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SHORT COMMUNICATIONS

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SAFFLOWER APHID (*Uroleucon compositae* (Theobald)) - A SERIOUS INSECT PEST OF SAFFLOWER IN INDIA - A REVIEW

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ABSTRACT

Safflower aphid, *Uroleucon compositae* (Theobald) is one of the serious pests of safflower crop, *Carthamus tintorius* L in India. Besides safflower, this pest also attacks a number of other economic plants. Both the nymphs and the adults suck cell sap in colonies from the growing parts of inflorescences, shoots, capitula and leaves. In case of severe attack, plants remain stunted and results in poor seed set. Loss in yield caused by this pest in India is about 68%. The pest is active from December to February, but its appearance on crop totally depends on prevailing climatic conditions. Low temperature, high humidity and cloudy weather are conducive for the multiplication of the pest. Incidence of pest is more on late sown crop and with copious irrigation. Various pest management strategies such as Plant resistance, sowing time, parasites, predators offered control of this pest in field. But the most effective control has been obtained through the use of insecticides. On the basis of work carried out during the last three decades, the insecticides like dimethoate 0.05%, endosulfan 0.05% and phosphomidon 0.05% are effective for the control of this pest of safflower.

Safflower (*Carthamus tinctorius* L) is the most important oilseed crop and is extensively cultivated in Southern India. India is the largest producer of this crop in the world. Within Indian Union as regards the area and production, Maharashtra stands foremost followed by Karnataka and Andhra Pradesh (Anonymous, 1981 and 1982).

The average production in India is 552.63 Kg seed per hectare (Anonymous, 1981). One of the most important factors for low yield of this crop is the heavy incidence of insect pest, particularly safflower aphid, *Uroleucon compositae* (Theobald) Homoptera : Aphididae). Anonymous (1981) listed 15 insect species damaging safflower crop in India. Of these safflower aphid is the most serious pest.

Host range

Safflower aphid is the specific pest of safflower. Besides safflower, the pest also attacks a number of other economic plants such as Niger in *Kharif*, and winter annuals like arctotis, aster, callopsis, chrysanthemum, dahalia, gallardia, helichrysum, laune, sweet sultan, vernonia etc. in *rabi* season (Narayanan 1961; Bindra and Rathore, 1967; Rathore, 1983) and mulberry (Devaiah *et al.*, 1976).

Damage

Both the nymphs and adults suck cell sap in colonies on the growing parts, inflorescence, shoots, capitula and under side of leaves (Dhoble, 1984, Jagtap *et al.*, 1986, Bhat *et al.*, 1989 and Dhembare and Nimbkar, 1994). This insect has syringe like proboscis which is injected into the plant tissue for sucking cell sap. In case of severe attack the entire plant gets densely covered with aphids resulting in stunted growth and poor capitula with negligible seeds. Severely infested plants do not flower at all. Basavangoud, (1979) reported 68% loss in the yield of safflower crop due to this pest in Bangalore. The yield losses reported by various workers due to severe infestation ranged from 20 to 25% (Khan and Hussain, 1958) 24% (Shetgar *et al.*, 1992) 26 to

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38% (Anonymous, 1983), 36% (Bindra and Vaishampayan, 1965 and Bhumannavar and Thontadrya, 1979), 55% (Karve *et al.*, 1978) and 55 to 60% (Suryawanshi and Pawar, 1980).

Life History

Biology of the safflower aphid has been studied by Bindra and Rathore (1967) and Bhumannavar (1977). Dhembare and Nimbkar (press) has estimated intrinsic rate of natural increase of the pest. The pest appear in the field by migration of alatae and invade by immigrated apterae (Rathore, 1983). The pest appears in the field and is met till maturity of the crop i.e. December to February in Deccan canal region of Maharashtra (Chavan, 1960), November to February at Hyderabad (Andhra Pradesh) (Khan, 1964), December to March at Jaipur (Rajasthan) (Upadhyay *et al.*, 1980) and January to April at Jabalpur (Madhya Pradesh) (Rathore and Pathak, 1981).

The mode of reproduction is through Parthenocarpy. The first female which appears on plants is called as stem mother. They give birth to tiny young ones (all females) Parthenogenetically. Average pre-reproductive period, reproductive period, post reproductive period and total life span of apterous aphid varied from 6 to 11, 9 to 13, 1 to 1.7 and21 to 25 days. Single apterous female gives birth to 82 to 88 nymphs in her life span. A single female produced 8.5 nymphs/day (Dhembare and Nimbkar) and 13 nymphs/day (Rathore, 1983).

At the end of period (February to March) the population decreases considerably. A generation of winged adults is produced which colonise on plants growing parts and moist places. Often winged adults emigrate to hills from where they return to the places during winter when the safflower crop occurs in the field.

Appearance of safflower aphid totally depends on climatic conditions. It is highly adaptive to cool and cloudy weather. Dhoble (1984) indicated that low temperature below 16°C and high relative humidity(more than 60%) was highly condusive for aphid population, where as rainfall considerably reduces the infestation.

Safflower aphid population build up on the young crop was significantly less at flowering stage and beginning of pod formation stage (Deokar *et al.*, 1984; Dhoble, 1984 and Dhembare and Nimbkar, 1984). Deokar *et al.* (1984) also reported that spineless varieties of safflower are highly susceptible to aphid attack. These varieties are mainly of greater succulence in comparison with their spiny counterparts. Incidence of this pest on safflower was more on the late sown than the early sown crop (Anonymous, 1986). Aphid population in irrigated crop is more than unirrigated crop as irrigation enhances crop succulency. Salinity does not seem to have any significant influence on aphid population (Balikai *et al.*, 1991).

MANAGEMENT STRATEGIES

Host Plant resistance

Studies on plant resistance in safflower to Uroleucon compositae have been made by Karve and Ketkar (1976), Karve (1980), Deokar *et al.* (1984) and Jagtap *et al.* (1985). According to these studies none of the strains or varieties of *Carthamus tinctorius* L. was immune or absolutely resistant but show varied degree of tolerance. The varieties of thin woody, spiny and early maturity were mostly tolerant, while late non-spiny were susceptible (Karve *et al.*, 1976, Karve, 1980). Deokar *et al.* (1984) reported that spiny character imparts aphid tolerance. The varieties without spines on their bracts were mostly susceptible to the pest (Jagtap *et al.*, 1985, Naik, 1987).

Sowing time

The incidence of this pest has been reported more on late sown safflower crop than that sown early (Anonymous, 1986). The effect of sowing time of safflower on aphid incidence has been studied by Rathore and Pathak (1985), Mhase *et al.* (1986), Ghule *et al.* (1987) and Dhembare *et al.* (in press). According to Rathore and Pathak (1985) early sowing during first week of November was more effective to avoid the need for chemical application in Jabalpur (MP). Mid September was better for sowing of crop in Solapur MS (Mhase *et al.*, 1986). Ghule *et al.*, (1970) reported lowest aphid densities in Jalgaon (MS) when the sowing was done in mid-September, while Dhembare *et al.*, (in press) revealed that mid- October sown crop escaped from safflower aphid attack in Phaltan, Satara (MS). Sowing time obviously influences the safflower aphid attack.

Natural enemies

Endpahis Aphidimyzra (Shiv.) (Diptera: Cecidomyiidae) is an endo parasite of safflower aphid, *U. compositae* (Shivpuje and Raodeo, 1985). According to them the percentage parasitisation and collection of aphids was undertaken at weekly intervals in late winter 1982. During first observation 46.00% of the aphids were parasitised by these midges. Subsequently, the parasitism was reduced to 35.0, 22.0 and 6.66% during second, third and fourth observations, respectively.

Lady bird beetles (Coccinelid) are the main predatory insects of aphid (Srivastava *et al.*, 1978, Chaudhary *et al.*, 1983 and Upadhyay *et al.*, 1983). According to Srivastava *et al.*, (1978) the safflower aphid was least preferred among the nine species of aphid tried by *C.sep tempunctata* L. Choudhary *et al.* (1983) observed that *C. sexmaculata* consumed more aphid. The aphid population rose in january-February, while population of *C. septempunctata* and *M. sexmaculata* had their peak appearance in mid-February controlling pest in field (Upadhyay *et al.*, 1983).

Chemical control

During the first half of the sixties, the safflower aphid was controlled by botanical insecticides (Singh and Sidhu, 1959 and Narayanan, 1961). They recommended spraying of nicotine sulphate at 0.05% concentration against this pest but it was prohibitively expensive as the cost of chemical worked out to Rs. 250/ha. Singh and Sidhu (1959) have opined earlier that nicotine sulphate is not as cheap as the modern insecticides they tried.

During sixties several contact synthetic insecticides have been evaluated and recommended for the control of this pest. Several workers have worked out the relative toxicity of different insecticides against safflower aphid in India and elsewhere. According to Bindra and Vaishampayan (1965) dimethoate 0.05% or manazon 0.05% were most effective insecticides. Carlson (1969) evaluated several insecticides against this pest and reported that endosulfan at 1.12 kg/ha was best for aphid control.

In another investigation Carlson (1972) reported that mavinphos 0.25 kg/ha was significantly superior to all other insecticides tested. Sarode and Taley (1976) indicated that combined toxicity of BHC and carbaryl (10:3) and phosalone and malathion (6:10) had shown higher synergistic action on this pest. Rathore and Pathak (1982) also observed that demeton-methyl at 250 ml a.i/ha offered the most effective control, followed by monocrotophos 400 ml a.i./ha and dimethoate 300 ml a.i./ha. The demeton-methyl remained effective upto four weeks, resulting in highest yield and was the most economical and selective to the coccinellid insects. Basavangoud *et al.* (1983) worked with phosphomidon 0.05%, phorate 50 D.P., pirimicarb 50 D.P., endosulfan, chloropyriphos, fenvalerate and fenitrothion on this pest and obtained better control with phosphomidon 0.05% second to phorate and pirimicarb 50 D.P. respectively. Endosulfan, chloropyriphos, fenvalerate and fenitrothion were less effective in suppressing the aphid. Choudhary *et al.* (1983) reported that quinalphos 0.03%

showed greater effect and observed predatory insect population after 10 days of application. On the basis of a laboratory study Singh and Sircar (1983) found that endosulfan, lindane and aphidan [S- (ethylsulfinyl) methyl] were effective against this pest, while being safer to economically important insects such as *A. septempunctata*, predator. Vora *et al.* (1984) recommended 0.025% dimethoate or manazone against aphid *D.* (Uroleucon) *compositae* (Theobald) *D. jaccae* (L) and *D. sonchi (*L). Dhoble *et al.* (1985) compared the efficacy of application of dust and spray formulation at 15 days interval and reported that dust application was fairly beneficial than spray formulation. Dimethoate at 0.025% controlled this pest effecttively upto 3 weeks, which gave highest yield in both the years of experimentation (Gorgav and Verma, 1985). Among the test insecticides thiometon or endosulfan at 0.05% were fairly superior while all the test insecticides gave reduction of this pest after 24 and 48 hours of treatment (Jagdale *et al.*, 1985). Sanap and Agri (1986) found that phosalone 4% dust application was most effective. Anonymous (1987) worked with ten insecticides and recommended that dimethoate 0.05% spray gave better result with two applications done at 15 days interval starting from 15 days after the first incidence of the aphid pest. Dimethoate 0.05% also gave highest benefit cost ratio than ten other test selective insecticides. Two sprays of 0.05% phosphomidon at 15 day interval gave better results on aphid pest and provided the highest yield (Ghule *et al.*, 1987).

Seed dressing with systemic insecticide showed better control of aphid, *U. compositae* (Theobald) without any adverse effect on germination (Naik *et al.* 1987). Singh and Dhamdhere (1987) based on the laboratory and field studies reported that phosphomidon 0.04% was most effective followed by demeton-s-methy 0.03%, dimethoate 0.04% and monocrotophos 0.36%, while thiometon 0.04% was the least effective. Spray of methyl-demeton 25 EC twice at 55 and 80 days after sowing offered best protection against this insect pest and provided higher benefit -cost ratio (Chandrakar and Gupta, 1989). Ghorpade *et al.* (1994) tested nine EC formulations and eight dust formulations and found that 0.05% methyl parathion 50 EC or 2% methyl parathion dust application, one spray 60 days after sowing gave the best protection against aphid and *Helicoverpa* borer resulting in the highest benefit-cost ratio.

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HETEROSIS FOR OIL CONTENT AND FATTY ACID COMPOSITION IN SESAME UNDER SALINITY STRESS

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ABSTRACT

The Extent of heterosis for oil quantity and quality in a full diallel set of 9 salt tolerant sesame lines was studied in normal and saline soils. The maximum heterosis value for oil content was observed in IER2xHT1 in all the environments over both mid and better parents. It was observed that HT1, the parent involved in producing highest heterotic effect, produced significant positive heterotic effect on combination with R9, B14, B67, T12 and RT4 over both mid and better parent (excepting better parent in T12 x HT1)in saline environment. It was noted that the crosses showing maximum heterosis for the unsaturated fatty acids - oleic and linoleic are the recombinant of better parents in both normal and saline environments.

Key words: Heterosis, oilquality,salinity, sesame.

INTRODUCTION

Sesame (*Sesamum indicum* L.) is an important oilseed crop. The sesame oil rich in favourable unsaturated fatty acids - oleic and linoleic acid together accounts for an extent of 88%, while the saturated fatty acid accounts for 20%. Higher quantity of poly-unsaturated fatty acids in seed oil is the most important criteria for oil quality. The great diversity of sesame types, their wide environmental adaptation and large genetic variability makes it an exceptional material to the plant breeders. However, the work relating to improvement in oil content and more specifically oil quality, in different situations is scanty in sesame.

The exploitation of hybrid vigour to increase the yields of agricultural crops has become one of the most important techniques in plant breeding. Earlier workers (Pal 1945, Kotecha and Yermanos, 1978, Singh *et al.*, 1986, Reddy and Haripriya, 1990, Ding *et al.* 1991) have reported considerable heterosis for yield and yield attributes in sesame except oil quality. Therefore, the present study was undertaken to determine the heterosis in a 9x9 diallel of sesame genotypes.

MATERIALS AND METHODS

Nine salt tolerant diverse genotypes R9, B67, B14, B9, T12, RT4, IDP51 and HT1 of sesame (Chakraborty and Basu, 1994) were crossed in all possible combinations (excluding reciprocals) giving a total number of 36 crosses. Nine parents and 36 F1s were sown at two locations - Kalyani (sandy-loam soil), District seed Farm, West Bengal (E1) and Kakdweep (saline belt, E.C. of the soil 4.3-4.5 ds/m), Regional Research Station, BCKV, West Bengal (E2).

Single row of 5 meter length each for 36 crosses and 9 parents was grown in a Randomised Block Design with a spacing of 60 cm between rows and 8 cm between plants. The experiment was replicated thrice.

Oil was extracted from the seeds following the soxhlet extraction method for 6 hours with petroleum ether (B.P. 60°-80° C) and was expressed in percentage. Methyl esters of fatty acids were prepared by Metcafe and Schimitz.s (1961) method. The estimation of fatty acids was done through GLC analysis and by comparison of the retention time (Rt) with standard methyl esters of fatty acids.

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Heterosis percentage was calculated over both mid and better parent.

RESULTS AND DISCUSSION

The heterosis of oil content and different fatty acids at two locations i.e Kalyani (E1) and Kakdweep (E2) revealed that HT1 could be identified as better parental line for its oil content in both the environmental situations (Table 1). It was also involved in producing the highest heterotic effect for oil content in combination with IET2 in normal and saline environments over both mid and better parent. HT1 also produced significant positive heterotic effect in combination with R9, B14, B67, T12 and RT4 over both mid and better parent (excepting over better parent in T12x HT1) in saline environment (E2). On the otherhand, it produced significant positive heterotic effect with R9, B14 and RT4 over mid parent only in saline situation (E1). Almost all the crosses showed significant heterosis for all the fatty acid components but most of them were in negative direction (Table 2).

The crosses showing high heterosis also showed positive and significant values of *sca* and the crosses showing maximum heterosis for the two unsaturated fatty acids - oleic and linoleic, are the recombinants of better parents in both the environmental situations, which may be due to their inherent potentialities for these characters. IET2 and HT1 in combination between themselves or with other genotypes produced higher heterosis for oilcontent and for unsaturated fatty acids, oleic and linoleic acid, in both saline and non-saline conditions. The genotypes can be better utilized in planning breeding programme for exploitation of high heterosis in oil content as well as in its fatty acid profiles.

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Table 1. Heterosis for oil content in sesame crosses under non-saline and saline conditions

Crosses	Non-saline environment (E1)		Saline environment (E2)	
	Mid	Better	Mid	Better
R-9xB-14	3.91**	-3.78**	5.46**	1.50
R-9xB-9	2.66**	0.29	4.17**	1.58
R-9xB-67	-9.18**	-13.74**	-5.35**	-9.08**
R-9xT-12	2.67**	0.95	8.65**	2.16**
R-9xRT-4	3.03**	1.12	9.08**	7.66**
R-9xIDP-51	-0.43	-4.01**	4.95**	1.26
R-9xIET-2	3.15**	-7.55*	4.11**	-1.90*
R-9xHT-1	9.11**	-7.55**	20.89**	17.46**
B-14xB-9	6.31**	0.63	4.30**	2.91**
B-14xB-67	7.54**	4.70**	5.61**	5.38**
B-14xT-12	-8.08**	-16.19**	-14.07**	-22.04**
B-14xRT-4	2.04**	-3.84**	-4.66**	-7.06**
B-14xIDP-51	-1.23	-5.28**	-4.17**	-4.42**
B-14xIET-2	2.52**	-1.06	-3.71**	-5.81**
B-14xHT-1	3.89**	-5.06**	7.65**	6.62**
B-9xB-67	-2.04**	-4.83**	4.35**	2.74**
B-9xT-12	-8.46**	-12.04**	-12.46**	-19.61**
B-9xRT-4	-0.47	-0.94	3.69**	2.43**
B-9xIDP-51	-19.97**	-21.04**	-17.82**	-18.70**
B-9xIET-2	-0.69	-9.10**	-16.83**	-19.70**
B-9xHT-1	-7.84**	-11.22**	-2.63**	-2.99**
B-67xT-12	-4.17**	-10.43**	-9.29**	-17.87**
B-67xRT-4	-17.02**	-19.75**	-19.05**	-21.25**
B-67xIDP-51	1.65*	0.08	6.02**	5.52**
B-67xIET-2	12.22**	5.54**	3.06**	1.03
B-67xHT-1	-3.52**	-9.60**	3.64**	2.43**
T-12xRT-4	-7.22**	-10.43**	-26.84**	-32.06**
T-12xIDP-51	0.50	-4.67**	-5.54**	-14.12**
T-12xIET-2	11.11**	-1.90*	2.42**	-8.90**
T-12xHT-1	0.55	0.29	7.07**	-2.02**
RT-4xIDP-51	-3.43**	-5.17**	-19.42**	-21.25**
RT-4xIET-2	8.60**	-1.02	-17.89**	-21.65**
RT-4xHT-1	4.24**	0.88	17.35**	15.49**
IDP-51xIET-2	14.30**	5.98**	7.18**	4.59**
IDP-51xHT-1	-5.09**	-9.75**	-3.42**	-4.10**
IET-2xHT-1	20.30**	6.45**	27.83**	23.87**
Comparison of Crosses with	CD 95%	CD 99%	CD 95%	CD 99%
Mid Parent	0.567	0.752	0.592	0.785
Better Parent	0.655	0.868	0.684	0.907

Table 2. Heterosis for Fatty acid composition in sesame crosses under non-saline and saline conditions

Crosses	Palmitic acid				Oleic acid				Linoleic acid			
	Non-saline (E1)		Saline (E2)		Non-saline (E1)		Saline (E2)		Non-saline (E1)		Saline (E2)	
	Mid	Better	Mid	Better	Mid	Better	Mid	Better	Mid	Better	Mid	Better
R-9xB-14	13.95**	8.80**	44.92**	27.29**	-9.31**	-11.98**	-6.95**	-10.74**	13.54**	6.87**	-1.67	-5.26**
R-9xB-9	-22.65**	-33.98**	11.66**	-12.06**	-5.55**	-7.57**	-2.57**	-3.57**	17.35**	8.29**	6.20**	2.67**
R-9xB-67	6.25**	-1.26**	49.81**	47.76**	-7.19**	-7.55**	0.69**	0.63**	6.99**	3.06**	-1.58	-1.62
R-9xT-12	-18.99**	-28.90**	-4.18**	-13.21**	-1.39**	-4.93**	2.28**	-1.63**	9.23**	9.10**	-0.73	-2.74*
R-9xRT-4	-27.84**	-34.00**	-14.08**	-23.60**	-10.26**	-13.50**	5.09**	1.06**	19.02**	16.58**	-1.51	-3.29**
R-9xIDP-51	0.45**	-1.09**	-9.80**	-24.45**	8.04**	6.45**	-6.77**	-8.02**	-8.70**	-11.05**	5.72**	4.72**
R-9xIET-2	-14.34**	-31.23**	52.48**	39.80**	-25.69**	-37.41**	-3.90**	-4.29**	88.86**	13.79**	-0.47	-3.12**
R-9xIIT-1	0.46**	-5.03**	-4.81**	-23.44**	5.13**	3.43**	11.82**	7.89**	3.53**	0.03	-6.46**	-7.53**
B-14xB-9	-5.79**	-16.28**	-20.28**	-29.84**	-0.29*	-1.12**	-3.61**	-8.44**	-1.59**	-3.65**	3.08**	2.72*
B-14xB-67	-14.72**	-24.06**	31.50**	16.89**	5.93**	2.43**	-1.66**	-5.61**	1.98**	-7.32**	-1.33	-4.97**
B-14xT-12	-19.80**	-26.60**	-11.91**	-14.88**	-4.76**	-10.79**	-3.75**	-11.05**	10.27**	3.68**	3.29**	-2.43*
B-14xRT-4	-18.53**	-22.13**	-7.07**	-8.36**	-3.34**	-9.47**	-8.19**	-15.16**	10.96**	2.43**	2.89**	-2.60*
B-14xIDP-51	-6.02**	-11.58**	-6.87**	-11.88**	-9.10**	-13.03**	-9.57**	-12.11**	11.56**	2.47**	1.83	-0.99
B-14xIET-2	-32.83**	-44.10**	20.30**	14.74**	-18.89**	-29.95**	-4.60**	-8.12**	85.60**	14.36**	4.77**	3.68**
B-14xIIT-1	-13.33**	-13.40**	13.14**	2.07**	-7.12**	-8.39**	-3.43**	-10.49**	15.97**	12.94**	0.47	-4.26**
B-9xB-67	-19.16**	-35.04**	-18.76**	-35.36**	-3.74**	-6.16**	0.72**	-0.37*	8.15**	-3.55**	1.21	-2.19*
B-9xT-12	-36.22**	-38.25**	3.14**	-11.88**	0.99**	-4.64**	-1.03**	-3.86**	21.53**	12.02**	3.97**	-1.46
B-9xRT-4	-29.58**	-34.77**	20.60**	4.87**	-6.79**	-12.01**	-2.26**	-5.07**	27.39**	15.34**	-1.16	-6.12**
B-9xIDP-51	-18.44**	-31.27**	-4.16**	-11.25**	-6.21**	-9.54**	-2.20**	-4.48**	14.67**	3.32**	3.48**	0.96
B-9xIET-2	-38.67**	-43.12**	-11.81**	-25.48**	-25.41**	-36.03**	3.36**	1.88**	112.08**	31.75**	6.28**	5.55**
B-9xIIT-1	-24.62**	-32.97**	17.36**	14.14**	-7.94**	-8.44**	1.52**	-1.07**	29.30**	23.36**	-5.01**	-9.18**
B-67xT-12	-13.45**	-28.66**	77.52**	62.81**	-2.33**	-5.49**	-3.34**	-7.08**	3.82**	0.12**	-8.10**	-9.93**
B-67xRT-4	82.39**	53.13**	85.08**	66.59**	30.29**	26.06**	34.79**	29.56**	-65.16**	-65.74**	-42.13**	-43.15**
B-67xIDP-51	-13.60**	-18.54**	-8.54**	-22.53**	10.58**	9.37**	2.47**	1.16**	0.24**	-1.39**	-0.47	-1.44
B-67xIET-2	-28.91**	-46.01**	38.81**	28.90**	-11.92**	-26.04**	4.67**	4.29**	56.06**	-7.15**	-5.00**	-7.57**
B-67xIIT-1	9.11**	-2.90**	-9.64**	-26.56**	3.04**	0.99**	19.58**	15.31**	-2.78**	-9.46**	-11.42**	-12.40**
T-12xRT-4	-17.10**	-20.80**	-4.57**	-6.53**	10.46**	10.44**	16.57**	16.55**	2.59**	0.61**	-6.58**	-6.79**
T-12xIDP-51	-15.89**	-27.15**	1.24**	-7.27**	-6.41**	-8.45**	0.52**	-4.56**	15.17**	12.34**	-0.74	-3.64**
T-12xIET-2	-34.98**	-41.47**	-0.64**	-1.96**	-25.34**	-38.95**	-3.87**	-7.91**	89.30**	14.01**	4.21**	-0.58
T-12xIIT-1	-22.47**	-28.99**	10.74**	-3.11**	4.54**	-0.78**	13.55**	13.18**	10.23**	6.30**	-10.48**	-11.29**
RT-4xIDP-51	-9.95**	-18.77**	-15.03**	-20.66**	0.56**	-1.65**	0.97**	-4.15**	8.64**	8.05**	5.03**	2.18*
RT-4xIET-2	-29.69**	-39.22**	5.86**	2.34**	-22.94**	-37.00**	6.58**	2.09**	84.16**	10.18**	-0.11	-4.50**
RT-4xIIT-1	-13.82**	-17.56**	12.37**	0.12	-0.79**	-5.86**	8.32**	7.96**	14.19**	8.07**	-7.44**	-8.07**
IDP-51xIET-2	-30.84**	-44.68**	-15.17**	-23.24**	-22.13**	-35.19**	-11.05**	-11.88**	77.26**	5.87**	10.99**	9.04**
IDP-51xIIT-1	-8.17**	-13.66**	14.53**	8.88**	-4.98**	-7.87**	-11.05**	-15.28**	8.27**	1.95**	5.33**	3.15**
IET-2xIIT-1	-30.49**	-42.11**	-22.48**	-32.95**	-24.89**	-35.87**	-6.54**	-10.19**	93.38**	17.98**	7.55**	3.51**
Comparison of Crosses with	CD 95%	CD 99%	CD 95%	CD 99%	CD 95%	CD 99%	CD 95%	CD 99%	CD 95%	CD 99%	CD 95%	CD 99%
Mid Parent	0.036	0.047	0.049	0.065	0.106	0.141	0.039	0.052	0.022	0.029	0.878	1.164
Better parent	0.041	0.054	0.057	0.075	0.123	0.163	0.045	0.060	0.025	0.033	1.013	1.344

Crosses	Non-saline (E1)		Saline (E2)		Non-saline (E1)		Saline (E2)	
	Mid	Better	Mid	Better	Mid	Better	Mid	Better
R-9xB-14	-36.10**	-43.77**	-19.52**	-21.55*	-44.11**	-46.99**	-21.66**	-50.88**
R-9xB-9	-21.25**	-38.60**	-26.63**	-27.02**	-16.34**	-16.71**	-95.34**	-96.71**
R-9xB-67	-17.99**	-30.70**	-16.01**	-16.31**	-8.42	-18.29**	-93.01**	-93.27**
R-9xT-12	-20.74**	-41.34**	-13.37**	-23.05**	-10.53	-12.14*	-1.25	-8.01**
R-9xRT-4	-43.96**	-53.50**	-4.03	-19.86**	-3.11	-7.67	2.67*	-5.93**
R-9xIDP-51	30.36**	10.94**	-12.85**	-17.02**	-4.23	-6.87	12.88**	-18.19**
R-9xIET-2	5.96**	-24.32**	-3.40	-4.26*	-84.48**	-88.78**	-70.87**	-72.15**
R-9xHT-1	-8.19**	-21.58**	23.37**	14.18**	-79.03**	-80.13**	-56.62**	-75.08**
B-14xB-9	164.98**	130.00**	-21.65**	-23.23**	14.70**	9.24	223.82**	162.55**
B-14xB-67	76.52**	68.40**	-22.70**	-24.92**	-51.72**	-58.88**	-75.00**	-84.07**
B-14xT-12	206.86**	150.40**	-15.12**	-26.26**	-3.73	-10.24	64.56**	6.50**
B-14xRT-4	47.32**	37.60**	130.45**	88.55**	-15.19**	-15.62**	80.24**	17.61**
B-14xIDP-51	45.11**	39.60**	33.33**	23.91**	4.23	-3.72	195.67**	131.37**
B-14xIET-2	25.83**	-1.60	-20.56**	-23.23**	-44.09**	-58.14**	-72.82**	-83.26**
B-14xHT-1	13.87**	10.00**	10.24**	-0.34	-14.56**	-14.65**	-82.11**	-85.80**
B-9xB-67	49.39**	35.24**	-36.28**	-36.84**	16.97**	3.96	62.64**	17.23**
B-9xT-12	20.47**	11.96**	-20.24**	-29.47**	-69.64**	-70.31**	-67.23**	-75.86**
B-9xRT-4	30.17**	20.28**	31.65**	9.47**	-85.78**	-86.40**	-66.17**	-74.78**
B-9xIDP-51	-37.83**	-44.16**	-19.63**	-23.86**	-3.19	-6.25	-48.27**	-50.62**
B-9xIET-2	19.38**	5.43**	-1.78	-3.16	-47.62**	-62.02**	-85.62**	-90.13**
B-9xHT-1	-16.55**	-25.32**	-18.48**	-24.91**	-73.10**	-74.41**	-76.72**	-84.12**
B-67xT-12	-1.82	-16.74**	40.68**	25.36**	29.47**	17.40**	-77.51**	-78.27**
B-67xRT-4	77.93**	74.01**	30.49**	9.29**	112.61**	81.84**	-80.67**	-81.65**
B-67xIDP-51	2.18	1.30	-14.77**	-18.57**	-82.91**	-84.36**	-73.43**	-80.26**
B-67xIET-2	35.87**	10.13**	-8.44**	-8.93**	-66.96**	-77.70**	-83.91**	-85.16**
B-67xHT-1	-81.74**	-81.97**	-31.92**	-36.79**	-14.99**	-27.66**	-49.29**	-70.56**
T-12xRT-4	5.60**	-8.76**	5.88*	-1.37	-76.83**	-78.29**	-79.58**	-79.94**
T-12xIDP-51	4.88**	-11.69**	-13.92**	-20.00**	-39.50**	-40.10**	-33.09**	-49.12**
T-12xIET-2	28.43**	21.52**	-8.06**	-17.69**	-41.16**	-57.93**	-5.85**	-15.86**
T-12xHT-1	-5.88**	-21.03**	-14.16**	-17.92**	-63.10**	-65.55**	-67.85**	-81.15**
RT-4xIDP-51	-9.38**	-12.12**	-16.22**	-27.06**	-71.77**	-73.81**	-73.50**	-79.60**
RT-4xIET-2	13.97**	-5.99**	-17.60**	-30.69**	-74.36**	-80.87**	-79.06**	-81.58**
RT-4xHT-1	-14.67**	-17.60**	44.06**	28.75**	-83.39**	-83.49**	-75.02**	-85.27**
IDP-51xIET-2	16.13**	-6.49**	-16.92**	-20.22**	-52.48**	-66.23**	20.89**	-14.77**
IDP-51xHT-1	-15.95**	-16.31**	-20.40**	-22.75**	-1.32	-8.93	-62.25**	-74.87**
IET-2xHT-1	20.32**	-3.43*	1.35	-5.42*	-46.03**	-59.57**	74.52**	-0.88
Comparison of crosses with	CD 95	CD99%	CD95%	CD99%	CD95%	CD99%	CD95%	CD99%
Mid parent	0.018	0.023	0.035	0.046	0.437	0.579	0.078	0.104
Better parent	0.020	0.027	0.040	0.053	0.505	0.669	0.090	0.120

Table 3 Mean Parental values for oil content (%) and fatty acids in sesame under non-saline and saline conditions

Parent	Oil content(%)		Palmitic acid		Oleic acid		Linoleic acid		Arachidic acid		Stearic acid	
	E1	E2	E1	E2	E1	E2	E1	E2	E1	E2	E1	E2
R9	44.17	42.28	11.37	8.54	43.22	40.91	40.41	45.45	1.10	0.94	4.17	4.16
B14	37.63	39.03	12.50	11.29	45.93	44.53	35.42	42.13	0.83	0.99	4.65	1.06
B9	42.13	40.10	16.08	14.65	45.16	40.07	33.94	42.43	0.61	0.95	4.21	1.70
B67	39.73	38.87	9.76	8.78	42.89	40.95	43.32	45.49	0.76	0.93	3.27	3.85
T12	45.70	47.93	15.05	10.52	40.12	37.78	40.24	47.38	0.53	0.73	4.02	3.59
RT4	42.53	41.10	13.71	10.97	40.10	37.77	41.86	47.16	0.72	0.69	4.61	3.46
IDP51	41.00	39.23	11.02	12.65	41.95	42.03	42.32	44.60	0.77	0.85	3.94	1.87
IET2	35.00	37.33	18.81	10.24	63.14	41.25	38.23	43.03	0.47	0.92	9.36	4.36
HT1	45.47	39.80	12.52	14.03	44.67	38.03	37.37	46.52	0.78	0.80	4.66	0.62

E1 = Non-saline; E2 = Saline condition.

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COMBINING ABILITY ANALYSIS FOR YIELD AND ITS COMPONENTS IN INDIAN MUSTARD

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ABSTRACT

The combining ability analysis of 8 parents and their 28 F_1s generated through diallel system of mating revealed that significant differences existed for general and specific combining ability for all the characters. GCA and SCA variances were important for all the characters indicating the presence of both additive and nonadditive gene effects in controlling the expression of various characters. Divya, Kranti and Vardan were found to be good general combiners for seed yield and some of its component traits. Thirteen crosses exhibited good combining ability for seed yield. Yield was found to be controlled predominantly by non-additive gene action. The crosses with high *sca* effects did not always had parents with good *gca* effects. Such a relationship between *gca* and *sca* indicates the importance of epistasis and the crosses are expected to produce desirable transgressive segregants if the additive genetic system of good general combiner and the complementary epistatic effect of F_1 act in the same direction to maximize the desirable yield attribute.

Key words :Indian mustard, combining ability, yield components.

INTRODUCTION

High yielding varieties contribute significantly towards increasing both production and productivity. A suitable breeding methodology and identification of superior parents are the important pre-requisites for the development of high yielding genotypes. Sound understanding of gene effects involved in the expression of various yield attributes is of prime importance in formulating any breeding methodology. Combining ability analysis provides a guideline for the assessment of relative breeding potential of parental material which can be utilized in pursuing a systematic breeding programme (Asthana and Pandey, 1977). This possibility was explored in the present investigation and the combining ability of the desirable lines was studied.

MATERIALS AND METHODS

There cultivars viz., Kranti, Vardan and Pusa Bahar and five experimental strains viz., Divya, Zem-2, Domo, PHR-Artola and Ornamental rai representing a wide range of diversity were selected for the study. These parents had been maintained by self-pollination for several generations and therefore may be considered as homozygous inbred lines. A complete set of 36 entries comprising 28 F1s and their 8 parents was grown in a randomized block design with three replications. The material was planted at a distance of 10cm. within the rows in 3m long one-row plots. The row-to-row spacing was 60cm. A single non-experimental row was grown all around the experimental plot to neutralize the border effect. Data for 15 characters were recorded on five randomly selected plants from each plot.

Combining ability analysis was carried out as per Model 1 and Method 2 of Griffing (1956).

RESULTS AND DISCUSSION

The analysis of variance for various characters revealed highly significant differences amongst the entries. The combining ability analysis of variance also revealed significant differences for all the characters under study (Table 1).

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Table 1 : Analysis of variance (M.S.S) for combining ability in indian mustard

Source	d.f.	Number of days to initiation of flowering	Number of days to 50 per cent flowering	Number of days to maturity	Plant height	Length of main shoot	Number of primary branches per plant	Number of Secondary branches per plant
General combining ability	7	199.95**	207.08**	244.51**	2569.01**	657.06**	2.91**	8.70**
Specific combining ability	28	27.54**	27.28**	25.25**	458.68**	233.17**	1.28	2.16**
Error	70	0.36	0.44	0.55	9.73	5.54	0.018	0.023

Table 1: Contd....

Source	d.f	Number of siliqua on main shoot	Number of siliquae per plant	Length of siliqua	Number of seeds per Siliqua	Seed yield per plant	1000-Seed weight	Oil content	Harvest index
General combining ability	7	134.08**	17349.2**	1.35	3.96**	40.69**	1.82	2.11	74.18**
Specific combining ability	28	97.61**	2495.24**	0.35	3.78**	5.58**	0.47	1.17	4.73**
Error	70	8.02	57.99	0.006	0.06	0.02	0.002	1.99	0.66

* Significant at 5 per cent level of probability; **Significant at 1 per cent level of probability.

Estimates of *gca* and *sca* variances revealed that both additive and nonadditive gene actions were important in the expression of different characters. However, non-additive variance was predominant for all the characters except days to maturity, oil content and harvest index (Table2). These results are in agreement with those of Singh *et al.* (1985). Negative estimates for avariance due to *sca* were obtained for oil content which may be due to sampling error. Predominance of non-additive variance could be utilized for improvement through breeding procedures like reciprocal recurrent selection that allow the predominance of non-additive variance to appear. However, the presence of both additive and non-additive variance suggests the simultaneous exploitation of these gene effects through F_1 hybrid syhthesis.

Variances due to *gca* were significant for all the characters except length of siliqua, 1000-seed weight and oil content, while *sca* variances were significant for all the characters except number of primary branches, length of siliqua, 1000-seed weight and oil content.

Divya, Kranti, Vardan and Pusa Bahar were good general combiners for days to initiation of flowering, days to 50 per cent flowering, days to maturity and plant height, exhibiting significantly negative *gca* effects. For length of main shoot and number of primary and secondary branches, Vardan was a good general combiner. For seed yield per plant and other yield contributing traits, Divya, Kranti, Vardan and Domo exhibited good general combining ability. None of the parents was found to be a good general combiner for oil content, while four parents viz., Divya, vardan, Kranti and Pusa Bahar showed good general combining ability for harvest index. The present findings regarding Kranti and Vardan are in conformity with those of Singh and Mittal (1993).

The *sca* estimates represent dominance and epistasis. The crosses, Divya x Zem-2, Varadan x Zem-2, Vardan x Domo, Pusa Bahar x Ornamental rai and Domo x Ornamental rai showed highly significant negative *sca* effects for days to initiation of flowering, 50 per cent flowering and days to maturity. These crosses can be used to isolate early

Table 2 : Estimates of σ^2 gca and σ^2 sca and mean degree of dominance $(\sigma^2 \text{ sca}/\sigma^2 \text{ gca})^{1/2}$ for different characters in diallel analysis in Indian musatrd

Character	Variance		Mean degree of dominance
	σ^2gca	σ^2sca	
Nuumber of days to initiation of flowering	17.24	24.17	1.26
Number of days to 50 per cent flowering	17.98	26.84	1.22
Number of days to maturity	24.70	21.93	0.88
Plant hight	211.03	448.954	1.46
Length of main shoot	49.38	227.64	2.32
Number of primary branches per plant	0.16	0.26	1.26
Number of secondary branches per plant	0.65	2.14	1.81
Number of siliquae on main shoot	3.65	89.59	4.96
Number of siliquae per plant	1485.40	2437.24	1.28
Length of siliqua	0.10	0.35	1.87
Number of seeds per siliqa	0.02	3.72	13.64
Seed yield per plant	3.51	5.56	1.26
1000-seed weight	0.14	0.48	1.85
Oil content	0.09	-0.82	0.00
Harvest index	6.95	4.07	0.77

maturing segregants in later generations (Table 4). In the similar way crosses viz. PHR - Artola x Ornamental rai, vardan x Domo, Zem-2 x PHR - Artola and Zem-2 x Ornamental rai can be used for isolation of genotypes with smaller plant height. It is wroth mentioning that the combinations Kranti x Zem-2 and Vardan x Zem-2 showed highly significant *sca* effects for most of the yield contributing traits including seed yield. These crosses can be used for isolation of trangressive segregants for seed yield.

Crosses Kranti x Ornamental rai, Zem-2x Domo, Divya x Pusa Bahar, Divya x Zem-2, Divya x PHR-Artola and Kranti x Vardan exhibited highly significant *sca* effects for harvest index, while none of the crosses exhibited significant *sca* effects for oil content. In general, the results are in conformity with Labana *et al.* (1975) for yield and other traits.

Based on *per se* performance and general combining ability best parents for general combining ability were indentified. Similarly, best crosses were identified on the basis of *per se* performance and specific combining ability.

It was observed that the parents having best *per se* performance did not appear as best general combiners for as many as eight characters, however, for seven characters there was a complete correspondence between *per se* performance and *gca* performance of the parents (Table 5). Also, the crosses with highest mean did not possess high *sca* effects for all the characters except days to 50 per cent flowering, length of main shoot, number of secondary branches and siliquae on the main shoot. These observations suggest that selection of good general combiners only on the basis of mean performance may not always be reliable. However, the crosses exhibiting high *sca* together with best *per se* performance can reliably be included in heterosis breeding programmes.

The crosses with high *sca* effects did not always had parents with high *gca* effects except in case of Kranti x Domo which had both the parents as good general combiners for days to 50 per cent flowering and harvest index. Such a relationship between *gca* and *sca* effects indicates the importance of epistasis in the expression of the characters under study. It also reveals the potentiality of parents with low *gca* to express high sca in cross combinations. Therefore, it may not always be necessary to attempt crosses between high x high *gca* parents. Crosses with average or low *gca* parents can also manifest high *sca* effects, in suitable cross combinations, attributable to interaction effects.

The superior F_1s involving high and low *gca* parents and exhibiting high *sca* effects, besides being promising hybrids, are expected to segregate transgressively if additive gene effect of the high *gca* parent and the complementary epistatic effect of the cross are coupled in the desirable direction to maximize the intensity of trait under consideration. This supports the importance of both additive and non-additive genetic variance in controlling yield and its components.

An overll view of the results suggest that genetically diverse parents with good *per se* performance and combining ability should be selected for breeding programmes aimed at improvement of mustard varieties.

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Table 3 : Esimates of general combining ability (gca) effects of parents of Indian mustard

Parent	Day to initiation of flowering	Days to 50 per cent flowering	Days to maturity	Plant height	Length of main shoot	Number of primary branches per plant	Number of Secondary branches per plant
Divya	-7.52**	-7.59**	-10.29**	-20.85**	4.04**	0.06	0.25
Kranti	-2.15**	-2.22**	-3.19**	-14.56**	-12.13**	0.23	0.34
Vardan	-2.65**	-2.45**	0.34	-12.26**	8.01**	0.96*	1.33*
Pusa Bahar	-2.39**	-2.75**	-0.52*	-10.37**	3.69**	0.11	0.76
Zem-2	4.60**	5.04**	2.14**	15.78**	-9.17**	-0.17	-0.27
Domo	2.47**	2.44**	2.20**	15.03**	-6.86**	-0.17	-0.77
PHR-Artola	5.97**	5.87**	5.60**	8.78**	-3.01**	-0.04	0.04
Ornamental rai	1.67**	1.67**	3.70**	18.45**	-8.83**	-0.99*	-1.69**
S.E(gi)	0.17	0.19	0.22	0.92	0.69	0.40	0.45
S.E. (gi-gj)	0.27	0.29	0.33	1.39	1.05	0.61	0.69

Table 3 Contd...

Parent	Number of siliquae on main shoot	Number of siliquae per plant	Length of siliqua	Number of seeds per siliqua	Seed yield per plant	1000-Seed weight	Oil content	Harvest index
Divya	-6.84**	19.28**	0.18**	0.16	0.84*	0.35*	-0.16	2.84**
Kranti	-2.26**	61.79**	0.54**	1.16	3.53**	0.51**	-0.05	3.56**
Vardan	-2.32*	16.24**	0.34**	0.41	2.001**	0.30*	0.55	2.26**
Pusa Bahar	0.39	0.79	0.21**	-0.77	-0.43	0.40*	-0.35	1.11*
Zem-2	2.94**	-3.44	-0.39**	0.18	0.64	-0.33*	-0.50	-1.64**
Domo	3.16**	-54.89**	-0.15**	-0.47	-2.28**	0.46*	-0.34	-3.60**
PHR-Artola	4.13**	24.11**	-0.39**	-0.07	-0.82	-0.34*	-0.79	-1.84**
Ornamental rai	0.79	-63.89**	-0.34**	-0.60	-2.23**	-0.43*	0.06	-2.52**
S.E.(gi)	0.83	2.25	0.023	0.76	0.43	0.13	0.41	0.24
S.E (gi-gj)	1.26	3.40	0.035	0.11	0.65	0.20	0.63	0.36

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

Table 4 : Estimates of specific combining ability (*sca*) effects of the crosses of Indian mustard.

Cross	Days to initiation of flowering	Days of 50 per cent flowering	Days to maturity	Plant height	Length of main shoot	Number of primary branches per plant	Numberof secondary branches per plant
Divya x Kranti	0.98	1.49*	0.64	16.52**	3.84	-0.42**	0.05
Divya x Vardan	0.48	1.39*	-3.22**	7.44*	4.75*	-1.28**	-0.72**
Divya x Pusa Bahar	1.55*	2.36**	-3.02**	8.39*	9.27**	0.12	-1.22**
Divya x Zem-2	-6.44**	-7.10**	-5.02**	1.96	8.65**	0.04	-1.12**
Divya x Domo	-0.97	-1.17	-4.75**	11.45**	8.94**	0.81**	-0.48**
Divya x PHR-Artol	-7.14**	-6.27**	2.84**	11.10***	10.18**	-0.01	3.16**
Divya x Ornamental rai	-1.17*	-1.07	3.07**	-12.23**	3.94	1.20**	0.29*
Kranti x Vardan	3.78**	3.35**	1.33	26.66*	1.75	-0.14	1.24**
Kranti x Pusa Bahar	5.19**	5.32**	1.20	-7.48*	10.77**	-0.008	-0.18
Kranti x Zem-2	-0.08	0.85	-6.46**	-20.45**	4.93*	-0.52**	-0.94**
Kranti x Domo	-1.67**	-1.54*	-1.52*	-11.03**	31.28**	0.41**	-0.57**
Kranti x PHR-Artola	-1.51*	-0.97	-8.58*	-9.11**	11.43**	0.31*	1.80**
Kranthi x Ornamental rai	-4.54**	-4.77**	2.31**	-9.85**	2.65	3.63**	0.80**
Vardan x Pusa Bahar	4.69**	3.56**	2.34**	-4.92	17.89**	0.46**	0.76**
Vardan x Zem-2	-5.64**	-6.24**	-3.65**	7.70*	23.31**	2.08**	1.39**
Vardan x Domo	-4.48**	-4.64**	-3.39**	-24.97**	6.27*	1.35**	1.10**
Vardan x PHR-Artola	5.65**	5.59**	1.53*	-1.71	0.21	1.15**	1.61**
Vardan x Ornamental rai	-2.04**	-0.20	3.43**	-5.49	13.64**	0.30*	0.21
Pusa Bahar x Zem-2	1.75**	2.05**	-2.79**	19.25**	-17.69**	0.66**	2.83**
Pusa Bahar x Domo	-3.11**	-2.34**	0.80	12.04**	10.65**	1.93**	1.47**
Pusa Bahar x PHR-Artola	-6.94**	-7.44**	0.07	-5.94*	20.03**	-0.19	0.34*
Pusa Bahar x Ornamental rai	-2.64**	-1.90**	-4.35**	-11.57**	10.35**	0.75**	0.39*
Zem-2 x Domo	3.88**	2.85**	2.47**	-2.25	1.19	0.15	0.711**
Zem-2 x PHR-Artola	-0.94	0.09	-0.26	-23.26**	4.14	0.69**	0.29*
Zem-2 x Ornamental rai	5.35**	5.62**	1.97*	-23.34**	-1.16**	0.77**	0.77**
Domo x PHR-Artola	1.85**	2.69**	-8.98**	-19.45**	-28.70**	-1.97**	-2.002**
Domo x Ornamental rai	-13.17**	-14.10**	-6.75**	-18.12**	-22.34**	-1.15**	-0.26
PHR Artola x Ornamental rai	2.99**	2.46**	-1.15	-30.80**	0.02	-1.28**	-1.02**
S.E. (S_{ij})	0.54	0.60	0.67	2.82	2.13	0.12	0.14
S.E. (S_{ij}-S_{ik})	0.81	0.89	1.00	4.18	3.15	0.18	0.20
S.E. (S_{ij}-S_{kl})	0.76	0.84	0.94	6.94	2.97	0.17	0.19

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

Cross	Number of suliquae on mains hoot	Number of siliquae per plant	Length of siliqua	Number of seeds per siliqua	Seed yield per plant	1000-seed weight	Oil content	Harvest index
Divya x Kranti	-2.91	-81.46**	-0.09	0.06	-4.13**	-0.34	0.54	2.66**
Divya x Vardan	3.67	16.42*	-0.19*	1.34**	0.15	-0.32	0.38	1.38
Divya x Pusa Bahar	-6.04*	26.07**	-0.05	0.59*	2.74**	0.40	-1.74	2.89**
Divya x Zem-2	-3.72	40.68**	1.07*	2.50**	2.00**	0.59	1.09	2.47**
Divya x Domo	2.38	26.29**	0.35*	1.89**	2.23**	-0.39	-0.66	1.16
Divya x PIIR-Artola	6.61*	88 15**	-0.39*	-7.43**	1.15**	-0.49	1.31	2.43**
Divya x Ornamental rai	-2.77	29.30**	0.11	-2.83**	-2.20**	0.33	-0.08	0.16
Kranti x Vardan	-5.43*	45.25**	0.17*	0.87**	2.18**	-0.28	-0.354	2.34**
Kranti x Pusa Bahar	-2.22	52.42**	-0.96*	-0.53*	-3.55**	-0.31	-0.02	-1.84*
Kranti x Zem-2	14.62**	65.01**	0.50*	1 44**	1.44**	-0.74	1.79	-0.84
Kranti x Domo	3.33	19.85*	0.24*	0.36	2.18**	0 68	-2.31	-0.87
Kranti x PIIR-Artola	-2.96	15.68*	0.53*	-0.49*	1.76**	0 52	0.15	-0.30
Kranthi x Ornamental rai	1.64	62 85**	0.74*	0.03	5.26**	0.68	-0.32	5.51**
Vardan x Pusa Bahar	-6.23*	29.07**	-0.34*	2.47**	-3.17**	-0.48	-0 77	-1.46*
Vardan x Zem-2	17.48**	16.43*	0.27*	-0.27	1.35**	-0.24	0.84	-0.03
Vardan x Domo	4.06	51.39**	0.28*	1.10**	-1.86**	0 70	0.30	-1.92*
Vardan x PIIR-Artola	-0.56	20.79**	0.47*	1.71**	3 62**	-0.01	-0 38	1.83*
Vardan x Ornamental rai	4.17	29 25**	0.55*	0.44	-0.001	0.62	-0.29	-1.48*
Pusa Bahar x Zem-2	-20.96**	78.38**	-0.72*	-0 22	-0.27*	-0.31	0 12	-1.17
Pusa Bahar x Domo	23.34**	3.14	0.39*	-1.77*	-0.02	1.15*	0.77	-0.36
Pusa Bahar x PIIR-Artola	1.11	42.31**	0.82*	2.10**	0.13	-0.90*	-0.57	-0.75
Pusa Bahar x Ornamental rai	-0.67	2.66	0.72*	1.50**	-2.22**	-1.10*	0.66	-1.66*
Zem-2 x Domo	-0.20	21 16**	-0.61**	1.47**	0.47**	0.24	-2.52	3.27**
Zem-2 x PIIR-Artola	-1.76	36 95**	-0.44*	-0.05	-1 71**	-0.52	0 56	-1.43
Zem-2 x Ornamental rai	-9.89**	2.22	-0.34*	-0.51*	-1.08**	0 38	-1 29	-1.00
Domo x PIIR-Artola	12 68**	106.46**	0.68*	2.20**	-1.40**	-1.24**	-0.22	-1.73*
Domo x Ornamental rai	-11 31**	10.05	-0.26*	2.73**	1.60**	-0.29	1 14	1 53*
PIIR Artola x Ornamental rai	3 65	65.79**	-0 29*	-1.12**	-1.83**	-0.40	-0.50	-1.56*
S.E. (S_{ij})	2.56	6.90	0 071	0.23	0 13	0 40	1 28	0.73
S.E. (S_{ij}-S_{ik})	3.80	10.21	0.10	0 34	0.19	0 60	1 89	1.09
S.E. (S_{ij}-S_{kl})	3.58	9 63	0.10	0 32	0.18	0.56	1 78	1.03

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

Table 5: Correspondence of mean performance of best general combiner, best F_1 and the best specific cross combination in desired direction

Character	Best parent	Best general combiner	Best F_1	Best specific cross combination
Days to initiation of flowering	Divya	PIIR-Artola	Vardan x Divya	Domo x Oramental rai
Days to 50 percent flowering	Divya	PIIR-Artola	Domo x Ornamental rai	Domo x Ornamental rai
Days to maturity	Divya	PIIR-Artola	Pusa Bahar x Divya	Domo x PIIR-Artola
Plant height	Divya	Divya	Divya x Ornmental rai	Kranti x Pusa Bahar
Length of main shoot	Pusa Bahar	Kranti	Kranti x Domo	Kranti x Domo
Number of primary branches	PIIR-Artola	Vardan	Vardan x PIIR-Artola	Vardan x Zem-2
Number of secondary branches	Divya	Vardan	Divya x PIIR-Artola	Divya x PIIR-Artola
Number of siliquae on main shoot	Ornamental rai	PIIR-Artola	Pusa Bahar x Domo	Pusa Bahar x Domo
Number of siliquae per plant	Kranti	Kranti	Kranti x Zem-2	Divya x PIIR Artola
Length of siliqua	Kranti	Kranti	Kranti x Vardan	Divya x Zem-2
Number of seeds per siliqua	Kranti	Kranti	Divya x Zem-2	Domo x Oranamental rai
Seed yield per plant	Kranti	Kranti	Kranti x Vardan	Kranti x Ornmental rai
1000-seed weight	Vardan	Kranti	Divya x Pusa Bahar	Pusa Bahar x Domo
Oil content	PIIR-Artola	PIIR-Artola	Divya x PIIR Artola	Karnti x Zem-2
Harvest index	Kranti	Kranti	Kranti x Vardan	Kranti x Vardan

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HETEROSIS FOR YIELD AND ITS COMPONENTS IN INDIAN MUSTARD

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ABSTRACT

Estimates of heterosis were obtained for 15 characters in 28 hybrids of Indian Mustard (Brassica juncea). Manifestation of heterosis was of high order for length of main shoot, number of primary branches, seeds per siliqua, seed yield per plant and 1000-seed weight. The range of heterosis was quite low for days to maturity and oil content. A large number of crosses exhibited significant negative heterosis for days to maturity and plant height. For seed yield, Kranti x Vardan recorded highest standard heterosis of 27.47 per cent. In general, crosses involving at least one of the parents with high performance yielded heterotic results. However, standard heterosis exhibited by Domo x Ornamental rai and Divya x PHR - Artola indicates manifestation of high heterosis even when both the parents are low performing.

Key Words : Brassica juncea, yield, yield components.

INTRODUCTION

Mustard is predominantly a self - pollinted crop and the exploitation of hybrid vigour will depend upon the direction and magnitude of heterosis, biological feasibility, and nature of gene action involved. The magnitude of heterosis provides a basis for genetic diversity, and a guide for the choice of desirable parents for developing superior F1 hybrids to exploit hybrid vigour and/or building gene pools to be employed in breeding programmes. Study of heterosis has a direct bearing on the breeding methodology to be used for varietal improvement. Promising F1s can directly be included in evaluation trials, while others exhibiting heterosis for one or the other desirable trait may be advanced further to obtain transgressive segregants.

MATERIAL AND METHODS

The cultivars viz., Kranti, Vardan and Pusa Bahar and five experimental strains viz., Divya, Zem-2, Domo, Ornamental rai and PHR-Artola representing a wide range of diversity were selected for the study. These parents have been maintained by self-pollination for several generations and therefore, may be considered as homozygous inbred lines. A complete set of entries comprising 28 F1s and their 8 parents was grown in a randomized block design with three replications. The material was planted at a distance of 10cm within the rows in 3m long one row plots. The row-to-row spacing was 60cm. A single non-experimental row was grown all around the experimental area to neutralize border effect. Data for 15 characters were recorded on five randomly selected plants from each plot. Heterosis was calculated as percentage deviation from mean value (MP); the better parent (BP) and the check variety (CH) Kranti for each character.

RESULTS AND DISCUSSION

Highly significant differences were observed amongst entries for the characters studied. The range of heterosis was quite wide, except for oil content, indicating wide variability in the parent material (Table 1). Most of the crosses exhibited heterosis for various characters, however, mean heterosis was comparatively lower for days to maturity, number of siliquae per plant, length of siliqua, seeds per siliqua, oil content and harvest index.

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Table 1: Range of heterosis for various characters in Indian mustard

Character	*Range of heterosis (%)*		
	Mid parent	Better parent	Check
Days to initiation of flowering	-38.51- 16.97	-36.81- 41.43	-12.18 - 45.49(8)
Days to 50 per cent flowering	-36.84-16.01	-34.53 - 38.40	-8.78 - 44.81 (7)
Days to maturity	-12.68 - 2.03	-11.76 - 12.68	-10.37 - 7.18(10)
Plant height	-30.08 - 15.38	-38.51 - 13.16	-7.02 - 30.50 (2)
Length of main shoot	*-54.83 - 54.96*	*-54.83 - 59.90*	*-63.19 - 53.70 (8)*
No. of primary branches	-51.04 - 75.78	-57.31 - 47.50	-55.13 - 55.11 (12)
No. of secondary branches	-16.19 - 57.71	-18.25 - 44.36	-28.46 - 45.52 (16)
No. of siliquae on main shoot	-22.72 - 54.17	-30.72 - 38.71	-20.94 - 71.70 (18)
No. of siliquae per plant	-56.10 - 31.69	-64.15 - 28.89	-69.78 - 8.65 (nil)
Length of siliqua	-18.14 - 48.14	-26.91 - 66.41	-34.28 - 10.69 (10)
No. of seeds per siliqua	16.87 - 49.55	-18.71 - 45.57	-30.08 - 3.39 (9)
Seed yield per plant	-62.38 - 88.43	-75.46 - 50.56	-80.06 - 27.47 (3)
1000-seed weight	-60.60 - 32.14	-71.28 - 56.41	-71.98 - 35.75 (14)
Oil content	-7.69 - 3.78	-10.19 - 2.83	-8.34 - 4.19 (4)
Harvest index	-17.77 - 27.24	-23.36 - 28.11	-35.74 - 5.37 (1)

Figures in parentheses indicate the number of crosses showing significant standard heterosis (at 5% and 1% level of probability) in the desired direction.

