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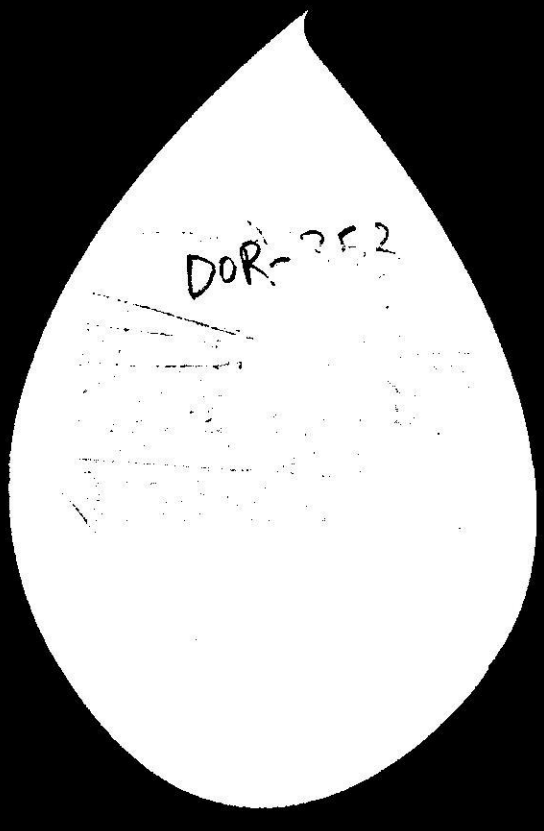

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Announcements

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GENETIC ANALYSIS OF CARBON ISOTOPE DISCRIMINATION AND SPECIFIC LEAF AREA IN GROUNDNUT. *(Arachis hypogaea L.)* *

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ABSTRACT

Combining ability analysis of a seven parent half-diallel set of groundnut indicated predominant additive genetic effects for carbon isotope discrimination Δ and specific leaf area (SLA). Parental genotypes ICG 2716 and TMV2-NLM for Δ and TMV2-NLM and ICGV 86031 for SLA were identified as good general combiners with high mean *per se* for respective characters. Carbon isotope discrimination exhibited a significant positive genotypic association with SLA in parents and hybrids. SLA and Δ had positive association with harvest index. Δ exhibited a significant negative association with root drymass. The study indicated the need for careful consideration of association between traits conferring water use efficiency and harvest index/kernel yield inbreeding programmes intended to improve drought tolerance of groundnut genotypes.

Key words: Carbon isotope discrimination, Specific leaf area, Combining ability, Groundnut.

INTRODUCTION

High yielding genotypes better adapted to limited water environments could be bred more efficiently if attributes that confer drought resistance could be identified and used as criteria. Water use efficiency (WUE) is one of the traits that can contribute to productivity when water resources are scarce. Genotypic variation in WUE has not been easily or efficiently exploited due to the difficulty in the direct assessment of WUE under field conditions. Groundnut is one among a number of C3 species for which a negative relationship between WUE and carbon isotope discrimination has been demonstrated across a range of Genotypes (Farquhar and Richards., 1984, Hubick *et al.;* 1986 and Wright *et al.*, 1988). Further it has been observed that specific leaf area (SLA) is closely and negatively correlated with WUE and also that SLA and Δ are positively correlated (Wright *et al;* 1988 and Nageswara Rao and Wright, 1994). The Potential value of specific traits in breeding for WUE will greatly be enhanced if information is generated on their genetic architecture with the help of appropriate genetic anaylsis, a prerequisite to designing more efficient breeding methodologies. Therefore the present investigation was taken up to study nature of gene action by combining genetic ability analysis and genetic associations of Δ/SLA with other desirable and undesirable attributes.

MATERIALS AND METHODS

Twenty one crosses in a non-reciprocal diallel set with seven parents Viz. ICG 2716, ICGV 86031, TAG 24, TG 26, Tirupati 1, JL 24 and TMV2-NLM were evaluated in F1 generation in a randomized block design with three replications during the rainy season of 1995 at the S.V. Agricultural College Farm, Tirupati. Observations were recorded on five randomly selected plants in each of the three replications.

Data were obtained for shoot biomass per plant, root dry mass, harvest index and kernel yield per plant besides carbon isotope discrimination Δ and specific leaf area (SLA). For SLA and Δ measurements, sampling was done at 75 days after sowing. In each genotype 20 fully expanded 3rd

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or 4th leaf (from main stem apex) from randomly selected plants were sampled. SLA was calculated as the ratio of the leaf area to the oven dry weight of leaf sample and was expressed in cm^2g^{-1}. Δ values in ground leaf samples were measured by ratio mass spectrometry at the Australian National University, Canberra, Australia using techniques described by Hubick *et al.*, (1986).

Combining ability analysis was done as per Model 1 and Method 2 of Griffing (1956). Heritability in narrow sense was calculated according to Gardner (1963). Genotypic and Phenotypic correlations were calculated as per Johnson *et al* (1955). The significance of correlation co efficients was tested by comparing the observed values with the table value of correlation coefficients given by Fisher and Yates (1963) for(n-2) degrees of freedom.

RESULTS AND DISCUSSION

Analyses of variance broughtout highly significant differences for carbon isotope discrimination Δ and specific leaf area (SLA) among 28 genotypes (seven parents and 21 F1 hybrids). Combining ability analysis indicated that mean squares due to general combining ability (*gca)* alone were significant for Δ and SLA (Table1). A successful breeding programme for improving water use efficiency (WUE) in groundnut based on selection for low Δ values requires a better knowledge of nature of gene action in the inheritance of this trait. The component of variation due to *gca* was higher than that due to *sca* for both Δ and SLA. This reveals the preponderance of additive gene actions in the genetic control of those traits. Heritability (in narrow sense) was found to be high in case of Δ (0.62) as well as SLA (0.51).

The largely additive gene effects and high heritability values for these traits suggest that selection may be effective for these characters in early generations. Al Hakimi *et al.* (1996) and Ehdaie and Waines (1994) in wheat obtained intermediate heritability (narrow sense) values for Δ and they indicated that response to selection in segregating populations under field condition should be effective while in cowpea, Menendez and Hall (1995) observed heritability (realized) values that were lower and concluded that family selection in advanced generations may be more appropriate than F2 selection.

The breeding potential of seven parents was ascertained based on generalcombining ability effects and *per se* performance (Table2). TMV2 - NLM for Δ and SLA, ICG 2716 for Δ and ICGV 86031 for SLA were found to be promising. Since, high *gca* effects are due to additive and additive x additive gene action, they can be readily exploited in breeding programmes (Griffing, 1956).

Further selection based on Δ /SLA requires a good knowledge of eventual relationship between Δ /SLA and other morphological and physiological attributes besides yield *per se.* Character association analyses indicated a

Table 1 : Mean squares, components of general and specific combining ability variances and heritability (in narrow- sense) for carbon isotope discrimination D and specific leaf area (SLA) in 7 parents and 21 F1, hybrids of groundnut.

Source	Degrees of freedom	Carbon isotope discrimination Δ	Specific leaf area (SLA)
gca	6	1.349**	717.147**
sca	21	0.087	71.256.
Error	54	0.086	59.491
σ^2gca		0.140	73.073
σ^2sca		0.001	11.766
h^2(narrow-sense)		0.62	0.51

**Significant at $P \leq 0.001$

significant positive association between Δ and SLA at genotypoic level in parents (rg=0.482) and Fls (rg = 0.547). The magnitude of genotypic correlations were higher than the corresponding phenotypic correlations between the pairs of characters under study. This indicates that the phenotypic expression of correlation is lessened under the influence of envioronment. Wright *et al.*, 1988; Nageswara Rao and Wright, 1994 and Wright *et al.*, 1993 observed that SLA was extremely well correlated with WUE and Δ over a wide range of cultivars and environments. They suggested SLA as an even more rapid and inexpensive technique for selection for WUE, especially indeveloping countries where access to, and resources to purchase and maintain, mass spectrometers are limited. Δ also exhibited a strong negative relationship with shoot biomass and root dry mass. Hubick *et al.*, (1988) also reported a moderate negative correlation between top dry weight and Δ in groundnut and suggested that variation in photosynthetic capacity is the predominant source of variation in Δ groundnut. White (1993) in common bean genotypes found that extent of rooting was positively correlated with Δ and it is suggestive that any positive genetic correlation between Δ and the extent of rooting would tend to constrain breeding to water limited environments, where deep rooting and high water use are adaptive. However, in this study, a negative correlation between Δ and root dry mass was observed. Δ and SLA exhibited a strong positive relationship with harvest index in parents as well as F_1 hybrids. Similar observations were made by Hubick *et al.*, 1988 amd Wright *et al.*, 1993.

Table 2 : Mean values (in parentheses) and estimates of general combining ability effects for carbon isotope discrimination Δ and specific leaf area (SLA) in 7 parental genotypes of groundnut.

Genotype	Carbon isotope discrimination Δ x 10^3	Sepcific leaf area (cm^2g^{-1})
ICG 2716	-0.449** (17.57)	2.443 (125.70)
ICGV 86031	-0.069 (18.10)	-10.365** (98.54)
TAG 24	0.582** (19.84)	0.511 (130.65)
TG 26	0.337** (18.93)	9.732** (140.55)
Tirupati 1	-0.077 (17.96)	8.036** (146.04)
JL 24	0.140 (18.41)	3.526 (138.83)
TMV2-NLM	-0.464** (17.33)	-13.882** (99.42)
SE of G(I)	0.090	2.380
SE of G(I) - G (J)	0.138	3.636

** Significant at $P \leq 0.01$

SLA exhibited a significant and positive association with kernel yield in parentsand F_1 hybrids. However, a positive relationship between kernel yield and Δ was observed in F1 hybrids but not in parental genotypes. Positive correlation between Δ and kernel yield were observed in groundnut (Hubick *et al.*, 1988) and wheat (Ehdaie *et al.*, 1991) while no such association between Δ and yield were reported in groundnut by Wright *et al.* (1993) and in wheat by Matus *et al*, (1997). Some workers interpret these inverse relationships between Δ and yield as a function of whether Δ is changing as a result of photosynthetic capacity and / or stomatal limitation (Hubick *et al.*, 1986 and Morgan *et. al*, 1993).

This study highlights that the association between traits conferring drought tolerance and kernel yield or harvest index should be considered carefully in breeding programmes intended to improve drought tolerance of groundnut genotypes as several researchers demonstrated that the development of low partitioning lines for drought tolerance will have an yield cost especially when drought does not occur.

Table 3 : Phenotypic (P) and genotypic (G) correlation coefficients between carbon isotope discrimination Δ, specific leaf area (SLA) and other attributes in groundnut.

Characters			Specsific leaf area (SLA) ($cm^2 g^{-1}$)	Shoot biomass/ plant (g)	Root dry mass (g/plant)	Harvest index (HI)	Kernel yield/ plant (g)
Carbon isotope	Parents	P	0.339	-0.522**	-0.412	0.665**	0.138
deiscrimination Δ x 10^3		G	10.483*	-0.633**	-0.539*	0.892**	0.237
	F1	*P*	*0.254**	*-0.476***	*-0.449***	*0.496***	*0.141*
		G	0.547**	-0.848**	-0.754**	0.998**	0.519*
Specific leaf area (SLA)	Parents	P	1.000	-0.254	0.013	0.558**	0.531*
		G	1.000	-0.365	-0.113	0.820**	0.868**
	F1	P	1.000	-0.077	0.011	0.313*	0.334**
		G	1.000	-0.297*	-0.050	0.524**	0.484**

* Significant at P $\leq$ 0.05, ** Signinicant at P $\leq$ 0.01

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STABILITY PARAMETERS IN SAFFLOWER *(Carthamus tinctorius L.)**

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ABSTRACT

The phenotypic stability of 35 genotypes of safflower grown over eight environments was studied for six characters, viz. No. of primary branches/ plant, No. of secondary branches/plant, No. of capitula/plant, No. of seeds/capitulum, 100-seed weight and yield/plant. Variance due to genotypes, envioronments, G x E interactions, environment (linear), G x E (linear) and pooled deviation were significant for all the characters. Both, linear as well as non-linear components of genotype x environment interaction were present for all the characters. The stability parameters revealed that, genotype Co-1 was most stable for yield. Genotypes, viz. Bhima, S-144, No. 83, APP-A-1 and 352-6 were found below average stable.

Keywords : Safflower; stability; interaction; environment; regression; phenotype; genotype

INTRODUCTION

Safflower has been gaining considerable importance in the recent past because of its superior performance under limiting moisture conditions in different parts of the country (Rao and Ramchandram, 1978). It is imperative to develop genotypes endowed with high degree of adaptability combined with superior productivity levels over a wide range of eco-geographical conditions for successfully exploiting its inherent potential. Genotype x environment interaction is supposed to be one of the genetic parameters responsible for phenotypic stability and adaptation. In the present investigation attempts were made to identify stable genotypes for yield and its components in safflower by following Eberhart and Russell (1966) stability model.

MATERIALS AND METHODS

A set of 35 genotypes of safflower was tested in randomized block design with three replications in eight environments (two locations, two seasons and two sowing dates). Each genotype at each of the locations was grown in a single row of twenty five plants spaced at 45x20 cm. Five competitive plants were selected at random to record observations on yield and its components, namely, number of primary branches per plant, number of secondary branches per plant, number of capitula per plant, number of seeds per capitulum and 100-seed weight. The stability analysis was done according to Eberhart and Russell (1966).

RESULTS AND DISCUSSION

Pooled analysis of variance (Table 1) showed that differences between genotypes and environments were highly significant indicating substantial variability among genotypes and environments. The significant genotype x envioronment interaction for all the six characters indicated that the genotypes interacted strongly with the environments confirming the earlier findings of Abel (1976), Ehadaie *et al.*, (1977), Makne and Sharma (1979) and Ranga Rao and Ramchandram (1979).

The variances due to genotype x environment (linear) were higher as compared to non-linear portion for No. of primary branches per plant, No. of capitula per plant, 100-seed weight and yield per plant. The non-linear component (pooled deviation) was significantly higher as compared to linear portion for No. of seeds per

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capitulum. These findings are in close agreement with the findings of Ehdaie *et al.* (1977) for number of capitula and seed yield per plant, Narkhede *et al.* (1984) for seed yield, Pandya *et al.* (1991) for number of seeds per capitulum and test weight.

Existence of genotype X environment interaction necessiated the computation of different stability parameters. Therefore a critical study was carried out in order to identify suitable genotype for specific environment. A knowledge of the nature and relative magnitude of genotype X environment interactions is useful in making decisions converting breeding method, selection programme and testing procedure in crop plants.

According to Eberhart and Russell (1966), a stable genotype is one which shows a high mean, unit regression coefficient and deviation from regression as small as possible. The results of the stability parameters for the six characters are presented in Table 2 and discussed below.

Number of primary branches per plant The eight genotypes, namely, GMU-179, HUS-341, Bhima, 343-12-14, 398-26-1, 484-2, KAS-1 and 179-7 possessed more number of primary branches with average responsiveness ($bi \simeq 1$)and non-significant S^2di indicating that these genotypes had average stability and wider adaptability. Genotypes, GMU-181, GMU-187, A-1, HUS-342, S-144 and 425-2-1 showed below average stability indicating their suitability for favourable environments.

Number of secondary branches per plant Genotypes, JSF-1, 398-15 and 425-2-1 exhibited significant regression coefficients with non-significant S^2di values suggesting that linear component alone was responsible for almost all portion of genotype x environment interaction. Genotypes GMU-181, A-300 and S-144 were stable and had wider adaptability over different environmental conditions.

Number of capitula per plant Two gentoypes, viz. GMU-179 and GMU-181 manifested more number of capitula, ($bi \simeq 1$) and non-singnificant S^2di, thus were considered average stable for this trait. Genotypes JSF-1, S-144 and 425-2-1 depicted below average stability and these genotypes were better suited to favourable environments.

100 Seed Weight The genotype JSF-1 was found with wider adaptability because of high mean with average responsiveness and least deviation from

Table 1. Analysis of variance when stability parameters are estimated

Source	d.f.	No. of primary branches per plant	No. of secondary branches per plant	No. of capitula per plant	No. of seeds per capitulum	100-seed weight	Yield per plant
Genotypes	34	2.002**	65.010**	79.321**	36.230**	3.197**	60.827**
Environments	7	44.928**	1145.300**	1234.959**	373.637**	6.830**	933.910**
G X E	238	0.905**	13.150**	15.533**	14.492**	0.353**	11.094**
Environment (Linear)	1	314.498**	8017.062**	8644.635**	2615.439**	47.809**	6537.390**
G X E (Linear)	34	1.512**	29.856**	32.599**	9.570**	0.493**	32.607**
Pooled deviation	210	0.781**	10.047**	12.327**	14.874**	0.320**	7.294**
Pooled error	544	0.534	2.218	2.695	2.127	0.101	1.922

** Significant at 1% level against pooled error.

Table 2. Distribution of various safflower genotypes in different groups

Characters	Average stable	Below average stable	Above average stable
No. of primary branches/plant	GMU-179 ($\bar{X}$=7.64; bi=o.67 and S^2di=0.42) ;	GMU-181 (bi-1.19*) ;	
	HUS-341 ($\bar{X}$=8.03);bi=1.05 and S^2di=0.87) ;	GMU-187 (bi-1.25*) ;	
	Bhima ($\bar{X}$=7.68; bi-0.77 and S^2di=0.16) ;	A-1 (bi=1.54**) ;	
	343-12-14 ($\bar{X}$7.23; bi-1.01and S^2di=0.16) ;	HUS-342 (bi=1.23*) ;	
	398-26-1 ($\bar{X}$=7.28; bi=1.17 and S^2di=0.53) ;	S- 144 (Bi - 1.31**) ;	
	484-2 ($\bar{X}$=7.26; bi = 1.06 and S^2di=0.47) ;	425-2-1 (bi=1.69**)	
	KAS-1 ($\bar{X}$=7.14 ; bi -0.81 and S^2di= 0.93) ;		
	179-7 ($\bar{X}$=7.32; bi=1.04 and S^2di= 0.60) ;		
	CO-1 ($\bar{X}$=6.23; bi-0.60 and S^2di= 0.46) ;		
No.of secondary branches/plant	GMU-181 ($\bar{X}$=2.30; bi=1.06 and S^2di=2.67) ;	JSF-1 (bi = 1.29**)	398.15 (bi=0.57**)
	A-300 ($\bar{X}$=19.00; bi = 0.93 and S^2di=3.71)	425-2-1 (bi=1.35*)	
	S-144 ($\bar{X}$=20.68; bi-1.22 and S^2di=3.32)		
No. of capitula/ plant	GMU-179 ($\bar{X}$22.56; bi-0.96 and S^2di=4.51) ;	JSF-1 (bi=1.28**)	
	GMU-181 ($\bar{X}$21.67; bi=1.04 and S^2di=2.87)	S-144 (bi=1.28**)	
		425-2-1 (bi=1.36**)	
No.of seeds/ capitula	Bhima ($\bar{X}$15.74; bi=1.17 and S^2di=-2.34)	A-300 (bi=1.30*)	GMU-178 (bi=0.52*)
	No.83 ($\bar{X}$14.71; bi=1.27 and S^2di=3.56)	App-A-1 (bi=1.41*)	
100-seed weight	JSF-1 ($\bar{X}$=3.81; bi=1.39 and S^2di=0.11)	HUS-342 (bi=1.18*)	GMU-186 (bi=0.34**)
		Tara (bi=1.70*	Bhima (bi=0.82*0
			S - 144 (Bi = 0.10**)
Yield per plant	CO-1 ($\bar{X}$11.17; bi=1.11 and S^2di=2.08)	Bhima (bi=1.44**)	
		S-144 (bi=1.27**)	
		No.83 (bi=1.82**)	
		App-A-1 (bi=1.36**)	
		352-6 (bi=1.53**)	

* and ** indicate significance at 5% and 1% levels, respectively

regression. Genotypes HUS-342 and Tara showed below average stability. Genotypes, GMU-186, Bhima and S-144 depicted above average stability suggesting that these genotypes were less sensitive to changing environments and showed their suitability for low yielding environments.

Number of seeds per capitulum Genotypes Bhima and No. 83 exhibited average stability with high mean performance, whearas genotypes A 300 and APP-A-1 displayed below average stability. The GMU-178 had more number of seeds per capitulum with above average stability and less sensitivity to environmental changes.

Yield per plant Only one genotype Co 1 was considered as stable since it had high mean ($\bar{X}$ =11.17 g), near unity regression coefficient (bi=1.11) and least deviation from regression (S^2di=2.08), accompanied with average stability for number of primary branches per plant. The genotypes 18-66-1 and 179-1 were also average stable, but were low yielders. The genotypes vi. Bhima, S-144, No. 83, APP-A-1 and 352-6 had high mean with high responsiveness and non-significant deviations from regression indicating below average stability and were suitable for high yielding environments. Thus, it was evident that stability parameters varied from genotype to genotype for various characters. Not a single genotype showed average stability for all the characters studied.

The knowledge of stability is of utmost importance to plant breeder, who is concerned with the development of potential genotypes which could express their consistant superiority over a range of environments.

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INHERITANCE OF CANOPY COMPACTION IN GROUNDNUT (*Arachis hypogaea* L.)

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ABSTRACT

Genetics of canopy compaction was studied in 45 crosses involving the genotypes categorised for canopy development as compact (1), medium compact (2), medium spreading (3) and spreading (4). Results revealed that trigenic segregation pattern was in a greater proportion for extreme canopy types (1 and 4). The digenic segregation was observed in crosses with intermediate parental canopy (2 and 3) combinations (70%) as well as extreme canopy (1 and 4) types (30%). while monogenic segregation was confined only to the crosses involving both the parents with intermediate canopy development (2 and 3). The study clearly indicated that the intermediate canopy types represent the intermediate levels of genetic divergence, while the extreme canopy types seemed to be characterised by the genetic modifiers including zygotic and developmental lethals.

Key words: *Arachis hypogaea* L, Canopy category, Genetic divergence.

INTRODUCTION

The cultivated groundnut offers clear cut and perceptible levels of variability for canopy development including branching and leaf type. In view of this seemingly discontinuous variation available, there have been a number of investigations to work out and understand the mode of inheritance of various components of canopy development (Hammons, 1973b and Wynne andCoffelt, 1982). By and large, monogenic inheritance has been attributed to branching pattern (Schori and Ashri, 1970; Balaiah *et al.*, 1977 and 1984 and Jadhav and Shinde, 1979) and leaf type (Hammons, 1964; Bhide and Desale, 1970; Balaiah *et al.*, 1977; Branch, 1987 and Desale, 1987). However, the information on mode of inheritance of different characters influencing canopy development is not available. Nagabhushanam and Prasad (1992) reported the categorisation of groundnut genotypes into compact (1), medium compact (2), medium spreading (3) and spreading (4) based on canopy development, irrespective of their taxonomic position. Their studies indicated that the canopy growth could be related to the agronomic potential of groundnut crop. They observed higher levels of yield stability in the intermediate canopy types than in the extreme canopy types. In the present investigation, an attempt was made to understand the genetics of canopy compaction in groundnut by utilizing the genotypes categorised for canopy development by Nagabhushanam and Prasad (1992).

MATERIALS AND METHODS

Forty five crosses were made involving a wide range of parents (Table 1) previously categorised for canopy development at 60 days of growth (Nagabhushanam and Prasad, 1992) into four categories, compact (1), medium compact (2), medium spreading (3) and spreading (4). The study was carried out at the College Farm, Rajendranagar, Hyderabad. The F_1 plants were space planted and categorised for canopy development by measuring canopy circumference and diameter at 60 days as per the procedure of Nagabhushanam and Prasad (1992). Seeds were harvested separately from each F_1 plant.

The F_2 generation of 45 crosses were grown in a Randomized Complete Block Design with two

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replications. The inter and intra - row spacings adopted were 60 cm and 20cm, respectively. At 60 days duration of the crop, each F_2 plant was categorised for canopy development as above. The F_2 phenotypic frequencies were tested for goodness of fit to genetic hypothesis by means of Chi-square analysis of 45 F_2 progenies (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

The results obtained indicated the universal dominance of canopy category 4 (spreading) over the rest (Table 2). In respect of combinations not involving canopy category 4 (spreading), F_1 exhibited a canopy category 3 (medium spreading) indicating its dominance over 1 (compact) and 2 (medium compact), barring a few exceptions of occurrence of F_1 with canopy category 2 in the case of certain 2 x 3 canopy combinations (PGNI X TAP5, TMV2 X TAP5, JL24 X TAP5, J11 X TAPS and PI 350680 X TAP5). The segregation pattern in respect of the crosses studied was not uniform. Most of the crosses involving MH2 (compact - category 1) and M13 (spreading - category 4) segregated for canopy spread in F_2 generation trigenically (Table 2).

