	11.0 ± 0.76	29 ± 1.4	125 ± 0.6	152

The differences were statistically significant at 1% level

1-2 was 33.2, whereas for disease score greater than 2, it ranged from 29.5-30.3. The above results confirm the yield losses reported to be caused by the disease. The crop losses caused by the disease varied from 20% for more than 50% depending on the severity of the disease and there was loss of seed and oil quality (Jackson *et al.*, 1982; Ramesh Chand and Chaurasia, 1984 and Kolte, 1985). Under rainfed conditions of dry lands of India the losses were estimated to 10-25% and in irrigated areas it varied from 10% to 39% (Shambharkar and Indi, 1987) . With regard to days to maturity, the mean values were 130, 129, 126 and 125 for the four types of disease reaction (scores of 1-2, 3, 4, 5). Out of 269 accessions which were found to be in the resistant/moderately resistant group, 61.3% were having days to physiological maturity 129 days. Likewise out of 397 accessions that were in the susceptible/highly susceptible group, 59.4% accessions were having days to physiological maturity 125 days. This confirms that early maturing types tend to be more prone to the

Table 4. Entries tolerant to aphids (per cent drying <40) and moderately resistant to Alternaria leaf spot (per cent disease < 40)

Collection No.	Source country	Collection No.	Source country
EC - 137334	AUS	S - 144*	IND
EC - 181626	IND	EC - 181613	IND
EC - 181883	IND	EC - 181824	IND
EC - 182077	IND	EC - 181974	IND
EC - 181321	IND	A - 1*	IND
EC - 181785	IND	EC - 181440	IRN
EC - 181962	IND	EC - 181210	SDN
EC - 181247	IND	EC - 181453	TUR
EC - 181779	IND	EC - 159627	USA
EC - 181912	IND	EC - 159684	USA
EC - 182078	IND	EC - 151970-1	NOI
BHIMA*	IND	EC - 163747-2	NOI

AUS - Australia; IND - India; IRN - Iran; SDN - Sudan; TUR - Turkey;
USA - United States of America; NOI - unknown.
* : Check entries from India

disease at flowering stage whereas, the late maturing types tend to escape the vulnerable stage of the disease cycle. It has been recommended that sowing of safflower beyond second fortnight of September in dry lands of peninsular India be taken as it reduced the disease incidence, whereas early sowing caused more disease incidence (AICORPO, 1985). On 1-9 disease scale, the disease scores were 8 and 5 respectively in 1st and 2nd fortnight September sown crops while they were 3.7 and 3.0, respectively for 1 st and 2nd fortnight October sown crops. Nevertheless, the late sown crops were found to be highly susceptible to aphid infestation and reduced the yields and the maximum yield reported in crops sown in 2nd fortnight of September (More and Nikam, 1987). The germplasm evaluation could identify 24 entries which were moderately tolerant/resistant to both the aphids and disease and the list is shown in Table 4.

Table 5 summarizes the mean number of days to physiological maturity vis-a-vis the morphological types of growth habit, texture of upper leaves, shape of upper stem leaves and spines on upper stem leaves. Appressed and erect plant types had 135 and 130 days to maturity respectively, whereas bushy and cone shaped plant types had 125 and 126 days to maturity respectively. When viewed in the light of the earlier results that late maturing ones were predominantly resistant/moderately resistant to the disease, this indicate that a larger proportion of appressed and erect plant types were found to be in the tolerant group as they tend to have longer maturity duration, whereas bushy and cone shaped plant types had larger proportion of susceptible entries as they tend to have shorter maturity duration. Plant types with fleshy upper leaves had a maturity duration of 136 days, whereas those with leathery and normal type of leaves had 127- 128 days to maturity. This confirms the earlier result that fleshy upper leaf was associated with better tolerance to the disease as they tend to mature late while the other two types which tend to mature early were more susceptible to the disease. Plant types with lanceolate and narrow shape of upper stem leaves had a mean of 136 days to maturity followed by oblong leaves (131 days) and ovate leaves (126 days). The earlier finding that lanceolate and oblong shaped leaves were associated with larger proportion of resistant or moderately resistant entries confirms that longer duration plant types are predominantly resistant/tolerant to the disease. Non-spiny plant types matured on an average in 137 days and those with few spines matured in 130 days.

Table 5. Days to physiological maturity of different morphological types in safflower

Character	Days to maturity Mean ± SE
Growth habit	
Bushy	125 ± 0.5
Cone shaped	126 ± 0.4
Appressed	135 ± 0.8
Erect	130 ± 0.3
Texture of upper stem leaves	
Fleshy	136 ± 1.0
Leathery	127 ± 0.4
Normal	128 ± 0.3
Shape of upper stem leaves	
Lanceolate	136 ± 0.8
Oblong	131 ± 0.3
Ovate	126 ± 0.3
Spines on upper stem leaves	
Non-spiny	137 ± 1.0
Few spines	130 ± 0.4
Intermediate/Many	127 ± 0.3

The differences in the mean values were statistically significant at 1% level

These two types were less susceptible than those with intermediate or many spined plant types which matured in 127 days. The above results indicate that delayed crop maturity is very closely associated with better tolerance to the disease. Hence, by selecting a suitable morphological type showing less susceptibility to the disease and manipulating the crop duration, the loss due to the disease can be minimized.

In conclusion, it was found that morphological types in safflower were significantly associated with reaction to Alternaria leaf spot. Appressed and erect plant types were showing more degree of tolerance than bushy and cone shaped plant types. Fleshy texture of upper stem leaves and oblong and lanceolate shape of upper stem leaves were associated with better tolerance to the disease than normal and leathery leaves or ovate shape of upper stem leaves. Plants with more tolerance had higher mean seed yield and capitula per plant than the less tolerant ones and susceptible ones. Plant types maturing late showed better disease tolerance than the early maturing ones.

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A FACTOR ANALYSIS OF SOME QUANTITATIVE CHARACTERS IN SAFFLOWER (*Carthamus tinctorius* L.)

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ABSTRACT

Factor analysis of 14 quantitative characters in safflower helped in identifying two most important factors, designated as the maturity factor and the yield factor. Projections of the data sets on the factor space indicated that the accessions from source countries formed distinct groups. The factor analysis also brought out the variations in maturity and yield components of some morphological types like growth habit and branching. The factors indicated that late maturing plant types were more tolerant to Alternaria leaf spot and early maturing plant types were tolerant to aphids.

Key Words : Safflower; Factor analysis; Quantitative characters

Factor analysis is one of the important multivariate statistical tools used as a *dimension* reduction technique. The method is essentially a study of inter-relationships among a set of variables in an effort to evaluate a new set of variables, fewer in number than the original set of variables, which in turn express that which is *common* among the original variables (Catell,1965a and 1965b; Kendall,1968; Seal,1968; Dillon and Goldstein,1984). Thus it uncovers common dimensions or factors that link together a set of variables and provides an understanding of the data structure. Walton (1971) and Denis and Adams (1978) are a few examples where it had been used to analyze yield components in wheat and morphological traits in drybeans respectively. In the present study an investigation has been made on the use of factor analysis technique as a *dimension* reduction method in the analysis of a set of quantitative characters evaluated in safflower (*Carthamus tinctorius* L.), an oilseed crop.

MATERIALS AND METHODS

The basic data for the study is from a germplasm management trial conducted at Mahatma Phule Agricultural University, Solapur, India. The germplasm material was raised in Germplasm Management Unit, Solapur (Longitude - 17° 14' N and Latitude 75° 56' E and Elevation 483.6 m MSL) in single rows of 6 m length spaced at 45 cm between rows and 35 cm within rows using augmented block design with 13 standard checks of Indian origin. A large number of qualitative and quantitative characters were evaluated for three years (1987-88 to 1989-90) on a world collection of 3250 accessions and details of the character evaluation were reported in a catalogue of the germplasm material (Ghorpade *et al.*,1991). The inter-correlation coefficients among 15 variables were computed and using standard procedures the factors were extracted and factor scores estimated (Dillon and Goldstein, 1984) for all the accessions for first two factors.

RESULTS AND DISCUSSION

A list of characters under study and their abbreviations are provided in Table 1. The inter-correlations among the characters were computed and as the number of observations were large, even a small correlation value of 0.03 could be significantly different from zero at 5% level. In order to provide a picture of the underlying correlation structure, the absolute correlations (other than those of yield with other characters) were sorted and the results presented in a graphical form in Fig .1. The yield was excluded as it was the dependent

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Table 1. List of characters and their abbreviations

YIELD	Seed yield/plant (g)
D50ELG	Days to 50% elongation
DPBINT	Days to primary branch initiation
DBUD	Days to bud initiation
D1FLR	Days to first flowering
D50FLR	Days to 50% flowering
DMATUR	Days to physiological maturity
PLHGT	Plant height (cm)
SPREAD	Plant spread (cm)
LNGBRN	Length of first primary branch
ANGBRN	Angle of first primary branch
PRMBRN	No. of primary branches/plant
CAPNUM	No. of capitula/plant
NODLNG	Inter node length (cm)
CAPDIA	Main capitula diameter

variable. The portions of the shaded matrix which are darker in Fig. 1 indicate the closeness of the group of characters involved. The lighter shades indicate that the variables under them are not closely related (though the significance tests may indicate that they are different from zero). A perusal of the shaded matrix clearly shows that there are two groups of characters which emanate from the correlation structure. The first group consists of D1FLR, D50FLR DBUD, DPBINT and DMATUR. The second group consists of PRMBRN, CAPNUM, SPREAD and LNGBRN. The first group is related to plant maturity characters whereas the second group is related to yield characteristics.

In view of the correlation structure as brought out in Fig 1, factor analysis was used for more detailed study of the factors that link the set of characters. A summary of the factor analysis is shown in Table 2. The first two factors put together (58.3 % and 26.0 % respectively) accounted for 84.3% variance in the data. The remaining factors accounted for a small proportion of the variance and hence only the first two factors were further considered for estimation of factor loadings. The magnitudes of the factor loadings on the first six variables (Table 2) clearly indicate that the first factor explaines the common variance among them. Likewise, SPREAD, LNGBRN, PRMBRN and CAPNUM load heavily on Factor 2. The estimated values of the communalities for the variables are used to assess the magnitude of the variance of the characters accounted for by the common factors 1 and 2. The factor analysis reflected the results of the correlation matrix shown in sorted and shaded form in Fig. 1. We may designate the first factor as 'maturity factor' and the second as 'yield components factor' in view of the factor loadings of the variables.

The projection of each observation (location of data sets in the common factor space) on each of these factors are called factor scores and they provide additional insights into the structure of the data by highlighting patterns of common variation. Table -3 provides the estimated factor scores (averaged over a specified number of individual accessions) for the first two factors of accessions from various source countries. The values are plotted in a two-dimensional plane and shown in Fig. 2. The accessions from India and Australia had their projections close together in the factor space and the low values of Factor -1 indicated that the accessions from these countries were early maturing types. Iran, Turkey and Spain ; Hungary,Germany,Portugal and Soviet Union

Fig-1. Absolute correlations in sorted and shaded form

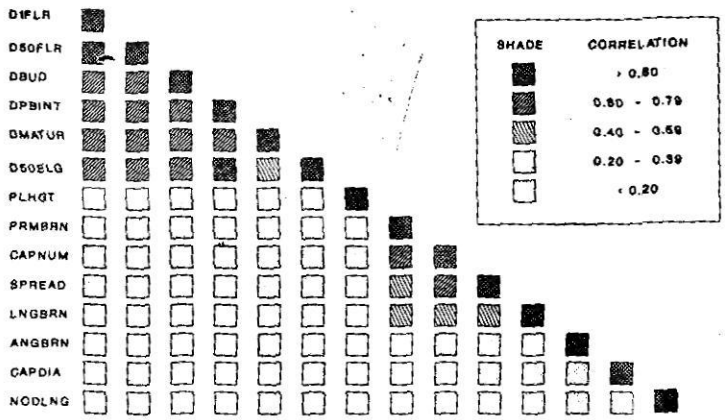
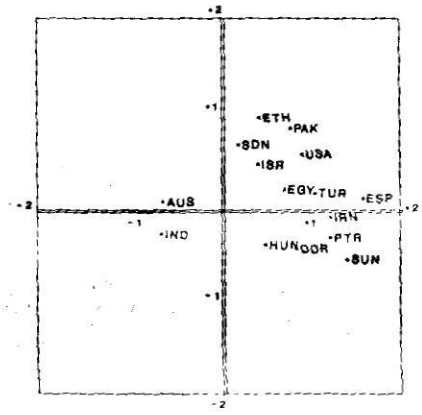


Fig- 2. Distribution of source countries of safflower germplasm in the factor space representing maturity and yield components



X - Axis is Factor-1 and Y - Axis is Factor-2

Factor -1 corresponds to maturity components & Factor -2 corresponds to yield components

Table 2. Variance explained by factors and the loadings of first two factors on various characters.

Factor No.	Eigen value	Per cent variation	Cumulative variation
1	4.6851	58.3	58.3
2	2.0937	26.0	84.3
3	0.7801	9.7	94.0
4	0.3157	3.9	97.9
5	0.1612	2.0	99.9

Factor loadings on various characters

Character	Factor - 1	Factor - 2	Estimated communality
D50ELG	**0.7931**	0.0031	0.629
DPBINT	**0.8778**	-0.0013	0.771
DBUD	**0.8634**	-0.0329	0.746
D1FLR	**0.9386**	0.0479	0.883
D50FLR	**0.9378**	0.0596	0.883
DMATUR	**0.7809**	0.1436	0.630
PLHGT	0.3443	0.0570	0.122
SPREAD	-0.0976	**0.7240**	0.533
LGNBRN	-0.0176	**0.5631**	0.317
ANGBRN	0.1462	0.2088	0.065
PRMBRN	-0.1333	**0.7201**	0.536
CAPNUM	-0.0214	**0.8025**	0.644
NODLNG	-0.0294	0.1234	0.016
CAPDIA	-0.0330	-0.0171	0.001

Factor loadings printed in bold indicate that respective factors are highly correlated with corrsponding characters.

formed two other groups in the factor space. The latter group displayed more variation in crop maturity. The other countries stood apart and not forming close groups. The countries whose projections fell in the third and fourth quadrants revealed that yield factor was relatively lower for these accessions than those of others.