Significant negative heterosis was recorded for days to initiation of flowering, days to 50 per cent flowering and days to maturity which is desirable for the development of early types. It was observed that crosses involving Divya as one of the parents showed earliness in flowering and maturity suggesting its use as a potential donor for development of early and extra early varieties. It was, however, observed that crosses showing negative heterosis for initiation of flowering and 50 per cent flowering *did not always exhibit* negative heterosis for dsys to maturity, revealing complex nature of the character. Twelve crosses recorded significant negative standard heterosis for plant height, the highest being 7.02 per cent (Divya x Zem-2). The cross Divya x Ornamental rai exhibited highest negative heterosis over the best parent i.e., Divya which has the lowest mean value for this character. The inclusion of these promising crosses is advocated in breeding programmes aimed at developing varieties with smaller plant height.

Significant heterosis was recorded for various yield contributing characters. The crosses showing highest heterosis with respect to each of these characters are presented in Table 2.

For seed yield, 15 crosses exhibited significant relative heterosis, 7 exhibited heterobeltiosis, while standard heterosis was exhibited only by 3 crosses viz., Kranti x Vardan, Kranti x Ornamental rai and Vardan x PHR- Artola. With regard to this character, not all the crosses showing heterosis for one or more yield components ended up with high seed yield heterosis suggesting that heterosis in the complex character is not due to manifestation of heterosis in all of its component traits. In some cases, heterosis in one component alone contributed heterosis for seed yield as in Kranti x Vardan which showed standard heterosis only for the length of siliqua. Specific combining ability was also computed for all the 28 crosses. The crosses with high *sca* for seed yield exhibited high mid parent

Table 2: Summary table showing highest heterotic cross combinations in the desired direction, with respect to each Character

	Highest heterotic cross combination		
	Mid parent (%)	Better parent (%)	Check (%)
Days to initiation of flowering	Domo x Ornamental rai (-38.51)	Domo x Ornamental rai (-36.81)	Divya x Vardan (-12.18)
Days to 50 per cent flowering	Domo x Ornamental rai (-36.84)	Domo x Ornamental rai (-34.53)	Domo x Ornamental rai (-8.78)
Days to maturity	Domo x PHR-Artola (-12.68)	Domo x PHR-Artola (-11.76)	Divya x Pusa Bahar (-10.37)
Plant height	*PHR-Artola x Ornamental rai* (-30.08)	Divya x *Ornamental rai* (-38.51)	Divya x Zem-2 (-7.02)
Length of main shoot	Domo x PHR-Artola (-54.83)	Domo x PHR-Artola (-54.83)	Domo x PHR-Artola (-63.19)
No. of primary branches	Pusa Bahar x Domo (75.78)	Pusa Bahar x Domo (47.50)	Vardan x Zem - 2 (55.11)
No. of secondary branches	Pusa Bahar x Domo (57.71)	Pusa Bahar x Zem-2 (44.36)	Divya x PHR-Artola (45.52)
No. of siliquae on main shoot	Pusa Bahar x Domo (54.17)	Domo x PHR-Artola (38.71)	Domo x PHR-Artola (45.52)
No. of siliquae per plant	Divya x PHR-Artola (31.39)	Divya x PHR-Artola (28.89)	Divya x PHR-Artola (8.65)
Length of siliqua	Vardan x Ornamental rai (48.14)	Kranti x Ornamental rai (66.41)	Kranti x Vardan (10.69)
No. of seeds per siliqua	Vardan x Pusa Bahar (49.55)	Vardan x Pusa Bahar (45.57)	Divya x Zem-2 (8.89)
Seed yield per plant	Kranti x Ornamental rai (88.43)	Domo x Ornamenta rai (50.56)	Kranti x Vardan (27.47)
1000-seed weight	Vardan x Domo (32.14)	Zem -2 x Ornmental rai (56.41)	Divya x Pusa Bahar (37.75)
Oil content	Divya x PHR-Artola (3.78)	Divya x Zem-2 (2.83)	Divya x PHR-Artola (4.19)
Harvest index	Divya x Zem-2 (27.24)	Divya x Zem -2(28.11)	Kranti x Vardan (5.37)

Table 3 : Relationship between sca and heterosis for seed yield per plant in Indian mustard

Hybrid	Heterosis			
	SCA	Mid parent	Better parent	Check
Kranti x Otrnamental rai	5.26**	88.43**	17.59**	17.59**
Vardan x PHR-Artola	3.62**	63.53**	19.19**	2.60**
Divya x Pusa Bahar	2.74**	13.42**	3.71**	-11.47**
Divya x Domo	2.23**	26.55**	-20.94**	-40.97**
Kranti x Vardan	2.18**	37.01**	48.09**	27.47**
Kranti x Domo	2.18**	54.14**	-8.57**	-8.57**
Divya x Zem-2	2.00**	38.89**	7.83**	-19.48**
Kranti x PHR-Artola	1.76**	43.13**	-0.23	-0.23
Domo x Omamental rai	1.60**	72.03**	50.56**	-62.64**
Kranti x Zem -2	1.44**	39.63**	-1.36**	-1.36**

** Significant at 1% level of probability

heterosis (Table 3).

The range of heterosis for oil content was quite low as compared to other characters even though the parents exhibited wide diversity for this character. A standard heterosis of 4.19 per cent was recorded by Divya x PHR - Artola. Standard heterosis for harest index was exhibited by Kranti x Vardan. An interesting feature of the study was the standard heterosis exhibited by Domo x Ornamental rai and Divya x PHR - Artola for days to flowering and oil content, respectively although Domo and omamental ari are late maturing, and Divya and PHR - Artola are low in oil content. These results suggest the potential of parents with low mean performance to mainfest high heterosis in suitable cross combinations. In general, crosses involving one high performing parent yielded heterotic results.

The use of crosses exhibiting high standard heterosis for yield and its component characters in breeding programmes aimed at development of high yielding varieties is advocated. The superior F_1 hybrids are expected to produce transgressive segregants if additive genetic systems of the superior parent and complementary epistatic effects of the F_1 act in the same direction to maximize intensity of the desirabale yield attribute.

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INHERITANCE OF NARROW LEAF SHAPE IN GROUNDNUT (*Arachis hypogaea* L.)

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ABSTRACT

Inheritance pattern of narrow leaf shape was studied in the crosses involving two narrow leaf mutants TMV2NLM and GNLM as male parents and other normal leaf genotypes as female parents. In the F_2 generation, the crosses involving TMV2NLM exhibited a segregation pattern of 1:2:1, while the crosses with GNLM showed a ratio of 3:1. The F_2 of the cross between the two narrow leaf mutants segregated in the ratio of 1:60:3, suggesting a trigenic model involving a recessive sterile due to complementary gene action. The results brought out that the two narrow leaf mutants were genetically different.

Key words : Arachis hypogaea L., Narrow Leaf Mutant.

INTRODUCTION

Leaf shape and leaf orientation are considered to be important attributes of canopy development which has a bearing on photosynthesis as well as transpiration rate of groundnut plant (Mahapatra, 1966 and Mc Cloud *et al.*, 1980). Gopani and Vaishnani (1970) reported a Virginia type Gujarat Narrow Leaf Mutant (GNLM) which was found to be tolerant to drought. Prasad *et al.*, (1984) also recovered a narrow leaf *Virginia* mutant from ethyl methane sulfonate treated *Spanish* bunch variety TMV 2. The earlier investigations of inheritance of narrow leaf shape by Matlock *et al.*, (1970) indicated a partial dominance of narrow leaf shape over normal leaf. Balaiah *et al.*, (1977) reported dominant nature of narrow leaf over normal leaf with monogenic inheritance pattern. The present investigation was undertaken to study the inheritance of narrow leaf shape and allelic relationship between these two narrow leaf mutants (GNLM and TMV2NLM).

MATERIALS AND METHODS

Crosses were made using two narrow leaf mutants viz., TMV 2 Narrow leaf Mutant and Gujarat Narrow Leaf Mutant as pollen parent with other normal leaf groundnut genotypes as ovule parents in *rabi* 1990-91. TMV2NLM was crossed with genotypes such as M 13, MK 374, Kadiri-3, 32-2-5 and G 201 belonging to the *Virginia*. TMV2, PGN 1, JL 24 and J 11 belonging to the *Spanish* and MH 2 and TAP 5 belonging to the *Valencia* group. Gujarat Narrow leaf Mutant was crossed only with MH 2, 32-2-5 and TAP 5 due to limited quantity of seed. The cross between TMV2NLM and GNLM was also made by using latter as pollen parent.

In the F_1 generation, leaf shape was carefully observed and seeds harvested separately from each F_1 plant. In F_2 generation, single plant progenies of each cross were grown in a Randomized Block Design with two replications by adopting inter and intra - row spacings of 60 cmx 20 cm, respectively. Each plant was observed for its leaf shape. Chi-square for goodness of fit was calculated to test the probability of the genetic ratios (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Results of the F_1 generation confirmed the earlier observations (Balaiah *et al.*, 1977) of the dominant

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Table 1 : Inheritance of narrow leaf shape in groundnut.

Crosses	Phenotype of the F_1	Phenotypic classes in the F_2	Observed frequency in the F_2	Total population in the F_2	Chi-square value	Probability level
M13 X TMV2NLM (Normal x Narrow)	Narrow	Narrow Intermediate Normal	56 121 53	230	0.7043[a]	0.50
MK374 X TMV2NLM (Normal x Narrow)	Narrow	Narrow Intermediate Normal	102 200 91	393	0.7404[a]	0.50
Kadiri-3 X TMV2NLM (Normal x Narrow)	Narrow	Narrow Intermediate Normal	68 156 70	294	1.1293[a]	050
G201 X TMV2NLM (Normal x Narrow)	Narrow	narrow Intermeidate Normal	92 196 100	388	0.3711[a]	0.75
TMV2 X TMV2NLM (Normal x Narrow)	Narrow	Narrow Intermediate Normal	81 162 72	315	0.7715[a]	0.50
PGN1 X TMV2NLM (Normal x Narrow)	Narrow	Narrow Intermediate Normal	60 119 51	230	0.9825[a]	0.50
JL24 X TMV2NLM (Normal x Narrow)	Narrow	Narrow Intermediate Normal	58 117 47	222	1.7387[a]	0.25
J11 X TMV2NLM (Narrow x Normal)	Narrow	Narrow Intermediate Normal	60 103 49	212	1.3113[a]	0.50
TMV2NLM X MH2 (Narrow x Normal)	Narrow	Narrow Intermediate Normal	60 123 71	254	1.2047[a]	0.50
TMV2NLM X 32-2-5 (Narrow x Normal)	Narrow	Narrow Intermediate Normal	56 110 51	217	0.2719[a]	0.75
TMV2NLM X TAP5 (Narrow x Normal)	Narrow	Narrow Intermediate Normal	61 108 58	227	0.6123[a]	0.50
GNLM X MH2 (Narrow x Normal)	Narrow	Narrow Normal	273 101	374	0.8021[b]	0.25
GNLM X 32-2-5 (Narrow x Normal)	Narrow	Narrow Normal	187 58	245	0.2299[b]	0.50
GNLM X TAP5 (Narrow x Normal)	Narrow	Narrow Normal	224 70	294	0.2223[b]	0.50
TMV2NLM X GNLM (Narrow x Narrow)	Narrow	Needle shape Narrow Normal	4 487 25	516	2.0940[b]	0.25

a = x^2 values for an expected ratio of 1 Narrow : 2 Intermediate : 1 Normal leaf types
b = x^2 values for an expected ratio of 3 Narrow : 1 Normal leaf types
c = x^2 values for an expected ratio of 1 Needle shape : 60 Narrow : 1 Normal leaf types.

nature of the narrow leaf character. The F_2 data (Table1) also indicated a typical monogenic inheritance based on two alleles as reported by earlier workers. However, the segregation pattern of F_2 crosses between TMV2NLM (induced narrow leaf mutant of TMV2) and normal leaf parents indicated a segregation pattern of 1 narrow : 2intermediate : 1 normal leaf shape. The crosses involving GNLM on the other hand exhibited a segregation pattern of 3 narrow : 1 normal. This indicated that TMV2NLM and GNLM could be genetically different, as reported by Prasad etal., (1984).

The cross involving TMV2NLM and GNLM, both narrow leaf types,showed a very interesting trend. While the F_1 of this cross was absolutely narrow leaf type, the F_2 segregated for 1 needle shaped narrow leaf type (Sterile) : 60 narrow leaf types : 3 normal leaf types, suggesting a trigenic model involving recessive sterile due to complementary gene action (Table 1).Such type of results were also obtained for chlorophyll deficient mutants by Coffelt and Hammons(1971) and Tai *et al.* (1977).

These results amply bring out that the TMV2NLM (TMV2 Narrow Leaf Mutant) reported by Prasad et al (1984) is genetically different from GNLM (Gujarat Narrow Leaf Mutant) of Gopani and Vaishnani(1970). It was also observed that in the case of TMV2NLM ,the narrowness of leaflet starts manifesting after the first4 to5 normal leaves; while in the case of GNLM, the narrow leaflet starts from 3rd leaf onwards (Prasad et al., 1984). Such genetically different genotypes for the same phenotypic attribute could be of immense use in overcoming the genetic vulnerability (Hammons, 1976) of groundnut plant.

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COMBINING ABILITY FOR VIGOUR CHARACTERS UNDER NORMAL AND SALINE ENVIRONMENTS IN INDIAN MUSTARD (*Brassica juncea* (L) CZERN & COSS.)

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ABSTRACT

Combining ability analysis of 6x6 diallel of Indian mustard for per cent germination, speed of germination and seedling vigour under normal (0 meq/l) and two saline environments (125 and 175 meq/l) which corresponds to 0 dsm^{-1}, 10 dsm^{-1} and 15 dsm^{-1} revealed that both additive and non-additive gene effects were involved in the inheritance of these characters. The predictability ratio indicated greater importance of non-additive action. RH 7859 for speed of germination and seedling vigour and RH 7846 for seedling vigour were the best general combiners. The crosses RH 781 x RHW 1 for per cent germination and speed of germination, RH 7859 x RH 781 and RH 7859 x RH 8113 for seedling vigour were the best cross combinations in all the three environments.

Key words ; Combining ability, Vigour characters, salinity, mustard.

INTRODUCTION

Soils of semi-arid and arid regions where Indian mustard is largely grown show alkalinity-salinity problems. No reports on the genetic information of seedling parameters, which are important for salt tolerance at initial stage, are available. The present investigation was, therefore, undertaken to generate information on combining ability in Indian mustard under normal and saline environments.

MATERIALS AND METHODS

A half diallel set (excluding reciprocals) was developed by crossing six parents, selected on the basis of early seedling vigour and salinity tolerance, three tolerant (RH 7859, RH 7846 and RH 781) and three susceptible for salinity (RH 8315, RHW 1 and RH 8113). The reduction in vigour in the salt tolerant parents over normal environments was less than 20%, where as it was more than 70% in the susceptible parents. The F_1s and parents were grown during 90-91 in randomized block design with three replications in petriplates of 9" diameter having salt solutions of O meq/1 (E_1) 125 meq/1 (E_2) and 175 meq/1(E_3) chloride dominated salts. The data on per cent germination was recorded by counting the normal seedlings as per procedure for testing seeds (ISTA, 1985). The normal seedlings were counted daily and speed of germination was calculated by the method described by Maguire (1962). Root and shoot length (cm) of five randomly selected seedlings were measured after eight days of sowing and the same were dried at 80°C for 24 hours and weighed in milligrams. The seedling vigour was calculated as follows :

Seedling vigour = (Root length + Shoot length) x Seedling dry weight

The combining ability analysis was carried out by Griffing's (1956) Method 2, Model 1.

RESULTS AND DISCUSSION

The mean squares associated with the general combining ability analysis (*gca*) were significant

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Table 1. General and specific combining ability analysis for seedling vigour characters in Indian Mustard.

Source of variation	d.f.	Germination per cent			Speed of germination			Seedling vigour		
		E_1	E_2	E_3	E_1	E_2	E_3	E_1	E_2	E_3
General Combining ability	5	28.944	25.439	30.721	0.063*	0.110*	0.017*	676.441*	1337.397*	854.350*
Specific combining ability	15	117.037*	115.683*	117.391*	0.096*	0.055*	0.020*	19893.780*	1590.700*	469.687*
Error	40	17.690	15.405	0.020	0.001	0.006	0.0004	6.700	4.604	5.224
Predictability ratio		0.028	0.024	0.017	0.141	0.799	0.172	0.078	0.171	0.314

(Mean squares)

*Significant at $P = 0.05$; E_1, E_2 and E_3 = 0 meq/l, 125 meq/l and 175 meq/l salinity levels, respectively

Table 2. Estimates of general combining ability effects for germination per cent and vigour charactes under three environments in Indian Mustard

Parents	Germination per cent			Speed of germination			Seedling vigour		
	E_1	E_2	E_3	E_1	E_2	E_3	E_1	E_2	E_3
RH 7859	1.937	0.615	1.336	0.074*	0.090*	0.039*	12.919*	17.722*	12.890*
RH 7846	0.492	1.783	-1.467	-0.062*	0.102*	-0.018*	0.268*	14.005*	9.980*
RH 781	-0.739	1.259	-1.083	0.005	-0.011	0.029	-9.253*	-14.414*	11.613*
RH 8315	-1.475	-1.782	-0.358	-0.133*	-0.207*	-0.031*	-2.292*	-3.298*	1.668*
RWH 1	-2.490	-2.644	-2.449	0.004	0.072*	-0.069*	-11.644*	-8.633*	-11.287*
RH 8113	2.275	0.770	3.023	0.122*	-0.045*	0.049*	5.419*	-5.473*	1.678*
S.E. (gi)	1.358	1.267	1.580	0.009	0.008	0.006	0.836	0.693	0.738
S.D. (gi-gj)	2.103	1.962	2.449	0.014	0.012	0.010	1.295	1.073	1.143

*Significant at $P = 0.05$; E_1, E_2 and E_3 = 0 meq/l, 125 meq/l and 175 meq/l salinity levels, respectively for speed of germination and seedling vigour and non-significant for per cent germination in all the three environments. Mean squares due to specific combining ability (*sca*) were significant for all the characters over all the environments (Table 1). This showed that both additive (except for germination per cent) and non-additive gene effects were responsible for these characters. Similar results were obtained by Moeljopawiro and Ikehasi (1981) in rice in normal and saline environments.

The estimates of predictability ratio in this study were far from unity in all the environments except for speed of germination in E_2, indicating the preponderance of non-additive genetic components controlling these traits.

None of the parents was a good general combiner for per cent germination as *gca* effects were non-significant. The parent RH 7859 was consistently good general combiner for speed of germination and seedling vigour. RH 7846 was also a good general combiner for seedling vigour in all the environments. The parallel trend between *per se* performance and *gca* effects was also shown by these parents for speed of germination and seedling vigour. Other good general combiners for speed of germination and seedling vigour were RH 8113 in E_1 and E_3 and RH 781 in E_3 (Table 2).

A critical examination of *sca* effects (Table 3) revealed that cross combination RH 7846 x RH 8315 was the best for per cent germination in all these three environments. Three crosses viz., RH 7859 x RH 8315, RH 7859 x RHW 1 and RH 781 x RWH 1 had positive *sca* effects consistently over the environments for speed of germination. RH 781 x RWH 1 in E_1 and E_3 and RH 7859 x RWH 1 in E_1 and E_2 had high *per se* performance. Likewise, for seedling vigour, five crosses namely; RH 7859 x RH 781, RH7859 x RH 8113, RH 7846 x RH 781, RH 8315 x RWH 1 and RH 8315 x RH 8113 were potential crosses in all the environments. The cross RH 7859 x RH 8113 also had high *per se* performance.

Considering the above results, parents RH 7859 and RH 7846, hybrids RH 781 x RWH1, RH 7859 x RH 8113 can be utilized for improvement of seedling vigour. These crosses are expected to give more number of desirable recombinants in the segregating generations.

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Table 3. Estimates of specific combining ability effects, Griffing (1956) method, model 1

Crosses	Germination per cent			Speed of germination			Seedling vigour		
	E_1	E_2	E_3	E_1	E_2	E_3	E_1	E_2	E_3
RH 7859 x RH 7846	7.582	4.629	4.855	0.077*	-0.167*	-0.032	2.371	-11.277*	-0.311
RH 7859 x RH 781	2.667	-0.994	3.471	0.038*	-0.301*	-0.005	34.412*	40.703*	15.034*
RH 7859 x RH 8315	9.650*	-0.660	1.040	0.366*	0.318*	0.058*	19.075*	1.910	0.926
RH 7859 x RWH 1	4.418	9.056*	-3.106	0.399*	0.339*	0.103*	11.869*	16.441*	-0.872
RH 7859 x RH 8113	5.800	11.789*	12.659*	0.031	0.202*	0.039*	68.687*	36.649*	20.602*
RH 7846 x RH 781	10.259*	10.131*	-10.212*	0.317*	0.257*	-0.182*	59.543*	77.813*	17.265*
RH 7846 x RH 8315	10.995*	13.172*	18.840*	0.098*	-0.084*	0.258*	20.018*	-3.000*	6.438*
RH 7846 x RWH 1	-14.550*	-14.550*	-10.062*	-0.032	0.211*	-0.181*	-0.366	18.511*	4.579*
RH 7846 x RH 8113	7.755	-7.819	-13.318*	-0.373*	-0.213*	-0.081*	-2.316	11.126*	11.921*
RH 781 x RH 8315	-0.068	1.403	2.456	-0.158*	0.049*	0.068*	19.601*	-25.574*	-5.421*
RH 781 x RWH 1	-13.240*	14.558*	19.547*	0.422*	0.280*	0.219*	38.034*	0.217	11.244*
RH 781 x RH 8113	8.475*	11.144*	7.928	0.060	-0.073*	0.118*	9.525*	-14.169*	10.712*
RH 8315 x RWH 1	-1.024	-0.841	-4.031	-0.527*	-0.221*	-0.114*	36.309*	39.985*	35.037*
RH 8315 x RH 8113	-3.082	-4.255	-0.649	0.102*	-0.021	-0.001	18.254*	31.172*	20.015*
RWH 1 x RH 8113	10.226*	2.754	1.441	0.268*	0.030	0.086*	11.449*	20.280	3.963
S.E (Sij)	3.729	3.479	4.342	0.025	0.021	0.018	2.295	1.073	2.026
S.E (Sij-Sik)	5.564	5.192	6.480	0.037	0.031	0.026	3.425	2.839	3.024

*Significant at P = 0.05; E_1, E_2 and E_3 = 0 meq/l, 125 meq/l and 175 meq/l salinity levels, respectively

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STABILITY FOR YIELD AND ITS COMPONENTS IN GROUNDNUT (*Arachis hypogaea* L.)

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ABSTRACT

Twenty one genotypes of groundnut were evaluated during *Kharif*, 1995, summer 1996 and *Kharif* 1996. The analysis of variance indicated significant differences among environments for all the characters. Genotype x Environment interaction was significant for all the characters except number of branches per plant. The effect due to environment (linear) was significant for all the characters. The variance due to genotype x environment (linear) was significant for number of branches per plant and number of mature pods per plant. Non linear component was significant for all the characters except number of mature pods per plant. The genotypes JSSP-6, JL-24and DH-47 were the most stable which showed higher pod yield and oil yield per plant. On the basis of environmental indices, environment II (summer 1996) was the most favourable for the expression of most of the characters.

Key words : Stability, genotype x environment interaction, environmental indices, groundnut.

INTRODUCTION

Groundnut is one of the important oilseed crops of India. Though several improved varieties of the crop have been developed, most of them showed inconsistent performance under varied environmental condition due to genotype x environment interaction. The stable performance of varieties under different environments with regard to pod yield has gained considerable significance in any varietal improvement programme. The present investigation was planned to generate information on these lines for identifying high yielding and stable genotypes for cultivation under varied environments and also for future breeding programme.

MATERIALS AND METHODS

The experimental material comprised 21 promising genotypes of groundnut sown in a Randomized Complete Block Design (Sundararaj *et al.*, 1972) with three replications at Agricultural Research Station, GKVK, University of Agricultural Sciences, Bangalore during *Kharif* 1995 (E_1), summer 1996 (E_2), and *Kharif* 1996 (E_3) with a spacing of 30 cm between rows and 15 cm between plants. The fertilizers were applied at the rate of 25:50:25 kg N, P_2O_5 and K_2O per hectare. In the summer season, the crop was irrigated through out the period of crop growth. Observations were recorded on 8 quantitative characters viz., days to 50 per cent flowering, plant height (cm), number of branches per plant, number of mature pods per plant, pod yield per plant (g), 100 Kernel weight, shelling per cent and oil yield per plant (g). Stability analysis was carried out following Eberhart and Russell (1966) model.

RESULTS AND DISCUSSION

The mean square due to genotypes (Table 2) were significant for plant height, number of branches per plant, number of mature pods per plant and shelling percentage when tested against pooled error indicating that genotypes were distinct in these attributes. The mean squares due to genotype x environment (G x E) interactions were significant for all the characters except number of branches per plant implying differential behavior of genotypes under three different environments. Similar results were reported by Wynne and Coffelt

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(1980), Kumar *et al.*, (1984), Sarkar *et al.*, (1988), Bansal *et al.*, (1992) and Reddy and Gupta (1994). Significant variation due to environment (linear) for all characters was observed revealing considerable differences among environments and its predominant effect on all characters. The linear component of G x E interaction was significant for number of branches per plant and number of mature pods per plant, suggesting that the genotypes differed for their linear response to environments. The mean squares for pooled deviation were significant for all the traits except number of mature pods per plant. Thus, the performance of genotypes with respect to characters which showed significance for pooled deviation was entirely unpredictable in nature.

According to Eberhart and Russell (1966) a stable genotype is one which shows (i) a high mean, (ii) a regression coefficient equal to unity (b_i=1) and (iii) a mean square deviation from regression (S^2d_i) was considered as the measure of stability (Breese, 1969). Then, the type of stability (measure of response of sensitivity to environmental changes) was decided on regression coefficient (b_i) and mean values (Finlay and Wilkinson, 1963). If b_i was equal to unity, a genotype was considered to have average stability (same performance in all the environments). If b_i was more than unity, it was suggested to have less than average stability (good performance in favourable environments) and if b_i was less than unity, it was reported to have more than average stability, (good performance in poor environments).

The estimates of stability parameters in respect of seven characters that have direct influence on varietal performance are presented in (Table 3). It was found that summer 1996 (E_2) was most favourable for all the characters except 100 Kernel Weight, shelling percentage and oil yield per plant (Table 1). Maximum number of genotypes (20 out of 21) showed stability for pod yield per plant and oil yield per plant, followed by 19 for number of mature pods per plant. Thus, these three characters appeared to be relatively more stable than other characters.. In case of days to 50 per cent flowering, the genotypes K-134, DH-47, TAG-24 and TNAU-97 possessed average stability and are desirable as they flowered early. The genotypes R-9251, VG-8919 and ICGS-76 were found stable for plant height with lower mean values. The genotype TAG-26 with desirable mean value for plant height exhibited less than average stability. For number of branches per plant, only three genotypes JL-24, DH-47 and TAG-26 showed

Table 1 : Performance of groundnut genotypes in three environments

Character	Mean			Range			Environmental Index		
	E1	E2	E3	E1	E2	E3	E1	E2	E3
X1	35.57	41.56	35.49	27.00-44.67	37.33-48.67	32.17-39.67	-2.30	3.69	-1.38
X2	24.25	45.99	31.57	13.07-31.50	35.73-59.04	19.33-37.69	-9.69	12.05	-2.37
X3	6.40	7.58	7.71	3.80-9.77	4.73-11.13	5.46-9,51	-0.83	0.35	0.48
X4	15.39	40.32	16.46	10.60-18.87	26.88-59.52	12.47-20.20	-8.67	16.26	-7.60
X5	14.50	31.30	21.76	10.29-20.59	21.80-39.00	15.07-32.80	-8.02	8.78	-0.76
X6	37.79	32.16	44.12	31.20-49.67	26.73-39.40	35.33-59.33	-0.24	-5.87	6.09
X7	6.92	59.03	62.53	53.67-79.00	54.38-68.50	52.94-68.91	4.09	-3.80	-0.30
X8	6.46	9.43	14.47	4.43-8.65	6.33-14.28	10.38-18.94	-3.66	-0.69	4.35

E1 = Kharif 1995
E2 = Summer 1996
E3 = Kharif 1996

X1 = Days to 50% flowering
X2 = Plant height at maturity
X3 = Number of branches per plant
X4 = Number of mature pods per plant

X5 = Pod Yield per plant
X6 = 100 Kernel Weight
X7 = Shelling percentage
X8 = Oil yield per plant

Table 2 : Analysis of variance for stability of seven characters in groundnut over three environments

Source of variance	df	X1	X2	X3	X4	X5	X6	X7
Total	62	14.468	2.382	112.651	163.571	65.444	201.006	15.34
Varieties	20	15.847	4.616**	64.451**	39.860**	21.959	83.756**	5.054
Variety x Env.	40	29.528**	41.766**	2.502	74.935**	47.885**	77.354**	12.196**
Env.+Var.xEnv.	42	19.716**	1.319**	135.604**	222.480**	86.151**	256.839**	20.238**
Env. (linear)	1	436.072**	22.015**	5138.834**	8345.037**	2979.627**	9079.874**	637.404**
Var. x Env. (linear)	20	7.271	0.899	18.590**	46.247**	13.665	51.736	4.185
Pooled deviation	21	11.742**	0.732**	8.796**	3.533	17402*	32.032**	3.758*
Pooled Error	126	0.905	0.315	4.439	11.534	10.222	12.875	2.090

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

E1 = Kharif 1995
E2 = Summer 1996
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X1 = Days to 50% flowering
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X4 = Number of mature pods per plant
X5 = Pod Yield per plant
X6 = Shelling percentage
X7 = Oil yield per plant

average stability with high mean values and the genotype ICGV-86325 was found to perform well only under favourable environments with less than average stability. The genotypes DH-39 and R-9251 were the only two stable genotypes for number of mature pods per plant. Average stability with high mean value was exhibited by the genotypes DH-45, DRG-4, TNAU-97, DH-39, DH-47, R-9251 and TMGG-28-38 for shelling per cent. For pod and oil yield per plant, the genotypes JSSP-6, R-8806, JL-24and DH-47 were found to be stable with high mean values.

The genotypes JSSP-6, JL-24 and DH-47 showed stability for pod yield per plant, oil yield per plant and plant height. In addition JL-24 and DH-47 exhibited stability for number of branches per plant. Accordingly, on the basis of the above results these three genotypes may be advocated for all the environments specified in the present investigation. Further they are to be used as parents in the breeding programme to evolve better varieties.

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Table 3 : Estimates of stability parameters of genotypes of different characters in groundnut

Genotypes	Days to 50% flowering			Plant Height			Number of branches per plant			Number of mature pods per plant			Pod yield per plant			Shelling per cent			Oil Yield per plant		
	Mean	b_i	s^2d_i	Mean	b_i	s^2d_i	Mean	b_i	s^2d_i	Mean	b_i	s^2d_i	Mean	b_i	s^2d_i	Mean	b_i	s^2d_i	Mean	b_i	s^2d_i
K-134	34.56	1.15	0.08	35.03	0.99	9.90	5.96	1.57	1.30	24.33	1.40	-10.77	22.28	1.10	13.53	60.24	2.54**	-8.54	10.50	1.12	2.79
JSSP-6	43.56	1.52	6.19**	36.35	0.60	-3.20	9.48	-0.46	1.20*	20.69	0.53**	-11.53	30.75	1.23	15.21	57.07	0.73	-5.59	13.48	1.37	1.09
TAG-24	35.22	1.49	3.58	29.22	1.16	43.97**	6.93	1.41	0.35*	17.82	0.73	-9.21	16.07	0.64	28.81	62.72	1.17**	-16.27	8.27	0.67	5.36
TAG-26	36.00	1.57	13.02**	22.06	1.06**	-4.44	7.59	1.47	-0.27	24.67	1.08	-11.47	18.72	0.99	0.54	65.82	3.11**	-15.08	8.07	0.92	0.95
R-9251	37.67	0.68	-0.65	24.11	1.05	-2.76	7.41	0.50**	-0.31	27.51	1.47	-9.73	20.66	1.54	19.50	66.50	2.44	-0.15	9.17	1.53	2.76
R-8806	37.78	0.82	12.31**	35.56	0.89	-2.25	6.91	1.63	-0.26	27.52	1.43**	-11.50	30.13	1.48	-9.80	60.34	-0.19	36.00	11.66	1.57	-1.80
VRI-2	35.00	1.82	34.48**	33.57	1.06	-3.70	6.80	0.81	-0.10	19.47	0.92	-8.04	21.72	1.13	20.90	66.90	1.64**	-16.30	10.62	1.26	4.42
DH-39	35.44	1.27	14.52**	36.57	1.15	-2.33	5.83	1.90	1.80*	32.20	1.69	-9.91	23.42	1.30	-5.47	67.26	1.00	-16.23	10.20	1.21	-1.35
DH-45	35.11	1.28	9.93**	34.13	0.80	-4.34	7.25	1.38	0.08	22.53	1.24	-8.95	19.34	0.92	2.09	70.40	0.80	-4.29	10.35	0.91	-0.52
DH-47	34.98	0.69	1.96	40.73	1.38	12.77	7.60	2.43	-0.03	23.71	1.32	-9.65	24.34	1.46	11.36	67.17	0.31	-4.41	11.14	1.61	5.00
DRG-4	37.11	0.55**	-0.89	34.90-	0.93	-3.23	7.82	-0.03	1.99*	24.60	1.00	-10.97	22.08	0.68	-10.06	69.14	-0.22	-12.60	9.13	0.70	-2.08
TGG-28-38	38.00	0.45	2.95	36.47	1.19	6.41	7.47	0.66	-0.01	23.89	0.86	-8.84	23.68	0.78	-4.89	66.04	1.80	-12.91	9.33	0.80	-1.48
R-8892	38.11	0.34	5.88**	35.84	1.48	1.11	6.93	1.93**	-0.32	22.39	1.25	-9.66	19.69	1.05	-3.92	58.99	0.29**	-16.27	9.31	1.03	0.67
VG-8919	40.78	0.78	0.60	29.82	0.48	-4.08	8.49	-0.74	1.37*	18.81	0.44	-6.18	23.49	0.33	-8.08	57.75	-0.57	31.81	10.51	0.37	-1.14
TNAU-97	36.22	0.94	-0.90	42.28	1.46**	-4.37	6.60	1.45	-0.23	21.49	1.02	-7.73	21.15	1.20	15.40	68.00	1.17	-11.03	10.55	0.38	3.52
ICGS-30	38.89	1.04	-0.71	37.65	1.14	-3.38	4.67	1.42	0.51	16.89	0.72	-4.67	19.60	1.03	-2.58	58.54	-0.71	-11.03	10.00	1.05	-0.97
ICGV-86325	38.45	0.66	46.19**	30.74	0.69	60.97**	7.80	-1.25*	-0.07	20.38	0.74	15.26	16.81	0.85	2.48	62.89	0.56	-14.60	8.99	0.66	4.53
FDRS-10	38.45	-0.45	56.28**	33.04	1.02	-1.76	4.85	1.29	-0.29	23.67	0.76	-9.08	20.18	0.56	-8.56	64.04	0.18	39.03	9.35	0.48	-2.09
JL-24	38.56	1.97	23.10**	36.12	1.13**	-4.33	8.95	1.36	0.12	22.02	0.78	-7.89	26.85	1.02	23.28	61.95	2.45	9.54	11.28	0.79	7.65
ICGS-76	40-89	1.88	1.00	32.57	0.67	4.35	9.76	0.85	1.40*	19.16	0.62	-6.59	22.95	0.84	60.03*	64.95	0.50	8.56	11.72	0.75	12.53**
TMV-2	38.11	0.58	-0.80	37.57	0.68**	-4.42	6.51	0.71	-0.30	23.25	1.03	-10.93	19.46	0.88	-2.50	63.29	2.01	-8.67	8.83	0.83	-1.56
Over all Mean	37.88			34.02			7.23			22.75			22.16			63.81			10.12		

* Significant at P = 0.05, ** Significant at P = 0.01, b was tested against 1

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LINE X TESTER ANALYSIS OF SEED YIELD AND ITS COMPONENTS IN LINSEED (*Linum usitatissimum* L.)*

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ABSTRACT

A line x tester set was obtained by crossing 15 lines with 2 testers in linseed. The resultant 30 derived F_1's were evaluated alongwith 17 parents to estimate general and specific combining ability variances and effects for 11 quantitative characters. The results showed importance of both additive and non-additive gene effects. Additive gene effect predominantly governed the expression of plant height and 1000-seed weight, while non-additive gene effect was predominant in primary branches, secondary branches, capsules per plant, seeds per capsule, seed yield per plant, harvest index and oil content. Days to 50% flowering and days to maturity were under the control of both additive and non-additive gene action. The parents, Sweta and Chambal were the best combiners for seed yield. Three crosses viz. Pusa-3 x T -397, ACC-841 x Subhra and Jeevan x T-397 were most significant specific combiners for seed yield.

Key words : Line x tester, Combining ability, gene action, linseed.

INTRODUCTION

In the last few decades, exploitation of hybrid vigour and selection of parents on the basis of combining ability has been used as an important breeding approach in crop improvement programme. Linseed (*Linum usitatissimum* L.) is an important oilseed crop grown primarily for its quick drying oil widely used in paint and varnish industries. For proper understanding of inheritance of various quantitative characters as well as selection of suitable parents for hybridization, combining ability studies can be very useful for crop improvement. Combining ability analysis helps plant breeders in identifying potential parents either to be used for heterosis breeding or to hybridization to evolve desirable pure line varieties through pedigree, bulk or back cross method. In the present study an attempt has been made to estimate the magnitude and effect of general and specific combining ability for seed yield and its component characters in linseed using line x tester mating design. Line x tester analysis is a very good technique for evaluation of large number of germplasm lines at a time in terms of combining ability variances and effects (Singh *et al.*, 1978). This study will also help in formulating breeding strategy for further improvement in this crop.

MATERIALS AND METHODS

Fifteen diverse germplasm lines of different origin were crossed with two well adapted males (Subhra and T-397) as testers to produce 30 F_1's in line x tester mating design. All the 30 hybrids along with 17 parents were raised in a randomized complete block design with three replications. Each plot consisted of single row of 2m length. The spacing between rows was kept at 30 cm and plant to plant maintained at 15 cm. All recommended cultural practices were followed. Observations were recorded on 5 randomly selected plants in each row in every replication for 11 quantitative characters. Combining ability analysis was done according to Kempthorne (1957) and Arunachalam (1974). The oil content was estimated by nuclear magnetic resonance spectrometer on dry seed basis.

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RESULTS AND DISCUSSION

The ANOVA for line x tester analysis have been presented in Table 1. Significant differences for all the characters both among parents as well as crosses were found. The differences among crosses due to lines were significant for the characters -days to maturity, plant height, seeds per capsule and 1000 seed-weight. The differences due to testers were significant for days to 50% flowering, plant height and 1000-seed weight, while differences due to line x tester interaction were significant for all the characters except number of secondary branches per plant.

The estimates of *gca* and *sca* variances revealed greater importance of the latter for most of the characters, indicating predominance of non additive gene action in inheritance of these traits. The ratio of *gca* to *sca* was greater than one for plant height and 1000-seed weight, indicating more *gca* variance than *sca*. This indicated predominance of additive type of gene action in the expression of these characters. Similar findings have been reported by Sharma (1986), Thakur *et al.*, (1987) and Thakur *et al.*, (1991). On the basis of the magnitudes of variances the two characters - days to 50% flowering and days to maturity were considered to be controlled by both additive and non-additive gene actions. Badwal and Gupta (1970) and Thakur *et al.*, (1987) also found both types of gene action to be important for these characters.

The estimates of *gca* effect of the parents (Table - 1) revealed that no single parent was a good combiner for all the characters taken together. However, the parent Chambal was found as best combiner for days to 50% flowering and seed yield per plant and second best for 1000-seed weight and oil content. Patel *et al* (1997) also identified Chambal as a good general combiner for seed yield, test weight and oil content. Next to Chambal, Sweta performed well for seed yield per plant and was among the three best general combiners for number of primary branches per plant, number of seeds per capsule, harvest index and oil content. Himalini was highly significant *gca* performer for the characters days to maturity, days to 50% flowering and plant height. Thakur *et al.*, (1987) and Singh (1990) also found Himalini as good general combiner for most of the characters including seed yield. Therefore, these parents would be useful for crossing programme.

On the basis of *sca* effect, the cross Pusa-3 x T-397 showed consistently significant performance for number of secondary branches, capsules per plant, seed yield per plant, harvest index and oil content. BAU-352 x Subhra was good specific combiner for days to 50% flowering, days to maturity and harvest index. Among other crosses Acc-841 x Subhra and Jeevan x T-397 had significant *sca* effect for seed yield. These crosses also showed close correspondence with the heterotic expression. Such crosses can be exploited either by developing hybrids or by fixing desirable genes by intermating promising cross combination and selecting desirable types. Availability of CMS system in linseed (Dubey *et al.*, 1966) indicates a definite possibility of developing hybrids for commercial cultivation. However, suitable restorer and maintainer lines must be isolated for effective exploitation of heterosis before going in for heterosis breeding.

A comparison among three best performers in terms of *per se* performance, *gca* effect, hybrid performance and *sca* effect have been given in Table 2. On considering the *per se* performance and *gca* effects of different genotypes, it was found that Himalini showed consistent mean performance for most of the characters and also ranked high in terms of *gca* effect for the characters days to maturity and plant height. Chambal was among the top three performing genotypes in terms of *per se* performance and *gca* effect for the characters 1000-seed weight, seed yield per plant and harvest index.

Ayogi and Neelum showed the best mean performance as well as *gca* effect for the characters

Table 1 : Line x Tester analysis of variance for eleven quantitative characters in linseed.

Source	d.f	Days to 50% flowering	Days to Maturity	Plant height (cm)	Primary branches/ plant	Secondary branches/ plant	Capsules/ plant	Seeds/ capsule	1000-seed weigtht (g)	Seed yield/ plant (g)	Harvest index (%)	Oil content (%)
Replications	2	2.48	15.28**	8.75	1.43*	39.427**	281.27**	0.03	0.12	3.03*	23.02	2.95
Genotypes	46	187.17**	37.42**	149.49**	0.08**	20.00**	1447.32**	0.88**	3.95**	2.52**	73.43**	17.69**
Parents	16	432.00**	40.17**	308.76**	0.86**	21.26**	598.01**	0.48**	4.98**	1.65**	93.33**	7.96**
Parents vs Crosses	1	465.71**	2.79	72.83**	3.96**	221.91**	21961.5**	3.56**	33.57**	30.18**	625.03**	17.97**
Crosses	29	42.49**	37.10**	64.26**	0.66**	12.36*	1208.52**	1.01**	2.36**	2.06**	40.68**	165.34**
Line (Females)	14	48.57	67.25**	89.75**	0.76	12.56	989.88	1.48**	1.81*	1.57	52.90	17.58
Testers (Male)	1	220.90**	16.04	252.34**	0.004	21.60	5125.70	0.73	33.49**	2.65	96.14	41.56
Line x Tester	14	23.66**	8.45**	25.33**	0.61**	11.49	1147.36**	0.56**	0.68**	2.50**	24.48**	16.68**
Error	92	3.65	2.23	8.57	0.15	6.47	72.29	0.19	0.07	0.46	9.67	1.02
σ^2gca		4.356**	1.302**	5.715**	-0.009	0.219**	74.919**	0.022	0.666**	-0.015*	1.962**	0.505
σ^2sca		6.670**	2.045**	5.584**	0.154**	1.672	358.355**	0.123**	0.204**	0.680**	4.936**	5.220**
σ^2gca/σ^2sca		0.653	0.628	1.023	-0.058	0.130	0.209	0.179	3.265	-0.022	0.397	0.097

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

Table 2 : Ranking of top three parents / crosses with respect to their superiority for *per se* performance, *gca* effects, hybrid performance and *sca* effects for 11 quantitative characters in linseed.

Characters	*per se* performance	*gca* effects	Hybrids	*sca* effects	*gca* status of the parents
Days to 50% flowering	BAU-352	Chambal	BAU-352 x Subhra	Jeevan x Subhra	L x H
	Pusa-3	LS-2	Chambal x Subhra	BAU-352 x Subhra	H x H
	Himalini	BAU-352	Jeevan x Subhra	Chambal x Subhra	H x H
Days of Maturity	Kiran	Himalini	Neela x Subhra	BAU-352 x Subhra	L x L
	Himalini	Neela	Himalini x T-397	Sweta x T-397	L x L
	T-397	Pusa-3	Pusa-3 x Subhra	Neelum x T-397	H x L
Plant height	Ayogi	Ayogi	Ayogi x T-397	S-36 x Subhra	L x L
	Flake	Himalini	Ayogi x Subhra	Neela x T-397	L x L
	BAU-352	Flake	Himalini x T-397	Aec-841 x Subhra	L x L
No. of primary branches/plant	Subhra	Flake	LS-2 x T-397	BAU-352 x T-397	L x L
	LS-2	Neela	BAU-352 x T-397	LS-2 x T-397	L x L
	Himalini	Sweta	Flake x Subhra	Ayogi x Subhra	L x L
No. of secondary branches/plant	LS-2	BAU-352	Pusa-3 x T-397	Pusa-3 x T-397	L x L
	Subhra	Pusa-3	BAU-352 x Subhra	ACC-841 x Subhra	L x L
	Himalini	Jeevan	BAU-352 x T-397	C-439 x Subhra	L x L
No. of capsules *per plant*	Himalini	Jeevan	Jeevan x T-397	Jeevan x T-397	H x H
	LS-2	BAU-352	BAU-352 x T-397	Pusa-3 x T-397	M x H
	Kiran	Flake	Pusa-3 x T-397	S-36 x T-397	L x L
No. of seeds per capsule	C-439	Pusa-3	Neelum x Subhra	C-439 x T-397	L x L
	Ayogi	Neelum	Sweta x Subhra	ACC-841 x T-397	L x L
	Himalini	Sweta	C-439 x T-397	S-36 x T-397	L x L
1000-seed weight (g)	Neelum	Neelum	Neelum x Subhra	C-439 x T - 397	L x L
	Pusa-3	Chambal	Chambal x Subhra	Flake x Subhra	L x H
	Chambal	Subhra	Sweta x Subhra	Ayogi x Subhra	L x H
Seed yield per plant (g)	Himalini	Chambal	Jeevan x T-397	Pusa-3 x T-397	L x L
	LS-2	Sweta	Pusa-3 x T-397	ACC-841 x Subhra	L x L
	Chambal	Jeevan	LS-2 x T-397	Jeevan x T - 397	L x L
Harvest Index (%)	Chambal	LS-2	LS-2 x T - 397	Pusa-3 x T-397	L x L
	Himalini	Sweta	Chambal x Subhra	BAU-352 x Subhra	L x M
	Neela	Chambal	Sweta x Subhra	Himalini x T-397	L x L
Oil Content (%)	Neela	Sweta	Sweta x T-397	Sweta x T-397	H x L
	T-397	Chambal	Chambal x Subhra	Neela x T-397	L x L
	Neelum	Neelum	Neelum x Subhra	Kiran x Subhra	L x H

plant height and 1000-seed weight, respectively. Neelum was also in third position for oil content under both the criteria. This suggested that *per se* performance of the parents provide an indication of their general combining ability for utilizing them in hybridization programme (Singh *et al.*, 1987). Further, parents having high *gca* effect will not necessarily have high estimate of *sca* in crosses. The superior specific combiners involved a combination of high x high, high x medium, high x low and low x low general combiners. However, most of the cross combinations showed low x low *gca* status of their parents for different characters including seed yield and oil content. It may be due to the fact that parents which exhibit low *gca* effect have relatively high magnitude of complementary gene action and thus resulting in highly responsive to heterozygous environment when crossed.

Only three crosses - BAU-352 x Subhra and Chambal x Subhra for days to 50% flowering and Jeevan x T-397 for capsules per plant involved high x high general combiners indicating additive x additive type of gene action for these characters and may be exploited through pedigree method of selection.

A close association was found to exist between three top ranked crosses, based on hybrid performance and *sca* effect for all the characters except days to maturity, plant height, seeds per capsule and harvest index.

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STABILITY ANALYSIS OF SOYBEAN (*Glycine max L. Merrill*) VARIETIES IN RICE ZONE OF MADHYA PRADESH

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ABSTRACT

Thirteen genotypes of soybean were evaluated for successive six years for their stability. Significant differences among genotypes and in different environments were observed for eight characters viz., seed yield, oil percentage, days to 50% flowering, days to maturity, plant height, pods/plants and 100seed weight except seeds/pod. None of the genotypes showed average stability for all the traits. Varieties JS 80-21 and Bragg showed stable performance for seed yield, oil percentage and seeds/pod over the years. Where as PK 262 was found to be stable for oil percent and 100 seed weight traits. Utility of stability analysis for Chhattisgarh plains has been discussed.

Key words : Stability, soybean, yield, oil percentage.

INTRODUCTION

Although Madhya Pradesh is known as soybean state, but Chhattisgarh is a new region for soybean cultivation. In 1995-96 the total soybean growing area in Chhattisgarh reached upto one lakh hectares indicating their wider adaptability and stability for yield. Some, soybean (*Glycine Max* L. *Merrill*) varieties showed fluctuations in their performance in varied agroclimatic conditions. Some genotypes perform well over a wide range of environments, while others require specific environmental conditions to express their full genetic potential. Therefore, significant improvement in crop productivity can be achieved by identifying suitable stable varieties for yield.

MATERIALS AND METHODS

Thirteen genotypes of soybean were tested during six consecutive years in rainy seasons (1991 to 1996) at Research farm of Indira Gandhi Agricultural University, Raipur, M.P. The experimental materials were sown in randomized block design with three replications. Observations were recorded from ten randomly tagged plants from each replication on the seed yield, oil percentage, days to 50% flowering, days to maturity, plant height, pods/plant, 100-seed weight and seeds/pod. Stability analyses were carried out as per method proposed by Eberhart and Russell (1966).

RESULTS AND DISCUSSION

Pooled analysis of variance (Table 1) for all the traits except seeds/pod revealed that the mean square differences among genotypes and environments were highly significant, which indicated the presence of high variability among the genotypes as well as environments. Highly significant values of mean squares due to environment x genotype interactions revealed that the average performance of the genotypes with regard to seed yield and other attributes varied significantly. Similar results were reported by Sharma *et al.*, (1994) and Tiwari *et al.*, (1994), whereas genotype x environment interaction was found non significant for oil percentage, 100 seed weight and seeds/pod which showed that these characters were less influenced by environment.

The linear environment component was also significant for all the traits (Table -1). However, highly significant values were observed for

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Table 1 : Joint regression analysis in respect of seven characters for 13 genotypes in stability analysis.

Sources	d.f.	Seed yield	Oil yield	50% Flowering	Days to Maturity	Plant height	Pods/ plant	100-Seed wt.
Variety	12	211.1**	4.9173*	86.5511*	93.3098**	893.577*	60.8063*	2.4520*
Environment	5	504.1	10.7395**	118.4791*	793.722*	1607.33*	1583.74*	17.3301*
Vari. x Envi.	60	24.3	0.2359	6.0209*	12.6434	71.0916*	19.1863	0.7423
Env. (Var.xEnv.)	65	13.6**	1.0439	14.6715*	72.7264*	189.264*	139.537*	2.0183*
Environ. (linear)	1	2520.8**	53.6891*	592.4347*	3968.572*	8036.68**	7918.693*	86.6523*
Var. x Env. (linear)	12	469.8**	0.4689	3.7533**	9.6977**	105.641**	50.9495**	1.2392
Pooled deviation	52	990.7	0.1642	6.0803**	12.3514**	57.65**	10.3811**	0.5705
Pooled error	144	4.5**	0.0297	0.5429	3.7778**	4.8978**	3.3484**	0.0129

* P = 0.05, ** P = 0.01

genotype x environment (linear) interaction for all the characters except oil percentage, which indicated high adaptation in relation to yield contributing traits in soybean. Similar results were reported by Sharma *et al.* (1994) and Tiwari *et al.* (1994).

A variety is likely to be stable over different environments if it shows high mean value unit regression coefficient (b_i) with lowest deviation from the linear regression (b_i). Genotype JS 80-21 was found to be well adapted to all years.

Higher mean seed yield, regression value (<1) below average with non significant S^2di values were obtained for MACS-58, JS-335, MACS-13 and Pusa-16. The genotypes viz., PK-472, PK-262, JS 75-46 and MACS -124 showed high seed yield and their regression (b_i) value was more than one (>1) with low S^2di value. These genotypes can be categorized as suitable for unfavourable environmental condition (Table 2).

For oil content genotypes PK-464, JS 80-21, and Pusa -16 showed variable stability in different environments. Only genotype JS 80-21 was found to be stable for days to 50% flowering and days to maturity. The large variation in regression coefficients indicated that genotypes had different degree of response to environmental conditions. The variability among environments determines the usefulness of regression response parameters. The higher values of S^2di for days to 50% flowering, days to maturity and plant height indicates that these characters are not much stable indifferent environments.

The genotype Bragg was specifically adapted to favourable environment as far as 100 seed weight was concerned as it had higher mean and regression value below average and less S^2di value, while PK-262 genotype was specifically adapted to unfavourable (poor) environment for 100 seed weight since its mean value for this trait was higher than the average regression value and value of S^2di was comparatively low.

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Table 2 : Estimates of stability parameters based on Six environments for seven traits in soybean

S.No.	Seed Yield (Kg/ha)			Oil %			Days to 50% Flower			Days-Maturity		
	X	bi	S^2di	X	bi	S^2di	X	bi	S^2di	X	bi	S^2di
1. BRAGG	1.00	0.99	0.07	18.84	1.41*	0.48	41.06	0.65	21.92	104.62	0.94	1.65
2. PK-416	1.03	1.12	0.02	20.29	1.12	1.47	40.67	0.61	33.89	100.00	1.23	40.02
3. PK-472	1.30	1.93	0.02	18.14	1.44	0.18	46.17	1.18	15.87	102.50	0.86	19.79
4. MACS-58	1.23	0.59	0.04	18.91	0.65	0.21	49.22	1.06	41.21	103.94	1.09	1.36
5. PK-262	1.25	1.51	0.02	19.12	1.19	0.63	43.61	0.95	14.03	103.50	0.98	7.85
6. JS-335	1.47	0.77	0.09	18.85	0.78	0.70	39.50	1.15	24.36	92.94	0.91	28.86
7. JS 80-21	1.56	0.96	0.03	18.66	0.96	0.50	47.00	1.17	8.54	104.44	1.08	0.67
8. MACS-13	1.20	0.55	0.10	17.10	1.51	0.19	49.33	1.21	29.32	104.00	1.00	17.30
9. PUSA-16	1.20	0.13	0.08	18.81	0.84	0.27	40.72	1.36	20.56	96.94	0.99	57.14
10. PK-564	0.96	0.99	0.32	18.62	0.59	0.37	39.39	0.56	34.52	98.94	1.11	24.59
11. JS 75-46	1.36	1.30	0.04	19.88	0.78	0.33	45.28	1.43	22.97	103.39	0.99	13.69
12. MACS-124	1.38	1.17	0.03	17.29	0.52	0.61	49.28	0.75	26.49	107.83	1.26	375.36
13. NRC-2	1.02	0.99	0.14	17.81	1.20	2.60	42.50	0.91	22.52	99.28	0.55	53.69

* P = 0.05, ** P = 0.01.

Table 2 : Contd..

S.No.		Plant height			Pods/plant			100-Seed weight		
		X	bi	S^2di	X	bi	S^2di	X	bi	S^2di
1.	BRAGG	38.39	0.99	122.40**	30.17	0.57	60.81*	13.17*	0.68	0.45
2.	PK-416	39.17	0.67	26.14	28.56	0.75	18.70	12.32	0.85	5.03
3.	PK-472	34.22	0.90	140.33	35.28	1.32	54.21	12.79	0.84	1.43
4.	MACS-58	67.39	1.40	141.96	35.67	1.26	14.07	12.47	1.95	1.55
5.	PK-262	38.94	0.61	261.16	34.39	1.07	4.48	13.27	1.37	0.70
6.	JS-335	43.33	0.43	109.50	36.22	0.96	90.68	11.41	0.81	1.61
7.	JS 80-21	58.61	1.52	167.97	39.33	1.02	11.22	12.30	0.44	1.46
8.	MACS-13	44.56	0.89	128.57	34.00	0.79	38.98	11.87	0.81	1.64
9.	PUSA-16	47.00	0.83	131.48	36.06	1.31	81.01	11.59	0.63	1.59
10.	PK-564	36.44	0.99	141.74	29.56	0.42	69.71	12.59	1.29	2.74
11.	JS 75-46	63.78	1.57	336.75	37.06	1.11	13.53	12.78	1.37	1.49
12.	MACS-124	65.83	1.66	344.97	36.50	1.17	21.36	12.43	0.60	6.48
13.	NRC-2	36.67	0.54	44.82	33.06	1.25	61.04	11.24	1.36	3.50

* P = 0.05, ** P = 0.01.

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FLOWERING PATTERN AND REPRODUCTIVE EFFICIENCY IN BUNCH VARIETIES OF GROUNDNUT

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ABSTRACT

The pattern of flowering and reproductive efficiency was studied in eight genotypes of the bunch variety of groundnut (*Arachis hypogaea* L.). Flowering commenced 24 to 30 days after sowing. More than 80 per cent of the flowers were produced within 45 days of commencement of flowering. Reproductive efficiency studies in these cultivars revealed that a large proportion of flowers failed to produce mature pods. Only 32 to 50 per cent of the flowers formed pegs and 12 to 21 per cent formed mature pods.

Key words: Groundnut, days to flowering, flowering pattern, reproductive efficiency.

INTRODUCTION

Groundnut is indeterminate in growth and flowering commenced 20 to 30 days after emergence, depending upon the genotype and environment. Though the plants flower profusely, only a small proportion of these flowers become mature pods. About 30 to 50 per cent of the flowers do not develop into pods. The ovaries, pegs and pods fail to reach maturity at various stages of development. Fruiting efficiency depends on the pattern of flowering (number of flowers at different periods of flowering) which is more important than the total number of flowers per plant. The present investigation was undertaken to study the flowering pattern and reproductive potential in eight genotypes of cultivated groundnut.

MATERIALS AND METHODS

A set of eight cultivars, four belonging to early group (duration <100 days) and four to medium group (duration - 105 to 110 days) were raised during *kharif*, 1997 in RBD with 3 replications. The details of the cultivars taken for study are presented in table 1. The crop was raised as rainfed with supplemental irrigation. Data were recorded from ten randomly selected plants in each replication in each cultivar and the mean data were used for the study. The number of fresh flowers appearing in each plant was recorded each day from the day of commencement of flowering for about ninety days to calculate the weekly mean number of flowers. The stages of fruit development finally attained by the various flowers of a given plant were determined by studying the number of pegs that failed to enter the soil, number of immature and mature pods which were present at the time of harvest. The total number of pegs formed was calculated by summing up the number of pegs that failed to enter the soil, number of immature pods and number of mature pods. Flower to peg, peg to mature pod and flower to mature pod ratios were estimated to evaluate reproductive efficiency.