The crosses involving TMV2NLM (category 3), TAP5 (category 3), GNLM (category 3) 32-2-5 (category 3), and MH2BC28 (category 2) as one of the parents predominantly exhibited a digenic segregation involving duplicate and complementary factors (Table 2). The crosses which segregated monogenically for canopy spread in F_2 consisted of largely 32-2-5 (category 3), TAP5 (category 3) and TMV2NLM (category 3) as one of the parents.

The trigenic inheritance was observed in respect of 10 crosses out of which seven involved combinations of extreme canopy types such as 1x 4, 1 x 3, 1 x 2 and 2 x 4 and there were also combinations involving intermediate canopy types

Table - i : Experimental Material

Name of the Genotype	Botanical Group	Canopy Category	
MH2	*Valencia*	Compact	(1)
J11	*Spanish*	Medium Compact	(2)
JL24	*Spanish*	Medium Compact	(2)
PGNI	*Spanish*	Medium Compact	(2)
TMV2	*Spanish*	Medium Compact	(2)
MH2BC28	*Valencia*	Medium Compact	(2)
G201	*Virginia* bunch	Medium Compact	(2)
PI 259747	*Valencia*	Medium Compact	(2)
PI 350680	*Valencia*	Medium Compact	(2)
TAP 5	*Valencia*	Medium Spreading	(3)
MK 374	*Virginia* bunch	Medium Spreading	(3)
TMV2NLM	*Virginia* bunch	Medium Spreading	(3)
32-2-5	*Virginia* bunch	Medium Spreading	(3)
GNLM	*Virginia* bunch	Medium Spreading	(3)
Kadiri -3	*Virginia* bunch	Medium Spreading	(3)
M13	*Virginia* runner	Spreading	(4)
ICG 2271	*Virginia* runner	Spreading	(4)

such as 2x2, 3x2, 3x3 (Table 3). In other words, a large proportion of these crosses involved extreme canopy types as one of the parents and only one-third of the crosses involved both parents with intermediate canopy development.

Examining the cross combinations resulting in digenic segregation pattern, it could be observed that sixteen (around 70%) out of 23 such crosses formed combinations involving both parents of intermediate canopy types such as 2 and 3. Considering the crosses segregating monogenically in F_2, it could be observed that all the cross combinations involved both the parents with only intermediate canopy development and practically without even a single parent of extreme canopy type.

It is very interesting to note that the trigenic inheritance was characterized by 70 percent of parental combinations involving extreme types and 30 percent with intermediate parental combinations (Table 3). In the digenic segregation pattern the reverse was observed with higher proportion of intermediate canopy type parental combinations (70%) and the reduction in parental combinations involving extreme types to 30 percent. As is evident from Table 3, the monogenic segregation pattern was totally characterized by parental combinations of intermediate canopy

Table 3. The crosses exhibiting monogenic, digenic and trigenic inheritance of canopy compaction in groundnut.

Monogenic		Digenic		Trigenic	
JL24x TMV2NLM	(2 x 3)	TMV2 x MH2	(2 x 1)	G201 x MH2	(2 x 1)
J11 x TMV2NLM	(2 X 3)	PGNI x MH2	(2 x 1)	MK374 x MH2	(3 x 1)
P1259747 x 32-2-5	(2 x 3)	JL24 x MH2	(2 x 1)	Kadiri-3 x MH2	(3 x 1)
JL24 x 32-2-5	(2 x 3)	G201 x JL 24	(2 x 2)	GNLM x MH2	(3 x 1)
TMV2 x 32-2-5	(2 x 3)	JL24 x MH2BC28	(2 x 2)	TMV2NLM x MH2	(3 x 1)
G201 x TAP 5	(2 x 3)	MH2BC28 X TMV2	(2 x 2)	M13 x MH2	(4 x 1)
TMV2 x TAP 5	(2 x 3)	G201 x TMV2NLM	(2 x 3)	G201 x MH2BC28	(2 x 2)
P1350680 x TAP5	(2 x 3)	TMV2 x TMV2NLM	(2 x 3)	TMV2NLM x MH2BC28	(3 x 2)
MK374 x TMV2NLM	(3 x 3)	PGNI x TMV2NLM	(2 x 3)	MH2BC28 x M13	(2 x 4)
Kadiri-3 x TAP 5	(3 x 3)	PGNI x TAP5	(2 x 3)	TMV2NLM x GNLM	(3 x 3)
GNLM x TAP 5	(3 x 3)	JL24 x TAP 5	(2 x 3)		
TMV2NLM x TAP5	(3 x 3)	J11 X TAP 5	(2 x 3)		
		Kadiri-3 x JL24	(3 x 2)		
		Kadiri-3 x MH2BC28	(3 x 2)		
		M13 X JL24	(4 x 2)		
		Kadiri-3 x TMV2NLM	(3 x 3)		
		TMV2NLM x 32-2-5	(3 x 3)		
		GNLM x 32-2-5	(3 x 3)		
		Kadiri-3 x 32-2-5	(3 x 3)		
		MK374 x TAP 5	(3 x 3)		
		M13 x TMV2NLM	(4 x 3)		
		M13 x TAP 5	(4 x 3)		
		ICG2271 x TAP5	(4 x 3)		
Percentage of intermediate canopy combinations in each model :					
100%		70%		30%	

Values in parenthesis indicate the canopy of corresponding genoytpes

Table 2. Inheritance of canopy compaction in groundnut.

Canopy cross combination	*Crosses*	Phenotypes of F_1	Phenotypic Classes in F_2	Ratio	Observed frequency in F2	Total population F2	Chi-square value	'P' value
Medium Compact X Compact (2 X 1)	*G201 x MH2*	Medium Compact (2)	Compact (1)	1	3	167	0.3530	0.900
			Medium Compact (2)	35	89			
			Medium Spreading (3)	24	63			
			Spreading (4)	4	12			
Medium Compact X Compact (2 X 1)	TMV2 X MH2	Medium Compact (2)	Compact (1)	1	14	190	0.4038	0.500
			Medium Compact (2)	15	176			
Medium Compact X Compact (2 X 1)	PGN1 X MH2	Medium Compact (2)	Compact (1)	1	28	395	0.4733	0.250
			Medium Compact (2)	15	367			
Medium Compact X Compact (2 X 1)	JL24 X MH2	Medium Compact (2)	Compact (1)	1	17	206	1.4062	0.100
			Medium Compact (2)	15	189			
Medium Spreading X Compact (3 X 1)	MK374 X MH2	Medium Spreeding (3)	Compact (1)	1	4	336	0.3463	0.950
			Medium Compact (2)	4	22			
			Medium Spreading (3)	48	252			
			Spreading (4)	11	58			
Medium Spreading X Compact (3 X 1)	Kadiri-3 X MH2	Medium Spreading (3)	Compact (1)	1	5	368	0.3688	0.900
			Medium Compact (2)	12	71			
			Medium Spreading (3)	47	267			
			Spreading (4)	4	25			
Medium Spreading X Compact (3 X 1)	GNLM X MH2	Medium Spreading (3)	Compact (1)	1	4	174	0.8269	0.750
			Medium Compact (2)	14	36			
			Medium Spreading (3)	35	94			
			Spreading (4)	14	40			
Medium Spreading X Compact (3 X 1)	TMV2NLM X MH2	Medium Spreading (3)	Compact (1)	1	3	254	0.3745	0.900
			Medium Compact (2)	23	93			
			Medium Spreading (3)	36	141			
			Spreading (4)	4	17			
Spreading X Compact (4 X 1)	M13 X MH2	Spreading (4)	Compact (1)	1	6	333	0.1682	0.975
			Medium Compact (2)	12	63			
			Medium Spreading (3)	15	79			
			Spreading (4)	36	185			

Table 2. Cont...

Table 2

Canopy cross combination	Crosses	Phenotypes of F_1	Phenotypic Classes in F_2	Ratio	Observed frequency in F2	Total population F2	Chi-square value	'P' value
Medium Compact X M. Compact (2 X 2)	G201 X JL 24	Medium Spreading (3)	Medium Compact (2)	6	67	186	0.9787	0.500
			Medium Spreading (3)	9	110			
			Spreading (4)	1	9			
Medium Compact X M. Compact (2 X 2)	G201 X MH2BC28	Medium Compact (2)	Compact (1)	1	4	153	1.2483	0.500
			Medium Compact (2)	35	81			
			Medium Spreading (3)	24	59			
			Spreading (4)	4	9			
Medium Compact X M. Compact (2 X 2)	JL24 X MH2BC28	Medium Compact (2)	Compact (1)	1	14	203	0.1442	0.500
			Medium Compact (2)	15	189			
Medium Compact X M. Compact (2 X 2)	MH2BC28 X TMV2	Medium Compact (2)	Compact (1)	1	11	201	0.2067	0.500
			Medium Compact (2)	15	190			
Medium Compact X M. spreading (2 X 3)	G201 X TMV2NLM	Medium Spreading (3)	Medium Compact (2)	6	73	188	0.3547	0.750
			Medium Spreading (3)	9	102			
			Spreading (4)	1	13			
Medium Compact X M. spreading (2 X 3)	TMV2 X TMV2LM	Medium Spreading (3)	Medium Compact (2)	4	81	315	0.5424	0.750
			Medium Spreading (3)	9	180			
			Spreading (4)	3	54			
Medium Compact X M. spreading (2 X 3)	PGN1 X TMV2NLM	Medium Spreading (3)	Medium Compact (2)	6	87	230	0.8541	0.500
			Medium Spreading (3)	9	132			
			Spreading (4)	1	11			
Medium Compact X M. spreading (2 X 3)	JL24 X TMV2NLM	Medium Spreading (3)	Medium Compact (2)	1	56	222	0.0060	0.900
			Medium Spreading (3)	3	166			
Medium Compact X M. spreading (2 X 3)	J11 X TMV2NLM	Medium spreading (3)	Medium Compact (2)	1	59	212	0.9056	0.250
			Medium spreading (3)	3	153			
Medium Compact X M. spreading (2 X 3)	P1259747 X 32-2-5	Medium spreading (3)	Medium Compact (2)	1	40	143	0.6736	0.250
			Medium Spreading (3)	3	103			
Medium Compact X M. Spreading (2 X 3)	JL24 X 32-2-5	Medium Spreading (3)	Medium Compact (2)	1	60	211	1.3285	0.100
			Medium Spreading (3)	3	151			
Medium Compact X M. Spreading (2 X 3)	TMV2 X 32-2-5	Medium Spreading (3)	Medium Compact (2)	1	49	177	0.6799	0.250
			Medium Spreading (3)	3	128			

Table 2

Canopy cross combination	Crosses	Phenotypes of F_1	Phenotypic Classes in F_2	Ratio	Observed frequency in F2	Total population F2	Chi-square value	'P' value
Medium Compact X M. Spreading (2 X 3)	G201 X TAP5	Medium Spreading (3)	Medium Compact (2) Medium Spreading (3)	1 3	45 122	167	0.3373	0.500
Medium Compact X M. Spreading (2 X 3)	PGN1 X TAP5	Medium Compact (2)	Medium Compact (2) Medium Spreading (3)	15 1	284 23	307	0.8068	0.250
Medium Compact X M. Spreading (2 X 3)	TMV2 X TAP 5	Medium Compact (2)	Medium Compact (2) Medium Spreading (3)	3 1	168 47	215	1.1303	0.250
Medium Compact X M. Spreading (2 X 3)	JL24 X TAP5	Medium Compact (2)	Medium Compact (2) Medium Spreading (3)	15 1	164 14	178	0.7898	0.250
Medium Compact X M. Spreading (2 X 3)	J11 X TAP5	Medium Compact (2)	Medium Compact (2) Medium Spreading (3)	15 1	159 15	174	1.6723	0.100
Medium Compact X M. Spreading (2 X 3)	P1350680 X TAP5	Medium Compact (2)	Medium Compact (2) Medium Spreading (3)	3 1	122 46	168	0.5080	0.250
Medium Spreading X M. Compact (3 X 2)	Kadiri-3 X JL 24	Medium Spreading (3)	Medium Compact (2) Medium Spreading (3) Spreading (4)	6 9 1	84 135 12	231	0.6891	0.500
Medium Spreading X M. Compact (3 X 2)	Kadiri-3 X MH2BC28	Medium Spreading (3)	Medium Compact (2) Medium Spreading (3) Spreading (4)	3 12 1	22 103 8	133	0.4641	0.750
Medium Spreading X M. Compact (3 X 2)	TMV2NLM X MH2BC28	Medium Spreading (3)	Compact (1) Medium Compact (2) Medium Spreading (3) Spreading (4)	1 11 48 4	5 39 171 13	228	0.6930	0.750
Medium Comapct X Spreading (2 X 4)	MH2BC28 X M13	Medium Spreading (3)	Compact (1) Medium Compact (2) Medium Spreading (3) Spreading (4)	1 12 37 14	4 28 91 36	159	1.0935	0.750
Spreading X M. Compact (4 X 2)	M13 X JL24	Spreading (4)	Medium Compact (2) Medium Spreading (3) Spreading (4)	4 3 9	63 40 135	238	0.6956	0.500
M. Spreading X M. Spreading (3 X 3)	MK374 X TMV2NLM	Medium Spreading (3)	Medium Spreading (3) Spreading (4)	3 1	147 46	193	0.1399	0.500

Table 2. Cont...

Table 2

Canopy cross combination	Crosses	Phenotypes of F_1	Phenotypic Classes in F_2	Ratio	Observed frequency in F2	Total population F2	Chi-square value	'P' value
M. Spreading X M. Spreading (3 X 3)	Kadiri-3 X TMV2NLM	Medium Spreading (3)	Medium Spreading (3) Spreading (4)	15 1	**276** **18**	294	0.0084	0.900
M. Spreading X M. Spreading (3 X 3)	TMV2NLM X 32-2-5	Medium Spreading (3)	Medium Spreading (3) Spreading (4)	15 1	201 16	217	0.4684	0.250
M. Spreading X M. Spreading (3 X 3)	GNLM X 32-2-5	Medium Spreading (3)	Medium Spreading (3) Spreading (4)	15 1	233 **12**	245	0.7633	0.250
M. Spreading X M. Spreading (3 X 3)	Kadiri-3 X 32-2-5	Medium Spreading (3)	Medium Spreading (3) Spreading (4)	15 1	254 20	274	0.5165	0.250
M. Spreading X M. Spreading (3 X 3)	MK374 X TAP5	Medium Spreading (3)	Medium Compact (2) Medium Spreading (3)	1 15	13 166	179	0.3123	0.500
M. Spreading X M. Spreading (3 X 3)	Kadiri-3 X TAP5	Medium Spreading (3)	Medium Compact (2) Medium Spreading (3)	1 3	**61** **170**	231	0.2439	0.500
M. Spreading X M. Spreading (3 X 3)	GNLM X TAP5	Medium Spreading (3)	Medium Spreading (3) Spreading (4)	3 1	153 41	194	1.5464	0.100
M. Spreading X M. Spreading (3 X 3)	TMV2NLM X TAP5	Medium Spreading (3)	Medium Spreading (3) Spreading (4)	3 1	177 **50**	227	1.0705	0.250
M. Spreading X M. Spreading (3 X 3)	TMV2NLM X GNLM	Medium Spreading (3)	Compact (1) Medium Compact (2) Medium Spreading (3) Spreading (4)	1 3 55 5	**4** 16 **273** **23**	316	0.3978	0.900
Spreading X M. Spreading (4 X 3)	M13 X TMV2NLM	Spreading (4)	Medium Spreading (3) Spreading (4)	7 9	100 130	230	0.0070	0.900
Spreading X M. Spreading (4 X 3)	M13 X TAP 5	Spreading (4)	Medium Compact (2) Medium Spreading (3) Spreading (4)	1 6 9	**14** **89** 120	223	0.5810	0.500
Spreading X M. Spreading (4 X 3)	ICG2271 X TAP 5	Spreading (4)	Medium Compact (2) Medium Spreading (3) Spreading (4)	1 6 9	**7** **52** **84**	143	0.6281	0.500

M. Spreading = Medium Spreading, M.Compact = Mediun Compact.

development. It appears from foregoing that the intermediate levels of canopy development justifiably represents intermediate levels of genetic divergence as suggested by Nagabhushanam (1989). Therefore, it is also probable to guess that the parents characterized by extreme levels of canopy development such as MH2 (1), M13 (4) and ICG 2271 (4) in crosses would bring about the probable involvement of genetic modifiers including zygotic and developmental lethals for canopy development as suggested by Coffelt and Hammons (1971).

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HETEROSIS IN RELATION TO COMBINING ABILITY FOR SEED YIELD AND ITS CONTRIBUTION TRAITS IN SESAME (*Sesamum indicum* L.)

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ABSTRACT

Six diverse genotypes (lines) were crossed with five varieties (testers) in line x tester mating design resulting in 30 hybrids. These 11 parents and 30 crosses were used to estimate the general combining ability of parents, specific combining ability of crosses and heterosis over mid parent and better parent fortraits, including seed yield. The good general combiners identified for seed yield and its contributing characters were SI-44, INST-15/3, Rajeswari and Vinayak. Based on *sca* effects and heterosis, the superior crosses were identified for each trait. The crosses, SI-44 x Rajeswari and SI-44 x. SVPR 1 which showed the highest *significant values of sca and heterosis for seed yield, number of branches and number of capsules per plant* can be considered as the best combinations among the 30 crosses evaluated for exploitation of heterosis in sesame.

Key words : Genetic variance, heterosis, yield components, sesame

INTRODUCTION

Though India is the largest producer of sesame with an area of 2.03 m.ha and production of 0.62 m.tonnes, the average per hectare yield is low (304 kg/ha) compared to other sesame growing countries of the world. For improving the present yield level and to overcome yield stagnation, it is very essential to reshuffle the genes by hybridisation in suitable parents. For this, it is necessary to know the gene action involved in the expression of various yield contributing characters and also the combining ability of the parents and the resulting crosses. Among the various methodologies available for estimation of combining ability of parents and crosses, Line x Tester analysis of Kempthrone (1957) is an useful tool for screening large number of lines with a reasonable degree of confidence. In the present study, 6 females, 5 males and their 30 crosses were evaluated for combining ability and heterosis for yield and its related characters.

MATERIALS AND METHODS

Six diverse germplam lines (SI-44, SI-253, IS-34-1, IS-349, INST-15/3 and IS-231-1) selected based on their performance during summer 1996 were used as females and crossed with five well adapted commercial varieties (Rajeswari, Phuletil, JLT-26, SVPR 1 and Vinayak) in L x T mating design resulting in 30 hybrids. These 11 parents and 30 hybrids were grown in completely Randomised Block Design with 3 replications during *kharif* 1996. A single row of 4 meter length was alloted to each genotype for each replication with a spacing of 45 cm between the rows and 15 cm between the plants. Observations on plant height (PH), number of branches (BN), number of capsules per plant (PN), capsule lenth (CL), days to maturity (DM) and seed yield (Y) were recorded on five randomly selected plants in each replication. Combining ability analysis was done as per the method given by Kempthrone (1957). Heterosis over mid parent and better parent was estimated as per the standard procedures.

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RESULTS AND DISCUSSION

The ananlysis of variance revealed significant differences among the genotypes for all the characters studied indicating the wealth of variability created by the hybridisation of diverse parents. The variances due to lines, testers and due to line x tester interaction were significant showing the involvment of both additive and non additive gene actions in controlling all these traits (Table 1). However, all these characters except plant height appeared to be controlled predominantly by non additive gene action as evidenced by the high *SCA* variance compared to *GCA* variance indicating the scope of improvement of these traits through heterosis breeding in sesame. For plant height, the estimates of *GCA* was higher than the *SCA* indicating the predominance of additive gene action for this trait.

The predominance of dominance genetic component over the additive component was recorded for number of branches per plant, number of capsules per plant, capsule length, days to maturity and seed yield per plant (Table 1). Mishra and Yadav (1996) also observed the predominance of dominance genetic component for days to maturity, number of capsules per plant and seed yield per plant. The general combining ability effects (*gca*) of lines and testers are given in Table 2. Among the lines, SI-44 and INST-15/3 were found to be good general combiners for seed yield and its components with highly significant *gca* effects for these traits. Among the testers, Rajeswari and Vinayak has registered highly significant gca effects for seed yield, number of branches and capsules per plant. As regards to earliness, SI-44, IS-349, IS-231-1, Rajeswari and JLT-26 were found to be the best general combiners.

Based on *sca* effects, five best crosses showing highly significant ***sca*** effects were identified for each character and their heterosis over mid parent and better parent are presented in Table 3. In general, crosses with significant *sca* effects also exhibited highly significant heterosis for most of the characters studied indicating that *sca* of cross can be a suitable index to determine the performance of a cross in the exploitation of heterosis. The highest heterosis (over better parent) of 165.24 percent was recorded in the cross, SI-44 x Rajeswari followed by SI-44 x SVPR 1 for seed yield per plant. Similar higher values of

Table 1. Analysis of variance for combining ability in sesame.

Source	df	Plant height	Branches/pl.	Capsule/pl.	Capsule length	Days to maturity	Yield/pl.
Crosses	29	575.48**	7.00**	1679.37**	0.09**	14.51**	9.62**
Lines	5	2302.37**	16.24**	5687.12**	0.12**	12.35**	10.30**
Testers	4	658.45**	7.43**	1798.89**	0.18**	13.28**	25.76**
Line x Testers	20	127.17**	4.61**	653.52**	0.08**	15.29**	6.23**
Error	58	18.12	0.31	23.29	0.01	0.85	0.31
σ^2 GCA	-	82.01	0.44	187.24	0.005	-0.15	0.72
σ^2 SCA	-	36.35	1.43	210.88	0.02	4.81	1.97
σ^2A	-	164.03	0.88	374.88	0.01	-0.30	1.43
σ^2 D	-	36.35	1.43	210.08	0.02	4.81	1.97

*, **- Significant at 5 and 1 percent level, respectively. σ^2A = Additive variance ; σ^2D = Dominance variance

heterosis (over BP) for seed yield (189.36 and 143 percent) were reported by Shinde et al., (1993) and Anandakumar (1996), respectively.

The cross combinaions SI-44 x Rajeswari showed highly significant *sca* effects and heterosis for all the characters studied, in which both the parents were good general combiners that produced high *sca* effects indicating the predominance of additive x additive gene interaction. Whereas all the other superior crosses were the combinations of high x low, high x medium or medium x low general combiners indicating the involvement of additive x dominant and dominant x dominant type of gene action. It was evident that in general, crosses involving atleast one parent with high *gca* effects and the other with high, medium or low combining parent would produce heterotic hybrids with high *sca* effects.

In the present study, seed yield and its contributing characters like number of branches and number of capsules per plant were governed by non additive gene action indicating the scope of genetic improvement of sesame through exploitation of hybrid vigour for seed yield and its components. The crosses that exhibited high heterosis for seed yield and its contributing traits (SI-44 x Rajeswari, SI-44 x SVPR 1, IS-349 x Rajeswari and IS-34-1 x Vinayak) could be used for commercial exploitation of heterosis in sesame.

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Table 2. General combining ability effects of parents

Parents	Plant Height	Branches/pl.	Capsule/pl.	Capsule Length	Days to Maturity	Yield/Plant
Lines						
SI-44	18.55**	1.70**	31.38**	0.15**	-0.87**	1.22**
SI -253	8.15**	-0.31**	1.73	-0.02	0.47*	0.48**
IS-34-1	-5.98**	-0.63**	-9.11**	-0.01	0.73**	-0.93**
IS-349	-7.85**	-0.56**	-21.43**	0.04*	0.33	-0.82**
INST-15/3	2.96**	0.82**	12.19**	-0.10**	0.73**	0.33**
IS-231-1	-15.83**	-1.02**	-14.75**	-0.06**	-1.40**	-0.28*
SE (lines)	0.86	0.11	0.97	0.02	0.19	0.11
Testers						
Rajeswari	7.22**	0.62**	12.66**	0.07**	-0.72**	1.91**
Phuletil 1	2.44**	-0.97**	-9.81**	0.13**	0.61**	-0.38**
JLT-26	2.00**	-0.20*	0.74	-0.02	-1.06**	-1.44**
SVPR-1	-8.68**	0.01	-10.05**	-0.09**	0.94**	-1.31**
Vinayak	-2.99**	0.54**	6.46**	-0.09**	0.22	0.22*
SE (testers)	0.77	0.10	0.87	0.02	0.17	0.10

*, ** - Significant at 5 and 1 percent level, respectively.