The projections of morphological types on the factor space clearly indicate the patterns of variation with regard to crop maturity and yield components (Table 4). Appressed plant types

Table 3. The mean factor scores for major source countries

Country Name	No.of accns.	Factor-1 Mean	Factor-2 Mean
Australia (AUS)	18	0.0	-0.2
Germany (DDR)	12	0.9	-0.2
Egypt (EGY)	28	0.6	0.1
Spain (ESP)	10	1.3	0.0
Ethiopia (ETH)	12	0.4	0.7
Hungary (HUN)	23	0.6	-0.2
India (IND)	2438	-0.3	-0.1
Iran (IRN)	61	1.2	0.0
Israel (ISR)	18	0.4	0.3
Pakisthan (PAK)	58	0.7	0.5
Portugal (PRT)	20	1.0	-0.1
Sudan (SUN)	17	0.1	0.4
U.S.S.R. (SUN)	15	1.2	-0.3
Turkey (TUR)	69	1.0	0.1
US Of America (USA)	327	0.8	0.3

Note : Only countries for which number of accessions are more than 10 are included

had the maximum crop maturity followed by erect plant types. Bushy and cone shaped plant types had low maturity factor indicating that these were early maturing types. Appressed types had the lowest yield factor compared to the other types. Plant types for which location of branching is primarily basal had low maturity factor (early types) but high yield factor (high yielding types). Those types which branch at upper 1/3 of plant had maximum

Table 4. Mean factor scores for some morphological types and plant types with varying degrees of reaction to disease and pest.

Character Type	Factor - 1 Mean	Factor - 2 Mean	No. of cases
Growth habit			
Appressed	0.80	-0.26	174
Bushy	-0.15	0.07	1082
Cone shaped	-0.27	-0.01	1176
Erect	0.42	-0.02	818
Error mss	0.85	-0.80	
Branch location on main stem			
Primarily basal	-0.17	0.24	1544
Upper 1/3 of plant	0.95	-0.53	212
Upper 2/3 of plant	0.04	-0.17	1494
Error mss	0.90	0.75	
Reaction to Alternaria leaf spot disease			
Moderate resistant	0.64	0.36	269
Tolerant	0.56	0.18	470
Susceptible	0.15	0.20	245
Highly susceptible	-0.13	0.11	152
Error mss	1.03	0.85*	
Reaction to aphids			
Tolerant	-0.01	0.42	67
Moderately tolerant	0.08	0.24	645
Susceptible	0.95	0.14	424
Error mss	0.92	0.85*	

* The differences were significant at 5% level; in all other cases the difference were significant at 1% level

maturity factor with least yield factor. The types with branch location at upper 2/3 plant had maturity factor and yield factor between the range of the other two types. It is also seen from the above results that low maturity (earliness) is associated with high yield component and high maturity is associated with low yield component. This was also seen from the correlation matrix which showed negative correlations between yield and the maturity factor variables.

Accessions which showed moderately resistant and tolerant reactions to Alternaria leaf spot disease had higher maturity factor compared to those which showed susceptible reaction. In other words, plant types which mature later tend to escape the disease phase whereas, the early maturing types tend to be susceptible to the disease. Shambharkar and Indi (1987) also reported that safflower varieties which matured late, escaped the disease at flowering stage and early maturing types were more susceptible. The yield factor was maximum for moderately resistant types and least for highly susceptible types. For other types the yield factor was mid-way. In case of reaction to aphids, the tolerant and moderately tolerant types had

low maturity factor (indicating that they are early types), whereas the susceptible types had larger maturity factor. Parlekar (1987) reported that safflower varieties which matured early escaped the active phase of the pest at flowering stage and that late maturing types remained succulent at the stage when aphid population was at maximum and hence became susceptible to the pest. The tolerant and moderately tolerant plant types had higher yield factor value whereas the susceptible ones had the least yield factor score.

The above study helped in identifying 2 most important factors out of 14 variables in safflower, namely, the maturity factor and the yield factor. Projections of the data sets on the factor space showed that the accessions from source countries formed distinct groups. The factor analysis brought out the variations in maturity and yield components of some morphological types and the reaction to pest and disease could be clearly explained in terms of variabilty in maturity and yield factors.

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SHORT COMMUNICATIONS

INHERITANCE OF GLUCOSINOLATE AND OIL CONTENT IN OILSEED RAPE

Glucosinolate and oil content are the major determinants of quality in oilseed rape. The cake and meal are used mainly as a cattle feed, however, the rapeseed meal and the oil both had some shortcomings which limited their availability in comparison with other oils and meals. To develop the varieties with low glucosinolates and high oil content, it becomes necessary to understand the mode of inheritance of glucosinolates and oil content in rapeseed.

The materials of the present study comprised of P_1, P_2, F_1, (P_1 x P_2), F_2, BC_1 (F_1 x P_1) and BC_2 (F_1 x P_2) of each of the two crosses namely GSL-1 x Nikalis and Bronowski x Topa were grown in a Randomized Block Design with three replications during *rabi* 1986, at PAU, Ludhiana. The parents and F_1's was represented by single, BC_1 and BC_2 by two and F_2 by three rows. The glucosinolate was determined as per the method suggested by Brezezinski and Mendelewski (1984), where as oil content was estimated using NMR. The data were subjected to statistical analysis by following the least square method as outlined by Mather and Jinks (1971).

Glucosinolate

The scaling and joint scaling tests indicated the inadequacy of additive - dominance model in cross Bronowski x Topa. The elimination of non-significant parameters and the re-estimation of other parameters was done to test the adequacy of the model. But this model against failed as indicated by Chi-square value (Table 1). In this case, the standard errors were again computed to test individual components. The additive (d), dominance (h) and additive x additive (1) were found highly significant. In the second cross GSL - 1 x Nikalis, the variation could be explained on simple additive - dominance model with significant additive (d) and dominance (h) gene effects. The magnitude of non-additive genetic components was much higher than the additive component (Table 2).

Table 1. Estimates of genetic components based on three parameter model and different scaling tests

	Bronowski x Topa		GSL-1 x Nikalis	
	Glucosino late	Oil content	Glucosino late	Oil content
A	8.88** ± 3.23	-1.49** ± 0.15	-1.83 ± 2.07	-1.50** ± 0.29
B	12.82** ± 3.58	0.07** ± 0.18	-4.45 ± 2.86	1.02 ± 0.18
C	31.69** ± 6.18	-1.11** ± 0.50	-4.20 ± 4.31	0.31 ± 0.56
m	12.67 ± 0.52	42.50 ± 0.06	92.60 ± 0.63	42.30 ± 0.08
[d]	0.73 ± 0.53	0.005 ± 0.05	2.62** ± 0.64	0.47 ± 0.07
[h]	5.67** ± 1.25	1.08** ± 0.10	3.84** ± 1.08	0.35** ± 0.14
χ^2	32.72**	150.65**	4.55	79.82**

** significant at 1 per cent level

Oil content

The scaling and joint scaling tests failed to explain the variation on simple additive - dominance model in both the crosses and therefore, indicated the presence of non-allelic interactions. The fitting of digenic interaction model revealed the non-significant of additive

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Table 2. Estimates of components of means of fitted parameters in cross Bronowski x Topa and GSL-I x Nikalis

	Bronowski x Topa		GSL-I x Nikalis	
	Glucosinolate	Oil content	Glucosinolate	Oil content
m	0.09 ± 0.80	42.26 ± 0.18	92.60 ± 0.63	42.39 ± 6.24
[d]	1.37** ± 0.26	0.60** ± 0.21	2.62** ± 0.64	0.06 ± 0.09
[h]	10.65** ± 1.04	1.65* ± 0.24	3.84** ± 1.08	-0.03 ± 0.31
[i]	5.12** ± 0.85	0.61** ± 0.21	-	0.03 ± 0.27
[j]	-	-2.33** ± 6.20	-	-2.34 ± 6.28
[l]	-	-	-	-
χ^2	48.74**	0.18	4.45	2.96

*, ** Indicate significant at 5 and 1 per cent level of significance, respectively

x additive (i) and dominance x dominance (1) interaction in Bronowski x Topa, and additive x additive (1)and dominance x additive (i) in GSL-1 x Nikalis. After successive elimination of non-significant parameter, the re-estimation of other parameters revealed the adequacy of additive - dominance model with digenic interactions. The additive x additive (1) and additive x dominance (i) interactions were highly significant in cross Bronowski x Topa. Similar results have also been reported as additive and dominance gene effects for glucosinolate by Gupta and Labana (1989) using the diallel analysis and Gupta *et al.*, (1983) for oil content.

On the basis of these results, the breeding procedures like bi parental approach, diallel selective mating system should be used which could capitalize both additive and dominance gene effects and hold the promise for genetic improvement in oilseed rape.

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EFFECT OF SUNFLOWER CROPPING FOLLOWING FINGER MILLET UNDER *KHARIF* RAINFED CONDITIONS

A field investigation was carried out from 1987 to 1990 to study the effect of sunflower in comparison with other dry land crops on the following finger millet raised under different fertility levels. It was found that continuous cropping of finger millet reduced the grain yield significantly. The effect of raising sunflower was similar to that of other crops such as maize, groundnut and pigeonpea on the yield of following finger millet.

There is a general apprehension among sunflower farmers that sunflower is a soil exhaustive crop and adversely affects the succeeding crop. However, continuous cropping of sunflower is not advisable and this results in low yield due to build up of soil pathogens causing in disease problem thereby affecting the yield. Keeping these in view, a field investigation was conducted at GKVK, Bangalore to study the exhaustive effect of sunflower in comparsion with other dry crops if any, on the following finger millet, a principal crop of this region.

A field experiment was conducted at GKVK, Bangalore on red sandy loam soil, low in organic carbon (0.4%) medium in available P (18 kg/ha) and available K (200 kg/ha) for four years from 1987 to 1990 to study the effect of preceding crops including sunflower on the following test crop of finger millet if any. The treatments consisted of five crops viz., sunflower (KBSH-1), groundnut (TMV-2), pigeonpea (TTB-7), maize (Ganga-5) and finger millet (Indaf-5) grown with their recommended package of practices in *kharif* 1987. During 1988 the test crop of finger millet was raised under three levels of fertilizer (No fertilizer, recommended fertilizer and 50% higher

Table 1. Distribution of rainfall during the period of investigation

Rainfall distribution periods	Rainfall in mm during cropping years of			
	Different preceding crops		Succeeding finger millet as test crop	
	1987	1989	1988	1990
0 to 4 weeks	158.0	47.4	146.2	61.4
4 to 8 weeks	131.6	283.0	161.4	112.7
8 to 12 weeks	155.0	185.4	384.8	57.0
12 to 15 weeks	20.5	8.0	123.9	21.0
Total for sunflower, maize, groundnut and finger millet	465.1	523.8	816.3	252.1
12 to 16 weeks	28.3	30.6		
16 to 20 weeks	117.2	-		
20 to 22 weeks	12.4	-		
Total for pigeonpea	602.5	546.4		
Sowing dates	August 4th	August 9th	July 11 th	August 28th

Note : Sunflower, maize, finger millet and groundnut were of 15 weeks duration, wheras pigeonpea was of 22 weeks duration

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the recommended dose of fertilizer). Thus the design of the experiment was split plot with three replications. The above cycle of growing different crops as main plot treatments and followed by a common test crop of finger millet with three levels of fertilizer as sub-plot treatments was repeated in 1989 and 1990, respectively to complete two cycles.

The distribution of rainfall was more favourable in 1987 inspite of lower total amount, which was a favourable year to pigeonpea because of higher amount and better distribution of late rains in November- December coinciding with the post-flowering stage of pigeonpea. The 1989 was a drought year because of longer dry spells during germination, establishment and seed filling stages of crop growth. During both the years, sunflower suffered most from moisture stress at seedling stage during 1987 and high intensity rains at flowering stage during 1989, which affected the pollination and seed filling besides resulting in Alternaria infestation (Table 1).

During the finger millet cropping periods of 1988 and 1990, the amount (816 mm)and distribution of rainfall was good in 1988 and very much poor (252 mm) in 1990. Thus the rainfall was more favourable during first cycle of investigation as compared to the second cycle.

In general maize followed by finger millet had highest productivity followed by groundnut, sunflower and pigeonpea (Table 2). The rainfall distribution was most unfavourable to sunflower during both years consequently resulted 40 to 50% of normal sunflower yield of one tonne per ha of this station.

In 1988 , the grain yield of finger millet following different crops,viz., sunflower (3043 kg/ha), maize (2908 kg/ha), groundnut (2893 kg/ha) and pigeonpea (2742 kg/ha) was substantially higher than that grown after finger millet (2238 kg/ha) indicating the adverse effect of monocropping. In the second cycle(1990) however, the yield of finger millet following different crops was unaffected, though the

Table 2. Effect of fingermillet based crop sequences on the grain and straw yields of component crop under rainfed condition

Previous crops	Grain yield of preceding crop (kg/ha)		Straw yield of preceding crop (kg/ha)		Grain yield of finger millet (kg/ha)		Straw yield of finger millet (kh/ha)	
	1987	1989	1987	1989	1988	1990	1988	19990
Finger millet - finger millet	2241	1558	5855	2166	2238	921	6025	1302
Maize - finger millet	4152	2207	5281	10590	2908	1020	6354	1485
Sunflower - finger millet	516	376	1492	1166	3043	884	7184	1400
Groundnut - finger millet	1884	1073	1965	652	2893	902	6643	1423
Pigeonpea - finger millet	958	362	3005	1300	2742	866	6469	1569
S.Em ±					129	133	303	222
CD (P = 0.05)					421	NS	NS	NS

highest yield was obtained after maize (1020 kg/ha)

Application of recommended dose of fertilizer to finger millet significantly increased the yield in both the years over the control which in turn differed significantly with 50 per cent higher recommended fertilizer dose (Table 3).