RESULTS AND DISCUSSION

Flowering pattern : The days to flower ranged from 24 to 30 days in the cultivars studied (Fig. 1 and 2). Similar results were reported by Seshadri (1962) and Varisai Muhammad and Stephen Dorairaj (1969) who described that days to flowering depended on the genotype as well as the seasonal factors that prevailed during the preflowering period. The duration of flowering ranged from 70 to 77 days in the present study, while the range of 34 to 75 days were observed by Varisai Muhammad and Stephen Dorairaj (1969). There was a rapid

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increase immediately after the commencement of flowering and peak flowering was attained within two weeks. Among the four genotypes belonging to early group (duration less than 100 days), except for TVG 20, all the others formed pointed peaks. In the medium group (duration 105 to 110 days) TNAU 269 and VRI 2 formed pointed peaks. In these cultivars flower production was minimum after 59 days. The cultivars with pointed peaks produced more number of mature pods than those with flatten peaks in the early group and vice-versa in the medium group. In ALG 84 and VRI 4, appreciable number of flowers (20 to 40 per cent) were produced after 59 days. This pattern of flowering is expected to result in lower reproductive efficiency, as the groundnut flower requires a minimum of 60 days from the time of fertilization to complete pod development (Patel and Seshadri, 1934). However, the present study showed that the two cultivars, ALG 84 and VRI 4 had reproductive efficiencies of 13.48 and 20.63 per cent, respectively. This was comparable with the reproductive efficiencies of the other cultivars. Hence it can be said that the time required for complete pod development will vary depending upon the genotype.

There was no appreciable difference in the flowering pattern of the cultivars belonging to early and medium group. Though the five cultivars, viz., VRI 3, Local Red, TMV2 of the early group and TNAU 269 and VRI 2 of the medium group formed pointed peaks, no common parent was involved in their pedigree. The pattern of flowering was more related to genotypes rather than duration.

Reproductive efficiency : In the early group, 32 to 39 per cent (Table2, Fig.3) of the flowers formed pegs, while in the medium group 37 to 50 per cent (Table2, fig 4) formed pegs. The remaining ovaries were eventually lost. This may be due to lack of fertilization or ovule abortion (Palaniswamy, 1976). The suppression of fruit development at the early post fertilization stage parallels the early abscission of large proportions of flowers and young pods in legumes (Smith, 1954). One fifth to two fifth of the pegs failed to penetrate the soil. This may be due to the fact that they arose from the late flowers of the inflorescence or from inflorescence in the upper axils. Of the pegs that penetrated the soil, 35 to 50 per cent representing 12 to 16 per cent of the original flowers formed mature pods in the early group. In the medium group, 27 to 42 per cent of the pegs formed mature pods and this represented 12 to 21 per cent of the original flowers. The percentage of flowers that formed mature pods was observed to be 13.5 by Smith (1951); 20 to 40 per cent by Muralidharan (1978); 8 to 17 by Sastry *et al.*, (1980).

In the early group, TMV 2 had the highest reproductive efficiency of 15.74 per cent. This was because of its high flower to peg ratio (39.36%) and peg to pod ratio (40.00%). In the medium group, VRI 2 had the highest reproductive efficiency (21.02%). This may be attributed to its high flower to peg ratio (50.15%) and peg to pod ratio (41.92%). Reproductive efficiency of the early cultivars ranged from 12 to 16 per cent, while the range was 12 to 21 per cent in the medium group. It was observed that reproductive efficiency depended more on the genotypes rather than duration and high reproductive efficiency was because of high flower to peg ratio accompanied by high peg to pod ratio.

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Table 1 : Particulars of groundnut cultivars used

Genotype / Cultivar	Botanical type	Pedigree
Early group		
TVG 20	Spanish Bunch	ICRISAT accession
VRI 3	Spanish Bunch	Extract of the Cross J11 x Robout 33-1
Local Red	Valencia	Thiruvannamalai land race
TMV 2	Spanish Bunch	Mass Selection from "Gudiatham Bunch" (AH 32)
Medium Group		
ALG 84	Valencia	Cross derivative
TNAU 269	Valencia	Cross derivative of TMV 10 x ICGS 82
VRI 2	Spanish Bunch	Extract of the cross JL 24 x CO 2
VRI 4	Spanish Bunch	Extract of the cross VG 5 x NcAc 17090

Table 2 : Reproductive effeciency in bunch groundnut genotypes

Genotype	Mean no. per plant			Reproductive Efficiency (%)		
	Flowers	Pegs	Mature Pods	Flowers	Pegs	Mature Pods
Early group						
TVG 20	43.80	14.70	5.20	33.56	35.37	11.87
VRI 3	50.90	17.80	6.50	34.97	36.52	12.77
Local Red	45.50	14.35	7.00	31.54	48.78	15.38
TMV 2	47.00	18.50	7.40	39.36	40.00	15.74
Medium Group						
ALG 84	54.90	20.20	7.40	36.79	36.63	13.48
TNAU 269	42.50	18.90	5.20	44.47	27.51	12.24
VRI 2	33.30	16.70	7.00	50.15	41.92	21.02
VRI 4	47.50	23.20	9.80	48.84	42.24	20.63

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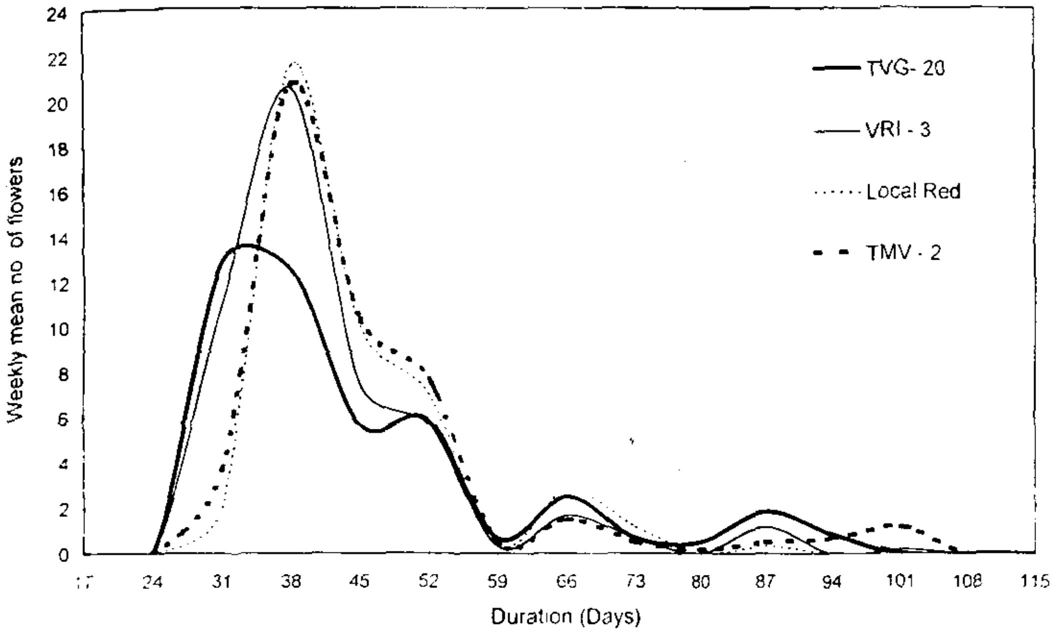

Fig. 1 : Flowering pattern in genotypes belonging to early group

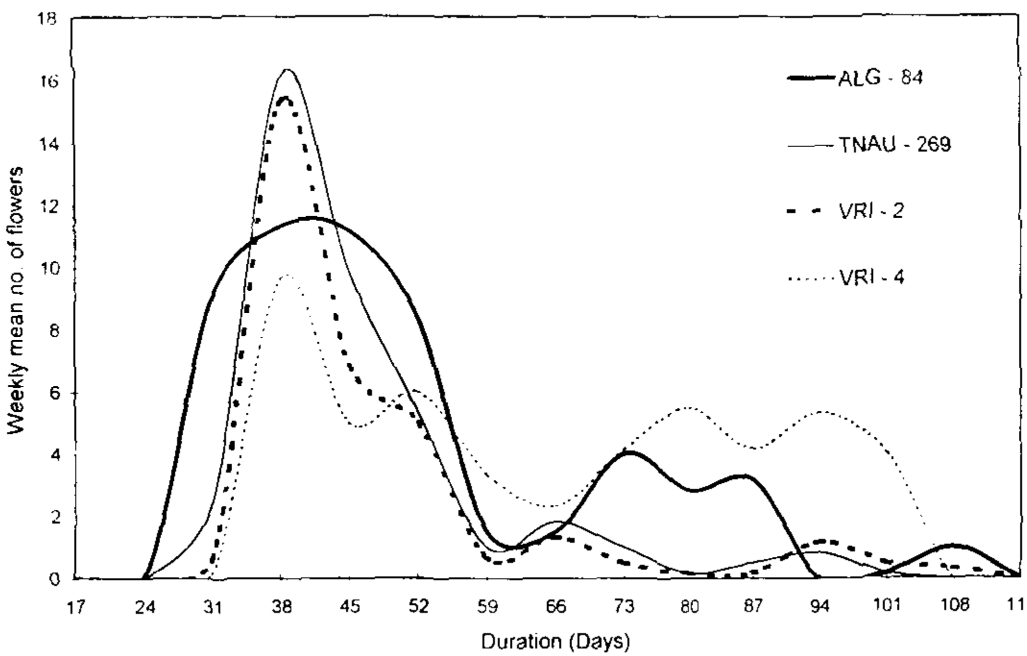

Fig. 2 : Flowering pattern in genotypes belonging to medium group

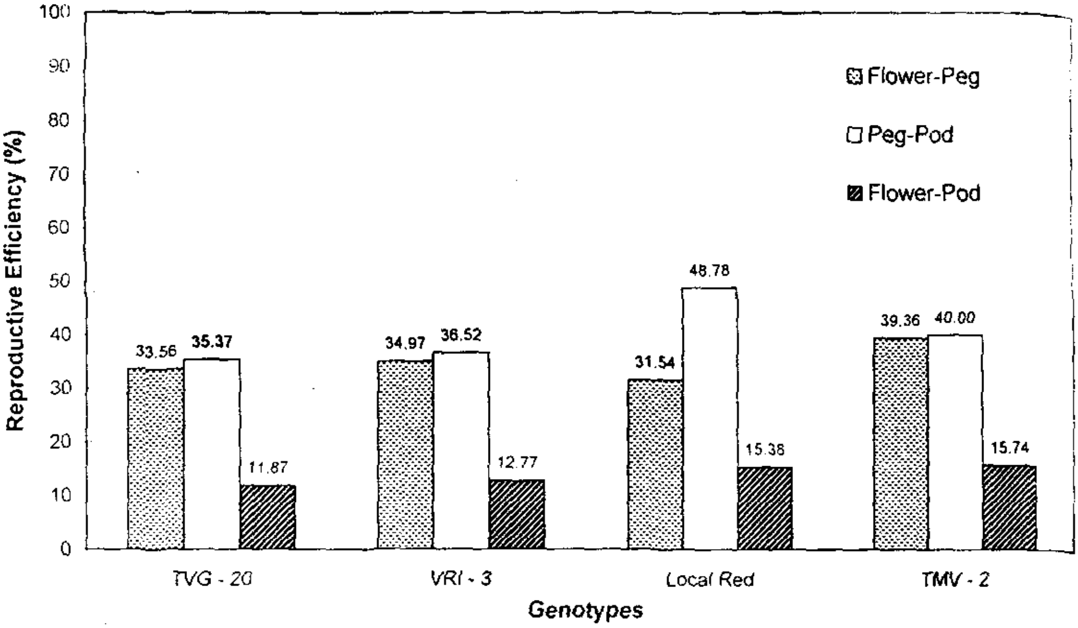

Fig. 3 : Reproductive efficiency in genotypes belonging to early group

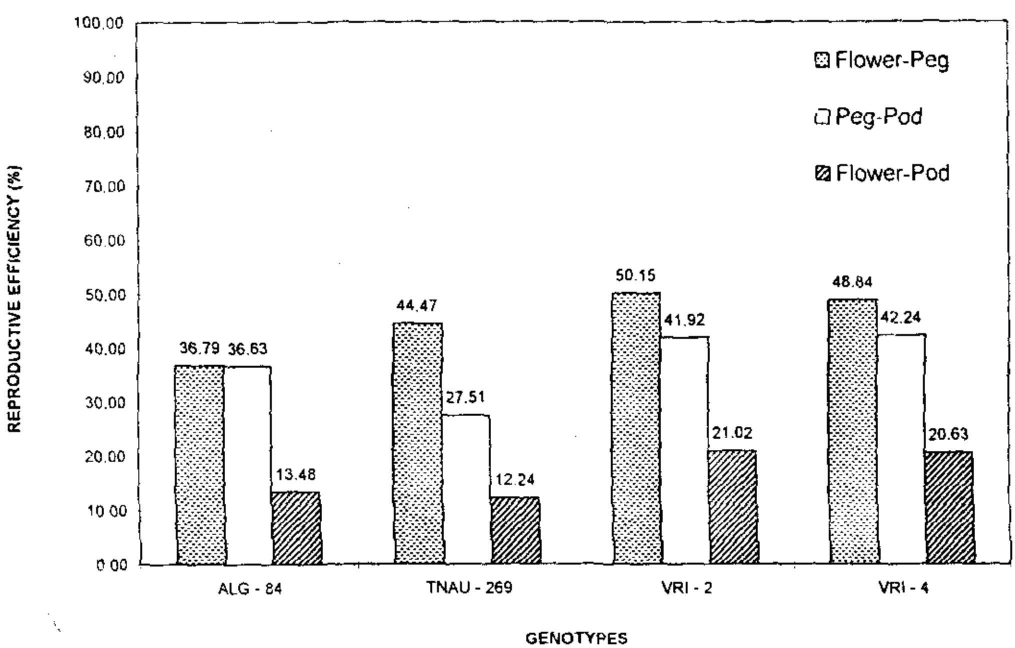

Fig. 4 : Reproductive efficiency in genotypes belonging to medium group

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STUDY OF SOMACLONAL VARIATION IN TISSUE CULTURES OF SAFFLOWER THROUGH ISOZYME ANALYSIS

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ABSTRACT

Peroxidase isozyme activity was studied in different explants such as cotyledonary leaf, hypocotyl and root and respective calli of MS-105 A line and Manjira variety of safflower by using rod gel electrophoresis, with an objective to detect somaclonal variation based on peroxidase banding pattern. The specific bands observed in calli suggest the release of new type of isozymes which can be attributed to the phenomena of somaclonal variation.

Key words : Isozyme, somaclonal variants, zymogram, safflower.

INTRODUCTION

Safflower, an important oil seed crop of semi arid regions, is suited for cultivation particularly under limiting soil moisture conditions and considerable soil salinity. Somaclonal variants in safflower would complement the conventional breeding techniques for widening the genetic base of existing cultivars. Enzymes occur in multiple molecular forms which differ in their electrophoretic mobilities termed as isozyme (markert and Moller, 1959). Stability of isozyme patterns and their use in varietal identification has been reported by Kabrel and Fautier (1974) in *Triticum* sp. Tejovathi *et al.*, (1988) reported differences in peroxidase isozyme banding pattern between salt tolerant and sensitive varieties in safflower. Chommoneva *et al.*, (1984) studied the perioxidase activity in roots and above ground organs on the 5th and 10th day of development in four rice varieties of different heights and earliness and reported a negative correlation between peroxidase activity in both height and root length in the early stages of growth. The early maturing variety had a higher peroxidase activity than late maturing variety. In the present investigation peroxidase isozyme activity was studied in different explants and respective calli of MS-105 A line and Manjira variety of safflower with an objective to detect somaclonal variation based on peroxidase isozyme banding pattern.

MATERIALS AND METHODS

Polyacrylamide gel was prepared according to the method of Davis (1964). Gel columns were prepared in glasstubes with uniform length (10 cm) and diameter (1 cm). Different explants such as cotyledonary leaf, hypocotyl and root were excised from seven day old seedlings of Manjira and MS-105 A line of safflower for callusing. Manjira variety is widely cultivated in Andhra Pradesh. It is a spiny variety, matures in 120 days, with an oil content of 31%. MS-105 A line was developed at Parbhani, male sterilityis reported to be governed by single dominant gene. Native protein from the explants and respective calli was extracted by using Tris-glycine buffer at pH 8.9. The suspension was centrifuged and the supernatant was absorbed on to a filter paper disc of 0.5 cm diameter and placed on the top of rod gels. A drop of bromophenol blue was added to serve as an indicator dye. Electrophoresis was conducted in controlled room temperature conditions. The samples were allowed to run until the indicator dye reached bottom of

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the gel tubes. The zymograms of peroxidase izozymes of different explants and their calli were displayed by staining the gels in a staining mixture of saturated benzidine, 30% ammonium chloride and 0.2% hydrogen peroxide in the proportionof 100:15:20. The regions of enzyme activity on the gels appeared as brown coloured bands in the form of distinct discs displaying the enzyme with similar catalytic properties. The relative migration (Rm) values for each band was calculated as ratio of distance travelled by the specific band from the top of thegel, to the distance travelled by the indicator dye from the top of the gel. Based on the relative migration of bands, they were classified into three categories ie., bands of low mobility (Rm values of 0.0 to 0.3), medim mobility (Rm values of 0.3 to 0.6) and high mobility (Rm values of 0.6 to 1.0). Similarity Index values were calculated as percentage of homologous bands to the total number of bands on zymograms to study the extent of gene homology between different explants and their respective calli.

RESULTS AND DISCUSSION

The banding patterns on zymograms of explants and their respective calli were anlaysed in terms of total numberof bands, relative migration (Rm) values and similarity Index values.

In MS-105 A line highest number (9) of isozyme bands were observed in cotyledonary leaf callus, while least number (5) were observed in root explant. Whereas in Manjira, calli of cotyledonary leaf and hypocotyl explants showed the highest number (8) of bands each, while theleast number of bands (5) were observed in the root and hypocotyl explants. In both the genotypes, more number of isozymes were observed in the calli than in their respective explants (Table 1).

The 'Rm' values of perioxidase isozyme bands ranged from 0.04 to0.65 in different explants and thier calli. In general more number of bands with higher mobility were observed in calli than in their respective expants (Table 1).

Similarity Index values for different explants and their calli ranged from 0.0 to 9.09. The highest Similarity Indix value 9.09 between the hypotocyl and its callus of Manjira variety indicated more homology between them. Where as zero Similarity Index value between the root and its callus of MS-105 A line indicated higher variation (Table 2).

The presence of more number of peroxidase isozymes in different calli than in the original explants suggested that more number of peroxidase isozymes are released during the processof callus initiation and growth. The specific bands observed in calli which were not present in the explants, suggest the release of new type of isozymes, which can be attributed to the phenomena of somaclonal variation. This somaclonal variation may complement the conventional breeding techniques, since safflower has narrow genetic base forsome of the important characters. Such calli, when subcultured on suitable medium can be regenerated into whole plants. These plants are likely to show variation for some characters and suitable somaclonal variants can be isolated.

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Table 1 : Number of Peroxidase Isozyme bands based on Electrophoretic mobility

Genotypes and explant	Number of Bands			Total bands
	Low Mobility (0.0-0.3)	Medium Mobility (0.3-0.6)	High Mobility (0.6-1.0)	
MS-105 A Line				
Cotyledonary leaf	4	3	-	7
Cotyledonary leaf callus	5	3	1	9
Hypocotyl	3	2	1	6
Hypocotyl callus	4	4	-	8
Root	3	2	-	5
Root callus	4	2	-	6
Manjira				
Cotyledonary leaf	4	2	-	6
Cotyledonary leaf callus	5	3	-	8
Hypocotyl	3	2	-	5
Hypocotyl callus	5	3	-	8
Root	3	2	-	5
Root callus	3	3	1	7

Table 2 : Similarity Index values for Peroxidase Isozymes

Genotypes and explant	Cotyledonary Leaf Callus	Hypocotyl Callus	Root Callus
MS-105 A			
Cotyledonary leaf	6.25	-	-
Hypocotyl	-	7.14	-
Root	-	-	-
Manjira			
Cotyledonary leaf	7.69	-	-
Hypocotyl	-	9.09	-
Root	-	-	8.33

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CALLUS DIFFERENTIATION IN TISSUE CULTURES OF SAFFLOWER

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ABSTRACT

Callus was induced from cotyledonary leaf and hypocotyl explants of two safflower genotypes : MS-105 A line and Manjira, on Murashige and Skoog medium supplemented with 0.1, 0.5, 1.0, 2.0 and 5.0 mg l^{-1} of NAA in combination with 0.25 mg l^{-1} BAP and Kinetin. MS medium supplemented with 2.0 mg l^{-1} BAP gave maximum shoot differentiation from five week old primary calli. Rhizogenesis of *in vitro* differentiated shoots was achieved on MS basal medium devoid of any hormone,however Murashige and Skoog medium supplemented with 2.0 mg l^{-1} NAA was good for rhizogenesis.

Key words : Callus, differentiation, caulogenesis, rhizogenesis, safflower.

INTRODUCTION

Safflower is an important oilseed crop cultivated in semi-arid regions of the world, as the crop is suited for cultivation under limited soil moisture conditions and considerable soil salinity. Seed oil has therapeutic value on account of high degree of polyunsaturation in the form of linoleic acid. Recent advances in plant cell and tissue culture have evoked keen interest among plant geneticists to solve basic problems of genetics and to apply this technique to solve practical plant breeding problems (Bottino, 1975). Culture-induced variation is a general phenomenon observed among regenerants arising out of plant regeneration from an intervening phase of callus growth. The variation is genetic in origin (Evans *et al.*, 1984). Such changes have been observed in a wide range of crop species including cereals, legumes, oil yielding plants, vegetables and ornamentals.

Yellow-seeded somaclones have been recovered in mustard and have an important place in oil economy (George and Rao, 1980). Somaclonal variation has also been observed for genes of mitochondrial genomes. Kembel *et al.* (1982) isolated the *Drechlospora maydis* race T-toxinresistant male fertile maize somaclone from a toxin susceptible male sterile line. As safflower has narrow genetic base for certain economically important traits, somaclonal variants would complement the conventional breeding techniques for widening the genetic base of existing cultivars. Present investigation aims to standardise the hormonal requirements for maximum callus differentiation.

MATERIAL AND METHODS

Seed of MS-105A line and Manjira varieties of safflower were sterilized with 0.1% mercuric chloride for three minutes and were thoroughly washed with sterile water and germinated aseptically. Different explants such as cotyledonary leaves and hypocotyls were excised from 7 day old seedlings and inoculated on the Murashige Skoog medium (Murashige and Skoog, 1962) supplemented with 0.1, 0.5, 1.0, 2.0 and 5.0 mg l^{-1} naphthalene acetic acid (NAA) in combination with 0.25 mg l^{-1} benzyl aminopurine (BAP) and Kinetin.

Callus induction and proliferation was good from cotyledonary leaves of both the genotypes, cultured on Murashige and Skoog medium supplemented with 5.0 mg l^{-1} NAA + 0.25

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content. Similarly quality of seeds was not altered much with extended light duration and CO_2 enrichment.

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Table 3 : Effect of light duration and CO_2 enrichment on seed quality parameters of sunflower.

Treatments*	Germination percentage	Seedling growth rate (mg)	Speed of germination	Vigour Index (Germination % X seedling length)
T1	87.3	23.99	21.20	3213
T2	90.1	24.31	21.78	3360
T3	88.7	24.05	21.01	3292
T4	88.2	24.07	21.49	3286
T5	88.3	24.02	21.25	3275
T6	88.1	23.91	21.18	3262
T7	90.1	24.63	21.97	3405
T8	90.0	24.12	21.41	3348
T9	90.1	24.11	21.58	3374
SEm ±	0.986	0.124	0.268	36.68
CD at 5%	NS	NS	NS	104.81

* Details of treatments are given under materials and methods.

light and elevated CO_2 from 10 DAS upto 40 DAS (44.1g). Whereas control had recorded 37.2 g. Hardmann and Brun (1971) reported that seed yield was increased by 20 percent when enrichment was imposed during flowering, 37 per cent from 50per cent flowering to harvest and 50 per cent through continuous enrichment. Chen *et al.*, (1987) also observed a change in test weight (± 5g) due to variation in daily mean photoperiod by 1 h in the range of 4.7 to 10.2h. CO_2 enrichment coupled with extended daylight had a profound effect on growth and yield components as a result of which seed yield increased, but the extent of increase in seed yield depended on the growth stage and duration of enrichment.

Seed quality of sunflower

Among seed quality parameters studied, except vigour index other parameters were not influenced either due to CO_2 enrichment or due to extended light duration (Table 3). However, there was marginal increase in parameters like germination, seedling growth rate and speed of germination due to either of the treatments and in comination of the treatments too. Vigour index in control was 3212 which increased to 3360 with extended light alone and to 3405, 3348 and 3374 with combination of extended light and Co_2 enrichment at 10 DAS upto 40 DAs, 40 DAS upto harvest and 60 DAS upto harvest, respectively. Marginal increase in germination percentage and seedling growth had contributed for higher vigour index of sunflower cv. Morden when exposed to CO_2 enrichment and to extended light duration. Sunflower is usually grown in temperate countries during summer where the crop is exposed to long day conditions and found to have high oil content. In contrast to this in tropical countries though it is grown in summer, contains low oil. This could be due to short photoperiod. However, this investigation did not lend support that photoperiod has an effect on oil

Table 1 : Effect of light duration and CO_2 enrichment on growth components of sunflower.

Treatments*	Days to 50% flowering	Leaf area (cm2) at		Head diameter (cm)
		30 DAS	60 DAS	
T1	48.3	818.67	1978.55	14.65
T2	58.4	1077.63	3037.17	16.00
T3	47.8	1121.50	2838.83	15.93
T4	49.5	1064.02	2715.17	15.86
T5	49.9	821.93	2064.50	15.27
T6	49.3	819.08	1992.34	15.09
T7	57.0	1379.73	3243.00	17.80
T8	49.7	818.38	2094.00	15.40
T9	48.5	819.84	2006.14	14.98
SEm ±	0.83	28.22	60.26	0.297
CD at 5%	2.38	80.64	172.20	0.849

* Details of treatments are given under materials and methods.

Table 2 : Effect of light duration and CO_2 enrichment on yield and yield components of sunflower.

Treatments	No. Filled seeds/head	Seed filling (%)	Test weight (g/1000 seeds)	Seed density (g/cc)	Seed oil content (%)	Seed yield / plant (g)
T1	664	75.6	57.8	0.458	37.11	37.2
T2	710	80.0	59.0	0.460	38.26	41.2
T3	692	78.2	59.1	0.461	37.50	40.0
T4	688	77.3	58.4	0.459	37.39	39.4
T5	669	76.7	58.2	0.459	36.98	37.8
T6	666	75.5	57.3	0.458	37.08	37.3
T7	736	81.5	60.0	0.469	38.08	44.1
T8	681	76.9	58.1	0.462	37.55	38.4
T9	670	76.5	57.9	0.460	37.28	37.8
SEm ±	8.01	0.82	0.43	0.004	0.40	0.98
CD at 5%	22.89	2.34	1.24	NS	NS	2.71

* Details of treatments are given under materials and methods.

For calculating speed of germination, daily germination counts were made and the seeds which have produced minimum 3 cm root were considered germinated. The speed of germination was calculated by using the formula suggested by Maguire (1962).

Speed of germination =

$$\frac{\text{No. of seeds germinated on}}{\text{First day}} + \frac{\text{No. of seeds germinated on}}{\text{Second day}} + \ldots\ldots + \frac{\text{No of seeds germinated on}}{\text{Final day}}$$

RESULTS AND DISCUSSION

Growth studies

Data on days taken to 50% flowering, leaf area at 30 and 60 DAS, and head diameter are presented in Table-1. Days taken to 50% flowering was delayed significantly with extended light alone (58.5 days) and also in combination with CO_2 enrichment (57.0 days) from 10 DAS upto harvest compared to the plants grown undernormal condition (48.3 days). Other treatments did not influence this character significantly. The leaf area at 30 and 60 DAS increased significantly under extended light alone from 10 DAS upto harvest, elevated CO_2 alone from 10 DAS upto harvest and from 10 DAS upto 40 DAS and also in combination of both from 10 DAS upto 40 DAS. The influence of light duration and CO_2 enrichment on head diameter was significant. It was 16.00, 15.93, 15.86 and 17.80 cm in the treatments with extended light alone from 10 DAS upto harvest, elevated CO_2 alone from 10 DAS upto harvest and from 10 DAS upto 40 DAS and in combination of both from 10 DAS upto 40 DAS, respectively; while the head diameter in all other treatments was on par with the control (14.65 cm). When sunflower was grown under longer days, Goyne and Schineiter (1988) noticed increased plant height and leaf number. Dhawan *et al*; (1981) observed increase in photosynthetic rate of sunflower plants grown under elevated CO_2 levels. This resulted in higher dry matter production due to CO_2 enrichments which was attributed to increase in substrate levels for increased rubisco activity or due to substantial increase in specific leaf weight, Net Assimilation Rate and Relative Growth Rate (Kreidmann and wong, 1984). These physiological changesin sunflower when exposed to extended light and elevated CO_2 levels might have contributed for higher DM production in present study also.

Yield and Yield components

The number of filled seeds per head (Table 2) increased significantly in plants grown under extended light alone from 10 DAS upto harvest (710), CO_2 enrichment alone from 10 DAS upto harvest (692) and 10 DAS upto 40 DAS (688) and in combination of extended light and elevated CO_2 from 10 DAS upto 40 DAS (736); whereas the number of filled seeds per head in other treatments was on par with the control (664). The per cent of filled seeds increased significantly due to extended light and CO_2 enrichment. In control, the per cent of filled seeds was 75.5 which increased to 80.0, 78.2 and 81.5 per cent in plants grown under extended light alone from 10 DAS upto harvest, elevated CO_2 alone from 10 DAS upto harvest and in combination of both extended light and CO_2 enrichment from 10 DAS upto 40 DAS, respectively. Compared with control (57.8g), the test weight increased significantly only in plants grown under combination of both elevated CO_2 and extended light from 10 DAs upto 40 DAS (60.0 g), where as in all other treatments, test weight did not differ. Seed density was not influenced either due to extended light or due to elevated CO_2 concentration. Seed oil content was also not influenced by these treatments. However, effect of light duration and CO_2 encrichment resulted in increased seed yield per plant. It increased in plants grown under extended light alone from 10 DAS upto harvest (41.2g) and elevated CO_2 alone from 10 DAS upto harvest (40.0 g) and 10 DAS upto 40 DAS (39.4 g) and also in combination of extended and seed quality of popular sunflower cv. 'Morden'.

MATERIALS AND METHODS

A pot culture experiment was conducted in the Department of Crop Physiology, GKVK, Bangalore, during winter season of 1990-91. The treatments included were T_1 : control, T_2: extended light from 10 DAS upto harvest; T_3 : CO_2 enrichment from 10 DAS upto harvest; T_4 : CO_2 enrichment from 10 DAS upto 40 DAS; T_5: CO_2 enrichment from 40 DAS upto harvest; T_6 : CO_2 enrichment from 60 DAS upto harvest; T_7; Extended light + CO_2 enrichment from 10 DAS upto 40 DAS; T_8 : Extended light + CO_2 enrichment from 40 DAS upto harvest and T_9: Extended light + CO_2 enrichment from 60 DAS upto harvest. Control treatment had the ambient CO_2 level of 340 ppm and normal day length. In the treatment of extended light, the plants were exposed to extra light for 4 hours from 6.00 PM to 10.00 PM. Elevated CO_2 concentration of 700-800 ppm was maintained in the treatments of CO_2 enrichment. The rectangular plastic pots measuring 35x25x15 (LxBxH) cm were filled with red loamy soil. At the time of sowing 4g urea, 8 g of single super phosphate and 4g of muriate of potash were applied to pots. Six such pots were used as replication for each treatment. The seeds of cv Morden were sown. After one week, thining was done leaving only one seedling. The pots were watered regularly. Trenches of 4x1x0.6m were dug and the pots were transferred to trenches at different growth stages. The trenches which constituted CO_2 enrichment treatments were covered with polythene sheets from 4.00 PM to 10.00 AM. Metallic frame measuring 12 feet length, 4 feet width and 2 feet height was placed on the polythene sheet for holding the sheet firmly. The trenches were made air tight by fixing the free end of polythene sheet into the soil. By doing so, CO_2 released by dark respiration and soil respiration was trapped during night for making it available to plants during morning hours upto 10 AM. The polythene structures were removed at 10 AM and plants were allowed to photosythesise under ambient CO_2 concentration. The trenches meant for extended light treatment were provided with four fluorescent light tubes by mounting them on wooden plank above the trenches. In control treatment, seedlings were transferred to similar trenches for exposing to ambient CO_2 concentration and normal day light.

Observations on growth characters such as days to 50 per cent flowering and Leaf Area by LI-3100 leaf area meter at 30 and 60 DAS were recorded, besides observations related to yield components were also made and they were head diameter,number of filled seeds/head, seed filling percentage, test weight/1000seeds, seed density etc. The standard germination test between the paper towel method prescribed by the International Seed Testing Association (ISTA) rules for seed testing was followed. The Vigour Index was computed by adopting the formula suggested by Abdul-Baki and Anderson (1973) and expressed as a number.

Vigour Index = Mean germination x Mean shoot length + root length (cm) percentage

For finding out Seedling Growth Rate (SGR), 20 seeds were germinated in four replications using between paper towel method. Rolled paper towels of 25 cm inner diameter were placed at 45° angle in plastic container covered by polythene sheet to retain moisture till the end of the test period. After incubating for 10 days at 25° ± 1° C,normal seedlings were counted. Later on,the seedlings were dried in shade for one hour followed by oven drying at 80° ± 1°C for 24 hours. After noting down dry weight in milligram, SGR was computed by using the following formula (Anon., 1983).

$$SGR = \frac{\text{Dry weight of the normal seedlings (mg)}}{\text{Number of normal seedlings}}$$

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INFLUENCE OF LIGHT DURATION AND CO_2 ENRICHMENT ON GROWTH, SEED YIELD AND QUALITY OF SUNFLOWER CV.MORDEN*

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ABSTRACT

A pot culture experiment was conducted during winter season of 1990-91 to study the influence of duration of light and CO_2 enrichment during different crop growth stages on growth, seed yield and quality of sunflower CV 'Morden'. Treatments included were control, extended light from 10 DAS upto harvest, CO_2 enrichment during different crop growth periods (viz. 10 DAS upto harvest; 10 DAS to 40 DAS, 40 DAS upto harvest and 60 DAS upto harvest) and combination of extended light and CO_2 enrichment during different crop growth periods. The results revealed that Vigour Index was significantly increased due to these treatments and it ranged from 1.53 to 5.98 per cent. Seed filling percentage and test weight were increased significantly due to *extended light duration and CO_2* enrichment when imposed from 10 DAS upto 40 DAS. Seed yield per plant increased significantly from 37.2 g in control to 41.2g per plant in extended light duration alone, 40.0 g in CO_2 enrichment alone and 44.1g in combination of both from 10 DAS upto 40 DAS. Leaf area index per plant increased due to both CO_2 enrichment and extended light duration imposed from 10 to 40 DAS. Days to 50 per cent flowering was delayed by 0-10 days when plants were exposed to longer day length alone and in combination with elevated CO_2 concentration from 10 to 40 DAS.

Key words : Sunflower, Morden, carbondioxide enrichment, light duration, vigour index.

INTRODUCTION

The area under sunflower crop in India is spreading rapidly not only in the southern states but also in the northern states like Punjab, Haryana, Uttar Pradesh and Others. Owing to its short growth period coupled with photo insensitivity enabling the cultivation of crop throughout the year and wide adaptability to differentagro-climatic conditions and soil types, the crop is becoming more popular in non-traditional areas too. Low productivity of this crop in India has been attributed to poor seed filling and non-availability of high quality seed, Doyle (1975) studied the phenological development range of sunflower varieties at New South Wales (Australia)and found that, as constant photoperiod increased from 15 to 21 hours, time from sowing to first authesis increased by 9 to 12 days. Carbon dioxide enrichment was found to increase the photosynthetic rate of sunflower (Dhawan *et al.*, 1981). The increase in Photosynthetic efficiency in these studies has been attributed to increase in substrate levels for *ribusco* activity or in specific leaf weight. Kriedmann and Wong (1984) investigated photosynthetic acclamatization of sunflower to continuous CO_2 encrichment (1350 ppm) in long and short term green house study. They noticed that high CO_2 resulted in higher final dry weight due to increased NAR and Leaf expansion rate during the early exponential growth phase. Usually C_3 plants like sunflower respond to light intensity indicating that light is a limiting factor for photosynthesis thus affecting the productivity. The present study was, therefore, carried out to examine the effect of extended light duration in presence or absence of CO_2 enrichment at different crop growth phases on the productivity

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Table 2 : Effect of MS medium with different hormonal treatments on rhizogenesis in two genotypes of safflower.

Hormonal Concentration in the medium (mg l^{-1})	Mean Caulogenesis frequency (percentage)		Mean
	MS-105 line	Manjira	
MS basal	10.9	2.2	6.5
MS + 0.1 NAA	15.4	4.4	9.9
MS + 0.5 NAA	28.6	8.9	18.7
MS + 1.0 NAA	38.5	25.3	31.9
MS + 1.5 NAA	41.8	35.2	38.5
MS + 2.0 NAA	46.2	40.7	43.5
Mean	80.2	19.4	29.5
	Genotype	Hormonal treatment	
S.E	0.8646	1.4976	
C.D. (5%)	1.7896	3.0921	

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mg l^{-1} BAP. Four to five week old primary callus from these cultures was transferred to shooting medium (Murashige and Skoog medium supplemented with 0.5,1.0, 2.0 mg l^{-1} BAP and Kinetin).

Eight to ten centimeter long *in vitro* produced shoots were transferred to Murashige and Skoog medium supplemented with 0.1,0.5,1.0,1.5 and 2.0 mg l^{-1} NAA for induction of rooting.

Frequency of shoot differentiation (caulogenesis) and rooting (rhizogenesis) of *in vitro* produced shoots was measured as percentage of the cultures responding among the total number of cultures inoculated. Statistical analysis was carried out by using 2 x 6 mixed factorial laid out in completely randomised design (Panse and Sukhatme, 1975) using two genotypes and six hormonal treatments to know the significance of differences between them.

Table 1: Effect of MS medium with different hormonal treatments on caulogenesis in two genotypes of safflower

Hormonal Concentration in the medium (mg l^{-1})	Mean Caulogenesis frequency (percentage)		Mean
	MS-105 line	Manjira	
MS + 0.5 BAP	35.2	31.9	33.6
MS + 1.0 BAP	41.8	40.7	41.3
MS + 2.0 BAP	45.1	41.8	43.5
MS + 0.5 Kinetin	31.9	30.8	31.4
MS + 1.0 Kinetin	37.4	34.1	35.8
MS + 2.0 Kinetin	40.7	36.3	39.6
Mean	38.7	36.3	37.5
	Genotype	Hormonal treatment	
S.E.	1.100	1.5557	
C.D. (5%)	2.2705	3.2110	

RESULTS AND DISCUSSION

Development of small shoots was observed from green spots that appeared in the callus subcultured on differentiating medium. Seeta (1991) also reported shoot regeneration from cotyledonary leaf calli of safflower varieties (Manjira, A-1, Sagaramuthyalu, Co-1 and S-4) on Murashige and Skoog medium supplemented with 0.5 mg l^{-1} BAP and 5.0 mg l^{-1} adenine sulphate.

Significantly higher average caulogenesis frequencies (41.3% and 43.5%) were observed on Murashige and Skoog medium supplemented with 1.0 and 2.0 mg l^{-1} of BAP (Table 1).

In general significantly higher shoot regeneration was observed on medium containing BAP than Kinetin irrespective of the concentration.

Rhizogenesis of the differentiated shoots was maximum (43.5%) on Murashige and Skoog medium supplemented with 2.0 mg l^{-1} NAA, irrespective of genotype (Table 2). Significantly low rhizogenesis was observed on Murashige and Skoog medium devoid of any hormone.

Tejovathi and Anwar (1987) reported no rhizogenesis from *in vitro* produced shoots directly from cotyledones without callusing, when transferred to MS medium containing varying concentration of NAA. However, they reported that rhizogenesis of shoots was achieved on MS basal medium with 9% sucrose. In the present investigation, the ability of *in vitro* produced shoots to produce roots might be due to change in physiological status of cells during callusing so as to react positively with the supplements added to the medium.

The potential for regeneration of whole plant exists in safflower both for Rhizogenesis, though in low frequency. Higher frequencies could be achieved through careful manipulation of environmental conditions (light effects) and more importantly by successive media transfer.

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INTER-CROPPING SESAME WITH PIGEONPEA UNDER VARYING SOWING DATES

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ABSTRACT

An experiment was conducted during rainy seasons of 1994-95 and 1995-96 at Powarkheda to assess the optimum sowing date of pigeonpea (*Cajanus cajan* (L.) Millsp.), sesame (*Sesamum indicum* L.) and their intercrops and also to find out the remunerative pigeonpea based intercropping system. Grain yields of pigeonpea sown in the month of July were significantly more as compared to delayed sowing during 15-20 August and 5-10 September. The grain yield of sesame u der 5-10 July and 5-10 September were at Par but significantly higher than the yields under 25-30 July and 15-20 August sowing. The pigeonpea equivalent yield (2690 kg /ha) net returns (Rs.29,985/ha) and benefit; cost ratio (3.81) with 5-10 July sowing were maximum but at par with that under 25-30 July. Among different cropping systems, pigeonpea + sesame in the row proportion of 2:2 was more promising and recorded highest pigeonpea equivalent yield (2925 kg/ha), net returns (Rs. 33035/ha) and benefit : cost ratio (4.05) over 2:4, 2:6 row proportion and mixed seed proportion too.

Key words : Pigeonpea, sesame, intercropping, date of sowing.

INTRODUCTION

In Central Narmada valley of Madhya Pradesh pigeonpea (*Cajanus cajan* (L.) Millsp.) is widely planted as sole or mixed crop with sesame (*Sesamum indicum* L.) in late *Kharif* under residual soil moisture or partially irrigated condition. The pigeonpea and sesame varieties grown in this system are of long duration, maturing in about 270 and 130 days, respectively resulting in low yields. Besides, the broad-cast sowing gives an uneven stand of mixed crops and creates problem in interculture operations. Therefore, the land resource is not best utilized. There were reports that sesame has less adverse effect on pigeonpea as compared to other intercrops (Goyal *et al.*, 1991). Chimanshette and Dhoble, (1992) reported higher seed yield of sesame when sown early. Recently a medium duration (180 days), wilt resistant, high yielding variety (SPMA-1) of Pigeonepa, and a short duration (90 days) high yielding variety (TKG-21) of sesame has been released for Central Narmada Valley. Hence, these improved varieties of pigeonpea and sesame were intercropped under partially irrigated condition with various sowing dates.

MATERIALS AND METHODS

A field experiment was conducted at Zonal Agricultural Research Station, Powarkheda, during rainy seasons of 1994-95 and 1995-96 on deep vertisol. The soil had 230, 40 and 430 kg/ha available N, P_2O_5 and K_2O, respectively with pH 7.8. The experiment was laidout in spilt plot design with three replications. Treatments comprised four dates of sowing and six cropping systems (Table 1). Sowing was done on 7, 9 and 27 July, 16 and 17 August and 10 and 7 September in 1994and 1995, respectively. Sole pigeonpea (SPMA-1) was sown in rows spaced60 cm apart, whereas sole sesame (TKG-21) and the intercrops were planted in a common row to row distance of 30 cm. Under intercrops pigeonepa was planted in paired rows. The seed rate for sole crops of pigeonpea and sesame was 20 and 5 kg/ha,respectively. In case of intercrops the seed of sesame was adjusted according to the row ratio, while for mixed cropping

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Table 1 : Growth and yield attributing characters of pigeonpea and sesame under different treatments (pooled data of two years).

Treatments	Plant Height (cm)		Branches/ plant		Pods or capsules/plant		1000 grain weight (g)	
	Pigeonpea	Sesame	Pigeonpea	Sesame	Pigeonpea	Sesame	Pigeonpea	Sesame
Date of sowing								
05-10 July (D1)	185.7	90.6	11.4	2.3	194.9	24.2	100.2	3.2
25-30 July (D2)	168.4	83.3	10.9	1.3	175.6	23.3	100.7	3.3
15-20 August (D3)	148.0	77.5	9.6	2.3	142.2	24.7	97.1	2.5
05-10 September (D4)	111.7	76.4	8.2	2.1	120.4	19.3	105.4	3.1
S.Em ±	2.6	2.5	0.5	0.1	10.1	1.3	1.3	0.1
CD (0.05)	7.8	7.5	1.6	0.3	30.6	3.9	4.1	0.3
Cropping Systems								
Sole sesame	-	82.3	-	2.1	-	23.6	-	3.1
Sole Pigeonpea	155.0	-	9.5	-	143.0	-	100.6	-
Pigeonpea + Sesame 2:2	155.4	81.4	9.7	2.2	155.6	24.3	99.3	3.0
Pigeonpea + Sesame 2:4	153.5	82.9	10.1	2.1	166.9	24.4	100.0	3.1
Pigeonpea + Sesame 2:6	155.7	81.7	9.9	2.0	171.6	23.0	101.6	3.1
Pigeonpea + Sesame mix	147.7	81.5	11.0	1.7	154.3	19.0	102.8	2.9
S.Em ±	1.5	1.6	0.3	0.1	7.2	1.0	1.36	0.1
CD (0.05)	4.2	NS	NS	0.3	20.3	2.9	NS	NS

full seed rate of both the crops was mixed and broadcasted. Pigeonpea received 20, 60 and 20 kg N, P_2O_5 and K_2O/ha, respectively as basal,whereas for sesame it was 60:40:20 kg NPK/ha where nitrogen wasapplied in two splits ie., 1/2 as basal and 1/2 at 30 days stage. In case of intercropping full dose of fertilizers for pigeonpea was given, while sesame received as per the row ratios ie., 50. 66 and 75 per cent of the recommended dose in 2:2. 2:4 and 2:6 ratios, respectively. In mixed cropping full quantity of fertilizers recommended for both the crops was given. July and August sown crop of pigeonpea received only one irrigation at pod filling stage, while september sown crop received irrigation at flowering and pod filling stages. Leaf roller/capsule borer (*Antigastra Catalaunal-is* Dup.) was observed as a major pest in sesame which wascontrolled by spraying 0.07% Nuvacron at 20 and 50 days stages. In september sown sesame powdery mildew was controlled by spraying 0.25% Dithane M-45. In pigeonpea pod fly (*Melenagromyza obtusa*) and gram pod borer (*Helicoverpa armigera*) were controlled by spraying Nuvacron at full flowering and pod filling stage. The total rainfall received during crop season was 1470.2mm and 818.8 mm in 1994-95 and 1995-96, respectively.

RESULTS AND DISCUSSION

Pigeonpea : Sowing on 5-10 July (D_1) gave maximum grain yield of pigeonpea but it was at par with the yield obtained with 25-30 July (D_2) sowing in both years (Table 2). The pooled data also showed hgher yield under D_1 (2566 kg/ha) andD_2 (2488 kg/ha) and significant increase in yield over D_3 (2131 kg/ha) and D_4 (1213 kg/ha). Since the early sown crop had longer growth period, it resulted in better growth and vigour, more branches and pods per plant (Table -1) and ultimately gave higher yield. Similar resutls were reported by Verma *et al.*, (1992). Besides, at pod formation and filling stage (last week of January to first fortnight of February) of September sown crop (D_4) severe attack of *Helicoverpa armigera* caused considerable yield loss.

Data on cropping system revealed that the grain yields in sole pigeonpea (2425 kg/ha) and pigeonpea + sesame 2:2 (2454 kg/ha) were at par. This is in conformity with the findings of Goyal *et al.*, (1991). The yield under pigeonpea + sesame intercropping in 2:4 (2045 kg/ha) and 2:6 (1680 kg/ha) row ratio was significantly reduced as the plant population of pigeonpea was decreased. The mixed crop gave significantly lower yield (1893 kg/ha) when compared with sole crop as well as the intercropping in 2:2 and 2:4 ratio, which was mainly due to uneven plant stand of pigeonpea. Bishnoi *et al.*, (1987)also reported that the intercropping system has no adverse effect on growth and yield attributes of pigeonpea which in turn gave identical yield in all the treatments.

Sesame : Plant height, branches/plant, capsules/plant, test weight (Table 1) and grain yield of sesame (Table 2)were significantly influenced by date of sowing. During first year, early sowing (D_1) gave significantly higher grain yield (568 kg/ha) as compared to the succeeding dates. Under late sowing excess moisture caused poor aeration, which affected crop growth adversely and resulted in lower yield. During second year, september sowing (D_4) gave maximum yield of 589 kg/ha due to better interculture and insect pest management under the condition of lower precipitation (105.1 mm during crop period). However, the pooled data revealed that the yield under D_1 (498 kg/ha) and D_4 (504 kg/ha) were at par.

Consistently lower yields under D_2 (470 kg/ha) and D_3 (390 kg/ha) were due to poor aeration and lower efficiency of insecticide in the month of peak rainfall i.e. August. Higher yield of sesame with early sowing was also reported by Chimanshette and Dhoble (1992).

The number of branches and capsules per plant under sole crop and intercrops were at par but significantly more than that under mixed crop (Table -1). The pooled yield of 573 kg/ha in sole sesame was significantly higher than the yield in other treatments (Table -2). Grain yield under different intercropping treatments appeared to vary according to area occupied during both the years. Pigeonpea + Sesame 2:6 and pigeonpea + Sesame mixed crop ranked second (517 kg/ha) and third (468 kg/ha) with a significant difference indicating economy of 1/4th area under intercropping system.

Table 2: Effect of date of sowing and cropping system on yield and economic returns (Pooled data based)

Treatments	Grain yield (kg/ha)						Pigeonpea equivalent yield (kg/ha)	Net returns (Rs/ha)	Benefit cost ratio
	1994-95		1995-96		Pooled				
	Pigeonpea	Sesame	Pigeonpea	Sesame	Pigeonpea	Sesame			
Date of sowing									
05-10 July (D1)	2404	568	2728	427	2566	498	2690	29985	3.81
25-30 July (D2)	2428	491	2549	450	2488	470	2596	28576	3.65
15-20 August (D3)	2335	464	1927	317	2131	390	2209	22785	3.14
05-10 September (D4)	1825	419	600	589	1213	504	1570	13284	2.26
S.Em ±	50	14	79	15	51	13	48	705	0.08
CD (0.05)	173	47	272	51	155	39	144	2139	0.23
Cropping Systems									
Sole sesame	-	570	-	575	-	573	764	4802	1.73
Sole Pigeonpea	2577		2273	-	2425	-	2425	27327	4.03
Pigeonpea + Sesame 2:2	2542	371	2365	335	2454	353	2925	33035	4.05
Pigeonpea + Sesame 2:4	2302	451	1787	381	2045	416	2599	27592	3.42
Pigeonpea + Sesame 2:6	1840	540	1519	495	1680	517	2370	23860	3.04
Pigeonpea + Sesame mix	1976	494	1810	441	1893	468	2517	25330	3.01
S Em ±	83	13	65	15	52	10	48	722	0.07
CD (0.05)	238	39	186	42	148	28	135	2031	0.19

Cost of produce : Pigeonpea Rs 15/kg, Sesame Rs. 20/kg.

Pigeonpea equivalent yield and economic returns: Pooled data revealed that the pigeonpea equivalent yield (PEY) with D_1 (2690 kg/ha) and D_2 (2596 kg/ha) were at par but significantly more than that under D_3 (2209 kg/ha) and D_4 (1570 kg/ha) which was due to consistantly better performance of both crops under early sowings (Table-2).

The intercroping of pigeonpea + Sesame 2:2 (2925 kg/ha PEY) proved significantly superior to all other treatments due to addition of sesame yield without any loss in pigeonpea yield. Intercropping in 2:4 row ratio (2599 kg/ha PEY) registered significant yield increase over sole pigeonpea (2425 kg/ha), whereas the latter was at par with pigeonpea + sesame 2:6 (2370 kg/ha) and mixed crop (2517 kg/ha). These findings are in conformity with those reported by Bajpai and Singh (1992) and Rajput *et al.*, (1989).

Data presented in Table - 2 showed that the net returns (Rs.- 29,985/ha) and benefit : cost ratio (3.81) obtained with D_1 was the highest but at par with D_2 (Rs. - 28,576/ ha and 3.65), whereas the last two sowing dates resulted in significantly lower returns. This was in accordance with the yield obtained under respective dates. Among different cropping systems, pigeonpea + sesame 2:2 proved consistantly superior with the highest values of net returns (Rs. 33035/ha) and benifit : cost ratio (4.05).

Thus, the present investigation revealed that early planting (5-10 July) of pigeonpea + sesame in 2:2 row proportion may be recommended to achieve maximum yield and economic returns.

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PERFORMANCE OF SUNFLOWER HYBRIDS AS INFLUENCED BY ORGANIC MANURE AND FERTILIZER

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ABSTRACT

A field experiment was conducted on sandy loam soil at CCS Haryana Agricultural University, Hisar during the spring seasons of 1995 and 1996 to study the effect of nutrient management on the growth and yield of sunflower hybrids. The dry matter accumulation plant^{-1} was significantly higher in hybrid MSFH-8 than in Badshah in both the years, whereas seed yield was significantly higher in hybrid Badshah. The dry weight plant^{-1} and yield components were significantly higher with vermicompost at 10 t ha^{-1} and with FYM at 10 t ha^{-1} over no organic manure. The seed yield was also significantly higher with vermicompost at 10 t ha^{-1} over rest of the treatments. In case of organic manures and fertility levels interaction, the dry matter and seed yield of sunflower generally increased significantly by increasing levels of fertility upto 120+60kg ha^{-1} N+P_2O_5 without organic manures and upto 80 + 40kg ha^{-1} N+P_2O_5 with the application of organic manures. Use of vermicompost at 10t ha^{-1} alongwith 80 + 40kg ha^{-1} N+P_2O_5 was the best combination among all treatments for the dry matter and seed yield of sunflower hybrids. The net returns were more with hybrid Badshah than with MSFH-8.

Key words : Sunflower, Vermicompost, Organic manure, fertilizer.

INTRODUCTION

One of the new vistas in the remunerative cultivation of sunflower is to select appropriate hybrid/varieties suited to particular agroclimatic situations which can yield more per unit of nutrients used. Sunflower has been introduced recently in North-India and became an important oilseed crop with rapidly increasing area under its cultivation. To realise its potential yield, and understanding of growth parameters in relation to nutrient application and productivity is vital. It ranks third as an oilseed crop on world map (Singh *et al.*, 1997). The average yield of sunflower in India is very low i.e. 565kg ha^{-1} compared to 2282 kg ha^{-1} in USA. Sunflower, being a day neutral and short duration (90-115 days) crop, fares well in spring season in North India and its acceptability among the farmers of this region is increasing with the introduction of high yielding varieties (Singh and Singh, 1996). Selection of variety and proper nutrition are important factors affecting the productivity of this crop. Therefore, an experiment was conducted to study the effect of nutrient management on the growth characters and yield of sunflower hybrids.

MATERIALS AND METHODS

Field experiment was conducted during the spring seasons of 1995 and 1996 at Agronomy Research Farm of CCS HAU, Hisar. The soil of the experimental field was sandy loam in texture, low in organic carbon (0.38%) and available nitrogen (195 kg ha^{-1}), medium in available phosphorus (17kg ha^{-1}), high in available potash (460kg ha^{-1}) and slightly alkaline in reaction (pH 7.7). The experiment was laid out in split-plot design with three replications keeping two hybrids of sunflower: (MSFH-8 and Badshah), and five organic manure treatments, viz., control (no organic manure), FYM at 10t ha^{-1}, vermicompost at 5t ha^{-1}, vermicompost at 10t ha^{-1} and Bio-organic soil enricher (Fertonic) at 250 kg ha^{-1} in main plots and four fertiliser levels viz., control (no fertilizer), 40+20, 80+40 and 120 + 60kg ha^{-1} N+P_2O_5 in sub-plots. The chemical composition of bio-organic soil enricher was recorded as 1.13% Nitrogen, 0.23% phosphorus and 0.25% potassium with 19.2% moisture.

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Biologically it is stated to contain total bacter count 10^{10}, Actinomycetes/g 10^4, Fungi/g 10^6, Azotobacter/Root Nodules/g 10^5, Bacteria/g10^4, Phosphate solubilizers 10^5 and Nitrobacter/g 10^3. Full dose of phosphorus and half dose of nitrogen as per treatments were applied at the time of sowing and remaining half nitrogen was topdressed after first irrigation. The seed was sown in rows 45cm apart with intra-row spacing of 30cm by dibbling method on 10 and 6 February in 1995 and 1996, respectively. The seed was also soaked in water for four hours before sowing and treated with Aldrin to avoid the effect of cutworms.

RESULTS AND DISCUSSION

Performance of hybrids

Dry matter production of MSFH-8 was significantly higher than Badshah in both the years (Table 1). The variation in growth behaviour of two hybrids might be attributed to genetic make up which limit the extent to which a plant may develop. The MSFH-8 due to its tall growth habit had more dry matter (20.6g) over Badshah on an average basis. Significant variation in dry weight plant^{-1} in sunflower hybrids was also observed by Bhola and Faroda (1990). The number of seeds head^{-1} were significantly higher in Badshah as compared to MSFH-8 during both the years. Whereas, the 100-seed weight was significantly higher in MSFH-8 than Badshah. The higher test weight in MSFH-8 might be due to lesser number of seeds head-1 and ultimately larger seed size than Badshah.

In general, the seed yield was higher during 1995 than in 1996. The hybrid Badshah gave significantly higher yield than MSFH-8 during both the years as well as on average basis. Based on mean of two years, sunflower hybrid Badshah gave 14.23 per cent higher seed yield over MSFH-8. The higher seed yield of Badshah is due to its better yield attributes. Bhola and Faroda (1990) also reported variations in seed yield of sunflower hybrid/varieties.

Effect of organic manures

Application of FYM or vermicompost at 10t ha^{-1} as well as vermicompost at 5t ha^{-1} produced significantly higher dry matter plant^{-1} than no organic manure during both the years (Table 1). At harvest, dry matter production was significantly improved by the application of organic manures specially with FYM and vermicompost at 10t ha^{-1}. The significant increase in dry weight might be due to cumulative effects of improvement in all the growth parameters due to application of organic manures. Average increase in dry weight plant^{-1} was 7-9 per cent with 10t ha^{-1} FYM and 10.5 per cent with 10 t ha^{-1} vermicompost over no organic manure. Increase in dry weight of sunflower by the application of organic sources was also reported by Jimenez *et al.* (1986) and Nirmalnath and Sreenivasa (1993).

Application of organic manures significantly improved the yield attributing characters over no organic manure. The vermicompost at 10 t ha^{-1} produced significantly more number of seeds head^{-1} which were on an average 18.95 per cent higher than no organic manure in both the years. The 100-seed weight was significantly higher with FYM and vermicompost at 10 t ha^{-1} during 1995 and with any of the organic manures during 1996 which were on an average 5.19, 51.0, 5.29 and 5.15 g with FYM, vermicompost at 5 t ha^{-1}, vermicompost at 10 t ha^{-1} and bio-organic soil enricher compared to no organic manure (5.02 g), respectively (Table 1).

Application of organic manures resulted in significantly higher seed yield compared to no organic manure. The seed yield increased significantly due to the application of either vermicompost or FYM as well as bio-organic soil enricher as compared to no organic manure in 1996. Mean data showed that the seed yield of sunflower was significantly higher with the application of vermicompost at 10 t ha^{-1}(2415 kg ha^{-1}) compared to other organic sources. The seed yield was also

Table 1: Dry weight, yield attributes and seed yield of sunflower hybrids as influenced by organic manure sources and $N+P_2O_5$ levels.