Table 3. Superior cross combinations based on sca effects and heterosis

Trait	Crosses	F1 Mean	*sca*	Heterosis over	
				Mid parent	Better parent
Plant height	IS-231-1 X Rajeswari (W)	90.40	7.16**	20.12**	2.97
	INST-15/3 x Rajeswari (BI)	113.67	5.95**	28.23**	22.10**
	IS-231-1 x Vinayak (Br)	83.20	5.83**	24.06**	21.64**
	SI-44 x Phuletill (W)	120.02	4.79**	36.73**	28.84**
	SI-44 x Rajeswari (W)	126.80	4.77**	35.79**	33.87**
Branches/plant	SI-44 x Rajeswari (W)	10.00	1.56**	89.03**	70.35**
	INST-15/3 x Rajeswari (BI)	9.53	1.54**	80.03**	68.89**
	INST-15/3 x Vinayak (BI)	9.40	1.49**	87.48**	66.35**
	SI-44 x SVPR-1 (W)	8.67	1.41**	85.19**	56.98**
	IS-34-1 x JLT-26 (W)	6.20	1.15**	30.07*	25.68*
Capsules/plant	*SI-44 x SVPR 1 (W)*	141.00	31.42**	103.36**	64.81**
	IS-231-1 x Rajeswari (W)	99.70	18.24**	73.90**	47.04**
	INST-15/3 x Vinayak (BI)	102.20	15.30**	78.65**	47.23**
	IS-231-1 x Vinayak (Br)	79.30	9.34**	73.62**	65.95**
	SI-44 x Rajeswari (W)	138.10	5.78**	76.38**	61.38**
Capsule length	SI-44 x Rajeswari (W)	3.04	0.35**	29.40**	22.12**
	IS-34-1 x SVPR-1 (W)	2.53	0.27**	20.27**	19.12**
	SI-253 x JLT-26 (W)	2.67	0.18**	5.54*	2.83
	INST-15/3 x Vinayak (BI)	2.58	0.11**	8.24**	3.66
	IS34-1 x JLT-26 (W)	2.62	0.09*	6.72**	0.40
Days to maturity	INST-15/3 x Phuletil (BI)	106.70	-2.34**	-1.40**	-2.47**
	SI-253 x Vinayak (Br)	106.30	-2.02**	-4.11**	-4.26**
	INST-15/3 x Vinayak (BI)	107.30	-1.96**	-3.07**	-3.66**
	SI-253 x Rajeswari (W)	105.60	-1.41**	-3.83**	-4.56**
	IS-231-1 x Vinayak (Br)	104.00	-1.16**	-4.29**	-4.88**
Seed yield/plant	*SI-44 x Rajeswari (W)*	11.14	2.27**	178.50**	165.24**
	SI-44 x SVPR-1 (W)	7.65	1.99**	94.16**	87.57**
	SI-253 x JLT-26 (W)	7.41	1.96**	46.22**	23.12**
	IS-34-1 x Vinayak (Br)	6.57	1.53**	70.86**	48.12**
	IS-349 x Rajeswari (W)	7.87	1.04**	110.53**	87.30**

*, ** - Significant at 5 and 1 percent level, respectively. W = White ; BI = Black ; Br = Brown

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NATURE OF GENE ACTION FOR YIELD ATTRIBUTES AND *PROTEIN CONTENT IN SOYBEAN*

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ABSTRACT

Diallel analysis with nine parents was conducted to determine genetic control of yield attributes and protein content in soybean. The estimates of genetic components of variance showed the presence of both additive and non-additive gene effects but the non addtive effects were observed to be more predominant for these traits under study except days to maturity. The Vr-Wr graphs also confirmed these findings. An ambidirectional dominance with relatively greater frequency of favourable dominant alleles among the parents was observed for plant height, number of branches, number of pods, 100-seed weight, yield per plant and protein content. Dominant alleles appeared to increase pod number and braches while recessives led to increase in days to maturity and protein content.

Key words : *Glycine max*, gene action, yield, protein.

INTRODUCTION

Soybean (*Glycine max* L. Merr.) is an important crop of the world because it has very high level of protein (40%). In recent years this has received considerable attention as a source of vegetable protein in the form of processed foods. So there is an immense need for bringing about genetic improvement in yield potential. Since the knowledge of genetic analysis helps in the formulation of an efficient breeding programme, the present study was undertaken to study the nature of gene action for seed yield attributes and protein content in soybean.

MATERIALS AND METHODS

Nine genetically diverse genotypes viz. SL 96, SL 152, SL 160, PK 416, PK 472, PK 564, DS 75-12-1, F 87-3065 and F 98-3095 were crossed in a diallel mating design excluding reciprocals. The F^1 seed so produced was not sufficient to plan a replicated experiment. Therefore, the 36 F1s were grown to produce F_2 seed for a replicated trial. So 36 F2s and nine parents were grown in a randomized complete block design with three replications. Data were recorded with respect to days to flower, days to maturity, plant height (cm), number of branches, number of pods, yield per plant (g) and 100- seed weight (g) from ten randomly selected plants. Total protein content on plot basis was worked out by kjeldahl's method. Components of variation were worked out following Jinks (1954-1956) and graphic analysis of Hayman (1954).

RESULTS AND DISCUSSION

The results indicated that both additive (D) and non-additive components (H_1 and H_2) were significant for all the yield attributes and protein content except for D component in case of plant height and number of branches and H_2 for 100-seed weight (Table 1). Alam Muresan and Denceson (1984) in soybean and Mann and Mishra (1995) in wheat also reported that both additive and non-additive components were important for yield and yield components. The Vr-Wr graphs (fig 1 to 6) were drawn for all the characters except yield per plant where the regression coefficient was not significant. The results obtained in the graphic analysis confirmed the gene action as determined by component of variance. However, non-additive component was larger than the additive component. The degree of dominance was observed in the over dominance range for most of the traits. Tawar, Mishra and Rao (1989) and Mann and Mishra (1995) also observed over-dominance

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Table 1 : Components of variation for different characters in soybean

Genetic Component	Plant height (cm)	No. of branches per plant	No. of pods per plant	100- seed weight (g)	Yield per plant (g)	Days to flower	Days to maturity	Protein content (%)
D	20.689	1.007	103.01**	0.671**	2.417**	2.155**	16.463**	5.184**
	±11.60	±0.56	±17.70	±0.180	±0.351	±0.41	±0.94	±0.88
H_1	601.40**	13.47**	1188.63**	6.896**	15.316**	20.765**	39.934**	49.912**
	±102.50	±4.90	±156.60	±1.56	±3.10	±3.60	±8.30	±7.77
H_2	539.90**	11.33**	960.01**	5.599	11.899**	16.730**	33.471**	38.816**
	±22.38	±4.10	±33.90	±4.01	±4.05	±4.04	±4.38	±4.33
F	2.008	2.32	245.25**	1.299**	5.312**	2.996**	9.371**	4.397**
	±27.10	±1.30	±41.30	±0.42	±0.82	±0.95	±2.20	±2.05
E	0.83	0.046	0.672	0.006	0.021	0.320**	0.662**	0.279
	±3.60	±0.18	±5.60	±0.056	±0.11	±0.13	±0.29	±0.28
h^2	62.33	0.455	44.78	0.15	1.343	22.02**	127.56	0.689**
	±59.00	±2.80	±90.10	±0.91	±1.80	±2.08	±4.80	±4.48
f^2	2.32	0.0002	0.055	0.80	0.37	0.24	0.11	0.034

** Significant at 1 percent level

Table 2 : Genetic components for different characters in soybean

Genetic Component	Plant height (cm)	No. of branches per plant	No. of pods per plant	100- seed weight (g)	Yield per plant (g)	Days to flower	Days to maturity	Protein content (%)
H1/D¼	7.27	3.34	2.88	2.56	1.58	2.41	0.60	2.40
H2/4H1	0.22	0.21	0.20	0.20	0.19	0.20	0.21	0.19
$\frac{¼\ (4DH1)^{½} + ½\ F}{¼\ (4DH1)^{½} - ½\ F}$	1.00	1.09	1.00	1.15	1.07	1.03	1.01	1.00
h^2/H_2	0.11	0.04	0.04	0.02	0.11	1.32	3.81	0.01
r	0.26	-8.05*	-0.70*	-0.24	0.18	0.17	0.87*	0.73*
b	0.32	-0.44	0.70	0.41	0.38	0.89	0.85	0.81

* Significant at 5 percent level

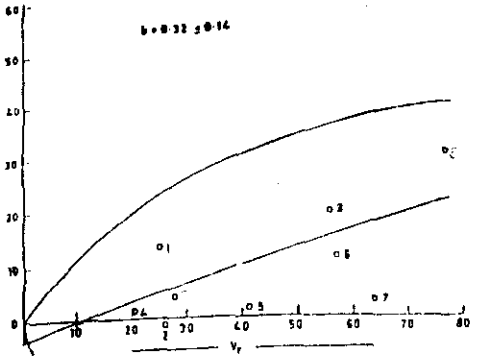

Fig 1. Plant height

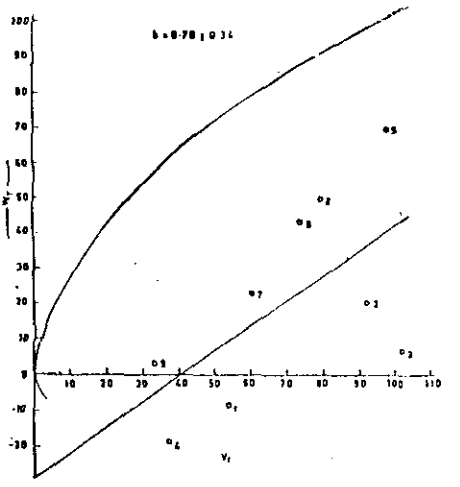

Fig 2. No. of pods/plant

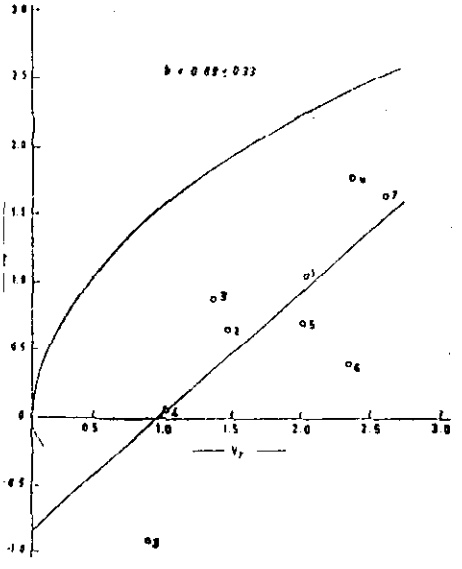

Fig 4. Days to flower

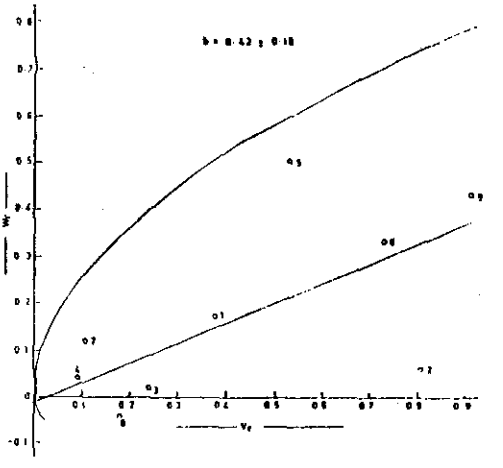

Fig 3. 100 seed weight

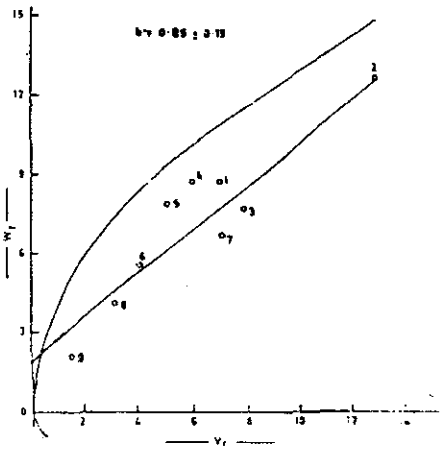

Fig 5. Days to maturity

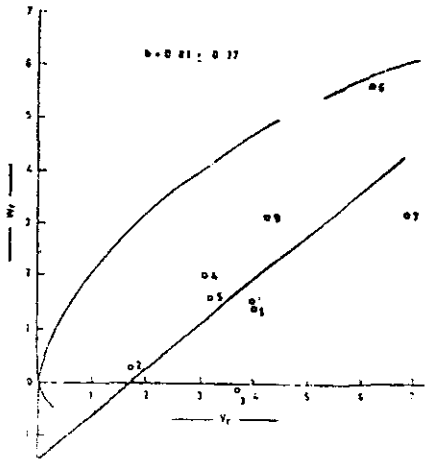

Fig 6. Protein content percent

for most of the quantitative traits.

Significant and positive F value for number of pods, 100-seed weight, yield per plant, days to flower, days to maturity and protein content indicated more frequency of dominant alleles in the parents (Table 2). Days to flower and days to maturity had environmental effect. The h^2 value for most of the traits exhibited ambidirectional dominance except in case of days to flower and days to maturity. Significant r vaule for days to maturity and protein content indicated that the maximum expression of these traits was under the control of recessive genes, whereas for number of pods and branches, it was controlled by the dominant genes. The observed regression line intersected below the point of origin for all the characters except days to maturity indicating thereby that these traits were under the control of non additive gene effects.

The present investigations clearly showed the importance of both additive and non-additive gene action for these traits with the preponderance of non additive gene action. Therefore, Multiple crosses or biparental mating or diallel selective mating which may allow intermating of the selects in the different cycles could hold promise for genetic improvement of the traits in soybean.

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COMBINING ABILITY IN SESAME (*Sesamum indicum* L.)

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ABSTRACT

The present investigation on a line x tester cross of 7 parents and 12 crosses in sesame indicated that the character, number of capsules per plant had a fixable additive genetic variance which can be improved by simple selection, whereas the characters viz., days to first flowering, branches per plant, seed yield per plant and oil content showed the preponderance of non-additive gene action which can be improved by biparental mating. Two parents, viz., CMS-C_1 and $Paiyur_1$ were good general combiners for majority of characters. The combination of CMS-T_6 x Si 1525 and CMS-C_1 x $Paiyur_1$ which combine high sca effect and high mean performance were the best specific combinations.

Key words: Sesame; combining ability; additive; dominance.

INTRODUCTION

Studies on combining ability is essential to break the prevailing yield plateau in this crop. The combining ability studies provide useful information for the selection of high order parents for effective breeding besides elucidating the nature and magnitude of different types of gene action governing the expression of quantitative characters of economic importance.

MATERIALS AND METHODS

The experimental material consisted of seven parents viz., (lines: CMS-T_3, CMS-T_4, CMS-T_6, CMS-C_1 and testers: Si 1525, SVPR 1, Paiyur 1) crossed in a line x tester mating design. The seven parents and each of the 12 crosses were grown in a randomized block design with three replications. Each genotype was accommodated in two rows of 3 metre length with a spacing of 30 x 15 cm. Observations were recorded on 10 plants from each replication. The general combining ability effects of the parents and specific combining ability effects of the crosses were worked out, as suggested by Kempthorne (1957).

RESULTS AND DISCUSSION

The relative estimates of variance due to general combining ability and specific combining ability for the different characters studied are given in Table 1. The GCA variance was higher than SCA variance for number of capsules per plant. For the characters viz., days to first flowering, no. of primaries and secondaries, plant height, days to maturity, 1000 seed weight, seed yield per plant and oil content SCA variance was higher than GCA variance. This indicated that both additive and non-additive gene actions played a role in determining various characters in sesame. This indicates the high scope for exploitation of heterosis in hybrid sesame. This corroborated with the findings of several workers (Ananda Kumar and Sree Rangaswamy, 1987; Ramalingam *et al.*, 1990 and Fatteh *et al.*, 1995).

The results obtained in general combining ability effects (Table 2) indicated that female parents viz., CMS-T_3, CMS-T_4, CMS-T_6, and CMS-C_1 exhibited significant *gca* effects for plant height, number of capsules per plant, seed yield per plant and oil content. For plant height, number

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Table 1 . ANOVA for combining ability in Sesame.

Source	Degrees of freedom	Mean square								
		Days to first flowering	No. of primaries	No. of secondaries	Plant height	Days to maturity	No. of capsules per plant	1000 seed weight	Seed Yield per plant	Oil content
Hybrid	11	6.33**	1.37	1.17	584.25**	11.85**	2829.65**	0.34	81.06**	4.97**
Line	3	9.57*	0.46	1.07	478.57**	6.61	448.82**	0.53	14.02**	5.36**
Tester	2	4.41	2.12	0.11	1527.52**	41.23*	1381.27**	0.23	309.43**	2 94
Line x Tester	6	5.35*	1.57	1.57	322.67**	4.67*	359.05**	0.28	38.45**	5.46**
Error	36	30.01	1.72	2.37	44.22	47.33	17.78	0.17	1.93	1.40
c^2gca		0.16	0.03	0.09	64.80	1.83	644.92	0.01	11.74	0.12
c2sca		7.38	0.18	0.44	96.19	16.59	115.30	0.05	11.96	1.56
c2gca/c2sca		0.02	0.17	0.20	0.67	0.11	5.59	0.20	0.98	0.08

* Significant at 5 per cent level, **Significant at 1 per cent level.

Table 2 : General combining ability effects of female and male parents of Sesame.

Parents	Characters								
	Days to first flowering	No. of primaries	No. of secondaries	Plant height	Days to maturity	No. of capsules per plant	1000 seed weight	Seed yield per plant	Oil content
Female parents									
CMS-T3	-0.01	-0.02	0.43	-9.67**	1.20	-3.30**	-0.14	0.85*	0.46*
CMS-T4	1.44	0.27	0.02	-1.61	-0.58	0.81	-0.01	-1.82**	0.25
CMS-T6	-0.52	0.02	-0.04	5.45**	-0.64	-6.97**	-0.20*	0.78*	0.44*
CMS-C1	-0.91	-0.27	-0.41	5.83**	0.02	9.46**	0.35**	0.19	-1.15**
SE	1.20	0.33	0.39	1.34	1.69	0.83	0.08	0.37	0.20
Male parents									
Si 1525	0.69	0.25	0.01	6.92**	1.43	22.21**	-0.10	3.77**	-0.42*
SVPR 1	-0.42	-0.49	0.09	-13.02**	-2.10	-39.05**	-0.06	-5.77**	-0.12
Paiyur 1	-0.27	0.24	-0.10	6.10**	0.67	16.84**	0.16*	2.00**	0.54**
SE	0.98	0.27	0.32	1.09	1.38	0.68	0.07	0.30	0.17

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

of capsules per plant, seed yield per plant and oil content, the male parents viz., Si 1525, SVPR 1, and Paiyur 1 exhibited significant *gca* effects. Murthy (1975) reported larger GCA variance for number of capsules per plant. Shinde *et al.*, (1993) reported higher magnitude of *GCA* variance than SCA variance for number of capsules per plant.

The results obtained in specific combining ability effects (Table 3) indicated that CMS-C_1 x SVPR 1 exhibited significant *sca* effect for plant height; CMS-T_4 x Paiyur 1 for number of capsules per plant; CMS-C_1 x Paiyur 1 for seed yield per plant and oil content. Fatteh *et al.*, (1995) showed the predominance of non-additive gene action in the inheritance of number of capsules per plant.

In the present study, some crosses where both the parents exhibited significant and positive *gca* effects, gave negative *sca* effect, as for example CMS-T_6 x Paiyur 1 for seed yield per plant and CMS-T_3 x Paiyur 1 for oil content. The constituent parents of these crosses had high gca effects. The results indicated the absence of epistatic interaction for these characters and dependability of these crosses for further breeding work. Sharma and Chauhan (1985) met with similar results in sesame. Specific combining ability effects include dominant and epistatic components of variance, which are non-fixable. Since the cross combinations CMS-C_1 x Paiyur 1, CMS-T_6 x Si 1525 involved atleast one or both parents with general combining ability effect for seed yield and its components, they could be expected to generate transgressive segregants in later generations through biparental mating and suggested for recombination breeding.

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Table 3 : Specific combining ability effects of crosses involving male sterile lines and restorers of Sesame.

Crosses	Characters								
	Days to first flowering	No. of primaries	No. of secondaries	Plant height	Days to maturity	No. of capsules per plant	1000 seed weight	Seed yield per plant	Oil content
T3 x Si 1525	-0.44	-0.24	0.35	6.13**	**-0.35**	6.59**	0.39**	-0.80	**-0.35**
T3 x SVPR 1	**-0.23**	-0.57	0.14	-11.44**	**1.36**	4.02**	0.04	0.98	**1.08****
T3 x Paiyur 1	**0.67**	0.81	-0.49	5.31**	**-1.01**	-10.61**	-0.43**	-0.18	-0.73*
T4 x Si 1525	2.15	-0.48	0.87	-2.25	**0.22**	-10.70**	-0.03	1.86**	-0.54
T4 x SVPR 1	**-0.51**	0.17	-0.58	-1.82	**0.57**	-7.29**	-0.04	0.26	1.14**
T4 x Paiyur 1	**-1.64**	0.31	-0.29	4.07*	**-0.79**	17.99**	-0.07	-2.12**	-0.60*
T6 x Si 1525	**-0.58**	0.55	-0.25	5.38**	**-0.70**	2.21	-0.19	3.60**	1.16**
T6 x SVPR 1	**0.18**	-0.29	0.17	-2.59	**-0.39**	-0.27	-0.15	-0.95	-0.79**
T6 x Paiyur 1	**0.40**	-0.26	0.08	-2.79	**1.09**	-1.94	0.34**	-2.65**	-0.37
C1 x Si 1525	**-1.12**	0.17	-0.97	-9.27**	**0.83**	1.89	-0.16	-4.66**	0.26
C1 x SVPR 1	**0.55**	0.70	0.27	15.85**	**-1.54**	3.55**	0.14	-0.29	-1.44**
C1 x Paiyur 1	**0.57**	-0.87	0.70	-6.58**	**0.71**	-5.44**	0.02	4.95**	1.70**
SE	1.70	0.47	0.55	1.89	2.39	1.18	0.12	0.52	0.29

T3 : CMS-T3; T6 : CMS-T6 T4 : CMS-T4; C1 : CMS-C1 *Significant at 5 per cent level **Significant at 1 per cent level.

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STANDARD HETEROSIS OF EARLY MATURING CMS LINES AND RESTORERS IN SUNFLOWER

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ABSTRACT

Three early maturing CMS lines (CMS 338 (c), CMS 302 and CMS 234) and four restorers (RHA-84SR$_1$ RHA-274, RHA 83R6 and RHA-297) were crossed to obtain 12 hybrids. The hybrids so synthesized were studied for 50% flowering, seed yield/plant, 100 seed weight, oil content and oil yield per plant. The line CMS 338(c) produced earliest flowering hybrids (46.5 days) in combination with RHA-274 and the mean productivity of the hybrids derived from this CMS line was 24.8 g seed yield per plant, along with mean test weight of 3.4 g, oil content of 36.3% and 9.0 g oil yield per plant. On the other hand CMS 234 produced late hybrids with the mean values of 28.0 g seed yield per plant, 3.7 g 100 seed weight, 35.9 per cent oil content and 10.1 g oil yield per plant. The combination of CMS 338(c) x RHA-297 was the best among hybrids flowering in less than 50 days; CMS 338(c) x RHA-84SR$_1$ among the hybrids flowering between 50-55 days and CMS 234 x RHA-83R$_6$ among the hybrids flowering in more than 55 days and these were superior to respective standarad checks in both seed and oil yield.

Key words : Standard heterosis, Early maturing lines, CMS, Restorer

INTRODUCTION

Combining earliness (flowering in less than 50 days with a maturity peroid of around 80 days) with high seed and oil yield has been one of the major objectives in sunflower improvement. The hybrids presently under cultivation fall into medium (90 days) to late (more than 90 days) group. Obviously breeders have been attempting to identify productive early hybrids of duration comparable to Morden. Earlier efforts in this direction have not been successfull as earliness was usally associated with low seed yield and oil content. The identification of potential early flowering CMS line with ability to result in a productive early hybrid is an important pre-requisite for combining earliness with seed yield. Development of early maturing hybrids (80-85 days) is most prefered in multiple cropping system (Giri Raj, 1991). In the present study the potentilal of three such CMS lines in obtaining early as well as late maturing hybrids of promise is highlighted.