In 1988 fingermillet raised following a finger millet gave significantly lower yield while its yield was unaffected by various preceding crops in 1990 indicating that these crops have no undesirable influence on the succeeding finger millet crop. At the yield levels of sunflower obtained in this study there was no adverse influence of sunflower on the yield of succeeding finger millet. Muthuvel and Manickam (1982) and Muthuvel *et al.*, (1985) reported that the major nutrients NPK in soil were not depleted significantly with continuous cropping of sunflower for six seasons. Further studies are warranted under high management conditions including irrigation to identify if there is some exhaustive effect of sunflower on the succeeding crops.

Table 3. Influence of fertilizer on the productivity of finger millet (following different dry land crops) under *kharif* rainfed condition

Fertilizer levels as N-P_2O_5-K_2O (kg/ha)	Grain yield (kg/ha)		Straw yield (kg/ha)	
	1988	1990	1988	1990
F0 -0-0-0	1917	714	4996	1126
F1 -50-25-25	2851	887	6860	1512
F2 -75-37.5-37.5	3527	1155	7750	1670
S.Em ±	106	62	219	51
CD (P = 0.05)	313	182	647	149

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RESPONSE OF SOYBEAN TO DIFFERENT NITROGEN LEVELS WITH AND WITHOUT *Bradyrhizobium* INOCULATION.

Soybean (*Glycine max* (L.) Merill) is an important legume crop rich in protein(42%) and oil (22%). It is the third largest oilseed crop of India with an area of about 30 lakh hectares and production of about 24 lakh tonnes. It also earns Rs.700 crores annually an export value of soymeal.

With increasing cost of chemical fertilizers in recent years their use for cultivation of crops like soybean by small and marginal farmers in India is becoming limited. In order to fulfill this gap, the use of *Bradyrhizobium* (Jardon, 1982) culture was evaluated. Inoculation of crop with the bacterium has been reported extensively in foreign countries with an increase in yields (Peterson, 1980). In India also use of *Bradyrhizobium* culture has been reported to be beneficial (Rao, 1980). Since information on these aspects is meagre the present experiment was conducted during *kharif* seasons for two years on sandy clay loam soil at the Instructional Farm, College of Agriculture, (JNKVV), Rewa M.P. The soils of the experimental site possessed 7.2 pH, 0.5% organic carbon, 145 kg/ha total N, 15.6 kg/ha of available P_2O_5 and 338 kg/ha of exchangeable K_2O. It was laid out in split-plot design with three replications. The plot size was 4 x 2.4 sq m. The treatments comprise five levels of nitrogen (0, 15, 30, 45 and 60 kg/ha) with and without *Bradyrhizobium* culture inoculation using the soybean variety JS-72-44 (Gaurav).

The entire nitrogen alongwith 60 kg/ha P_2O_5 and 40 kg/ha K_2O were given at basal dose. The *Bradyrhizobium* culture was used for seed inoculation @ 5 gm/kg seed.

The effect of nitrogen levels and inoculation on yield attributes and on number of root nodules per plant were found to be significant in both the years (Table 1). The highest number of pods per plant was produced by 30 kg N followed by 45 kg N/ha in both the years. Inoculating the seed with the culture proved to be significantly

Table 1. Effect of nitrogen and inoculation on yield attributing characters of soybean (Mean of two years)

Treatments	Number of pods/plant	Test weight of 100 seeds(g)	Number of root nodules/plant	Seed yield/ plant (g)	seed yield (q/ha)	Cost benifit ratio
Nitrogen levels						
0 kg/ha	51.18	9.76	16.44	14.09	23.57	-
15 kg/ha	61.33	9.98	20.65	16.01	26.87	11.32
30 kg/ha	71.34	10.29	28.20	18.54	31.23	13.30
45 kg/ha	70.24	10.27	27.99	18.34	30.07	7.09
60 kg/ha	62.80	10.14	25.71	17.39	28.50	3.60
CD (5%)	0.82	0.11	0.70	0.83	0.59	-
***Bradyrhizobium* culture inoculation**						
Uninoculated	56.70	9.90	19.85	15.19	25.80	-
Inoculated	70.04	10.24	27.90	18.61	30.29	49.51
CD (5%)	0.23	0.05	0.55	0.67	0.54	-

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Table 2. Interaction effect of nitrogen and inoculation on the seed yield (q/ha) and net return (Rs./ha) of soybean production (Mean of two years)

Treatments	Seed yield (q/ha)			Net return (Rs./ha)		
	Uninoculated	Inoculated	Mean	Uninoculated	Inoculated	Mean
Nitrogen levels (kg/ha)						
0	22.25	24.89	23.57	3258	3947	3602.5
15	24.06	29.69	26.87	3675	5171	4423.0
30	27.58	34.88	31.23	4553	6500	5526.5
45	28.61	31.53	30.07	4759	5523	5141.0
60	26.52	30.48	28.50	4122	5167	4644.5
Mean	25.80	30.29	-	4073.4	5261.6	-

CD at 5% Nitrogen x inoculation 0.89

better than no inoculation for this character. Increasing level of nitrogen increased test weight of seeds in both the years. A dose of 30 kg N/ha was found to be optimum for producing the highest seed weight of soybean. Seed treated with *Bradyrhizobium* culture also increased seed weight significantly during both the years. Yields were also significantly influenced by inoculation with the culture. Significant increase in the number of root nodules per plant was obtained with 30 kg N/ha in both the years. Inoculation of soybean seed with *Bradyrhizobium* culture gave 40% more nodules per plant as compared to no inoculation.

The mean grain yield increased significantly with each successive increase in nitrogen levels upto 30 kg N/ha. The highest mean grain yield was obtained at 30 kg N/ha during both the years. The increase in the grain yield was found to be due to favourable effect of both nitrogen and inoculation on all the yield contributory characters. These results are in accordance with the findings of Paikera (1988)and Mishra (1990). The differences in grain yield due to bacterial culture were significant in both the years. The mean percentage increase in grain yield was 17.40% over no inoculation. Beneficial effects of inoculation have also been reported by Peterson (1980) and Jain *et al.*, (1988). The interaction effect was found to be significant in both the seasons. Applications of 30 kg N plus culture proved to be the best economical treatment resulting in yield of 38.83 and 30.94 q/ha respectively(Table 2). The cost benefit ratio and net returns were also higher under this combination.

Harper (1974) found that both symbiotic N_2 fixation and nitrate (NO_3) utilization appear essential for maximum yield. However, he found that excessive NO_3 appears detrimental to maximum yield because symbiotic fixation is completely inhibited. The present study had identified the optimum dose of 30 kg N with bacterial inoculation to harness productivity potential of soybean under Indian conditions.

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STUDY ON THE PERFORMANCE OF SESAME ENTRIES IN TWO ENVIRONMENTS

Four sesame entries VS 339 (85 days) VS 350 (65-75 days) TMV 6 (85 days) and local (65-75 days) were tested under farmers' input and recommended input management practices in five villages of six holdings in Cauvery Delta Zone of Tamil Nadu during summer 1992 under irrigated condition. The main objective was to understand the performance of these varieties in the above two input management practices.

The recommended input management includes seed treatment with fungicides and Azospirillum, soil application of Azospirillum, basal application of Gypsum, three split application of nitrogen i.e, basal, 20 DAS and 30 DAS (35:23:23 kg NPK ha^{-1}) three plant protection sprays, while under farmers input management, three split application of nitrogen i.e, basal 20 DAS, 30 DAS (30:20:40 kg NPK ha^{-1}) one plant protection, one planofix spray and manual hand hoeing and weeding were done. Phosphorus and potassium were applied at basal at the time of sowing in the above two practices. The plot size was 1000 m^2 per entry for each management practices and the mean yield is presented in Table1.

The result indicated that there was 15 per cent increase in yield under recommended practice over farmers' input management. The entry VS 350 recorded 23 per cent higher yield under recommended input management over farmers' management practice. This was comparatively higher than the yield obtained from other entries tested. The culture VS 339 had exhibited its yield potential in both the environments, indicating its stability.

Table 1. Sesame yield kg ha^{-1}

Entries/Environment	VS 339	TMV 6	VS 350	LOCAL	MEAN
Farmers' input management	1009	928	897	750	896
Recommended input management	1111	1021	1102	881	1029
			SEd	CD (P=0.05)	
Between practices			43.5	88.0	
Within practices			87.1	176.0	

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EFFECT OF VARIETIES AND MIXTALOL ON LEAF CHLOROPHYLL, FERROUS CONTENT AND NITROGEN UPTAKE OF MUSTARD (*Brassica juncea* (L.) czern and coss).

An increase in chlorophyll and iron content in leaves and uptake of nitrogen under the influence of triacontanol based compounds like mixtalol have been found associated with increased photosynthetic activity of plants resulting in higher accumulation of photosynthates and consequently higher yield (Menon and Shrivastava, 1984). Keeping this in view, a field experiment was conducted at the Agronomy farm of Rajasthan College of Agriculture, Udaipur during *rabi* season of 1987-88. The soil was clay loam in texture with pH 8.2, total nitrogen 21.2 kg/ha and 16.8 and 172.4 kg/ha of available P_2O_5 and K_2O respectively. The treatments consisted of three mustard cultivars (T- 59, Pusa bold and Kranti) and four levels of mixtalol (control, seed treatment with mixtalol @ 50 g/kg seed, foliar application of mixtalol 2 ppm at 40 and 50 days of sowing and seed treatment + foliar spray of mixtalol) were tested in Randomized Block Design with four replications. A common dose of 80 kg N and 40 kg P_2O_5/ha was applied to the crop. Determination of chlorophyll, iron and nitrogen in plants was made by the methods as suggested by Arnon (1949), Champan and Pratt, (1961) and Linder (1944) respectively.

Results (Table 1) show that highest total chlorophyll and iron content in leaves as well as maximum uptake of nitrogen was recorded under variety Pusa bold. Higher chlorophyll and iron content of Pusa bold leaves clearly indicated the effect of increased uptake of nitrogen under variety Pusa bold compared to that of T-59 and Kranti. The results are in conformity with those of Saran and Giri (1984), who reported better response of Pusa bold to nitrogen as compared to other mustard cultivars.

Data (Table 1) indicate that seed treatment of mixtalol followed by two foliar sprays to this

Table 1. Effect of varieties and mixtalol on chlorophyll and iron content, N uptake and seed yield

Treatment	Total chlorophyll (mg/g fresh leaf wt.) of leaves at flowering	Iron content of leaves at flowering (ppm)	N uptake at harvest (kg/ha)	Seed yield (q/ha)
Variety				
T - 59	1.47	264.0	92.9	16.9
Pusa bold	1.53	282.0	96.9	18.2
Kranti	1.52	277.7	95.9	17.9
CD at 5%	0.043	NS	3.81	0.71
Mixtalol				
Control	1.43	253.3	89.2	16.7
Seed treatment	1.46	264.0	92.3	17.2
Foliar application	1.56	286.6	98.4	18.3
Seed treatment + Foliar application	1.58	294.3	101.0	18.6
CD at 5%	0.049	29.93	4.40	0.83

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substance at 40 and 50 days of sowing produced maximum total chlorophyll and iron content of leaves along with highest uptake of nitrogen by crop at harvest, which was significantly higher over control and seed treatment but was at par with foliar application of mixtalol. Beneficial effect of foliar application of mixtalol in increasing content of chlorophyll and iron in leaves may be due to greater dry matter production under this treatment which in turn resulted in greater nitrogen uptake by crop. Significant increase in iron content of plants could probably be also due to higher osmotic uptake of this nutrient under the influence of mixtalol. Similar were the findings of Ries and Wert (1977). It is evident that more chlorophyll and iron in leaves and higher uptake of nitrogen under mixtalol treatment had resulted in greater accumulation of photosynthates in plants and its effective translocation from source to sink and finally resulted in higher seed yield of mustard (Table 1).

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ECONOMICS OF FERTILIZER USE ON LINSEED UNDER RAINFED CONDITIONS OF *DIARA* AREAS OF EASTERN UTTAR PRADESH

Diara (flood prone) areas of Eastern Uttar Pradesh, situated inbetween natural levees and get flooded for different periods of time, are periodically eroded and formed due to meandering, braiding and course changing of rivers. These *Diara* lands have good agricultural potential, but they suffer from floods during monsoon and soil moisture stress during pre and post flood periods. Oilseeds in general and linseed in particular is a dominant winter season crop of rainfed *Diara* areas, but its average yields on farmers' fields are lower (6 to 8 q/ha) mainly due to poor socio-economic conditions of farmers, who still follow traditional cultural practices, and seldom use fertilizers. The objective of this study was to determine the most profitable fertilizer combination to applied to linseed in *Diara* areas.

On farm fertility trials on linseed variety - Garima with different combinations of N, P_2O_5 and K_2O were conducted for two consecutive winter seasons of 1988-89 and 1989-90 in Ganga *Diara*, Karanda, Ghazipur, Uttar Pradesh under rainfed conditions. A Randomized Block Design was used with four N, P, K combinations, and five replications (Table 1). Seeds were sown at moist layer of furrows 30 cm apart at the rate of 25 kg/ha. The total quantities of fertilizers as per treatments were applied as basal in furrow 2-3 cm below the seeds. Recommended cultural practices were followed. The soil (fluvisol) was sandy clay loam in texture with neutral pH having initial average available N, P_2O_5 and K_2O levels of 210, 15, 225 k/ha, respectively and available water holding capacity of 20-22 cm upto 120 cm depth. Rainfall during crop growth periods in 1988-89 and 1989-90 was 84.0 mm and 94.5 mm, respectively.