Treatments	Dry weight plant^{-1} (g)		No. of seeds head^{-1}		100-seed weight (g)		Seed yield (kg ha^{-1})		
	1995	1996	1995	1996	1995	1996	1995	1996	Pooled
Hybrids									
MSFH-8	150.18	144.54	931.6	824.7	**5.28**	**5.26**	2234	1884	2059
Badshah	128.05	125.44	1031.2	943.8	**5.05**	**5.04**	2519	2185	2352
CD (0.05)	4.69	4.96	76.0	69.5	**0.07**	**0.08**	121	123	**63**
Organic sources									
No organic manure	131.02	127.11	903.7	812.2	**5.03**	**5.00**	2067	1787	**1927**
FYM at 10 t ha^{-1}	141.48	136.94	971.5	848.3	5.20	5.18	2361	1969	**2165**
Vermicompost @ 5 t ha^{-1}	140.86	135.43	986.5	893.8	5.04	5.15	2438	2068	**2253**
Vermicompost @ 10 t ha^{-1}	144.07	141.23	1056.1	985.0	5.40	5.28	2575	2255	**2415**
Bio-organic soil enricher (Fertonic) @ 250 kg ha^{-1}	138.15	134.22	989.0	881.7	5.15	5.15	2440	2096	**2268**
C.D. (0.05)	7.41	7.84	120.1	109.9	**0.12**	**0.12**	191	194	100
$N+P_2O_5$ (kg ha^{-1})									
0	106.80	99.75	799.2	708.8	**4.59**	**4.57**	1799	1376	**1588**
40+20	135.46	131.18	935.2	863.4	**5.00**	**4.99**	2187	1914	2051
80+40	153.26	150.31	1056.0	937.2	**5.39**	**5.41**	2717	2381	**2549**
120+60	160.95	158.70	1135.1	1027.5	5.67	5.64	2802	2468	2635
C.D (0.05)	1.36	1.86	21.8	27.1	0.03	0.04	50	33	**28**

significantly higher (103 kg ha^{-1}) with bio-organic soil enricher than FYM. It might be due to imporvement in physical, chemical and biological properties of soil by vermicompost and bio-organic soil enricher being rich in nutrients, especially nitrogen.

Effect of fertilizer

Each successive increase in $N+P_2O_5$ level resulted in significant increase in dry weight plant-1 in both the years (Table 1). The increase in dry weight with the application of 120+60kg ha^{-1} $N+P_2O_5$ was 19.9 and 54.8 per cent over 40+ 20 kg ha^{-1} $N+P_2O_5$ and no fertilizer, respectively. The number of seeds $head^{-1}$ and 100-seed weight also improved significantly by the application of $N+P_2O_5$. The respective average increase in these parameters were 43.41 and 22.12 per cent with 120 + 60 kg ha^{-1} $N+P_2O_5$ over no fertilization. Such favourable response to increased rate of fertilisers might be attributed to availability of sufficient amount of plant nutrients throughout the growth period that had resulted into better plant vigour and superior yield attributes.

The seed yield increased significantly with the successive increment in fertility levels in both the years as well as in pooled analysis. The increase in seed yield was 388, 918, 1003 kg ha^{-1} in 1995 and 538, 1005 and 1092 kg ha^{-1} in 1996 with 40+20, 80+40 and 120+60 kg ha^{-1} $N+P_2O_5$ over no fertilizer, respectively.

Nitrogen and phosphorus are the most common elements limiting sunflower growth and yield. Adequate supply of these nutrients to crop helps in the synthesis of carbohydrates and proteins in plants, which in turn are required for the formation of protoplasm which result higher cell division and cell enlargement and favourable improvement in the growth characters and ultimately the higher dry matter accumulation. An overall improvement in sunflower due to application of nitrogen and phosphorus has been reported by singh *et al.* (1987) and Vivek and Chakor (1992).

The interaction effect of organic x inorganic manures on dry matter revealed that response to applied fertilizers was more under no organic manure conditions (Table 2). All the organic manures were significantly superior to no organic manure under no fertilization. But vermicompost 10 t ha^{-1} which was at par with other organic manures, produced significantly higher dry matter plant-1 compared to no organic manure under increasing levels of fertility.

Interaction effect on seed yieldshowed that seed yield increased sgnificantly due to higher rate of $N+P_2O_5$ application under no organic manure in both the years as well as in pooled analysis (Table 3). The seed yield of sunflower increased significantly only upto 80 + 40 kg ha^{-1} $N+P_2O_5$ based on pooled analysis. It was also observed that vermicompost at 10 t ha^{-1} gave significantly higher seed yield than other organic surces under 120+60kg ha^{-1} $N + P_2O_5$ on two years average basis, but this was not true with bio-organic soil enricher.

Economics

The mean data on net returns revealed that among the two sunflower hybrids Badshah gave appreciably higher net returns than MSFH-8 which was mainly due to higher seed yield of Badshah (Table 4).

The gross and net returns increased with the application of any of the organic manures. Application of FYM, vermicompost at 5 t ha^{-1}, vermicompost at 10t ha^{-1} and bio-organic soil enricher gave net return of Rs. 2194, 4090, 5226 and 4425 in MSFH-8 and Rs. 5644, 5385, 5550 and 6099 in Badshah as compared to no organic manure, respectively.

These data celearly showed that both hybrids gave better returns either at 120 + 60 kg ha^{-1} $N+P_2O_5$ without organic manure or with the

Table 2: Interaction effect of organic manure sources and $N+P_2O_5$ levels on dry weight of plant (g) at harvest

Organic sources	$N+P_2O_5$ levels (kg ha^{-1})			
	0	40+20	80+40	120+60
		1995		
No organic manure	96.08	128.40	144.78	154.32
FYM @ 10 t ha^{-1}	111.93	133.97	156.15	163.85
Vermicompost @ 5 t ha^{-1}	108.40	139.83	153.88	161.32
Vermicompost @ 10 t ha^{-1}	110.72	140.70	159.80	165.07
Bio-organic soil enricher (Fertonic)@ 250 kg ha^{-1}	106.85	134.40	151.68	159.68
		1996		
No organic manure	89.05	123.82	143.90	151.68
FYM @ 10 t ha^{-1}	100.83	132.05	152.60	162.28
Vermicompost @ 5 t ha^{-1}	101.73	130.45	150.17	159.37
Vermicompost @10 t ha^{-1}	105.63	139.43	157.20	162.65
Bio-organic soil enricher (Fertonic) @ 250 kg ha^{-1}	101.52	130.17	147.67	157.52

C.D. (0.05)

	1995	**1996**
Two levels of $N+P_2O_5$ at same organic source	3.03	4.17
Two organic sources at same or different $N+P_2O_5$ levels	7.85	8.63

Table 3: Interaction effect of organic manure sources and N+P_2O_5 levels on seed yield (kg ha^{-1}) of sunflower

Organic sources	N+P_2O_5 levels (kg ha^{-1})			
	0	40+20	80+40	120+60
		1995		
No organic manure	1355	1785	2447	2680
FYM @ 10 t ha^{-1}	1787	2228	2685	2743
Vermicompost @5 t ha^{-1}	1890	2272	2787	2805
Vermicompost @10 t ha^{-1}	2068	2433	2880	2920
Bio-organic soil enricher (Fertonic) @ 250 kg ha^{-1}	1895	2217	2788	2862
		1996		
No organic manure	1003	1617	2168	2358
FYM @ 10 t ha^{-1}	1323	1855	2318	2380
Vermicompost @ 5 t ha^{-1}	1397	1928	2438	2507
Vermicompost @ 10 t ha^{-1}	1683	2155	2558	2622
Bio-organic soil enricher (Fertonic) @ 250 kg ha^{-1}	1473	2015	2423	2472
		Pooled		
No organic manure	1179	1701	2308	2519
FYM @ 5 t ha^{-1}	1555	2042	2502	2562
Vermicompost @ 5 ha^{-1}	1643	2100	2613	2656
Vermicompost @ 10 t ha^{-1}	1876	2294	2719	2771
Bio-organic soil enricher (Fertonic) @ 250 kg ha^{-1}	1684	2116	2612	2661

	C.D. at 5%		
	1995	1996	Pooled
Two levels of N+P_2O_5 at same organic source	112	74	62
Two organic sources at same or different N+P_2O_5 levels.	214	204	113

Table 4 : Gross and net returns (Rs./ha) of sunflower hybrids as influenced by organic manure sources and N+P_2O_5 levels

Treatments	Mean seed yield (kg ha^{-1})		Gross returns (Rs. /ha)		Total cost of cultivation (Rs./ha)		Net Returns (Rs./ha)	
	MSFH -8	Badshah	MSFH-8	Badshah	MSFH-8	Badshah	MSFH-8	Badshah
No organic manure +N+P_2O_5								
0	1062	1297	9823	11997	8970	8970	854	3027
40+20	1515	1887	14014	17455	9620	9620	4394	7835
80+40	2150	2465	19887	22801	10270	10270	9618	12531
120+60	2274	2765	21034	25576	10920	10920	10115	14656
FYM at 10 t ha^{-1}+n+P_2O_5								
0	1369	1742	12663	16113	10470	10470	2193	5644
40+20	1875	2209	17344	20433	11120	11120	6224	9313
80+40	2236	2686	20683	24845	11770	11770	8913	13076
120+60	2382	2821	22033	26094	12420	12420	9614	13674
Vermicompost at 5 t ha^{-1} +N+P_2O_5								
0	1574	1714	14559	15854	10470	10470	4090	5385
40+20	1940	2260	17905	20905	11120	11120	6825	9785
80+40	2436	2771	22533	25632	11770	11770	10763	13862
120+60	2524	2806	23347	25955	12420	12420	10927	13536
Vermicompost 10t ha^{-1} +N+P_2O_5								
0	1859	1894	17196	17519	11970	11970	5226	5550
40+20	2190	2399	20257	22191	12620	12620	7638	9571
80+40	2571	2890	23782	26732	13270	13270	10512	13463
120+60	2606	2914	24105	26954	13920	13920	10186	13035
Bio-organic soil enricher (Fertonic) at 250 kg t ha^{-1} +N+P_2O_5								
0	1594	1775	14744	16419	10320	10320	4425	6099
40+20	2025	2207	18731	20415	10970	10970	7761	9445
80+40	2460	2745	22755	25391	11670	11670	11135	13771
120+60	2541	2801	23504	25909	12270	12270	11234	13639

combination of 80 + 40 kg ha^{-1} N+P_2O_5 with different organic manures.

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SUITABILITY OF EXCISED LEAF WATER RETENTION CAPACITY (ELWRC) TECHNIQUE FOR SCREENING CASTOR GENOTYPES FOR YIELD

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ABSTRACT

Excised leaf water retention capacity (ELWRC) has been used as a selection criteria for screening promising germplasm for both yield and also drought tolerance. In this study this technique was employed to screen castor genotypes for their superior yield performance. The results showed that the popular castor hybrid GCH-4 had highest leaf moisture content even 165 minutes after excision. To understand the basis of ELWRC of castor genotypes investigations were carried out with respect to epicuticular wax content, stomatal conductance, respiration and leaf reflectance and transmittance properties. The findings showed that the superior performance of GCH-4 was due to quick response of stomata coupled with low radiation load due to higher leaf reflectance and transmittance properties in the wavelength range of 400-1000nm. The fact that both GCH-4 and its male parent had similar ELWRC indicates that this trait is heritable.

Key words : ELWRC technique, screening, castor.

INTRODUCTION

Various techniques have been employed in the past to screen genotypes for their ability to perform better under limited soil water environments (Jordon *et al.*, 1983, Sinha, 1986). One of the easiest techniques that has been used relates to excised leaf water retention capacity (ELWRC) of the crops (Clarke and Mc Caige, 1982; Rao, 1988) which involves monitoring the rates of water loss in the excised leaves of the crops. It has been shown that the technique also reflects the crop performance under water limited field conditions. Dedio (1975) found differences in excised leaf water loss rates among wheat genotypes and obtained encouraging results. This technique is quite rapid enabling screening large number of genotypes. This technique has been evaluated in sorghum both under filed and pot grown plants (Rao, 1988). The underlying physiological reasons for differences in excised leaf water retention capacity have been poorly understood and need further investigation. This trait seems to be some what heritable and is positively related to yield and drought tolerance (Clarke, 1987).

Castor is an important commercial crop grown under rainfed conditions in the alfisols of Deccan plateau of the Indian sub continent. Presently, the yield of castor is limited by drought occurring at various pheno-phases during the crop season. Being a long duration crop, various factors influence the final performance and hence field evaluation of the genotypes becomes relatively difficult. It would be useful to evolve a simple criteria for evaluating the crop performance in terms of yield under water limited conditions. In this study, an attempt was made to screen promising genotypes of castor using the excised leaf water retention technique and correlate with crop performance. Efforts were also directed to understand the physiological basis of ELWRC of castor genotypes.

MATERIALS AND METHODS

Eleven genotypes of castor (*Ricinus communis L.*). RCP 5-2, 48-1, JI-35, HC-6, HC-8, Sowbhagya, Aruna, VP-1, NES-6, LRES-17 and GCH-4 were raised in summer 1996 at CRIDA's experimental field. The crop was sown on 12-1-96 with90 cm

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rows and the experiments were conducted 80 days after sowing. Recommended agronomic practices were followed in raising the crop. Three fully expanded leaves of the genotypes were selected for the study. The room temperature during the study varied from 28 to 30°C.

The leaves were excised at the base excluding the petioles and immediately transferred to the laboratory to record their fresh weights. The water retention capacity of leaves after excision was measured by recording the weights of the leaves at different time intervals. The weight loss of the leaves was recorded every 15 to 30 minutes up to 165minutes. The initial weights of the leaves after excision was taken as 100 per cent moisture. ELWRC was calculated based on the percentage of weight loss of leaves from initial weight over a period of time.

The stomatal conductance of the excised leaves was monitored at regular intervals after excision using a delta T portable porometer (model AP4). The porometer was standardized before using.

Immediately after excision the leaf reflectance was estimated in the wavelength range of 400-1000 nm using an integrating sphere of (LICOR-1800) Spectroradiometer. Standard procedures were followed for determining the spectral properties of the leaves.

The epicuticular wax content (EWC) in different castor genotypes was estimated by extracting the leaf wax with chloroform by adding 20 ml of chloroform to 10 dm^2 leaf discs and gentle shaking for 15 seconds. Subsequently after evaporation of chloroform, colour was developed with acidic $K_2Cr_2O_7$. The intensity of the colour was measured colormetrically (Ebercon *et al.*, 1977). The amount of epicuticular wax was determined from a standard graph prepared using polyethylene glycol as standard..

Leaf area of three young fully expanded leaves of each genotype was measured and oven dried at 70°C. The ratio between dry weight and leaf area was used to calculate specific leaf weight (SLW).

The respiration rates of intact and excised leaves were measured with portable Infrared gas analyser (LICOR-6200). The leaves were enclosed in the chamber and covered with a black cloth for measuring the respiration rates.

RESULTS

Excised leaf water retention capacity

The ELWRC of the eleven castor genotypes showed that VP-1, the female parent of GCH-4 lost less moisture compared to all other genotypes upto 45 minutes after excision (Fig. 1). For the remaining part of the study both GCH-4 and its male parent 48-1 had higher per cent leaf moisture content than all the genotypes studied. The next genotype to follow GCH-4 and 48-1 was HC-6. The genotype Aruna had lowest moisture content throughout the study. At the end of 165 minutes after excision GCH-4 and 48-1 had highest per cent moisture of 79.4 and 76.5 per cent, respectively, while Aruna had the lowest value of 42.8%. The mean per cent water loss was significantly lower in GCH-4, JI-35, 48-1 and HC-6 compared to Aruna, Sowbhagya, RCP5-2, HC-8, VP-1, NES-6 and LRES-17 (Table 1). Obviously, Aruna had highest rate of (0.347 per cent) water loss.

The stomatal conductance of intact leaves ranged from 0.3 to 1.03 cm s^{-1} (Fig. 2). Excising the leaves resulted in decrease of stomatal conductance of all the genotypes. The steepest decline could be observed in Aruna and Sowbhagya which also had the highest rates of stomatal conductance. GCH-4 had the lowest rate of stomatal conductance of 0.3cm s^{-1}. In LRES-17 the stomatal conductance increased after excision

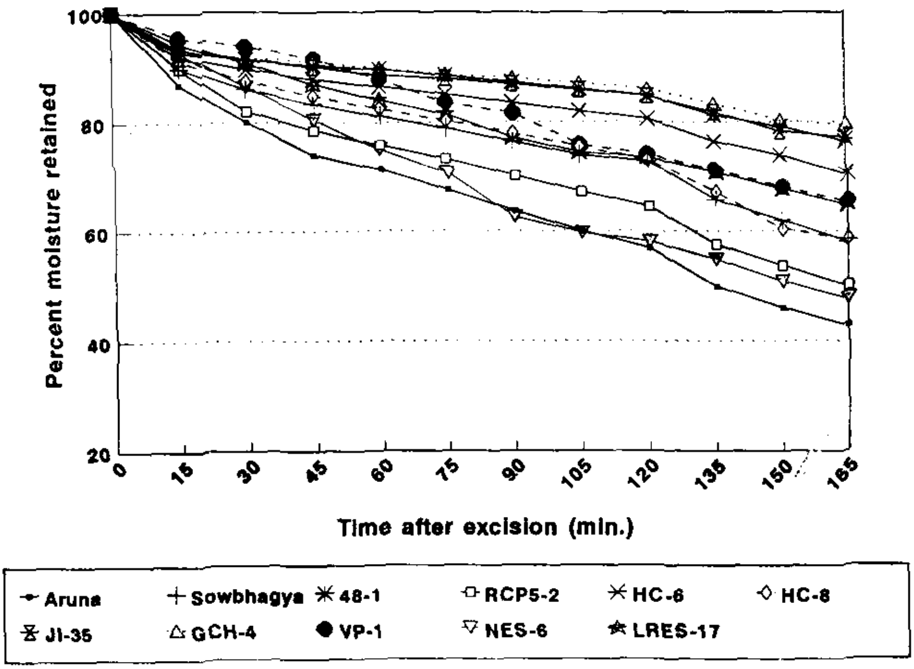

Fig-1 : ELWRC of castor genotypes under field conditions

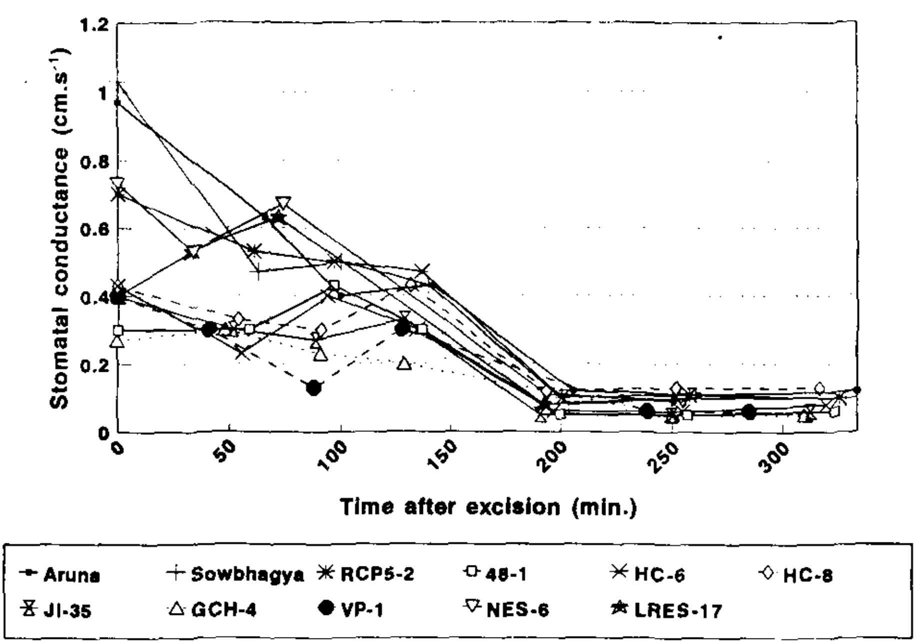

Fig-2 : Stomatal conductance of excised leaves of castor genotypes

Table 1 : Epicuticular wax content, specific leaf weitht, rate of water loss and mean bean yield of castor *genotypes under field conditions.*

Genotypes	Epicuticular Wax (μg.dm^{-2})	S.L.W (mg.cm^{-2})	Rate of Water loss (% units min^{-1})	Mean Bean Yield* (g. plant^{-1})
Aruna	806	6.2	0.35	26.07
Sowbhagya	813	6.4	0.26	15.33
RCP 5-2	875	8.0	0.30	19.50
48-1	1034	6.8	0.14	31.73
HC-6	1014	6.5	0.18	29.45
HC-8	1324	6.9	0.25	31.72
JI-35	793	6.3	0.14	31.11
GCH-4	914	6.5	0.13	32.5
VP-1	978	7.7	0.21	23.92
NES-6	537	7.2	0.32	20.0
LRES-17	653	7.0	0.21	29.8
SE	**86.4**	**0.517**	**0.024**	**3.73**
C.D. (0.05)	**254.93**	**NS**	**0.069**	**10.79**

* Mean Yield of castor cultivars; (Pooled data from 91 to 93 from both Irrigated and Rainfed)

but later it declined. All the genotypes had stomatal conductance of less than 0.2 cm s $^{-1}$, 200 minutes after excision.

Specific leaf weight and epicuticular wax content

The specific leaf weights of the genotypes ranged from 6.22 to 8.00 mg cm^2 in RCP 5-2. However, the differences were not significant (Table 1). The genotype HC-8 had highest quantity of epicuticular wax, which was significantly higher than the others, while NES-6 had the lowest quantity. GCH-4 had 914.6 μg dm^{-2} ,while its male parent had second highest amount of epicuticular wax (Table 1).

The respiration of the excised leaves were followed throughout the period of experimentation. NES-6 maintained lower respiration compared to all other genotypes (Fig. 3). Excision resulted in an increase in the respiration of all the genotypes except JI-35. Sowbhagya registered the steepest increase in respiration upto 40 minutes after excision. The respiration of all the genotypes was restored back within 140-180 minutes after excision.

GCH-4 had the highest reflectance properties in the entire spectral range (Fig. 4). In the infrared range it had significantly higher reflectance compared to other genotypes. In the same range NES-6 had the lowest reflectance.

GCH-4 transmitted maximum radiation in the infrared region starting from 725 nm onwards. On the contrary, NES-6 transmitted significantly higher

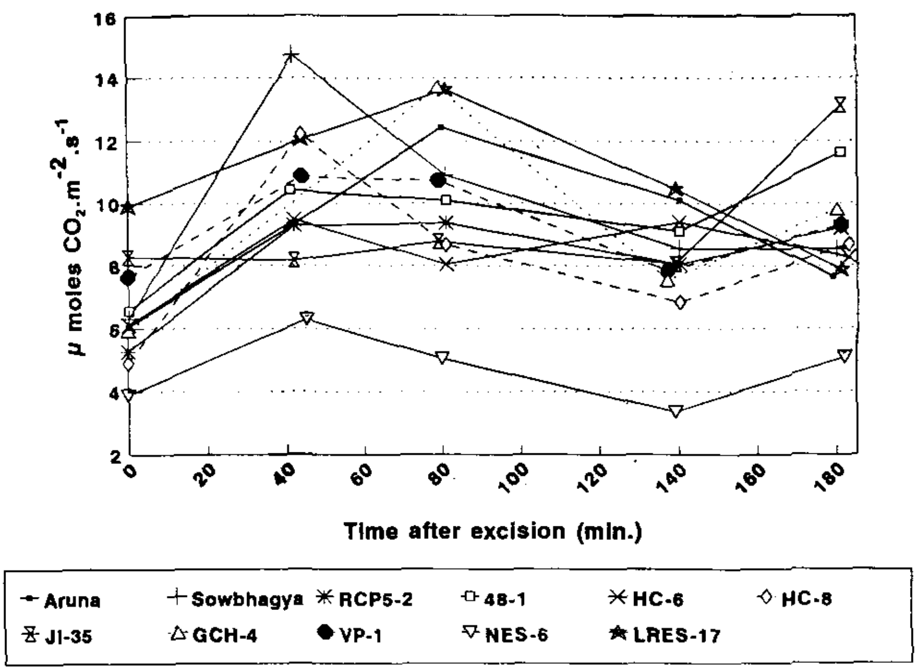

Fig-3 : Respiration of excised leaves of castor genotypes

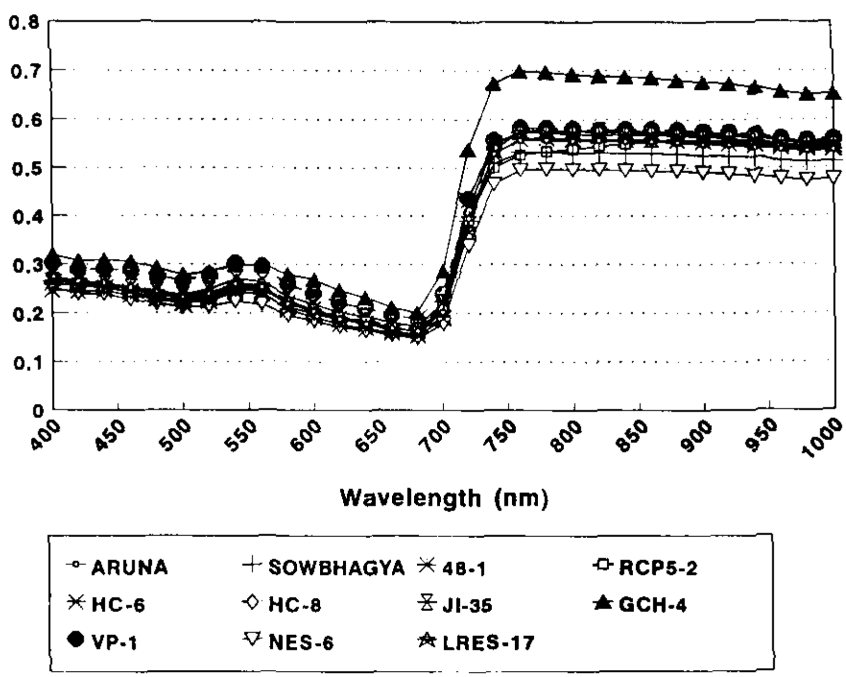

Fig-4 : Leaf reflectance properties of castor genotypes under filed conditions light in the wavelength range of 400-700 nm. There were no differences in this range among the other genotypes.

DISCUSSION

The hybrid GCH-4 and its male parent 48-1 had higher leaf water content than all other genotypes during the study (Fig. 1). The reason for this could partly be explained if the stomatal conductance rates of the genotypes after excision were considered. Immediately, after excision, the hybrid GCH-4 had lowest stomatal conductance of 0.3 cm s^{-1} (Fig. 2). Sowbhagya and Aruna had the highest stomatal conductance of around 1.0 cm s^{-1}. Because of the high rates of water loss Aruna had the lowest leaf water content, while Sowbhagya was intermediate among the genotypes. There were no differences among the genotypes for stomatal conductance 200 minutes after excision. Fluctuation in the stomatal conductance was found among the genotypes upto 150 minutes after excision.

The reflectance of GCH-4 was found to be higher in the infrared wavelength range (fig. 4). This was followed by VP-1, the female parent of GCH-4. Thomas *et al.*, (1967) observed increased reflectance of cotton leaves as relative water content (RWC) decreased and was more when the RWC was lower than 80%. The correlations of transmittance with RWC varied with wavelength. The transmittance values were also found to be higher in GCH-4 with the wavelength range of 700-1000 nm, whereas NES-6 had higher transmittance at 400-700 nm. The decreased radiation load may lead to lesser leaf water loss. This definitely is advantageous in the field as less transpiration would be required for evaporative cooling.

The specific leaf weight of the genotypes showed no relationship between the ELWRC and also the leaf reflectance (Table 1and Fig. 4). RCP 5-2 had higher SLW of 8.00 mg cm^{-2} was intermediate in reflectance properties. While, GCH-4 which had highest leaf reflectivity had a SLW value of 6.46 mg cm^{-2}. Leaf parameters particularly stage of development and structural changes due to environmental stresses, seem to influence the leaf spectral response irrespective of specific leaf weights (Table 1).

The epicuticular wax contentof these castor genotypes also did not show definite relationships with ELWRC and leaf reflectance. It is well known that in sorghum the EWC had a definite role to play in conserving the plant water content. Glaucousness in sorghum resulted in reduced photosynthetic rate (Chatterton *et al.*, 1975). In the present study, however the wax content could not be related to the ELWRC.

The respiration of genotypes showed fluctuations during the course of study and ranged from 4 to 10 μ moles of CO_2 m^{-2} s^{-1}, immediately after excision. Excision resulted in a steep increase in the rates of respiration except in JI-35. NES-6 maintained lower rates of respiration throughout (Fi.g 3). *One of the probable reasons could be that* it is a medium duration variety compared to other *female parents like* VP-1 *and* LRES-17.

GCH-4 had better ELWRC than all the other genotypes but was closer to its male parent. GCH-4 seems to have inherited better traits from both the male and female parents. It inherited the superior performance of its male parent with respect to ELWRC, while it bequeathed from its female parent better leaf reflectance properties. Even in the stomatal conductance pattern, the hybrid GCH-4 and its parents was similar. Inheritance by hybrids of desirable traits from both the parents is well known (Sinha and Khanna, 1975; Rao and Sinha,1988).

In drylands, one of the basis of superior performance can be traced to the ability of the crop to efficiently utilise the available moisture by avoiding the infrared radiation load. This can be achieved by reflecting or/and transmitting the

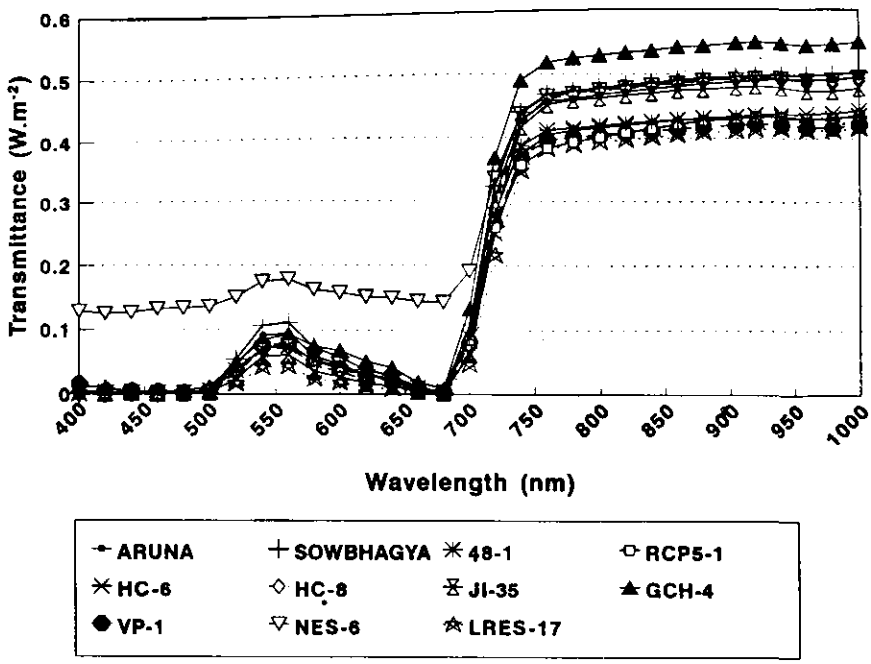

Fig-5 : Leaf transmittance of castor genotypes under field conditions

infrared radiation leading to decreased demand for transpirational cooling. Scientists have been using the canopy temperature differential for selecting the crops for limited water conditions. In the present study the basis for superior performance of GCH-4 with respect to ELWRC could be explained on the basis of quick stomatal response to excision, coupled with lower radiation load due to higher leaf reflectivity and higher transmittance in the infrared region.

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PERFORMANCE OF SUNFLOWER CULTIVARS IN RICE FALLOW SITUATIONS UNDER ALLUVIAL TRACT OF COASTAL ORISSA

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ABSTRACT

Field experiments (both on-station and on-farm) were conducted at Central Rice Research Institute, Cuttack in alluvial soils under upland and shallow lowland situations to evaluate the performance of recently developed sunflower hybrids and cultivars for their suitabilities in rice fallow situation. The hybrids/cultivars which were identified to be promising for upland situation were KBSH 1 (18.3q/ha), TNAU SUF 7 (17.4 q/ha) and PAC 36 (16.8 q/ha) while for shallow lowlands ICI 308, PAC 36 and TNAU SUF 7 proved better with average yields of 21.5, 19.5 and 19.4 q/ha respectively. Under farmers field condition, the varieties ICI 308 (25.8 q/ha) and KBSH1 (24.6 q/ha) were found superior to Morden (15.2 q/ha).

Keywords : Rice fallows, uplands, shallow lowlands, sunflower.

INTRODUCTION

Sunflower (*Helianthus annuus* L.) is predominantly grown in south and West Indian states viz., Karnataka, Andhra Pradesh, Tamil Nadu and Maharashtra in an area of 2.4 million hectares. Of late it is spreading into Indo-Gangetic belt of northern India and is becoming popular in the states of Punjab, Haryana, Uttar Pradesh and Bihar and covers an area of 3-4 lakh hectares in these states. Recently attempts are also being made to extend the area under this crop by cultivating it in Indo-Gangetic alluvial lands of West Bengal under rice fallow situation (Sarkar *et al.*, 1995). No systematic work on sunflower under the rice fallow situation in Mahanadi alluvial belt in Coastal Orissa was done so far. Most of the rice area under uplands (0.85 million hectares) and 1.74 million hectares under shallow lowlands in the state remains fallow during *rabi*/summer season and thus offering scope to cultivate other crops. Since sunflower is a photoinsensitive, deep rooted and short duration crop, enough possibilities exist to grow this crop in rice fallow situations after the harvest of *Kharif* rice of different durations under different land types. Hence, investigations were conducted at the Central Rice Research Institute, Cuttack to identify a suitable genotype of sunflower for growing under rice fallow situations in alluvial belt of coastal Orissa.

MATERIALS AND METHODS

Field experiments were conducted to evaluate different sunflower varieties for their suitability and yield potential under rice fallow situations and shallow lowlands. The soil was alluvial (Haplaquept). In the upland trial, which was conducted during *rabi* season of 1995-96, after the harvest of short duration rice (cv. Annada), nine cultivars of sunflower viz., KBSH1, BSH 1, MSFH8, TNAU SUF 7, PSCL 5015, PAC 36, CO1, CO2 and Morden were tested. Under shallow lowland situation, after the harvest of long duration rice (cv. Gayatri), during the summer season (Feb. to May) of 1996, nine sunflower cultivars viz., KBSH 1, BSH 1, TNAU SUF 7, PSCL 5015, PAC 36, ICI 308, CO 1, CO2 and Morden, and during 1997, eight sunflower varieties viz., KBSH 1, TNAU SUF 7, PAC 36, ICI 308, Jwalamukhi, CO 1, CO 2 and Morden were evaluated. Among the cultivars used in different experiments KBSH 1, BSH 1 and MSFH 8 were hybrids and the rest were varieties. The design adopted in all the trials was randomized complete block design with three replications. Besides these on-station trials, on-farm trials under shallow lowland situation were also carried out to test the performance of three selected cultivars of

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sunflower viz., ICI 308, KBSH 1 and Morden during summer season of 1996 in Jagatsingpur district of Orissa.

The crop under upland situation was sown on December 8, 1995. Sowing in this situation which could be done in October-November was delayed due to continuous rains during the year. Under Shallow upland situation, the crop was sown on January, 27 and January 22, during 1996 and 1997, respectively. A spacing of 60 cm x 30 cm was adopted in all the trials. A common fertilizer dose of 30 kg N, 30 kg P_2O_5 and 20 K_2O/ha was applied at the time of sowing. Another dose of 30 kg N and 20 kg K_2O/ha was applied 45 days after sowing during the peak vegetative stage. In upland trial, three irrigations were given; each at sowing, early vegetative growth stage (20 days after sowing) and peak vegetative growth stage (45 days after sowing). In shallow lowland situation also same number of irrigations was given during 1996 but during 1997, only two irrigations, first at sowing and another one 20 days after sowing was given. Adequate rains occured during peak vegetative stage and hence irrigation was not given. In the on-farm trials also the same practice of three irrigations was followed for raising the crop.

The flower heads were harvested when the back of the head turned into lemon yellow colour and the leaves started drying and withering. Data on duration, plant height (mean of five plants) at harvest, seed yield per plot (expressed as q/ha), head diameter (mean of five heads), seed weight/head, seed filling % and test weight (100 seed weight) in case of on-station trials, while only seed yield in case of on-farm trials were recorded.

RESULTS AND DISCUSSION

On-station trials

Performance under upland situation

Among the nine cultivars tested, highest seed yield was obtained in the hybrid KBSH 1 followed by TNAU SUF 7. The others, BSH 1, MSFH 8, PSCL 5015 and PAC 36 were comparable to KBSH 1 in seed yield. The % increase in yield of these cultivars over Morden was in the range of 38-62%. The variety TNAU SUF 7 was the tallest followed by KBSH 1, while the variety Morden was the dwarfest among the cultivars. The highest yielding KBSH 1 also produced heads of widest diameter which could accommodate more number of seeds. The cultivars TNAU SUF 7 and PSCL 5015 were the next best in terms of head diameter. The seed weight/head, test weight and seed filling % were also highest in KBSH 1. The duration of different varieties ranged from 80 to 100 days (Table 1).

Performance under shallow lowland situation

During 1996, among the nine cultivars tested, PSCL 5015 produced the highest seed yield closely followed by KBSH 1, TNAU SUF 7 and ICI 308, BSH 1 and PAC 36 were also comparable to these cultivars. During 1997, among the eight varieties tested, best performance was shown by ICI 308. The varieties viz., Jwalamukhi and PAC 36 were comparable to it. Mean maximum plant height was recorded in the variety TNAU SUF 7, followed by KBSH 1. Morden was the dwarfest among all the varieties. The duration of different varieties during the season varied from 82-105 days which was more or less similar to that of upland situation (Table 2).

The diameter of the head was maximum in PSCL 5015 closely followed by KBSH 1 during 1996; while during 1997, ICI 308 recorded the highest head diameter closely followed by Jwalamukhi and PAC 36. The seed weight./head was higher in PSCL 5015, ICI 308 and KBSH 1 during 1996, while during the subsequent year, ICI 308, Jwalamukhi and TNAU SUF 7 were superior. Test weight and seed filling % were the highest in KBSH 1 during both the years. The varieties BSH 1, TNAU SUF 7, PAC 36, Jwalamukhi and ICI 308 produced almost similar seed filling % as that of KBSH 1 (Table 3).

Table 1 : Plant height, yield attributing characters, yield and duration of different sunflower cultivars grown in upland rice fallows during 1995-96.

Cultivar	Plant height (cm)	Head diameter (cm)	Seed wt./ head (g)	100 seed weight (g)	Seed filling (%)	Seed yield (q/ha)	Duration (days)
KBSH1	147	16.6	64	10.2	78	18.3	95
BSH 1	140	15.7	53	9.1	74	16.3	94
MSFH 8	131	15.7	55	7.0	72	16.2	97
TANU SUF 7	148	16.5	60	8.4	75	17.4	94
PSCL 5015	134	16.2	57	8.7	71	15.6	100
PAC 36	138	15.2	59	8.2	71	16.8	99
CO 1	105	11.1	34	7.0	66	9.7	78
CO 2	118	13.3	38	7.0	67	11.0	81
Morden	71	13.6	41	8.2	71	11.3	80
S.Em±	3.3	0.3	1.5	0.1	1.2	1.4	-
CD (0.05)	10.0	0.8	4.6	0.3	3.7	4.2	-

Table 2 : Plant height, seed yield and duration of different sunflower cultivars grown in rice fallows of shallow lowland during 1996 and 1997.

Cultivar	Plant height (cm)		Seed yield (q/ha)		Duration (days)	
	1996	1997	1996	1997	1996	1997
KBSH1	151	160	19.9	18.2	96	100
BSH 1	128	-	18.9	-	94	-
TNAU SUF7	141	186	19.5	19.3	98	105
PSCL 5015	137	-	20.1	-	99	-
PAC 36	126	160	17.1	21.8	94	99
Jwalamukhi	-	152	-	22.9	-	107
ICI 308	138	182	19.2	23.7	99	103
CO 1	113	87	10.6	7.4	82	84
CO 2	125	125	13.3	10.0	84	84
Morden	81	83	11.6	13.0	85	87
S.Em±	2.6	3.6	1.8	0.8	-	-
CD (0.05)	7.9	10.8	5.4	2.4	-	-

Correlation of yield attributes with yield

In upland trial, the characters viz., plant height, head diameter, seed weight/head and seed filling % showed highly significant positive correlation with the seed yield. Only one character i.e. test weight did not show any correlation with yield. In the shallow lowland trial, all the characters (plant height, head diameter, seed weight/head, test weight and seed filling % showed highly significant positive correlation with seed yield during 1997, however, during 1996 all the characters except plant height and head diameter showed highly significant positive correlation with seed yield (Table4). Patil *et al.*, (1996) reported correlation between seed yield and different yield attributing characters indicating that enough scope exists for improvement of these characters in genotypes for realizing the desired yield levels. Thus, these correlation studies indicate that the higher yield levels achieved in the promising cultivars identified in the trials, were due to better expression of their yield attributing characters (Table 4).

On-farm trials

Among the three cultivars tested, KBSH 1 and ICI 308 were superior to Morden in terms of seed yield. The highest yield was obtained from ICI 308 followed by KBSH 1. The yield advantage of these two varieties over Morden was to an extent of 50 to 95% (Table 5). In general, the performance of on-farm trials conducted during 1996 was superior to on-station trials conducted during the sesame year. It was due to better management of the experiments by the farmers.

From the investigations, it is evident that for the rice fallows of alluvial belt of Orissa, the sunflower varieties KBSH 1, TNAU SUF 7 and PAC 36 for upland situation after the harvest of short duration rice and for shallow lowland situation, the cultivars ICI 308, Jwalamukhi, PAC 36, PSCL

Table 3 : Yield attributing characters of different sunflower cultivars grown in rice fallows of shallow lowland situation during 1996 and 1997.

Cultivar	Head diameter (cm)		Seed weight/head (g)		100 seed Weight (g)		Seed filling %	
	1996	1997	1996	1997	1996	1997	1996	1997
KBSH1	17.3	16.4	67	64	10.3	9.8	74	70
BSH 1	16.5	-	64	-	9.4	-	72	-
TNAU SUF7	17.0	16.8	66	65	8.7	8.9	73	70
PSCL 5015	17.6	-	69	-	9.5	-	68	-
PAC 36	15.3	17.8	57	66	8.9	9.1	71	71
Jwalamukhi	-	18.0	-	65	-	9.2	-	71
ICI 308	16.2	18.4	68	70	8.6	9.1	69	73
CO 1	10.7	10.6	36	31	6.8	6.3	56	51
CO 2	15.8	14.0	45	34	7.2	6.8	64	54
Morden	13.0	13.1	41	46	8.0	8.1	61	63
S.Em±	0.4	0.2	2.3	0.7	0.1	0.1	0.1	0.9
CD (0.05)	1.2	0.6	6.9	2.0	0.3	0.3	3.3	2.6

Table 4 : Correlation coefficient (r) between seed yield (kg/ha) and other yield attributing characters of sunflower

A. Upland trial

	Characters	Values
1.	Plant height	0.828 **
2.	Head diameter	0.942 **
3.	Seed weight/head	0.986 **
4.	Test weitht (100 seed)	0.572
5.	Seed filling (%)	0.862 **

B. Shallow lowland trials

	Characters	Values	
		1996	1997
1.	Plant height	0.194	0.826 **
2.	Head diameter	0.604	0.967 **
3.	Seed weight/head	0.999 **	0.972 **
4.	Test weitht (100 seed)	0.825 **	0.894 **
5.	Seed filling (%)	0.929 **	0.966 **

** - Significant at 1% Level

5015 and TNAU SUF 7 after the harvest of long duration rice were found promising with seed yield ranging from 19.5 to 24.6 q/ha.

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Table 5 : Seed yield of sunflower cultivars in On-farm trials conducted during 1996 at different locations of Jagatsingpur district

Locations	Seed yield (q/ha)					
	ICI 308		KBSH-1		Morden	Mean
Puranodapada	26.3	(54.7)	24.8	(45.9)	17.0	22.7
"	27.1	(62.3)	25.1	(50.3)	16.7	23.0
"	26.0	(62.5)	24.0	(50.0)	16.0	22.0
Joinkoti	25.5	(70.0)	25.0	(66.7)	15.0	21.8
"	25.0	(95.3)	24.5	(91.4)	12.8	20.8
"	25.0	(85.2)	24.0	(77.8)	13.5	20.8
Mean	25.8		24.6		15.2	21.9

Figures in parenthesis indicate % yield advantage over Morden.

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INFLUENCE OF SOWING TIME ON THE PERFORMANCE OF GROUNDNUT (*Arachis hypogaea* L.) VARIETIES.

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ABSTRACT

An experiment was conducted during *Kharif* 1992 and 1993 to study the response of groundnut varieties (ICGS 11, Gimar 1, J 11 and ICGS 44) to different sowing dates. The results indicated that in the eastern part of Madhya Pradesh, sowing of groundnut upto 10th July was suitable during both the years. Thereafter, yield decreased to the extent of 78.5 kg/day. Among the varieties ICGS 11 performed better followed by Gimar 1 over rest of the varieties. Oil and protein content in kernel were not affected significantly due to different dates of sowing, where as N, P and K uptake decreased significantly with delayed sowing.

Key words : Groundnut, varieties, sowing dates, N, P and K uptake, yield.

INTRODUCTION

Groundnut is grown extensively during rainy season in eastern part of Madhya Pradesh. But the productivity of this crop is very low i.e, 400 to 600 kg/ha owing to delayed sowing and lack of suitable varieties. Sowing of suitable varieties at proper time was reported to enhance pod yield, shelling percentage and oil yield (Padma *et al.*, 1991). Sowing of groundnut beyond or before its optimum time causes reduction in pod yield (Ahmad, 1992). Therefore, the present study was undertaken to find out the optimum sowing time with suitable variety for maximum productivity.

MATERIALS AND METHODS

Field experiments were conducted at IGKV, Regional Agricultural Research Station, Raigarh (M.P.) during *Kharif* seasons of 1992 and 1993. The soil of the experimental site was sandy loam. The available nitrogen, phosphorus and potash in the experimental site were 230.8, 6.4 and 224.4 kg/ha in 1992 and 240.2, 7.8 and 236.2 kg/ha in 1993, respectively with pH 6.2. Three dates of sowing (from end of June to third week of July) and 4 varieties (ICGS 11, Gimar 1, J 11 and ICGS 44) were tried in a split-plot design with three replications. A uniform basal dose of 30 kg N, 60 kg P_2O_5 and 30 kg K_2O were applied at the time of field preparation. The crop was sown in 30 cm x 10 cm spacing using 120 kg/ha seed rate. All the recommended cultural practices were followed to raise the crop. Ten plants from each treatment were selected randomly for yield attributing parameters. Pod yield was recorded net plot wise and finally expressed in quintals per hectare. The nitrogen content was estimated by Kjeldhal method (Chapman and Pratt, 1961) and phosphorus and potassium contents were analysed as described by Piper (1966). Protein content was calculated by multiplying the per cent concentration of nitrogen with a factor of 6.25 (Singh, 1985). The oil content in seed was determined using Soxhlet method (Sankaram, 1966).

RESULTS AND DISCUSSION

Yield Attributes and Yield

The data presented in Table 1 revealed that the number of pods per plant, shelling per cent, 100 seed weight (g) and pod yield were significantly influenced due to sowing dates and varieties during both the years. Sowing of groundnut upto second

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Table 1 : Effect of sowing dates and varieties on yield components and yield of *Kharif* groundnut.

Treatments		Pods/Plant			Shelling per cent			100 seed weight (g)			Pod yield (kg/ha)		
		1992	1993	Pooled	1992	1993	Pooled	1992	1993	Pooled	1992	1993	Pooled
Date of sowing													
1992	1993												
28 June	27 June	29.0	19 2	24.1	63 8	66 0	64.9	28 7	25.3	27.0	2155	1472	1814
10 July	7 July	28 2	17.9	23.1	62 8	62.3	62.6	27 9	24 8	26.4	2007	1372	1689
23 July	19 July	13.7	10 8	12.3	58 5	56 0	57.3	22.4	19.0	20.7	720	626	673
SEm±		0.69	0.25	0.35	0 59	0 64	0.58	0.47	0.32	0 32	50	27	39
CD (P=0.05)		2.70	0.98	1.14	2 30	2.51	1.89	1.84	1.25	1.04	198	106	128
Varieties													
ICGS 11		26.3	18.9	22.6	60 8	61.4	61.1	26 8	23.5	25.1	1881	1313	1597
Girnar 1		21.8	15.5	18.7	59 6	53.2	56.4	22.0	19.6	20.8	1697	1137	1417
J 11		22.7	13.0	17.9	65.3	66.6	66.0	25.7	22.8	24.2	1554	987	1271
ICGS 44		24 1	16 1	20.1	62 0	63.5	62.7	29 1	25.3	27.2	1512	1147	1329
SEm±		0.44	0.36	0.29	0.68	1 30	0.90	0.61	0 47	0.47	63	28	39
CD (P=0.05)		1.29	1.05	0.83	2.00	3.79	2.58	1.78	1 37	1.34	183	82	112

week of July (July 10 in 1992 and July 7 in 1993) being at par produced significantly higher pod yield compared to the sowing in third week of July (July 23 in 1992 and July 19 in 1993). The higher pod yield in earlier sowing could be attributed to the longer period available for vegetative and reproductive growth phases of the crop which enhanced the number of pods/plant, shelling percentage and 100 seed weight. Delay in sowing beyond second week of July showed adverse effect on yield attributes and yield, due to the higher rainfall at early stages of the crop that increased vertical growth of the plant, which could be the possible reason for inferior development of yield attributes and lower pod yield (Padhi, 1994). Delay in sowing also encountered with moisture stress during pod development stage which hampered growth of pods and finally pod yield whereas early sowing (last week of June) was observed to provide favourable moisture during the crop growth period. Padma *et al.* (1991) also reported reduction in various yield components and pod yield due to delay in sowing suggesting that partitioning of photosynthates from source for the development of sink (pods) was adversely affected. The reasons for such reduction were sharp decrease in temperature, rainfall and humidity at fag end of crop growth or restricted development of yield attributes and finally pod yield. Similar results were also reported by Patel *et al.*, (1991).

Among the different varieties, ICGS 11 produced significantly higher yield than the rest of the varieties with early sowing (last week of June). Padhi (1994) reported minimum number of filled pods/plant and pod yield in case of ICGS 44

Table 2 : Effect of sowing dates and varieties on N, P, and K uptake and quality of groundnut (mean of two years)

Treatments		Uptake of nutrients (Kg/ha)			Oil	Protein	Oil	Protein
		N	P	K	(%)	(%)	Yield (Kg/ha)	Yield (Kg/ha)
Date of sowing								
1992	1993							
28 June	27 June	96.2	25.5	78.4	48.4	22.4	565.3	262.1
10 July	7 July	92.3	23.1	74.6	47.8	22.2	500.9	233.1
23 July	19 July	84.3	12.4	62.8	46.6	22.1	176.1	85.1
SEm±		1.4	0.6	1.7	1.9	0.3	22.6	9.2
CD (P=0.05)		5.5.	2.4	6.7	NS	NS	88.7	36.1
Varieties								
ICGS 11		97.8	22.4	77.6	49.2	22.9	486.2	223.8
Girnar 1		90.4	20.2	70.2	46.8	21.8	378.1	177.9
J 11		83.8	18.6	67.8	46.4	21.5	388.4	182.3
ICGS 44		91.8	19.8	72.0	48.2	22.7	403.9	189.6
SEm±		2.2	1.0	2.8	0.7	0.5	33.1	13.3
CD (P=0.05)		6.5	3.0	8.3	2.1	NS	98.3	39.5

compared to AK 12- 24, JL 24 and Kadrai 3. In general ICGS 11 produced significantly higher pods/plant followed by Girnar 1, ICGS 44 and J 11. Higher number of pods/plant and 100 seed weight contributed mainly to higher pod yield of variety ICGS11.

Nutrient uptake and quality

Nitrogen, phosphorus and potassium uptake, oil and protein yield (Table 2) were significantly higher with sowing of groundnut upto second week of July compared to third week of July, owing to the higher pod yield during both the years. Oil and protein content of kernel were not affected with the different sowing dates (Patel and Thakur, 1997).

Among the varieties, ICGS 11 showed significantly higher uptake of nitrogen, phosphorus and potassium, oil and protein content in kernel than the rest of the varieties. Similarly, ICGS 11 recorded significantly higher oil and protein yield compared to other varieties. Girnar 1, J 11 and ICGS 44 varieties showed non significant variation in respect of nitrogen, phosphorus and potassium uptake and oil and protein content in kernel.

In view of the above, it could be infered that, the sowing of groundnut after 10th of July is not beneficial and among varieties, ICGS 11 performed better than Girnar 1, J 11 and ICGS 44.

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THE SENSITIVITY OF GROWTH AND YIELD OF MUSTARD TO EVAPO-TRANSPIRATION DEFICITS *

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ABSTRACT

A field study was conducted during 1993-94 *rabi* season on a sandy loam soil to examine the sensitivity of growth and yield of mustard to evapotranspiration (Eta) deficits imposed at different crop growth subperiods. Fully irrigated control (W-W-W) showed beneficial effects on growth and yield components which resulted in a maximum seed yield of 1047 kg/ha. The crop was insensitive to Eta deficits at vegetative period (D-W-W) as evident from low (0.46) yield reduction ratio (YRR) and there was not any significant reduction in seed yield relative to fully irrigated control. But the crop was found to be highly sensitive to Eta deficits at flowering-pod initiation and addition (YRR=1.55) and pod filling periods (YRR=2.49) and their combination growth sub periods (YRR=1.31to 1.74) which significantly reduced (33.4 to 91.4%) the seed yield in comparison to W-W-W. Lowest seed yield (89 kg/ha) resulted from severe Eta deficits from establishment to maturity. Hence, under deficient water supply situations to minimize yield losses available water should be directed to pod filling and flowering-pod initiation and addition crop-growth sub-periods.

Key words : Mustard, evapotranspiration deficit, yield reduction ratio.

INTRODUCTION

In order to produce maximum crop yield per unit of water used under limited water supply, there is a need to distribute the available limited water supplies during the crop growth sub periods when it is most needed. This requires the knowledge of relative sensitivity of crop yield to Eta deficits at different crop-growth sub-periods.

The present study was, therefore conducted to examine the sensitivity of mustard crop to Eta deficits imposed at different crop-growth sub periods and to suggest optimal irrigation practices to minimize yield losses under deficient water supply.

MATERIALS AND METHODS

The field experiment was conducted during the winter season of 1993-94 on a sandy loam soil at the College Farm of Acharya N.G. Ranga Agricultural University, Hyderabad, India (17°19N, 78°23' E and 542 m above m.s.l.).

The weekly mean maximum temperature for the crop period (31.10.1993 to 1.2.1994) ranged from 26.4°C to 30.9°C with an average of 28.7°C, while the mean weekly minimum temperature ranged from 8.7°C to 18.2°C with an average of 13.7°C. Weekly mean relative humidity varied between 50 and 71.9%, with an average of 55.7%. The sunshine hours varied from 5.0 to 10.5 hours per day. The climate of the region is semi-arid.

The evaporation from USWB class A pan evaporimeter ranged from 2.8 to 4.2 mm/day during the cropping season. The seasonal pan evaporation was 31.0 cm. An effective rainfall of 2.7 cm spread over two rainy days was received during the transition period of vegetative to flowering period, hence it was accounted in net irrigation requirement while scheduling irrigation to the crop.

There were eight irrigation treatments designed to allow Eta deficit to develop in one or more of three specific crop-growth sub periods viz., Vegetative, flowering-pod initiation and

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addition, and pod filling periods including a fully irrigated control water regime (Table 1). In any given growth sub period, the crop in a given treatment was either irrigated (W) to ensure Eta proceeded at maximum rate or the crop was not irrigated at All (D). For instance the crop in D-W-W was not irrigated during vegetative growth sub period (8 to 30 days after sowing) and was irrigated during flowering-pod initiation and addition and pod filling growth sub periods. Like wise the crop in treatments D-W-W, W-D-W, W-W-D, D-D-W, W-D-D, D-W-D, D-D-D, if irrigated (W) in a given growth sub period, the schedule duplicated that of the crop in W-W-W, if not irrigated (D) the actual Eta rate may have fallen below the maximum evapotranspiration rate relative to that in W-W-W treatment and the absolute difference was expressed for the period as an Eta deficit.

Following an Eta deficit at the end of crop growth sub period in stress treatments, the amount of irrigation water required was calculated on the basis of soil water deficit in the profile as follows. Irrigation (cm) equals soil water storage at field capacity (cm) less soil water storage before irrigation (cm).

The designed eight irrigation treatments provide all possible combinations of growth subperiods in which Eta deficits occurred, ranging from non (W-W-W) to all the three growth sub periods (D-D-D). The eight treatments were laid out in randomized block design with four replications.

The average moisture retentivity at -0.03 MPa, -1.5 MPa and available water storage in 60 cm soil profile was 17.16 cm, 8.68 cm and 8.48cm, respectively. The average bulk density was 1.66 g/ cm^3. The pHand electrical conductivity were 7.5 and 0.13 dS/m, respectively. The chemical constituents revealed that the experimental soil was

Table 1 : Details of irrigation treatments

Treatment designation	Discription	Field water supply (FWS)
W-W-W	Fully irrigated (Eta/Etm=1) control throughout the crop season	38.19
D-W-W	With-holding of irrigations at vegetative period (8-30 DAS)	32.43
W-D-W	With-holding of irrigations at flowering-pod initiation and addition period (30-70 DAS)	29.40
W-W-D	Withholding of irrigations at pod filling period (70-93 DAS)	33.94
D-D-W	With-holding of irrigations at vegetative and flowering-pod initiation and addition period (8-70 DAS)	27.56
W-D-D	With-holding of irrigations at flowering-pod initiation and addition and pod filling period (30-93 DAS)	21.23
D-W-D	With-holding of irrigations at vegetative (8-30 DAS) and pod filling period (70-90 DAS)	28.18
D-D-D	With-holding of irrigations at vegetative, flowering-pod initiation and addition and pod filling periods (8-93 DAS)	11.18

W = Water application equivalent to Eta/Etm/1 in a given growth sub period

D = With-holding of irrigations in a given growth sub-period

FWS = Available soil water at planting + effective rainfall + irrigation water applied.

low in available N (270 kg/ha), medium in available P (18kg/ha) and high in available K (508 kg/ha).

'Seetha' mustard variety was planted on 31st October, 1993 by adopting a row-to-row spacing of 30 cm and plant-to-plant distance of 10 cm in plots of 6.0 m x 5.0 m. Other recommended measures of production (80,22,30 kg, N,P and K/ha) and plant protection were adhered to. The crop was subjected to Eta deficits at different crop growth sub periods by with-holding irrigations from 8 days after sowing onwards. A 7.5 cm Parshall flume was used for measuring water during each irrigation. The potential evapotranspiration (PET) was computed by the FAO Penaman method (Doorenbos and Pruitt, 1977).

The actual Eta was estimated by gravimetric soil moisture measurements. This method is reliable where "water tables are not involved and good control over irrigation is possible" (Praveen Rao, 1993). Soil samples were collected at 15 cm intervals to full profile depth of 60 cm at planting and harvest, before and after each irrigation, and on intermediate dates as considered necessary. The crop was harvested on 1 February, 1994.