MATERIALS AND METHODS

Three CMS lines - (CMS 338(c), CMS 302 and CMS 234) and four restorers - (RHA-84SR$_1$, RHA-274, RHA-83R$_6$ and RHA-297) distinctly differing in their flowering and possessing the other desirable agronomic attributes were involved in the present study. They were crossed in all possible combinations to develop 12 hybrids. These hybrids were evaluated along with three standard checks (Morden, KBSH-1 and MSFH-17) at GKVK, Bangalore during *kharif* 1995 in a replicated randomised trial adopting recommended package of practices. Observations were taken on five most important agronomic characters namely 50% flowering, seed yield per plant, 100 seed weight, oil content and oil yield per plant. Standarad heterosis was estimated for the seed yield and oil yield. Potential combination of crosses for obtaining early, medium and late hybrids were identified.

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RESULTS AND DISCUSSION

The data on mean performance of parents along with three standard checks for various characters are presented in Table 1. Among CMS lines CMS 338 (c) and among restorers RHA-84SR1 were the earliest to flower. For seed yield and oil content CMS 338 (c) was superior to rest of the parents. Among standard checks Morden was earliest to flower followed by MSFH-17 and KBSH-1. For seed yield per plant MSFH-17 was the best followed by KBSH-1 and Morden. KBSH-1 was superior in oil content among the checks. Among the 12 hybrids studied (Table 2) CMS 338(c) x RHA-274 was the earliest to flower (46.5 days) followed by CMS 338(c) x RHA-297 (49.0 days). In general the hybrids synthesized in the background of CMS 338(c) flowered earlier than the hybrids synthesized in the background of CMS 234. For seed yield, the hybrid CMS 234 x RHA $83R_6$ was the best (33.2g) followed by CMS 338(c) x RHA-84SR1 (28.6g). The other promising combinations were CMS 338(c) x RHA-$83R_6$, CMS 302 x RHA-83R6 and CMS 234 x RHA - 274.

For oil content also the hybrids synthesized in the back ground CMS 338(c) were the best (36.3%) followed by hybrids of CMS 234 background (35.9%).

As far as oil yield is concerned the hybrids CMS 234 x RHA-$83R_6$ was the best (12.9g/plant) follwed by CMS 338(c) x RHA-$84SR_1$ (10.6 g). The other promising combinations were CMS 338(c) x RHA-$83R_6$ (10.3g), CMS 302 x RHA-$83R_6$ (9.9 g) and CMS 234 x RHA-297 (9.5 g).

As far as standard heterosis is concerned all hybrids were superior to Morden in both seed and oil yield (Table 2) over KBSH-1. For seed yield CMS 234 x RHA-$83R_6$ recorded highest standard heterosis of 47.01% followed by CMS 338 (c) x RHA-$84SR_1$ (26.34%) and CMs 302 x RHA-$83R_6$ (23.40 %). Similar results were reported by Skoric (1977) and Vulpe (1977). For oil yield 3 hybrids- CMS 234 x RHA-$83R_6$, CMS

Table 1 : Mean performance of parents and checks for five characters of sunflower

Material	Days to 50% flowering	Seed yield per plant (g)	100 seed weight (g)	Oil content (%)	Oil yield/ plant (g)
Females					
CMS 338(c)	46.0	11.4	3.3	40.0	4.7
CMS 302	53.7	10.5	2.6	31.2	3.3
CMS 234	58.0	7.0	2.4	40.0	2.8
Males					
RHA-84SR1	49.2	3.8	2.1	36.5	1.4
RHA- 274	51.3	3.8	1.6	34.8	1.3
RHA-83 R6	54.8	5.2	2.3	31.1	1.6
RHA-297	57.3	0.8	1.2	37.7	0.3
Checks					
Morden	46.8	17.7	3.8	34.5	6.1
KBSH-1	57.3	22.6	3.4	38.4	8.7
MSFH-17	57.0	29.6	4.2	34.8	10.1

Table 2 : Individual perfomance of 12 hybrids and standard heterosis for seed yield superiority / inferiority over checks

Material	Days to 50% flowering	Seed yield per plant (g)	100seed weight (g)	Oil content (%)	Oil yield per plant (g)	Morden		KBSH-1		MSFH-17	
						Seed yield	Oil Yield	Seed yield	Oil yield	Seed yield	Oil yield
CMS 338(c) x RHA-84SR$_1$	52.0	28.6	3.8	37.3	10.6	61.29**	73.61**	26.34**	22.33*	-4.52	2.18
MMS 338(c) x RHA-274	46.5	21.2	3.2	35.3	7.5	19.86*	22.06	-6.10	-13.99	-29.05**	-28.16**
CMS 338(c) x RHA-83R6	50.8	27.7	3.6	37.4	10.3	56.39**	89.64**	22.50**	33.62**	-7.43	11.62
CMS 338(c) x RHA-297	49.0	21.6	3.1	35.0	7.6	21.75**	24.14	-4.62	-12.53	-27.93**	-26.93**
Mean for CMS 338 (c)	49.5	24.8	3.4	36.3	9.0						
CMS 302 x RHA-84SR1	54.3	23.4	3.7	33.7	7.9	32.18**	28.59	3.53	-9.40	-21.76**	-24.32**
CMS 302 x RHA-274	50.3	22.0	3.2	33.5	7.4	24.51**	20.31	-2.46	-15.23	-26.30**	-29.19**
CMS 302 x RHA-83R6	54.3	27.9	3.4	35.4	9.9	57.54**	61.17**	23.40**	13.56	-6.75	-5.14
CMS 302 x RHA-297	52.8	20.7	3.1	33.8	7.0	16.67	14.27	-8.60	-19.48	-30.94**	-32.74**
Mean for CMS 302	52.9	23.5	3.4	34.1	8.0						
CMS 234 x RHA-83SR1	56.3	25.1	3.8	35.8	9.0	42.05**	47.55**	11.27	3.97	-15.92**	-13.15
CMS 234 x RHA-274	52.8	27.3	3.5	32.7	8.9	54.20**	45.84**	20.79**	2.76	-8.72	-14.16
CMS 234 x RHA-83R6	56.5	33.2	4.1	38.9	12.9	87.68**	111.6**	47.01**	49.14**	11.09*	24.58**
CMS 234 x RHA-297	53.8	26.5	3.3	36.0	9.5	49.57**	55.46**	17.16*	9.54	-11.46*	-8.50
Mean for CMS 234	54.2	28.0	3.7	35.9	10.1						

* Significant at 5% level, ** Significant at 1% level

338 (c) x RHA $83R_6$ and CMS 338 (c) x RHA-$84SR_1$ showed significant superiority. Against MSFH-17 excepting for one hybrid CMS 234 x RHA-$83R_6$ (11.09%) all other hybrids showed negative standard heterosis for seed yield. However, for oil yield three hybrids- CMS 234 x RHA-$83R_6$, CMS 338(c) x RHA-$83R_6$ and CMS 338 (c) x RHA-$84SR_1$ showed significant superiority.

From the above study it is evident that the early flowering line CMS 338(c) is highly promising in obtaining hybrids combining earliness, yield and oil content.

Among restorers RHA-$84SR_1$ and RHA-$83R_6$ are most promising ones. The hybrids CMS 338 (c) x RHA-$84SR_1$, CMS 234 x RHA-$83R_6$ and CMS 338 (c) x RHA-$83R_6$ have performed very well and hold promise for exploitation.

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EFFECT OF POLLINATION METHODS ON SEED FILLING AND SEED QUALITY IN SUNFLOWER CV. MORDEN

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ABSTRACT

Among various methods of pollination, Confined honey bee pollnation recorded highest seed yield of 1288 kgha^{-1} with an increased oil content over other methods. However, hand pollination (daily) in addition to open pollination also registered equally better seed yield of 1200 kg ha^{-1} with an oil content of 42.4 per cent.

Key words: Sunflower, Pollination, Bees, Yield, Quality.

INTRODUCTION

Sunflower (*Helianthus annuus* L.) is an important oil seed crop grown almost throuthout the country. Photo in sensivity of this crop has given the advantage of its cultivation throughout the year. Owing to the highly cross fertilized nature and incompatibility encountered in sunflower, quality seed production with maximum recovery of uniform size seeds with good filling and high density becomes a problem. Sunflower is a cross pollinated crop with differential imcompatibility and also a typical protandrous separating the sex temporally. The timely visit of bee population conciding with anthesis and stigma receptivity for effective pollination and fertilization is very important.

MATERIALS AND METHODS

The experiment was conducted with the sunflower CV. Morden at Agricultural College and Research Institute, Madurai with the following treatments.

Pn_1 - hand pollination daily in addition to open pollination. Pn_2 - hand pollination alternate days in addition to open pollination. Pn_3 - hand pollination daily without allowing for open pollination. Pn_4 - Open pollination and Pn_5 - Confined honey bee pollination.

The experimental crop was raised under five blocks, each block constituting an area of 80 sq.m with required population. Five plants from each block were selected at random in each replication and the observations on diameter of unfilled portion of head (cm), total number of filled seeds per head, filled seed percentage, kernel / husk (k/h) ratio, seed yield kg ha^{-1}, 100 achene weight, germination percentage, root lengh, shoot length, vigour index and oil content were recorded.

RESULTS AND DISCUSSION

It was evidently confirmed from the investigation that seed yield was very much increased with an assured availability of sufficient honey bee population. Unless sufficient population of honey bee with increased frequency coincided with anthesis and stigma receptivity the setting of seed will be poor. (Goyal and Atwal, 1973). More over as the sunflower is a poor yielder of nector the frequency and population of honey bee will be reduced if alternate crops with full of nector are available in the vicinity.

In the present investigation the seed yield and quality were increased with an asured availability of sufficient population of honey bees coupled with increased frequency of visit when the bees were confined in specified area by

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Table 1. Effect of pollination method on seed filling, yield and quality of seed in sunflower CV. Morden.

Pollination methods	Diameter of unifilled portion of head (cm)	Filled seed (%)	Kernel/husk ratio	Seed yield $kgha^{-1}$	Germination (%)	Vigour Index
Daily hand pollination +OP	4.08	87.9	1.59	1200	96.00	3.50
Hand pollination alternate day + OP	4.30	87.3	1.61	1183	92.00	2831
Daily hand pollination	6.55	82.5	1.45	883	91.00	2828
Open pollination only	7.60	80.5	1.30	779	88.00	2551
Confined honey bee pollination	3.70	91.0	1.70	1288	97.00	3247
C. D. (p=0.05)	0.31	1.98	0.048	61.5	2.33	41.7

OP = Open pollination

covering the plot with a net. The percentage increase in yield, yield parameters and quality of seed and resultant seedlings were also found to be higher than the rest of the treatments.

Similar results were also obtained by Heich (1973). Sunflower is a relatively poor nector producer and the pollen has low protein content. Therefore, confined pollination by honey bees should be widely practiced to increase the seed set as stated by Donald (1980).

Though open pollination supplemented with hand pollination daily may be equivalant to confined honey bee pollination the reason for increased seed yield due to increased number of filled seeds per cent, kernel/husk ratio and 100 achene weight, and increased seed quality might be due to the inducement given either by their saliva or by inexplicable stimulations.

A sigjificant improvement in oil content by 2% by confined honey bee pollination over open pollination was also observed (Table 1).

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COMBINING ABILITY ANALYSIS FOR SEED YIELD, OIL AND OIL QUALITY IN SUNFLOWER *Helianthus annuus* L.

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ABSTRACT

The line x tester analysis of thirty hybrids obtained from five CMS lines and six inbreds, over two environments, revealed the preponderance of non-additive gene action for seed yield, oil content, palmitic acid, stearic acid, oleic acid and linoleic acid. The CMS 234A and the inbred 187-333 were observed good general combiners both for seed yield and oil content. In general, good general combiners for oleic acid were the poor general combiners for linoleic acid and vice-versa. The CMS-300 A and 207A were top combiners for linoleic acid and vice-versa. The CMS-300 A and 207A were top combiners for oleic and linoleic acids, respectively. Similarly, the 68-3 and 108-3 male inbreds were good general combiners for oleic and linoleic acids, respectively. The hybrid 86A3x68-3 was one of best cross for seed yield as well as oil content. The hybrids of high sca effects also had high *per se* performance for most of the traits studied. The best hybrids selected on the basis of highest sca effect involved atleast one good or medium general combining parent. The maintainers of these CMS lines and good combiners of male lines could be used in creating dynamic population for recurrent selection.

Key words: Sunflower, line x tester, Fatty acids.

INTRODUCTION

Among the oilseeds, sunflower can greatly help to boost edible oil production of high quality in the country. Therefore, the improvement of both seed yield and oil quality have now become the prime concern for the sunflower breeders. Oil quality in sunflower is mainly determined by the fatty acid composition. From nutritional point of view, high content of two fatty acids i.e. linoleic and oleic acid is important.

In the present investigation, an attempt has been made to know the nature of gene action for seed yield, oil content, and four fatty acids in sunflower.

MATERIALS AND METHODS

Line x tester mating design consisting of 30 F_1 hybrids of five cytoplasmic genic male sterile lines F1 (300A), F2 (234A), F3 (7-1-A), F4 (207A) and F5 (86A3) and six inbreds M1 (68-3), M2 (187-333), M3 (108-3), M4 (261-2), M5 (38-2) and M6 (98-2-3) as testers was used for this study. Thirty hybrids and their 11 parents were studied in two environments. The environments were created by applying two doses of nitrogen i.e. 60kg/ha and 90kg/ha in first and second environment respectively. All recommended cultural practices were followed to raise the crop. Data for seed yield were recorded on five randomly selected competitive plants. Biochemical analysis was done using nuclear magnetic resonance (NMR) instrument Newport Analyzer, MK 111A for oil content, and gas liquid chromatography (GLC) for fatty acid composition. Fatty acids were converted into their methyl esters by following the method of Luddy *el al* (1968) before GLC analysis. The methyl esters thus prepared were subjected to gas liquid chromatography, in which peaks observed were identified using internal standard fatty acid esters. Relative proportion of different fatty acids was worked out from the area of the peaks. The data thus generated were subjected to combining ability analysis using fixed effect model for individual environments (Kaushik *et al*, 1984) and pooled over environments (Dhillon and Pollmer, 1978).

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RESULTS AND DISCUSSION

The pooled analysis of variance (Table 1) revealed that parents (males and females) and hybrids differed significantly with respect to their *gca* and *sca* genetic variances respectively for all the traits studied. The interactions of males and also females with environment were significant for seed yield, palmitic acid and stearic acid. But for oleic and linoleic acid, interactions due to females with environment were significant. Similarly, male x female x environment interactions were significant for all the traits except for stearic and linoleic acids. The interactions indicated that gene effects were prone to change with change in the environment. The $2\sigma^2$gca / $2\sigma^2$ gca + σ^2sca ratio (Baker, 1978) indicated mostly the preponderance of non additive gene action for all the traits. These results were in agreement with those of Alba *et al* (1979) for oil content and Rudranaik *et al* (1990) for seed yield. The magnitude of σ^2mf1, σ^2f1, and σ^2m1 indicated that σ^2mf1 was greater than σ^2f1 and σ^2m1 for all the traits except palmatic acid which showed that *gca* effects of the parents were relatively less affected by changing environments than *sca* effects of hybrids except palmitic acid in case of females.

Estimates of gca effects for different traits (Table 2) indicated that CMs 234A was the best general combiner both for seed yield and oil content, CMS 300A for oleic acid and CMS 207A for linoleic acid. Among the male parents, M2 (187-333) was the best general combiner for seed yield (7.50) followed by M1 (68-3). For oil content, the male M6 (98-2-3) was the best general combiner followed by M2 (187-333). The male parent M2 (187-333) was also good general combiner for palmitic acid, but it was poor general combiner for stearic acid. For oleic acid, the male parent M1 (68-3) was the best combiner (2.19), but poor combiner for linoleic acid.

Most of the crosses possessing highest *sca* effect also has high *per se* perfomance for most of the traits (Table 3). The cross F5 (86A3) x M1 (68-3) showed highly significant positive *sca* effect for seed yield and oil content. For oleic acid and linoleic acids, the crosses F1 (300A) x M4 (261-2) and F1 (300A) x M6 (98-2-3) displayed highest positive significant *sca* effects respectively.

It was evident that the cross exhibiting desirable *sca* effects involved high x medium, high x low, medium x low and medium x medium *gca* parents. The crosses F2 (234A) x M2 (187-333) and F2 (234A) x M1 (68-3) between high x high *gca* parents for seed yield were valuable because of the presence of additive gene action. The crosses F3 (7-1-A) x M1 (68-3) for oil content and F4 (207A) x M2 (187-333) for stearic acid were high x low *gca* combinations in which additive gene action was present in the high *gca* parent and may be complementary genes in a low *gca* parent. It might produce better transgressive segregates in later generations (Langham, 1961),

It is suggested that good combining parents i.e. maintainers of CMS 234A, CMS 300A and 207A as well as the male testers 68-3, 187-333, and 98-2-3 for different traits may be utilized in constituting a dynamic population which could be improved through recurrent selection. The most promising parents in the hybrids can be used for hybrid breeding programme.

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Table 1. Analysis of variance for combining ability for different characters over two environments using fixed effect model

Source	d. f.	Mean sum of squares					
		Seed Yield	Oil content	Palmitic acid	Stearic acid	Oleic acid	Linoleic acid
Environment (E)	1	469.81**	215.90**	11.48**	0.17**	18.97	1.88
Females (F)	4	215.42**	81.47**	1.96**	0.03**	319.14**	279.22**
Males (M)	5	434.25**	53.11**	0.61**	0.06**	64.25**	58.12**
F x M	20	68.89**	22.70**	1.22**	0.05**	94.88*	82.91**
F x E	4	56.19**	7.65	1.94**	0.03**	22.18**	35.83**
M x E	5	26.38**	19.22**	0.34**	0.02**	4.44	8.55
F x M x E	20	87.92**	19.46**	0.18**	0.01	17.76*	16.63
Error	116	3.00	3.33	0.08	0.007	6.46	8.16
$\sigma^2 f$		7.91	0.87	0.08	0.00	13.03	11.29
$\sigma^2 m$		11.06	4.49	0.03	0.00	2.89	2.50
$\sigma^2 gca$		9.34	2.52	0.06	0.001	8.42	7.29
$\sigma^2 sca$ ($\sigma^2 fm$)		44.30	3.23	0.28	0.01	22.10	18.69
$\sigma^2 fl$		3.40	0.10.	0.15	0.00	1.31	2.30
$\sigma^2 ml$		8.22	1.06	0.03	0.00	-	0.04
$\sigma^2 fml$		34.97	5.38	0.05	0.00	5.65	4.23
$\frac{2\sigma^2 gca}{2\sigma^2 gca + \sigma^2 sca)}$		0.29	0.61	0.30	0.17	0.43	0.44

*, ** indicates significanc at 5 and 1 percent levels, respectively, σ^2 indicates variance (fixed effect)

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Table 2. Estimates of general combining ability effects and *per se* perfomance (in parenthesis) of parents pooled over two environments

Parents	Seed yield per plant (g)	Oil content (%)	Palmitic acid (%)	Stearic acid (%)	Oliec acid (%)	Linoleic acid (%)
(Lines)						
F1 (300A)	-3.17** (6.10)	-1.53** (27.95)	-0.10 (27.77)	-0.03 (1.76)	6.20** (33.06)	-5.90** (57.41)
F2 (234A)	4.56** (6.37)	1.04* (38.62)	0.00 (6.28)	0.03 (1.86)	-0.58 (51.44)	0.49 (40.42)
F3 (7-1-A)	-0.84** (6.22)	0.45 (27.50)	-0.38** (7.01)	-0.02 (2.02)	-0.38 (48.95)	0.97 (42.47)
F4 (207A)	-0.53* (5.29)	-0.01 (30.15)	0.07** (6.34)	-0.05 (1.79)	-3.12** (31.57)	2.82** (59.27)
F5 (86A3)	-0.02 (6.63)	-0.01 (34.13)	0.41** (6.22)	-0.03 (1.90)	-2.13** (46.95)	1.62* (44.98)
S. E. (Females)	0.16	0.17	0.05	0.01	0.40	0.52
(Testers)						
M1 (68-3)	2.06** (4.59)	-1.02* (38.20)	0.26** (7.62)	0.00 (1.56)	2.19** (42.02)	-1.74* (48.81)
M2 (187-333)	7.50** (13.56)	1.72** (40.72)	0.24** (6.27)	-0.07** (1.65)	-0.57 (39.29)	0.71 (52.80)
M3 (108-3)	0.20 (10.57)	-0.58 (38.20)	0.04 (5.66)	0.01 (1.56)	-3.08** (34.75)	2.98** (58.01)
M4 (261-2)	-4.65** (6.17)	-2.46** (37.52)	0.13 (6.55)	0.09** (1.76)	0.94 (34.66)	-1.32 (57.03)
M5 (38-2)	-3.59** (9.89)	0.12 (37.60)	-0.09 (7.85)	0.01 (1.92)	-0.18 (37.56)	0.02 (56.66)
M6 (98-2-3)	-1.52 (9.05)	2.22** (38.50)	-0.06 (7.70)	-0.03 (1.71)	0.70 (33.28)	-0.64 (57.29)
S. E. (Males)	0.30	0.32	0.06	0.01	0.51	0.58

*, ** significant at 5% and 1% levels, respectively.

Table 3. Best crosses based on pooled analysis in respect of sca effects and their *per se* performance

Character	Best Crosses	Sca effect	gca effects			per se performance		
			Female parent		Male Parent	F1	Female Parent	Male Parent
Seed yield (g)	234Ax187-333	30.73**	High	x	High	73.77	6.37	13.36
	86A3x68-3	8.74**	Medium	x	High	40.75	6.63	4.59
	234Ax68-3	6.58*8	High	x	High	43.17	6.37	4.59
Oil Content (%)	86A3x98-2-3	3.02**	Medium	x	High	44.40	34.13	38.50
	7-1-Ax68-3	*3.01***	*High*	*x*	*Low*	*40.00*	*27.50*	*38.20*
	86A3x68-3	2.65**	Medium	x	Low	40.78	34.13	38.20
Palmaitic Acid (%)	300Ax38-2	0.06**	Medium	x	Medium	7.03	7.77	7.85
	300Ax187-333	0.50**	Medium	x	High	7.26	7.77	6.27
	234Ax108-3	0.45**	Medium	x	Medium	7.11	6.28	5.66
Stearic acid (%)	7-1-Ax261-2	0.23**	Medium	x	High	2.13	2.02	1.76
	207Ax187-333	0.14**	High	x	Low	1.95	1.79	1.65
	300Ax108-3	*0.08*	*Low*	*x*	*Medium*	*1.89*	*1.76*	*1.56*
Oleic acid (%)	300Ax108-3	9.02**	Medium	x	Low	61.71	33.06	34.78
	7-1-Ax98-2-3	6.39**	Low	x	Medium	56.27	48.95	33.28
	86A3x261-2	5.85**	Low	x	Medium	54.23	46.95	34.66
Linoleic acid (%)	300Ax98-2-3	8.77**	Low	x	Medium	44.26	57.41	57.29
	86A3x187-333	7.09**	High	x	Medium	51.44	44.98	52.80
	7-1-Ax261-2	4.88**	Medium	x	Low	46.56	42.47	57.03

*, ** indicate significance at 5 and 1 percent levels, respectively

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EFFECT OF NITROGEN AND SULPHUR ON THEIR CONTENT AND UPTAKE IN LINSEED

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ABSTRACT

The content and uptake of nitrogen and sulphur in linseed (*Linum usitatissimum* L) due to application of nitrogen (0,40,80, 120 kg/ha) and sulphur (0,20,40,60 kg/ha) increased significantly in a two years field study on Alluvial soil of Kanpur. The content of N and S was observed to be higher at 30 DAS than at 60 DAS. Oil content significantly increased upto 40 kg S/ha, where as nitrogen had reducing effect on oil content. The maximum apparent recovery of nitrogen and sulphur was recorded at N_{80} and S_{20} levels, respectively.

Key words: Oil content, uptake, apparent recovery, nitrogen, sulphur, linseed.