For determining the economics of fertilizer use, partial budget was prepared which included only the extra costs of fertilizers, their applications and field losses of produce ignoring the common costs of cultivation.

Results of the experiments presented in Table 1 indicate that yields of linseed increased significantly with the increasing fertility levels upto 60 kg N, 30 kg P_2O_5 and 20 kg K_2O/ha under rainfed *Diara* land conditions of Eastern Uttar Pradesh Similar results have been reported by many other workers (Singh, 1984, Singh and Tiwari 1985 and Pasricha *et al.*, 1988) in various agro-climatic conditions. However, pooled as well as individual year's data clearly show that yields of linseed at two fertility levels viz., 60, 30, 30 and 40, 20, 20 kg/ha of N, P_2O_5

Table 1. Effect of different fertility levels on grain yield of linseed

Treatment No.	Nutrient (kg/ha)			Grain yield (q/ha)		
	N	P_2O_5	K_2O	1988-89	1989-90	Pooled
1(Control)	0	0	0	15.8	15.4	15.6
2	20	10	10	18.2	16.8	17.5
3	40	20	20	20.4	18.5	19.5
4	60	30	30	20.5	18.6	19.5
S.Em ±				0.53	0.31	0.35
CD at 5%				1.63	0.96	1.07

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Table 2. Economics of nutritional trial (average)

Treatment No.	Benefit variable cost (1)		MINB (2)	MIVC (3)	MRR (4)
	(Rs.)	(Rs.)	(Rs.)	(Rs.)	(Rs.)
1(Control)	15464	0	0	0	0
2	17059	236	1595	236	676
3	18816	448	3352	448	748
4	18686	659	3222	659	489

1. Net benefit = Cost of net yield (Gross yield - 10% field loss) - Variable cost (Cost of fertilizers - Cost of their application)

2. MINB (Marginal increase in net benefit) = (Net benefit in a treatment) - (Net benefit in control)

3 MIVC (Marginal increase in variable cost) = (Variable cost in a treatment) - (Variable cost in control)

4. MRR (%) = Marginal rate of return = $\frac{MINB}{MIVC} \times 100$

and K_2O were at par. The yields were generally higher in 1988-89 than in 1989-90, because of light shower received during late flowering to pod formation stage in 1988-89.

Partial budget of the trial shows that inspite of marginally higher net return in the treatment where 60 kg N, 30 kg P_2O_5 and 30 kg K_2O/ha were applied, MINB and MRR were found to be much higher in the treatment where 40 kg N, 20 kg P_2O_5 and 20 kg K_2O/ha were applied (Table 2).

As such, for linseed grown in rainfed *Diara* land conditions of Eastern U.P., a fertility level of 40 kg N, 20 kg P_2O_5 and 20 kg K_2O/ha is optimum for highest yield and benefit.

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UTILITY OF SALT WATER FOR SUNFLOWER CULTIVATION

Four genotypes of sunflower viz., BSH- 1, KBSH-1, EC 68415 and Morden were grown in the pot culture experiment to suit for-sunflower cultivation using different levels of salt water. Common salt was used for artificially salinising the water to different levels viz., 0.5, 1.0, 1.5 and 2.0 dSm^{-1}, apart from control which received normal water for growth with conductivity less than 0.25 dSm^{-1}. There were three replications i.e, three pots, at each salinity level and three seedlings were retained for studying the effect of salt water on the growth after recording observations for germination on the 7th day after sowing. The measured EC of artificially salinised water using Elico conductivity bridge was in the range of $\pm$ 0.025 dSm^{-1} of the expected values.

There was significant reduction in germination per cent, plant height, head diameter and leaf area due to salt water irrigation, exposing some of the adverse effects of salt water usage on sunflower growth (Table 1). Further, both test weight of the seeds and its oil content (%) increased when plants received salt water upto 1.0 dSm^{-1} and with respect to oil per cent increase was significant at 0.5 dSm^{-1} salt water usage compared to control. This may be due to nutritional requirement of very low concentrations of salt (NaCl), probably less than 0.5 dSm^{-1} salt water irrigation for sunflower cultivation. Control plants and plants which received higher levels of salt water i.e., 1.5 and 2.0 dSm^{-1} of growth did not differ significantly with respect to test weight of the seeds and oil content (%), suggesting safe usage of salt water upto 1.5 dSm^{-1} for sunflower cultivation. Reduction in germination per cent of salinity was highest compared to other growth attributes indicating that sunflower crop was more sensitive to salinity during germination compared to later stages of growth. Genotypic variation to salinity was also significant for various parameters (Table 1), indicating differential response of sunflower genotypes to salinity. Further, the ratio of per cent total saturated fatty acids to that of per cent total unsaturated was not altered much due to salinity and oil from salt water treated plants exhibited higher degree of unsaturation as there is an increase in linoleic acid and reduction in oleic acid contents (Table 2). Other oilseeds such as safflower (Francois and Bernstein, 1964; Yermanos *et al.,* 1964), mustard (Rao, 1977), niger (Sain, 1980) etc., are equally good as salt tolerant crops or even better compared to sunflower, but utility of these crops for reclaiming of salt affected soils is meagre, whereas sunflower is useful in reducing the soil salinity by salt uptake (Bhatt and Indira Kutty, 1973) and is better suited as reclaimer for salt affected soils and to minimise the salinity built up in soil where irrigation is the only source of water and rains are scanty.

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Table 1. Effect of using different levels of saline water (NaCl) on the performance of sunflower

Treatments	Germination per cent	Plant height (cm)	Head diameter (cm)	Stem girth (cm)	Leaf area (sq.cm)	Test weight 100 seeds (g)	Oil content (%)	Husk per cent
Control (T_1)	75.56	114.16	10.27	1.26	955.04	3.11	38.83	22.38
Irrigated with 0.5 dSm^{-1} saline water T_2	62.78	112.03	9.34	1.23	863.88	3.45	40.58	21.34
Irrigated with 1.0 dSm^{-1} saline water T3	51.11	109.62	9.63	1.28	872.75	3.30	38.88	22.46
Irrigated with 1.5 dSm^{-1} saline water (T_4)	35.28	106.47	10.10	1.36	836.63	3.14	38.42	23.56
Irrigated with 2.0 dSm^{-1} saline water (T_5)	25.80	97.30	9.10	1.21	740.18	2.92	39.99	22.68
S.Em.	4.34	1.88	0.29	0.04	36.41	0.15	0.46	0.71
CD at P = 0.05	12.42**	5.39**	0.82	NS	104.30**	0.42	1.33	NS
Genotypes								
BSH -1	68.43	111.67	9.05	1.21	736.70	2.88	38.77	24.22
KBSH -1	62.66	120.10	9.05	1.29	821.37	3.07	40.50	23.34
EC 68415	52.44	117.79	9.37	1.19	922.20	3.71	39.53	20.31
Morden	16.90	82.04	10.70	1.38	934.47	3.01	38.60	22.06
S.Em	3.89	1.68	0.26	0.04	32.57	0.14	0.42	0.63
CD at P = 0.05	11.10**	4.82**	0.73**	0.0998**	93.30**	0.38**	1.19**	1.81
Interaction								
SEm	8.69	3.77	0.57	0.08	72.82	0.30	0.93	1.41
CD at P = 0.05	24.83**	NS	1.64	0.22**	NS	NS	NS	NS
CV %	30.03	6.04	10.23	10.65	14.78	16.16	4.09	10.90

Table 2. Effect of salt water irrigation on fatty acid composition of sunflower

Genotypes	Control					
	Palmitic acid (%)	Stearic acid (%)	Total saturated acids (%)	Oleic acid (%)	Linoleic acid (%)	Total unsaturated acid (%)
BSH -1	7.97	7.65	15.62	35.10	49.30	84.40
EC 68415	5.89	3.93	**9.82**	40.97	49.22	90.12
MORDEN	5.45	3.57	9.02	**46.15**	44.84	90.99
MEAN	6.43	5.05	11.48	40.74	47.78	88.52

Genotypes	Saline conditions (2.0 dSm^{-1})					
	Palmitic acid (%)	Stearic acid (%)	Total saturated acids (%)	Oleic acid (%)	Linoleic acid (%)	Total unsaturated acid (%)
BSH -1	5.46	**4.70**	10.16	36.60	53.23	89.83
EC 68415	6.97	**3.14**	10.11	36.59	**53.31**	89.90
MORDEN	7.69	**2.40**	10.09	35.87	**54.04**	89.91
MEAN	6.70	**3.41**	10.12	36.35	53.52	89.88

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ADAPTATION AND PERFORMANCE OF SUNFLOWER HYBRIDS AND POPULATIONS IN ARID REGION OF HARYANA

Growing sunflower crop in Haryana got momentum recently although the studies on this crop showed promising yields in this region long ago (Yadav *et al.,* 1975) and hybrids performed better than populations (Yadava and Singh 1978 and Singh *et al.,* 1979). In 1990-91 the estimates of area in the state was 18000 hectares with a total production of 31000 tonnes. During the year 1992 the area of sunflower was about one lakh hectares with a total production of about 1.7 lakh tonnes. Looking into the bright prospects of this crop in the arid region of Haryana, the present study was under taken with a view to analyse the adaptation of the crop in two seasons, performance of hybrids/composites in respect of yields, maturity, oil and other characteristics and finally to identify the best hybrids/composites for this region.

The experiment comprised eighteen hybrids, viz., MSFH 8, MSFH 17, MSFH 30, MSFH 31, U 5002, U 5025, APSH 11, B-158, GHS 777, NSFH 401, LDMRSH 3, PSH 16, PSH 17, PSH 18, AH 3425, A-1, A 18, A 19 and two populations, namely HS 1 and Morden. The trial was conducted in spring 1991 and with the addition of some new hybrids repeated in 1991 rainy season and 1992 spring season. The experiment was laid out in a Randomized Block Design having three replications. The plot size was 18 m^2. The inter-row and intra-row spacing was kept at 60 cm and 30 cm, respectively. The crop was provided with 60 kg N and 40 kg P_2O_5/ha. Full package of recommendations was adopted to raise a good crop under irrigated conditions at the research farm of Chaudhary Charan Singh Haryana Agricultural University, Hisar. The observation on five plants on each entry were recorded for days to 50 per cent flowering, plant height (cm), days to maturity, head diameter (cm), stem girth (cm), total number of seeds per head, percentage of filled seeds, 100 seed weight (g) and seed yield per plant. Oil content for each entry was analysed by NMR (Nuclear Magnetic Resonance Analyser, New Port UK made). Both the seasons were climatically different. The data were therefore, statistically analysed, season wise.

The results presented in Table 1 indicated significant differences among the entries in respect of all the characters in both the seasons. In spring 1991, hybrid LDMRSH 3 recorded highest (3134 kg/ha) seed yield, followed by MSFH 8 (2897 kg/ha), U 5025 (2781 kg/ha) and U 5002 ((2759 kg/ha). Hybrid BSH 1 and HI 7 were at par in yield with populations HS 1 (2091 kg/ha). These hybrids maintained their performance in 1992 spring as well. In addition, PSH 16 (2976 kg/ha) and PSH 17 (3089 kg/ha) based on 1992 spring testing alone were also promising. the performance of the hybrids in rainy season was generally quite different. On an average, yields were reduced by 33.3 per cent in the rainy season as compared to the spring season. Hybrids LDMRSH 3, MSFH 31, MSFH 30 and MSFH 8 shown maximum reduction in seed yield in the rainy season was compared to their performance in the spring season. However, the performance of three hybrids, namely U 5002, MSFH 17 and U 5025 was fairly comparable in both the seasons.

A perusal of the data of 1992 spring season on various ancillary characters presented in Table 2 revealed considerable variation in the other attributes like, days to flowering, plant height, head diameter, per cent filled seeds and 100 seed weight apart from variation in yield, maturity and oil content presented in Table 1. Days taken for 50 per cent flowering varied from 70 days in HS 1 to 82 days in U 5025. Plant height ranged from 111 cm (Morden) to 186 cm (LDMRSH 3); head diameter from 14.5 cm (B 158) to 20.1 cm (U 5025, GHS 777) and 100 seed weight from 4.79 g (PSH 18) to 7 g (A 19, LDMRSH 3, MSFH 17).