To quantify the sensitivity of crop yield to Eta deficits the yield reduction ratio (YRR) was worked out as follows :

$$YRR=(1-Ya/Ym)/(1-Eta/Etm)$$

where, Ya is actual seed yield of the crop as affected by Eta deficits; Ym, maximum seed yield of fully irrigated crop; Eta, seasonal evapotranspiration of the crop as affected Eta deficits and Etm, seasonal maximum evapotranspiration of fully irrigated crop.

RESULTS AND DISCUSSION

Seed yield was highest (1047 kg/ha) in fully irrigated control (W-W-W) treatment (Table 2). Eta deficits at different crop-growth sub periods in W-D-W, W-W-D, D-D-W, W-D-D, D-W-D and D-D-D treatments caused significant reduction (33.3 to 91.4%) in seed yield as compared to fully irrigated crop (W-W-W). But Eta deficit in vegetative growth sub period (D-W-W) did not cause any significant decrease in seed yield relative to that in W-W-W treatment.

The higher seed yield in W-W-W and D-W-W treatments could be attributed to favorable soil-water balance as evident from Eta/PET ratio (> 1.0 at flowering through pod initiation and addition and pod filling periods) an indicator of Eta deficit. Further the regression of seed yield on seasonal Eta (Fig. 1) and seasonal Eta deficit (Fig. 2) showed a significant correlation.

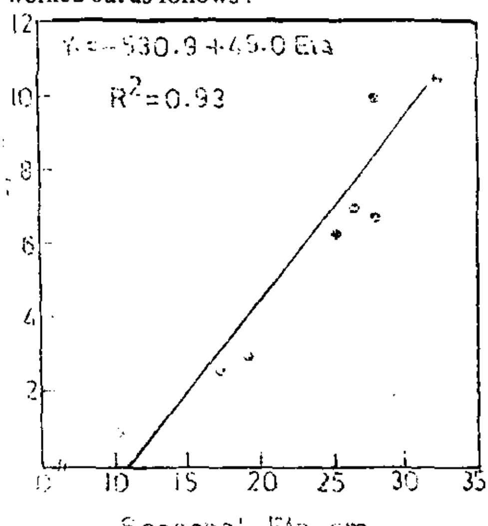

Fig-1 : Mustard seed yield response to seasonal Eta.

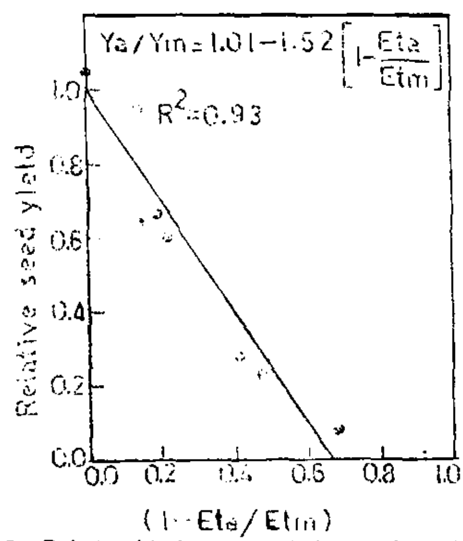

Fig-2 : Relationship between relative seed yield of mustard and relative Eta deficit.

The better performance of the crop in D-W-W is due to its insensitivity to early season (vegetative) Eta deficits apparent from low YRR (0.46). The probable reason for insensitivity of the crop during vegetative period could be low Eta requirement during vegetative period and its remarkable ability to recover from the early season Eta deficit owing to rapid recovery in leaf water potential consequently the net photosynthetic rates as reported by Sharma and Kumar (1989). Moreover it has been reported (Munoz and Fernandez, 1979) that early Eta deficit upto 35 days after sowing is beneficial, since it induces profuse flowering and fruiting.

The favourable soil water balance under W-W-W and D-W-W has aided the crop plants to increase their height, which in turn put forth more photosynthetic surface (LAI) contributing to more dry matter (Table 2). Agarwal et al (1992) opined that LAI was the growth characteristic which limited the rate of dry matter accumulation of mustard under Eta deficits. It is well known that the cell enlargement is very sensitive to Eta deficits and the consequence is marked reduction in leaf area (Begg and Turner, 1976) as is evident in W-D-W, W-W-D, W-D-D, D-D-W and D-W-D and D-D-D treatments. The dry matter showed a positive and significant (P=0.01) correlation with LAI (r=0.89) and plant height (r=0.95). Thus, the accumulated photosynthates in turn may have contributed to more number of siliquae/plant and seeds/siliquae with greater mean seed weight (Test weight) leading to higher harvest indices in W-W-W and D-W-W treatments as compared to other treatments. The siliquae/plant (r = 0.84), seeds/siliquae (r = 0.78), test weight (r = 0.89) and harvest index (r = 0.88) were positively and significantly (p = 0.01) correlated to LAI.

The YRR's which reflect the sensitivity of crop yield to Eta deficits, indicated that the mustard crop is 2.35 (235%) and 4.41 (441%) times more sensitive to Eta deficits, at flowering-pod initiation and addition and pod filling periods, respectively, than vegetative period, provided the crop has not experienced any prior Eta deficit. Like wise the pod filling period is 0.61 times (61%) more sensitive than flowering-pod initiation and addition period.

The greater sensitivity of the crop yield to Eta deficits at flowering-pod initiation and addition (YRR=1.55) and pod filling (YRR=2.49) periods could be due to lush growth of the crop until it was suddenly curtailed of water during above crop growth sub periods resulting in harsh response of the crop. It is also the period during which the crop reaches its peak Eta requirement. Additionally adequate water supply during flowering-pod initiation and addition period spanning over 30-70 DAS is crucial for higher seed yield because full siliquae load is set in this period. The siliquae/plant (r = 0.92) was found to be significantly (P = 0.01) and positively correlatedto seed yield. Therefore Eta deficit during flowering-pod initiation and addition period (30 days after sowing onwards) may have inactivated the flower buds thus inhibiting flowering eventually affecting the siliquae number/plant (Reddy and Pandey, 1980) as can be seen in W-D-W, D-D-W, W-D-D and D-D-D treatments. After the full siliqaue load is set (70 DAS for cv. Seetha) Eta deficits during pod filling period reduced the yield by causing smaller and younger pods to terminate their growth and possibly by reducing the growth rate of older pods. This eventually leads to reduced seeds/siliquae and test weight as is evident from W-W-D, W-D-D, D-W-D and D-D-D treatments. The seed yield showed positive and significant (P = 0.01) dependence on seeds/siliquae (r = 0.90) and test weight (r = 0.93).

However, the sensitivity of the crop yield to Eta deficits at flowering-pod initiation and addition and pod filling periods has been found to be greatly lessened when there was an Eta deficit in the preceeding growth sub period as is evident from the YRR's (1.52 to 1.74) in D-D-W, W-D-D, D-W-D and D-D-D treatments. The probable explanation for this could be that the prior Eta

Table 2 : Yield and yield attributes of mustard as influenced by evapotranspiration deficits

Treatment	Plant height (cm)	Leaf area index	Dry matter/ plant (g)	Siliquae/ plant	Seeds/ siliquae	Test weight (g)	Harvest index (%)	Seed yield (kg/ha)	Seasonal Eta (cm)	Yield reduction ratio
W-W-W	120.6	2.89	18.77	127 2	16.75	2.45	30.2	1047	32.53	-
D-W-W	113.7	2.61	17.76	125.0	16.00	2.32	29.4	992	28.02	0 46
W-D-W	88.9	2.06	14.74	84 7	13.25	2.32	24.5	632	25.35	1.55
W-W-D	104.3	2.79	15.86	110 5	10.00	2.05	22.1	672	27.93	2 49
D-D-W	79.4	1.55	12.99	74.2	13.15	2.27	16.3	239	17.27	1 52
W-D-D	72.4	1.80	12.35	75 2	9.25	1.82	20.3	292	19.21	1 74
D-W-D	97.6	2.35	15.82	111.5	10.75	2.06	23.5	698	26.39	1.74
D-D-D	55.5	1.18	7.69	40.2	6.25	1.47	10.3	89	10.23	1 31
S.Em±	2.6	0.14	0.38	4.2	0.76	0.03	1.3	32	-	-
CD (P = 0 05)	7.8	0 42	1.10	12.5	2.24	0.10	3.7	95	-	-

deficits may have conditioned or hardened the crop, consequently the negative impact of flowering-pod initiation/pod filing periods was greatly blunted.

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GROWTH OF SUMMER GROUNDNUT IN RELATION TO SOWING DATE, IRRIGATION AND SPACING

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ABSTRACT

Growth of summer groundnut was investigated in relation to sowing date, irrigation and spacing at Kalyani, West Bengal. Sowing on 15 March recorded the highest leaf area index (LAI), crop growth rate (CGR) and leaf area duration (LAD) upto 70 days of sowing. However, LAI at pod filling and maturity stages was the highest in the sowing on 15th February. Pod yield reduced in the sowings done on 15th January and 15 March by 22.9 and 26.0% respectively over 15 February sowing. Growth attributes viz. LAI, CGR and LAD increased with increase in irrigation frequency. Moisture stress at pod development stage and both at pod initiation and development stages reduced pod yield by 13.4 and 44.2% respectively. Higher LAI and pod yield were recorded with 25 cm x 12 cm than 50 cm x 6 cm spacing.

Key words : Groundnut, sowing date, irrigation, spacing.

INTRODUCTION

The growth, flowering and pod development of groundnut (*Arachis hypogaea L.*) are greatly influenced by temperature. The sowing time varies from place to place to adjust crop phenology with the existing climate (Nichlolaides *et al.*, 1969). The water status invariably affects plant growth and development. However, economic use of water during summer season saves water resource without causing reduction in economic yield. The information regarding the planting geometry of summer groundnut is limited. Keeping all these in view an experiment was carried out to study the effect of sowing date, irrigation and spacing on growth of summer groundnut in Indo-gangetic alluvial soils of West Bengal.

MATERIALS AND METHODS

A field experiment was conducted during summer season of 1993 and 1994 at Kalyani, West Bengal. The soils were sandy loam in texture, medium in fertility status (0.07% total N, 15.3 Kg available P and 132.7 kg available k/ha) with a pH 7.4. The experiment was laid out in split-split plot design with three replications having three sowing dates (early sowing by 15th January, normal sowing by 15th February and late sowing by 15th March)in main plots, three water management practices (one irrigation at first flowering; two irrigations at first flowering and pod initiation stages; and three irrigations at first flowering, pod initiation and pod development stages) in sub plots and two spacings (50 cm x 6 cm and 25 cm x 12 cm) in sub-sub-plots. A common basal dose of 20 kg N, 40 kg P_2O_5 and 40kg K_2O/ha was applied through urea, single super phosphate and muriate of potash, respectively. Enough soil moisture was ensured by a presowing irrigation for uniform germination. The crop was irrigated to field capacity as per the treatment schedule. The variety used was JL 24. There was no serious incidence of pests and diseases. Standard package of practices was followed to raise the crop. Meteorological data pertaining the cropping season is given in Table 1.

RESULTS AND DISCUSSION

Effect of sowing date

Early sown crop recorded lower leaf area index (LAI)

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upto 70 days after sowing (DAS) due to cool weather prevailing all that time. But late sowing by 15March recorded higher LAI upto 70 DAS due to comparatively higher temperature and bright sunshine,and at90 DAS there was drastic reduction in LAI due to rainfall and humid weather in June (Table 1) which caused senescence of leaves. Early sowing recorded significantly lower crop growth rate (CGR) upto 70 DAS but thereafter it recorded highest CGR. Late sowing recorded significantly higher CGR upto 70 DAS and thereafter the lowest (Table 2). Normal sowing recorded highest leaf area duration (LAD) during 70-90 DAS. Early sowing showed significantly lower LAD during all the growth stages because of slow vegetative growth and longer crop duration. Chhonkar and Kumar (1985) also reported that LAD in groundnut depends on sowing date. Low temperature at sowing of early sown crop delayed the germination by about week and further low temperature in January and February caused slow vegetative growth and late reproductive growth thus resulting in longer crop duration. Late sowing caused early and quick vegetative growth due to high temperature and the crop attained maturity earlier.

The 15th February sowing recorded significantly higher pod yield (2336 kg/ha) than early or late sowings. Sowing on 15th January and 15March caused a reduction of 22.9 and 26.0 % in pod yield, respectively. In early sowing, the vegetative growth was checked for about a month due to cool weather and when the temperature increased, the vegetative growth was dominant over the reproductive growth. In late sowing, though the vegetative growth was comparatively high from the beginning, continuous high temperature at flowering caused lower LAI, CGR and LAD. Nicholadies et al. (1969)also reported that temperature had an important role in determining the rate of flowering and constant temperature above 33°C affected pollen viability adversely.

Effect of irrigation

Leaf area index at 70 and 90 DAS increased significantly with increase in irrigation frequency. Water stress at pod development, and at both pod initiation and pod development stages reduced LAI by7.4 and 19.1% at 90 DAS. This reduction might be due to early senescence of leaves. Padma and Rao (1992) also obtained similar result. Crop growth rate decreased significantly with lower irrigation frequency during 70-90 DAS. Reduction in cell enlargement due to water deficit might be the

Table 1 : Meteorological data during the experimental period

Month	Rainfall (mm)		Mean temperature °C				Relative humidity %			
			Maximum		Minimum		Maximum		Minimum	
	1993	1994	1993	1994	1993	1994	1993	1994	1993	1994
January	0	10.0	26.0	26.1	10.5	12.1	89	94	41	48
February	0.5	54.0	30.2	26.8	15.3	15.5	86	95	50	56
March	3.3	0	31.9	33.8	18.0	21.5	83	92	37	44
April	47.4	106.7	34.4	35.0	23.1	23.8	84	87	51	54
May	148.5	148.9	35.0	36.0	24.7	26.2	84	90	60	58
June	341.0	350.4	32.2	33.1	25.4	26.6	89	94	72	80

Table 2 : Effect of sowing date, irrigation and spacing on growth of summer groundnut (mean of 1993 and 1994)

	Leaf are index			Crop growth rate (g/m^2)				Leaf area duration (Days)		Corp duration	Pod yield
	Days after sowing			Days after sowing				Days after sowing		Days	(kg/ha)
	50	70	90	30-50	50-70	70-90	90-110	50-70	70-90		
Date of sowing											
15 Januray	0.65	2.08	3.18	3.77	6.54	11.17	6.68	24.4	51.6	134	1801
15 February	1.38	3.54	3.47	8.03	10.35	10.66	2.30	45.9	70.4	120	2336
15 March	1.57	3.56	2.66	8.65	11.33	10.16	1.54	48.5	61.6	112	1729
C.D. (P=0.05)	0.08	0.16	0.12	0.35	0.47	0.63	0.20	2.9	3.1	-	50
Irrigation											
I_1	1.18	2.73	2.75	6.82	9.11	9.84	3.27	36.9	54.8	114	1351
I_2	1.21	3.16	3.15	6.80	9.35	11.15	3.44	40.5	63.0	125	2095
I_3	1.20	3.29	3.40	6.83	9.34	11.46	3.69	41.4	66.9	127	2420
C.D. (P=0.05)	NS	0.09	0.06	NS	NS	0.34	0.09	0.05	1.5		35
Spacing											
50 cm X 6 cm	1.18	2.94	2.97	6.54	9.27	10.44	3.68	38.6	59.1	122	1765
25 cm X 12 cm	1.25	3.17	3.23	7.09	9.55	10.94	3.34	41.2	64.0	122	2145
C.D. (P=0.05)	NS	0.06	0.06	NS	NS	NS	NS	NS	NS	-	-30

I_1 = One irrigation at first flowering, I_2 = Two irrigations at first flowering and pod initiation, I_3 = Three irrigations at first flowering, pod initiation and pod development reason of lower CGR (Reddy, 1988). Water stress at pod initiation and pod development stages reduced leaf area duration significantly due to lower LAI values. Crop duration was reduced by allowing the crop under moisture stress.

The highest pod yield (2420 kg/ha) was recorded with three irrigations at first flowering, pod initiation and pod development stages. Water stress at pod development stage and at both pod initiation and pod development stages reduced pod yield by 13.4 and 44.2 %, respectively. Reproductive growth in groundnut occurs over a period of at least 2 months. Moisture stress has a depressing effect on flowering. The flower production reduces by effect of water stress on stem growth and reduction in number of nodes from which the flower arise, and to a limited extent effect the flower buds themselves (Ochos and wormer, 1959). Similar results were also reported By Padma and Rao (1992) and Singh *et al.* (1994).

Effect of spacing

Sowing at 25 cm x 12cm spacing increased LAI by 7.8 and 8.8% over sowing at 50 cm x 6 cm spacing at 70 and 90 DAS, respectively. Similar result was also reported by Pannu *et al.* (1989). Sowing at 25 cm x 12 cm gave significantly higher pod yield (2145 kg/ha) than sowing at 50 cm x 6 cm (1764 kg/ha). Severe competition among the plants due to intra-row crowding might be the cause of lower pods/plant which ultimately resulted in lower yield in case of 50 cm x 6 cm spacing. Similar result was also reported by Nandania *et al.*, (1992).

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RELATIVE PERFORMANCE OF HERBICIDES IN SOYBEAN (*Glycine Max*)

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ABSTRACT

A field experiment was taken up with MACS 58 variety of soyeban during *kharif* seasons of 1993 and 1994 to identify suitable herbicide for soybean in the rainfed black soils, where frequent hand weeding is problematic due to continuous rains. Among the herbicides tested pre-emergence application of clomozome 1.0 kg/ha gave higher yield (751 kg/ha) and better weed control efficiency (49.9%), followed by alachlor 2.0 kg/ha and fluchloralin 1.0 kg/ha. However, maximum yield (877 kg/ha) and weed control efficiency (92.1%) were obtained from weed-free check.

***Key words*:** Herbicides, weed control, soybean.

INTRODUCTION

In the black soils of Krishna - Godavari zone of Andhra Pradesh, weed competition is a major constraint to achieve high productivity of *kharif* soybean. During rainy season, the unfavourable soil conditions, as a result of heavy rains does not permit frequent inter cultivations. Added to this, the non-availability and high cost of manual labour during peak periods of field operations leads to delayed weeding causing reduction in crop yields. Under such conditions use of herbicides can protect the crop from weeds in critical stages of crop-weed competition. Suitability of herbicides for soybean was worked out by several workers (Nimje, 1989; Ved Prakash *et al.*, 1991 and Shekar *et al.*, 1992). However, such studies in the rainfed black soils of Krishna - Godavari zones were limited. Hence, the present study was taken up to asses the relative performance of different herbicides against weed-free and hand weeded treatments.

MATERIALS AND METHODS

A field experiment was taken up during the *Kharif* seasons of 1993 and 1994 in the rainfed black soils of Krishna - Godavari Zone. The soil of the experimental field was black-clayey in texture, with a pH of 8.3. The available nitrogen, phosphorus and potash status of the soils was 185, 12.6 and 557 kg/ha, respectively. The soybean variety MACS 58 was sown on 5th July and 9th July and harvested on 1st November and 7th November during 1993 and 1994, respectively. The gross plot size was 3.6 m x 6.0 m. A rainfall of 515.6 mm and 1330.7 mm was received during 1993 and 1994, respectively. Four herbicides, fluchloralin, alachlor, clomozome and lectofen were compared against three checks viz; weedy, weed free (kept weed free by taking up weedings at 10 days interval upto 90 days of crop stage) and hand weeding twice treatments. The herbicide fluchloralin was incorporated one day before sowing. The pre emergence herbicides were applied one day after sowing and the post emergence herbicide was applied at 20 days after sowing. A uniform fertilizer dose of 30-60-40 kg/ha of nitrogen, phosphorus and potash was applied and the seed was inoculated with *Rhizobium japonicum*. The weed samples were collected from 1m x 1m quadrat at 45 days after sowing and at harvest. The weed control efficiency of different treatments was calculated on the basis of weed dry mass at harvest.

RESULTS AND DISCUSSION

The experimental plots were infested by a number of weed species. Dicot weeds like *Amaranthus tricolor*, *Phyllanthus niruri*, *Aristolochia bracteata* (Retz.) *Achyranthus indica* L.,

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Boerhaevia diffusa, Digera arvensis and monocot weeds like *Chloris barbata*, sw., *Ischaemum pilosum*, Hock., *Cyperus rotundus*, L. and *cynodon dactylon* were dominant.

Weed dry matter recorded at 45 days and at harvest stage of crop (Table 1) was significantly low in the weed free treatment followed by hand weeded treatment. A 54% decrease in weed dry matter was recorded with clomozome and 39.5% with alachlor at 45 days stage when compared with weedy plots. Similar reduction in weed dry matter due to herbicide application was also reported by Chandel *et al.*, 1995. Highest weed control efficiency (92.1%) was recorded from weed free treatment followed by hand weeded treatment (73.7%).

The grain yield (Table 2) recorded in general was poor. The crop suffered due to severe moisture stress in the early stages during 1993, whereas during 1994 heavy and continuous rains at maturity stage damaged the seed. In both the years maximum grain yield was recorded in weed free plot with a mean yield of 877 kg/ha followed by handweeding treatment (808 kg/ha) which was 62% and 49.6% more than that of unweeded check. The herbicides clomozome, fluchloralin, alachlor, and lectofen recorded an increase of 39.1, 32.0, 22.4 and 19.4 percent, respectively. The yield increase can be attributed to reduced weed intensity and better yield attributes like number of pods per plant.

It can be concluded that the maximum yields could be recorded from weed free and hand weeding treatments. Application of herbicides like clomozome / alachlor / fluchloralin can also bring about not only 50% weed control efficiency but also 20-40% yield increase.

Table 1 : Weed dry matter and weed control efficiency as influenced by weed control treatments (mean of two years)

Treatment	Weed dry matter (g/m^2) at 45 DAS	Weed dry matter (g/m^2) at harvest	Weed Control efficiency at harvest (%)
Fluchloralin 1.0 kg/ha (pre planting incorporation)	97.0 (9.82)	130.3 (10.89)	46.5
Alachlor 2.0 kg/ha (pre emergence)	68.3 (8.27)	112.7 (10.89)	49.7
Clomozome 1.0 kg/ha (Pre emergence)	52.0 (7.17)	122.0 (11.07)	49.9
Lectofen 0.15 kg/ha (Post emergence)	77.0 (8.78)	162.6 (12.77)	31.3
Weed free	2.0 (1.56)	19.3 (4.55)	92.1
Two hand weedings at 30 and 45 DAS	17.3 (4.18)	64.0 (7.74)	73.7
Weedy	113.0(10.64)	243.6 (15.59)	—
C.D. (0.05)	27.23(1.61)	84.06 (3.81)	

Figures in the parentheses are transformed $\sqrt{x+0.5}$ values, DAS : days after sowing

Table 2 : Seed yield and yield attributes (mean of 2 years) of soybean as influenced by weed control treatments

Treatments	Seed yield (kg/ha)			Plant height (cm)	No. of pods/plant	100 seed wt.(g)
	1993	1994	Mean			
Fluchloralin 1.0 kg/ha (pre planting incorporation)	997	434	716	59.1	36.9	11.1
Alachlor 2.0 kg/ha (pre emergence)	870	451	661	63.5	37.0	11.6
Clomozome 1.0 kg/ha (Pre emergence)	933	569	751	60.9	43.3	11.5
Lectofen 0.15 kg/ha (Post emergence)	829	457	645	57.6	35.2	11.2
Weed free	1029	724	877	57.1	39.2	12.1
Two hand weedings at 30 and 45 DAS	877	740	808	56.6	37.0	11.6
Weedy	713	366	540	66.3	32.0	11.2
C.D. (0.05)	175.6	109.0	66.0	NS	3.33	NS

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STUDIES ON THE PERFORMANCE OF SOME NEW MUSTARD GENOTYEPS UNDER IRRIGATED CONDITION

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ABSTRACT

Several new mustard genotypes were tested for their yield output at the Indian Agricultural Research Institute, New Delhi, during the winter seasons of 1994-95 and 1995-96 under irrigated condition. Significant reduction in grain yield, oil content and oil yield of every genotype was observed in delayed sowing on November 27 than on October 27. In 1994-95, the new selections Early Flower I and Early Flower II contained significantly lower amount of seed oil (%) than Pusa Bold, jai Kishan and PR 45 but the per hectare oil yield in all the above cultures was on par. Simple leaf, a mutant developed from RLM 198, although showed superiority in some plant characters (per cent light interception and LAI at 60 DAS, number of fruiting branches per plant, number and weight of siliqua per plant and grain yield weight per plant) during 1995-96, its oil content and oil yield were significantly lower than in all other genotypes except, Early Flower I and Early Flower II.

Key words : Yield, oilcontent, mustard genotypes.

INTRODUCTION

Rape-seed mustard is the second most important oilseed crop grown in India., It occupies about 23% of the total oilseed area and contributes 25% of the total oilseed production. The per hectare productivity of oilseed Brassica has increased by 156% since 1975-76 in the country, it is still far below the International Levels of 39 q/ha obtained in Germany, 27.8 q/ha in Poland and 21.8 q/ha in France (Bhoyar, 1996). Numerous breeding activities and investigations on several aspects of management for augmenting its production are, therefore being pursued for identification of superior genotypes with other additional advantages. Also are there continued efforts to evolve short duration, early flowering varieties of mustard for fitting in a multiple cropping system. With this view, the present experiment with some new mustard genotypes was undertaken for their yield performance.

MATERIALS AND METHODS

A field experiment was carried out at the Water Technology Centre, Indian Agricultural Research Institute, New Delhi, during the winter seasons of 1994-95 and 1995-96, to study the performance of some new genotypes of mustard under irrigated conditions. The experimental field remained fallow during *Kharif* season in both years. The soil was sandy loam in texture, low in organic carbon (0.43%) and available nitrogen (152.6 kg/ha), medium in available P_2O_5 (10 kg/ha) and K_2O (270.20 kg/ha) with pH 7.3. Six mustard genotypes viz., RLM 198, Pusa Bold, Jai Kishan, PR 45, Early Flower I and Early Flower II were tested for their performance both in terms of grain and oil yield in 1994-95. Another objective was to see whether the time of sowing had any effect on the oil content and oil yield of these genotypes. Therefore, sowing of mustard was planned for twice in the first year at one month interval on 27th October and 27th November, 1994. Sown on 17th October 1995, the same experiment was repeated durung 1995-96, with the exception of adopting one more genotype, Simple Leaf which was a mutant developed from RLM 198 and was characterized by simple, unserrated leaves of larger area supposed to correspond for higher total photosynthesis. It was therefore, perceived for higher oil yield. RLM 198,

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a variety from Punjab, although inferior in grain and oil yield than three recent varieties (Pusa Bold, jai Kishan and PR 45), was opted for the study for comparing the differential behavior of the mutant Simple Leaf from its parent. Observations on several growth and yield parameters were made at 60 and 90 DAS and at harvest. Per cent light interception at the middle height as well as at the base of the mustard plant were recorded by using a Lux Meter (model LUXOMET - 300 XD) and Leaf area index (LAI) by a Plant Canopy Analyzer (Model LAI - 2000). Number of fruiting branches, number and weight of siliqua and weight of grain per plant were calculated from randomly chosen five plants in each plot, whereas number of plants, dry weight of fallen leaves, grain and stover yield of mustard were recorded from a 2.4 m x 2.0 m area out of a 5.0 m x 4.0 m gross plot. Mustard seed oil content was measured by Pulsed Nuclear Magantic Resonance Technique (Tiwari *et al.* 1974). The first trial was laid out in a Factorial Randomized Complete Block Design and the second one in a Randomized Complete Block Design with four replications. In both the years, spacing was maintained at 40 cm between rows and 10 cm between plants using a seed rate of 5 kg/ha. The crop, as per recommendation, received doses of N, P_2O_5 and K_2O (80, 40 and 40 kg/ha respectively) and irrigation at branching, flowering and pod development stage. Full dose of P and K was applied as basal, whereas N was given in splits.

RESULTS AND DISCUSSION

Grain yield, total biomass yield, oil content and oil yield 1994-95

A perusal of data (table 1) revealed that the second date of sowing affected grain yield, total biomass yield, oil content and oil yield adversely in every genotype as compared to first date of sowing. Significant reduction in oil content and oil yield due to delay in sowing from October 10 to October 30 and November 20 was also reported (Bishnoi and Singh, 1979; Bishnoi and Singh 1979a). Low temperature prevailed during seed setting had an adverse effect on seed development. The grain yield differed significantly among the genotypes. Early Flower I recorded the highest grain yield, but was on par with Pusa Bold and PR 45. The Jai Kishan and Early Flower II were also similar to Pusa Bold. RLM 198 gave the lowest yield irrespective of time of sowing. Early Flower I, Early Flower II and RLM 198 contained comparable amount of seed oil which was significantly lower than in Pusa Bold, Jai kishan and PR 45. The per hectare oil yield in all the genotypes except RLM 198 was, however, on par.

Days to fifty per cent flowering, light interception (%) and LAI

Early Flower I, Jai Kishan and PR 45 took similar days to 50% flowering (Table 2) and were significantly earlier than the rest of the cultures which differed greatly among themselves. Early Flower II and Pusa Bold flowered 3-4 days late and Simple Leaf almost 10 days late. Whereas RLM 198 had profuse vegetative growth and much elongated stature as compared to other cultures and flowered very late at 67 DAS. At 60 DAS, Simple Leaf registered the highest per cent light interception at the base of the crop canopy which was significantly higher than the other genotypes except RLM 198 and Pusa Bold. But, per cent light interception at the middle height of the crop was significantly higher in RLM 198 than in the rest of the cultures. Although, the leaf area index at this stage did not significantly differ among the genotypes, Simple Leaf recorded the highest value. At 90 DAS too, RLM 198 maintained significantly higher light interception both at the base and at the middle height of crop and leaf area index. At this stage, Early flower II, Simple Leaf, Pusa Bold and PR 45 registered almost similar LAI. These were due to variations in plant architecture of these cultures.

Yield attributes

Significantly lower plant populations were observed at harvest in RLM 198 and Simple Leaf than in all other cultures (Table 3). This was due to their bigger lateral as well as vertical stature than

Table 1. Grain yield, total biomass yield, oil yield and oil content(%) of different mustard genotypes as affected by time of sowing in *rabi* 1994-95

Genotypes	Grain yield (q/ha)			Total biomass yield (q/ha)			Oil content (%)			Oil yield (q/ha)		
	F	S	Mean	F	S	Mean	F	S	Mean	F	S	Mean
Early Flower I	25.7	15.5	20.59	120.6	80.5	100.0	40.1	37.3	38.7	10.3	5.8	8.0
Early Flower II	21.1	15.1	18.15	106.5	75.0	90.7	39.9	38.0	38.9	8.4	5.7	7.0
RLM 198	19.0	8.7	13.87	101.2	76.9	89.1	40.2	37.9	39.0	7.6	3.3	5.4
Pusa Bold	23.5	15.6	19.55	119.4	85.6	102.5	42.3	39.8	41.0	9.9	6.2	8.0
Jai Kishan	22.1	15.0	18.56	109.7	75.6	92.6	42.1	39.8	40.9	9.3	6.0	7.6
PR 45	24.1	16.2	20.17	119.0	81.6	100.3	42.0	39.6	40.8	10.1	6.4	8.2
Mean	22.6	14.3		112.7	79.0		41.1	38.7		9.3	5.6	
	S.Em	LSD(P=0.05)		S.Em	LSD(P=0.05)		S.Em	LSD(P=0.05)		S.Em	LSD(P=0.05)	
Sowing date (S)	0.55	0.93		2.1	3.55		0.4	0.7		0.7	1.2	
Genotypes (G)	0.95	1.60		3.7	6.25		0.5	0.8		0.9	1.5	
S X G	1.34	2.26		5.2	NS		0.7	1.2		1.0	1.7	

F = First sowing, S = Second sowing

Table 2. Days to 50% flowering, light interception and leaf area index (LAI) of different mustard genotypes during 1995-96

Genotypes	Days to 50% Flowering	60 DAS			90 DAS		
		Light interception (%)		LAI	Light interception (%)		LAI
		Middle	Base		Middle	Base	
Early Flower I	49.5	45.3	74.3	3.94	72.5	88.9	4.16
Early Flower II	53.5	59.2	81.9	4.34	75.3	91.6	5.32
Simple Leaf	59.0	58.0	85.2	4.98	77.5	91.5	5.48
RLM 198	67.2	73.2	83.8	4.23	84.8	95.5	6.60
Pusa Bold	52.0	64.1	82.9	4.46	75.7	90.2	5.07
Jai Kishan	49.7	60.7	81.3	4.30	73.8	89.4	4.53
PR 45	49.7	56.1	79.4	4.33	73.5	87.6	4.71
S.Em ±	0.7	3.1	1.8	0.42	1.8	1.1	0.22
LSD (P = 0.05)	1.2	5.4	3.1	NS	3.2	2.0	0.37

other cultures which offered intraspecific competition of higher order among themselves and the plant population got reduced significantly, although germination was good at the beginning and spacing between the plants adjusted by gap-filling and thinning. Otherwise Simple Leaf had significantly greater number of fruiting branches and number of siliqua and higher grain weight per plant than others. The weight of siliqua per plant, although did not differ significantly, Simple Leaf recorded the highest value. Early Flower I, Early Flower II, Pusa Bold, Jai Kishan and PR 45 produced identical grain weight per plant and were significantly higher than in RLM 198. Similar study with appressed mutant of mustard has been reported (Kinra *et al.* 1972).

Grain yield, stover yield, seed oil content and oil yield

Although, there was no significant difference in stover yield, significant difference in grain yield existed among the genotypes (Table 3). Pusa Bold appeared to be the highest yielder of grain per hectare, but the grain yields of jai Kishan, PR 45, Early Flower II, Early Flower I and Simple Leaf were comparable with each other and higher than in RLM 198. Seed oil content as well as seed oil yield (kg/ha) of Pusa Bold, jai Kishan and PR 45 were, significantly higher than in other genotypes.

It may be concluded that late sowing at the end of November may not at all be advocated for either of the genotypes. The Simple Leaf would have been superior toall these genotypes if the plant population as in other genotypes was maintained. The Simple Leaf, being a mutant, inherited almost all the characters profuse vegetative growth, taller stature, lateral spreading of branches etc. except the leaf shape from RLM 198. The performance of Early Flower I and Early Flower II, although varied over the years, offered a promise.

Table 3. Grain yield, yield attributes, oilcontent and oil yield of mustard genotypes during 1995-96

Genotypes	Plant Population (No./plot)	Fruiting branches (No./plant)	Siliqua/plant		Grain weight (g/plant)	Fallen leaves biomass (q/ha)	Grain yield (q/ha)	Stover yield (q/ha)	Oil content (%)	Oil yield (q/ha)
			Number	weight(g)						
Early Flower I	25.5	23.0	277.7	46.7	24.2	7.4	31.5	64.9	39.5	12.4
Early Flower II	25.2	24.5	312.7	48.7	28.3	9.3	31.9	76.5	39.6	12.6
Simple Leaf	18.6	33.2	424.5	62.5	32.6	10.1	31.2	76.1	40.1	12.5
RLM 198	18.4	26.1	346.2	46.9	17.4	10.4	21.1	80.0	39.2	8.3
Pusa Bold	24.2	24.0	231.5	48.6	27.4	9.7	35.6	76.6	41.5	14.8
Jai Kishan	27.1	19.4	235.1	47.2	25.7	7.9	34.5	72.6	41.1	14.2
PR 45	29.3	19.8	274.4	46.6	24.5	9.2	34.1	70.0	41.2	14.1
S.Em ±	1.3	1.4	23.8	4.0	2.3	0.6	2.1	2.7	0.4	0.8
LSD (P=0.05)	2.2	2.4	41.2	NS	4.0	1.1	3.6	NS	0.7	1.4

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RESPONSE OF GROUNDNUT TO IRRIGATION SCHEDULES BASED ON IW/CPE RATIOS

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ABSTRACT

Field experiment conducted on sandy-loam soils of S.V. Agricultural college farm, Tirupati revealed that plant height, leaf area index and dry matter production varied significantly due to depths and IW/CPE ratios. Interaction between depths and ratios failed to produce significant differences in these parameters. IW/CPE ratio of 0.5 with 7 cm depth resulted in early flowering, 5 cm depth of water and IW/CPE ratio of 1.0 resulted in more number of filled pods, volume - weight of pods and shelling percentage and also significantly higher pod weight and kernel weight. Highest pod yield was obtained with 5 cm depth of water (25.5 q/ha) and 1.0 IW/CPE ratio (28.7 q/ha) and due to their interaction (32.1 q/ha). Scheduling irrigation at 1.0 IW/CPE ratio with 5 cm depth of water produced highest haulm yield and offered higher net returns.

Key words : IW/CPE ratio, Irrigation, groundnut.

INTRODUCTION

Groundnut (*Arachis hypogaea L.*) is the most important oilseed crop grown under well irrigation during *rabi* in Chittoor district of A.P. Adequate and timely supply of water is essential to realise high yields. Productivity of groundnut can be enhanced 2 to 3 times by proper irrigation management when compared to rainfed situation. Several methods of scheduling irrigation have been suggested by many research workers, but none of them were sufficiently simple to be adopted by the farmers. Prihar *et al.*, (1974) reported that IW/CPE ratio approach of scheduling irrigation has been found to be more practicable for adoption by the farmers for irrigating wheat in Punjab. But not much work was done on irrigation requirements of groundnut in relation to depth of water to be supplied for each irrigation in conjunction with IW/CPE ratios. Hence, the present investigation was carried out to work out optimum depth of water to be given for each irrigation scheduled at different IW/CPE ratios on sandy-loam soil.

MATERIALS AND METHODS

A field experiment was conducted at S.V. Agricultural College Farm, Tirupati during *rabi* 1993-94 on sandy-loam soils. The soil was neutral in reaction (pH 7.5), low in organic carbon (0.26%), low in available nitrogen (170.1 kg/ha), high in available P_2O_5 (105 kg/ha) and medium in available K_2O (206 kg/ha). The experiment was laid out in randomised block design with factorial concept involving three irrigation depths (5,6 and 7 cm) and three IW/CPE ratios (1.0, 0.75 and 0.5) in three replications. Depth of water was measured with the help of V-notch fitted in the channel. To avoid conveyance losses polythene lining was provided in waterways from the cement channel sections to individual plots. A pre-sowing irrigation was given two days before sowing to ensure uniform germination. Subsequent irrigations were scheduled as per the treatments.

RESULTS AND DISCUSSION

Growth parameters

Crop growth parameters like plant height, leaf area index and dry matter production suffered a set back at higher depths of irrigation water and at low IW/CPE ratios (Table 1). Depth of water at each irrigation and IW/CPE ratio varied the available

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soil moisture content in the root zone depth of soil. Increasing the depth of irrigation water decreased the irrigation frequency leading to less available soil moisture for crop between two irrigations especially during each part of the period before giving next irrigation. This was due to the fact that higher depths of water applied at each time was more than that required to bring the soil to field capacity. As such the excess water has been lost through deep percolation beyond the root zone. In the case of different ratios (IW constant and CPE increased to arrive at different ratios), decreasing the IW/CPE ratio from 1.0 to 0.5 also decreased the irrigation frequency thus subjecting the crop to varying degrees of soil moisture stress leading to differences in crop growth and development. Reduction in dry matter production at low IW/CPE ratios was reported by Shinde and Pawar (1984).

Days to 50 per cent flowering

Decrease in the IW/CPE ratio from 1.0 to 0.5 significantly reduced the days for flowering from about 44 to 39 days due to less available soil moisture. Increasing the depth of irrigation water from 5 to 7 cm decreased the days to flowering. The frequency of irrigation decrease with increase in depth of irrigation. Hence there was long gap between two irrigations with 7 cm depth of water which created soil moisture stress. Interaction of depths and IW/CPE ratios also significantly influenced days to 50 per cent flowering. Scheduling irrigation with 7 cm depth and at IW/CPE ratio of 0.5 resulted in earlier flowering (38 DAS) (Table 3). This again was due to soil moisture stress with this combination. Early flowering of crop due to stress has been reported by Reddy (1974).

Yield attributes and yield

Number of filled pods per plant, shelling percentage and 100-kernel weight were significantly higher at 5 cm depth of irrigation water, 1.0 IW/CPE ratio and their interaction (Table 2). Poor pod

Table 1 : Plant height, leaf area index, drymatter production, 100 pod weight and kernel weight of groundnut as influenced by irrigation depths and IW/CPE ratios.

Treatments	Plant height (cm)	Leaf area index	Drymatter (g/plant)	100 pod weight (g)	100 kernel weight (g)
Irrigation depths (cm)					
5.0	16.56	2.95	12.53	72.40	36.88
6.0	16.07	2.88	12.01	68.84	32.65
7.0	14.62	2.74	11.40	63.95	29.82
CD (0.05)	1.08	0.09	0.75	4.43	2.93
IW/CPE ratios					
1.0	17.44	3.18	13.74	79.61	36.73
0.75	15.43	2.88	11.93	67.33	33.02
0.5	14.38	2.51	10.20	58.23	29.61
CD (0.05)	1.08	0.09	0.75	4.43	2.93

Table 2 : Number of filled pods per plant, volume weight of pods and shelling percentage of groundnut as influenced by irrigation depths and IW/CPE ratios

IW/CPE ratios/	Number of filled pods per plant				Volume weight of pods ($g\text{-}l^{-1}$)				Shelling percentage			
Depth	1.0	0.75	0.5	Mean	1.0	0.75	0.5	Mean	1.0	0.75	0.5	Mean
5 cm	12.03	9.03	8.70	10.22	0.37	0.31	0.35	0.35	66.59	64.56	53.22	61.56
6 cm	10.53	9.43	9.60	9.85	0.34	0.37	0.29	0.33	67.30	53.16	52.20	57.55
7 cm	10.03	7.70	6.10	7.94	0.38	0.28	0.26	0.30	57.43	54.63	50.33	54.13
Mean	10.86	9.02	8.13		0.36	0.32	0.30		63.77	57.45	52.02	
	Depths	Ratios	I x R		Depths	Ratios	I x R		Depths	Ratios	I x R	
CD (0.05)	0.73	0.73	1.26		0.04	0.04	0.06		2.93	2.93	5.07	

Table 3 : Days to 50% flowering, pod yield and haulm yield of groundnut as influenced by irrigation depths and IW/CPE ratios.

IW/CPE ratios/	Days to 50% flowering				Pod yield ($q\ ha^{-1}$)				Haulm yield ($q\ ha^{-1}$)			
Depths	1.0	0.75	0.5	Mean	1.0	0.75	0.5	Mean	1.0	0.75	0.5	Mean
5 cm	46.0	41.0	38.7	41.9	32.1	24.9	19.5	25.5	56.9	45.3	38.0	46.6
6 cm	44.0	42.0	40.7	42.2	26.7	24.8	16.3	22.6	44.3	49.5	39.2	44.3
7 cm	43.0	40.3	38.0	40.4	27.2	23.1	7.4	19.2	44.5	43.3	39.0	42.3
Mean	44.3	41.1	39.1		28.7	24.3	14.4		48.4	46.0	38.7	
	Depths	Ratios	I x R		Depths	Ratios	I x R		Depths	Ratios	I x R	
CD (0.05)	0.35	0.35	0.59		2.96	2.96	5.13		2.74	2.74	4.75	

filling under soil moisture stress decreased the shelling percentage. Similar results were reported by Reddy *et al.*, (1980). Scheduling irrigation with 7 cm depth at 0.5 IW/CPE ratio resulted in lower number of filled pods per plant and shelling percentage. Longer period of soil moisture stress between two irrigations especially at moisture sensitive pod forming and developmental stages contributed for reduction in these yield attributes. The adverse effect of low frequency irrigation on growth characters contributed for decrease in 100 - kernel weight. Similar adverse effect on kernel weight due to soil moisture stress has been reported by Reddy *et al.* (1981).

Higher pod yields (25.5 and 22.6q/ha) were obtained due to 5 cm and 6 cm depths of irrigation water which were significantly higher than 7 cm depth (19.2 q/ha). This increased yield with 5 and 6 cm depth of irrigation water was due to improvement in the yield attributes, especially number of filled pods per plant, shelling percentage and 100 kernel weight. Decrease in IW/CPE ratio from 1.0 to 0.5 significantly decreased the pod yield. The pod yield at lowest IW/CPE ratio of 0.5 was only 50 per cent (14.4 q/ha) of that of 1.0 IW/CPE ratio (28.7 q/ha) (Table 3). Severe soil moisture stress due to wide gap between two irrigations drastically affected the yield attributes like filled pods per plant, volume-weight of pods and shelling percentage leading to poor yield in this treatment. The results suggest that the quantity of irrigation water applied at each irrigation could be equal to that lost through CPE. Any shortage adversely affect yield attributes and hence the final pod yield (Patel *et al.*, 1988). Combination of 5 cm depth and scheduling irrigation at 1.0 IW/CPE ratio resulted in highest pod yield of 32.1 q/ha which was significantly higher than that due to 6 and 7 cm depth at the same ratio. Irrigation at frequent intervals in quantity equal to that lost in evaporation from open pan resulted in providing adequate soil moisture to meet the crop needs leading to improvement in all the yield attributes and hence the final pod yield.

Haulm yield followed almost similar trend as that of pod yield. Higher haulm yield due to 5 cm depth of irrigation water was due to adequate available soil moisture for improving all the growth parameters (Table 3). IW/CPE Ratio of 1.0 where the depth of irrigation water applied was equal to that lost in CPE provided adequate soil moisture althrough the crop growth and hence improved crop growth parameters leading to higher haulm yield.

Economics

There were marginal differences in cost of cultivation due to treatments in accordance with the number of irrigations given to each of the water management practice. Gross returns were Rs. 28,497.5 ha^{-1} when the crop was irrigated at 1.0 IW/CPE ratio with 5 cm water depth. The crop subjected to severe moisture stress due to 0.5 IW/CPE ratio with 7 cm depth of water recorded lowest gross returns (Rs. 7,870/ha).

Net returns (Table 4) were highest when irrigations were scheduled at 1.0 IW/CPE ratio with 5 cm depth of water (Rs. 19.822.5 ha^{-1}) while lowest net returns of Rs. 3/ha were recorded with 7 cm depth at 0.5 ratio which was due to severe moisture stress and wilting of the plants. Net returns per rupee invested was more than 2.0 in treatments which received 5 cm water depth at 0.75 and 1.0 IW/CPE ratio (I1R2 and I1R1). Lowest net returns per rupee invested was with 7 cm depth at 0.5 IW/CPE ratio (0.004).

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Table 4 : Gross and net returns in cultivation of groundnut as influenced by different irrigation treatments

Treatments	Cost of Cultivation (Rs. ha^{-1})	Pod yield (q ha^{-1})	Haulm yield (q ha^{-1})	Gross returns (Rs ha^{-1})	Net returns (Rs ha^{-1})	Net returns per rupee invested
I^1 R1	8675	32.1	56.35	28497.5	19822.5	2.28
I^1 R2	8314	24.9	45.29	27944.5	19630.5	2.36
I^1 R3	7952	19.5	38.03	17501.5	9549.5	1.20
I^2 R1	8708	26.7	44.33	23576.5	14868.5	1.71
I^2 R2	8255	24.8	49.48	22314.0	14059.0	1.70
I^2 R3	7953	16.3	39.18	14999.0	7046.0	0.88
I^3 R1	8557	27.2	44.52	23986.0	15429.0	1.80
I^3 R2	8212	23.1	43.25	20642.5	12430.5	1.51
I^3 R3	7867	7.4	39.00	7870.0	3.0	0.0004

Price : Pods Rs. 8.00/- kg, Haulm Rs. 0.50/- kg: I = Irrigation depth, R = IW/CPE ratio.

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ETHREL EFFECTS ON TOTAL PHENOL CONTENT IN SUNFLOWER

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ABSTRACT

Effect of pre-harvest sprays of ethrel (2-chloro ethyl phosphonic acid) on total phenol content in sunflower revealed that its content decreased with increase in the concentration of ethrel in pericarp and embryo. Ethrel at 250 ppm was more effective in decreasing the total phenol compared to 75 and 150 ppm ethrel sprays. An inverse relationship was observed between germination and phenol content in achenes. Among the cultivars SS-56 responded better to ethrel compared to Morden.

Key words : Ethrel, phenol, sunflower.

INTRODUCTION

Seeds of sunflower exhibit a dormancy period ranging from 35-45 days after anthesis (Srivastava and dey, 1982). This inherent inadequacy delays the seed production programmes of hybrids, where a continuous germination of seeds is required. Further, in hybrid seed programmes synchronous flowering of male and female parents is very much essential. Extensive staggering of the parental planting dates result due to differential seed dormancy of parents.

Occurrence of dormancy in seeds be related to the amount of phenolic compounds in seeds. Lane (1965) observed sunflower dormancy as phenolic type. Even in groundnut, the increase in the levels of the phenolic compounds with seed development rendered the seeds to be dormant (Sriramulu and Rao, 1971). These compounds responsible for inhibition of germination and growth were identified as phenolic (hydrobenzoic acid), cinnamic acid (cinnamic and ferulic) and unsaturated lactones (coumaric and para-scorbic acid) (Ketring, 1973). The higher amounts of the above compounds had an additive inhibitory effect on germination in dormant sunflower types compared to nondormant ones (Cvikrova *et al.*, 1994). Ethrel was reported to counteract these inhibitory substances and stimulate germination (Zade *et al.*, 1994). Hence the present study was undertaken to examine the utility of ethrel in reducing the total phenol content in sunflower seeds and thereby relieving the seeds from innate dormancy.

MATERIALS AND METHODS

The effect of pre-harvest sprays of ethrel on the total phenol content in the pericarp as well as embryo was studied in the genotypes of sunflower viz., Morden and SS-56 during *rabi*, 1996 at College of Agriculture, ANGRAU, Rajendranagar, Hyderabad.

Different concentrations of ethrel viz., 75, 150 and 250 ppm were sprayed exclusively on the capitulum from the day of anthesis at weekly intervals till harvest. After 5 days of every spray, seeds were sampled and the total phenol content was estimated. A sample of 500 mg each of pericarp and embryo in three replicates was taken and homogenized separately with 5ml of 80% ethanol in a glass mortar and these samples were used to determine the total phenol content in the pericarp and embryo (Malick and Singh, 1980).

After every 5 Days of the chemical spray, the developing seeds, preferably from outer peripheral in the capitulum, were collected and used to study the germination percentage (ISTA, 1976).

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RESULTS AND DISCUSSION

The total phenol content was significantly more in the pericarp compared to embryo in both the varieties viz., Morden and SS-56 at 7 DAA (Fig I, II). In general, the mean values for total phenols in untreated seeds of Morden and SS-56 were 6.00 and 5.46 mg g-1 especially in pericarp (Fig 1). Further, a comparison of varieties indicated that the total phenol content was also significantly more in embryo of Morden (5.48 mg g-1) compared to the value of 5 mg g^{-1} in SS-56 at 7 DAA (Fig II).

The total phenol content in pericarp and embryo of both the varieties decreased as the seed advanced in its developmental mode and the reduction was more remarkable in ethrel treatments at 250 ppm (Fig I, II)

The extent of decrease in total phenol content at 150 and 75 ppm was not as effective as observed with 250 ppm. It was observed that the seeds did not attain germinable capacity in either of the varieties viz., Morden and SS-56 or with any of the ethrel treatments upto 14 days after anthesis (DAA). These seeds started germinating only from 21st day after anthesis in control as well as ethrel treatments (Table 1).

Among the different concentrations, ethrel at 250 ppm was more effective in decreasing total phenols to the levels of 3.16 and 2.25 mg g-1 in pericarp (Fig I) and to an extent of 1.94 and 1.48 mg g-1 in embryo of Morden and SS-56 respectively at 21 DAA. Hence there was a significant increase in germination (69-70) due to ethrel in both the cultivars compared to 25-29 per cent in control (Table I). Though the seeds responded to germination at 21 DAA, the values appear to be above the certification standards (70%) only at 28 DAA. But in control the values of certification standards were attained at 15 and 45 days after physiological maturity in SS-56 and Morden respectively, which denotes the primary dormancy period of 15-45 days in the genotypes studied.

Table 1 : Effect of Pre-harvest sprays of ethrel and water at different days after anthesis on germination percentage in intact seed of sunflower

	Days after anthesis					
	21 DAA			28 DAA		
Treatments	Morden	SS-56	Mean	Morden	SS-56	Mean
Control	25.2 (30.12)	29.2 (32.70)	27.2 (31.41)	42.2 (40.51)	59.6 (50.53)	50.9 (45.52)
Waterspray	35.5 (36.56)	49.1 (44.50)	42.3 (40.53)	62.10 (52.02)	73.16 (58.80)	67.63 (55.41)
Ethrel 75 ppm	48.5 (44.17)	60.3 (50.90)	54.4 (47.53)	65.2 (53.87)	75.63 (60.42)	70.41 (57.14)
Ethrel 150 ppm	57.4 (49.20)	65.3 (53.90)	61.35 (51.58)	71.6 (57.79)	81.26 (64.35)	76.43 (61.07)
Ethrel 250 ppm	69.1 (56.27	70.0 (56.80)	69.55 (56.53)	82.23 (65.07)	87.9 (69.64)	85.06 (67.36)
Mean	47.14 (43.27)	54.78 (47.74)		64.66 (53.83)	75.57 (60.75)	

Values within parenthesis are arc-sine values

CD at 5% Var	0.43	0.153
Treatment	0.69	0.811
Interaction	0.980	1.14
S.Em	0.104	0.122

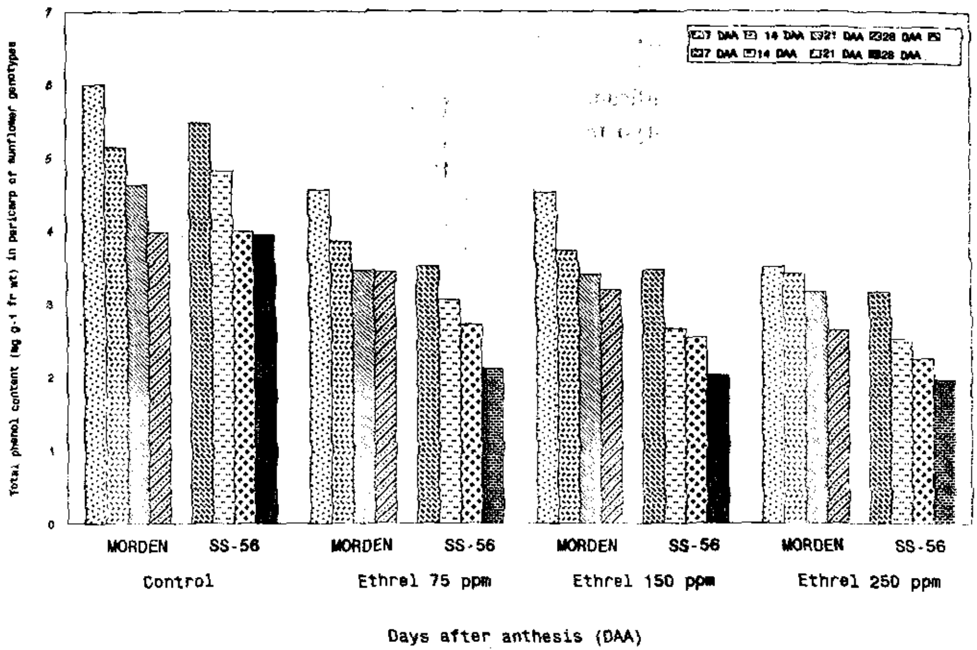

Fig-1 : Effect of pre-harvest sprays of ethrel on the total phenol *content (mg g-1 fr wt)* in pericarpof Morden and SS-56 at different days after anthesis.

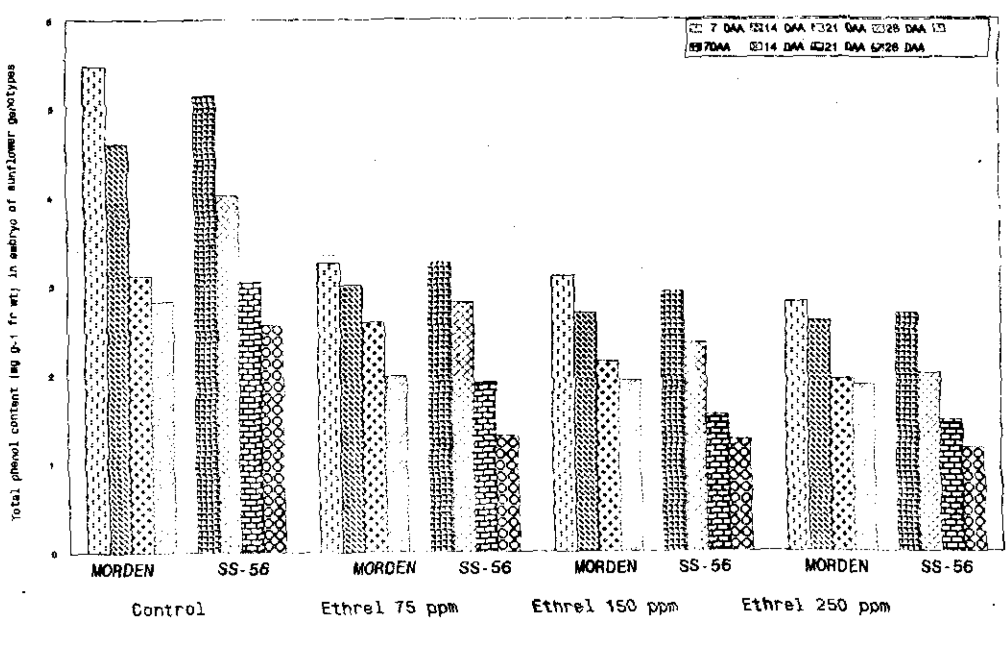

Fig-2 : Effect of pre-harvest sprays of ethrel on the total phenol content (mg g-1 fr wt) in embryo of Morden and SS-56 at different days after anthesis

This may be attributed to the interference of dormancy inducing factors (phenols) with the normal development and maturation of embryo to retain the seed in dormant condition for some more time.

The dormancy inducing factors like phenols and other inhibitors in the maternal structure (pericarp) surrounding the embryo are usually counteracted or balanced by the hormones to release the seeds from dormancy. Inadequate supply of hormones from the mother plant to the seed would be one of the possibilities for innate dormancy and in nature this will be fulfilled during the after ripening.

The ethrel treatments enhanced the germination by counteracting the adverse effects of phenols and other inhibitors. These results further clarify that dormancy in sunflower is controlled by internal (endogenous) and external (exogenous) factors (Krishnamurthy, 1990). Irrespective of the inadequacies causing dormancy, it is the embryo that has to finally overcome them and respond to the conditions otherwise favourable for germination. The internal factors may be associated with the changes in the levels of total phenols in the embryo and pericarp. The chemical changes in these may operate for the maintenance or release of dormancy.

Hence, the actual mechanism of dormancy in sunflower can be assessed by the changes related to promoters, inhibitors and secondary metabolites viz., phenols. Thus, dormancy is said to be relieved depending on the interaction between inhibitor - promoter complex in the developed seed.

However, our approach to mediate the above inadequacy through pre-harvest application of ethrel further elucidated that its supply at 250 ppm can effectively reduce the total phenol content in pericarp and embryo and influence germination. These studies may also help in understanding the changes associated with ethrel phenol ratios in the seed. The mechanisms of phenol release differ from species to species and the relation between phenol content and occurrence of dormancy remains still speculative. However, a detailed study has to be conducted at the molecular level to understand any role of genes in regulation of seed dormancy.