INTRODUCTION

Linseed (*Linum usitatissimum* L) is a source of vegetable oil and is the mainstay of oil based paints, varnish and linolenum industries. Fibre obtained from its stem is known for its length, strength and beauty. It is spun into linen and yarn. It is also used for various household and interior decoration purposes. The linseed cake is a rich proteinous feed of livestock and preferred for milch cattle.

Linseed is grown throughout the country, mostly on submarginal land under unirrigated and *utera* conditions. Among the several agro-techniques that can increase the productivity of crop, adequate nutrition, particularly nitrogen and sulphur are closely linked to protein metabolism, and their combined effect on oilseed crops could be synergistic (Jaggi *et al* 1993). The effect of N and S on linseed crop is reported in this paper.

MATERIALS AND METHODS

The field experiments were conducted on sandy loam soil during *Rabi* 1989 - 90 and 1990 - 91 at Crop Research Farm Nawabganj, C.S.Azad Unity. of Agric. and Tech. Kanpur with linseed variety Garima as a test crop. The experiment was conducted in split plot design. Nitrogen was applied at four levels (0, 40, 80, and 120 kg/ha) through urea in two splits. Sulphur was applied @ 0, 20, 40 and 60 kg/ha using elemental sulphur as source. The treatments were replicated thrice. Plant samples were taken at 30 and 60 DAS (Days after sowing) and dried at 70°C to a constant weight and ground to pass through a 40 mesh sieve. The deoiled cake was used for the analysis of N and S content. The nitrogen was estimated by microkjeldahl method (Jackson, 1973). Digested sample (HNO_3 : $HCLO_4$ 4 : 1) was taken and sulphur was estimated turbimetrically on colorimeter spectronic 20 (Chesin and Yien 1950). The oil from linseed seed was extracted with the help of petroleum ether using soxhlet extraction assembly. The uptake was obtained by multiplication of yield and nutrient contents. To compare the relative merits of nutrient levels, apparent nutrient recovery was estimated employing the following formula.

$$\text{Apparent nutrient recovery} = \frac{N_r - N_0}{N_a} \times 100$$

N_r = Amount of nutrient recovered by the crop from nutrient treated plot.

N_0 = Amount of nutrient recovered by the crop from control plot

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N_a=Amount of nutrient applied

RESULTS AND DISCUSSION

Nitrogen content

The application of N revealed significant effect on nitrogen content irrespective of season and stages (Table 1). Maximum N content was observed with N_{120} followed by N_{80} at both the stages. Similarly, the response of S application on N content was significant at both stages. The N content increased with increase in the level of sulphur and maximum N content was at S_{60}. The interaction effects of nitrogen and sulphur were also observed to be significant with maximum N content at N_{120} S_{60} during both the years and stages. It is attributed to synergistic effect of S and N content. The enhancement of N content with nitrogen application was also reported by Jaipurkar and Puri (1985). It is also evident that the plant sampled at 30 DAS contained higher nitrogen than 60 DAS, which might be due to translocation of nitrogen in enlarged growth of plant attained at later stage.

Sulphur content

Application of sulphur and nitrogen indiviually and in interactions there of were found significantly effective for increasing the S content during both the years and stages of crop growth (Table 2). On mean basis maximum S content (0.40%) was attributed to N_{120} and 0.442 % to S_{60}. Among the combinations, N_{120} S_{60} increased the S content to maximum at both the stages during the two years.

The magnitude of S content due to S application was higher than N. The increasing trend of sulphur content may be attributed to the added supply of sulphur in soil and also to benificial effect of applied nitrogen on growth and development of plant. The positive effect of sulphur application on S content was also observed by Singh and Singh (1990)

Nitrogen Uptake

Table 1 Effect of nitrogen and sulphur on N content (%) at different stages

N (kg/ha)	1989-90 : S kg/ha					1990-91 : S kg/ha				
	0	20	40	60	Mean	0	20	40	60	Mean
					30 DAS					
0	2.529	2.533	2.540	2.543	2.536	2.530	2.534	2.539	2.595	2.550
40	2.769	2.780	2.792	2.802	2.786	2.779	2.789	2.802	2.818	2.797
80	2.925	2.958	3.042	3.059	2.996	2.935	2.960	3.068	3.032	2.999
120	3.033	3.048	3.057	3.067	3.051	3.285	3.300	3.307	3.313	3.301
Mean	2.156	2.830	2.858	2.868		2.882	2.896	2.929	2.940	
					60 DAS					
0	2.112	2.124	2.130	2.133	2.125	2.129	2.134	2.140	2.143	2.137
40	2.359	2.370	2.382	2.394	2.376	2.369	2.380	2.392	2.404	2.386
80	2.517	2.550	2.615	2.651	2.583	2.525	2.558	2.617	2.659	2.590
120	2.721	2.744	2.753	2.763	2.745	2.741	2.748	2.757	2.797	2.761
Mean	2.427	2.447	2.470	2.485		2.441	2.455	2.477	2.501	

	CD (P = 0.05)		CD (P - 0.05)	
	30 DAS	60 DAS	30 DAS	60 DAS
N	0.055	0.045	0.040	0.043
S	0.011	0.010	0.010	0.012
NXS	0.041	0.040	0.035	0.048

Table 2 Effect of nitrogen and sulphur on S content (%) at different stages

N (kg/ha)	*1989-90 : S kg/ha*					*1990-91 : S kg/ha*				
	0	20	40	60	Mean	0	20	40	60	Mean
					30 DAS					
0	0.306	0.351	0.382	0.386	0.356	0.283	0.385	0.417	0.453	0.385
40	0.307	0.378	0.393	0.396	0.369	0.303	0.397	0.427	0.464	0.398
80	0.310	0.387	0.409	0.433	0.385	0.330	0.410	0.433	0.473	0.412
120	0.312	0.395	0.417	0.448	0.393	0.341	0.424	0.411	0.480	0.414
Mean	0.309	0.378	0.400	0.416		0.314	0.404	0.422	0.468	
					60 DAS					
0	0.253	0.326	0.339	0.364	0.321	0.255	0.329	0.342	0.368	0.324
40	0.273	0.347	0.366	0.384	0.343	0.275	0.350	0.361	0.388	0.344
80	0.304	0.356	0.371	0.394	0.356	0.306	0.359	0.369	0.398	0.358
120	0.323	0.361	0.372	0.400	0.485	0.325	0.364	0.375	0.404	0.367
Mean	0.288	0.348	0.362	0.386		0.290	0.351	0.362	0.390	

	CD (P = 0.05)		CD (P - 0.05)	
	30 DAS	60 DAS	30 DAS	60 DAS
N	0.013	0.017	0.008	0.149
S	0.002	0.005	0.004	0.006
NXS	0.006	0.019	0.011	0.022

The nitrogen uptake in seed and straw were found to be significant (Table 3). The maximum uptake of nitrogen 47.34 and 25.31 kg/ha was observed at N_{120} during both the years in seed and straw, respectively. Similarly, significant effect of sulphur on nitrogen uptake was observed. With each added dose of either nitrogen or sulphur, nitrogen uptake increased significantly. Although interaction effect was not significant the maximum uptake of 49.76 and 27.52 kg/ha in seed and straw, respectively was observed at 120 kg N and 60 kg S/ha. This also indicates the synergistic effect of N and S on seed yield which ultimately leads to nitrogen uptake. Such results were also reported by Singh and Singh (1984). The uptake of nitrogen in seed is higher than straw. This further underlines that the nitrogen is an essential part of protein and higher nitrogen application resulted in higher uptake of nitrogen in the seed.

Sulphur Uptake

The S application significantly and positively influenced the S uptake both in seed and straw (Table 4). The maximum S uptake of 19.23 and 5.70 kg/ha in seed and straw, respectively was recorded with 60 kg/ha. Nitrogen was also found to be significantly effective for enhancing the S uptake. The maximum uptake was observed at 120 kg N/ha and minimum with no nitrogen. The interaction of nitrogen and sulphur was statistically not significant but numerically, the combined application of nitrogen and sulphur increased the sulphur uptake in seed as well as straw. The maximum S uptake of 25.59 and 8.09 kg/ha was recorded with 120 kg N and 60 kg S/ha application. This reveals synergistic effect of nitrogen and sulphur on their uptake. Similar results were also reported by Singh and Singh (1984).

Oil content

The perusal of Table 5 reveals that oil content increased with increasing levels of sulphur. Significant increase in oil content was recorded upto 40 kg S/ha. At higher doses however the

Table 3 Effect of nitrogen and sulphur on N uptake (kg/ha)

N (kg/ha)	1989-90 : S kg/ha					1990-91 : S kg/ha				
	0	20	40	60	Mean	0	20	40	60	Mean
					Seed					
0	14.26	14.70	17.18	17.89	16.01	14.36	17.43	16.75	16.25	16.20
40	20.50	22.71	29.43	29.02	25.42	25.98	29.68	31.29	33.14	30.02
80	30.70	36.14	39.44	40.79	36.77	38.44	40.28	43.87	44.32	41.73
120	34.05	37.96	41.18	43.49	39.17	44.05	46.93	48.63	49.76	47.34
Mean	24.88	27.88	31.81	32.80		30.71	33.58	35.14	35.87	
					Straw					
0	4.65	5.76	6.49	6.56	5.87	6.59	6.45	7.70	7.95	7.17
40	9.21	10.03	10.92	10.89	10.26	10.84	11.25	12.19	12.26	11.64
80	15.87	17.14	17.89	18.63	17.38	17.39	18.72	19.92	20.36	19.10
120	21.14	22.53	24.70	25.72	23.52	22.89	24.29	26.54	27.52	25.31
Mean	12.72	13.87	15.00	15.45		14.43	15.18	16.59	17.02	

	CD (P = 0.05)		CD (P - 0.05)	
	Seed	Straw	Seed	Straw
N	1.190	4.24	2.27	4.50
S	0.31	0.42	0.36	0.52
NXS	NS	NS	NS	NS

Table 4 Effect of nitrogen and sulphur on sulphur uptake (kg/ha)

N (kg/ha)	1989-90 : S kg/ha					1990-91 : S kg/ha				
	0	20	40	60	Mean	0	20	40	60	Mean
					Seed					
0	6.81	7.73	9.75	10.21	8.63	6.67	9.35	9.78	9.68	8.87
40	9.08	11.34	15.79	15.54	12.94	11.27	14.75	16.84	18.16	15.26
80	13.54	17.87	21.42	21.45	18.57	16.97	19.92	22.83	23.50	20.81
120	14.01	17.69	21.07	22.29	18.77	18.24	21.83	24.52	25.59	22.55
Mean	10.86	13.66	17.01	17.37		13.29	16.46	18.49	19.23	
					Straw					
0	1.92	2.38	2.90	3.07	2.57	2.38	2.35	3.02	3.25	2.75
40	3.01	3.56	4.16	4.38	3.78	3.14	3.77	4.41	4.59	3.98
80	4.69	5.33	6.06	6.62	5.68	4.89	5.62	6.47	6.88	5.97
120	5.26	5.98	7.18	7.88	6.58	5.45	6.19	7.41	8.09	6.79
Mean	3.72	4.31	5.08	5.49		3.97	4.48	5.33	5.70	

	CD (P = 0.05)		CD (P - 0.05)	
	Seed	Straw	Seed	Straw
N	2.89	1.25	2.99	1.11
S	0.98	0.16	0.72	0.17
NXS	NS	NS	NS	NS

Table 5 Effect of nitrogen and sulphur on Oil Content (%)

N (kg/ha)	1989-90 : S kg/ha					1990-91 : S kg/ha				
	0	20	40	60	Mean	0	20	40	60	Mean
					Seed					
0	40.77	41.65	42.86	42.96	42.06	40.94	41.93	43.24	43.33	42.36
40	40.69	41.22	42.07	42.09	41.52	40.87	41.50	42.44	42.27	41.77
80	39.86	40.86	41.72	42.28	41.18	40.03	41.01	42.09	42.39	41.38
120	39.72	41.10	41.57	41.97	41.09	39.89	41.12	41.94	42.41	41.34
Mean	40.26	41.20	42.06	42.37		40.43	41.39	42.43	42.59	
		CD (P = 0.05)					CD (P - 0.05)			
	N	NS					NS			
	S	0.41					0.27			
	NXS	NS					NS			

effect was not statistically significant. The maximum oil content of 42.59% was recorded with 60 kg S/ha which is numerically higher but at par with 40 kg S/ha. Interestingly, nitrogen application did not influence the oil content significantly. The maximum oil content of 42.36% was observed when no nitrogen was applied. On the other hand minimum oil content was estimated with 120 kg N/ha during both the years. The increasing effect of S application on oil content was also reported by Dubey *et al* (1987) and reducing effect of nitrogen application on oil content was reported by Dybing (1964).

Recovery of Nitrogen and Sulphur

The apparent increase in N recovery by the plant from applied doses of nitrogen was linear upto 80 kg N/ha (43.58%) but reduced with higher dose (Table 6). The recovery of S from sulphur application was maximum (17.70%) at 20 kg S/ ha but reduced by further application of sulphur. Thus, it can be concluded that application of 80 kg N and 20 kg S/ha is optimum.

Table 6 Apparent N and S recovery at their different doses on two year mean basis.

N levels	Total N uptake (kg/ha)	%N recovered	S levels	Total S uptake (kg/ha)	%S recovered
0	22.63	-	0	15.92	-
40	38.67	40.10	20	19.46	17.60
80	57.49	43.58	40	22.96	17.60
120	67.67	37.53	60	23.90	13.30

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EFFECT OF SULPHUR AND ANTITRANSPIRANTS ON CHLOROPHYLL CONTENT, DRY MATTER PRODUCTION AND OIL YIELD OF RAINFED LINSEED*

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ABSTRACT

Studies were made on rainfed linseed cv. R-552 in clay loam soil of Sagar (M. P.) during winter season 1989-90 and 1990-91 to determine chlorophyll content, dry matter (DM) production and oil yield under varying sulphur levels (0, 10, 20, 30 kg S ha^{-1}) and antitranspirants. Increasing levels of S upto highest level correspondingly increased DM production, leaf area index (LAI) and chlorophyll (a, b and total) contents, but variations beyond 20 kg S ha^{-1} were not significant. Oil content in seeds and oil yield ha^{-1} significantly increased upt 20 kg S ha^{-1}. Foliar application of kaolin 6%, suncap 0.5% and cycocel 0.5% at 30-day growth of crop significantly increased DM production, oil content and oil yield ha-1 over control, but chlorophyll content and LAI were unaffected by them. Numerically, kaolin was one of the best antitranspirants.

Keywords : Sulphur, antitranspirant, oil, linseed.

INTRODUCTION

Linseed (*Linum usitatissimum* L.), a drought tolerant crop, is extensively grown under rainfed conditions on poor and marginal lands of Vindhyan Plateau Zone of M. P. Its productivity is quite low (294 kg ha^{-1}) due to poor growth. Beneficial effects of application of S (Upasani and Sharma, 1986) and suitable antitranspirants (Mathur, 1987) on chlorophyll content, dry matter production and oil yield of rainfed mustard have been emphasized. Hence the present investigation was aimed to evaluate the effect of S and antitranspirants on some growth parameters and oil yield of linseed under rainfed condition.

MATERIALS AND METHODS

A field experiment was conducted on rainfed linseed cv. R-552 during *rabi* season of 1989-90 and 1990-91 in clay loam soil of Sagar (M. P.). The soil of the experimental field was neutral (pH 7.1) in reaction having low available N (235 kg ha^{-1}) and P (9.6 kg ha-1), and high available K (390 kg ha-1) contents. Treatments consisted of four S-levels (0, 10, 20 and 30 kg S ha^{-1}) and four antitranspirants (spraying of water as a control, kaolin 6%, suncap 0.5% and cycocel 0.5%). All treatment combinations were tested in randomized block design with four replications. Sowing was done on November 6, 1989 and October 26, 1990 by drilling 30 kg seeds ha^{-1} in rows 30cm part. A uniform dose of 30 kg N plus 10 kg P_2O_5 ha^{-1} was given at the time of sowing through S-free fertilizers like urea (46% N) and diammonium phosphate (18% N and 46% P_2O_5). Sulphur was applied through elemental sulphur (80% S). Antitranspirants were sprayed at 30-day growth stage of crop by using 250 litres of water ha^{-1}. Chlorophyll 'a' and 'b' contents (Arnon, 1949) and leaf area index (Watson, 1952) were recorded at 60 day-growth (maximum vegetative growth) stage. Dry matter (DM) production of plants was recorded at maturity. Oil content of seeds was determined by Soxhelet extraction method (AOAC, 1965).

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RESULTS AND DISCUSSION

Chlorophyll Content and Dry Matter Production

Growth attributing parameters like leaf area index (LAI) and chlorophyll content (a, b and total) at 60-day growth stage increased correspondingly with every increasing level of S upto the highest level, but variations between closer levels were not much (Table 1). Dry matter production m^{-2} also significantly increased upto 20 kg S ha^{-1} and it slightly reduced with addition of S beyond this limit (Table 2). Sulphur application probably exerted synergistic effects on uptake of essential nutrients by the plants and resulted in increase in these growth parameters. Similar results have been reported by Khanpara *et al.* (1993) in rainfed mustard. Application of antitranspirants like kaolin 6%, suncap 0.5% and cycocel 0.5% increased DM production m^{-2} over control, but they were at par with each other. These antitranspirants had no remarkable influence on LAI and chlorophyll contents as compared to control.

Oil yield

Oil content in seeds significantly varied due to S application over control, but variations between different rates of application did not show consistency in the two years of experimentation (Table 2). Oil Yield significantly increased upto 20 kg S ha^{-1} and further increase beyond this level had no significant increase in first year and even significant reduction was noted in the second year. Seed yield and oil content of seed appeared to be directly related with oil yield and attributed to significant increase upto 20 kg S ha^{-1}. The results are in conformity with the findings of Verma and Swarnkar (1987). Foliar spray of different antitranspirants at 30 days growth stage had no remarkable effects on oil content of seeds over control. But kaolin 6% produced significantly higher oil yield (2.38 q ha^{-1}) than control and remaining two antitranspirants viz., suncap (2.16 q ha^{-1}) and cycocel (2.09 q ha^{-1}). Kaolin had significantly higher seed yield than others which contributed to higher oil yield.

Table 1. Effect of sulphur levels and antitranspirants on LAI and chlorophyll content of linseed at 60-day growth stage.

Treatment	*Leaf Area Index*			Chlorophyll content (mg g^{-1})								
				a			b			Total		
	89-90	90-91	Mean	89-90	90-91	Mean	89-90	90-91	Mean	89-90	90-91	Mean
S kg ha-1												
0	0.497	0.507	0.502	1.25	1.26	1.25	0.62	0.60	0.61	1.87	1.86	1.86
10	0.667	0.665	0.666	1.30	1.33	1.31	0.68	0.69	0.68	1.98	2.02	2.00
20	0.735	0.780	0.757	1.34	1.35	1.34	0.69	0.71	0.70	2.03	2.06	2.04
30	0.829	0.831	0.830	1.37	1.38	1.37	0.71	0.72	0.71	2.08	2.10	2.09
C D (P=0.05)	0.117	0.096	--	0.05	0.06	--	0.06	0.04	--	0.05	0.06	--
Antitranspirants												
Control (water spray)	0.666	0.651	0.658	1.32	1.33	1.32	0.68	0.65	0.66	2.00	1.98	1.99
Kaolin 6%	0.686	0.717	0.701	1.30	1.34	1.32	0.67	0.68	0.67	1.97	2.02	2.00
Suncap 0.5%	0.718	0.724	0.721	1.33	1.32	1.32	0.68	0.68	0.68	2.01	2.00	2.00
Cycocel 0.5%	0.664	0.691	0.677	1.31	1.33	1.32	0.67	0.69	0.68	1.98	2.02	2.00
C D (P=0.05)	N S	N S	--	N S	N S	--	N S	N S	--	N S	N S	--

Table 2. Effect of sulphur levels and antitranspirants on dry matter production, seed yield, oil content and oil yield of linseed

Treatment	Dry matter Production at maturity			Seed Yield (q ha-1)			Oil Content (%)			Oil Yield (q ha-1)		
	89-90	90-91	Mean	89-90	90-91	Mean	89-90	90-91	Mean	89-90	90-91	Mean
S kg ha-1												
0	165	148	156	5.68	2.74	4.21	39.21	39.85	39.53	2.22	1.09	1.65
10	199	169	184	5.96	3.40	4.69	43.40	42.82	43.11	2.59	1.45	2.02
20	211	181	196	6.23	4.93	5.58	43.88	43.21	43.54	2.74	2.13	2.43
30	210	181	195	6.45	4.37	5.41	44.54	43.19	43.68	2.87	1.89	2.38
C D (P=0.05)	1.9	1.7	--	0.35	0.16	--	0.81	0.37	--	0.24	0.14	--
Antitranspirants												
Control (water spray)	186	161	173	5.48	3.65	4.56	40.55	40.43	40.49	2.22	1.48	1.85
Kaolin 6%	201	174	188	6.85	4.06	5.45	43.88	42.82	43.35	3.01	1.75	2.38
Suncap,0.5%	198	171	184	5.91	3.78	4.84	43.37	43.01	43.19	2.56	1.63	2.09
Cycocel 0.5%	201	174	187	6.07	3.94	5.01	43.51	42.82	43.06	2.63	1.70	2.16
C D (P=0.05)	1.9	1.7	--	0.35	0.16	--	0.81	0.37	--	0.24	0.14	0.14

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EFFECT OF CADMIUM ON GROWTH, YIELD AND NUTRIENT COMPOSITION OF SUNFLOWER

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ABSTRACT

The effect of Cd toxicity on Sunflower hybrid (APSH-11) grown on both red and black soils was studied with different levels of Cd applications. There was reduction in plant height and it was significant at 80 mg Cd kg^{-1} soil application both under red and black soils. The dry matter yields significantly decreased beyond 10mg Cd kg^{-1} soil application in red soils and beyond 40 mg Cd kg^{-1} soil application in black soils. There was no further reduction in yield beyond the level of 80 mg Cd kg^{-1} soil and (even upto 160 mg Cd kg^{-1} soil) under black soil conditions. Yellowing of leaves due to Cd toxicity was observed with increased levels of soil Cd applications which are associated with reduction in yield. There is a possibility of deleterious effect of Cd on human beings when it enters the human body through food. The significant positive correlation between tisue Cd and Zn in sunflower grown under both red and black soils was noticed and Zn/Cd ratio was narrowed with increased application of Cd. Tissue Fe content decreased slightly with increase in Cd content but was not significant. There was no correlation between Cd and Cu ; Cd and Mn contents in plant tissue. There was accumulation of Cd in soils after harvest of crop due to application of high doses of Cadmium.

Key words: Sunflower; Toxicity; Cadmium, Nutrient composition.

INTRODUCTION

Cadmium is a non essential and highly toxic element which affects plant growth. Plants take up small quantities (<1mg kg^{-1}) of Cd from soils under normal conditions (Fleischer *et al.*, 1974), but in areas of suspected Cd contamination, the plant contents may be much higher than 1 mg kg^{-1}. Excess cadmium contents in soils lead to reduction in plant growth and dry matter yields (Haghiri, 1973). Plant Cd level should be known to asses the hazards which is effected by several factors like soil properties including soil Cd level. The tolerance of crops to Cd toxicity depends on the ability of crop to absorb cadmium. High levels of Cd in plants also was hazardous to animals and human beings when they consume. Although, information on the toxic effect of Cd on some crops is available, it is lacking with regard to sunflower crop. Hence the present study was undertaken to know the toxic effect of Cd on plant growth, dry matter yield, and tissue nutrient contents in sunflower grown in Red (Sandy loam) and Black (clay loam) soils.

MATERIALS AND METHODS

A pot experiment was conducted during *kharif* 1992 at Agricultural Research Institute, Rajendranagar, Hyderabad to know the excess application/toxic effects of Cd on plant growth, dry matter yield and tissue Cd content in sunflower crop (var. APSH-11). Two types of soils viz Red (sandy loam) and Black (clay loam) soils were selected for study with Cd levels 0, 10, 20, 30, 40, 80mg kg^{-1} soil for Red and 0, 20, 40, 80 and 160 mg kg^{-1} soil for Black soils respectively. Soils were weakly alkaline (pH 7.9-8.2 %), normal in salt content (0.17-0.22 d sm^{-1}), noncalcareous (0.50-0.72%) low in organic carbon content (0.12-0.14 %), medium in available p_2o_5 (18-16 kg ha^{-1}) and high in k_2o (300-310 kg ha^{-1}) content in soil.