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Table 1. Performance of hybrids in arid region of Hisar (Haryana) for 1991 and 1992

Entry	Seed yield (kg/ha)				Days to maturity				Oil content (%)			
	1991 R	1991 S	1992 S	Av. of season (S)	1991 R	1991 S	1992 S	Av. of season (S)	1991 R	1991 S	1992 S	Av. of season (S)
MSFH 8	1941	2879	2850	2864	94	108	105	106	39.70	44.75	44.80	44.80
MSFH 17	2190	2469	2982	2725	91	100	100	100	36.50	37.35	36.80	37.10
MSFH 30	1597	2488	2605	2546	93	104	102	103	42.50	39.25	42.20	40.70
MSFH 31	1154	2536	2917	2726	93	104	102	103	41.50	40.70	42.20	41.50
U 5002	2940	2759	3121	2940	94	106	104	105	41.50	43.35	42.60	43.00
U 5025	2471	2781	1779	2285	91	108	105	106	43.00	43.60	40.70	42.10
AH 3425	2016	2690	2506	2598	91	94	100	97	42.30	40.35	44.90	42.60
PSH 16	-	-	2976	2976	-	-	102	102	40.62	-	42.70	42.70
PSH 17	-	-	3089	3089	-	-	101	101	-	-	45.70	45.70
PSH 18	-	-	2768	2768	-	-	98	98	-	-	42.00	42.00
GSH 777	-	-	2109	2109	-	-	107	107	-	-	43.80	43.80
APSH 11	1624	2463	2268	2365	90	92	95	94	40.20	37.55	44.10	40.80
LDMRSH 3	1684	3134	3671	3402	90	106	103	105	40.40	38.55	40.50	39.50
NSFH 401	-	-	2414	2414	-	-	103	103	-	-	44.70	44.70
B 158	-	-	2744	2744	-	-	102	102	-	-	40.90	40.90
A1	-	-	1045	1045	-	-	103	103	-	-	37.40	37.40
A18	-	-	1911	1911	-	-	101	101	-	-	42.20	42.20
A19	-	-	2202	2202	-	-	103	103	-	-	42.40	42.40
MORDEN	1730	-	1752	1752	90	-	103	103	41.20	-	44.60	40.60
HS 1	1678	2091	1934	2012	89	91	93	92	40.50	40.90	40.80	40.00

S : Spring Season ; R : Rainy Season

Table 2. Average values of ancillary characters in spring 1992 season

S.No.	Entries	Days to 50% flowering	Plant height (cm)	Head diameter (cm)	Per cent of filled seeds	100 - seed wt. (g)
1.	MSFH 8	81	155.1	17.8	88.5	5.55
2.	MSFH 17	74	132.4	14.8	90.8	7.07
3.	MSFH 30	77	131.8	17.6	86.2	6.15
4.	MSFH 31	79	153.1	18.3	88.8	6.81
5.	U 5002	79	143.5	18.8	93.3	5.37
6.	U 5025	82	164.3	20.1	91.2	6.24
7.	AH 3425	74	150.0	18.3	87.3	6.69
8.	PSH 16	76	142.9	16.5	89.8	5.51
9.	PSH 17	74	143.4	15.5	81.7	5.72
10.	PSH 18	74	139.9	16.1	84.5	4.79
11.	GHS 777	75	165.6	16.7	93.5	5.30
12.	APSH 11	74	150.9	14.8	85.7	5.53
13.	LDMRSH 3	77	186.1	15.9	90.0	7.15
14.	NSFH 401	77	155.1	15.2	91.0	6.87
15.	B 158	76	151.4	14.5	89.3	6.64
16.	A 1	80	145.4	18.1	84.7	5.65
17.	A 18	79	149.7	17.6	88.5	5.17
18.	A 19	77	173.9	17.4	79.5	7.01
19.	MORDEN	74	111.1	15.9	89.7	6.03
20.	HS 1	70	145.0	16.1	84.5	6.54

It is evident that i) spring season is best for sunflower cultivation from yield and disease incidence point of view, ii) lower yields coupled with higher incidence of diseases, is a common feature of the rainy season crop, iii) hybrids U 5002, MSFH 17, and U 5025 were found promising for both the seasons. However, hybrids LDMRSH 3, MSFH 3 and AH 3425 were found specific to spring season in this region.

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INFLUENCE OF GROWTH PHASES ON SEED YIELD UNDER DIFFERENT PLANTING DATES IN SOYBEAN

The productivity of soybean cultivars grown under high temperature and short day length conditions (tropics/sub-tropics) often has been limited because flowering is initiated before sufficient vegetative growth has occurred. Hinson and Hartwig (1977) pointed out that the best suited genotypes for the tropics should have a longer vegetative phase and shorter reproductive phase in 100 to 110 days growing in seasons. Therefore, it is essential to assess the relative importance of these growth phases in Indian conditions on which precise information is lacking.

25 soybean varieties widely differing in their vegetative and reproductive phase durations were evaluated in a randomized complete block design with 4 replications over 2 years in 5 planting dates (15 June, 15 July and 3 August, 1986 and 13 June and 18 July, 1987). Each plot had 3 rows, 5 m long spaced 60 cm apart and within row spacing was about 5 cm (Commercial spacing). The observations were recorded in central row. Path coefficient were worked out according to the method of Dewey and Lu (1959)using Phenotypic correlations.

Genotypic correlations were in general, higher than the corresponding phenotypic correlations. Seed yield showed significant and positive correlation with vegetative phase and maturity duration in late sowing date (August, 1986) and with reproductive phase in early (June, 1986) and normal (July, 1986) sowing dates both at genotypic and phenotypic level. Plant height exhibited significant and positive correlation with seed yield in July, 1987 and August, 1986 and significant negative correlation with seed yield in June, 1986 indicating in consistency over the sowing dates. Yield showed significant and positive association with number of nodes in early (June, 1987), normal (July,1987) and late (August, 1986), sowing dates (Table 1).

The correlation were further partitioned into direct and indirect effects to establish the cause and effect relationship between seed yield and growth characters (Table 2).

The direct contribution of vegetative phase was found to be positive in late sowing date. Thus, longer vegetative phase was found to be relatively more important in late sowing environments. However, under early sowing (June, 1987),the dominating fact observed was the preponderant positive direct influence of vegetative phase upon seed yield, inspite of its low correlation. Positive correlation of seed yield with late flowering (long vegetative phase) has also been reported by Carter and Boerma (1979) in soybean.

Maturity duration exerted positive direct influence upon seed yield in early and normal sowing dates of 1986. This character was also involved indirectly as vegetative phase, reproductive phase, plant height and number of nodes contributed substantially via maturity in most of the test environments. Thus, maturity duration proved to be an important character in increasing the seed yield in soybean.

Reproductive phase had negative role directly upon seed yield in June and July plantings of 1986, although in all these environments, correlation with yield was significant and positive. Thus, path analysis indicated that this character was relatively unimportant in these environments. In contrast to this, it had positive direct effect upon seed yield in August, 1986, and June and July planting of 1987, inspite of its low

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Table 1. Phenotypic (rp), genotypic (rg) and environmental (re) correlation coefficients between growth characters and seed yield (g) in different dates

Character		Dates of planting				
		1986			1987	
		15 June	15 July	3 August	13 June	18 July
Vegetative phase (days)	rp	-0.300	-0.002	0.571**	0.348	0.280
	rg	-0.320	0.001	0.684	0.374	0.305
	re	-0.204	-0.064	-0.162	0.096	0.240
Maturity duration (days)	rp	-0.059	0.233	0.491*	0.369	0.114
	rg	-0.070	0.243	0.564	0.406	0.109
	re	0.107	0.222	0.055	-0.217	0.245
Reproductive phase (days)	rp	0.429*	0.403*	-0.004	-0.131	-0.179
	rg	0.457	0.429	-0.019	-0.139	-0.231
	re	0.201	0.233	0.155	-0.070	0.235
Plant height (cm)	rp	-0.469*	-0.221	0.736**	0.353	0.453*
	rg	-0.502	-0.273	0.826	0.375	0.505
	re	-0.193	0.279	0.327	0.167	0.092
Number of nodes/main stem	rp	-0.256	-0.114	0.803**	0.484*	0.630*
	rg	-0.291	-0.151	0.897	0.517	0.683
	re	0.138	0.284	0.382	0.193	0.373

* P = 0.05; ** P = 0.01

Table 2. Direct and indirect effect of growth characters on plant yield in soybean under different planting dates over two years

Character/ year	Planting dates	Vegetative phase	Maturity	Reproductive phase	Plant height	No. of nodes on main stem	Phenotypic correlations with yield (rp)
Vegetative phase							
1986	15 June	-1.357	1.132	0.441	-1.523	1.007	-0.300
	15 July	-1.366	1.212	0.094	-0.442	0.500	-0.002
	3 August	0.288	-0.128	-0.017	-0.355	0.793	0.571**
1987	13 June	5.870	-2.937	-2.710	-0.383	0.508	0.348
	18 July	2.144	-2.007	-0.344	-0.121	0.608	0.280
Maturity							
1986	15 June	-1.089	1.409	0.068	-1.307	0.860	-0.059
	15 July	-1.123	1.475	-0.174	0.349	0.404	0.238
	3 August	0.223	-0.165	0.140	-0.293	0.586	0.491**
1987	13 June	4.537	-3.799	-0.457	-0.374	0.462	0.369
	18 July	1.627	-2.644	0.777	-0.113	0.467	0.114
Reproductive phase							
1986	15 June	0.918	-0.148	-0.653	0.916	-0.604	0.429*
	15 July	0.284	0.571	-0.451	-0.115	0.114	0.403*
	3 August	-0.020	-0.0.91	0-.255	0.040	-0.188	-0.004
1987	13 June	-4.243	0.463	3.748	0.186	-0.285	-0.131
	18 July	-0.450	-1.253	1.640	-0.011	-0.105	-0.179
Plant height							
1986	15 June	-0.988	0.881	2.286	-2.092	1.444	-0.469*
	15 July	-1.013	0.864	-0.087	-0.596	0.611	-0.221
	3 August	0.195	-0.092	-0.020	-0.523	1.176	0.736**
1987	13 June	3.986	-2.519	-1.237	-0.564	0.687	0.353
	18 July	1.590	-1.840	0.107	-0.163	0.759	0.453*
No.of nodes on main stem							
1986	15 June	-0.884	0.785	0.255	-1.956	1.544	-0.236
	15 July	-1.043	0.911	-0.079	-0.557	0.654	-0.114
	3 August	0.183	-0.078	-0.039	-0.498	1.235	0.803**
1987	13 June	3.827	-2.253	-1.372	-0.497	0.779	0.484*
	18 July	1.473	-1.393	-0.195	-0.140	0.885	0.630**

* P = 0.05 ; ** P = 0.01
Underlined figures indicate direct effects

correlation with yield in these environments. Thus, the relative importance of character cannot be judged on the basis of magnitude of correlation alone. Significant and positive correlation between seed yield and reproductive period had also been reported by Smith and Nelson (1987)

The direct relationship of plant height in general was negative upon seed yield which was marked by its pre-dominant positive indirect influence via number of nodes on the main stem. Most of the growth character contributed negatively via plant height upon seed yield. Thus, path analysis indicated that this character was not important for increasing seed yield.

Study of path coefficients, revealed that number of nodes on the main stem was unique character in the sense that it showed in general positive contribution directly and indirectly both to seed yield in each environment separately. Thus, the number of nodes on the main stem was another important character in addition to maturity to increase seed yield in soybean.

In Northern plants genotypes with longer reproductive phase will be suitable for early and normal sowings while for later sowings date of northern plains or normal sowings of central and southern parts of our country. Longer vegetative phase will be the desirable trait for higher seed yields.

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ROLE OF SUNFLOWER STALK MULCHING IN DEVELOPING THE INITIAL INOCULUM OF ALTERNARIA LEAF SPOT OF SUNFLOWER (*Helianthus annuus* L.)

Alternaria leaf spot caused by *Alternaria helianthi* is a serious and widespread disease of sunflower. In India, the first major epidemic was encountered in 1987 *kharif* season (AICORPO, 1987). The yield losses may upto 80 per cent (Agrawath *et al.*, 1979) under epidemic situations. The pathogen could readily be isolated from sunflower crop debris from a diseased crop that had harvested one year earlier (Allen *et al.*, 1983) and may serve as an excellent initial infection source of *Alternaria helianthi* for the succeeding crop. It is in this context, an experiment was undertaken to know the role of mulching of sunflower stalk as a source in developing successful Alternaria leaf spot epidemic and the results of the experiment are described here.

Sunflower hybrid, BSH1,which is moderately field resistant to Alternaria leaf spot was used for this study. After the harvest of the summer 1992 crop grown at GKVK farm, UAS Bangalore, the stalk was procured and the same was made into pieces of 2-5cm. Sowing was taken up during July 1992 with a spacing of 45 x 30 cm. One week after sowing, the pieces of sunflower stalks were spread on the ground, in between the rows at three doses i.e, 10, 5 and 0 t/ha (control) and were replicated three times. Observations were recorded soon after the emergence of the seedlings i.e, at 15 DAS and later on the every week. Number of lesions on cotyledonary leaves and their size, percentage leaf spot severity on cotyledonary leaves and on true leaves at 15 DAS in each treatment were recorded. At 22 DAS, percentage leaf spot severity on true leaves and the physical effect on cotyledonary leaves due to the disease in all the treatments were recorded. Percentage leaf spot severity was arrived at by taking average of 10 such observations in each plot by visual scoring in each treatment following the procedure described by Nagaraju *et al.*, (1992).

The disease started appearing a week after mulching was done on cotyledonary leaves.

Table 1. **Effect of sunflower stalk mulching on the initial infection and severity of Alternaria leaf spot of sunflower under field conditions.**

Treatments	15 Days after sowing				22 DAS severity (%)
	On cotyledonary leaves			On true leaves	
	Lesion size	No. of lesions	severity (%)	severity (%)	
Sunflower stalk mulch (10 t/ha)	1 - 3	17.3	74.3	1.9	67.3
Sunflower stalk mulch (5 t/ha)	1 - 3	16.4	66.7	3.5	60.7
Control (0 t/ha no mulch)	0 - 1	0.2	0.2	0.0	2.1
CD at 5%	-	5.45	12.02	NS	18.00
SEm	-	1.39	3.06	1.09	4.58
CV (%)	-	21.25	11.26	10.50	18.12

* Lesion size on 0-9 scale (AICORPO, 1991)

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The lesion size (0-9 scale) (AICORPO, 1991), number of lesions and percentage severity of Alternaria leaf spot on cotyledonary leaves at 15 DAS and percentage leaf spot severity on true leaves at 15 and 22 DAS on all the treatments are presented in Table 1. There was no difference in lesion size in any of the treatments and varied from 0-3 scale on the cotyledonary leaves. At 15 DAS., on cotyledonary leaves, the number of lesions were more (17.3 and 16.4) compared with negligible number of lesions in control plots. The severity was very high in mulched plots on cotyledonary leaves (74.3 and 66.7%) and was negligible in control plot (Table 1), whereas it was least on true leaves in all the treatments.

The situation was suddenly changed at 22 DAS. The percentage severity on true leaves was very high (67.3 and 60.7%) and was minimum in control plot (2.1%). At this stage, all the cotyledonary leaves in mulched plots were dead, but were quite healthy in control plot. Outward curling of leaves due to severe leaf spot and hindering of normal expansion of leaf lamina of young leaves were observed in the mulched plots and most of the plants in the mulched plots started dieing due to severity of this disease. Whereas, the plants in control plot, through nearby were quite healthy and the severity did not increased beyond 5.00 per cent even after 22 DAS.