Further, shortening of the duration of dormancy period by pre-harvest ethrel sprays would be useful to the seed corporations as well as farmers for timely use of the seed without resorting to the tedious process of breaking dormancy before sowing.

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PREFERENTIAL VISITS OF HONEY BEE SPECIES TO MALE STERILE AND MALE FERTILE LINES OF SUNFLOWER

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ABSTRACT

Activity of four honey bee species, viz. *Apis dorsata, A. cerana, A. mellifera* and *A. florea* was studied on two sunflower lines, one male sterile (A line or CMS line) and the other its counterpart male fertile line (maintainer of A or B line). On CMS line, *A. cerana* was predominant (63%) in the forenoon and *A. mellifera* in the afternoon (47-86%). On male fertile line *A. dorsata* and *A. cerana* were more active in the morning (37-40%). The comparitive distribution of these species on CMS and maintainer lines planted in 3 : 1 row ratio showed distrinct patterns. Exepting *A. cerana* other bee species visited maintainer lines more number of times than CMS line. The time of the day did not influence the frequency of visit of bees to these lines significantly. Distribution of bee species on rows of CMS block at different distances from adjoiningmaintainer block revealed no definite influence of pollen parent rows on bee visits to male sterile rows.

Key words : Honey bee, A line, B line, sunflower.

INTRODUCTION

Three honey bee species viz. *Apis dorsata, Apis cerana* and *Apis florea* are sympatric and successfully co-exist in parts of Deccan India wherever the flora is abundant. The feral population of these species construct semi permanent nests and may compete for their forage from certain flora instead of from the plethora of flora available in that area. The availability of various species to co-exist would depend on the partitioning of food resources available in the area. The manner in which bee species are distributed among the resources would indicate the pattern of species interaction, extent of food availability from each source and the energy requirement by them (Roubik, 1989). So the larger bees are likely to tend to forage on richer sources whereas smaller bees can profit from scanty resource. Sunflower produces prolific amount of pollen and nectar (Gowda, 1996) and is being foraged by all the four species of honey bees including *A. mellifera* (Sinha and Vaishampayan, 1995, Swaminathan and Bharadwaj, 1982, Satyanarayana and Seetharam, 1982). Sunflower hybrid seed production system includes crossing between cytoplasmic male sterile lines (CMS or A) and restorer line (R lines) and maintainer line (B). The former one is devoid of pollen and the latter two produce both pollen and nectar (Gowda, 1996). It is likely that the bee species would distribute differentially among male sterile and male fertile lines due to the difference in the resource. Further, the better distribution of these species between male sterile and male fertile lines would enhance cross pollination. The information on these with respect to the bee species and the time dependent resource exploitation is not available. Therefore an attempt was made to understand the time and resource partitioning among bee species on sunflower pollen producing and non producing lines.

MATERIALS AND METHODS

The investigation was carried out using CMS line (A) and its maintainer line (B) of Pro Agro sunflower hybrid at Ardeshhally of Bangalore district. The A and B lines were planted in about two acres in a ratio of 3 : 1 in two different adjoining blocks with a spacing of 60 x 30 cm (Block planting)

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during *Rabi* 1995. In another plot of similar size, A and B lines were planted aternately in row ratio of 3 : 1 (Sandwich method). In the block, the CMS block was demarcated into three replications in such a way that each replication had forty rows running parallel to seed parent rows at different distances under each replication. The row adjacent to pollen parent and subsequent fourth row successively away from pollen parent were tagged and in each row five plants were selected for observation. In sandwich planting four blocks were selected and in each block pollen line, CMS line adjacent to pollen line and CMS line one row away from pollen line were randomly chosen under each replication. Five tagged plants per line were used for observation on bee activity.

The bee activity was observed at 0900, 1200 and 1500 hours for three days during peak flowering period. Hundred bees were counted randomly on CMS and maintainer lines for three days at 1000,1200, 1400 and 1600 hours. The bees visiting this crop belonged to feral populations of *A. dorsata*, *A. cerana* and *A. florea* and hive populations of *A. mellifera* (3 colonies).

RESULTS AND DISCUSSION

Among the species of bees visiting CMS line, *A. cerana* was the most predominant one (63%) at 1000 hours (Fig 1). With the progress of the day, *A. mellifera* activity became predominant, which was 47, 57 and 86 per cent respectively at 1200, 1400 and 1600 hours. Proportion of *A. dorsata* remained steady and that of *A. cerana* declined gradually with the progress of the day from 63.1 per cent at 1000 hours to 5.81 per cent at 1600 hours. On maintainer line, *A. dorsata* (39.8%) and *A. cerana* (37.2%) were more predominant (Fig 2). At 1200 *A. florea* was the dominant one with its proportion of 68.9 per cent of the total bees. At 1400 hours, *A. dorsata* was not found visiting these lines, whereas *A. florea* was still more active with 79.6 per cent of the total bees. At 1600 hours, both *A. mellifera* (38.4%) and *A. florea* (41%) were the most frequent visitors.

The observations on the proportion of each species on CMS and maintainer lines revealed that *A. mellifera* activity improved with the progress of the day whereas, *A. cerana* activity declined. These two species appeared to complement each other in maintaining steady overall activity of bees on sunflower. Sinha and Vaishampayan (1995) observed that the predominant honey bee was *A. mellifera* among *A. dorsata*, *A. mellifera* and *A. florea* on both male and female parents of sunflower. Comparing the bee proportions on CMS lines and maintainer lines it was clear that *A. dorsata* was the prominent visitor only at 1000 hours on pollen line and *A. florea* intensity was distinctly higher during other hours on the pollen line. *A. mellifera* and *A. cerana* were dominant of four bee species on CMS line than on pollen line. Their activity on both the lines was less discriminatory. The above findings suggest that 1. *A. dorsata* and *A. cerana* exploited the pollen resource no sooner the dehiscence took place. 2. The scantily available pollen left out by the above species could be efficiently gathered by the little bee, *A. florea* 3. *A. mellifera* seemed to be more involved in the nectar gathering, especially at the later part of the day.

When three rows of the CMS line were planted alternatively with a pollen line (sandwich planting), the total bee activity constituting four bee species recorded on them revealed that pollen line was significantly more attractive compared to the CMS line (Table 1). Further, the distance of CMS lines by 0.6 and 1.2 m from pollen line did not cause any difference in their ability to attract the bee species on them. The mean activity of four species of bees on two rows of CMS and the pollen line showed significant difference between the above genotypic groups (Table 1). Irrespective of genotypes, the activity of *A. cerana* was significantly the highest (1.74 bees/5flowers/5min) followed by that of *A. dorsata* (1.0 bee/5 flowers/5 min) and *A. mellifera* (0.55 bee/5 flowers/5 min) and *A. florea* activity was significantly thelowest (0.08 bees/5 flowers/5 min).

The differences in the density of four bee species on the sunflower crop, irrespective of the genotypes, may be ascribed to the differences in the feral populations of *A. dorsata*, *A. cerana*, *A. florea* and hive populations of *A. mellifera* bees. However, the high activity of bees on pollen lines as compared to CMS line is probably due to the reward of pollen in addition to nectar in the former and nectar only in the latter.

In block planting, irrespective of genotypes, the highest activity of *A. mellifera* was recorded (1.32 bees/5 flowers/5 min) followed by *A. cerana* (0.845 bees/ 5 flowers/5 min), *A dorsata* (0.546 bees/5 flowers/5 min) and *A. florea* (0.318 bees/5 flowers/5min) with a significant difference between them (Table 2). The interaction between the species and different time of the day for the diurnal activity was also significant. For example the activity of *A. dorsata* at 0900 hours was the highest which sharply decreased towards the later part of the day. The activity of *A. mellifera* was converse to the above. The density of *A. cerana* on these lines though declined with the time, it was gradual. *A. florea* hardly foraged at 0900 hours but its visits increased at 1200 hours and 1500 hours irrespective of lines. The activity of bees on pollen line was highly significant (5.78 bees/ 5flowers/5 min) compared to CMS line at all distances from pollen block (Table 3). The activity of these did differ between rows of CMS block without any definite pattern and this variation seems to be incidental. Satyanarayana and Setharam (1982) observed that the bee activity went

Table 1 : Mean activity of different species of honey bees on CMS and maintainer lines under sandwich planting

Lines	(Visits per 5 flowers per 5 min)				Mean
	A. dorsata	*A. mellifera*	*A. cerana*	*A. florea*	
CMS (0.6m)	0.00a	0.14a	1.93bc	0.00a	0.51a
CMS (1.2m)	0.26a	0.16a	1.90bc	0.06a	0.57a
Maintainer	2.74c	1.46b	1.43b	0.17a	1.45b
Mean	1.00c	0.55b	1.74d	0.08a	

Figures followed by the same letters are on par, 0.6 and 1.2m refer to distance from pollen line

Table 2 : Mean visits of different species of bees on sunflower lines (maintainer and CMS lines) at different times of the day planted in block method.

Time	*A. dorsata*	*A. mellifera*	*A. cerana*	*A. florea*	Mean
900	1.407cfg	0.672cd	1.050def	0.004a	0.783
1200	0.134ab	1.261ef	0.820cde	0.460bc	0.669
1500	0.099ab	2.034g	0.666cd	0.496bc	0.824
Mean	0.546b	1.322d	0.845c	0.318a	

Figures followed by same letter (s) are on par.

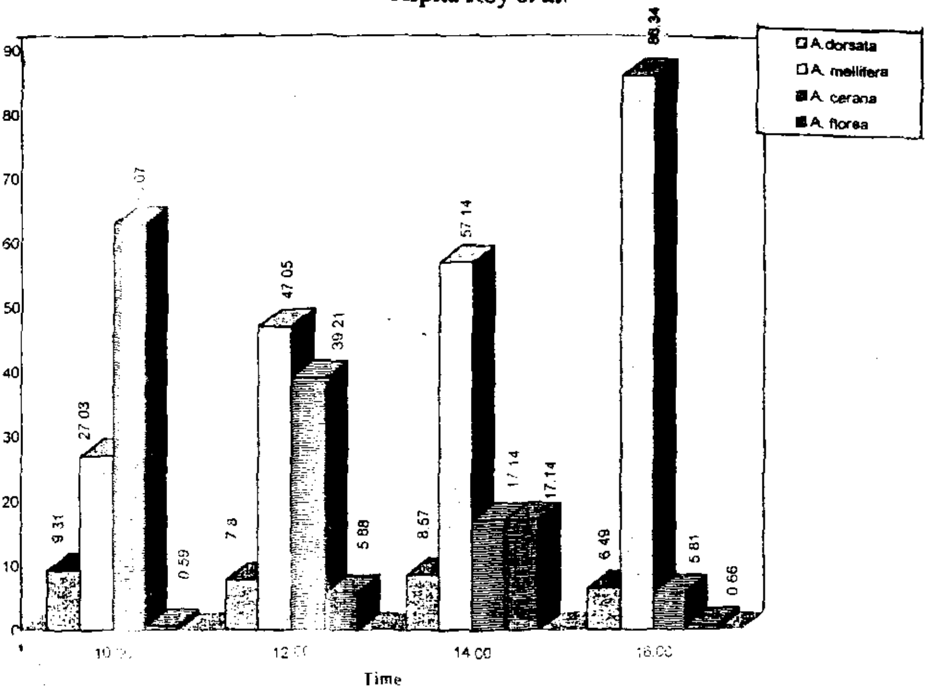

Fig-1 : Proportion of different honey bee species on CMS line at different times of the day

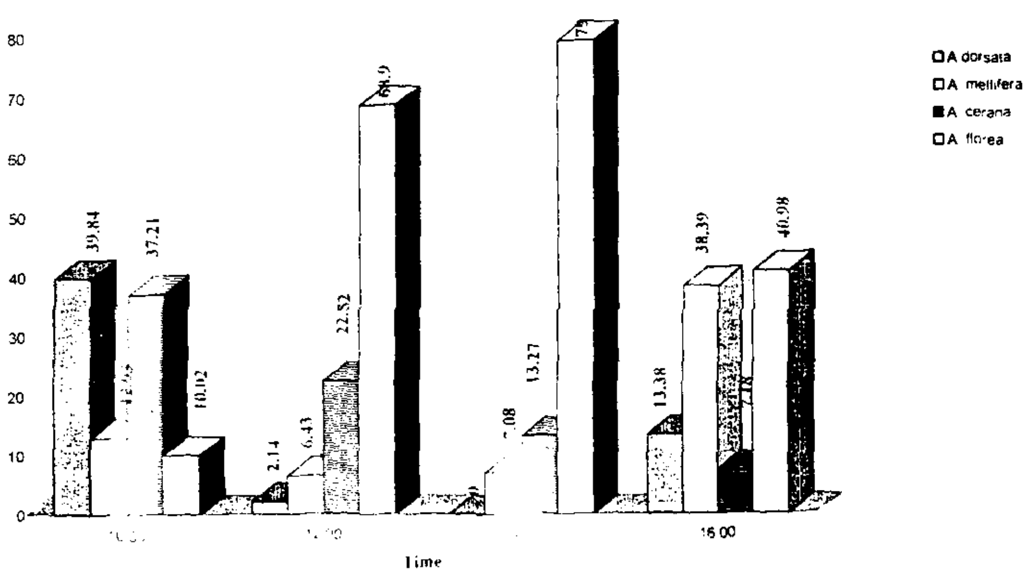

Fig-2 : Proportion of different honey bee species on maintainer line at different times of the day

Table 3 : Mean honey bee activity on CMS rows at different distances from pollen row and on pollen row

Distance (m)	Bees per 5flowers per 5min
0.6	0.556de
2.4	0.257a
4.8	0.257a
7.2	0.402abc
9.6	0.370abc
12.0	0.320ab
14.4	0.382abc
16.8	0.603e
19.2	0.460cd
21.6	0.357abc
Pollen row	5.780f

Figures followed by same letter(s) are on par

on decreasing on CMS row which is contradictory to our findings. However, similar to our observations were made by Hoffman and Martin (1993) who recorded *A. mellifera* activity on sunflower.

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EFFECT OF PLANTING DATES ON OCCURRENCE OF DISEASE-PESTS IN MUSTARD VARIETIES

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ABSTRACT

Four indian mustard varieties viz., Varuna, Vardan, Rohini and Vaibhav were tested for disease and pest reaction and grain yield in relation to sowing dates during 1991-92 and 1992-93. It was observed that varieties differed in respect of disease-pest infestation and grain yield and it was highly influenced by sowing dates. Early sowing (30th September) recorded lowest disease and pest score with highest grain yield. The disease and pest infestation enhanced with decrease in yield in subsequent sowings ie., 15th October, 30th October and 15th November. However, the alternaria blight and saw-fly score decreased in late sowing ie. 15th November and thereafter. Rohini was most tolerant variety against alternaria blight, while Vardan and Varuna were tolerant to white rust disease. Varuna was least preferred by the mustard aphid and leaf miner, while Rohini was most susceptible to aphid. Vaibhav was most tolerant to mustard saw-fly. Variety Rohini gave highest average grain yield (12.25 q/ha) followed by Vaibhav (11.92 q/ha), Varuna (10.65 q/ha) and Vardan (10.25 q/ha).

Key words : Mustard, varieties, sowing dates, diseases, insect pests, yield.

INTRODUCTION

In India rapeseed and mustard are very important oleiferous crops affected by a number of diseases and pests limiting productivity of the crop over a wide area. The losses due to diseases have been recorded in the range of 10-70% (Raoof, 1995). The most wide spread and destructive diseases of rapeseed mustard in India are- Alternaria blight, white rust, downy mildew, powdery mildew, Sclerotium rot and bacterial rot. Besides diseases thirty eight insect pests are known to be associated with different stages of rapeseed-mustard crops in India. The mustard aphid, *Lipaphis erysimi* (Kalt.) is the key pest through out the mustard growing belt, which causes 35.4 to 73.3% yield loss in different agroclimatic regions, while saw-fly, *Athalia lugens proxima* (klug) and leaf miner *Chromatomyia horticola* (Goureav) are considered as the major pests of the crops (Bakhetia and Sekhon, 1989). Agreat deal of work has been done on chemical control of diseases and pests in mustard but environmental imbalances are the major problems in various regions due to unplanned and excessive use of chemicals. To over come some of these problems Integrated pest management (IPM) has opened new avenues to harness the optimum benefits with minimum/negligible disturbance to the nature. An attempt has been made to exploit the potential of mustard varieties through altering the planting dates to avoid the pressure of diseases and insect-pests with least disturbance to the environment.

MATERIALS AND METHODS

A field trial was conducted at Regional Research Station, Mainpuri in South-western Semi-arid Zone of Uttar Pradesh, with four mustard varieties namely, Varuna, Vardan, Rohini and Vaibhav. They were planted on four dates ie. 30th September, 15th October, 30th October and 15th November with three replications in a split-plot design. A uniform plant population with row to row spacing of 45 cm and plant to plant spacing of 15 cm was maintained. A uniform dose of NPK at the rate of

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60:40:40 kg/ha was applied as basal dressing in the form of urea, diammonium phosphate and muriate of potash, respectively. Rest 60 kg N was applied as top dressing at first irrigation after 33 days of sowing.

Observations were recorded on intensity of Alternaria blight and white rust as they were the major diseases at the station. Other diseases were economically insignificant, therefore, not taken into account. Besides the population of mustard aphid per plant, mustard saw-fly grubs per plant and number of mines per leaf of mustard leaf-miner were recorded at weekly interval on selected tagged plants. Average of the observations are presented in Table 1 and 2. Finally the yield data were recorded.

RESULTS AND DISCUSSION

Effect of planting dates

Disease incidence

The mean data revealed that the minimum intensity of Alternaria blight (21.76%) was recorded in 30th September sowing, which enhanced in subsequent 15th October (28.01%) and 30th October (27.20%) sowing. These results support the findings of Hawlidar *et al.* (1989), Mian and Akande (1989) and Raoof (1995), who have recommended early sowing for minimum damage of crop from Alternaria blight disease. However, in the present study there was a declining trend in disease score after 15th October planting. The reason of higher score in the crop sown during 15th to 30th October may be due to exposure to favourable weather for disease development. Minimum score of white rust disease was also recorded in early (30th September) sowing with a rise in subsequent sowings. Similar results have been reported by Kolte *et al.* (1986) and Lakra and Saharan (1990).

Insect-Pest infestation

The major pests infesting the crop were mustard aphid, saw-fly, grub and leaf miner. The data (Table 2) revealed that early sown crop escaped from major pests viz., aphids, mustard saw-fly and leaf miner. Early sowing on 30th September escaped from attack of mustard aphids, while late sowing on 15 th November recorded maximum population of aphids (152.09/plant). Similar results have been reported by Singh *et al.* (1984) and Mathur and Singh (1986).

As regards the attack by mustard saw-fly, the minimum grub population was recorded in early (30th September) and timely (15th October) sown crops, while maximum was scored in 30th October sowing. Here again there was fall in grub population in 15th November sowing. The highest grub population in October may be due to exposure of crop to congenial weather parameters. Similar results have also been reported by Mathur and Singh (1986).

Leaf miner was another serious pest in the present study. The early (30th September)and timely sown crop (15th October) did not receive this pest. Maximum incidence (3.48 mines/leaf) was recorded in late sown crop (15th November).

Grain yield

Results presented in Table 1 showed that early sowing on 30th September gave higher grain yield (19.82 q/ha) than the crop sown on later dates during both the years. Every fifteen days delay in sowing reduced grain yield considerably. Maximum yield loss (83.80%) was recorded in 15th November sowing. This yield reduction was mainly due to disease and pests infestation. Saini (1984) also reported yield loss in late sown mustard.

Response of Varieties

Disease Incidence

The data revealed (Table 1) that Rohini was most tolerant variety for Alternaria blight showing 18.56 per cent disease incidence followed by Vardan and

Table 1: **Effect of planting dates and varieties on the disease intensity and yield in mustard**

Treatment	*Alternaria* blight (%)			White rust (%)			Yield (q/ha)		
	1992	1993	Mean	1992	1993	Mean	1992	1993	Mean
Palnting dates									
30th Sept	34.42 (35.92)	21.76 (22.70)	21.76 (27.81)	0.92 (5.53)	9.94 (18.38)	5.39 (13.43)	18.16	19.82	19.82
15th Oct.	34.42 (35.92)	22.04 (28.00)	28.01 (31.96)	0.83 (5.24)	15.07 (22.84)	5.88 (14.04)	13.62	15.49	14.55
30th Oct.	32.18 (34.56)	22.52 (28.33)	27.20 (31.44)	11.51 (19.44)	19.9 (26.53)	15.24 (22.98)	10.35	14.33	12.64
15th Nov.	29.80 (33.09)	18.95 (25.81)	24.17 (29.45)	12.90 (25.72)	19.01 (25.88)	18.94 (25.80)	4.48	1.97	3.22
C.D. (0.05)	1.68	0.79	1.23	4.10	1.14	2.62	1.69	1.81	1.75
Varieties									
Varuna	42.06 (40.43)	38.07 (38.10)	40.04 (39.26)	9.81 (18.25)	12.41 (20.63)	11.07 (19.44)	9.47	11.83	10.65
Vardan	29.71 (33.03)	18.40 (25.40)	23.81 (29.21)	9.54 (17.99)	11.64 (19.95)	10.56 (18.97)	8.99	11.52	10.65
Rohini	22.10 (28.04)	15.28 (23.01)	18.56 (25.52)	7.18 (15.55)	19.13 (25.95)	12.55 (20.75)	9.14	15.36	12.25
Vaibhav	35.54 (36.60)	15.84 (23.45)	25.03 (30.02)	7.11 (15.47)	20.12 (27.08)	13.15 (21.27)	10.34	13.50	11.92
C.D. (0.05)	6.27	0.57	3.42	NS	0.67	0.33	1.13	1.20	1.16

Figures in parenthesis are angular transformed values

Varuna with 23.81, 25.03 and 40.04 % respectively. The intensity of Alternaria blight in vardan and Vaibhav were statistically at par. As regards white rust, on the basis of two years average, minimum incidence was recorded in Vardan (10.56%) followed by Varuna (11.07%), Rohini (12.55%) and Vaibhav (13.15%). Khetmaloo *et al.* (1994) also reported Varuna to be moderately susceptible to *Albugo candida.*

Insect-Pest incidence

The major pests attacking the crop were mustard aphid, saw-fly, grub and leaf-miner. It was found that variety Varuna was most tolerant to the mustard aphid. The average incidence of aphid in Varuna was 61.33 per plant followed by Vardan (68.75), Vaibhav (72.34) and Rohini (96.24). Variety Varuna was most resistant to leaf-miner also, scoring 2.35 mines per plant followed by Vardan (2.36), Rohini (4.11) and vaibhav (4.80) (Table 2).

Variety Vaibhav was least preferred by the mustard saw-fly with an average of 2.73 grubs per plant followed by Varuna (2.76), Rohini (2.90) and Vardan (3.09).

Grain Yield

The varieties differed markedly in grain yield. Rohini gave significantly higher average grain yield (12.25 q/ha) followed by Vaibhav (11.92 q/ha), Varuna (10.65 q/ha) and Vardan (10.25 q/ha). Kumar *et al.* (1989) also found that Rohini out yielded

Table 2: Effect of planting dates and varieties on the incidence of insect pests in mustard.

Treatment	Number of mustard aphids per plant (10cm central twigs)			Number of mustard saw-fly grubs per plant			Number of mines per leaf made by mustard leaf miner		
	1992	1993	Mean	1992	1993	Mean	1992	1993	Mean
Planting date									
30th Sept	0.00	0.00	0.00	0.00	0.65	0.32	0.00	0.00	0.00
15th Oct.	23.53	0.00	11.76	1.87	0.74	1.30	0.00	0.00	0.00
30th Oct.	30.23	14.66	22.44	5.97	4.12	5.04	4.74	1.94	3.34
15th Nov.	167.96	136.22	152.09	3.88	1.82	2.85	5.96	1.00	3.48
C.D. (0.05)	6.67	12.57	9.62	0.05	0.06	0.05	0.06	0.04	0.05
Varieties									
Varuna	59.91	62.76	61.33	3.79	1.73	2.76	3.33	1.38	2.35
Vardan	69.02	68.49	68.75	4.11	2.07	3.09	3.38	1.34	2.36
Rohini	92.96	99.53	96.24	3.96	1.84	2.90	6.88	1.35	4.11
Vaibhav	73.71	70.97	72.34	3.70	1.69	2.73	7.81	1.80	4.80
C.D. (0.05)	5.13	4.41	4.77	0.05	0.06	0.05	0.14	0.20	0.17

(14.31 q/ha) Vardan and Vaibhav in Central Zone of India. The interaction effect of planting dates and varieties were non significant in disease-pest infestation as well as grain yield.

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BIOLOGICAL CONTROL OF COLLAR ROT (*Aspergillus niger* Van. *Teighem*) OF GROUNDNUT

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ABSTRACT

Trichoderma harzianum was found to inhibit the growth of two virulent isolates (soil isolate 16 and seed isolate 24) of *A. niger* by 63% and 58%, respectively after 72 hrs of inoculation in dual culture in Petridishes; manifested by producing branches inside the conidiophores resulting into rupturing of conidiophores. In different soil environments (non-autoclaved, autoclaved/contaminated with *T. harzianum*) collar rot disease incidence was more in autoclaved soil. Seed treatment with *T. harzianum* after storing upto 5 months reduced collar rot incidence when inoculated with *A. niger*.

Key words : Biocontrol, *Trichoderma harzianum*, *Aspergillus niger*, autoclaved soil, Collar rot, groundnut.

INTRODUCTION

Groundnut cultivation is gaining importance as oilseed crop in the Gangetic plains of West Bengal. But due to repeated cultivation of groundnut for years together in the same field, inoculum density of *Aspergillus niger*, the causal agent for collar rot disease is increasing at a constant rate and recently threatening groundnut production in the state. To check collar rot or seed rot or pre-emergence damping off disease, fungicides are generally used. But due to their low persistance and having residual toxicity, research towards the management of collar rot disease has been focused to select biocontrol agent as a durable, safe and cost-effective alternative to soil applied chemicals. Among the biocontrol agents, *Trichoderma harzianum* has been selected for the management of collar rot of groundnut. *T. harzianum* has been used against various plant pathogens in different crops (Lewis and Papavizas, 1980; Cook and Baker, 1983).

MATERIAL AND METHODS

Ten isolates of *Aspergillus niger* were selectively isolated from groundnut cultivated soils from different agroclimatic zones of West Bengal using M3, SIB medium. Their relative pathogenicity was tested against groundnut cultivar Phule Pragati (JL-24). The isolates were identified by Division of *Mycology and Plant Pathology, IARI, New Delhi.* The culture of *T. harzianum* was collected from Departmental laboratory BCKV and both fungi were maintained in PDA medium. The efficacy of *T. harzianum* was tested both *in vitro* and *in vivo* condition.

In Vitro : A 5 cm disc of *A. niger* isolate-16 (a soil isolate) and isolate-24 (a seed isolate) were tested as virulent isolates and transferred to PDA medium in 10 cm diameter Petriplates. A 5 cm disc of *T. harzianum*, 2-3 cm, away from the edge was placed on the medium of the plate at a distance of 2 cm from the disc of *A. niger*. Three replications were used along with a blank (control). The plates were incubated at 28 ± 1°C in a BOD. The percentage of reduction in growth of *A. niger* colony was calculated after 24h and 72h of inoculation. To note the mycoparasitism, the intermingled hyphae of *T. harzianum* with *A. niger* were mounted on slides and observed in the microscope. Inhibition of growth of *A. niger* was calculated by the following formula :

$$\text{Reduction \% of Linear growth} = \frac{R_1 - R_2}{-R_1} \times 100$$

R_1 = Radium of normal growth

R_2 = Radium of inhibited growth

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***Invivo* : Seed dressing with *T. harzianum* spores**

Spore suspensions (250 x 10 spores/ml of *T. harzianum*) from 7 days old culture were mixed with surface sterilized groundnut seeds @ 20 ml/ 20 g of seeds. Seeds mixed with equal quantity of sterile water was considered as control. Virulent isolate of (Isolate 16). *A. niger* grown in sand maize meal medium was mixed with the soil of earthen pots @ 50% of soil weight, 5 days before sowing of the treated seeds. Four replications were used and watering was done as and when required. The percentage of incidence of seed rot and collar rot was recorded.

In the second method both the fungi of *T. harzianum* and *A. niger* (isolate 16) were grown in sand maize meal medium for 10 days at 28 ±1°C. Sandy loam soil collected from upland cultivated field was mixed with fungal inoculum in the ratio of 1 : 1 (v/v) and kept in 10 cm surface sterilized earthen pots. Soil was used as autoclaved and non autoclaved conditions in this experiment. The upper 5 cm of potted soil was mixed with the inoculum. Ten groundnut seeds were surface sterilized and sown in each pot. There were 10 treatments viz. T_1 = inoculum of *T. harzianum* in autoclaved soil; T_2 = Inoculum of *T. harzianum* in non autoclaved soil; T_3 = Inoculum of *A. niger* (isolate 16) in autoclaved soil; T_4 = Inoculum of *A. niger* in non autoclaved soil, T_5 = Inoculum of *A. niger* in autoclaved soil and seed sown after seed dressing with *T. harzianum* (250 x 10^6 spores/ml). T_6 - Inoculum of *A. niger* in non autoclaved soil and seed sown after dressing with *T. harzianum*; T_7 = Both the inoculum of *T. harzianum* and *A. niger* mixed with autoclaved soil; T_8 = Both the inoculum of *T. harzianum* and *A. niger* with non autoclaved soil. T_9 = Surface sterilized seeds in autoclaved soil; T_{10} = Surface sterilized sown in non autoclaved soil. For each treatment four replications were maintained and kept in glass house. Disease incidence was recorded upto 45 days after sowing (DAS).

An experiment was also conducted to find out the efficiency of biocontrol agent with *T. harzianum* at long storage after seed dressing. Two separate spore suspensions (250 x 10^4 spores/ ml) of *Trichoderma harzianum* and *A. niger* (isolate-16) were prepared from 7 days old culture and the method of seed dressing was used as T_1 = 200 nos. Surface stelized seeds treated with the spore suspension of *T. harzianum* 20 ml/100 g seeds and dried in shade; T_2 = same as T_1 and after 2 days, same seeds were treated with *A. niger* and dried in shade: T_3 = 200 surface sterilized seeds treated with the spore suspension of *A. niger* 20 ml/100 g seed and then dried in shade; T_4 = 200 surface sterilized seeds soaked in sterile water and then dried in shade was used as control. All the treated seeds were stored in different paper packets upto 5 months. Incidence of seed rot and collar rot were recorded at one month interval. In each treatment there were three replications.

RESULTS AND DISCUSSION

Trichoderma harzianum was found to inhibit the growth of two *A. niger* isolates (Isolate-16 and Isolate-24) by 60.46% and 60%, respectively after 72 h of inoculation in dual culture in Petridish, though no significant reduction was observed in between two isolates (Table 1). The intermingled hyphae from dual culture plates, when observed under microscope, *T. harzianum* was found to penetrate frequently the conidiophores of *A. niger* after coming into direct contact with each other. The parasitic hyphae coiled around the vegetative hyphae. The parasitic behaviour of *Trichoderma* was recorded to be of a necrotrophic or destructive type (Barnet and Binder, 1973; Gupta *et al.*, 1979; Transmo and Dennis, 1978; Upadhyay, 1979). The hyphae of *T. harzianum* was found to produce branches inside the conditiophores after penetration which causes repturing of *A. niger* conidiophores.

In glass house condition, it was observed that all the treatments showed significant reduction

Table 1 : Effect of *T. harzianum* on the growth of *A. niger* after 24 hrs and 72 hrs of inoculation

A. niger Isolates	Liner growth (mm)					
	24 hrs			72 hrs		
	R1	R2	Reduction (%)	R1	R2	Reduction (%)
Isolate 16	19**	9	52.63	43	17	60.46
Isolate 24	17	8	52	40	16	60

of collar rot as well as pre-emergence damping off. The treatment T_1 and T_2 showed no adverse effect on plant. In T_3 and T_4 it was observed that *A. niger* developed more collar rot disease due to artificial inoculation of the inoculum on which no biocontrol agent was added. Though disease developed more in autoclaved soil than non autoclaved soil, may be due to absence of other antagonistic saprophytes, but no significant difference was observed among them selves. In T_5 and T_6 it was observed that seed dressing with *T. harzianum* significantly reduced the seed and collar rot incidence both in autoclaved and non autoclaved soil, though reduction was not significantly different among themselves. T_7 and T_8 also showed results similar to T_5 and T_6 and no significant difference was observed among themselves (Table 2).

It was observed from the above experiments that seed dressing with *T. harzianum* and soil application of the same bioagent had no significant difference in reduction of collar rot as well as pre-emergence damping off, but biocontrol agent has a significant effect in reduction of collar rot and pre-emergence damping off in groundnut.

Study on seed dressing of groundnut seeds with *T. harzianum* and storage on paper packets for viability and efficiency to control collar rot disease was also conducted and observed that upto 5 months storage after seed dressing, the *T. harzianum* also reduced seed rotting and collar rot incidence significantly over untreated control. In case of pre-emergence damping off or seed rotting, it was observed that *T. harzianum* provided good protection when treated seeds were kept upto 3 months (T_3). In T_1 treatment it was observed that *T. harzianum* showed fairly good control upto 5 months than T_2 when the seeds were treated with both *T. harzianum* and *A. niger* (Table 3). It was also observed that upto 3 months storage there was a negligible attack of collar rot disease which increased after 4 months. The treatments were significantly different among themselves over time of storage and their interaction in seed rotting as well as collar rotting (Table 3).

Trichoderma harzianum proved to be best biocontrol agent for the management of collar rot disease of groundnut caused by *Aspergillus niger* for soil application as well as seed treatment upto 5 months storage.

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Table 2 : Effect of *T. harzianum* on the incidence of collar rot disease of groununut under glass house condition

Treatments	Disease incidence		
	Seed rot and pre-emergence damping off (%)	Collar rot (%)	Plants infected but not dead (%)
T-1	0(0)	0(0)	0(0)
T-2	0(0)	0(0)	0(0)
T-3	30(33.21)	27.5(31.63)	12.5(20.7)
T-4	22.5(28.32)	27.5(31.63)	15.0(22.79)
T-5	7.5(15.89)	10(18.43)	10(18.43)
T-6	5.0(12.92)	7.5(15.89)	10(18.43)
T-7	10(18.43)	7.5(15.89)	5(12.43)
T-8	7.5(15.89)	5(12.92)	5(12.92)
T-9	0(0)	0(0)	0(0)
T-10	2.5(9.1)	0(0)	0(0)
CD(0.05)	12.55	8.26	

Figures in parenthesis are angular transformed values

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Table 3 : Effect of seed dressing of groundnut with *T. harzianum* on the incidence of seed rot and collar rot at different storage periods.

Treatment	1 month		2 months		3 months		4 months		5 months		Mean	
	A	B	A	B	A	B	A	B	A	B	A	B
T 1	3.3	0	0	0	3.3	0	13.3	0	16.6	0	7.3	0
	(10.47)	(0)	(0)	(0)	(10.47)	(0)	(21.39)	(0)	(24.04)	(0)	(13.27)	(0)
T 2	13.3	0	3.3	0	13.3	6.6	30.0	13.3	33.3	10.0	18.64	5.98
	(21.39)	(0)	(10.47)	(0)	(21.39)	(14.89)	(33.21)	(21.39)	(35.24)	(18.43)	(24.34)	(10.94)
T 3	20.0	3.3	26.6	0	16.6	10.0	40.0	30.0	87.5	3.3	38.14	9.32
	(26.57)	(10.47)	(31.05)	(0)	(24.04)	(18.43)	(39.23)	(33.21)	(69.3)	(10.47)	(38.04)	(14.52)
T 4	6.6	6.6	13.3	0	13.3	0	40.0	6.6	44.66	16.6	23.57	5.96
	(14.89)	(14.89)	(21.39)	(0)	(21.39)	(0)	(39.23)	(14.89)	(40.16)	(24.04)	(27.41)	(10.76)
CD at 5%	Seed rot	Collar rot										
Treatment	6.61	0.42										
Time	7.37	0.65										
Interaction	14.78	10.88										

A = Percent seed rot. B = Percent collar rot, Figures in parenthesis are angular transformed values.

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OIL AND PROTEIN QUALITY OF THE SELECTED GROUNDNUT VARIETIES

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ABSTRACT

The present study was purported to evaluate the quality of oil and protein contents of the selected varieties of groundnuts. The protein content and the digestibility of proteins were markedly high in the hybrid derivative PBNG-6 as compared to the other varieties, while the oil content was maximum in the check variety M 13. Wide variations were noticed in the fatty acid composition of oils of the four selected varieties and in the ratio of oleic acid to linoleic acid. The hybridization programme is considered to be invaluable in improving the quality and in increasing the quality of proteins in groundnuts.

Key words : Oil quality, protein quality, groundnut varieties

INTRODUCTION

Protein energy malnutrition is an economic as well as a social and health problem. For alleviating the problem of protein energy malnutrition of the population, oilseeds have been recognised to play a valuable role as a source of edible protein apart from their customary use as a source of oil.

Groundnut (*Arachis hypogaea* Linn.) is the main source of edible oil in the country. The Plant Breeding Department of MAU, Parbhani developed several hybrid derivatives of groundnuts; three of which alongwith the variety M 13 were evaluated for protein and oil quality as it is known that varietal differences exist in the protein and oil contents of groundnuts (Kumar, 1984; Sharma *et al.*, 1981; 1985).

MATERIALS AND METHODS

Three newly developed hybrid derivatives of groundnuts namely PBNG-6 [M 13 x EC 76446 (292)], PBNG-26 [Robut 33-1 x Shulamit] and PBNG-27 [Robut 33-1 x EC 76446 (292)] and one check variety M 13 were obtained in one lot of 500g each from the plant breeding and genetics department, MAU, Parbhani.

Crude protein content of the samples of groundnuts was ascertained by determining the total nitrogen content using Macro-Kjeldahl method (A.O.A.C., 1975). Non-protein nitrogen content of the samples of groundnuts was estimated by the method of Lees (1975). Digestibility of proteins was assessed by the *in vitro* method of Akeson and Stachman (1964).

The oil content in the groundnuts was estimated by the standard Soxhlet method of A.O.A.C. (1975). Methyl esters were prepared by transestrification method and the esters were isolated by spectro-scopic grade hexane (Morrison and Smith, 1964). The methyl esters of fatty acids were then analysed in AIMIZ-NUCON-5500 model gas chromatography.

The results were analysed by ' Analysis of variance' and critical difference tests. Correlation co-efficient test was also applied to find the relationship between any two components of the groundnuts (Rosender, 1965).

RESULTS AND DISCUSSION

Crude protein, non-protein nitrogen and the digestibility of proteins of the four selected

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varieties of groundnuts are presented in Table 1.

The protein content of the four varieties varied from 19.1 to 23.4 g per 100 g. It was the lowest in M13 variety and the highest in PBNG-6 variety. The three selected hybrid varieties of groundnuts were found to be having markedly more protein content than the check variety M 13. The non-protein nitrogen in the variety PBNG-6 was maximum and it was minimum in the variety M 13. The other two varieties had obtained the same values for crude protein and non-protein nitrogen.

The digestibility of proteins (%) of the four selected varieties varied from 59.2 to 73.9. The per cent digestibility of protein was the highest from PBNG-6 variety and it was the lowest from PBNG-27 variety. The digestibility of proteins from the check was very low when compared with that from the hybrid variety PBNG-6.

On the whole, the varieties showed differences for the crude protein, non-protein nitrogen and digestibility of proteins. Even Sharma *et al.*, (1981, 1985) and Kumar (1984) reported varietal differences in the protein content of groundnut.

The oil content of the four varieties of groundnuts varied from 44.5 to 48.2 per cent (Table 2). The oil content in the variety M 13 (48.2 g/

Table 1: Crude protein, non-protein nitrogen and digestibility of proteins of the four selected varieties of groundnut

Varieties	Crude protein (g)	Non-protein nitrogen (g)	Digestibility of proteins (%)
M 13	19.1	0.26	69.1
PBNG-26	22.5	0.34	67.6
PBNG-27	22.5	0.34	59.2
PBNG-6	23.4	0.42	73.9

100g) was significantly higher than that in the other three hybrid varieties. However, among the hybrid varieties the oil content of PBNG-26 was significantly higher than that of the other two varieties.

It is evident from the results that the oil content in hybrid varieties of groundnuts was significantly less, while the protein content was significantly more than in the check variety M 13. A highly significant negative correlation ($r = -0.812$) was observed between the protein and oil contents in different varieties of groundnuts. This implies that with an increase in protein content, there was a corresponding decrease in the oil content of groundnuts. Dhawan *et al.* (1972) also reported a negative correlation between the oil and protein contents in different varieties of sesamum seeds.

Fatty acid composition of oils from the groundnut varieties showed variation not only with respect to check variety but also with in the varieties. The contents of palmitic acid (12.28%), stearic acid (4.83%) and arachidic acid (2.31%) were found in maximum amount in the oil of PBNG-26. Oleic and linoleic acids were the major acids present in the oils of four different varieties of groundnut but they varied markedly in quantity. The oils of the four varieties had higher oleic and lower linoleic acid contents. The oil of M 13 variety contained the highest amount of oleic acid and the oil of PBNG-27 (45.16%) contained the lowest amount of oleic acid. In contrast, the linoleic acid content was found to be more in oil of variety PBNG-6 than in the oil of M 13.

Although the high oleic acid content in the oil of M 13 is desirable from the storage quality of oil, the linoleic acid content in the oil of this variety is undesirable from the nutritional point of view. It has been reported by Grande *et al.* (1970) that linoleic acid is hypocholesteramic and palmitic acid appears to have little effect on blood cholesterol level in humans. Therefore, the low palmitic acid content in the oil of M 13 is nutritionally desirable.

Table 2: Oil content and fatty acid composition of oils in the *four selected varieties of groundnut*

Varieties	Oil content (g)	Fatty acids							
		Palmitic 16:0	Stearic 18:0	Oleic 18:1	Linoleic 18:2	Arachidic 20:0	Eicosenoic 20:1	Behenic 22:0	Oleic/Linoleic
M 13	48.2±0.3	8.50±0.47	2.32±0.87	45.16±0.18	25.41±3.86	1.06±0.04	1.01±0.03	4.36±0.10	1.78±0.02
PBNG-26	46.8±0.8	12.28±0.21	4.83±0.09	34.94±0.17	28.03±0.37	2.31±0.05	1.20±0.01	5.88±0.21	1.25±0.02
PBNG-27	44.7±0.8	8.87±0.36	1.75±0.03	33.94±0.28	27.33±0.40	1.33±0.11	1.34±0.16	6.84±0.16	1.24±0.01
PBNG-6	44.5±0.5	10.16±0.14	1.15±0.14	40.19±0.38	29.16±0.43	1.62±0.02	1.50±0.06	4.93±0.24	1.38±0.01
C.D. (0.05)	1.2	3.64	1.70	2.45	21.50	0.60	0.80	1.51	0.51

The ratio of oleic to linoleic acid which gives an idea of the stability of oil, was the highest in the oil of the variety M 13 (1.78) and it was the lowest in the oil of the variety PBNG-26 (1.24). The ratio of oleic to linoleic acid and the composition of fatty acids in the oils of four selected varieties differed significantly.

These results are in the line with the findings of several other workers where different mutants of groundnuts exhibited variations in fatty acids composition and in the characteristics of oil stability (Young, 1960; Sharma *et al.*, 1981; Gupta *et al.*, 1982; Sharma *et al.*, 1985).

In conclusion it can be said that M 13 in terms of quantity and quality of oil and PBNG-6 with regard to the quality and quantity of protein were found to be the superior varieties.

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GENETIC BEHAVIOUR OF YIELD AND ITS COMPONENTS IN INDIAN MUSTARD (*Brassica juncea* L.Czern & Coss)

In planning of an efficient breeding programme in any crop, selection of parents plays a crucial role and combining ability analysis serves as a very handy tool for the selection of parents. Information on the relative importance of general and specific combining abilities is also helpful in the analysis and interpretation of the genetic basis of the important traits. The present study was, therefore, undertaken to gather such an information in Indian mustard regarding seed yield and its component traits.

Fifteen diverse genotypes/Cultivars viz., RB 89/2, PSR-1, PR 8903, RSK 28, PBM 16-7, RH 8814, RK 8902, DLM2, RW 89/86, DIR 463, JMM 1628, KBJ 15, NDR 281, RSK 8 and PR 8958 were crossed with three testers viz., DIRA 313, PR 8801, and NDR 8501. The F1's along with their parents were sown in a randomized block design with 3 replications. The plot consisted of a single row of 3 meters length for parents and crosses. The planting distance between and within the row was 45cm and 15cm, respectively. Five plants from each row, selected randomly were used to record observations for days to 50% flowering, days to maturity, number of primary branches/plant, secondary branches/plant, seed yield/plant (g), 1000-seed weight (g) and oil content. Combining ability analysis was carried out using Kempthorne (1957).

Analysis of variance for combining ability revealed that the mean square due to males were significant for all the traits except primary branches, secondary branches and 1000-seed weight (Table 1). For females it was significant for all the characters. The lower magnitude of variance in the female x male interaction, although highly significant for all characters except oil content suggested greater uniformity among the hybrids than among the parental variations. The variance due to *sca* was found to be considerably higher than that of *gca* for secondary branches, 1000-seed weight and seed yield indicating greater importance of non-additive gene actions. For remaining traits additive gene action was responsible. Thakral and Singh (1995) also reported greater importance of additive gene action for days to maturity and non-additive type of gene action for oil content. The general predictability ratio (Baker, 1978) being close to 0.5 indicated both additive and non-additive gene actions for expression of seed yield.

The estimates of *gca* effects revealed that parents RH 8814, RK 8902 and KBJ 15 are the best general combiners for seed yield, also showed highest *gca* effects for yield components like primary branches, secondary branches and oil content. For earliness, RSK 28 and NDR 281 emerged best general combiners. DIR 463 and JMM 1628 for 1000-seed weight and oil content. The parent RSK 28 showed good *gca* for earliness associated with poor combining ability for seed yield, 1000-seed weight and oil content.

The cross RH 8814 x PR 8801 followed by JMM 1628 x DIRA 313 were found to be the best combinations involving high x high general combiner parents and also exhibited high mean performance for seed yield and 1000-seed weight. The cross KBJ 15 x PR 8801 was observed to be the best combination for oil content followed by RSK 8 x PR 8801 and RB 89/2 x PR 8801. The cross NDR 281 x NDR 8501was also found to be promising for oil content and 1000-seed weight. Thus, these crosses are of worth exploitation in varietal breeding programme. But in some cases

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Table 1. Analysis of variance for combining ability in Indian mustard

Source	d.f.	Mean Squares						
		Days to 50% flowering	Days to maturity	Primary branches/ plant	Secondary branches/ plant	Seed yield/ plant (g)	1000-seed weight (g)	Oil content (%)
Females	14	49.98**	190.13**	0.66**	43.91**	156.12**	1.36**	5.35**
Males	2	241.30**	863.79**	0.001	26.18	72.74**	0.58	26.86**
Female x males	28	10.14**	33.16**	0.28**	17.40**	22.10**	0.37**	1.63
Error	124	0.89	1.54	0.06	0.68	0.99	0.01	0.002
Equivalent components of mean squares								
$2\sigma_g$		5.02	18.29	0.01	0.65	3.42	0.02	0.54
$2\sigma_s$		3.08	10.54	0.07	5.57	7.04	0.12	0.54
Predictability Ratio $\frac{2^2\sigma_g}{2^2\sigma_g + {}^2\sigma_g}$		0.76	0.78	0.24	0.19	0.49	0.25	0.62

** Significant at P = 0.01

average x average, average x good or poor x poor combinations were associated with significant *sca* effects indicating the presence of interallelic interactions. Such crosses and their derivatives may or may not be of immense utility in hybrid breeding programme.

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GENETIC VARIABILITY AND CORRELATION OF YIELD, COMPONENT TRAITS AND FOLIAR DISEASE RESISTANCE IN GROUNDNUT

Late leaf spot caused by *Phaeoisariopsis personata* and rust caused by *Puccinia arachidis* are major diseases of groundnut causing yield loss upto 50% (Ghewande *et al.* 1993). The knowledge of variability and nature of association of the resistance with yield and its attributes will enable a breeder to plan effective breeding programme for its transfer into existing popular varieties. Therefore, the present study was undertaken.

The material consisted of eleven elite lines groundnut developed at ICRISAT viz., ICGV 52, 89402, 88261, 89412, 87301, 87846, 87860, 68, 88256, 88258, 86590 and three varieties viz., ICG(FDRS)-10 ICG(FDRS)-4 and JL-24. The experiment was laid out in a randomized block design with three replications during 1993 *kharif season at Regional Agricultural Research Station,* Tirupati. Lines were sown in 3 rows of 5 m length with infector rows of susceptible variety on either side of the test line. Normal spacing of 30 cm between rows and 10 cm. between plants was followed. Crop was grown under unprotected condition. Data were recorded on 10 plants selected at random for days to 50% flowering, days to maturity, late leaf spot and rust severity at 100 DAS (1-9 scale of ICRISAT, Subramanyam et al. 1982), haulm weight per plant (g), pod weight per plant (g), 100 pod weight (g), 100 kernel weight (g), shelling percentage and sound mature kernel percentage.

The analysis of variance revealed significant differences among varietal means for all the characters. Phenotypic co-efficient of variability was higher than genotypic co-efficient of variability for all the characters. The differences between *PCV* and *GCV* were narrow for 100 pod and 100-kernel weights, shelling percentage, sound mature kernel percentage, late leaf spot and rust severity, days to 50% flowering and days to maturity. All these characters showed high heritability which shows the usefulness of phenotypic selection in improving these traits. Late leaf spot and rust severities showed high heritability of 96.55% and 93.28%, respectively

Table 1: Estimates of co-eefficients of variability, heritability and genetic advance for yield, its components, late leaf spot and rust severity

Character	PCV	GCV	Heritability(%)	Expected Genetic advance as % of the mean
100 Pod weight	141.03	105.50	74.81	20.33
100 kernel weight	35.80	33.85	94.56	20.16
Shelling %	11.11	8.42	75.84	6.76
Sound mature kernel weight %	13.51	10.43	77.23	7.02
Late leaf spot severity	72.87	70.35	96.55	69.03
Rust severity	63.83	46.35	72.62	72.54
Days to 50% flowering	8.90	8.30	93.28	11.24
Days to maturity	1.55	1.55	100.[illegible]	2.49
Haulms weight/plant	205.29	103.03	50.19	48.11
Pod weight/plant	41.88	2.00	4.77	2.54

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coupled with high genetic advance (69.03 and 72.54% respectively). 100 pod weight and 100 kernel weight also exhibited high heritability with moderate genetic advance (Table-1). Haulm weight per plant recorded moderate heritability and moderate genetic advance. High *GCV*, h^2 and genetic advance suggest the role of additive gene action in the inheritance of late leaf spot and rust resistance, haulm weight per plant, 100 pod and 100 kernel weights. Sandhu and Khehra (1977) reported high *GCV*, h^2 and *GA* for late leaf spot resistance. High heritability and genetic gain were reported for all the late leaf spot resistance characters by Bhat *et al.* (1996), Iroume and Knauft (1987), and Anderson *et al.* (1991). Singh *et al* (1982) and Deshmukh *et al.* (1986) reported high heritability and moderate genetic advance for 100 kernel weight.

The phenotypic correlations were, in general, lower than the genotypic correlations which showed the role of environment in masking the inherent association between the characters. At phenotypic level, none of the characters showed significant association with pod weight per plant. At the genotypic level, pod weight per plant showed significant positive correlation with sound mature kernel percentage and significant negative association with days to 50% flowering. Hundred pod weight showed significant positive correlation with 100 kernel weight. Shelling percentage showed significant positive association with sound mature kernel percentage, late leaf spot and rust severities but a significant negative association with days to maturity and haulm weight per plant. Late leaf spot and rust severities showed significant negative association with days to 50% flowering, days to maturity and haulm weight per plant. But studies of Miller and Norden (1980) indicated negative correlation of leaf spot resistance with yield and early maturity.

High *GCV*, h^2 and *GA* for late leaf spot and rust severities indicate additive gene action which is amenable for selection for late leaf spot and rust resistance. But the significant positive association of late leaf spot and rust severities with shelling percentage and negative association with days to maturity and haulm weight per plant are undesirable and hinder the selection of genotypes with good shelling percentage and early maturity coupled with resistance to late leaf spot and rust resistance.

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Table 2: **Genotypic and Phenotypic *correlations* between yield, its components, Late leaf spot and rust severity in groundnut**

	100 kernel weight	*Shelling %*	*Sound mature kernel(%)*	*Late leaf spot severity*	*Rust severity*	*Days to 50% flowering*	*Days to maturity*	Haulms weight/plant	Pod weight per plant
100 pod	G 0.7123**	0.0947	-0.0772	0.2501	0.3026	0.0928	-0.2796	-0.2043	0.1459
weight	P 0.7990**	0.1529	-0.1578	0.3324	0.3429	0.0781	-0.3232	-0.3925	0.3747
100 kernel		G 0.2087	0.0026	0.1423	0.1505	0.0891	-0.2723	-0.1741	0.0261
weight		P 0.1673	-0.0211	0.1558	0.1559	-0.0920	-0.2801	-0.2654	0.4880
Shelling			0.6047*	0.6590**	0.5558*	-0.3042	-0.6724**	-0.3658	0.0322
%			0.6997**	0.7591**	0.7043**	-0.3593	-0.7721**	-0.7419**	0.3017
Sound mature				0.4148	0.3248	-0.7099**	-0.4767	-0.3037	0.1148
kernel (%)				0.4589	0.4105	-0.8263	-0.5414*	-0.3971	1.5093**
Late leaf spot					0.8577**	-0.5233*	-0.7867**	-0.6279**	-0.0274
severity					1.0156**	-0.5493*	-0.8006**	-0.8777**	0.0372
Rust						-0.4360	-0.6143*	-0.5097*	0.0255
severity						-0.5370*	-0.7208**	-1.0139**	-0.1238
Days to 50%							0.4662	0.2617	-0.2853
flowering							0.4827	0.4822	-1.4402**
Days to								0.6206*	0.0196
maturity								0.8760**	0.0903
Haulms									0.4246
weight/plant									-0.0272

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CORRELATION AND PATH ANALYSIS OF SOME QUANTITATIVE CHARACTERS IN LINSEED

Though linseed is an important oilseed crop in the Indian economy due to its wide industrial utility, the average productivity is quite low as compared to other countries. Since yield is a complex quantitative character and is governed by a number of other characters, the exact association between these characters with yield must be known for effective selection. The present study was undertaken to study the genotypic and phenotypic correlations between various component characters and their direct and indirect effects on grain yield.

The seventeen parents and their thirty crosses were raised in RBD with three replications during *Rabi* season in 1995-96 at the University oilseed experimental field. Single row plots of 2m length for each treatment was adopted. The distance between two rows was kept at 30 cm. whereas plant to plant distance was maintained at 15 cm. The data were recorded on five randomly selected plants for each genotype in each replication for nine quantitative characters. Correlation and path coefficient analysis were done as per Miller *et al.* (1958) and Dewey and Lu (1959), respectively.

The results of present study revealed that most of the yield component characters showed a strong positive correlation with seed yield. Only three characters, days to 50 per cent flowering, days to maturity and seeds per capsule were found to be negatively associated with seed yield at genotypic and phenotypic levels. However, days to maturity and seeds per capsule at phenotypic level were non significant. Ingale (1985) also reported negative association of seed yield with seeds per capsule, days to maturity and days to flowering. Negative association of days to 50 per cent flowering and maturity suggested that the earliness favours seed yield per plant. Significant positive association existed for the characters primary branches per plant, secondary branches per plant, number of capsules per plant and 1000-seed weight with seed yield. Number of capsules per plant exhibited highest genotypic and phenotypic correlation coefficient. The results are in conformity with the findings of Rao *et al.* (1984), Patil *et al.* (1981) and Jagadev (1990).

In order to obtain a clear picture of the interrelationship between different characters, the direct and indirect effects of different related characters were worked out separately, using path coefficient analysis in respect of seed yield (Table 2). The results revealed that seed yield was resultant of capsules per plant, number of primary branches and number of secondary branches per plant directly. It may be mentioned that these characters also indicated highly significant positive correlation both at genotypic and phenotypic levels (Table 1). This suggests true relationship of these characters with seed yield. Patil et al. (1981) and Satpathi *et al.* (1987) also reported greatest direct effect of capsule number on seed yield as in the present finding. Negative direct effect on seed yield was observed for days to maturity.

From the above results it may be suggested that a breeder engaged in the improvement of linseed, should lay greater emphasis on the characters- capsules per plant and number of branches per plant as selection criteria for seed yield.

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Table 1: Genotypic and phenotypic correlation between 9 pairs of quantitative traits in linseed

Characters		Days to maturity	Plant height (cm)	Primary branches per plant	Secondary branches per plant	Capsules per plant	Seeds per capsule	1000 seed weight (g)	Seed Yield Per plant (g)
Days to 50% flowering	G	0.548**	0.485**	0.018	-0.206	-0.133	-0.720	-0.387**	-0.352*
	P	0.490**	0.440**	0.034	-0.078	-0.103	-0.042	-0.0369**	-0.234*
Days to maturity	G		0.482**	0.139	-0.892	-0.036	-0.106	-0.020	-0.123
	P		0.417**	0.097	-0.078	-0.015	-0.070	-0.001	-0.053
Plant height (cm)	G			0.071	-0.077	0.073	-0.069	-0.195*	-0.006
	P			0.063	0.079	0.093	-0.053	0.167	0.093
No. of primary branches/plant	G				0.737**	0.601**	-0.194	-0.010	0.627**
	P				0.542**	0.533**	-0.042	-0.007	0.522**
No. of sec. branches/plant	G					0.820**	0.428**	0.233**	0.834**
	P					0.603**	-0.190	0.276**	0.631**
No. of seeds per plant	G						-0.450**	0.168	0.902**
	P						-0.315**	0.149	0.778**
No. of seeds per capsule	G							-0.026	-0.271*
	P							-0.017	-0.099
1000 seed weight (g)	G								0.409**
	P								0.315*

*Significant 5% level; ** Significant 1% level., G = Genotypic correlation , P = Phenotypic correlation

Table 2. Phentoypic path coefficient analysis in linseed

Characters	Days to 50% flowering	Days to maturity	Plant height (cm)	Pr. branches per plant	Sec. branches per plant	Capsules per plant	Seeds per capsule	1000 seed weight (g)	Harvest index (%)	Correlation with Seed yield
Days to 50% flowering	**0.0056**	0.0028	0.0025	0.0002	-0.0006	-0.0006	-0.0002	-0.0021	-0.0028	-0.2341
Days to maturity	-0.0049	-0.0099	-0.0041	0.0010	0.0008	0.0001	0.0007	0.0000	0.0028	-0.0533
Plant height (cm)	0.1147	0.1087	**0.2609**	0.0165	0.0206	0.0242	-0.0139	-0.0436	-0.1173	0.0931
No. of Primary branches/plant	0.0036	0.0101	0.0066	**0.1045**	0.0566	0.0557	-0.0044	-0.0008	0.0162	0.5215
No. of secondary branches/plant	-0.0142	-0.0101	0.0102	0.0698	**0.1289**	0.0777	-0.0245	0.0356	0.0197	0.6313
No. of Capsules per plnt	-0.0519	-0.0076	0.0469	0.2691	0.3045	**0.5049**	-0.1591	0.0754	0.1309	0.7784
No. of seeds per capsule	-0.0018	-0.0031	-0.0023	-0.0019	-0.0083	-0.0138	**0.0438**	-0.0007	0.0060	-0.0993
1000 seed weight (g)	-0.0351	-0.0001	0.0159	0.0007	0.0263	0.0142	-0.0016	**0.0952**	0.0325	0.3153

Bold figures denote the direct effects

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EFFECT OF DATES OF SOWING ON PERFORMANCE OF TORIA (*Brassica compestris* var. *toria)* IN NON-TRADITIONAL AREA

In Northern Telangana, mustard is grown in garden lands during winter as a mixed crop with chillies, garlic and onion at very low population. Although the temperatures are suitable for growing mustard and *toria*, they are not grown in the region. The experiments conducted on *toria* at Regional Agricultural Research Station, Jagtial A.P. indicated that a yield of 1.3 t/ha could be obtained (RARS 1992-93). The optimum sowing time for *toria* has been found to be around 3rd week September under North Indian conditions (Saini *et al* 1977, Tomar, 1989 and Gupta and Saini, 1982). However under rainfed conditions of Delhi the ideal time was found to be mid October (Gangasaran and De, 1979). No information on suitable time of sowing *toria* is available for the non-traditional areas like Northern Telangana of Andhra Pradesh. An experiment was, therefore, conducted for three winter seasons to identify the optimum time of sowing of *toria* for the region.