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The initial DTPA extractable cadmium contents were 0.3 and 0.15 mg kg^{-1} for selected red and black soils, respectively.

An aqueous solution of Cd and Cd Cl2 was added to 5kg air dried soil in pot as per treatments. The treatments were replicated six times in a completley randomized design. The soils were watered to field capacity and kept in green house for one month to allow the added Cd to equlibrate before sowing. Basal dose of 60 mg N kg^{-1} soil and 50 mg P kg^{-1} soil was applied to both the types of soils at the time of sowing. Ten seeds were sown in each pot and seven seedlings were retained after germination. The plant tops from each pot were harvested at flowering stage, washed thoroughly with distilled and double distilled water and weighed after drying at 70° C in an oven for 48 hours. All the dreid plant samples were digested in 4 : 1 diacid mixture (HNO_3 and $HClO_4$). Soil samples from each pot after the harvest of crop were collected and extractions were prepared with DTPA (Lindsay and Norvell, 1978). Cadmium and other micronutrient contents in plant and soil extracts were determined by Atomic Absorption Spectrophotometer.

RESULTS AND DISCUSSION

Plant height

There was a reduction in plant height due to application of different levels of cadmium and it was significant at 80 mg Cd kg^{-1} soil application both in red and black soils (Table 1). The retardation of plant growth was due to high levels of Cd in plants. Reduction in plant height and root damage was associated with Cd concentrations in plants (Haghiri, 1973).

Dry matter yield

A reduction in dry matter yield of sunflower was observed with increased levels of Cd applications under both the soil types (Table 1). The dry matter

Table 1. Plant height and Dry matter yield of sunflower as affected by soil added Cd levels.

Cd applied (mg kg^{-1} soil)	Plant Height (cm)	Dry matter yield (g pot-1)	Percent reduction in Dry matter
		Red soil	
0	28.3	37.0	--
10	25.0	33.0	10.8
20	24.0	30.7	17.0
40	21.0	27.6	25.4
80	16.6	23.0	37.8
CD (P=0.05)	4.60	3.3	
		Black soil	
0	28.6	25.0	-
20	27.0	24.0	4.0
40	25.7	22.3	10.8
80	24.3	21.0	16.0
160	24.0	21.0	16.0
CD (P=0.05)	3.2	1.9	

yields were significantly reduced from 10 mg cd kg^{-1} soil application onwards for red soils and from 40 mg Cd kg^{-1} soil application onwards for black soils when compared to no application of cadmium. There was no futher reduction in dry matter yields of sunflower beyond the level of 80 mg Cd kg^{-1} soil in black soils. This may be due to higher fixation and higher CEC of black soils (50 cmol (p^+) kg^{-1}) compared to red soil (8.5 cmol (p^+) kg^{-1}). The percent reduction in dry matter yields of sunflower grown in red soils (10.8-37.8) was more compared to black soils (4.0-126.0). These results indicated that in the coarse texured soils, Cd was highly available to plants and had an adverse effect on yield even at lowest level of application of 10 mg Cd kg^{-1} soil. Similar observations were reported by Singh and Nayyar (1994) with regard to forage species. The reduction in crop yields due to Cd application are in agreement with the findings of Chaney *et al.* (1977), Honma and Hirata (1974), Mehla *et al.*, (1988), Sarkunan *et al.* (1991), Gupta and Dixit (1992). The yellowing of leaves and development of brown necrotic spots on older leaves were common toxicity symptoms observed at higher levels of Cd applications. The intensity of toxicity symptoms increased with enhanced soil applications of Cd levels to sunflower grown on both red and black soils. Haghiri (1973) also observed similar toxicity symptoms in soybean.

Cadmium and other micronutrient contents and their uptake by plant tissue

The relative concentrations of Cd in sunflower crop increased with increased rates of Cd application. There was significant increase in tissue Cd content and its uptake (Table 4) in

Table 2. Effect of applied cadmium levels on tissue cadmium and micro nutrient contents in Sunflower.

Cd applied ($mg\ kg^{-1}$)	Content in plant($mg\ kg^{-1}$)		Zn : Cd ratio	Cd content in soil after harvest of crop ($mg\ kg^{-1}$)	Micro nutrient concentration ($mg\ kg^{-1}$)		
	Cd	Zn			Cu	Fe	Mn
			Red soil				
0	1.2	27.6	23:1	0.25	9.7	235.0	24.8
10	22.5	30.4	1.4:1	8.0	9.1	203.5	25.6
20	33.7	31.6	0.9:1	16.0	9.8	208.6	23.6
40	63.5	33.1	0.5:1	24.0	9.4	189.0	24.8
80	110.0	35.2	0.3:1	30.0	9.3	116.8	22.5
CD (P=0.05)	4.3	5.8	-	-	NS	NS	NS
			Black soil				
0	0.75	26.4	35:1	0.1	9.8	253.1	26.4
20	11.8	28.9	2.4:1	4.8	11.8	213.5	25.9
40	16.2	30.6	1.9:1	10.0	12.1	209.1	25.9
80	30.7	31.6	1:1	24.0	11.1	199.7	18.5
160	43.5	32.4	0.7:1	34.0	10.8	197.5	30.5
CD (P=0.05)	1.6	0.7	-	-	NS	NS	NS

Table 3. Effect of cadmium levels on uptake of cadmium and other micronutrients.

Cd applied (mg kg^{-1}) soil	Uptake of nutrients (mg pot^{-1})				
	Cd	Zn	Cu	Fe	Mn
		Red Soil			
0	0.05	1.02	0.33	8.82	0.99
10	0.74	1.00	0.40	6.90	0.88
20	1.03	0.97	0.37	6.41	0.78
40	1.76	0.93	0.31	6.27	0.59
80	2.48	0.81	0.26	2.74	0.73
CD (P=0.05)	0.25	0.06	0.10	2.94	**NS**
		Black Soil			
0	0.02	0.66	0.24	6.16	0.61
20	0.28	0.69	0.22	5.12	0.62
40	0.36	0.67	0.22	4.67	0.53
80	0.65	0.66	0.20	4.25	0.53
160	0.83	0.68	0.20	4.23	0.55
CD (P=0.05)	0.15	NS	NS	0.96	NS

sunflower crop grown on both red and black soils with increased levels of cd applictions to soil. The yield reduction has been attributed to the direct effect of cd concentration in plant tissue. These results are in conformity with the findings of Gupta and Dixit (1992) and Singh and Nayyar (1994).

Tissue Zn content increased with increased applications of Cd doses (Table 2) in both the types of soils. Significant positive correlations were observed between Cd and Zn content in plants grown on both red soils (r=0.96**) and black soils (r=0.93**). These results are similar to the findings of Singh and Nayyar (1994). Apart from ionic composition, the growth depression caused by cd is the possible explanation for enhancing tissue zn (walker *et al.* 1979). The Zn/Cd ratio in plant tissue in the absence of applied Cd was 23 and 35 which reduced drastically to 1.4 to 2.4 when 10 to 20 mg cd kg^{-1} soil was applied to red and black soils respectively. Gupta and Dixit (1992) reported similar results in cereals and pulses.

Even though there was a slight tendency of decrease in tissue Fe content with increased applications of Cd, it was not significant (Table 2). There was no correlation between Cd and Cu; Cd and Mn contents of plant tissue. Theuptake of Fe by sunflower crop grown on both red and black soils, significantly decreased at higher doses of Cd application when compared to control. No consistant trend in uptake of Zn, Cu and Mn was observed due to Cd application (Table 3).

DTPA exractable Cd in soil after crop harvest

It could be noticed from the data (Table 2) that accumulation of Cd after the harvest of sunflower crop was more in soil applied with higher doses of cadmium in both red and black soils. The accumulation of DTPA extractable Cd in soil after harvest was more in red soils than in black soils. This may be due to the fact that red soil has less CEC than black soil resulting in the higher percent saturation of Cd in red soil than in black soil.

From the above discussion, it may be concluded that when crops are grown on soils having toxic levels of cadmium, there will be adverse effect not only on soil properties and plant growth, but also in increasing Cd contents in plant tissues. Therefore, it could also be expected to have deleterious effect of Cd on the animal systems, especially the human beings, when it enters the human body through food.

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CONTRIBUTION OF PRODUCTION FACTORS TO YIELD AND INCOME OF RAINFED CASTOR

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ABSTRACT

The yield levels of castor in rainfed environment in farmer's field were very low (+ 180-250 kg/ha) and widely fluctuate due to vagaries of rainfall, use of local seed and poor management. To achieve stability of castor in farmer's fields, the Farm Science Centre of 'CRIDA' organized skill oriented trainings and also demonstrations after assessing the gaps in production of castor for the farmers in Ranga Reddy district. The results of crop cutting survey in both trainees and non-trainees fields indicated that use of improved seed (GCH-4) alone on an average increased the seed yield by 41 per cent compared to the local 'Aruna'; while top dressing of 20 kg N/ha through urea recorded additional income of Rs.1150/ha compared to basal application of 10-30-0 over years. Under moisture stress situations, 20 kgN/ha as top dressing along with basal application of 10-30-0 NPK kg/ha was found optimum. Sowing of castor in second fortnight of June recorded the highest bean yields of castor. Delayed sowing of castor by 15,30 and 45 days after first fortnight of June reduced yield by 9, 30 and 40 per cent respectively. Control of weeds with two harrowings recorded additional cost-benefit ratio of 11.5 as against the recommended practice of two blade harrowings followed by one hand weeding over the years. Use of improved seed, recommended dose of fertilizer and control of semilooper by the farmers increased the bean yield of castor by 95 per cent compared to the traditional practices adopted by the farmer.

Keywords : Production factors, Yield, Income, Castor.

INTRODUCTION

Castor (*Ricinus communis* L.) is an important non-edible oilseed crop grown widely in rainfed Alfisols of Andhra Pradesh. The productivity of this crop in rainfed environment ranged from 180 to 250 kg/ha (Anon, 1989). The yield levels of castor quite often fluctuate due to vagaries of monsoon, use of non-descriptive cultivars and poor management practices (Anon, 1990). The seed yield of castor in the farmers' fields can be enhanced atleast by 200 per cent with adoption of improved genotypes, moderate levels of nutrients, timely sowing and control of semilooper (Anon, 1986). Hence there is a need to assess the effect of factors of production on yield and income gains in the farmers' fields for rapid spread of the technologies.

MATERIALS AND METHODS

For this study, the castor growing farmers in Yacharam and Ibrahimpatnam Mandals of Ranga Reddy District of Andhra Pradesh were selected randomly. The practices adopted by the farmers and the need to enhance the castor production were assessed by the rapid rural survey methods. About 60 farmers from different villages of varied size holdings in each year were trained in improved technologies at Farm Science Centre, CRIDA from 1990 to 1995 from February-May. In addition, the frontline demonstrations on castor to quantify the benefits of critical inputs (improved seed (GCH-4), Top dressing of N @ 30 kg/ha and control of semi-looper) were also conducted in the farmers' fields along with controls in all the years. At the time of harvest, the yields of castor in both demonstrations and non-demonstrations were recorded through crop cutting surveys. The economic analysis of input and output relationships were also worked out to quantify the benefits of technologies in all years.

The castor crop in demonstration sites

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received about 718, 519, 410, 495, 594 and 726 mm rain in 1990,1991,1992,1993,1994 and 1995 respectively as against the normal of 553 mm during the crop growth periods. Dry spells of >13 days during vegetative phase was noticed in 1991,1992 and 1994. The early withdrawal of monsoon in 1993 and 1995 affected the seed yields of secondary and tertiary spikes of castor (Table 1).

RESULTS AND DISCUSSION

Contribution of production factors

The use of hybrid castor (GCH-4) on an average recorded additional bean yield of 283 kg/ha compared to local Aruna (295 kg/ha). The additional investment of Rs.185/ha on hybrid seed offered Rs.1525/ha over the variety (Fig.1 and 2). The difference in the seed yield of castor with hybrid over Aruna increased with moisture stress conditions in years of erratic distribution of rainfall (Rao *et al.*, 1986).

The farmers in selected villages normally use 10-30-0 NPK kg/ha as basal dose for castor. Top dressing of urea at 30-60 days after sowing @ 20 kg N/ha along with basal (10-30-0 NPK kg/ha) as critical input recorded additional seed yields of castor by 221, 40, 170, 203 and 212 kg/ha compared to the normal practice adopted by the farmers in 1991, 1992, 1993, 1994 and 1995, respectively. Additional application of 40 kg N/ha gave increased bean yields of castor by 190 and 360 kg/ha in 1992 and 1993, respectively. However, application of 20 kg N/ha as top dressing was found economically optimum while considering additional cost benefit ratios although higher bean yields were achieved with 40 kg N/ha (Fig.3). Castor with 50-30-0 NPK kg/ha gave higher seed yields under rainfed conditions in favourable environment in sole and intercropping with clusterbean (Reddy, 1986 and Venkateswarlu, 1989).

Timely sowing and precision are critical factors in stepping up the seed yields of castor in

Table - 1: Rainfall quantum and distribution in experimental sites during crop growth period.

Years	Rainfall (mm)						Total rainfall	Time of sowing
	July	Aug.	Sep.	Oct.	Nov.	Dec.	(mm)	
1990	138 (11)	212 (12)	61.4 (5)	256 (10)	51.2	--	718 (42)	1st week of July
1991	65 (5)	42 (5)	292 (5)	82 (3)	38 (5)	--	519 (23)	2nd week
1992	64 (7)	95 (9)	110 (9)	52 (5)	89 (4)	--	410 (34)	"
1993	126 (9)	79 (6)	135 (9)	110 (11)	--	45 (2)	495 (35)	"
1994	65 (7)	151 (10)	62 (4)	279 (9)	37 (4)	--	594 (34)	"
1995	183 (10)	103 (5)	186 (9)	242 (11)	11.8 (1)	--	726 (36)	"
Normal (Average)	195	118	136	80	19	5	553	"

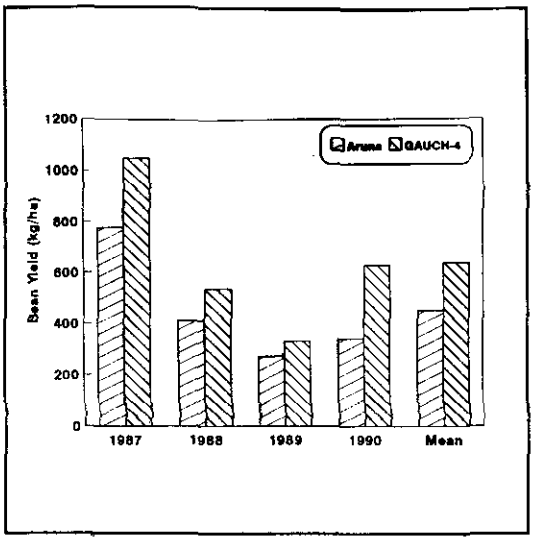


Fig - 1: Contribution of improved seed on bean yield of castor

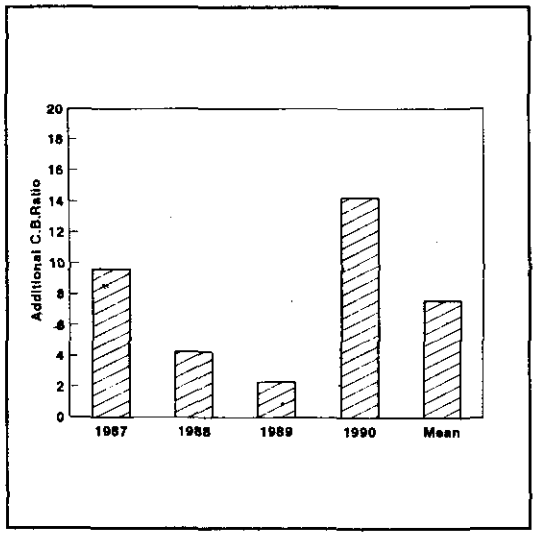


Fig - 2 : Effect of hybrid castor on additional C.B. Raito over Aruna

rainfed environment. Sowing of castor in farmers' fields in second fortnight of June gave on an average bean yield of 672 kg/ha over the years (Table-2). While castor sown in first and second fortnight of July and first fortnight of August recorded 9, 30 and 40 per cent reduction in bean

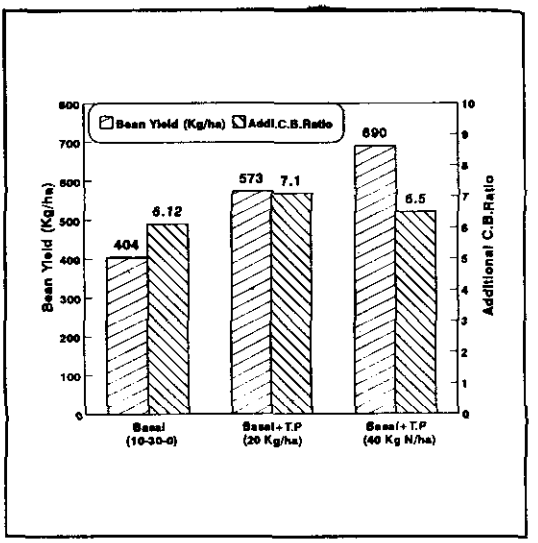


Fig - 3: Economics of fertilizer use in rainfed castor

yield and also reduced income of Rs.992, 2234 and 2882/ha respectively than second fortnight of June. Thus, castor can be sown in the farmers' fields upto first fortnight of July with marginal reduction in income. Early sowing of castor was found advantageous in the years of normal distribution of rainfall and also in case of early withdrawl of monsoon. Weed control in inter rows is a common practice adopted by the majority of the farmers. Hand weeding to control intra row weeds is a rare practice in castor fields. The results showed that controlling of intra row weeds with hand weeding with investment of Rs.600/ha alongwith two blade harrowing gave on an average additional seed yield of 150 kg/ha than farmers' practice of weed control. Intra row weed control in castor has marginal/no benefit in stressed environment while considering additional cost benefit ratios (Fig. 4).

Potential effects of critical inputs on seed yields.

The Front Line Demonstrations conducted in the farmers' fields in same villages showed that use of hybrid (GCH-4), top dressing of 40 kg N/ha

Table 2: Influence of time of sowing on seed yield and income in rainfed castor (1990-95)

Time of sowing	Seed Yield (kg/ha)	Gross Income (Rs./ha)	Reduction	
			Seed yield (%)	Income (Rs./ha)
2nd fortnight of June	672	6482	--	--
1st fortnight of July	610	5490	9.0	992
2nd fortnight of July	472	4248	30.0	2234
1st fortnight of August	400	3600	40.0	2882

Fig - 4: Effect of weed management practices on bean yield and income of rainfed castor

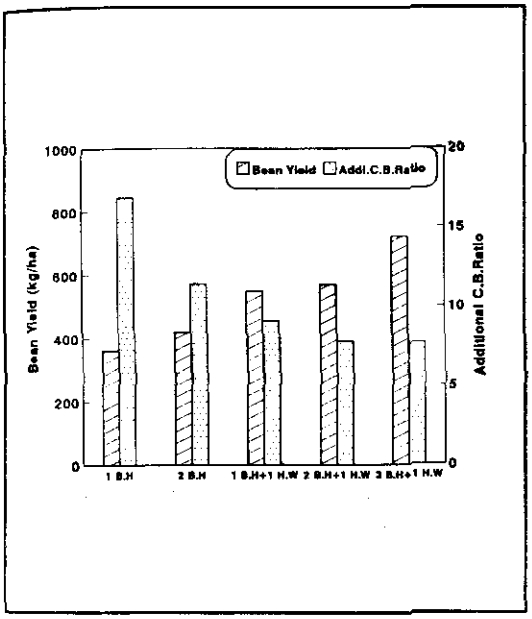
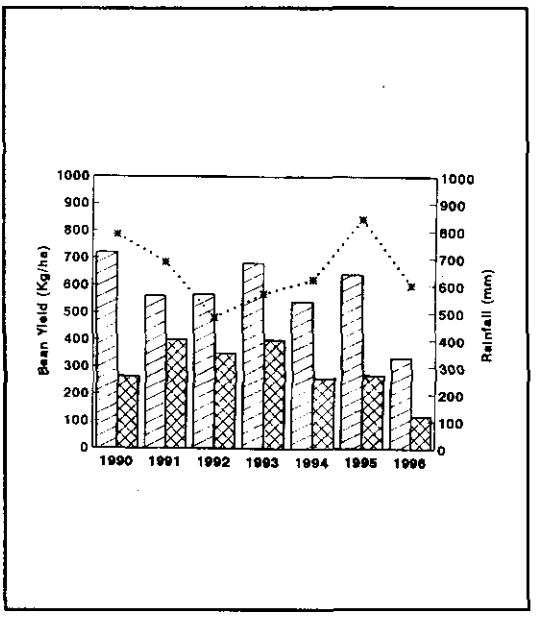


Fig - 5: Potential of critical inputs on yield and income in rainfed castor



and control of semilooper by chemicals on an average recorded an additional seed yield of 283 kg/ha and gross income of Rs.2660/ha (cost benefit ratio of 3.7) compared to no critical inputs (Fig.5). The differences in yield and income increased (4.34 to 6.83 CB ratio) in years of good rainfall distribution (Fig.5). The decreased cost benefit ratios of critical inputs in 1991 and 1992 was due to deficit of 136 and 70 mm of rainfall at vegetative growth stages and also excess rainfall of 136 mm during formation of secondaries which resulted in the incidence of Botrytis grey rot on capsules. Thus the critical inputs of improved seed (GCH-4), top dressing of N and plant protection measures to control semilooper gave highest yield and income gains (Rs.4100-280/ha) in good rainfall distribution years like 1990,1995,1993

Table -3 : Yields of rainfed castor as influenced by fertilizer

Practice	Castor Bean yield (kg/ha)					
	1991	1992	1993	1994	1995	Mean
Basal (10-30-0)	324	490	340	370	495	404
Basal (10-30-0) + 20 kg N/ha top dress	545	530	510	573	707	573
Basal (10-30-0) + 40 kg N/ha top dress	--	680	700	--	--	690

and 1994. While in severe drought years like 1991 and 1996, the additional income ranged from Rs.900-1950/ha. In years of normal rainfall improved seed (hybrid GCH-4), sowing of castor in the second fortnight of June, use of 10-30-0 NPK kg/ha and intra row weed control by hand weeding contributed to enhance the seed yields of castor by 150,210,170 and 155 kg/ha, respectively over the traditional practices of the farmers. While the combination of hybrid seed, top dressing of urea and semilooper control in castor enhanced the seed yields by 370 to 455 kg/ha in the farmers' fields as compared to the farmers methods of cultivation. While in drought years, hybrid seed followed by top dressing of 20 kg N/ha contributed to get higher seed yields of 275 and 100 kg/ha, respectively than a variety and basal application of (10-30-0 NPK kg/ha) as practiced by the farmers.

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INFLUENCE OF SULPHUR AND ANTITRANSPIRANTS ON MORPHO-PHYSIOLOGICAL GROWTH AND YIELD OF RAINFED LINSEED*

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ABSTRACT

A field experiment was conducted on rainfed linseed cv. R- 552 at Sagar (M.P.) during winter 1989-90 and 1990-91 to evaluate the effect of different S-levels (0,10,20,30 Kg S ha^{-1}) and antiranspirants on morpho-physiological growth pattern and yield. Continuous increase in plant-height and branches/ $plant^{-1}$ upto 90 days after sowing (DAS) and leaves $plant^{-1}$ upto 60 DAS was observed and then the values declined. But dry matter (DM) production m^{-2} increased til the maturity. The crop growth rate (CGR) during growing period was in sigmoid pattern, while relative growth rate (RGR) and net assimilation rate (NAR) reduced gradually till the maturity. The DM production m^{-2}, plant - height, branches $plant^{-1}$, leaves $plant^{-1}$, capsules $plant^{-1}$, seeds $capsules^{-1}$ and seed yield ha^{-1} correspondingly increased with S application upto the highest level, but differences were not significant beyond 20 Kg S ha^{-1}. Application of S at varying rates significantly increased CGR over control and the results reversed for RGR and NAR. Foliar spray of antitranspirants at 30 DAS helped to improve above growth parameters and seed yield as compared to control. Kaoline 6% proved superior to cycocel 0.5% and suncap 0.5%.

Key Words : Sulphur, Antitranspirants, Morpho-physiological parameters, Linseed.