There was no much difference in lesion size, number of lesions and percentage severity of leaf spot on cotyledonary and true leaves at all the stages of crop growth between the two levels of stalk mulching. This study also revealed that the sunflower stalk mulching is deleterious to succeeding sunflower crop. By considering these results, the sunflower stalk may be effectively used for effective screening of sunflower germplasm lines by creating artificial epidemic, after manipulating suitable dose of mulching material.

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EFFECT OF IRRIGATION AND MULCHES ON HYDRO-THERMAL REGIME OF SOIL AND YIELD OF *RABI* SUNFLOWER (*Helianthus annuus* L.)

Various kinds of mulches ares used to modify hydro-thermal regime of soil in the root zone and conserving soil moisture for the growth of plant (Bansal *et al.*, 1971). Investigations carried on the effectiveness of mulches have been mainly on its indirect effect on the crop yield. Their inherent effect on soil temperature and soil moisture regime in association with irrigation has not received adequate attention. The present study, therefore was undertaken to find out the effect of different IW/CPE ratios and sugarcane trash, paddy straw and black polyethylene mulch on hydro-thermal regime of clayey soil and yield of *rabi* sunflower.

A field experiment was conducted at the Main Water Management Project, Navsari (Gujarat) during *rabi* season of the year 1988-89. The experiment consisting of four IW/CPE ratios viz., 0.30, 0.45, 0.60 and 0.75 were allotted to main plots and three mulches viz., sugarcane trash @ 7.5 t/ha, paddy straw @ 7.5 t/ha and black polyethylene mulch alongwith one control (No mulch) treatment were allotted to subplots. The design of the experiment was split plot with four replications. The soil of the experimental field was clayey in texture having pH 7.9. Soil samples were collected periodically from different soil depths (upto 120 cm) during crop growth period and the moisture was determined gravimetrically. The soil temperature was measured at 15 and 30 cm soil depths at 8.30 am., and 2.30 pm. with the help of Digital Temperature Indicator with probes. Soil temperature was computed at bi-weekly means to minimize the errors involved. The crop was sown on December 12, 1988 and harvested on March 31, 1989.

The data in Table1 suggest linear increase in the seed yield upto 0.60 IW/CPE ratio and thereafter a slight decrease in yield. Maximum grain yield of 14.3 q/ha was realised from IW/CPE ratio of 0.60 which remained on par with 0.75 ratio (14.2 q/ha). There was progressive increase in consumptive use of water with the increase in irrigation frequencies under varying IW/CPE ratios, whereas reverse trend was observed with respect to water use efficiency. Variation in soil temperature due to irrigation ratios was nil and hence not reported.

The data presented in Table 1 show maximum grain yield under black polyethylene mulch (14.0 q/ha) followed by paddy straw (13.9 q/ha), sugarcane trash (12.9 q/ha) and control (11.6 q/ha). Gupta (1980) reported significant increase in grain yield of pearlmillet in polyethylene mulch over unmulched because of the moisture conservation and its utilization by the crop. Water use of 319 mm, 271 mm, 235 mm and 234 mm was observed under control condition, sugarcane trash, paddy straw and black polyethylene mulch respectively. However, reverse trend was observed for water use efficiency. Evaporation from soil under plastic and paddy straw mulches being negligible, there was more of transpiration loss which was responsible for increasing the dry matter yield. Lower yields under sugarcane trash mulch and control are indicative of more unproductive loss by evaporation and lower water use efficiency of the crop. Rajput and Singh (1970) highlighted the usefulness of straw mulch in conserving moisture and lowering soil temperature for optimum production. In the present study, however, higher water use ef-

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Table 2. Effect of mulches on soil temperature

Period	Soil temperature °C at 15 cm depth							
	Morning (8.30 am)				Afternoon (2.30 pm)			
	Control (No mulch)	S'cane trash	Paddy straw	Plastic mulch	Control (No mulch)	S'cane trash	Paddy straw	Plastic mulch
8 - 21.1.89	17.7	**16.3**	16.4	19.5	21.2	**18.2**	18.6	22.4
22 - 4.2.89	17.7	**16.0**	16.2	19.2	21.1	**18.2**	18.7	22.9
5 - 18.2.89	17.1	16.4	16.7	19.9	20.7	18.8	19.0	22.8
19 - 4.3.89	19.0	17.4	17.8	21.8	**23.3**	19.6	19.9	24.7
5 - 18.3.89	22.7	20.6	20.9	23.9	**26.4**	22.4	22.5	27.7
19 - 31.3.89	23.8	21.9	22.0	26.2	26.2	23.4	23.6	28.5
	Soil temperature °C at 30 cm depth							
8 - 21.1.89	19.3	17.2	17.3	20.9	20.2	17.8	18.1	21.4
22 - 4.2.89	19.2	17.2	17.4	**20.8**	20.3	18.1	18.4	21.8
5 - 18.2.89	19.3	17.5	17.7	**21.2**	20.4	18.2	18.3	21.6
19 - 4.3.89	21.0	18.6	18.8	**22.2**	21.5	19.5	19.6	**23.4**
5 - 18.3.89	23.9	21.2	21.4	**25.5**	24.8	21.9	22.0	**26.2**
19 - 31.3.89	24.7	22.5	22.8	27.0	25.5	23.0	23.2	**27.5**

Table 1. Effect of irrigation and mulches on seed yield, consumptive water use and water use efficiency

Treatment	Seed yield (q/ha)	Consumptive water use (mm)	Consumptive water use efficiency (kg/ha^{-mm})
IW : CPE ratios			
0.30	10.5	210	5.02
0.45	13.3	251	5.29
0.60	14.3	285	5.00
0.75	14.2	313	4.55
SEm ±	0.2		
CD at 5%	0.8		
Mulches			
Control (no mulch)	11.6	319	3.52
Sugarcane trash	12.9	271	4.67
Paddy straw	13.9	235	5.83
Black polyethylene	14.0	234	5.90
SEm. ±	0.1		
CD at 5%	0.3		

ficiency of sunflower has been observed under black polyethylene mulch possibly due to better moisture conservation and hence, more water availability for crop growth during entire crop growth period.

Sugarcane trash and paddy straw mulches considerably lowered the minimum (at 8.30 am.) and maximum (at 2.30 pm.) soil temperatures as compared to no mulch cover on soil surface. Contrary to this, both the maximum and minimum soil temperatures were increased by black polyethylene mulch at a surface and subsurface of the soil profile. Soil temperature during morning under sugarcane trash and paddy straw were ranged from 0.7 to 2.7°C,. and 0.4 to 2.5° C lower than control respectively. Whereas, during afternoon (2.30 pm.), it was 1.9 to 4.0 and 1.7 to 3.9° C. However, under black polyethylene mulch it was 1.2 to 2.8 and 1.2 to 2.3°C higher than control at morning and afternoon respectively.

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ECONOMICAL USE OF INORGANIC FERTILIZERS FOR BENEFICIAL RETURNS IN RAINFED SUNFLOWER

Karnataka is one of the potential states for sunflower cultivation both as pure and mixed crop. The crop being of short duration with high adaptability and drought tolerance has become popular amongst the farmers.

In India the consumption of fertilizer has been on the increase. From 0.1 million tonnes in 1950, it has reached 12.4 million tonnes in 1989, as against 11 million tonnes in 1988. The higher cost and timely supply of inadequate quantities of fertilizers has become a major constraint in crop production. About 60 to 70 per cent of the total cost of crop production goes for fertilizer. Under this circumstance, there is a need to economise the use of fertilizers. Keeping this in view a field experiment was conducted to find out the economical use of inorganic fertilizer for increased productivity and returns of sunflower.

A field experiment was conducted at the University of Agricultural Sciences, Bangalore, under rainfed condition of *kharif* 1988 and 1989 on the red loam soil. The soil had a pH of 7.1 and electrical conductivity of 0.07 m mohs/cm. The fertility status before the commencement of the experiment was medium in organic carbon (0.5 per cent) available phosphorus (23 kg/ha) and available potash (170 kg/ha). Application of organic manure (FYM) at the rate of 3 tonnes/ha was incorporated uniformly about 3 weeks before sowing of the crop. The variety of sunflower used was a new promising hybrid KBSH-1 developed at the University of Agricultural Sciences, Bangalore and recently released for the cultivation. The treatments consisted of six levels of fertilizers viz., recommended dose (40:50:40 N, P_2O_5, K_2O kg/ha.), 50 per cent and 25 per cent of recommended dose of NPK and 50 per cent and 25 per cent of recommended dose of nitrogen only as top dress. The NPK fertilizers used were in the form of urea, single super phosphate and muriate of potash respectively. Nitrogen was applied in two splits for NPK combination treatments. 50 per cent at sowing along with full dose of phosphorus and potash and remaining 50 per cent 30 days after sowing as top dress. The net plot size was 3.6 m x 4.2 m with a row to row spacing of 45 cm and plant to plant spacing of 30 cm. The experiment was laid out in Randomized Complete Block Design with three replications. The sowing was done in fourth week of July and the crop was harvested after 98 to 100 days. The recommended cultural operations and necessary plant protection measures were adopted. The biometric observations were collected from five random plants in each plot area. The seeds obtained from different treatments were tested for quality characters like oil content in seed (NMR. Method). All these characters were subjected to statistical analysis.

The results obtained on yield, yield components and economics are presented in Table 1. The seed yields obtained differed for the applications of inorganic fertilizers. The mean seed yields obtained with the application of fifty per cent (825 kg/ha) and twenty five per cent (497 kg/ha) of recommended NPK dose and fifty per cent(397 kg/ha) and twenty five (250 kg/ha) per cent of recommenced dose of nitrogen only were significant with each other among NPK and only N respectively and on par with fifty per cent and full recommended NPK dose of fertilizer (907 kg/ha). Similar results were reported by Muthuvel Manickam (1982). This result was also in accordance with the work reported at Kathalgera (Anon., 1992) that the use of 100 per cent NPK inorganic

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Table 1. Effect of inorganic fertilizers on seed yield, 100 seed weight, oil content and economics of sunflower

Treatments	Seed yield (kg/ha)			100 seed wt. (g)	Oil per cent	Per cent increase over control	Cost of fertilizer (Rs./ha)	Gross returns (Rs./ha)
	1988	1989	Mean					
Recommended dose of fertilizers (40:50::40 kg/ha)	860	954	907	4.69	35.1	384.0	834	9070
50% of recommended dose of fertilizers (20:25:20 kg/ha)	771	**879**	825	4.02	**34.8**	300.5	417	8250
25% of recommended dose of fertilizers (10:12.5:10 kg/ha)	530	**463**	497	3.76	**34.1**	141.3	209	4970
50% of recommended dose of Nitrogen only as top dress (20 kg N/ha)	427	**367**	397	3.26	32.7	92.7	142	3970
25% of recommended dose of Nitrogen only as top dress (10 kg N/ha)	182	**317**	250	3.08	32.1	14.1	71	2350
Control (No fertilizer)	156	**255**	206	3.73	31.5	-		2060
SEm ±	49.96	**29**	29	0.28	1.1			
CD 5%	150.58	89	84	0.48	NS			
CV %	19.49	10.94	15.6	14.7	6.6			

Note : Fertilizer rate : Rs.. 7.10/kg N
Rs. 8.75/kg P_2O_5
Rs. 2.80/kg K_2O

Sale price of sunflower : Rs. 10.00/kg

fertilizer was on par with the yield levels obtained with the application of 50 per cent of recommended dose of NPK fertilizer. The lowest seed yield of 206 kg/ha was recorded at control treatment. Similar yield trend was observed during *kharif* 1988 and 1989, except the differences were on par with only nitrogen as top dress and the control.

As per the economics, the per cent gross income increase over control was 14.1, 92.7, 141.3, 300.5 and 384, at 25 and 50 per cent recommended dose of nitrogen only as top dress and 25, 50 and full recommended dose of NPK fertilizers. The higher gross income increase of 300.5 per cent over the control was obtained at the economical application of only 50 per cent recommended dose of NPK fertilizer by incurring Rs. 417.00 only towards the cost of fertilizers and remaining was kept at constant. Although there was marginal increase in returns at recommended dose of NPK yield differences with 50 per cent recommended dose of NPK was statistically not significant. The yield contributing components like test weight were found to be significant with the application of fertilizers recording higher values for the treatment having higher yield. The oil content in seed was found to be not significant.

Since the yield differences were on par with 50 per cent and 100 per cent recommended dose of NPK inorganic fertilizers, an application of only 50 per cent recommended dose (20:25:20 kg/ha) is more economical than full dose of recommended dose in view of the increasing cost of fertilizers. This is in line with the findings of Jayaram *et al.*, (1992) who reported that the higher monetary returns were recorded in the crop receiving 50 per cent of recommended dose of NPK inorganic fertilizers.

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FIELD RESPONSE OF SUNFLOWER TO THE INOCULATION OF VESICULAR- ARBUSCULOR MYCORRHIZAL AT DIFFERENT PHOSPHORUS LEVELS

Vesicular-arbuscular mycorrhizal (VAM) fungi improve growth and yield of crop plants mainly through P nutrition (Jones Nirmalnath and Sreenivasa, 1992). VAM associations have been reported in castor, safflower and sunflower (Sulochana and Manoharachary, 1989; Cabello, 1987). Sunflower, one of the potential oilseed crops of India has a higher P requirement (75 kg/ha). The present field trial conducted during *kharif*, 1992 at Agricultural College Farm, Dharwad, was aimed to study the response of sunflower to the inoculation of VAM fungus, *Glomus fasciculatum* (Thaxt.) Gerd and Trappe at different P levels in black clayey soils under rainfed conditions.