Field experiment was conducted during winter seasons of 1993-94, 1994-95 and 1995-96 at Regional Agricultural Research Station, Jagtial on Sandy clay loam soil (red chalka) having a pH of 7.3, 273 kg/ha available nitrogen, 8.9 kg/ha available P_2O_5 and 381 kg/ha of available K_2O.

Three dates of sowing (Oct 4, Oct 19 and Nov 5) and two cultivars (PT 303 and Bhavani) were tested in split-plot design with, dates of sowing in main plots and varieties in sub-plots and replicated five times. A uniform fertilizer level of 60 kg N, 40 kg P_2O_5 and 40 kg K_2O was applied to all the treatments. The crop was sown at a spacing of 30 cm x 10 cm. Entire level of P_2O_5 and K_2O was applied at sowing time, N was applied in three equal splits at sowing, 21 and 41 days after sowing (DAS). Weeding was done at 20 and 40 DAS in each date of sowing. Three irrigations were given at rosette, flowering and pod filling stages in addition to one at sowing. Monocrotophos/ Endosulphan @ 1.5 ml/l of water was sprayed at 50 DAS. The crop was harvested at physiological maturity.

The maximum temperature at sowing was 33.1° C, 31.8° C and 31.1° C and minimum temperature was 21.3° C, 20.5° C and 17.0° C in Oct 4, Oct 19 and Nov 5 dates of sowing, respectively. During crop growth period, the maximum temperature ranged between 27.7 to 34.1°C, 27.5 to 36.9° C and 28.3 to 38.9°C and the minimum temperature 9.4 to 21.7°C, 9.4 to 20.6°C and 9.4 to 23.1 respectively in Oct 4, Oct 19 and Nov 5 dates of sowing.

The plant height at harvest was significantly higher in Oct 19 sowing over that of Oct 4 and Nov 5 sowing, while it was comparable in the latter two dates of sowing. The plant height was significantly higher in cultivar PT 303 than that of Bhavani. The crop matured in 82 to 86 days, irrespective of dates of sowing. The crop sown on Nov 5, was however, affected by powdery mildew and aphids.

There was no significant difference in number of branches among different dates of sowing and between two cultivars tested. The number of siliquae per plant were significantly higher in Oct 19 sowing when compared to Oct 4 and Nov 5. On the other hand, the Oct 4 sowing has resulted in significantly higher siliquae than that of Nov 5 sowing.

The mean seed yield for three years

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Table 1 : Effect of of dates of sowing on performance of toria (mean of 1993-94 to 1995-96)

Treatments	Plant height(cm)	No. of Branches / Plant	No. of siliquae / Plant	Stalk yield(kg/ha)
Dates of Sowing				
October 4	89	7	143	1175
October 19	94	8	169	1489
November 5	90	7	125	1049
S.Em ±	1.4	1	3	41
CD (0.05)	4	NS	8	120
Cultivars				
Bhavani	84	8	152	1128
PT 303	98	7	139	1328
S.Em ±	3	1	4	17
CD (0.05)	10	NS	11	50

showed that there was significantly higher seed yield in Oct 19 sowing compared to Oct 4 or Nov 5 sowing. Among the latter two dates of sowing, Oct 4 sowing resulted in significantly higher seed yield than Nov 5 sowing. The increase in seed yield in Oct 19 sowing was 57% and 167% over Oct 4 and Nov 5 sowing, respectively. Among the two cultivars tested, PT 303 gave significantly higher seed yield (593 kg/ha) than Bhavani (508 kg/ha).

Significant interaction effect of dates of sowing and cultivars on seed yield showed that the cultivar PT 303 sown on all the dates resulted in significantly higher yield than Bhavani. The seed yield increased with delay in sowing from Oct 4 to Oct 19, however, with further delay in sowing to Nov 5, there was a drastic reduction in seed yield.

These results indicate that in Northern Telangana, for realising higher yields of *toria*, the crop needs to be sown by third week of October.

Table 2 : Effect of dates of sowing on seed yield (kg/ha) of toria cultivars (mean of 3 years)

Dates of sowing	Cultivars		
	Bhavani	PT 303	Mean
Oct 4	486	563	524
Oct 19	761	881	821
Nov 5	278	337	307
Mean	508	593	
		S.Em.±	CD (0.05)
Cultivars		9	25
Dates of sowing		20	58
Cultivars x Dates of sowing		15	43

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EFFECT OF NITROGEN AND SULPHUR ON SEED YIELD, OIL CONTENT AND OIL YIELD OF INDIAN MUSTARD

The productivity of Indian mustard (*Brassica juncea* L.) is low largely because of poor and imbalanced nutrition management. Exploitative agriculture making use of high analysis sulphur free nitrogenous and phosphatic fertilizers like urea and di-ammonium phosphate has progressively depleted the soils of their native available and total sulphur reserves leading to sulphur deficiencies of the crops grown. Nitrogen and sulphur play an important role in the nutrition of rapeseed and mustard. Mustard is a recent introduction to Andhra Pradesh as a non-traditional crop. Information on the effect of N and S on Indian mustard is lacking for the Krishna-Godavari zone of Andhra Pradesh, hence the present experiment was taken up.

A field experiment was conducted during the *rabi* season of 1994-95 at Agricultural College Farm, Bapatla. The soil contained 251 kg/ha available N, 16 kg/ha available P_2O_5, 291 kg/ha available K_2O and 10.25 ppm available S.The experimental soil was slightly alkaline in reaction with a pH of 8.2 The experiment was taken in randomized block design with factorial concept involving 4 levels of N (0, 50, 100 and 150 kg/ha) and 3 levels of S (0, 25 and 50kg/ha) with 3 replications. Calculated quantities of N and S were applied through urea and gypsum, respectively. Entire quantity of phosphate and 40 kg K_2O/ha through mutriate of potash were applied at sowing. The remaining dose of N was applied at30 days after sowing. Indian mustard variety Seeta was sown in rows 45 cms apart using 5 kg seed/ha on7th December, 1994 and harvested on 26th February, 1995. Crop was maintained uniformly by thinning with 10 cm plant to plant distance. Gross plot size was 4.5 x 3.6 m.

Significant increase in seed yield was observed with successive increase in nitrogen and sulphur levels (Table 1). The highest levels of nitrogen (150 kg/ha) and sulphur (50 kg/ha) resulted in higher seed yield which were significantly superior to their respective lower levels. Seed yield increased by 123, 248 and 420 per cent respectively with N 50, N 100 over N 0. The increase in seed yield with S25 and S50 was 36 and 52 per cent respectively over no sulphur (S0). With increased supply of N and S cumulative effect of improvement of growth parameters through efficient metabolic activity and increased rate of photosynthesis might have led to maximum expression of yield contributing characters and hence higher seed yield. The results of the present investigation corroborate the findings of Narang *et al* (1993).

Oil content decreased with increase in the nitrogen level while sulphur application had a favourable effect. The oil content increased upto N 100 and later showed a declining trend (Table 1). N 50 and N 100 had non-significant difference. Better supply of nitrogen increased the formation of N containing protein precursors so that protein formation competes more strongly for photosynthates. As a result, less of the latter are available for fat synthesis (Holmes, 1980). The highest level of Sulphur (S 50) was significantly superior to 'no sulphur' with regard to oil content (Table 1). Due to sulphur nutrition, a favorable nutrition environment was created for production of metabolites responsible for oil synthesis in plants. These results conform the previous findings (Pasricha and Fox, 1993).

On the contrary, oil yield significantly increased with increase in the levels of nitrogen and sulphur (Table 1). The oil yield increased by 235, 372 and 472 per cent respectively with N 50, N 100 over N0. The per cent increase in oil yield due to S 25 and S 50 was 139 and 156 per cent

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Table 1: Seed Yield, Oil content and oil yield of Indian mustard as influenced by N and S levels

Treatment	Seed yield (kg/ha)	Oil content (%)	Oil yield (kg/ha)	Net return (Rs/ha)	Benefit:cost ratio
N levels (kg/ha)					
0	399	31.19	124	-2046	-0.36
50	890	32.57	291	2478	0.43
100	1387	33.16	461	7042	1.23
150	1677	31.51	529	9707	1.70
CD (0.05)	149	0.82	44	-	-
S levels (kg/ha)					
0	841	31.46	265	2016	0.35
25	1143	32.15	369	4807	0.84
50	1280	32.71	419	6063	1.06
CD (0.05)	129	0.71	39	-	-

Input costs (Rs/kg): N-7.6 (urea); P-8.3(DAP); K-7.5(MOP); S-1.0(GYPSUM); Output (mustard) - 9.0

respectively over S 0. Higher oil yield obtained due to 150 kg N/ha and 50 kgS/ha might be due to more seed yield. Similar results were reported by Bikram Singh *et al* (1994).

Both net returns and benefit cost ratio increased with every increase in the level of nitrogen and sulphur. Higher net returns and benefit cost ratio were obtained with higher levels of nitrogen (150 kg N/ha) and sulphur (50 kg s/ha). The net returns and benefit cost ratio were found to be negative in the absence of nitrogen (No) due to poor growth, yield attributes and consequently yield.

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RESPONSE OF SUNFLOWER (*Helianthus annuus* L.) CULTIVARS TO NITROGEN AND SOWING TIME

Sunflower is getting preference among the cultivators of eastern Madhya Pradesh. Since meagre information is available on agronomic apsects in general and on requirement of nitrogen and sowing time in particular under the agro-climatic conditions of Chhattisgarh plains, the present experiment was carried out during 1993-94 at IGKVV, Raipur. The soil was clay loam with available N, P_2O_5,K_2O content of 285, 17 and 35 kg/ha, respectively with pH 7.1. A split-plot design with 3 replications was followed. The experiment consisted of 4 sowing dates (30 December, 15 January, 30 January and 15 February) as main plot treatments and two cultivars (Morden and Hybrid-IAHS-1) and 3 nitrogen levels (50, 100 and 150 kg/ha) as sub-plot treatments. The crop was sown in rows at 45 cm x 20 cm using 20 kg seed/ha. Half N as per treatment and uniform dose of 60 kg P_2O_5 and 40 kg K_2O/ha was applied through urea, single superphosphate and muriate of potash, respectively. The remaining half quantity of N was top dressed at button stage (35 DAS).

Seed yield of sunflower declined with delay in sowing. The crop sown on 30 December gave 14.89 q higher seed yield than that sown on 15 February (Table1). This can be attributed to greater head diameter, filled seeds/head, 100-seed weight and seed weight/head in early sowing which significantly decreased by delay in sowing (Table 2). Bajpai and Singh (1995) reported similar results. Sowing on 30 December gave the highest gross monetary returns (Rs. 16,619/ha), followed by sowing on 15th January (Rs. 14,361/ha) and lowest returns (Rs. 985/ha) was obtained when sowing was done on 15th February.

Hybrid sunflower was found significantly superior to cultivar morden in relation to seed yield and gross monetary returns. This was attributed to higher head diameter, filled seeds/head and seed weight/head. The result conforms the findings of Ujjinaiah *et al.*, (1994).

There was positive effect of nitrogen application on productivity of sunflower and significant yield advantage was obtained upto 100 kg N/ha. However the difference in seed yield was

Table 1: Seed yield of sunflower as affected by sowing date, genotype and N-fertilzation

Sowing date	Genotype			Nitrogen (kg/ha)			
	Hybrid	Morden	Mean	50	100	150	Mean
30 December	17.15	14.51	15.83	13.07	17.09	17.34	15.83
15 January	14.57	12.79	13.68	11.42	14.79	14.84	13.68
30 January	8.61	5.19	6.90	5.78	7.47	7.47	6.91
15 February	1.04	0.83	0.94	0.72	1.02	1.09	0.94
Mean	10.34	8.33	-	7.75	10.09	10.19	-
			CD (0.05)				
Sowing date			0.78				
Variety			0.37				
Nitrogen			0.46				
Date x Variety			0.75				
Date x Nitrogen			0.92				

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Table 2 : Gowth, yield attributes, oil yield and gross monetary returns of sunflower as affected by sowing date, genotype and N-fertilizer

Treatment	Plants/m² at harvest	Plant height (cm)	Head diameter (cm)	Filled seeds/ head (no.)	100 seed weight (g)	Seed weight/ head (g)	Oil yield (q/ha)	Gross monetary returns (Rs./ha)
Sowing date								
30 December	10.94	137.97	13.39	666.19	6.18	35.63	5.71	16619
15 January	10.83	115.00	11.43	587.19	5.25	29.49	4.93	14361
30 January	8.61	109.63	10.46	400.82	4.81	22.96	2.52	7250
15 February	7.78	91.39	8.14	149.72	3.75	8.75	0.35	985
CD (0.05)	0.29	13.36	0.53	9.86	0.36	1.59	0.28	237
Genotype								
Hybrid	10.53	114.67	11.23	470.72	5.20	26.64	3.72	10858
Morden	9.56	112.33	10.49	431.25	4.79	21.78	3.03	8750
CD (0.05)	0.23	NS	0.43	7.59	0.25	0.93	0.14	392
Nitrogen (kg/ha)								
50	9.21	110.41	10.19	393.77	4.63	20.23	2.83	8133
100	10.33	110.78	11.42	476.38	5.11	25.91	3.63	10591
150	10.58	119.30	10.96	484.80	5.25	26.48	3.61	10688
CD (0.05)	0.28	NS	0.53	9.31	0.31	1.14	0.17	480

not significant between 100 and 150kg N/ha. Use of 100 kg N/ha was comparable with 150 kg N/ha in respect of filled seeds/head, seed weight/head and 100-seed weight. Singh and Kaushal (1975) also reported that filled seeds and test weight increased with increasing N levels. Gross monetary returns was also found comparable under 100 and 150 kg N/ha. Similar results with N levels were also reported by Ujjinaiah (1985).

Interaction effect showed that early sowing (30 December) of hybrid resulted in significantly higher seed yield (17.15q/ha) as compared to other treatment combinations. Similarly, application of 100 and 150 kg N/ha in early sown (30 December) sunflower produced significantly more yield than other treatment combinations. These results also show that early sowing on 30 December with 100 kg N/ha had an advantage of saving about 50 kg N/ha over 150 kg N/ha sown at the same time. The higher yield was significantly correlated with increase in growth and yield attributes (correlation coefficients 'r' between yield and yield attributes were viz., plant population/m² (0.92), head diameter (0.94), 100 seed weight (0.93), plant height (0.78), seed weight/head (0.96) and filled seeds/head (0.99).

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INFLUENCE OF NITROGEN AND ROW SPACING WITH DIFFERENT INTERCROPS ON GROWTH AND NITROGEN UPTAKE OF SUNFLOWER

After an exhaustive crop of rice, soils become short of nutrients. Cultivation of Sunflower (*Helianthus annuus* L.) in rice fallows either along or in combination with suitable intercrops needs proper row spacing and fertilization. The nitrogen, being utilized in greater amounts, use of N assumes greater significance since high doses of N may result in excessive vegetative growth. The uptake of nitrogen is affected by row spacing and N fertilization (Pandey, 1990). Since no information is available on sunflower alone and in combination with suitable intercrops, particularly in vertisols of Chattisgarh region of Madhya Pradesh, an effort was made to find out the response of sunflower to nitrogen and row spacing with different intercrops on its dry matter partitioning, light transmission ratio and nitrogen uptake.

A field experiment was carried out during January-April, 1996 at Raipur, after the harvest of transplanted rice. The soil was clayey in texture, medium in organic carbon (0.71%), low in available N (222.99 Kg/ha), medium in available P_2O_5 (19.21 kg/ha) and high in available K_2O(407.16kg/ha) having neutral pH 7.3. The experiment was laid out in split-plot design with 3 replications. The four row spacings with different intercrops i.e. sole sunflower at 50 cm, sole sunflower at 60 cm, sunflower (60cm) + Palak [1:1] and sunflower (60) + bottlegourd (1.8m) [3:1] were taken as main plot treatments and 3 nitrogen levels viz.40, 60 and 80 kg/ha were taken in sub plots. Basal application of 40kg P_2O_5 and 20 kg K_2O/ha was done trough DAP and muriate of potash uniformly. Nitrogen supplied by DAP was supplemented with urea raising its levels to one third of nitrogen level of that treatment. The remaining two third nitrogen was given through urea in corresponding plots at 30 and 45 days after sowing following irrigation. The crop period received a rainfall of 29.8mm.

Sole sunflower spaced at 60 cm absorbed highest amount of nitrogen and sole sunflower spaced at 50 cm absorbed lowest. However, in case of intercrops, sunflower spaced at 60 cm and intercropped with bottlegourd (1.8 m) [3:1] the uptake of nitrogen was higher than sunflower spaced at 60 cm and intercropped with Palak (60cm) [1:1]. Higher amounts of dry matter accumulated in the plants favoured by lesser competing conditions in treatments having wider spacing might have resulted in more uptake of nitrogen. Kharawara and Bindra (1992) also expressed similar views. In intercropping with palak, sunflower faced higher degree of competition for nutrients, moisture and light leading to lower uptake of nitrogen (Table1).

Light transmission ratio (LTR) at 30 days was not affected by row spacing with different intercrops. This might be because of less growth of leaves in number and area under different treatments which are the major cause for obstructing the light in its way to ground level. Afterwards, the trend of variations in LTR was not consistent. For the same number and area of leaves, the Path of descendence of light towards ground level through different canopies may vary because of change in leaf orientation. This might be the reason for inconsistent variations in LTR at later stages of observation.

Application of 80 KgN/ha resulted in higher uptake of nitrogen over 40 or 60 kg N /ha. Higher level of nitrogen might have helped in better growth and development of sunflower plant due to higher amount of nitrogen at the disposal of plant. As a result, higher concentration of nitrogen in plant

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Table 1 : Dry matter accumulation, light transmission ratio and nitrogen uptake by sunflower as affected by row spacing with different intercrops

Treatment	Dry matter accumulation (g)			Light transmission ratio (LTR)				Nitrogen uptake (kg/ha)			
	30DAS	60DAS	90DAS	30DAS	50DAS	70DAS	90DAS	30DAS	At harvest stover	At harvest seed	Total
Row spacing with intercrop											
Sole Sunflower (50 cm)	4.82	35.51	44.98	51.80	8.29	4.19	9.34	17 35	19.17	41.34	60.51
Sole Sunflower (60 cm)	6.11	56.06	56 58	50.56	9.29	4.57	8.27	20 46	23.97	50.16	74 13
Sunflower (60 cm)+ Palak (1:1)	5.99	41.29	52 44	52.43	7.39	4 53	8.65	18.62	21.01	46.06	67.07
Sunflower (60cm)+ Bottle gourd (1.8m) (3.1)	6.02	54.95	54.34	51.01	9.01	4.73	8 37	19 66	22.73	48.67	71.40
CD (P=0.05)	0.05	0.46	0 44	NS	0.31	0.26	0.31	0.07	0.06	0.07	0.08
Nitrogen (kg/ha)											
40	4.75	38.79	45.08	53.23	10.35	5.48	9.62	15.19	18.39	39.84	58 23
60	5 49	47.77	52.14	51.43	8.20	4.47	8 68	19.12	21.72	45.89	67 61
80	6 82	54 30	59.04	49.69	6.94	3.57	7 67	26 63	25.20	51.05	76 23
CD (P=0.05)	0 08	0.38	0.25	1.78	0.27	0.23	0.21	0 06	0.05	0.08	0 06

parts, multiplied by greater amount of dry matter in this treatment might have led to better uptake. This finding is in agreement with studies of Kharawara and Bindra (1994) Manoharan *et al.*, (1994) and Vivek *et al.*, (1994).

LTR decreased with increasing nitrogen levels. This might be due to transmission of more light to ground level because of relatively poor growth under lower levels of nitrogen. Similar result has been reported by Singh *et al.*, (1995).

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YIELD AND ECONOMICS OF SOYBEAN (*Glycine max* L. MERRIL) VARIETIES IN RELATION TO PHOSPHORUS LEVEL.

The area under soybean (*Glycine max* L. merr.) is fast increasing in South-eastern region of Madhya pradesh, which is known as rice bowl of India and invariably tests low to medium in available phosphorus content, Efficient use of phosphatic fertilizer and suitable variety is likely to play an important role in enhancing the production and productivity of soybean in the region. Hence, an attempt was made to ascertain response of varieties at varying phosphorus levels.

A field experiment was conducted during rainy (kharif) season of 1995 at Indira Gandhi Agricultural University, Raipur. The soil of the experimental site was clayey (vertisols) with ph 7.2. It analysed low for available nitrogen (275 kg/ha) and low to medium in available phosphorus (10.34 kg P/ha). The experiment was laid out in split plot design with three replications. The treatments included 3 levels of phosphorus [30, 60 and 90 kg P_2O_5/ha] in main plots and 5 varieties [Gaurav; PK 472; JS 335; JS 80-21 and JS 75-46] in sub plots. The soybean varieties were sown on 28th June and were fertilized uniformly with 30 kg / ha each of nitrogen and potassium. All the nutrients (NPK) were applied through urea, single super phosphate and muriate of potash, respectively, as basal in band placement. The crop was harvested from 2 to 12 Oct, 1995 depending upon the maturity period. Seeds were treated with culture of *Rhizobium japonicum* before sowing.

Pods per plant, and grain yield increased significantly with increasing level of phosphorus from 30 kg to 60 kg P_2O_5/ha. Although grain per pod, 100 grain weight and straw yield showed a similar trend, the differences were non significant (Table 1). Further increase in phosphorus level resulted in a decrease in values for all above referred characters. This is because of more vegetative growth in higher level of phosphorus and the vigorous vegetative growth could not be of help in translocating the photosynthates towards the sink but it was used in formation of new sources due to its indeterminate habit (Gupta, 1984). The vertisols of Chattisgarh region have been reported to exhibit phosphorus fixing capacity 3-5 times higher than that of alluvial soil (Kanwar *et al.* 1982). This may be one of the reasons for lowering the yield and yield attributes due to higher level of phosphorus. Mishra and Vyas, (1992) and Vyas *et al.* (1987) also reported similar results.

Maximum net return of Rs. 15,036/ha with 1.97 cost:benefit ratio was also recorded with 60 kg P_2O_5/ha followed by 30 Kg and 90 kg P_2O_5/ha (Table 2). Further, economic evaluation showed maximum return per rupee invested (Rs.2.97) and per day return (Rs. 147.40) with 60kg phosphorous per hectare. However, maximum return per rupee invested on phosphatic fertilisers (Rs. 27.98) was with 30 kg phosphorus/ha and it decreased with increasing level of phosphorus.

Significantly higher number of pods per plant, grains per pod and grain yield were recorded in JS 335 variety over rest of the varieties except PK472 which showed at par grain per pod (Table 1). Significantly higher 100 grain weight was recorded in PK472 over rest of the varieties. However varieties JS 335, JS 80-21 and JS 75-46 were at par in this character. Variety JS 80-21 and Gaurav recorded significantly higher straw yield than other varieties because of the more plant height and dry matter accumulation. Maximum return of Rs. 18018/ha with highest cost:benefit ratio (2.36) and harvest index was recorded in JS 335 followed by PK 472, JS 80-21, JS 75-46 and

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Table 1 : Yield and yield attributes of soybean varieties as influenced by phosphorus

Treatment	Pods per plant	Grains per pod	100 grain weight (g)	Grain yield (q/ha)	Harvest index	Straw yield (q/ha)
Phosphorus (kg/ha)						
30	54.4	2.07	10.79	23.87	0.36	41.90
60	65.1	2.25	12.52	27.17	0.37	45.98
90	53.8	2.11	11.14	23.68	0.34	45.78
SEm ±	1.8	0.07	0.80	0.78	0.02	1.41
CD (0.05)	7.0	-	-	3.06	-	-
Variety						
Gaurav	40.7	1.68	9.74	21.15	0.28	53.95
PK 472	70.7	2.29	13.66	26.26	0.38	42.71
JS 335	81.4	2.50	11.71	31.17	0.47	35.08
JS 80-21	50.9	2.19	10.78	23.86	0.30	56.60
JS 75-46	45.3	2.06	11.53	22.09	0.39	34.38
SEm ±	3.2	0.08	0.42	1.29	0.03	2.27
CD (0.05)	9.3	0.23	1.22	3.78	0.08	6.62

Table 2: Economic evaluation of soybean varieties as influenced by phosphorus

Treatment	Cost of cultivation (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	Cost : Benefit ratio	Return/ rupee invested (Rs)	Return/ rupee invested on P Fert.(Rs)	Per day return (Rs/ha)
Phosphorus (kg/ha)							
30	7146	19934	12788	1.79	2.78	27.98	125.4
60	7620	22656	15036	1.97	2.97	16.86	147.4
90	8094	19859	11765	1.45	2.45	9.27	115.3
Variety							
Gaurav	7620	17999	10379	1.36	2.36	11.95	97.9
PK 472	7620	21862	14242	1.87	2.87	16.02	141.0
JS 335	7620	25638	18018	2.36	3.36	20.00	178.4
JS 80-21	7620	20220	12600	1.65	2.65	14.29	131.2
JS 75-46	7620	18360	10740	1.41	2.41	12.33	101.3

Sale price (Rs) ; Soybean grain 800/q; Straw 20/q and Phosphorus 15.8/kg

Gaurav (Table 2). Maximum return per rupee invested (Rs. 3.36), return per rupee invested on phosphatic fertiliser (Rs. 20.00) and per day return (Rs. 178.40) were recorded with variety JS 335 followed by PK 472. Least benefit was accrued with traditional variety Gaurav. Variety Gaurav, PK 472, JS 335, JS 80-21 and JS 75-46 took 106, 101, 96 and 106 days to maturity with purple coloured flower in all the varieties except in PK 472 where it was white in colour.

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EFFECT OF HUMIC ACID, NITROGEN AND BIOFERTILIZER ON THE GROWTH AND YIELD OF SESAME

In India there is an urgent need for increasing Sesame production, since the production and productivity is far below the world average. The beneficial effect of humic acid on growth and yield of many crop plants had been well documented (Vaughan and Malcolm, 1976., Chandrasekaran, 1992). Enhanced response of Sesame to N application (Rao *et al.*. 1990) and Azospirillum (Arunachalam and Venkatesan, 1984) were reported earlier. However reports are not available on the use of humic acid, nitrogen and biofertilizer for Sesame. Hence this study was made.

A field experiment was conducted in Udic Rhodostulf at TANCOF farm, Neyveli during Feb-May, 1990. The soil of the experimental site was sandy clay loam with pH 5.68 having low organic carbon (0.38%), low available N (165.0 kg ha)and P(10.0 kg ha) and high available K (325.0 kg ha). The experiment was laid out in split-plot design with three replications utilising Sesame TMV 4 as test crop. The treatments comprising Control, Nitrogen @35 kg ha (N), Azospirillum (Azo), Nitrogen + Azospirillum (N+Azo) as mainplot treatments and four levels of humic acid (HA) @0, 10, 20 and 30 kg/ ha were tested in subplots.

A common dose of P and K @22.5 kg/ha was applied uniformly to all treatments. Nitrogen @35 kg/ha was applied to the respective plots basally. Humic acid was extracted from lignite of Neyveli adopting the fraction procedure of Stevenson (1965). Required quantity of HA powder was dissolved in a minimum amount of 0.05 NKOH and the K-humate solution of pH 7 was used for soil application. Five plants were earmarked for recording the biometrics and yield attributes for each treatment. Plant height and dry matter were recorded at 20, 40, 60 days after sowing and at harvest. Yield attributes viz., number of capsules per plant, number of seeds per capsule, 1000 seed weight and seed yield were recorded at harvest.

Among the mainplot treatments, N application @35 kg/ha registered highest plant height and dry matter at all stages of sesame growth followed by N+ Azo and Azo. All the levels of HA application had exerted stimulating effect on plant height and dry matter of sesame as compared to control. HA and N application registered higher dry matter (2926 kg ha) over control (2118 kg ha). The growth promoting harmone IAA maintained with the application of HA made the plant to produce more dry matter as reported by O' Donnel (1973).

Various yield components of Sesame viz, number of capsules per plant and 1000 seed weight were influenced by the application of N and HA. Increased number of capsules and 1000 seed weight were observed with the application of N (Rao *et al.*. 1990). The increased seed weight with HA application (2.92g) as compared to control (2.61g) might be due to better mobilization of nutrients as observed by Chandrasekaran (1992).

Significant increase in yield was observed with N application (775 kg/ha) over control (639 kg/ ha). This favourable effect might be due to the stimulating effect of N on different yield attributing characters as reported by Rao *et al.* (1990). Application of N + Azo and Azo alone also favoured seed yield (707 kg/ha and 676 kg/ha respectively) next to the above treatment. Similar result was earlier reported by Arunachalam and Venkatesan (1984).

The highest seed yield (839 kg/ha) was obtained

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Table 1 :Effect of humic acid, nitrogen and Azospirillum on the growth and yield of sesamum

Treatemnts	Dry matter (kg/ha)	Number of capsules per plant	1000 seed weight (g)	Seed yield (kg/ha)
Main Plot				
Control	2118	38	2.73	639
Nitrogen 35 kg/ha	2926	48	2.92	775
Azospirillum	2297	42	2.76	676
Nitrogen 35 kg/ha + Azospirillum	2544	45	2.86	707
CD (p = 0.05)	49.97	1.08	0.01	19.2
Humic acid (kg/ha)				
0	2059	37	2.61	633
10	2324	41	2.82	676
20	2870	50	2.95	767
30	2630	44	2.88	722
CD (P = 0.05)	45.39	0.93	0.03	14.1

with HA application @20kg/ha and N at 35 Kg ha. This might be due to direct influence of HA and N on plant growth characters (Chandrasekaran, 1992)

The present investigation shows that combined application of N at 35 kg/ha and humic acid @ 20 kg/ha would be beneficial for increasing the growth, yield attributes and yield of sesame under irrigated condition

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EFFECT OF DIFFERENT ORGANIC MANURES ON THE COLLAR ROT (*Sclerotium rolfsii*) INCIDENCE AND YIELD IN SOYBEAN

Soybean (*Glycine max* L.) is one of the best source of low cost protein and edible oil. In India, it is grown in an area of around 48 lakh hectares with an average yield of 10 q/ha. Though, India stands fifth in soybean production, it ranks very low (51st) in terms of productivity (Anonymous, 1994). The poor yield is a consequence of a number of biotic and abiotic factors. *Sclerotium* blight or collar rot caused by *Sclerotium rolfsii* Sacc. is one of the major bottleneck affecting yield. In spite of disease management practices, it can infect at all stages of plant growth and causes loss upto 65% (Agarwal and Kotasthane, 1971).

The growth of soil borne pathogen like *Macrophomina* spp., *Sclerotium rolfsii* and *Fusarium oxysporum* are influenced by organic soil amendments (Chattopadhyay and Mustaffe, 1977). Since, the pathogen is necrotrophic and survive on plant debris, a field experiment was conducted at National Research Centre for Soybean, Indore to study the effect of organic manures on the incidence of collar rot.

Soybean variety JS - 335 was sown @ 75 kg seed/ha in a plot size of 18m^2 in 9 lines at a distance of 45cm, after applying the farm yard manure (FYM), gobar gas slurry (GGS), poultry manure (PM) and urban compost (UC) @5,10 and 15 t/ha individually in fully prepared field. Two controls were also made, one with N:P:K @20:60:20 kg/ha (C) and the other without organic or inorganic fertilizers (AC). The organic manures were collected locally. The experiments were conducted in a randomized block design with three replications each as per the recommended package of practices. Total number of plants were counted after complete emergence and the disease incidence was recorded as percentage of plants killed in each plot having typical symptoms of collar rot upto two weeks before harvest. The pathogen was reisolated on Potato Dextrose Agar (PDA) from the plant having typical symptoms to confirm the involvement of pathogen in the disease.

The average nutrient content in the manures (Table 1) showed that PM contains both nitrogen and potassium in higher concentration i.e.7.5 and 2.5% and the minimum percentage in FYM i.e. 1.5 and 0.5% respectively.

All the sources of organic manures had a significant effect on the disease incidence as compared to controls. FYM had a significant impact on collar rot incidence vis-a-vis other sources at all levels of its application. However, with exception of FYM, other sources of organic manures were on par as regards to collar rot incidence. Among the levels, higher incidence of collar rot was observed at the highest level of FYM application, with increased incidence to an extent of 22%. Moreover, significant difference existed between all the levels of organic manures applied.

The disease incidence in relation to the rate

Table 1: Nutrient contents (%) of organic manures

Source	Nitrogen	Phosphorus	Potassium
Farm Yard manure (FYM)	1.5	0.6	0.5
Urban compost (UC)	1.5	1.0	1.5
Gobar gas slurry (CGS)	1.7	1.5	1.2
Poultry manure (PM)	7.5	12.5	2.5

Source : Katyal, (1992)

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Table 2 : Effect of source and levels of different organic manures on incidence of collar rot and yield of soybean

	Levels of organic manure (t/ha)			
Level t/ha	5	10	15	Mean
Source				
Farm yard manure (FYM)	0.998 (13)	1.187 (18)	1.241 (22)	1.142 (18)
Urban compost (UC)	1.243 (7)	1.302 (13)	1.367 (10)	1.304 (10)
Gobar gas slurry (GGS)	1.179 (8)	1.302 (10)	1.339 (12)	1.273 (10)
Poultry manure (PM)	1.541 (3)	1.654 (11)	1.792 (15)	1.662 (10)
Mean	1.240 (8)	1.361 (13)	1.435 (15)	
Control (C) (20-60-20 NPK/ha)	0.893 (8)			
Control (AC) (without organic or inorganic manure)	0.765 (6)			
	CD (P=0.05)			
Source	0.200 (2.07)			
Level	0.173 (1.79)			
Source x Level	NS (2.78)			
Treatment vs Control	0.446 (3.58)			

Data in parenthesis indicate the collar rot incidence

of organic manures showed that (Fig.1) the AC (control without organic and inorganic fertilizer) had minimum percentage of disease incidence (6%) followed by C (NPK) (8%). FYM 15 t/ha showed the highest incidence of 22%. Many workers (Chattopadhya and Dickson, 1960; Borkert *et al.* 1987; Deb and Dutta, 1992) have reported that the potassium fertilization reduces the disease incidence in many plants including Soybean. Though PM contained higher N content showed less disease incidence. The presence of higher concentration of K (Table 1) might have influenced the soil ecology or the soil microflora, which reduced the disease incidence. The same effect has been noticed by Sen (1991) in case of soil borne diseases caused by *Rhizoctonia solani* and *R. bataticola.* Low N and high K nutrition also has been found to increase phenol content in plants, which might have played a beneficial role in plant resistance (Perrenoud, 1990).

The higher incidence of collar rot in FYM application at all the three doses indicate that FYM provides good physical condition for multiplication of the fungus than other manures as it provides more oxygen which is essential for the survival of the pathogen (Chattopadhyay and Mustaffe, 1977; Mehan *et al.* 1994).

Among the sources of organic manures, the significantly lower yield was recorded in FYM application which was at par with UC and GGS. As regards to different levels of manures, irrespective of the source increased yields were recorded with increasing dose of manures. The results presented in Table 2 also clearly indicate that the yield reduction in the treatments, especially FYM, was due to the high incidence of collar rot.

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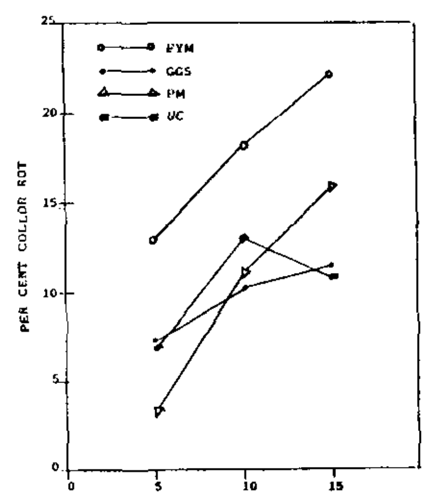

Fig. 1. Influence of organic manures on incidence of collar rot

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EFFECT OF DIFFERENT LEVELS OF NITROGEN AND PHOSPHORUS ON YIELD AND YIELD ATTRIBUTES OF GROUNDNUT INTER CROPPING

Oilseeds constitute the second major group of agricultural crops in the country next to food grains in terms of tonnage and value. The total production of oilseeds can be increased mainly through two ways, by increasing the area under oilseeds, and by increasing the production per unit area. The increase in area can be achieved without affecting food grain production through many ways and inter cropping is one such way. In over populated countries, poor soils and resource poor people co-exist and only there fertilizers occupy a key place in Agricultural Planning and programming. Fertilizer use efficiency holds the key to productivity, since its price has risen faster than the price of agricultural crops. An experiment was, therefore, planned to workout the effect different levels of nitrogen and phosphorus on yield and yield attributes of groundnut inter cropping with sesame.

The experiment was conducted at Regional Research Station, (Coastal Saline Zone) Bidhan Chandra Krishi Viswavidyalaya, West Bengal, during the pre-*kharif* seasons of 1993 and 1994 . The soil was clay loam in texture with pH range of 6.4 to 7.6. The EC values range from 2 to 8 mmhos/cm, organic carbon varies from 4.0 to 9.0 percent, available P_2O_5 and K_2O range from 30-60 and 200-400 kg/ha respectively. The trial comprised of groundnut CV Girnar - I inter cropped with sesamum CV-B-67 (Tilottama) at 2:1 and 1:2 row proportions with 4 levels of nitrogen and phosphorus. Seeds were sown during first week of February at a constant distance of 50 cm between rows in both the years. Groundnut and sesamum was sown at a distance of 30 cm and 10 cm plant to plant in both the years, respectively. Groundnut was harvested in the month of June and sesamum was harvested in the month of May in both the years.

Sole crops of groundnut and sesamum, groundnut inter cropped with sesamum in 2:1 ratio and 1:2 ratio were planted. The fertilizers levels were (0+0, 30N+25P, 60N+50P and 90N+75P kg/ha). 30 K_2O/ha was applied as basal dose for all treatments. These 16 treatments were tested with 3 replications in a split-plot design. The plot size was 5mx3m. Cropping systems were allotted to the main plots and fertilizer treatments were allotted to the sub-plots randomly.

Cropping system had significant influence on plant height. Maximum plant height was observed with 2:1 ratio which was significantly superior to sole groundnut and 1:2 row ratio. Sole groundnut recorded greater plant height than that obtained from 1:2 row ratio. Application of N and P increased plant height. Progressive and significant increase in plant height by the successive increment of N and P was observed and maximum plant height was recorded with 90N+75P. Bucha Reddy *et al.* (1984) and Bhosale *et al.* (1982) also reported increase in plant height of groundnut with the application of N and P. Cropping system influenced weight of 100 pods of groundnut in 1994 only. Inter cropping in 2:1 ratio recorded more weight of 100 pods than other cropping systems. However, sole groundnut showed almost equal weight of 100 pods as was observed in 1:2 row ratio (Table-1). Weight of 100 pods of groundnut was significantly influenced by the application of fertilizers. Significant increase in weight of 100 pods was observed with successive increment of nitrogen and phosphorus upto 60N+50P level. Jain (1983) reported increase in 100 kernal weight with N and P. Shelling percentage remained unaffected due to levels of

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Table 1 : Yield and yield components as affected by cropping system and varying levels of nitrogen and phosphorus

Treatments	Plant height (cm)			No. of pods per plant			Weight of 100 pods (g)			100 Kernel weight (g)		
	1993	1994	Mean	1993	1994	Mean	1993	1994	Mean	1993	1994	Mean
Cropping system												
Sole groundnut	40.57	44.62	42.59	15.91	15.16	15.54	111.33	119.41	115.37	53.50	**66.08**	**59.79**
G.nut + Sesame 2:1	42.77	47.25	45.01	16.83	15.08	15.96	107.00	126.58	116.79	55.25	67.50	61.37
G.nut + Sesame 1:2	37.62	42.75	40.18	16.91	15.83	16.37	106.75	114.58	110.66	56.75	63.66	60.20
SEm ±	1.059	0.142	0.464	**0.859**	**0.977**	**0.626**	**7.649**	**2.268**	**4.518**	**0.745**	**2.263**	**2.122**
CD (0.05)	2.940	0.396	1.290	**NS**	**NS**	**NS**	**NS**	**6.295**	**NS**	**2.068**	**NS**	**NS**
Fertilizer levels (Kg/ha)												
0 + 0	35.70	38.00	36.85	14.55	14.77	14.66	101.33	102.55	101.94	52.00	51.77	51.88
30 N + 25 P	39.50	43.16	41.33	17.44	15.33	16.39	101.77	117.66	109.71	54.00	64.77	59.38
60 N + 50 P	41.50	47.33	44.41	17.66	16.44	17.05	128.00	133.33	130.66	62.00	73.44	67.72
90 N + 75 P	44.60	51.00	47.80	16.55	14.88	15.72	102.33	127.22	114.77	52.66	73.00	62.83
SEm ±	1.038	0.900	0.648	1.760	1.770	1.242	4.206	4.656	2.412	2.324	2.888	2.048
CD (0.05)	2.182	1.892	1.363	NS	NS	NS	8.836	9.782	5.079	4.882	6.067	4.303

Table I Continued....

Treatments	Shelling (%)			Pod yield (kg/ha)			Oil content (%)			Oil yield (kg/ha)		
	1993	1994	Mean	1993	1994	Mean	1993	1994	Mean	1993	1994	Mean
Cropping system												
Sole groundnut	49.21	55.51	52.36	1359.25	1640.41	1499.83	37.22	37.35	37.28	507.72	617.94	562.83
G.nut + Sesame 2:1	52.03	53.10	52.56	955.54	1146.95	1050.95	36.75	38.07	37.41	351.04	446.16	398.60
G nut + Sesame 1:2	53.41	55.57	54.49	342.04	516.73	429.38	37.88	37.08	37.48	130.25	192.59	161.42
SEm ±	3.327	1.624	1.222	18.13	43.45	11.81	0.230	0.144	0.162	4.19	11.81	5.08
CD (0.05)	NS	NS	NS	50.348	120.625	32.808	0.639	0.401	NS	11.638	32.804	14.128
Fertilizer levels (Kg/ha)												
0 + 0	51.72	50.70	51.21	639.16	808.76	723.96	36.56	35.41	35.98	231.75	293.93	262.84
30 N + 25 P	53.46	55.30	54.38	910.72	1063.93	987.32	36.62	36.18	36.40	332.83	385.58	359.20
60 N + 50 P	49.35	55.37	52.36	999.61	1361.08	1150.34	37.41	38.77	38.09	371.91	507.90	439.90
90 N + 75 P	51.67	57.55	54.61	992.94	1230.91	1111.92	38.55	39.44	39.09	382.20	488.17	435.18
SEm +	2.908	3.106	2.181	29.46	50.95	19.60	0.285	0.160	0.129	11.91	19.60	11.91
CD (0.05)	NS	NS	NS	21.909	107.056	41.181	0.599	0.336	0.271	25.024	41.181	25.024

fertilizers. This trend confirms the findings of Shinde *et al.* (1981) and Katre *et al.* (1988).

Pod yield of groundnut was significantly influenced by the cropping system. Inter cropping groundnut in 2:1 ratio yielded significantly higher than inter cropping in 1:2 ratio. Significant increase in pod yield with successive increment of fertilizer was observed up to 60N+50P. Further increase to 90N+75P reduced pod yield though the difference was not significant. The increase in pod yield over control was 36.37%, 58.89% and 53.58% at 30N+25P, 60N+50P and 90N+75P, respectively. Panse *et al.* (1947) found significant increase in pod yield with the application of N fertilizers. Significant increase in oil content with increase in nitrogen and phosphorus level was recorded up to 90N+75P level. Favourable response of pod yield with P fertilizer application was noticed by Jana *et al.* (1990). Control plot showed minimum oil percentage. The significant increase in oil yield was observed up to 60N+50P, further increase to 90N+75P was at par with 60N+50P during both the years and in pooled data. The increase in oil yield over control was 36.66%, 67.36% and 65.56% at 30N+25P, 60N+50P and 90N+75P, respectively. Increased oil yield with application of P fertilizers was reported by Krishnananda *et al.* (1977).

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EFFECT OF DATES OF SOWING ON YIELD OF CASTOR CULTIVARS

Castor (*Ricinus communis* Linn.) in drylands of Andhra Pradesh is sown at times early with the onset of monsoon or late due to uncertain rainfall. Earlier studies with different dates of sowing indicated influence of day length, temperature and moisture on castor yield (Moshkin, 1986). To understand the response of different sowing dates on yield of castor cultivars and also to find out optimum date of sowing for different cultivars including Kranthi (PCS -4), a recently released castor variety from R.A.R.S., Palem, studies were carried out on medium fertile red sandy soils during *kharif* 1995, at Regional Agricultural Research Station, Palem.

The trial was laid out in a split-plot design with 5 dates of sowing (15 June, 30 june, 15 July, 30 July and 18 August) as main plot and castor cultivars viz., GCH-4, Kranthi, DCS-9 and Aruna as sub-plots in four replications with a gross plot size of 5.4 x 4.8 m. A common dose of 60-40-30 kg N, P_2O_5 and K_2O ha^{-1} was applied. Entire P_2O_5 and K_2O were applied as basal, while nitrogen was applied in three equal splits @20 kg before sowing and the rest at 30 days interval.

The data (Table-1) indicated significant influence of different dates of sowing on yield of castor cultivars. All the cultivars sown on 15 June gave higher yields. With delay in sowing, the period of moisture availability will be reduced resulting in shortening of vegetative period, ultimately decreasing the yield. Similar finding was reported by Moshkin (1986). However, 18 August sowing gave higher yield over 30 July sowing. Heavy rains occurred during the month of October (180.3mm) coupled with high relative humidity which caused severe incidence of *Botrytis* grey rot in 30 July sowing, coinciding with the development of primary spikes and also formation of secondary spikes, ultimately resulted in lower yields. In 18 August sowing though primary spikes were affected, secondary spikes escaped *Botrytis* incidence.

The higher yields of castor with 15th June sowing can be attributed to more effective spikes, lengthy primary spikes and also favourable female to male flower ratio in primary spike, probably due to favourable soil moisture regime during entire growth period caused by the rainfall received during the succeeding months. Venkateshwarlu and Reddy (1989) also observed higher yields from early sown castor due to above reasons. Dhoble *et al* (1990) also reported that sowing of castor and other *kharif* crops on 15 June was most advantageous in respect of productivity.

GCH-4 gave significantly higher yield (1589 kg/ha) compared to other cultivars under test. DCS-9, Kranthi and Aruna were at par. More effective spikes, lengthy spikes, favourable female to male flower ratio and also better 100 seed weight of GCH-4 contributed to perceptible increase in yield.

Thus, it can be indicated that sowing castor during first fortnight of June under rainfed conditions, increased the yield since the crop had favourable rainfall during entire growth period.

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Table 1:Effect of dates of sowing on the yield of castor cultivars

Treatement	No of nodes to Primary spike	No of effective spikes	Length of primary spike	100 seed weight	Seed yield (kg/ha)
Sowing date					
15 June 95	12.9	12.8	35.5	21.1	1730
30 June 95	13.0	11.2	33.6	20.5	1590
15 July 95	13.1	9.5	31.7	21.1	1320
30 July 95	12.5	5.9	26.9	21.3	835
18 August 95	11.6	7.8	4.0	20.8	1168
SEm ±	0.16	0.23	0.34	0.17	40.5
CD (0.05)	0.51	0.72	1.06	0.52	124.9
Genotypes					
Aruna	12.6	8.6	26.0	15.5	1132
Kranthi (PCS - 4)	12.1	9.4	26.2	21.5	1269
Jyothi (DCS-9)	12.6	9.5	25.4	21.9	1324
GCH-4	13.3	10.3	27.8	24.8	1589
SEm ±	0.18	0.20	0.31	0.31	54.3
CD (0.05)	0.51	0.58	0.89	0.89	154.6

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RESPONSE OF SPRING SUNFLOWER (*Helianthus annuus*) TO NITROGEN AND ROW SPACING WITH DIFFERENT INTERCROPS FOR RICE FALLOWS OF EASTERN MADHYA PRADESH.

Introduction of sunflower (*Helianthus annuus*) having photo and thermoinsensitivity with short duration, high production potential and greater adaptability to a wide range of soil and climatic conditions with irrigation in the fields lying vacant after rice will be a right step. Introduction of a new crop needs generation of techonology for its cultivation. In this direction although information for other parts of country for Sunflower is available, but for rice fallows of eastern Madhya Pradesh, it is still scanty. The present experiment was, therefore, carriedout to findout optimum row spacing and nitrogen for sunflower under sole and intercropping systems.

The field experiment was carried out at the research farm of IGKVV, Raipur during January-April, 1996. The soil was clayey, medium in organic carbon (0.71%), low in available nitrogen (22.99 kg/ha), medium in available phosphorus (19.21 kg/ha) and high in available potassium (407.16 kg/ha) having neutral pH 7.3. The experiment was laidout in split-plot design with three replications. The four row spacings with different intercrops i.e. sole sunflower at 50cm, sole sunflower at 60cm, Sunflower (60cm) + *palak* (60cm) [1:1] and Sunflower (60cm) + bottlegourd (1.8m) [3:1] were taken as main plot treatments. Three nitrogen levels viz. 40,60 and 80 kg/ha were taken in sub-plots. Basal application of 40 kg P_2O_5 and 20kg K_2O/ha was done through DAP and muriate of potash uniformly. Nitrogen supplied through DAP was supplemented with urea raising its levels to one third of nitrogen level of that treatment. The remaining two third nitrogen was given through urea in corresponding plots at 30 and 45 days after sowing following irrigation. The crop period a received rainfall of 29.8mm.

Row spacing with different intercrops had significant effect on grain yield of sunflower (Table 1). Sole sunflower spaced at 60cm produced highest grain yield. Lowest grain yield was recorded with sole sunflower spaced at 50cm. Sole sunflower planted at 80 cm spacing gave the highest number of filled seeds/head, head diameter, 1000 seed weight. Due to more available space per plant there is every possibility of higher availability of growth factors. Similar findings were also reported by Chavan *et al.*, (1990) and Ujjinaih *et al.*, (1994). Between intercropping system, sunflower with bottlegourd produced significantly higher grain yield than sunflower with *palak*. Since bottlegourd was planted at considerable spacing as compared to *palak* with sunflower, the competition for moisture, nutrients, solar radiation and space was less.

Application of 80 kgN/ha resulted in higher yield attributes and yield of sunflower, *palak* and bottlegourd over 40 or 60 kg N/ha (Table 2). Better growth attributes might have functioned as a solid base to bear promising architecture of yield attributes and lower sterility percentage. Similar results have been reported by Ujjinaiah et al. (1994) and Singh *et al.*, (1995).

Though grain yield of sunflower was higher in sole sunflower spaced at 60 cm than under rest of the treatments; green leaves of palak obtained under intercropping system earned additional price for the produce under the treatment and were able to raise the level of net return higher than any of the spacing cum intercropping treatments. Higher level of nitrogen (80 kgN/ha) was able to produce more green leaves of palak than 40 or 60 KgN/ha, which resulted in higher net return.

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Table 1. Effect of row spacing with different intercrops and nitrogen on yield attributs, yield and net return of sunflower

Treatment	Head diameter (cm)	Filled Seeds / head (No)	Sterility Percentage	1,000 seed weight (g)	Seed yield (q/ha)	Stover yield (q/ha)	Net return Rs./ha)
Row spacing with intercrops							
Sole Sunflower (50cm)	15.02	600.9	29.51	58.70	15.20	31.43	7201.24
Sole sunflower (60cm)	18.01	728.0	22.59	59.63	17.18	35.26	9285.52
Sunflower (60cm) + Palak [1:1]	17.25	691.7	24.66	58.93	16.75	32.83	14879.71
Sunflower (60cm) + Bottle gourd (1.8m) [3:1]	16.94	713.1	22.19	59.32	16.96	33.94	9850.10
CD (P=0,05)	1.41	7.73	0.41	0.09	0.024	0.048	269.77
Nitrogen (kg/ha)							
40	15.34	594.4	29.41	58.17	15.15	30.66	8614.17
60	16.86	680.3	24.30	59.20	16.63	33.42	10399.83
80	18.22	775.6	20.51	60.06	17.79	36.01	11898.43
CD (P=0.05)	0.40	6.31	0.23	0.10	0.021	0.021	195.53

Table 2. Effect of nitrogen on fresh yield of *palak* and bottlegourd under intercropping system

Nitrogen (kg/ha)	Sunflower with palak yield* (kg/ha)	Sunflower with bottlegourd yields** (kg/ha)
40	2123.82	462.96
60	2543.29	694.44
80	3115.09	925.92

* Yield of green leaves of palak; ** Yield of bottlegourd

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PERFORMANCE OF MUSTARD VARIETIES ON ALFISOLS OF RAYALASEEMA REGION OF A.P.

Mustard is an important oilseed crop mostly confined to the northern part of India. Like wheat it is gaining ground in the tropical regions of South India, where cool and dry conditions prevailed during winter season. Success of any mustard variety under tropical belts will be useful to enhance the edible oil production. It can be included in the rice based cropping systems in the rice fallows. A number of mustard varieties were recommended for cultivation in South India. Varieties like varuna, kranti and seetha have out yielded other varieties (Singh and Yashwant Singh, 1989, Baradwaj, 1990 and Khan *et al.*, 1990). To assess the performance of different varieties of mustard, a field experiment was conducted for three *rabi* seasons at Agricultural Research Station, Utukur, Cuddapah District, Andhra Pradesh. Nine varieties of mustard (*Brassica Juncea*) were tested in a randomised block design with three replications. The soils were sandy loam in texture, poor in available nitrogen and phosphorus with medium available potash. The varieties were sown in the month of November with a spacing of 30 X 10 Cm. A fertilizer dose of 80-50-40 Kg. ha^{-1} of N, P_2O_5, and K_2O, respectively was given uniformly to all the plots as urea, single super phosphate and muriate of potash respectively. Half of the nitrogen and complete dose of phosphorus and potash were applied at the time of sowing and the remaining half of the nitrogen at flowering stage of the crop. Irrigations were provided at 30,45 and 60 days after sowing. Plant height at harvest, number of pods per plant and seed yield were recorded.

The differences in plant height among varieties were found significant in all the three years. Kranti recorded significantly taller plants in all the three years followed by vardan and G.M.-1. The mean plant height varied from 109 cm.(PT-303) to 162 cm. (Kranti).

The differences in number of pods per plant among varieties were found significant during 94-95 and 95-96. The variety G.M.-1 in 94-95 (409 pods per plant) and Vardan in 95-96 (273 pods per plant) recorded higher number of pods per plant. On the three year average it was G.M.-1 (262) followed by Vardan (234) Divya (226) and 4-C-6-3/2 recorded more number of pods per plant. Singh and Kumar (1990) also reported more number of pods per plant with Vardan.

The seed yield differences among varieties were found to be significant in all the three years (Table-1). However, the varietal performance differed from year to year. In 93-94 the variety 4C-6-3/2 recorded highest seed yield (1102 kg ha^{-1}) followed by TM-2 (1088 kg ha^{-1}) and the lowest yield with Vardan (382 kg ha^{-1}). In 1994-95 TM-2 recorded maximum seed yield (822 kg ha^{-1}) and was significantly superior to all other varieties except Divya (732 kg ha^{-1}). The lowest yield was recorded with PT-303 (189 kg ha^{-1}). In 1995-96 Vardan recorded highest seed yield (1041 kg ha^{-1}) and was significantly superior to all other varieties. The lowest yield was recorded with PT-303 (360 kg. ha^{-1}). On three year average, the maximum seed yield was recorded with TM-2 (882 kg ha^{-1}) followed by 4C-6-3/2 (806 kg ha^{-1}) and Divya (771 kg ha^{-1}) and minimum yield with PT 303 (498 kg ha^{-1}). The inconsistent performance of the varieties might be due to their introduction into new environment for the first time. Traditionally mustard is a temperate crop. The success of some varieties in the tropical belt indicate its adoptability to the new environment.

It can be concluded that mustard can be grown in the tropical belt of Rayalaseema (Andhra Pradesh) where the mean temperature of 20-25C prevails during winter season. Mustard can be included in the rice based cropping systems in the rice fallows.

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Table 1 : Performance of mustard varieties on alfisols of Rayalaseema region of Andhra Pradesh

Varieties	Plant height (Cm)				No. of pods per plant				Seed yield (kg/ha)			
	93-94	94-95	95-96	Mean	93-94	94-95	95-96	Mean	93-94	94-95	95-96	Mean
Bhavani	100	85	100	112	129	126	166	140	944	371	460	592
Divya	117	119	145	127	174	289	215	226	854	732	727	771
Pt-303	115	102	110	109	106	217	167	163	944	189	360	498
TM-2	142	143	142	142	136	308	175	206	1083	822	741	882
4C-6-3/2	124	126	141	130	162	263	208	211	1102	422	894	806
Kranti	162	152	172	162	124	177	189	163	506	443	924	624
Varuna	140	140	162	147	116	243	227	195	543	587	647	592
Vardan	159	129	168	150	120	309	273	234	382	519	1041	647
GM-1	150	129	172	150	144	409	233	262	867	524	866	752
SEm±	10.0	4.0	4.0	-	22.0	16.0	9.0	-	130	75	34	-
CD (0.05)	21.1	11.6	11.3	-	NS	47.0	25	-	415	225	102	-

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PERFORMANCE OF SUNFLOWER AS INFLUENCED BY LEVELS OF PHOSPHORUS AND ENRICHED F.Y.M

Sunflower, an important annual vegetable oil seed crop is making strides in the oil seeds scenario of India. Further, it is finding place in the newer agro-ecological niches and cropping systems. It is an energy rich and nutrient exhaustive crop requiring higher fertilization especially nitrogen and phosphorus. Conjunctive application of inorganic and organic sources of nutrients will reduce the dependence on chemical inputs. The present study was conducted to develop an appropriate integrated phosphorus management system for sunflower in Alfisols.