INTRODUCTION

Linseed (*Linum usitatissimum* L) is an important oilseed crop extensively grown under rainfed condition during winter season in Sagar region of Madhya Pradesh. Generally, morpho-physiological growth parameters of rainfed crop are very poor even with the use of fertilizer. Poor growth is mainly caused by moisture stress during the growing period of crop as well as S-deficiency in the soil developed due to intensive cropping and use of S-fertilizers. Thus, application of adequate quantity of S can improve the growth and yield of crop. Foliar spray of effective antitranspirants to reduce the moisture losses in rainfed crop without distrubing the physiological processes can also improve the growth and yield (Abou-Khaled *et al.* 1970). Hence, the present investigation was undertaken to evaluate the effect of Sulphur and antitranspirants on morpho-physiological growth parameters and yield of rainfed linseed.

MATERIALS AND METHODS

A field experiment was conducted on rainfed linseed cv. R-552 in clay loam soil at Sagar (M.P.) during winter season of 1989-90 and 1990-91. The soil of the experimental field was neutral in reaction (pH 7.1) having low available N (235 kg ha-1) and high available K (394 Kg ha^{-1}) contents. Treatments consisting of 4, S- levels (0,10, 20 and 30 Kg S ha^{-1}) and 4 antitranspirants (water spray, koaline 6%, cycocel 0.5% and sun cap 0.5%) were replicated 4 times in randomised block design. Sowing was done on November 6, 1989 and October 26, 1990 with a uniform basal dose of 40 Kg N, 30 Kg P_2O_5 and 10Kg K_2Oha^{-1} through urea, diammonium phosphate and muriate of potash. Sulphur was also applied at the time of

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sowing through gypsum (16% S) as per treatments. All antitranspirants were sprayed at 30-day growth stage of crop. Growth parameters viz., capsules plant^{-1}, seeds capsule^{-1} and seed yield ha^{-1} were recorded at maturity. The growth analysis viz. CGR and RGR (Watson, 1952) and NAR (Gragory, 1926) were determined at different growth stages. Mean data for both years were statisticaly analyzed.

RESULTS AND DISCUSSION

General growth pattern

Plant height and number of primary branches plant^{-1} successively increased till 90 DAS with more rapid rate between 30 to 60 DAS under all treatments and thereafter the growth of these parameters ceased (Table 1). Number of leaves plant^{-1} increased only upto 60 DAS and then declined. DM accumulation by plant m^{-2} (Table 2) gradually increased with the advancement in growth till maturity because of increasing rate of nutrient uptake including S (Aulakh and Pasricha, 1983). The CGR increased till 60 DAS and then decreased at 90 DAS and again increased at maturity. The translocation of photosynthates towards reproductive activities (flowering and seed formation etc.) after 60 DAS resulted in reduced CGR. But at maturity, photosynthates and food materials synthesized in seeds and thereby, CGR again increased. The RGR and NAR values were maximum at early growth stage

Table 1 Morpho-physiological growth parameters and yield of linseed at different growth stages under different S levels and antitranspirants

Growth stages	Sulphur (kg/ha)					Antitranspirants				
	0	10	20	30	C.D (P=0.05)	Control	Kaolin 6%	CCA 0.5%	Sun Cap 0.5%	C.D. (P=0.05)
Plant height (cm)										
30 DAS	17.3	18.1	18.9	19.6	0.9	18.4	18.7	18.3	18.5	N.S.
60 DAS	37.2	39.1	40.4	41.5	0.4	39.4	39.8	39.3	39.7	0.4
90 DAS	46.2	48.0	49.0	50.1	0.4	48.9	48.8	47.8	47.9	0.4
Maturity	48.0	49.4	50.9	49.6	0.6	49.8	50.2	49.0	49.4	0.6
Primary branches plant^{-1}										
30 DAS	1.50	1.56	1.59	1.62	N.S.	1.54	1.60	1.57	1.58	N.S
60 DAS	2.34	2.71	2.75	2.78	0.18	2.51	2.73	2.65	2.68	N.S.
90 DAS	2.61	2.92	2.95	2.99	0.16	2.69	2.98	2.88	2.92	0.16
Maturity	2.55	2.88	2.87	2.91	0.15	2.67	2.90	2.80	2.82	0.15
Leaves plant^{-1}										
30 DAS	118	137	147	174	8	144	143	145	143	N.S.
60 DAS	209	242	255	267	10	235	250	248	142	N.S.
90 DAS	49	71	81	94	2	71	76	74	73	2
Capsules plant^{-1}										
Maturity	24.5	26.4	28.7	29.3	0.7	26.0	29.4	27.1	26.7	0.7
Seeds capsule^{-1}										
Maturity	6.2	6.5	6.9	6.7	0.3	6.4	6.8	6.4	6.7	0.3
Seed yield q ha^{-1}										
Maturity	4.21	4.68	5.58	5.41	0.26	4.56	5.46	4.85	5.01	0.26

DAS - Days after sowing CCA - Cycocel

(30DAS) and then gradually reduced till the maturity.

Effect of S-levels

Every incremental dose of S (0,10,20 and 30 Kg ha^{-1}) correspondingly increased the morpho-physiological parameters at all growth stages of crop (Table 1). Plant height, primary branches $plant^{-1}$, leaves $plant^{-1}$, capsules $plant^{-1}$, seeds $capsule^{-1}$ and seed yield ha^{-1} increased due to S application upto the highest level, but differences were not significant beyond 20 Kg S ha^{-1} for branches and capsules $plant^{-1}$, seeds $capsule^{-1}$ and seed yield ha^{-1}. Increasing rates of S application significantly increased DM production m^{-2} upto the highest level (Table 2). The CGR, RGR and NAR values also increased correspondingly with increasing rates of S, but differences were significant mostly upto 20 Kg S ha^{-1}. As a consequence, the morpho-physiological parameters and seed yield increased upto 20 Kg S ha^{-1} which confirmed the findings of Agasimani (1991) and Mohan and Sharma (1992).

Effect of antitranspirants

As antitranspirants were applied at 30 DAS, morpho-physiological parameters changed with the advancement in the growth stages (Table 1). Use of different antitranspirants produced taller plants with more branches and leaves $plant^{-1}$ than control (water spray), but antitranspirants had no consistent effect on all parameters. Cycocel

Table 2 Physiological growth analysis of linseed at different growth stages under different S levels and antitranspirants

Growth stages	Sulphur (kg/ha)					Antitranspirants				
	0	10	20	30	C.D (P=0.05)	Control	Kaolin 6%	CCA 0.5%	Sun Cap 0.5%	C.D. (P=0.05)
D M production ($g\ m^{-2}$)										
30 DAS	24.90	33.25	42.30	44.00	0.67	36.05	36.40	35.93	36.08	N.S
60 DAS	77.13	85.17	90.56	97.57	0.74	83.60	88.95	88.04	89.35	0.74
90 DAS	119.45	126.59	130.04	132.21	1.10	118.70	130.61	128.75	130.20	1.10
Maturity	148.29	169.40	180.65	180.75	1.65	161.25	173.75	170.50	173.73	1.65
C G R ($g\ m^{-2} day^{-2}$)										
30 DAS	0.83	1.11	1.41	1.47	0.01	1.20	1.21	1.20	1.20	N.S.
60 DAS	1.60	1.63	1.85	1.79	0.02	1.61	1.70	1.77	1.78	0.02
90 DAS	1.31	1.29	1.38	1.42	0.04	1.14	1.36	1.32	1.45	0.04
Maturity	1.39	1.45	1.78	1.65	0.07	1.41	1.53	1.43	1.46	0.07
RGR ($mg\ g^{-1} day^{-1}$)										
30 DAS	46.45	50.30	53.93	54.57	1.10	51.87	51.53	51.20	51.28	N.S.
60 DAS	16.29	13.98	11.27	11.71	0.12	12.87	13.07	13.71	13.71	0.12
90 DAS	6.28	5.68	5.09	4.33	0.15	4.90	5.53	5.27	5.68	0.15
Maturity	3.24	4.21	4.89	5.59	0.19	4.49	4.38	4.08	3.98	0.19
NAR ($mg\ cm^{-2} day^{-1}$)										
30 DAS	1.763	1.463	1.395	1.378	0.033	1.356	1.384	1.315	1.344	N.S.
60 DAS	0.233	0.175	0.135	0.124	0.004	0.159	0.164	0.168	0.175	0.004
90 DAS	0.231	0.151	0.123	0.108	0.006	0.139	0.154	0.149	0.178	0.006

DAS - Days after sowing CCA - Cycocel

reduces the vegetative growth and thus, minimizes the water loss by the plants through transpiration. Kaolin forms stomatal plugs on leaf surface which reduces loss of water by transpiration. Suncap forms invisible films on transpiring surface to prevent stomatal opening and thus, effectively checks the transpiration. Hence, the application of these antitranspirants utilizes the available soil water more effectively to improve the morphological growth parameters. Application of antitranspirants significantly increased DM production m^{-2} and CGR over control, while RGR and NAR values did not show any consistent trend due to them (Table 2). Kaoline topped in DM accumulation by the plants closely followed by suncap and both were superior to cycocel in this regard. Therefore kaoline proved to be the best closely followed by suncap for improving the morpho-physiological growth parameters and seed yields. Similar results were reported by Joshi *et al* (1987) and Mathur (1987).

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EFFECT OF SOURCES AND LEVELS OF SULPHUR ON YIELD ATTRIBUTES, SEED YIELD AND ECONOMICS OF SOYBEAN*

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ABSTRACT

Field experiments were conducted on soybean cv. JS 335 in clayloam soil of jabalpur (M.P.) during rainy season 1995 and 1996 to evaluate the efficiency of S-source viz., elemental sulphur (ES), gypsum (GY) and oxalic acid industry waste (OAIW) under different S-levels viz., 0, 10, 20 and 40 kg S ha^{-1}. Results revealed that application of 10 kg S ha^{-1} significantly improved yield attributing characters viz., branches, pods, seeds $plant^{-1}$, seed index and seed yield ha^{-1} and proved more remunerative over control. Seed yields did not vary due to different S-levels, but seed yield and gross monetary return increased correspondingly with increase in S rates upto 20kg S ha^{-1}. The efficiency of all three S-sources was almost equal for soybean yield, but OAIW proved to be more economical.

Key words: S-sources, S-levels, Yield attributes, Soybean.

INTRODUCTION

Madhya pradesh is the largest soybean producer in the country. It covers nearly 80 percent of the national hactarage (39.93 lakh ha.) and production (38.92 lakh tonnes). Deficiency of S is spreading widely in soybean growing areas of the state resulting in reduction in the productivity level. Continuous cropping of soybean with use of S-free fertilizers like diammonium phosphate and urea under intensive crop sequences appears to be the probable reason for development of S-deficiency. Sulphur application with efficient source may be the remedial measure to improve the soybean yield in such areas. Thus, it is imperative to evaluate the efficiency of S-source and determine the suitable S-requirement of the crop. Keeping these in view the present investigation has been undertaken.

MATERIALS AND METHODS

The field experiments were conducted on soybean cv. JS 335 during rainy season of 1995 and 1996 in clay loam soils of Jabalpur (M.P.). The soil of the experimental field was neutral (soil pH 7.5) with low organic carbon (0.58%). The available N, P, K and S contents of the soil were 228, 7.9, 351 and 6.8 kg ha^{-1} respectively. The rainfall during crop season was 1159 and 767 mm during 1995 and 1996 respectively. The treatments consisting of three S-sources viz., elemental sulphur (ES), gypsum (GY) and oxalic acid industry waste (OAIW) ; three S-levels (10, 20 and 40 kg S ha^{-1}) and a absolute control (no S application) were tested in factorial randomised block design with three replications. Sowing was done on July 17 and 13 in the two consecutive years. Seeds were inoculated with Rhizobium bacterial culture 5 g kg-1 before sowing. A uniform dose of fertilizer 20 kg N+60 kg P_2O_5 and 20 kg K_2O ha^{-1} was applied through urea (46%), diammonium phosphate (18% N and 46% P_2O_5) and muriate of potash (60% K_2O) along with S through appropriate source and rate as per treatments. These fertilizers were applied at the time of sowing by placing 2-3 cm below the seeds.

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Data on different yield attributing characters and seed yield were recorded in both years and economics of the treatments were determined on the basis of two years mean seed yield.

RESULTS AND DISCUSSION

S-Source

Different S-sources did not cause marked influence on yield attributing characters viz., branches plant^{-1}, and seed index, but pods plant^{-1} and seeds pod^{-1}significantly varied (Table-1). Elemental Sulphur significantly produced higher pods plant^{-1} than GY and OAIW, while GY and ES being at par significantly produced more seeds pod^{-1} then OAIW. The S releasing efficiency of all the three S-sources was almost similar. Therefore, none of them was able to prove its consistency for superiority in yield attributing characters. As a consequence, seed yields did not differ due to different S-sources. The position of S-sources was in order of ES>GY>OAIW based on two years mean yield data (Table 2). Though OAIW produced the minimum seed yield among the three sources, it proved more remunerative withregards to net profit and benefit cost ratio because of its cheapness compared with other two sources. Theses results also corroborate the findings of Sharma and Gupta (1992) Kandpal and Chandel (1993), and Lal *et al.*, (1993).

S-levels

The treatments receiving S application with varying rates through different sources were significantly superior with regard to the yield attributing characters (Table 1) ; seed yield and monetary benefit (Table 2) than control (without S application). Yield attributes viz., branches plant^{-1}, pods plant^{-1}, seeds pod^{-1} and seed index

Table 1 : Effect of sources and levels of sulphur on yield attributes of soybean

Treatment	Branches plant^{-1}		Pods plant^{-1}		seeds pod^{-1}		Weight g seed $^{-100}$	
	1995	1996	1995	1996	1995	1996	1995	1996
S-source								
Elemental Sulphur (ES)	4.23	4.45	24.44	33.69	2.37	2.20	12.13	12.47
Gypsum (GY)	4.25	4.40	20.80	29.98	2.43	2.23	12.18	12.26
Oxcalic acid industry waste (OAIW)	3.81	4.63	21.36	32.63	2.20	2.08	12.13	12.61
S.EM. ±	0.19	0.11	0.74	0.68	0.04	0.03	0.05	0.05
C.D. (P=0.05)	0.47	N.S.	2.18	2.00	0.13	0.10	N.S.	N.S.
S-level (kg ha-1)								
10	3.51	3.82	21.23	29.77	2.25	2.09	11.84	12.32
20	4.08	4.45	21.48	32.55	2.36	2.16	12.22	12.51
40	4.73	5.20	23.89	34.38	2.49	2.25	12.36	12.51
S.Em.±	0.19	0.11	0.74	0.68	0.04	0.03	0.05	0.05
C.D. (P=0.05)	0.47	0.33	2.18	2.00	0.13	0.10	N.S.	N.S.
Control	3.08	3.57	17.20	26.34	1.84	1.75	11.09	11.95
Control vs. Treated								
S.Em.±	0.19	0.13	1.35	1.22	0.07	0.04	0.18	0.02
C.D.(P=0.05)	0.55	0.39	3.09	2.89	0.21	0.13	0.51	0.06

Table 2 : Effect of sources and levels of sulphur on seed yield and economics of soybean

Treatment	Seed yield q ha-1			Economic analysis on mean yield basis		
	1995	1996	Mean	Gross monetary return (Rs. ha-1)	Net monetay return (Rs. ha-1)	Benefit/ cost ratio
S-source						
E S	11.75	17.48	14.61	14,606	2,340	1.16
GY	11.52	17.53	14.37	14,370	1,870	1.15
O A I W	11.19	16.73	13.96	13,960	3,326	1.31
S.Em.±	0.37	0.36	--	271	132	0.01
C.D.(P=0.05)	N.S.	N.S.	--	N.S.	386	0.03
S-level kg ha-1						
10	11.53	16.85	14.19	14,188	3,188	1.26
20	11.75	17.39	14.57	14,548	2,968	1.25
40	11.18	17.20	14.19	14,193	1,393	1.12
S.Em.±	0.37	0.36	--	271	132	0.01
C.D.(P=0.05)	N.S.	N.S.	--	N. S.	386	0.03
Control	9.43	15.05	12.24	12,240	1,840	1.17
Control vs. Treated						
S.Em.±	0.46	0.47	--	310	192	0.01
C.D.(P=0.05)	1.36	1.37	--	900	557	0.05

correspondingly increased with increasing levels of S upto 40 kg S ha^{-1} but differences between closer levels i.e. 10 and 20, and 20 and 40 kg S ha^{-1} were not significant. Though seed yield did not vary due to different S levels, it increased correspondingly with increasing rate of S application upto 20 kg S ha^{-1}. As a whole, application of 10 kg S/ha proved to more remunerative than other levels because it fetched the highest net profit (Rs. 3188 ha^{-1}) and benefit-cost ratio (1.26) closely followed by 20 kg S ha^{-1} which had to the maximum gross profit (Rs. 14,548 ha^{-1}). Similar results were reported by Mishra and Agrawal (1994), Singh and Singh (1994) and Ganeshmurthy (1996).

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DRY MATTER PRODUCTION, NUTRIENT CONTENT AND UPTAKE BY GROUNDNUT INTERCROPPING AT DIFFERENT LEVELS OF NITROGEN AND PHOSPHORUS APPLICATION

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ABSTRACT

A study was undertaken at Regional Research Station, Kakdwip, West Bengal during pre-kharif of 1993 and 1994 with groundnut intercropping under different levels of fertilizers with the aim to evaluate the dry matter production, nutrient content and uptake by groundnut. Sole groundnut maintained its superiority over intercrop groundnuts in respect of dry matter production. With two rows of groundnut cv Girnar (CGS 4018) and one row of sesame cv B-67 (Tilottama), highest N, P and K content in plant had been observed. Application of 90N + 75 P (Kg per hectare) was found superior to other levels of fertilizers in almost all growth stages of groundnut.

Key words: Intercropping, Groundnut, *Dry matter, Nutrient uptake.*

INTRODUCTION

Groundnut (*Arachis hypogaea* L) is the most important oil seed crop. High seed rate (150 Kg / ha) and high cost of groundnut seed make a common farmer reluctant to increase the area under this crop. The seed rate can be reduced if another suitable crop is introduced as intercrop. The present investigation on intercropping of groundnut with sesamum as well as sole cropping of groundnut grown under different doses of nitrogen and phosphorus was conducted to study the dry matter production, the concentration and uptake of N, P and K by the groundnut.

MATERIALS AND METHODS

Experiments were carried out in the medium land situation of clay soil at Regional Research Station (coastal zone) of Bidhan Chandra Krishi Viswa Vidyalaya, Kakdwip in the district of South 24 parganas, West Bengal, during Summer seasons of 1993 and 1994. Thefarm is situated at about 35 Km away from the Bay of Bengal and intersected by 21° 91' N and 88° 10' E latitude and longitude respectively. The soil of the farm is clay with pH 7.6, EC 2.01 mmhos / cm, total nitrogen percentage (0.012), available P_2O_5 (286.71Kg / ha), K_2O (504.10 Kg / ha) and organic matter percentage (8.00) respectively.

The study was conducted in a split plot design with cropping system of sole groundnut (G), groundnut + Sesame (G + S) 2 : 1, (G + S) 1 : 2 in main plots and four levels of nitrogen and phosphorus (0, 30, 60, 90 Kg N and 0, 25, 50, 75 Kg P_2O_5 / hectare) in subplots replicated three times. Nitrogen, phosphorus and potassium (30 Kg K_2O / hectare) were applied in the form of urea, single super phosphate and muriate of potash, respectively. The crops were sown during first week of February in both the years and were harvested in first week of May (Sesame) and first week of June (groundnut).

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RESULTS AND DISCUSSION

Groundnut Yield

Pod yield of groundnut was significantly influenced by the cropping system in two years as well as in pooled data (Table - 1). Sole groundnut out yielded intercropped groundnut in both the years and in pooled data. Application of N and P increased pod yield significantly in both years of experimentation and in pooled data (Table - 1). Progressive and significant increase in pod yield with successive increment of fertilizer was observed upto 60N + 50P.

Dry matter

Sole groundnut maintained its superiority over intercrop groundnuts in respect of dry matter production in both the years and in pooled data. Between two intercropping systems 2 : 1 ratio showed significantly higher dry matter production than 1 : 2 ratio (Table - 2). With increase in the level of N and P, dry matter increased significantly upto 90N + 75P. However there was no significant difference in dry mater between 60N+50P and 90N+75P at 72 DAS in 1993, 87 DAS in 1993, 102 DAS in 1993 and at harvest in 1993 and pooled data. Patel et al (1981) and Shankar et al. (1984) found increase in dry matter with N and P application.

Interaction between cropping system and fertilizer levels was significant on dry matter production. Irrespective of the level of fertilizers, sole groundnut had significantly higher dry matter production than intercropped groundnut. Application of 90N + 75P produced maximum dry matter of groundnut grown both as sole and intercrop. Sole groundnut in combination with 90N + 75P had significantly greater dry matter than all other treatment combinations.

Total dry matter production

Sole groundnut has the lowest combined dry matter which was significantly lower than that of other cropping systems. Sole sesame had more dry matter than sole groundnut as well as two

Table - 1 : Effect of cropping system and fertilizer levels on yield (kg / ha) of groundnut and sesame.

Treatement	Pod yield					
	1993		1994		Pooled	
	Groundnut	Sesame	Groundnut	Sesame	Groundnut	Sesame
Cropping system						
Sole groundnut (G)	1359.25	-	1640.41	-	1499.95	-
g.nut+sesame(G + S) (2 : 1)	955.54	158.45	1146.37	167.55	1050.95	163.00
g.nut+sesame(G + S) (1 : 2)	342.04	364.68	516.73	429.14	429.38	396.91
SEm ±	18.13	9.95	43.45	6.22	11.81	7.50
CD (0.05)	50.35	27.63	120.62	17.27	32.80	20.84
Fetilizer levels (kg/ha)						
0 + 0	639.16	253.68	808.76	278.64	729.96	266.16
30N + 25P	910.72	318.22	1063.93	353.65	987.32	335.93
60N + 50P	999.61	387.97	1301.08	440.53	1150.34	414.25
90N + 75P	992.94	413.50	1230.91	461.60	1111.92	437.55
SEm ±	29.46	9.58	50.95	13.95	19.60	10.65
CD (0.05)	61.90	19.91	107.05	29.30	41.18	22.39

Table - 2 : Effect of Cropping System and fertilizer levels on dry matter production (g / m²) of groundnut.

Cropping system	Dry matter production												
	57 DAS		72 DAS		87 DAS		102 DAS		At harvest		Total dry matter of g.nut+sesame		
	1993	1994	1993	1994	1993	1994	1993	1994	1993	1994	1993	1994	Mean
SoleGroundnut(G)	85.43	109.45	144.73	178.99	182.94	241.33	294.85	390.98	397.02	497.15	375.02	497.15	436.05
Sole Sesame (S)	-	-	-	-	-	-	-	-	-	-	430.72	653.15	541.94
g.nut+sesame(G + S) (2 : 1)	60.07	69.20	93.55	100.15	133.30	133.65	208.75	224.98	300.78	297.32	437.38	507.05	472.21
g.nut+sesame(G + S) (1 : 2)	29.72	31.13	44.28	51.51	64.62	68.01	98.43	113.43	142.90	144.00	427.40	564.75	496.07
SEm ±	6.16	7.29	6.82	8.53	7.53	8.77	9.01	9.54	12.31	13.69	2.83	4.70	5.56
CD (0.05)	17.12	20.24	18.93	23.65	20.90	24.35	25.01	26.48	34.18	38.01	9.09	15.13	17.89
Fertilizer levels (kg/ha)													
0 + 0	36.83	49.51	60.98	74.49	79.76	96.59	127.11	162.02	201.97	217.30	314.05	430.55	372.30
30N + 25P	56.80	65.41	90.26	100.08	120.35	131.35	191.04	217.28	254.88	273.03	376.48	509.77	443.12
60N + 50P	64.69	76.35	108.32	120.33	152.36	168.23	242.42	274.19	322.57	361.48	463.70	608.48	536.09
90N + 75P	75.31	88.73	117.19	145.96	155.34	194.47	242.13	319.03	312.18	399.48	516.31	637.49	594.90
SEm ±	4.32	5.06	5.18	5.36	6.07	6.75	7.02	7.33	8.79	8.01	6.28	7.65	6.57
CD (0.05)	9.08	10.63	10.89	11.25	12.75	14.20	14.75	15.41	18.46	16.83	16.03	19.54	16.79
Interaction													
SEm ±	-	3.02	-	3.92	5.80	6.75	2.87	7.44	-	4.19	4.32	5.37	4.15
C. D at (0.05)	-	6.33	-	7.12	12.19	14.19	6.03	15.63		10.32	11.03	13.72	10.59

intercropping systems. Inter cropping systems produced greater dry matter than sole groundnut but had lower dry matter accumulation than sole sesame (Table - 2). Application of N and P increased combined dry matter significantly in both the years and inpooled data (Table - 2). Maximum dry matter accumulation was observed by the application of 90N + 75P which was significantly superior to other levels of fertilizers.