Plots of 3 m x 3m size were prepared in P-deficient black clayey soil with pH 7.7 and available P_2O_5 18.2 kg/ha (NH_4 F= HCl extractable). The recommended doses of N and K were given (62.5 kg/ha each) while P was tried at different levels in the available form i.e, 0, 50, 75 or 100% of the recommended dose (75 kg P_2O_5/ha). Pot cultures of *Glomus fasciculatum* maintained in rhodes grass (Sreenivasa and Bagyaraj, 1988) with 0.19 x 10^4/g infective propagules was used to inoculate @ 6 g/dibbling site (i.e., 300 g/plot). Sunflower seeds of Morden variety were dibbled at 60 x 30 cm spacing accounting 50 plants/plot. Proper comparable uninoculated plots were maintained. All the treatments were imposed on random basis with four replications in each treatment.

Plant height and number of leaves per plant were recorded at monthly intervals. Crop was harvested on 92nd day after sowing. Shoot dry biomass and the seed yield per plot were recorded. Percentage mycorrhizal colonization of roots was determined by staining with trypan blue (Philips and Hayman, 1970) and the mycorrhizal spore numbers in soil by wet sieving and decanting technique (Gerdemann and Nicolson, 1963). Shoot P concentration was estimated by Vanadomolybdate method (Jackson, 1967).

Sunflower crop responded well to the inoculation of *G. fasciculatum*. Per cent root colonization and spore count of VAM fungi increased with increase in P-level and were significantly highest at the recommended dose (Table 1). Consequently, shoot P concentrations showed a matching trend with root colonization and sporulation. The plant height increased with increase in the age of host and was highest on the day of harvest. However, the number of leaves were found to decrease on the day of harvest perhaps due to defoliation. The effect of VAM on number of leaves was not significant. Plant dry biomass and seed yield were significantly highest at the recommended dose of P in the inoculated plots (Table 1). The principal way in which VAM fungi increases plant growth and yield is through uptake of P, Zn, Cu, Mn, Fe etc. (Sreenivasa *et al.*, 1993). In this field trial also increase in shoot P concentration was observed with VAM inoculation. However, we did not observe inhibition of VAM at higher P levels in this trial contrary to our earlier observations of pot trials (Jones Nirmalnath and Sreenivasa, 1992). This can be ascribed to greater volume of soil available in the field for proliferation of VAM fungi. Plant height, number of leaves and shoot dry biomass were significantly higher in the inoculated plants. This increased vegetative growth due to better uptake of P might have resulted in increased photosynthetic activity and further

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Table 1. **Effect of inoculation of Glomus fesciculatum on per cent root colonization and spore count of VAM and shoot P concentration, plant height, number of leaves per plant, shoot dry biomass and seed yield at different P levels in sunflower**

Treatment	P level (% rec. dose)	Per cent root colonization	Spore count per 50 g soil	Shoot P concent-ration (%)	Plant height (cm)			Number of leaves/plant			Shoot dry biomass (g/plant)	Seed yield (kg/plant)
					30 DAS	60 DAS	92 DAS	30 DAS	60 DAS	92 DAS		
G. fasiculatum	0	76(60.67)	181	0.08	21	134	138	10	15	9	58	1.68
	50	81(64.16)	191	0.14	22	144	150	11	18	12	64	2.51
	75	86(68.03)	198	0.16	24	155	154	11	19	13	68	3.86
	100	92(73.57)	216	0.19	26	158	164	12	20	14	71	5.24
Uninoculated control	0	41(39.82)	71	0.04	20	117	125	10	15	11	41	0.92
	50	41(39.82)	80	0.09	23	139	145	11	17	12	45	2.09
	75	44(41.55)	83	0.13	24	146	152	11	18	12	62	3.08
	100	50(45.00)	97	0.14	27	156	161	12	19	14	65	3.88
F test Factor P		*	*	*	*	*	*	*	*	*	*	*
F test Factor VAM		*	*	*	NS	*	*	NS	NS	NS	*	*
LSD P = 0.05 Factor P		1.79	5.92	0.01	1.60	7.67	7.06	0.82	1.64	0.97	1.8	16.50
LSD P = 0.05 Factor VAM		1.67	4.19	0.01	-	5.43	5.00	-	-	-	2.1	11.53

Per cent root colonization values after arcsine transformation are given in parentheses
DAS : Days after sowing

translocation of photosynthates to sink. As a result, seed yield was significantly highest at the recommended dose of P in the inoculated plots. The seed yield at the recommended dose of P is the uninoculated plots was comparable with inoculated plots supplied with 75% of the recommended P which indicates a net saving of 25% P with VAM inoculation. Our study clearly brought out the beneficial effect of *G. fasciculatum* inoculation in sunflower under field conditions.

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PERFORMANCE OF GROUNDNUT AND PIGEONPEA INTERCROPPING SYSTEM UNDER DRYLAND CONDITIONS

Intercropping long duration varieties of pigeonpea helps better utilization of resources and ensures higher returns per unit area and time under rainfed conditions (Ray *et al.*, 1981). A groundnut and pigeonpea intercropping combinations is specially important because it involves two crops of different growth patterns for extended use of resources; it is prevalent in the red soil areas of the southern states of India.

Veeraswamy *et al.*, (1974) reported that the arrangement of six rows of groundnut with one row of pigeonpea was more economical than 8:1. Recent studies revealed that groundnut/pigeonpea at 3:1 or 5:1 ratios were more advantageous than either of the sole crops (Anon., 1982 and Hulihalli and Sheelavantar, 1987). There is a need to work out the different row proportions for intercroping different varieties of pigeonpea in groundnut.

The experiment was conducted on farmers' field at Rajanukunte, Bangalore during *kharif* 1991-92. The experiment consisted of 13 treatments tested in a Randomized Block Design with four replications. Three pigeonpea varieties (ICPL-87, Hyd-3C and TTB-7) were intercropped with groundnut (TMV-2) at three row proportions (6:1, 6:2, 8:2) and sole stands of the component crops were maintained.

The soil of the experimental site was alfisols, slightly acidic (pH = 5.7), in reaction, high in available nitrogen (640 kg/ha) low in available phosphorus (12.5 kg/ha) and medium in available potassium (200 kg/ha). The size of the plot was 5.4 m x 3.0 m. The crops received a fertilizer dose of 25 kg N + 50 kg P_2O_5 and 25 kg K_2O/ha as basal before sowing. Sowing of both the crops was done on 22nd June, 1991. Groundnut was harvested at 112 days after sowing while pigeonpea cultivars ICPL-97 at 122 days, Hyd-3C at 170 days and TTB-7 at 210 days after sowing. A rainfall of 1345 mm was received during the cropping season as against 661 mm of normal rainfall.

Land equivalent ratio for intercroping system was worked out by using the formula outlined by Willey (1979) . Gross retruns were calculated at the market price prevailing at the time of harvest.

The results revealed that the pod yield of groundut was significantly higher in sole crop than in intercroping (Table 1). Reduction of groundnut yield in intercropping has been reported by Mehta *et al.*, (1985) and Verma and Srivastava (1987). The maximum yield reduction (37.8%) was recorded when eight rows of groundnut were sown with two rows of pigeonpea ICPL-87. This perhaps could be due to greater shading effect of ICPL-87 during initial stages and its competition for nutrients, moisture and space throughout the growth period of groundnut.

Land equivalent ratio was maximum (1.13) when 6 rows of groundnut altering one row of pigeonpea Cv. ICPL-87 compared to 6:2 or 8:2 row proportions.

Among the pigeonpea varieties, TTB-7 had least adverse effect on the growth and yield of groundnut. The pod yield of groundnut was highest (25.79 q/ha) in intercropping with TTB-7 at 6:1 row proportions., This is in contrary to the recommended practice of 8:2 ratio, perhaps due to normal rainfall distribution during the cropping period. Besides highest LER (1.34), B:C ratio (1.88) and monetary advantage were obtained by intercropping

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Table 1. Yield, LER, gross returns, net returns and benefit cost ratio of groundnut + pigeonpea intercropping at different row proportions

Treatments	Yield (g/ha)		LER	Gross returns (Rs./ha)			Net returns (Rs./ha)	B : C ratio
	Groundnut	Pigeonpea		Groundnut	Pigeonpea	Total		
Sole groundnut TMV-2	27.73	-	1.00	23568	-	23568	17110	2.65
Sole pigeonpea ICPL-87	-	9.66	1.00	-	7241	7241	1314	0.22
Sole pigeonpea Hyd-30	-	15.64	1.00	-	11731	11731	4016	0.52
Sole pigeonpea TTB-7	-	17.41	1.00	-	12956	12956	5241	0.68
Groundnut + pigeonpea ICPL-87 6:1	24.46	2.38	1.13	20793	1785	22577	13108	1.38
Groundnut + pigeonpea ICPL-87 6:2	19.83	4.18	1.15	16855	3136	19991	10572	1.11
Groundnut + pigeonpea ICPL-87 8:2	17.24	3.57	1.00	14653	2675	17329	7859	0.83
Groundnut + pigeonpea Hyd-3C 6:1	20.76	4.58	1.04	17650	3433	21083	11613	1.23
Groundnut + pigeonpea Hyd-3C 6:2	18.36	7.58	1.15	15610	5685	21295	11825	1.25
Groundnut + pigeonpea Hyd-3C 8:2	18.19	6.94	1.10	15461	5197	20659	11189	1.18
Groundnut + pigeonpea TTB-7 6:1	25.79	7.12	1.34	21925	5338	27263	17793	1.88
Groundnut + pigeonpea TTB-7 6:2	17.49	8.98	1.14	14870	6738	21609	12139	1.28
Groundnut + pigeonpea TTB-7 8:2	22.08	7.82	1.24	18772	5868	24640	15170	1.60
SEm ±	0.76	0.37	0.02	632	279	648	650	0.07
CD at 5%	2.16	1.03	0.06	1835	773	1797	1801	0.21

TTB-7 at 6:1 ratio with groundnut. This was a consequence of high combined yields and monetary returns realised with it, while groundnut + pigeonpea TTB-7 intercropping at 6:2 or 8:2 row proportions gave less gross returns and B:C ratio. These findings are in conformity with the findings of Veeraswamy *et al.*, (1974) and Reddy *et al.*, (1990) who have reported 6:1 ratio of groundnut + pigeonpea was more profitable than either of its sole crops.

The sole crop of groundnut gave highest gross returns (Rs. 23568/ha) and B:C ratio (2.65) compared to its intercropping due to the fact that groundnut did not suffer as the rainfall was normal. Shinde *et al.*, (1990) also found higher B:C ratio with sole crop of groundnut. However, growing of groundnut + pigeonpea TTB-7 at 6:1 row proportion seems to be viable and acceptable preposition as this would offer an insurance against the failure of crops due to drought which is common under dryland conditions.

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EFFECT OF HERBICIDES ON LEAF AREA, LIGHT INTERCEPTION AND POD YIELD OF GROUNDNUT (*Arachis hypogaea* L.)

Light supplied the energy for photo synthetic CO_2 fixation and controls the development and morphology of the plant. Weeds reduce the growth and pod yield of groundnut, since competition for light was found to be one of the major factors (Iwata *et al.*, 1983). Plant height, leaf inclination angle and leaf area are very important in light competition and leaves maintaining an angle close to perpendicular with solar beam are most effective. Hence the present investigation was to find out the effective herbicide interception in groundnut.

A field experiment was carried out during the *kharif* season of 1990-91 on well drained medium black soil at Main Research Station, Dharwad. The experiment was laid out in Randomized Block Design with thirteen treatments (Table 1) replicated thrice. The crop variety Dh-3-30 was sown on 26th June 1990 with seed rate of 100 kg/ha at 30 cm x 10 cm spacing. The recommended dose of NPK fertilizer was applied at the time of sowing. The herbicides viz., Alachlor, Pendimethalin and Metalachlor were sprayed two days after sowing. Fluchloralin was incorporated into the soil one week before sowing. The post emergent herbicide Fluazifop-p-butyl was sprayed at 15 days after sowing. Observations were made on crop growth at 30, 60, 90 days and at harvest. Light Transmission Ratio (LTR) was computed by using the formula as indicated below :

$$\text{LTR } \% = \frac{I_1}{I_0} \times 100$$

where I_0 = Light Intensity above the canopy

I_1 = Light intensity at ground surface

Crop growth

Leaf area presented in Table 1 indicated that hand weeding + intercultivation recorded significantly higher leaf area at all the stages of crop growth. Whereas significantly lower leaf areas was observed in unweeded control at all the stages of crop growth. Among herbicides, fluchloralin, alachlor and fluazifop-p-butyl in combination with intercultivation recorded higher leaf area as compared to other treatments. The higher leaf area was due to more number of leaves per plant and less weed competition. Girijesh (1988) reported that higher leaf area in weed control treatments was due to less weed competition.

Hand weeding + intercultivation recorded maximum amount of light interception at 45 and 60 DAS (95.57% and 98.33%) by groundnut crop and was significantly superior over rest of the treatments. Least or no competition for moisture, nutrients and space due to weeds, resulted in better crop growth and maximum interception of light. Among herbicides, fluchloralin at 1 kg a.i./ha followed by 3 intercultivation recorded higher light interception (93.65% and 95.56% at 45 and 60 DAS respectively). Whereas unweeded control recorded lowest light interception because of poor crop growth and maximum weed competition.

Hand-weeding twice followed by 3 intercultivation and pre-sowing incorporation of fluchloralin at 1 kg a.i./ha followed by 3 intercultivation recorded significantly higher pod yield (28.90 and 28.78 q/ha respectively) than the rest of the treatment (Table). Yield reduction due to weeds was reported by Diwakar (1981).