A field experiment was conducted during *kharif* 1996 at the University of Agricultural Sciences, Bangalore on an alfisol. The soil of the experimental site is a red sandy loam with a pHof 5.6, organic carbon content of 0.39 per cent. It is low in available N (189 kg/ha) and medium in available P (32 kg P_2O_5/ha) and K (224 kg K_2O / ha). The P content of enriched and ordinary FYM was 0.6 per cent and 0.27 per cent. The quantity of urine used was very small and hence the N content of urine is very negligible. The experiment consisted of 9 treatments to supply recommended dose of 75kg P_2O_5/ha viz ; T1: 2/3 SSP +1/3unenriched FYM, T2: 1/2 SSP+1/2 enriched FYM T3:1/3 SSP + 2/3 unenriched FYM, T4:unenriched FYM alone, T5: 2/3 SSP+1/3enriched FYM, T6 : 1/2 SSP+1/2 enriched FYM, T7 :1/3SSP +2/3 enriched FYM T8:enriched FYM alone and T9:SSP alone was laid out in a completely randomised block design with each treatment replicated thrice. For use in the treatments T5 to T8, FYM was enriched by incubating it in cattle urine for about 20 days before application under anaerobic conditions and was applied at the time of sowing as per the treatments. The NPK nutrients were applied to different treatments after considering nutrient contents (NPK) in the FYM so as to meet the treatment requirement. Half of the recommended dose of N and full dose of K_2O were applied at the time of sowing and remaining N was top dressed at 35 days after sowing. The sunflower (cv. MSFH -8) crop was sown at a spacing of 60 cm x 30 cm and was harvested at 96 to 100 days after sowing. The data on growth, yield and quality attributes were recorded and were subjected to statistical analysis.

The results revealed that application of 50 per cent recommended dose of phosphorus through SSP and 50 per cent through enriched FYM(T6) gave significantly higher seed yield (2286 kg/ha) followed by T7 (2127 kg/ha) than the recommended practice i.e., SSP alone (1646 kg/ha). However, the rest of the treatments recorded low yields 1850 kg to 2125 kg/ha (Table 1). In the present study the higher seed yield was due to significantly higher test weight (4.69 g), number filled seeds (860), per cent seed filling (88.68) and threshing per cent (71.45). The results are in agreement with the findings of Sankaran (1977) and Challamuthu *et al.* (1988), who reported that, availability of organic carbon, available phosphorus and potassium contents were increased with organic manure application and this may be due to some organic acids produced during decomposition, which in turn are responsible for higher seed yield. Similar higher seed yield due to improvement in yield components were reported by Mukundan (1972), Tripathi and Kalra (1981) and Warad (1992).

Though the oil content did not vary significantly due to treatments, the oil yield varied significantly. Application of half the recommended dose of phosphorus through SSP and remaining half through enriched FYM gave 42.13 per cent more oil yield (877 kg/ha) than the recommended

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Table 1. Effect of SSP and enriched FYM on yield and yield attributes of sunflower

Tratments	Seed yield (kg/ha)	Oil content (%)	Oil yield (kg / ha)	100 seed weight (g)	Filled seeds \head	Per cent seed filling (%)	Threshing percentage (%)
T_1: 2/3 SSP + 1/3 unenriched FYM	1850	37.75	698	4.02	699	81.91	69.97
T_2 : 1/2 SSP +1/2 unenriched FYM	2027	38.01	769	4.30	763	85.42	69.96
T_3 : 1/3 SSP + 2/3 unenriched FYM	1942	37.93	756	4.24	761	84.35	69.83
T_4 : unenriched FYM alone	1916	37.83	726	4.18	719	83.59	69.82
T_5 :2/3 SSP + 1/3 enriched FYM	2030	38.10	786	4.34	796	85.96	72.23
T_6 : 1/2 SSP + 1/2 enriched FYM	2286	38.38	877	4.69	860	88.68	71.45
T_7 : 1/3 SSP + 2/3 enriched FYM	2127	38.33	815	4.61	831	87.84	70.62
T_8 :enriched FYM alone	2125	38.30	814	4.53	820	87.13	70.29
T_9 : SSP alone	1646	37.51	617	3.77	664	79.90	66.60
C.D (0.05)	160	-	53	0.27	100	2.43	4.53

practice (SSP alone). However, in general, the oil yield varied from 698 to 814 kg/ha in rest of the treatments. Similar higher oil yield of sunflower due to application of SSP and FYM was earlier reported by Ujjinaiah *et al.* (1994).

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INTER-RELATION AMONG YIELD, YIELD ATTRIBUTES AND LATE LEAF SPOT SEVERITY IN GROUNDNUT

Late leaf spot caused by *Phaeoisariopsis personata* is a major foliar disease in groundnut. Studies on the inter-relationship of late leaf spot severity with pod yield and its attributes viz. shelling percentage, 100 pod weight and 100 kernel weight would reveal the nature of association. This knowledge in combination with path co-efficients will be very helpful to the breeder in planning breeding programmes to transfer resistance into existing susceptible genotypes.

A set of 35 genotypes of groundnut (Table 1) consisting of elite lines developed at Regional Agricultural Research Station, Tirupati and International Crops Research Institute for Semi-Arid Tropics (ICRISAT), Hyderabad were sown in randomised block design with three replications during 1993 and 1994 *kharif* seasons. Data were recorded on pod yield/plot, late leaf spot severity at 90 DAS (1-9 scale of Subramanyam *et al.* 1982), shelling per cent, 100 pod and 100 kernel weights. Correlation and path co-efficients were done by standard methods.

Pod yield showed a highly significant positive correlation with 100 pod and 100 kernel weights (Table 2). Earlier Narasimhulu and Reddy (1986) and Deshmukh *et al.* (1986) have also reported similar results for different character combinations with yield. Pod yield, however, had weak positive association with late leaf spot severity and weak negative association with shelling per cent. Such negative association of shelling per cent with pod yield has been reported by Narasimhulu and Reddy (1986). Late leaf spot severity showed negative association with 100 pod and 100 kernel weights. Hundred pod weight possessed high positive correlation with 100 kernel weight as has also been reported by Deshmukh *et al.*, (1986).

It is obvious from the Table 3 that 100 pod weight had high direct positive influence (0.5134) on pod yield and was followed by 100 kernel weight. Deshmukh *et al.*, (1986) and Narasimhulu and Reddy (1986) also observed similar results. Late leaf spot severity affected pod yield through its negative indirect effect on 100 pod and 100 kernel weights. The residual value (0.6090) which is towards slightly higher side might be due to non-involvement of other yield influencing characters. To improve existing varieties simultaneously for pod yield and resistance to late leaf spot, it is necessary to break the negative correlation of 100 pod weight and 100 kernel weight with late leaf spot severity.

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Table 1 : Details of groundnut genotypes used in the study

S. No.	Entry	Botanical group	Days to maturity	Reaction to late leaf spot (1-9 disease scale) (Mean 1993 & 1994 Kharif season)
1	TCGS - 93	SB	110	6.0
2	TCGS - 94	SB	100	5.0
3	TCGS - 95	SB	110	5.5
4	TCGS - 96	SB	110	5.0
5	TCGS - 97	SB	110	5.0
6	TCGS - 98	SB	110	5.5
7	TCGS - 99	SB	110	5.5
8	TCGS - 100	SB	110	5.0
9	TCGS - 101	SB	110	6.5
10	TCGS - 102	SB	110	5.0
11	TCGS - 103	SB	110	5.5
12	TCGS - 104	SB	115	4.0
13	TCGS - 132	SB	105	4.5
14	TCGS - 134	VB	116	3.5
15	TCGS - 136	SB	105	5.5
16	TCGS - 139	SB	105	4.5
17	TCGS - 140	SB	105	6.5
18	TCGS - 142	VB	110	6.5
19	TCGS - 143	SB	105	5.5
20	TCGS - 145	VB	116	4.5
21	TCGS - 147	SB	105	8.5
22	TCGS - 148	SB	105	7.0
23	TCGS - 150	SB	105	7.5
24	TCGS - 153	SB	105	7.5
25	TCGS - 155	SB	105	6.5
26	TCGS - 156	SB	105	6.5
27	ICGV 89402	VB	110	4.5
28	ICGV 87846	VB	110	6.5
29	ICGV 87860	VB	110	7.0
30	ICGV 88256	VB	110	8.0
31	ICGV 86590	VB	110	2.5
32	JL-24	SB	105	7.5
33	Tirupati-1	SB	105	9.0
34	ICG (FDRS)-10	SB	105	8.5
35	TMV-1 (LSB)	SB	105	8.5

Table 2 : Estimates of Genotypic and Phenotypic correlations between yield, yield attributes and late leaf spot severity in groundnut

Characters	LLS Score	Shelling %	100 pod weight	100 kernel weight	Pod yield
LLS Score	1.000	0.228	-0.109	-0.244	0.028 P
	1.000	0.252	-0.112	-0.259	0.025 G
Shelling %		1.000	-0.192	0.074	-0.056 P
		1.000	-0.216	0.082	-0.065 G
100 pod weight			1.000	0.758**	0.612** P
			1.000	0.781**	0.623** G
100 kernel weight				1.000	0.502** P
				1.000	0.518** G
Pod yield					1.000 P
					1.000 G

* Significant at 5 per cent and ** 1 per cent probability levels

Table 3 : Estimates of Direct and Indirect effects (Path co-efficients) of late leaf spot severity and three yield attributes in groundnut

Characters	LLS Score	Shelling %	100 pod weight	100 kernel weight	Genotypic Correlation
LLS Score	**0.1138**	0.0017	-0.0533	-0.0280 P	0.028
	0.1145	0.0032	-0.0608	-0.0320	0.025
Shelling %	0.0223	**0.0087**	-0.0822	-0.0082	-0.056
	0.0289	0.0217	-0.1168	0.0101	-0.065
100 pod weight	-0.0118	-0.0014	**0.5134**	0.0926	0.662
	-0.0128	-0.0027	0.5418	0.0965	0.623
100 kernel weight	-0.0247	0.0006	0.3692	**0.1288**	0.502
	-0.0297	0.0010	0.4231	0.1236	0.518

(i) Residual value 0.6090; (ii) Direct effects are indicated in bold and underlined

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EFFICACY AND ECONOMICS OF CERTAIN PLANT PRODUCTS ON THE CONTROL OF SESAME SHOOT WEBBER *(Antigastra catalaunalis* Duphonchel)

Sesame shoot webber/capsule borer, *(Antigastra Catalaunalis* Dup.,) is a pest of world importance causing significant reduction in the yield of sesame (*Sesamum indicum* Linn). Abraham *et al.*,(1997) reported damage by this pest between 27-40 percent. The yield loss of 10.71 per cent was also reported by Singh (1982). Many researchers have tested different insecticides to control this pest. Carbaryl 50WP@0.15% (Jakhmola and Yadav, 1990) and synthetic pyrethroids (Singh and Grewal, 1989) were effective to this pest. Basal application of carbofuran 3G @ 0.5Kg a.m/ha with two sprayings of carbaryl 50WP @0.2% (Choudhary, 1986) and carbaryl @ 0.15% or BHC 10D @25kg/ha (Nair, 1986) were also effective. The alternative to these chemicals could be plant derivatives having insecticidal properties. Extracts of the easily available indigenous plants and botanicals available in the local market were tested against sesame leaf webber/capsule borer at Regional Research Station, Vriddhachalam.

A field experiment using eight plant derivatives (Table 1) with one insecticide endosulfan 35EC (0.07%) was carried out to study the control of *A. Catalaunalis* on sesame TMV3 at Regional Research Station, Vriddhachalam in sandy soil during *kharif* 1995 and 96. A randomised block design with four replications was used. Planting was done in the first fortnight of June. A spacing of 30x30cm with a plot size of 5.0 x 3.0 m was used. A basal dose of fertilizer (60:40:0 NPK kg/ha) was applied. Two sprayings were done at 15 days interval starting from 30 days after sowing (DAS) using water @750lit./ha. Plant, flower and pod infestations were recorded a week after each application and the per cent damage was worked out. The data were subjected to arcsine angular values and analysed statistically.

Data of two years (Table 1) revealed significantly lower plant damage (9.66%) in endosulfan; neemgold (12.16%) during first spray in *kharif* 1995, while in the second spray too endosulfan treatment recorded less damage (18.50%). But the efficacy of endosulfan was on par with neem oil, neemax and neemicidin which recorded 20.40, 21.49 and 22.25 per cent damage, respectively. During *kharif* 1996, endosulfan treatment alone recorded less damage (9.95%) in the first spray, while in the second spray its efficacy was poor. Neem leaf extract, neemicidin and neemgold were found superior with 19.10, 20.40 and 21.00 percent damage, respectively (Table 1). The above neem product efficacy was on par with kemisol. Other treatments in the order of efficacy were NSKE (22.30%) > neemax (23.50%) > NG4 (22.10%).

With regard to flower damage, endosulfan alone recorded lowest infestation (7.56%) in the first spray during *kharif* 1995 and it was on par with neemoil (8.24%), while in the second NG4 (13.73%), endosulfan (14.50%) and neemoil (15.49%) were effective (Table 1). During *kharif* 1995, in the first spray neemoil and NSKE recorded the lowest flower damage of 10.70 and 11.06 per cent respectively, whereas in the second spray of *kharif* 1996, the efficacy of all plant products was similar to that of endosulfan (Table 1).

Regardless of the sprays, all plant products and endosulfan recorded significantly less pod damage than untreated control during *kharif* 1995 (Table 1), whereas in the first spray during 1996, neemoil treatment alone recorded least pod damage (9.63%) and was on par with neemgold which recorded 10.57 per cent pod damage. During second spray of *kharif* 1996 (Table 1), endosulfan, neemicidin, kemisol, NG4 and neemax recorded

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Table 1 : Sesame shoot webber response to plant derivatives at different stages of sesame cultivar (TMV3) .

Treatment	Average per cent infestation at different stages (1995)						Average per cent infestation at different stages (1996)					
	First spray			Second spray			First spray			Second spray		
	Seedling	flower	pod	Seedling	flower	pod	Seedling	flower	pod	Seedling	flower	pod
Neem leaf extract @ 2kg fresh leaves + 100g soap/ 5lit water	17.18 (24.95)b	13.66 (21.72)c	12.81 (20.96)a	23.11 (28.73)b	22.74 (28.45)b	13.61 (21.64)a	18.91 (25.74)c	14.48 (22 33)bc	13.73 (21.74)e	19.10 (25.08)a	16.70 (24.14)a	23.10 (28.73)bc
NSKE @ 20 ml/lit	16.60 (20.04)b	11.15 (19.82)a	12.87 (20.96)a	24.06 (29.40)b	24.98 (30.00)b	13.64 (21.64)a	17.48 (24.69)c	11.06 (19.42)ab	12.65 (20.83)de	22.30 (28.18)b	18.20 (25.20)a	19.10 (25.91)b
Neem oil @ 10ml/lit	12.16 (20.44)a	8.24 (16.64)ab	8.83 (17.26)a	20.40 (26.85)ab	15.49 (23.18)a	13.40 (24.17)a	14.22 (21.99)b	10.70 (19.09)a	9.63 (18.07)a	23.40 (28.86)c	18.40 (25.34)a	17.00 (24.32)b
Neem gold @ 3ml/lit	18.90 (25.77)b	14.70 (22.54)c	11.69 (20.00)a	23.81 (29.20)b	21.20 (27.42)b	14.46 (22.38)a	17.94 (25.02)c	12.15 (20.40)abc	10.57 (18.96)ab	21.00 (27.26)a	16.70 (24.01)a	13.20 (21.14)ab
Neemicidin @ 5ml/lit	20.58 (24.65)b	13.26 (21.30)b	11.94 (20 13)a	22.55 (28.32)ab	22.66 (28.45)b	13.41 (21.47)a	22.53 (28.33)d	14.28 (22.10)bc	12.13 (20.38)d	20.40 (26.85)a	15.50 (23.18)a	13.40 (21.47)a
NG4 @ 3ml/lit	17.40 (24.65)b	13.07 (21.22)c	11.69 (20.00)a	24.91 (29.93)b	13.73 (21.72)a	13.96 (21.97)a	17.59 (24.77)c	13.66 (21.68)abc	11.25 (19.00)bc	24.10 (29.40)b	18.60 (25.32)a	15.90 (23.15)a
Kemisol @ 2.5ml/lit	16.49 (23.97)b	12.43 (20.62)bc	11.13 (19.46)a	39.32 (32.85)c	20.82 (27.20)b	14.13 (22.06)a	16.52 (23.95)bc	13.46 (21 44)abc	10.79 (19.16)b	21 50 (27.62)ab	18.00 (25.10)a	14.80 (22.64)a
Neemax @ 5g/lit	16.69 (24.14)b	12.30 (20.53)bc	11.28 (19.64)a	21.49 (27.62)b	22.84 (28.52)b	13.20 (21.30)a	16.74 (24.13)bc	13.20 (21 26)abc	11.64 (19.94)bcd	23.50 (29.02)b	19.50 (26.15)a	16.00 (23.55)a
Endosulfan 35EC @ 1.5 lit/ha	9.66 (18.15)a	7.56 (16.00)a	10 81 (19 19)a	18.50 (25.40)a	14.50 (22.38)a	11.68 (20.00)a	9.95 (18.39)a	11.06 (19.42)ab	13.75 (21.75)e	19.50 (26.15)e	14.80 (22.64)a	13.20 (21.14)a
Untreated control	26.63 (31.05)c	22.06 (28.04)d	20.82 (27.13)b	36.55 (37.23)d	33.90 (35.61)c	26.56 (31 11)b	25.46 (30.92)d	20.30 (26.66)d	22.94 (28.61)f	35.40 (36.51)c	38.12 (38 12)b	43.20 (41.03)d

Figures in parentheses are arcsine per cent values; In a column means followed by similar letter are not statistically different.

Table 2 : **Economics of application of plant derivatives for the control of sesame shoot webber *A. catalaunalis* during kharif 1995 and 1996.**

Treatment	1995						1996				
	Required qty/spray (kg/ha)	Total cost of protct. (Rs/ha)	Yield (kg/ha)	Gross return (Rs./ha)	Net return (Rs./ha)	B.C ratio	Total cost of protct. (Rs./ha)	Yield (kg/ha)	Gross return (Rs./ha)	Net return (Rs./ha)	B:C ratio
Neem leaf extract	70	238	622bc	6842	948	1.10	698	508bc	6096	548	1.10
NSKE	53	462	614bd	6754	1157	1.20	462	522b	6624	1312	1.25
Neem oil	5	554	650ab	7150	1476	1.26	574	569b	6828	1409	1.26
Neem gold	1.5	724	589cd	6479	635	1.11	904	606b	7272	1518	1.27
Neemicidin	2.5	1244	634ab	6974	610	1 10	1244	622b	7464	1370	1.22
NG4	1.5	814	585d	6435	501	1.08	814	581b	6972	1308	1.23
Kemisol	1.5	964	638ab	7018	934	1.15	964	592b	7104	1290	1 22
Neemax	2.5	1394	592cd	6512	-776	0	1394	574b	6888	644	1.10
Endosulfan	1.5	836	669a	7359	1403	1.24	1108	723a	8676	2718	1.46
Untreated control	0	0	0	0	0	0	0	0	0	0	0

Neem leaf @ Rs.75/q; Neem seed @ Rs. 200/q; Neem oil @ Rs. 29/lit; Neemgold @ Rs. 220/lit; Neemicidin @ Rs. 200/lit; NG4 @ Rs 190/lit; Kemisol @ Rs. 240/lit; Neemax @ Rs.160/lit; Endosulfan 35EC @ Rs 197/lit; Soap sticker @ 70/kg; Labour cost : Men @ Rs 32/day; Women @ Rs. 29/day.

Means followed by similar letters are not different statistically.

13.20, 13.40, 14.80,15.90 and 16.00 per cent pod damage, respectively.

Although, endosulfan proved to be effective and best of all the treatments, Dethe and Kole (1991) detected residual toxicity in sesame seed (0.31 and 0.25 ppm) after four and three sprays of endosulfan 35 EC @ 0.07 per cent. Because of low residual toxicity the use of plant products such as neemgold, neemoil, and neem seed kernel extract can safely be recommended as an alternative to endosulfan.

During *kharif* 1995, endosulfan treatment recorded a maximum yield (669 kg/ha) which was on par with neem oil (650 kg/ha) and kemisol (630 kg/ha) whereas during *kharif* 1996, endosulfan treatment alone registered significantly higher yield of 723 kg/ha (Table 2). The yield performance in rest of the plant products ranked next to endosulfan except neem leaf extract treatment.

Neemoil treatment registered a maximum B:C ratio of 1.26 followed by endosulfan (1.24) and NSKE (1.21) during *kharif* 1995 (Table 2), whereas in *kharif* 1996, endosulfan alone gave a maximum B:C ratio of 1.46. Among plant products neemgold, neemoil and NSKE recorded a high B:C ratio. Rest *of the plant products were economically better than* control (Table 2).

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ASSESSMENT OF AVOIDABLE YIELD LOSS DUE TO INSECT PESTS IN GROUNDNUT

Groundnut is one of the most important oilseed crops in Saurashtra region of Gujarat State. The Major constraints to groundnut growing in India are insect pests, disease, and drought (Gibbon, 1980). The major insect pests of groundnut in Saurashtra are jassid (*Empoasca kerri* Pruthi), thrips (*Frankiliniella schultzei* Trybom, *Scirtothrips dorsalis* Hood and *Caliothrips indicus* Bagnall), leafminer (*Approacrma modicella* Deventer). Insects such as gram pod borer (*Helicoverpa armigera* Hubner), tobacco caterpillar (*Spodoptera litura* Fabricius) and aphid (*Aphis craccivora* Koch) which were not previously considered to be important pests, are now recognized as such.

The groundnut crop losses attributable to major insect pests in the range of 5.0 to 51.06% have been reported by various researchers in India. Kennedy *et al.* (1992) reported 22.2% yield loss of groundnut pods in Tamil Nadu. In Maharashtra Shetgar *et al.* (1992) observed 40.34% loss in pod yield due to various pests. According to Singh and Sachan (1992) the highest yield loss due to insect pests at any crop stage was 31.4% in Pantnagar (U.P). The present investigation deals with assessment of avoidable yield loss due to insect pests in *Kharif* groundnut.

Investigations were carried out during *kharif* season of 1995 and 1996 at Sagdividi Farm, Gujarat Agricultural University, Junagadh Campus, Junagadh. GG 4 variety of groundnut was sown at a spacing of 45 X 10 cm with gross plot size of 5.0 X 2.7 m and net plot size of 4.0 X 1.8 m and replicated 14 times in a paired plot design with two treatments. In the first treatment (T1-protected) monocrotophos 0.05% was sprayed by high volume Knapsack sprayer on 20,35,50 and 65 days old crop to control insect pests infestation. The other treatment (T2-unprotected) was left unsprayed to allow natural insect pest population and build up of pest infestation.

The data on pest population were recorded fortnightly, starting from 20 days after sowing (DAS) from ten randomly selected plants. Total number of jassid nymphs, thrips were recorded per plant. In case of lepidopterous pest larval counts were made per plant. To know the population of aphid, aphid index was calculated as suggested by Butani and Bharodia (1984).

Yield of groundnut pods and fodder from net plot area were recorded and computed on hectare basis. The data were analysed by paired 't' test. The avoidable crop loss was calculated by adopting the following formula :

$$\text{Avoidable yield loss} = \frac{\text{Yield in protected plot - Yield in unprotected plot}}{\text{yield in protected plot}} \times 100$$

The deductive approach employed by Stone and Pedigo (1972) to arrive at per cent yield loss necessary to reach gain threshold, where the benefits obtained by controlling insect was equal to cost involved in control. The gain threshold was calculated as per the following formula :

$$\text{Gain threshold} = \frac{\text{Cost of pest control (Rs/ha)}}{\text{Market value of the produce (Rs/q)}}$$

Per cent yield loss required to pay for the cost of pest control was obtained by the formula given below :

$$\text{Per cent yield loss required to pay for cost of pest control} = \frac{\text{Gain Thershold}}{\text{Expected yield of Gujarat State}} \times 100$$

When the observed crop loss was more than the per cent yield loss necessary to pay up

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Table 1 : Population of insect pests on groundnut as influenced by the application of monocrotophos 0.05%

Treatment	Average pest population per plant (Two years pooled)					
	Jassid nymphs	Thrips	Leaf minor larvae	Gram pod borer larvae	Tobacco cater pillar	Aphid index
Protected	1.38*(1.90)	0.94*(0.88)	1.44*(2.07)	0.81+(0.14)	0.81+(0.14)	0.80+(0.14)
Unprotected	2.06(4.24)	1.55(2.40)	2.09(4.37)	1.00(0.50)	0.96(0.42)	0.97(0.44)
't'	17.67**	25.69**	19.06**	21.19**	16.89**	13.38**

** Significant at 0.01 level; * Square root transformed values: + Square root of (x+0.5) transformed values
Figures in parenthesis are re-transformed values

for the cost of pest control, then it was considered as an economic loss needing control measures whereas, the observed crop loss was equal to or less than yield loss necessary to pay up for the cost of pest control, then it was considered uneconomic to spray.

The results (Table 1) revealed that the incidence of jassid, thrips, leafminer, gram pod borer, tobacco caterpillar and aphid was significantly higherin unprotected plot as compared to protected plot. It indicated that, there was a greater reduction in density of various insect pests in monocrotophos 0.50% treated plot. The moderate to severe infestation of these pests resulted in lower yield in unprotected plot as compared to protected plot (Table 2). The results also indicated that the difference in the pod yield of groundnut was highly significant between the treatments. Protected and unprotected plots recorded an average pod yield of 16.61 and 10.08 q/ha, respectively during *kharif* season.

The estimated avoidable loss of groundnut pod yield in unprotected treatment was 39.31% which exceeded the economic loss of 11.82% as calculated on the basis of grain threshold (0.78 q/ha) and state average yield of 6.60 q/ha. Thus, the yield loss obtained can be termed as the economic loss as it was well above the 11.83% yield loss equivalent to the cost of control measures of Rs. 1016/ha. Similarly, the high incidence of insect pests in unprotected treatment caused 43.54% loss in fodder yield.

Table 2 : Avoidable yield loss due to insect pest complex in groundnut

Treatment	Pod yield (q/ha)	Avoidable loss in pod yield (%)	Grain threshold (q/ha) +	Per cent yield loss required to pay for the cost of pest control ++	Monetary loss (Rs./ha)		Fodder yield (q/ha)	Avoidable loss in fodder (%)
					In expt.	As per Gujarat State Avg. Yield ++		
Protected	16.61	-	0.78	11.82	-	-	33.35	-
Unprotected	10.08	39.31	-	-	8489	3373	18.83	43.34
't'	28.69**	-	-	-	-	-	34.36**	-

** Significant at 0.01 level.
+ Cost of pest control was Rs. 1016/ha for both the seasons. Market price of Groundnut pods was Rs. 1300/q.
++ Gujarat States average yield from last five years was 6.60 q/ha.

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SUMMARIES OF RESEARCH PAPERS

DHEMBARE, A.J. 1998. Safflower Aphid (*Uroleucon Compositae* (Theobald))- A serious insect pest of safflower in India - Areview. *J. Oilseeds Res.* 15(2): 207-212

Safflower aphid besides attacking safflower also infests a number of economic plants and destroys inflorescences, shoots, capitula and leaves resulting in poor seed set and causes yield loss to the tune of 68%. It is active from Dec - February. Low temperature, high humidity and cloudy weather favour its multiplication. Aphid incidence is more in late sown crop than early sown one. various management strategies such as host plant resistance, sowing time, parasites, predators can offer control of aphids in field. Insecticides like dimethoate 0.05%, endosulfan 0.05% and Phosphomidon 0.05% are effective for the control of aphids in safflower.

PRABIR CHAKRABORTI. 1998. Heterosis for oil content and fatty acid composition in sesame under salinity stress. *J. Oilseeds Res.* 15(2) : 213-218.

The extent of heterosis for oil quantity and quality in a full diallel set of 9 salt tolerant sesame lines was studied in normal and saline condition. The maximum heterosis for oil content was observed in IER2 X HTI in all the environments over both mid and better parents. It was found that HT-1, the parent involved in producing higher heterotic effect, produced significant positive heterotic effect in combination with R9, B14, B67, T12, RT-4 over mid and better parent in saline environment. The crosses showing maximum heterosis for oleic and linoleic acids are the recombinants of better parents in normal and saline environments.

KHULBE, R.K., PANT, D.P, and RAWAT, R.S 1998. Combining ability analysis for yield and its components in Indian mustard. *J. Oilseeds Res.* 15(2): 219-226.

The combining ability analysis of 8 parents and their 28 F1s generated through diallel system of mating revealed significant differences for *Gca* and *Sca* for all characters, indicating the presence of both additive and non additive gene effects in controlling the expression of characters. Divya, Kranti, Vardan were found good general combiners for seed yield and yield component traits. Thirteen crosses exhibited good combining ability for yield which was controlled by non-additive gene action. The crosses with high *Sca* effects did not always had parents with good *Gca* effects. Such a relation between *Gca* and Sca indicates the importance of epistasis and the crosses were expected to produce desirable transgressive seggregants if the additive genetic system of good general combiner and the complementary epistatic effect of F1 act in the same direction to maximize the desirable yield attributes.

KHULBE, R.K; PANT, D.P. and RAWAT, R.S. 1998. Heterosis for yield and its components in Indian mustard. *J. Oilseeds Res.* 15(2): 227-230

Estimation of heterosis for 15 characters in 28 hybrids of Indian mustard (*Brassica Juncea*) revealed that heterosis was of high order for length of mainshoot, no. of primary branches, seeds siliqua, seed yield/ plant and 1000 seed weight. Heterosis was found low for days to maturity and oilcontent. Many crosses exhibited negative heterosis for days to maturity and plant height. Kranti x Vardan gave a standard heterosis of 27.4% for yield. In general crosses involving at least one of the parents with high performance yielded heterotic results. Standard heterosis shown by Domo x Ornamental rai and Divya x PHR-Artola indicates manifestation of high heterosis even when both the parents are low performers.

VANISREE, G. and PRASAD, M.V.R. 1998. Inheritance of narrow leaf shape in groundnut (*Arachis hypogaea* L). *J. Oilseeds Res.* 15(2) : 231-233

Inheritance pattern of narrow leaf shape was studied in the crosses involving 2 narrow leaf mutants TMV 2NLM and GNLM as male parents, and other normal leaf genotypes as female parents. In F2 generation, crosses involving TMV2NLM exhibited segregation pattern of 1:2:1, while crosses with GNLM showed 3:1 ratio. The F2 of the cross between the two narrow leaf mutants segregated in 1:60:3 ratio, suggesting a trigenic model involving a recessive sterile due to complementary gene action. The two narrow leaf mutants were genetically different.

THAKRAL, N.K and PRAKASH KUMAR. 1998. Combining ability for vigour characters under normal and saline environments in Indian mustard (*Brassica Juncea* (L) Czern & Coss). *J. Oilseeds Res.* 15(2) : 234-237.

Combining ability analysis of 6x6 diallel of Indian mustard for % germination, speed of germination. seedling vigour under normal (o meq/l) and saline environments (125 and 175 meq/l)revealed that both additive and non-additive gene effects were involved in inheritance of these characters. The predictability ratio indicated greater importance of non-additive action. For speed of germination RH7859 and for seedling vigour RH 7846 were the best general combiners. The crosses RH 781x RHW -1 for germination % and speed of germination, RH 7859 x RH 781 and RH 7859 x RH 8113 for seedling vigour were the best cross combinations in all the 3 environments.

MOINUDDIN, H.H., SURYANARAYANA REDDY, B.G., LOHITHASA, H.C., SHERIFF, R.A., KULKARNI, R.S. and PATIL, B.R. 1998. stability for yield and its components in groundnut (*Arachis hypogaea,* L). *J. Oilseeds Res.* 15(2) : 238-241.

Twenty one groundnut genotypes were evaluated in different environments. Genotype X environment interaction was significant for all the characters except number of branches/plant. The linear effect due to environment was significant for all the characters, while the variance due to genotype X environment was significant for no.of branches/pl. and mature pods/pl. Non-linear component was significant for all characters barring mature pods/pl. Genotypes JSSP-6, JL-24 and DH-47 were the most stable which showed higher pod and oil yields / P1. On the basis of environmental indices summer 1996 was the most favourable for character expression.

CHANDRA SEKHAR MAHTO and RAHMAN, M.H. 1998. Line X Tester analysis of seed yield and its components in liseed (*Linum usitatissimum* L). *J. Oilseeds Res.* 15(2): 242-246.

A line X tester set was obtained by crossing 15 lines with 2 testers in linseed. The resultant

30 F_1s were evaluated along with 17 parents to estimate *Gca* and *Sca* variances and effects for 11 quantitative characters. Additive gene effect governed the expression of plant height and 1000 seed weight, while non-additive gene effect was predominent in primary branches, sec. branches, capsules /pl. seeds / capsule, yield/pl, harvest index and oilcontent. Both additive and non-additive gene action controlled days to 50% flowering and days to maturity. The parents Sweta and Chembal were the best combiners for seed yield. The crosses Pusa 3 x T-397, Acc 841 x Subhra and Jeevan x T-397 were significant specific combiners for seed yield.

CHANDRAKAR,P.K., RAJEEV SHRIVASTAVA., AGRAWAL, S.K. and RAO, S.S. 1998. Stability analysis of soybean (*Glycine max* L. Merrill) varieties in rice zone of Madhya Pradesh. *J. Oilseeds Res.* 15(2): 247-249.

Thirteen soybean genotypes were evaluated for six years for stability. Significant differences among genotypes in different environments were observed for seed yield, oil content, days to 50% flowering, days to maturity, plant height, pods/pl and 100 seed weight. None of the genotypes showed average stability for all the traits. Genotypes JS-80-21 and Bragg showed stable performance for seed yield, oil %, and seeds/pod over years, whereas PK-262 was found stable for oil content and 100 seed weight.

PARAMESWARI, C., MURALIDHARAN, V and SUBBALAKSHMI, B. 1998. Flowering pattern and reproductive efficiency in bunch Varietiesof groundnut. *J. Oilseeds Res.* 15(2): 250-254.

The flowering pattern and reproductive efficiency of eight genotypes of groundnut was studied. Flowering commenced 24-30 days after sowing. More than 80% flowers were produced within 45 days of commencement of folwering. Reproductive studies showed that a large proportion of flowers failed to produce mature pods. Only 32-50% of the flowers formed pegs and 12-21% formed mature pods.

JHANSI RANI, K and NAGESWAR RAO, T. 1998. Study of somaclonal variation in tissue cultures of safflower through isozyme analysis. *J. Oilseeds Res.* 15(2) : 255-257.

Peroxidase isozyme activity was studied in different explants such as cotyledonary leaf, hypocotyl and root and respective calli of Ms-105 A line and Manjira Variety of safflower by using rodgel electrophoresis, with a view to detect somaclonal variation based on peroxidase banding pattern. The specific bands observed in calli suggest the release of new type isozymes which can be attributed to the phenomenon of somaclonal variation.

JHANSI RANI, K and NAGESWAR RAO, T. 1998. Callus differentiation in tissue cultures of safflower. *J. Oilseeds Res.* 15(2): 258-260.

Callus was induced from cotyledonary leaf and hypocotyl explants of MS-105 A line and Manjira on Murashige and Skoog medium supplemented with 0.1, 0.5, 1.0, 2.0 and 5.0 mg l^{-1} of NAA in combination with 0.25 mg l^{-1} BAP and Kinetin. MS medium supplemented with 2.0 mg l^{-1} BAP gave maximum shoot differentitation from 5 week old primary calli. Rhizogenesis of *in - vitro* differentiated shoots was activated on MS basal medium devoid of any hormone. However, Murashige and Skoog medium supplemented with 2.0mg l^{-1} NAA was good for Rhizogenesis.

VASUDEVAN, S.N., VIRUPAKSHAPPA, K., BHAKSAR, S and UDAYAKUMAR, M. 1998. Influence of light duration and Co_2 enrichment on growth, seed yield and quality of sunflower CV. Morden. *J. Oilseeds Res.* 15(2) : 261-266.

The results revealed that vigour index was significantly increased due to the treatments and ranged from 1.53 to 5.98%. Seed filling percent and test weight increased significantly due to extended light duration and Co_2 enrichment imposed from 10-40 DAS. Seed yield/pl increased from 37.2g in control to 41.2 g/pl in extended light duration alone, 40g in Co_2 enrichment alone and 44.1g in combination of both from 10-40 DAS. The LA1/Pl. increased due to both Co_2 enrichment and extended light duration from 10-40 DAS. Days to 50% flowering was delayed by 0-10 days when plants were exposed to longer day length alone and in combination with elevated Co_2 concentration.

SHARMA, P.B., RAGHUWANSHI, P.S, and AMBAWATIA, G.R. 1998. Intercropping sesame with pigeonpea under varying sowing dates. *J. Oilseeds Res.* 15(2): 267-271.

Grain yields of pigeonpea sown in July were significantly higher than sowing in 15-20 August and 5-10 September. The grain yield of sesame sown during 5-10 July and 5-10 September was at par but superior to that obtained from 25-30 July and 15-20 August sowings. The pigeonpea equivalent yields, net returns (Rs. 29,985/ha) and B:C ratio (3.81) with 5-10 July sowing were maximum. Pigeonpea + Sesame 2:2 was more promising and recorded highest pigeonpea equivalent yield of 2925 kg/ha, net return (Rs 33035/ha) and B:C ratio (4.05) over 2:4, 2:6 row proportion and mixed seed proportions.

DEVIDAYAL and AGARWAL, S.K. 1998. Performance of sunflower hybrids as influenced by organic manure and fertilizer. *J. Oilseeds Res.* 15(2): 272-279.

Field experiments conducted at HAU, Hisar during spring 1995 and 1996 to study the effect of nutrient management on growth and yield of sunflower hybrids revealed that seed yield was significantly higher in Badshah than MSFH-8. The dry matter/ plant and yield components were significantly higher with vermicompost @ 10t/ha and with FYM @10t/ha over no organic manure. The interaction between organic manure x fertility levels on dry matter and seed yield showed that they increased with increasing levels of fertility upto 120+60 NP/ha without organic manures and upto 80+40 NP/ha in conjunction with organic manures. Use of vermicompost @10t/ha along with 80+40 NP/ha was the best combination for dry matter and seed yield. The hybrid Badshah offered more net return than MSFH-8.

GANGADHAR RAO, D., VANAJA, M., LAKKINENI, K.C. and REDDY, P.R. 1998. Suitability of excised leaf water retention capacity (ELWRC) technique for screening castor genotypes for yield. *J. Oilseeds Res.* 15(2): 280-287.

The Excised leaf water retention capacity (ELWRC) has been used as selection criteria for screening promising germplasm for yield and drought tolerance. The results showed that GCH-4 castor hybrid had highest leaf moisture content even 165 minutes after excision. The superior performance of GCH-4 hybrid was due to quick response of stomata coupled with low radiation load due to higher leaf reflectance and transmittance properties in the wavelength range of 400-1000nm. The fact that both GCH-4 and its male parent (48-1) had similar ELWRC indicates that this trait is heritable.

SANJOY SAHA., MOORTHY, B.T.S and JHA, K.P. 1998. Performance of sunflower cultivars in rice fallow situations under alluvial tract of Coastal Orissa. *J. Oilseeds Res.* 15(2): 288-292.

Field experiments were conducted at CRRI Cuttack under upland and shallow low land situations to evaluate the performance of sunflower hybrids and cultivars for their suitability in rice fallows. The hybrids/cultivars suitable for upland situation are KBSH-1(18.3q/ha), TNAUSUF-7 (17.4 q/ha), PAC 36 (16.8q/ha). For shallow lowlands the promising ones are ICI 308, PAC 36 and TNAUSUF-7 with average yields of 21.5, 19.5 and 19.4 q/ha. Under farmers field condition ICI 1-308 (25.8q/ha) KBSH-1 (24.6 q/ha) were superior to Morden (15.2 q/ha).

PATEL, S.R., THAKUR, D.S. and PANDYA, K.S. 1998. Influence of sowing time on the performance of groundnut (*Arachis hypogaea* L) varieties. *J. Oilseeds Res.* 15(2): 293-296.

An experiment was conducted during *kharif* 1992-93 to study the response of groundnut varieties (ICGS11, Girnar -1, J-11, ICGS-44) to sowing dates. It was found that in Eastern Madhya Pradesh groundnut can be sown upto 10th July and there after yield declined to an extent of 78.5kg/day. Among varieties ICGS-11 performed better followed by Girnar-1 than the rest. Dates of sowing had no effect on oil and protein contents. Delayed sowing resulted in significant reduction in the uptake of N, Pand K.

MANJULA, A. and PRAVEEN RAO, V. 1998. The sensitivity of growth and yield of mustard to evapo transpiration deficits. *J. Oilseeds Res.* 15(2): 297-302.

Field experiments conducted during 1993-94 post-rainy season on mustard showed that fully irrigated control showed beneficial effects on growth and yield components resulting in maximum seed yield of 1047kg/ha. The crop was insensitive to Eta deficits at vegetative period as evident from low (0.46) yield ratio (YRR) and there was no significant reduction inseed yield relative to fully irrigated control. The crop was found to be highly sensitive to Eta deficits at flowering - pod initiation and addition (YRR=1.55) and Pod filling periods (YRR=2.49) and their combination growth subperiods (YRR=1.31 to 1.74) which significantly reduced (33.4 - 91.4%) seed yield in comparision to fully irrigated control. Under deficit water supply conditions to minimize yield losses, available water should be directed to pod filling and flowering - pod initiation and addition crop growth sub-periods.

PATRA, A.K., TRIPATHY, S.K. and SAMUI, R.C. 1998. Growth of summer groundnut in relation to sowing date, irrigation and spacing. *J. Oilseeds Res.* 15(2): 303-306.

Experiments conducted during summer 1993 and 1994 at Kalyani, West Bengal revealed that 15 March sowing recorded high LAI, CGR and LAD upto 70 DAS. Sowing on 15 February enhanced pod yield by 22.9 and 26% over 15 January and 15 March sowings. Growth attributes like LAI, CGR and

LAD increased with increase in irrigation frequency. Moisture stress at pod development stage and both at pod initiation and development stages reduced pod yield by 13.4 and 44.2%, respectively. Higher pod yields were obtained with 25x12cm than with 50x6 cm spacing.

PRAMILA RANI, B and RAMANA, M.V. 1998. Relative performance of herbicides in soybean (*Glycine max*). *J.Oilseeds Res.* 15(2): 307-309.

Field experiment conducted during *kharif* 1993 and 1994 on black soils showed that pre-emergence application of clomozome 1.0 kg/ha gave higher yield of soybean (751Kg/ha) and better weed control efficiency (49.9%) followed by alachlor 2 kg/ha and fluchloralin 1kg/ha. Weed free check recorded maximum yield (877 kg/ha) and weed control efficiency (92.1%).

DAS, T.K. 1998. Studies on the performance of some new mustard genotypes under irrigated condition. *J. Oilseeds Res.* 15(2): 310-314.

Several new mustard genotypes were evaluated for their productivity at IARI, New Delhi during *rabi* 1994-95 and 1995-96. Sowing on 27 October gave significantly higher grain yield, oil content and oil yield of genotypes than delayed sowing on 27 November. In 1994-95 Early flower I and Early flower -II had significantly lower oilcontent than Pusa Bold, Jaikisan and PR-45 but in per hectare oil yield they were all comparable. The cultivar Simple leaf although showed superiority in terms of light interception, LAI, no of fruiting branches/pl, number and weight of siliqua/pl and grain yield/pl in 1995-96, its oil content and oil yield were significantly lower than other genotypes except Early flower I and Early flower II.

SESHA SAILA SREE, P and GOPALA RAO, P. 1998. Response of groundnut to irrigation schedules based on IW/CPE ratios. *J.Oilseeds Res.* 15(2): 315-319.

Field experiment conducted on sandy loam soils of Tirupati showed that plant height, LAI, drymatter production varied significantly due to depth of irrigation and IW/CPE ratios. Irrigation at IW/CPE ratio of 0.5 with 7cm depth resulted in early flowering while 5cm depth with 1.0 IW/CPE ratio gave more number of filled pods, volume - weight of pods, shelling %, higher pod weight and kernel weight. Highest pod yield was obtained with 5cm depth (25.5q/ha) and 1.0 IW/CPE ratio (28.7 q/ha) and their interaction (32.1q/ha).

ARUNA KUMARI, CH. and GOPAL SINGH, B. 1998. Ethrel effects on total phenol content in sunflower. *J. Oilseeds Res.* 15(2): 320-323.

Studies on the effect of preharvest spray of ethrel (2-chloro ethyl phosphonic acid) on total phenol content in Sunflower revealed that its content decreased with increase in the concentration of ethrel in pericarp and embryo. Ethrel at 250 ppm was more effective in decreasing the total phenol compared with 75 and 150 ppm ethrel sprays. An inverse relationship was observed between germination and phenol content in achenes. The cultivar SS-56 responded better to ethrel than Morden.

ARPITA ROY., BHAT, N.S. VIRUPAKSHAPPA, K and KUBERAPPA, G.C. 1998. Preferential visits of honey bee species to male sterile and male fertile lines of sunflower. *J. Oilseeds Res.* 15(2): 324-328.

The activity of 4 honey bee species *Apis dorsata, A. cerana, A.mellifera* and *A. florea* was studied on male sterile and male fertile line of sunflower at Bangalore. It was observed that *A. cerana* was predominent (63%) in the FN and *A.mellifera* in the AN (47-86%). On male fertile line *A. dorsata* and *A.cerana* were more active in the morning (37-40%). The distribution of these honey bee species on CMS and maintainer lines planted in 3:1 row proportion showed distinct patterns. Barring *A.cerana*, other species visited maintainer lines more number of times than CMS lines. The time of the day did not influence the frequency of visit of bees to these lines. There was no definite influence of pollen parent rows on bee visits to male sterile rows.

JYOTI SINGH., SRIVASTAVA, S.K. and RAJENDRA SINGH. 1998. Effect of planting dates on occurance of disease - pests in mustard varieties. *J.Oilseeds Res.* 15(2): 329-333.

Four Indian mustard varieties were tested for disease and pest reaction and grain yield in relation to sowing dates during 1991-92 and 1992-93 at Kanpur. It was observed that early sowing on 30 September recorded lowest disease and pest scores with highest grain yield than late sowings. The incidence of *Alternaria* blight and sawfly decreased in late sowing on 15 Nov. Rohini was the most tolerant variety to *Alternaria* blight, while Vardan and Varuna were tolerant to white rust. Varuna was least prefered by aphids and leaf miner, while Rohini was most susceptible to aphids. Vaibhav was most tolerant to sawfly. Variety Rohini gave the highest grain yield (12.25q/ha) followed by Vaibhav (11-92q/ha), Varuna (10.65 q/ha) and Vardan (10.25q/ha).

SUKANTA DASGUPTA and RAJ, S.K. 1998. Biological control of collar rot (Aspergillus niger Var. Teighem) of groundnut. *J.Oilseeds Res.* 15(2): 334-338.

Studies made at Mohanpur (W.Bengal)on biocontrol of collar rot showed that *Trichoderma harzianum* was found to inhibit the growth of two virulant isolates (soil isolate 16 and seed isolate 24) of *A.niger* by 63 and 58% respectively after 72 hrs of incubation in dual culture in petriplates. In different soil environments collar rot disease incidence was more in autoclaved soil. Seed treatment with *T. harzianium* after storing upto 5 months reduced collar rot incidence when inoculated with *A.niger*.

SADHANA KUMARI and SNEHALATHA REDDY. 1998. Oil and protein quality of the selected groundnut varieties. *J.Oilseeds Res.* 15(2) : 339-342.

A study was made at Parbhani to evaluate the quality of oil and protein content of some groundnut cultivars. It was observed that the protein content and digestibility of proteins were markedly high in PBNG-6 as compared to other Varieties, while the oil content was maximum in the check variety M-13. Wide variations were observed in the fatty acid composition of oils of the 4 varieties and in the ratio of oleic to linoleic acid.

KARAN SINGH and VARMA, O.P 1998. Genetic behaviour of yield and its components in Indian mustard (*Brassica juncea* L. Czern & Coss). *J. Oilseeds Res.* 15(2): 343-344.

The estimatis of Gca effects revealed that parents RH 8814, RK 8902 and KBJ-15 are the best generel combiners for seed yield and yield components like primary branches, secondary branches and oil content. RSK 28 and NDR- 281 are best generel combiners for earliness. While the lines DIR 463, JMM 1628 are better for test weight and oil content. The cross RH 8814 x PR 8801 and JMM1628 x DIRA 313 were the best involving high x high general combiner parents and exhibited greater mean performance for yield and test weight.

VASANTHI, R.P. HARINATHA NAIDU, P. and SUDHAKARA RAO, A. 1998. Genetic Variability and correlation of yield, component traits and foliar disease resistance in groundnut. *J. Oilseeds Res.* 15(2): 345-347.

Studies conducted at Tirupati showed that late leaf spot and rust severities showed high heritability of 96.5 and 93.2% respectively coupled with high genetic advance (69.0 and 72.5% respectively). The late leaf spot and rust severity showed significant negative association with days to 50% flowering, days to maturity and haulm weight/plant. High *GCV*, h^2 and GA for late leaf spot and rust severities indicate additive gene action which is amenable for selection for resistance to these diseases.

CHANDRA SHEKHAR MAHTO and RAHMAN, M.H. 1998. Correlation and path analysis of some quantitative characters in linseed. *J. Oilseeds. Res.* 15(2): 348-351.

The results showed that most of the yield component characters showed a strong positive correlation with seed yield. Days to 50% flowering, days to maturity and seeds/capsule were negatively associated with seed yield at genotypic and phenotypic level. It was suggested that for improvement of linseed emphasis should be laid on capsules/plant and no. of branches/plant as selection criteria for seed yield.

AVILKUMAR, K and REDDY, M.D. 1998. Effect of dates of sowing on performance of Toria (*Brassica campestris* Var. Toria) in non-traditional area. *J. Oilseeds Res.* 15(2): 352-354.

Field studies conducted during post rainy seasons of 1993-94 through 1995-96 showed that sowing on 19 October gave significantly higher yield than 4 October and 5 November. The increase in seed yield in 19 October sowing was 57% and 167% over 4 October and 5 November. Among *toria* cultivars PT-303 gave significantly higher seed yield (17%) over Bhavani (508kg/ha).

DEEKSHITULU, V.V.R., SUBBAIAH, G., RAGHAVAIAH, R.V. and MEVSINGH. 1998. Effect of nitrogen sulphur on seed yield, oil content and oil yield of Indian mustard. *J. Oilseeds Res.* 15(2): 355-356.

Field experiment conducted during 1994-95 at Bapatla showed that the highest levels of nitrogen (150 kg N/ha) and sulphur (50 kg S/ha) resulted in higher seed yields than their respective lower doses. The oil content decreased with increase in the nitrogen level, while sulphur application had a favourable effect on oil content. Higher net returns and B:C ratio were obtained with higher doses of N and S.

SHRIVASTAVA, G.K., KHANNA, P and TRIPATHI, R.S. 1998. Response of sunflower (*Helianthus annuus* L)cultivars to nitrogen and sowing time. *J.Oilseeds Res.* 15(2): 357-359.

Experiments conducted in Madhya Pradesh on sunflower showed that seed yield of sunflower declined with delay in sowing beyond 30 December. The crop responded upto 100 kg N/ha. The hybrid IAHS-1 gave significantly higher seed yield than the variety Morden.

YADAV, N., TIWARI, O.P and SHRIVASTAVA, G.K. 1998. Influence of nitrogen and row spacing with different intercrops on growth and nitrogen uptake of sunflower. *J.Oilseeds Res.* 15(2): 360-362.

Studies made in rice fallows during January - April 1996 at Raipur (MP) with 4 row spacings and 3 N levels revealed that application of 80 kg N/ha resulted in higher uptake of N over 40 or 60 kg N/ha. The light transmission ratio decreased with increasing N levels. Sole sunflower spaced at 60cm absorbed higher amount of N and sole sunflower sown at 50cm absorbed the lowest. Sunflower spaced at 60cm and intercropped with bottle gourd (3:1) had higher uptake of N than sunflower spaced at 60cm and intercropped with *palak* (1:1).

SARAWGI, S.K and TRIPATHI, R.S. 1998. Yield and economics of soybean (*Glycine max* L.) varieties in relation to phosphorus level. *J.Oilseeds Res.* 15(2): 363-365.

Field studies made during *kharif* 1995 at Raipur (M.P) with 3 phosphorus levels and 5 varieties of soybean showed that pods/plant and seed yield increased significantly with increasing level of phosphorus from 30 to 60 kg P_2O_5/ha. Application of 60kg P_2O_5/ha provided maximum net return of Rs 15036/ha with B:C ratio of 1.97. The variety JS 335 gave significantly higher number of pods/plant, grains/pod and grain yield than rest of the varieties. Maximum return (Rs 18018/ha) with higher B:C ratio (2.36) and harvest index was recorded in JS335 followed by PK-472.

SINGARAVEL, R and GOVINDASAMY, R. 1998. Effect of humic acid, nitrogen and biofertilizer on the growth and yield of sesame. *J.Oilseeds Res.* 15(2): 366-367.

A field experiment was conducted at Neyveli (T.N) during *summer* 1990. The results revealed that combined application of 30 kg N/ha and humic acid @20 kg/ha was beneficial for enhancing the growth, yield attributes and seed yield of sesame under irrigated condition.

ANSARI, M.M., RAMESH, A. and BILLORE, S.D. 1998. Effect of different organic manuares on the collar rot (*Sclerotium rolfsii*) incidence and yield in soybean. *J.Oilseeds Res.* 15(2): 368-370.

The effect of different organic manures like FYM, gobargas slurry, poultry manure and urban compost on the incidence of collar rot was studied at NRCS, Indore (MP). It was observed that application of FYM had a significant effect on collar rot incidence vis-a-vis other sources at all the levels of application. Significantly lower yield of soybean was obtained with FYM application which was at par with urban compost and gobargas slurry. Irrespective of the source of organic manure, there was enhanced yield with increasing dose of manure.

MAHALANOBIS, D and MAITI, D. 1998. Effect of different levels of nitrogen and phosphorus on yield and yield attributes of groundnut intercropping. *J. Oilseeds Res.* 15(2): 372-374.

Groundnut was intercropped with sesame in 2:1 and 1:2 proportions under 4 levels of nitrogen and phosphorus during *kharif* 1993 and 1994 at Mohanpur (W.Bengal). It was found that intercropping groundnut in 2:1 ratio gave significantly higher yield than 1:2 ratio. The crop responded upto 60N+50P. The increase in pod yield over control was 36.3, 58.8 and 53.5 percent at 30N + 25P, 60N + 50P and 90N+75P, respectively. There was significant increase in oil content upto 90N+75P.

BABY AKULA and BAPI REDDY, T. 1998. Effect of dates of sowing on yield of caster cultivars. *J. Oilseeds Res.* 15(2): 375-376.

Field study carried out during *kharif* 1995 at Palem (A.P) with 5 dates of sowing (15 June, 30 June, 15 July, 30 July and 18 August) and 4 cultivars (Aruna, Kranti, Jyoti, and GCH-4) showed that 15 June sowing gave higher yield than delayed sowings. This was due to more effective spikes, lengthy spikes and favourable female: male flower ratio in primary spike. Among cultivars GCH-4 gave significantly higher yield (1589 kg/ha) than the other cultivars.

YADAV, N., TIWARI, O.P. and SHRIVASTAVA, G.K. 1998. Response of spring sunflower (*Helianthus annuus*) to nitrogen and row spacing with different intercrops for rice fallows of Eastern Madhya Pradesh. *J. Oilseeds Res.* 15(2): 377-378.

The results showed that sunflower spaced at 60cm produced higher grain yield. Sunflower intercropped with bottlegourd in 3:1 ratio produced significantly higher grain yield than sunflower + palak 1:1. Application of 80 kg N/ha resulted in higher yield attributes and yield of sunflower, palak and bottegourdd over 40 and 60 kg N/ha. Sunflower + Palak 1:1 provided highest net return (Rs 14879/ha).

SUBBIREDDY, C and RAMACHANDRA REDDY, P. 1998. Performance of mustard varieties on alfisols of Rayalaseema region of A.P. *J. Oilseeds Res.* 15(2): 379-380.

Nine mustard cultivars were tested to assess their performance in the tropical belt of Rayalseema (A.P) during 1993 through 1995. It was observed that the cultivars exhibited differential performance in all the years of testing. Mean data of 3 years showed that TM-2variety gave highest seed yield (882 kg/ha) followed by 4C-6-3/2 (806 kg/ha) and Divya (771kg/ha), while minimum yield was obtained with PT-303 (498 kg/ha).

MALLIKARJUNA, K., DEVAKUMAR, N., CHALAPATHI, M.V. and ANDANIGOWDA. 1998. Performance of sunflower as influnced by levels of phosphorus and enriched FYM. *J. Oil seeds Res.* 15(2): 381-382.

Experiment conducted during *kharif* 1996 at Bangalore on alfisols indicated that application of 50% recommended dose of P through SSP and 50% through enriched FYM gave significantly higher seed yield of sunflower (2286 kg/ha) than the recommended SSP alone (1646 kg/ha). This treatment also resulted in higher oil yield (877 kg/ha) than the SSP alone.

VASANTHI, R.P., HARINATHA NAIDU, P. and SUDHAKAR RAO, A. 1998. Inter relation among yield, yield attributes and late leaf spot severity in groundnut. *J. Oilseeds Res.* 15(2): 383-385.

A set of 35 groundnut genotypes developed at Tirupati and ICRISAT were tested during *kharif* 1993 and 1994. It was observed that late leaf spot severity showed a negative association with 100 pod and 100 kernel weight. 100 pod weight has high positive influence on pod yield followed by 100 kernel weight. To improve existing varieties for pod yield and resistance to late leaf spot, there isa need to break the negative correlation between late leaf spot severity and 100 pod and 100 kernel weight.

MANISEGARAN, S., MANIMEGALAI, N., VENKATESAN, S and DHARMALINGAM, V. 1998. Efficacy and economics of certain plant products on the control of sesame shoot webber (*Antigastra catalaunalis*). *J. Oilseeds Res.* 15(2): 386-389.

Afield experiment with 8 plant derivatives was carried out to study their efficacy in controlling *A. catalaunalis* in sesame at Vriddhachalam (TN). It was observed that regardless of sprays, all plant products and endosulfan recorded significantly less pod damage than untreated control during 1995. While in 1996 neemoil treatment alone recorded least pod damage. During 1995 endosulfan recorded maximum seed yield (669kg/ha) which was on par with neemoil (650 kg/ha)and Kemisol (630 kg/ha). During 1996 endosulfan alone gave the highest yield of 723 kg/ha.

SHERASIYA, R.A and BUTANI, P.G. 1998. Assessment of avoidable yield loss due to insect pests in groundnut. *J. Oilseeds Res.* 15(2): 390-392.

The results showed that the incidence of various sucking and cutting pests was significently greater in unprotected crop as compared to protected crop. This resulted in lower yields in unprotected crop. Protected crop recorded an average yield of 16.61 q/ha, while unprotected one gave 10.08 q/ha. The estimated avoidable loss of groundnut yield in unprotected treatment was 39.3%, which exeeded the economic loss of 11.82% as calculated on the basis of grain threshold (0.78q/ha) and state average yield of 6.6q/ha. The high incidence of insect pests in unprotected crop caused 43.54% loss in fodder yield.

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