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Table **Effect of herbicides on leaf area, light interception and pod yield of groundnut**

Treatments	Dose (kg a.i./ha)	Leaf area (dm^2/plant) DAS				Light interception (%) DAS		Pod yield (q/ha)
		30	60	90	At harvest	45	60	
Hand weeding + Intercultivation	15, 30 DAS + 15, 30, 45 DAS	4.86	9.21	8.19	3.07	95.57 (4.43)	98.33 (1.67)	28.90
Alachlor	2.00	3.52	8.46	7.33	2.69	87.16 (12.84)	98.50 (11.50)	17.79
Fluchloralin	1.00	3.52	8.62	7.51	2.79	88.57 (11.43)	91.76 (8.24)	20.13
Pendimethalin	1.00	3.82	8.56	7.26	2.68	86.40 (13.60)	87.93 (12.07)	15.01
Fluagifop-p-butyl	0.25	3.62	8.53	7.41	2.88	85.93 (14.07)	87.03 (12.97)	10.12
Metalachlor	1.00	3.50	8.43	7.36	2.81	85.33 (14.67)	85.56 (14.44)	14.00
Alachlor + Intercultivation	2.00 + 15, 30, 45 DAS	4.19	8.92	7.57	2.74	91.06 (8.94)	92.70 (7.30)	24.30
Fluchloralin + Intercultivation	1.0 + 15,30, 45 DAS	4.23	8.91	3.62	2.83	93.65 (6.35)	95.56 (4.44)	28.79
Pendimethalin + Intercultivation	1.0 + 15, 30, 45 DAS	3.87	8.58	7.31	2.78	89.7 (10.30)	92.20 (7.80)	23.29
Metalachlor + Intercultivation	1.0 + 15, 30, 45 DAS	3.98	8.89	7.53	2.92	84.40 (10.60)	90.60 (9.40)	12.55
Fluasifop-p-butyl + Intercultivation	0.25 + 30, 45 DAS	3.59	8.51	7.40	2.85	89.73 (10.27)	91.36 (8.64)	21.55
Intercultivation	15, 30, 45 DAS	3.46	8.30	7.28	2.41	86.23 (13.77)	88.60 (11.40)	14.12
Unweeded check	-	2.99	7.65	6.61	1.90	81.98 (18.02)	80.01 (19.90)	9.3
S.Em ±		0.03	0.08	0.20	0.05	0.83	0.65	1.23
CD at 5%		0.10	0.24	0.07	0.16	2.44	1.92	3.58

DAS : Days after sowing; Intercultivation at 15, 30, 45, DAS; Figures in parentheses indicate values of Light Transmission Raio (%)

The correlation coefficient (r) worked out between pod yield and leaf area and light interception indicated that the leaf area at different stages does not have any relation with pod yield. While the light interception at 45 days after sowing recorded significant positive correlation (r = 0.96) with pod yield of groundnut. This shows that the vigorous nature of crop growth during initial stage, because of its better weed control and thereby helps in better nutrient uptake from the soil which ultimately reflected in pod yield.

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POLLEN-PISTIL INTERACTIONS AND THE CONTROL OF SELF-INCOMPATIBILITY IN NIGER (*Guizotia abyssinica* Cass.)

Niger, an important edible oilseed crop sustaining the economy of tribal areas of India has not received due attention for its improvement. This is mainly because the elementary information on floral biology and pollination mechanism(s) which have a decisive bearing upon rational procedures in crop improvement are not adequately available in this crop. Self sterility in niger is controlled by the twin mechanisms of protandry and incompatibility. Self-incompatibility reported by Naik and Panda (1968) is governed by multiple oppositional alleles (Panda and Rao, 1976). However, the extent of interplay of the two mechanisms in promoting outcrossing and the factors modifying the self-incompatibility characters are not fully understood. The present investigation was undertaken to study the pollen recognition - rejection phenomenon and devise appropriate methods to overcome the self-incompatibility barrier.

Stigma receptivity and the stage of the pistil controlling intraspecific incompatibility were tested in a series of self and cross-pollinations at various stages of pistil development with fresh pollen *in situ*. Emasculations at all stages were as per the conventional method (Chavan, 1961) and on the day of anthesis by the refined method described (Sujatha and Angadi,1989). The pollen - stigma interactions were studied with pistils fixed in 3% glutaraldehyde in 0.1M phosphate buffer (pH 7.2) under a scanning electron microscope. The efficacy of various treatments viz. bud pollination, delayed pollination, stump pollination and temperature effects in surmounting the incompatibility barrier were assessed.

Pollen grains of niger are spiny, tricolpate and trinucleate. Stigmas of ray and disc florets are of dry type and stigma receptive surface is unicellular papillate and appressed.Scanning electron microscope studies indicated the stigma as the site for incompatible reaction. Under self-pollination, the papillae remained turgescent and retained their shape while under cross pollination the papillae collapsed, flattened and showed shrinkage patterns (Fig. 1a and 1b respectively). Similar flattening and shrinkage patterns in the papillae of the stigmas on the day of anthesis after a compatible pollination was observed while, papillae turgescence of the stigmas selfed and crossed at pre anthesis stage (24h, 48h and 72h prior to anthesis) was retained.

Stigma receptivity in terms of seed set (%) further confirmed the non-receptivity of stigmas in the buds. While, the highest seed set (%) was recorded with the stigmas pollinated 24h after anthesis (77.77%) followed by day of anthesis (70.90%) and ray florets (43.67%) no seed set was evident when stigmas still enclosed in the buds were pollinated. The pistils at all stages of development failed to promote seed set after self pollination. Thus, controlled self and cross pollinations indicated that the natural population of niger is self-incompatible and the absence of pre anthesis self pollination in niger. Scanning electron microscopic observations on the pollen pistil interactions and stigma receptivity in terms of seed set proved the functional nature of protandry operating in this crop.

Of the various treatments tested in overcoming the incompatibility barrier high temperatures and stump pollination methods were effective while, there was no seed set following bud pollination and delayed pollination. Percentage of seed set was very low when aged pistils were

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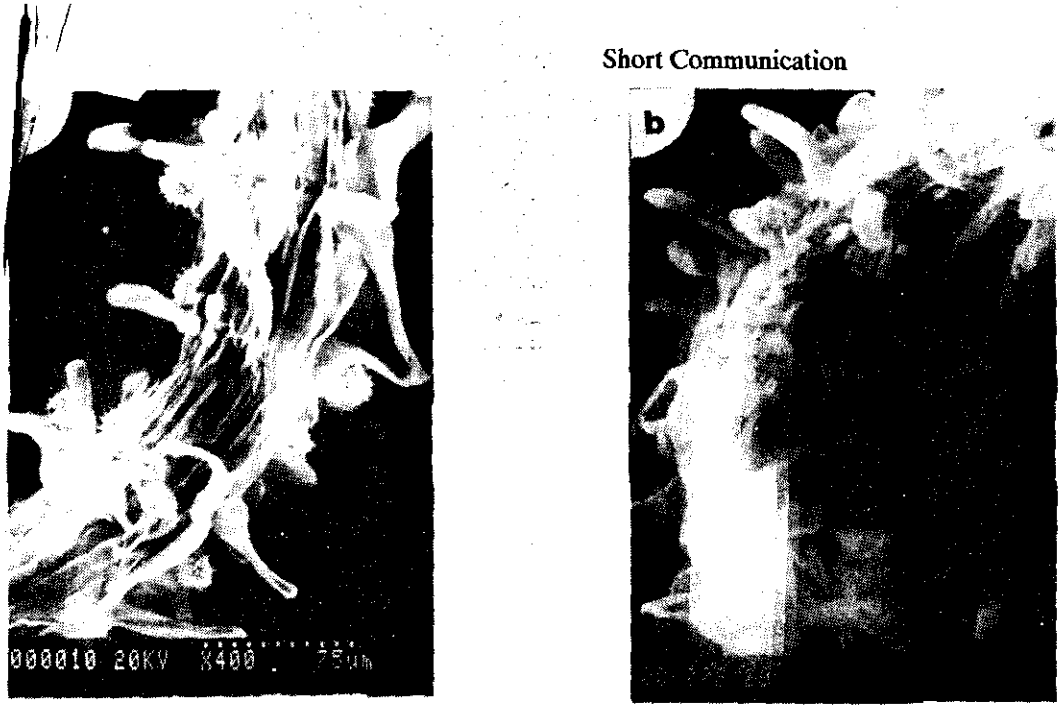

Figure 1. Scanning Electron Micrographs of *Guizotia abyssinica* stigma 24h after (a) cross pollination, (b) self pollination.

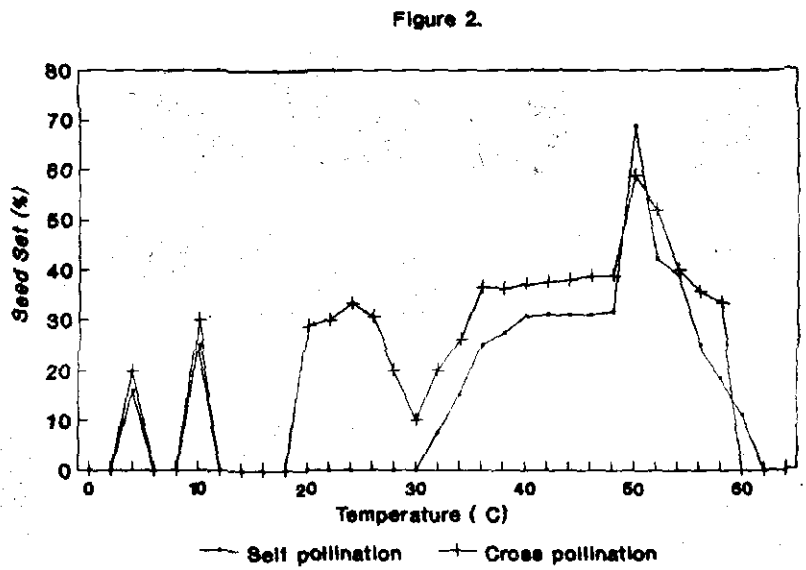

Figure 2. Effect of temperature in breaking down the incompatibility barrier in *Guizotia abyssinica*.

cross-pollinated (3.26%) and there was no seed set under self-pollination. The compatibility index under self-pollination (39.52%) after surgical treatment was almost equal to that of cross pollination (37.5%). However, a lower seed set under stump pollination in comparison to a compatible pollination could be due to mutilation injury. Though high and low temperatures were effective in improving seed set under selfing, the percentage seed set under selfing was higher at high temperatures (50°C - 56°C) with the maximum seed set (71.0%) at 52°C (Fig.2). Higher temperatures may be weakening the S-reaction products as most of the enzymes are heat labile. In several *Brassica* crops, culture in relatively high temperature was found to breakdown the incompatibility, especially of "weak" incompatibility S alleles. The lower temperatures may be temporarily inactivating the recognition factors as the time gap between treatment and pollination affected the seed set under selfing.

Thus temporary modification of incompatibility as in the present study could facilitate production of valuable combinations of recessive genes in homozygous condition and development of inbred lines with superior combining ability in highly cross pollinated crops like niger

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INDIAN SOCIETY OF OILSEEDS RESEARCH

DIRECTORATE OF OILSEEDS RESEARCH

Rajendranagar, Hyderabad - 500 003

HARDF AWARDS FOR OUTSTANDING OILSEEDS RESEARCH FOR 1993 AND 1994

Background of awards

Indian Society of Oilseeds Research founded in 1983 is a registered society of individuals and organisations/institutions engaged in oilseeds research and development and vegetable oil technology in India. The foremost amongst its objectives is the promotion of research in various aspects of oilseeds production. The society firmly believes that the initiative and dedication on the part of the scientific community is the prime driving force to accelerate the pace of oilseeds research in the country. In our endeavour to recognise outstanding research contributions in various disciplines of oilseeds research and to provide some incentive to the scientists it has been decided to institute fifteen awards, through the kind courtesy of Hexamar Agricultural Research and Development Foundation. The awards are named **HARDF AWARDS FOR OUTSTANDING OILSEEDS RESEARCH.**

Nature of awards

Cash awards of Rs. 3000/- each and a citation in the following disciplines of oilseeds research

i) Four awards for varietal improvement of groundnut, rapeseed-mustard, sesame, safflower, sunflower, soybean, castor, linseed and niger.

ii) Five awards for insect pest management. Of these one each is earmarked for groundnut and rape-seed mustard and the rest for sesame, safflower, sunflower, soybean, castor, linseed and niger.

iii) Four awards for disease management. Of these one each is earmarked for groundnut and rapeseed-mustard and the rest for sesame, safflower, soybean, castor, linseed and niger.

iv) Two awards for chemical weed control one each in groundnut and soybean.

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i) All scientists essentially members of Indian society of Oilseeds Research (for atleast three consecutive years preceding the year of awards) and working in research centres or departments or laboratories of universities, research institutes, directorates and national research centres under ICAR, CSIR, BARC etc., in India.

ii) Original Research work carried out during 5 years preceding the year of award which has bearing on finding solution to any important problem in the disciplines and crops specified.

iii) Outstanding basic research leading to inventions or discoveries in the disciplines concerned duly supported by publications in journals of repute.

iv) Results of routine experiments and the research work already submitted or to be submitted for award of any degree or diploma are not considered.

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i) Awards will be presented at Annual General Body Meeting of Indian Society of Oilseeds Research.

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iii) Indian Society of Oilseeds Research reserves the right to publish the results of research works selected for the awards and/or submitted for the awards in Journal of Oilseeds Research.

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i) Nominations for the award may be made by the Directors of Research Institutes, Vice-chancellors of Agricultural Universities and Presidents of recognised scientific societies. The nominations should invariably be accompanied by eight typewritten copies of proposals containing :

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nvestigator(s) duly authenticated by the Head of the institution where it was carried out, and

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i) Consists of (a) President of Indian Society of Oilseeds Research or his representative from Executive Committee, (b) Director of HARDF or his representative and (c) three experts in each disciplines nominated by the President or Executive Committee of ISOR.

ii) In all matters relating to the awards, the decision of the Judging Committee is final and no correspondence on this account shall be entertained.

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7. Objectives
8. Description of the work done.
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