Interaction between cropping system and levels of fertilizers on combined dry matter accumulation was significant in 1994 and in pooled data (Table - 2). Sole groundnut gave maximum dry matter with the application of 60N + 50P whereas sole sesame and intercropping systems (2 : 1 and 1 : 2) recorded maximum dry matter with the application of 90N + 75P. Intercropping system of 1 : 2 ratio with 90N + 75P produced significantly greater combined dry matter than all other combinations.

NPK content in plant

Nitrogen content in plant increased significantly by fertilizer application in two years and in pooled data (Table - 3). First increment of nitrogen and phosphorus did not show measurable increase over control in both the years, but subsequent increments of nitrogen and phosphorus augmented nitrogen content significantly upto 90N + 75P level. In pooled data nitrogen content increased significantly with successive increments of nitrogen and phosphorus upto 90N + 75P. Kulkarni *et al.* (1986) reported higher concentration of N with P application.

Intercropping groundnut and sesame at 2 : 1 ratio was found beneficial in improving

Table 3 : Effect of cropping system and fertilizer levels on nitrogen, phosphorus and potassium content of groundnut plant

Treatment	N Content (%)			P content (%)			K content (%)		
	1993	1994	Mean	1993	1993	Mean	1993	1994	Mean
Cropping system									
Sole g.nut (G)	2.155	2.197	2.171	0.288	0.335	0.331	0.790	0.790	0.790
g.nut + ses (G + S) (2 : 1)	1.925	1.925	1.925	0.338	0.363	0.350	0.843	0.828	0.869
g.nut + ses (G + S) (1 : 2)	1.945	1.945	1.945	0.257	0.293	0.275	0.725	0.728	0.726
SEm ±	0.073	0.055	0.006	0.046	0.002	0.002	0.029	0.011	0.010
CD (0.05)	NS	1.155	0.129	0.018	0.006	0.005	0.080	0.032	0.029
Fertilizers levels (kg/ha)									
0 + 0	1.820	1.810	1.815	0.240	0.293	0.267	0.673	0.703	0.688
30N + 25P	1.920	1.943	1.932	0.270	0.317	0.293	0.777	0.780	0.788
60N + 50P	2.073	2.113	2.093	0.303	0.333	0.318	0.840	0.823	0.832
90N + 75P	2.220	2.223	2.215	0.363	0.377	0.370	0.854	0.887	0.882
SEm ±	0.060	0.073	0.045	0.014	0.008	0.009	0.017	0.033	0.018
CD (0.05)	0.126	0.153	0.096	0.003	0.017	0.020	0.036	0.070	0.039

phosphorus content in plant as compared to intercropping groundnut+sesame 1 : 2 ratio and sole groundnut (Table - 3). Fertilizer levels enhanced P content of plant in both the years and in pooled data (Table - 3). Successive increment of nitrogen and phosphorus increased P content upto 90N + 75P. Sivasankar et al (1981) found increased P content with application of P.

Intercropped groundnut and sesame at 2 : 1 ratio had more K content than sole groundnut and intercropped groundnut+sesame at 1 : 2 ratio Application of nitrogen and phosphorus increased K content in plant significantly in two years and in pooled data (Table - 4). Successive increment of fertilizer levels increased K content significantly upto 60N + 50P level in 2 years, further increase to 90N+75P decreased K content but this decrease was not significant. In pooled data, K content increased with successive increment of fertilizer levels upto 90N + 75P.

NPK uptake in plant

Sole groundnut absorbed significantly greater N than intercropped groundnut. Intercropped groundnut at 2 : 1 ratio showed higher N uptake than that at 1 : 2 ratio owing to its higher N content. Maximum N uptake in groundnut plant was noticed at 90N + 75P which was at par with 60N + 50 P in two years as well as in pooled data (Table - 4). Higher uptake of N with P fertilizer was reported by Dubey and Shinde (1986).

Intercropped groundnut 2 : 1 ratio has higher P uptake due to greater P content and dry matter accumulation as compared to that at 1 : 2 ratio. Phosphorus uptake in plant was the highest

Table - 4 : Effect of cropping system and fertilizer levels on N P K uptake (Kg / ha) of groundnut.

Treatment	N uptake			P uptake			K uptake		
	1993	1994	Mean	1993	1993	Mean	1993	1994	Mean
Cropping system									
Sole g.nut (G)	86.92	111.80	98.86	11.45	16.80	14.12	31.70	39.85	35.77
g.nut+Ses(G + S) (2 : 1)	58.39	58.50	58.44	10.35	10.72	10.53	26.50	26.59	26.54
g.nut+Ses(G + S) (1 : 2)	28.35	28.54	28.44	3.72	4.31	4.01	10.49	10.67	10.58
SEm ±	5.74	7.56	2.57	0.82	1.21	0.66	1.97	2.33	1.04
CD (0.05)	13.94	20.98	7.15	2.27	3.37	1.84	5.49	6.47	2.90
Fertilizers levels (kg/ha)									
0 + 0	36.86	40.65	38.75	4.96	6.64	5.78	13.70	15.38	14.54
30N + 25P	49.77	54.36	52.06	7.02	8.76	7.89	20.18	21.50	20.84
60N + 50P	67.70	77.77	72.73	9.66	12.03	10.84	27.08	30.34	28.71
90N + 75P	77.21	90.98	84.09	12.42	15.01	13.71	30.62	35.60	33.11
SEm ±	6.32	8.18	5.90	0.92	1.11	0.74	2.81	3.44	2.32
CD (0.05)	13.29	17.20	12.40	1.94	2.34	1.55	5.90	7.23	4.87

at 90N + 75P which was significantly superior to other levels of fertilizer due to the maximum P content in plant (Table - 4) P fertilizer significantly increased P uptake as noticed by Zalawadia and Patel (1983).

Intercropped groundnut at 2 : 1 ratio was significantly superior to intercropped groundnut at 1 : 2 ratio due to greater K content. The response to N and P on K uptake was observed upto 60N + 50 P. Chavan and Kalra (1983) reported progressive increase in K uptake with application of P and K fertilizers.

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EFFECT OF LEVELS OF ZINC ON GROWTH DRY MATTER AND YIELD OF SESAME VARIETIES

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ABSTRACT

A field experiment with three sesame varieties, viz., T_4, T_{12} and T_{78} and four levels of zinc (0,10,20 and 30 kg/ ha) was conducted at the experimental block 'A' of C.S. Azad University of Agriculture and Technology, Kanpur, during Kharif 1988 and 1989. Results revealed that $ZnSO_4$ applied @ 30Kg/ha significantly increased growth in terms of plant height, No. of leaves/plant, No. of branches/plant, dry matter of leaf, stem and capsules, No. of capsules/plant, test weight of seed and seed yield. sesame Var T_{12} proved superior to T_4 and T_{78} in respect of seed yield.

Keywords : Zinc, Yield, Sesame

INTRODUCTION

Sesame (*Sesamum indicum* L.) is an important edible oilseed crop but has low yield potential. It is gaining considerable importance on account of its high economic value as edible oil. Seed yield of this crop in India is very low (180kg/ha) as compared to Venezuela (1960 kg/ha). Although a number of factors may be responsible for low yield of sesame in India, soil fertility especially of micronutrient may be limiting the yield. Zinc deficiency in agricultural crops is very common in the modern farming system. It plays specific roles in plant metabolism. It is a constituent of several important enzymes, helps in the synthesis of nuclic acid, protein and Carbohydrates (Scrutton *et al* 1971). Zinc deficiency prevent seed formation and thus reducing yield (Mehrotra and Shanker, 1971). The present study was therefore, carried out to asses the effect of zinc on growth and yield of sesame.

MATERIALS AND METHODS

Field experiments were conducted during *Kharif* 1988 and 1989 at Experimental Research Farm Block 'A' of C.S. Azad University of Agriculture and Technology, Kanpur. The Soil of the field was sandy loam having pH 7.5, E.Ce 0.25-0.36 dsm^{-1}, organic carbon 0.30%, available K_2O 150-200 Kg ha^{-1}, available sulphur 16-20 ppm, 0.5% HCL extractable Zn as 1.5 ppm. The treatments consisting all combinations of three varieties (T_4, T_{12} and T_{78}) and four levels of $ZnSO_4$ (0,10,20 and 30 $Kgha^{-1}$) were tested in a randomized block design replicated 3 times. Crop was sown on 15 July and 20 July in 1988 and 1989 respectively with a spacing of 30 x 10 cm. A basal dose of 30 Kg N, 15kg P_2O_5 and 15 Kg K_2O ha^{-1} through urea, diammonium phosphate and muriate of potash was applied at the time of sowing. Growth and yield observations were recorded by standard method and dry weight was determined in electric oven, dried first at 80°C for one hour which was then maintained at 60°C for 8 hours to a constant dry weight on 5 randomly selected plants from each plot.

RESULTS AND DISCUSSION

Growth

Application of zinc upto 30 Kg/ha increased significantly growth in terms of plant height, No.

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of leaves per plant, No. of branches/plant and also dry matter production of different plant parts. However, 20 and 30 Kg $ZnSO_4$/ha did not differ in dry matter production. Among the varieties T_{12} proved superior with regard to plant height, number of leaves and number of branches/plant. Dry matter production by leaves, stem and capsules was also higher in this variety as compared to T_4 and T_{78}.

Interaction of Zinc and variety was not significant in case of plant height, No. of leaves and No. of branches per plant suggesting that they act independently. However, increasing levels of Zinc tended to promote these parameters numerically. Irrespective of varieties application of 30 Kg $ZnSO_4$/ha produced plants with maximum growth as judged by plant height, leaf number, branches/plant and dry weight of leaf and stem. Application of 20 kg Zn So_4 remaining at par with 30 Kg $ZnSO_4$/ha increased dry matter production of leaves, stem and capsules significantly over Control (Table 1) and behaved in the same pattern in all the three genotypes.

Interaction between Variety and Zinc was significant in the case of capsules dry weight. The findings are in inconformity with Mishra and Mehrotra (1984). Sesame variety T_{12} recorded significantly higher dry matter accumulation in stem, leaf and capsules in comparison to T_4 and T_{78}. Interaction of ZnxV was not significant in case of leaf and stem dry weight, but dry weight of T_{12} revealed that 20Kg $ZnSO_4$/ha proved superior as compared to 30Kg $ZnSO_4$/ha and control.

Yield and Yield Components

Application of Zinc significantly increased number of capsules per plant (Table 1). Similar increase in siliqua production of mustard was reported by Subbaiah and Mitra (1996). Application of 30Kg $ZnSO_4$/ha produced significantly more number of capsules per plant over control but remained at par with 20kg $ZnSO_4$/ha. The variety T_{12} produced numerically higher number of capsules per plant as compared to T_4 and T_{78}. The interaction of VxZn was non significant in this respect. The test weight of seed increased with Zinc application in

Table 2. Interaction of Varieties and Zinc levels on seed yield (kg/ha) of sesame.

Levels of Zn (kg/ha)	Sesame varieties			
	T_4	T_{12}	T_{78}	Mean
0	582.0	638.0	578.0	599.3
10	724.0	732.0	674.0	710.0
20	730.0	735.0	732.0	732.3
30	739.0	750.0	745.0	744.6
Mean	693.8	713.8	682.3	-
		CD (0.05)		
Varieties		28.0		
Zinc level		31.0		
Varieties x Zinc		38.0		

Table 1. Effect of Zinc levels on growth, yield components and yield of sesame varieties.

Treatment	Plant height (cm)	No. of leaves/plant	Branches/ plant	Dry matter of (g) leaves			No. of Capsules/ plant	Test weight(g)	Seed yield (kg/ha)
				Leaves	Stem	Capsules			
Zinc level (kg/ha)									
0	74.7	74.8	2.0	3.1	3.1	4.2	27.5	2.5	599.3
10	78.5	85.1	2.3	4.2	3.7	5.4	33.0	2.7	710.0
20	81.8	93.1	2.9	5.6	5.2	7.1	40.2	2.9	732.3
30	82.4	95.0	3.0	5.9	5.8	7.2	41.3	2.9	744.6
C. D. (0.05)	3.9	6.2	0.3	0.4	0.6	2.6	3.0	0.1	31.0
genotypes									
T_4	78.9	85.4	2.5	4.4	4.3	5.7	34.5	2.7	693.8
T_{12}	81.3	91.4	2.8	5.3	5.0	6.7	37.5	2.9	713.8
T_{78}	77.9	84.4	2.4	4.5	4.2	5.5	34.5	2.7	682.3
C.D. (0.05)	NS	NS	0.2	0.5	0.5	2.1	NS	0.1	28.0
Variety x Zinc	NS	NS	NS	NS	NS	Sig.	NS	Sig.	Sig.

all genotypes and application of 20 and 30Kg $ZnSO_4$/ha did not differ significantly but proved superior to control. These results are supported by *Subbaiah and Mitra (1996)*, who found that Zinc application increased 1000 seed weight in mustard. It is thus obvious that different varieties of sesame though behave similarly as far as their Zinc requirement is concerned, but application of *20 to 30* Kg $ZnSO_4$ *produced a healthy crop which* increased yield significantly in comparison to control (Table 2).

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RELATIVE PERFORMANCE OF LINSEED (*Linum usitatissimum* L.) VARIETIES UNDER DIFFERENT SOWING MANAGEMENT IN RAINFED CONDITION

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ABSTRACT

Field experiments were conduced on rainfed linseed (*Linum usitatissimum* L.) in clay loam soils of Sagar (M. P.) during rabi 1993-94 and 1994-95 to evaluate the relative performance of varieties under varying sowing management. Kiran excelled all variaties in terms of seed yield and profit mainly due to superiority in branches plant^{-1} and capsules plant^{-1}. Regular sowing in rows 30 cm apart with 30 kg seed ha^{-1} and 40 kg N + 20 Kg P_2O_5 ha^{-1} significantly gave higher seed yield and profit than border sowing (leaving fourth row vacant in regular spacing) with 22.5 kg seed ha^{-1} and 40 kg N + 20 kg P_2O_5 ha^{-1} or 30 kg N + 15 kg P_2O_5 ha^{-1}.

Key words: Regular sowing, Border sowing, Seed rate, fertilizer, linseed.

INTRODUCTION

Linseed (*Linum usitatissimum* L.) is generally grown under rainfed condition with local varieties without or with rare use of fertilizers resulting in very poor productivity (304 kg ha^{-1}) in the state. Research evidences emphasized that cultivation of high yielding improved varieties by proper sowing method with adequate seed rate and fertilizer dose could be helpful to step up its productivity (Sharma and Rajput 1984 and Awasthi *et al.*, 1989). Lack of information on these aspects for Sagar region of M. P., prompted the present investigation.

MATERIALS AND METHODS

Field experiments were conducted on linseed at Regional Agricultural Research Station, Sagar (M. P.) during *rabi* 1993-94 and 1994-95 under rainfed conditions. The soil of the experimental field was medium black in colour, clay loam in texture and neutral in (pH 7.2) in reaction. It has low available N (240 kg ha^{-1}) and medium available P_2O_5 (33 kg ha^{-1}) and available K_2O (450 kg/ha). The rainfall in two consecutive years of experiment was 1237 and 1686 mm. The available soil moisture content at the time of sowing was 23 and 25 % during the two consecutive years. Twelve treatments consisting of four varieties (Kiran, JL-23, R-552 and Local) and three sowing management viz., regular sowing in rows 30 cm apart with 30 kg seeds ha^{-1} and full recommended fertilizer dose (40 kg N + 20 kg P_2O_5), border sowing (leaving fourth row vacant in regular spacing) with 22.5 kg seed ha^{-1} and full fertilizer dose, and border sowing with 22.5 kg seeds ha^{-1} and 30 kg N + 15 kg P_2O_5 ha^{-1} were tested in randomized block design with four replications. Fertilizers were applied as per treatments by placing them 2-3 cm below the seeds at the time of sowing. Sowing was done on October 25, 1993 and October 16, 1994 by drilling the seeds in rows as per treatments. Harvesting was done on February 22, 1994 and February 10, 1995.

RESULTS AND DISCUSSION

Seasonal Variations

The rainfall during crop season was more in 1994-95 than the preceding year and rains were distributed coinciding plant growth stage as per need. The residual soil moisture content at the time of sowing was also higher during 1994-95. Therefore plant population was more during this

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year because of germination of all seeds (Table 1). Due to rains as per need of crop in 1994-95, growth parameters of crop were superior than 1993-94. Consequently, yield attributing characters and seed yields were quite higher under all treatments during 1994-95 than the preceding year (Table 2). Though seed yields varied between the two years of experimentation, the effect of treatments were similar in both years.

Performance of Varieties

The plant population was similar with all the varieties, but growth parameters viz., plant height and branches plant^{-1} were significantly inferior in variety R-552 than Kiran and JL-23 which were comparable with each other (Table 1). Based on two years mean data, Kiran gave significantly maximum seed yield (6.74 q ha^{-1}) among all the varieties (Table 2). The next best was JL-23 (6.36 q ha^{-1}) but was at par with Local (6.09 q ha^{-1}). Variety R-552 produced minimum seed yield (5.92 q ha^{-1}). Though 1000-seed weight of Kiran was significantly lesser than rest of the varieties, its significant superiority in number of branches and capsules plant^{-1} resulted in higher seed yield. The harvest index values were similar for all varities. Similar variations in growth parameters, yield attributes and seed yield among the varieties due to their genetic ability have also been reported by Tomar and Mishra (1991).

Sowing Management

Plant population was maximum under regular sowing in 30 cm apart using 30 kg seeds ha-1 and full dose of fertilizers (40 kg N + 20 kg P_2O_5 ha^{-1}) which significantly reduced due to border sowing by leaving fourth row vacant with 22.5 kg ha^{-1} along with either full fertilizer dose or curtailed dose (30 kg N + 15 kg P_2O_5 ha^{-1}) mainly due to less seed rate (Table 1). Growth parameters viz., plant height and branches plant-1 and yield attributes viz., capsules plant^{-1} were also superior under former sowing management than the later (Table 2). Though test weight and harvest index

Table 1. Effect of sowing management and varieties on plant population and growth parameters of rainfed linseed.

	Plant population (Lakh ha^{-1})		Plant height (cm)		Branches plant^{-1}	
Treatment	1993-94	1994-95	1993-1994	1994-1995	1993-1994	1994-1995
Sowing management						
M_1 + 100 S + 100 F	4.57	5.44	44	54	5.3	5.5
M_2 + 75 S + 100 F	3.07	3.98	44	52	4.6	4.7
M_2 + 75 S + 75 F	3.03	3.83	43	46	3.5	3.8
C D (P = 0.05)	0.19	0.19	1.8	1.2	0.06	0.12
Varieties						
Kiran	3.57	4.44	43	47	4.6	4.9
JL - 23	3.57	4.25	44	49	4.8	4.8
R - 522	3.58	4.45	42	46	4.3	4.3
Local	3.55	4.53	44	48	4.5	4.7
C D (P = 0.05)	NS	NS	1.2	1.4	0.10	1.14

M_1 - Regular sowing in rows 30 cm apart, M_2 - Boarder sowing by leaving each fourth row vacant, 100 S - 30 kg seeds ha^{-1}, 75 S - 22.5 kg seeds ha^{-1}, 100 F - 40 kg N + 20 kg P_2O_5 ha^{-1} and 75 F - 30 kg N + 15 kg P_2O_5 ha^{-1}.

Table 2. Effect of sowing management and varieties on yield attributes and seed yield of rainfed linseed.

	Capsules plant-1		1000-seed weight (g)		Harvest index		Seed Yield (q ha-1)		
Treatment	1993-94	1994-95	1993-1994	1994-1995	1993-94	1994-95	1993-94	1994-95	Pooled
Sowing Management									
M_1 + 100 S + 100 F	85	93	7.00	7.24	33.60	36.16	4.88	10.15	7.52
M_2 + 75 S + 100 F	88	105	7.30	7.30	32.80	36.24	3.96	8.56	6.26
M_2 + 75 S + 75 F	82	87	7.10	7.15	32.10	36.21	3.24	6.86	5.05
C D (P = 0.05)	5.1	9.0	NS	NS	NS	NS	0.31	0.38	0.20
Varieties									
Kiran	88	103	6.70	6.81	34.10	36.57	4.50	8.97	6.74
JL - 23	87	99	7.50	7.47	32.50	36.15	4.03	8.69	6.30
R - 552	84	94	7.10	7.16	32.50	36.12	3.77	8.12	5.92
Local	81	92	7.50	7.46	32.30	36.05	3.86	8.32	6.09
C D (P = 0.05)	6.3	10.5	0.30	NS	NS	NS	0.37	0.45	0.29

M_1 - Regular sowing in rows 30 cm apart, M_2 - Boarder sowing by leaving each fourth row vacant, 100 S - 30 kg seeds ha^{-1}, 75 S - 22.5 kg seeds ha^{-1}, 100 F - 40 kg N + 20 kg P_2O_5 ha^{-1} and 75 F - 30 kg N + 15 kg P_2O_5 ha^{-1}.

Table 3. Economic analysis of the treatments (based on pooled data of 1993-94 and 1994-95)

Varieties	M_1 + 100 S + 100 F		M_2 + 75 S + 100 F		M_2 + 75 S + 75 F		Mean	
	Gross return (Rs.)	B/C ratio	Gross return (Rs.)	B/C ratio	Gross return (Rs.)	B/C ratio	Gross return (Rs.)	B/C ratio
Kiran	12,120	2.69	10,080	2.32	8,130	1.94	10,110	2.32
JL - 23	11,400	2.53	9,585	2.20	7,665	1.83	9,550	2.20
R - 552	10,650	2.37	8,835	2.03	7,155	1.70	8,850	2.03
Local	10,965	2.44	9,060	2.08	7,380	1.73	9,135	2.09
Mean	11,283	2.50	9,390	2.15	7,582	1.80	--	--

M_1 - Regular sowing in rows 30 cm apart, M_2 - Boarder sowing by leaving each fourth row vacant, 100 S - 30 kg seeds ha^{-1}, 75 S - 22.5 kg seeds ha^{-1}, 100 F - 40 kg N + 20 kg P_2O_5 ha^{-1} and 75 F - 30 kg N + 15 kg P_2O_5 ha^{-1}.

Cost of linseed is Rs. 1500 q^{-1}.

C D (P = 0.05)	For Varieties (V)	For sowing Management (M)
Monetary return	543	4.62
B/C ratio	0.11	0.09

did not vary due to different sowing management practices, regular sowing method having desired plant-population and adequate plant nutrition produced significantly higher seed yield (7.52 q ha^{-1}) than border sowing mainly due to superiority in capsules $plant^{-1}$. These results are in close conformity with the findings of Sharma *et al.*, (1994).

Economic analysis

Cost of cultication did not differ due to varieties. Variety Kiran produced significantly higher seed yield than other varieties almost with the same investment. Therefore, it proved more remunerative than other varieties in terms of monetary returns and benefit-cost ratio (Table 3). Regular sowing in rows 30 cm apart with recommended seed rate (30 kg ha^{-1}) and recommended fertilizer dose (40 kg N + 20 kg P_2O_5 ha^{-1}) fetched maximum monetary returns and profitability among all sowing management practices and these values significantly reduced with 22.5 kg seed ha^{-1} and recommended fertilizers. Seed yields reduced markedly by curtailing each of either seed rate or fertilizer dose in linseed, but fertilizer dose was more pronounced. The increase in cost of seed and fertilizer under regular sowing with recommended seed rate and full fertilizer dose was relatively quite less than the value of increased seed yield, hence it was significantly more renumerative than other sowing management practices.

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RESPONSE OF *KHARIF* GROUNDNUT TO VARYING LEVELS OF PHOSPHORUS POTASSIUM AND SULPHUR IN WEST BENGAL.

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ABSTRACT

A field experiment with different levels of P_2O_5 (0,50,100kg/ha), K_2O (0,50,100kg/ha) and their combinations was conducted in two wet seasons at the C Block Farm, Kalyani, B.C.K.V. The results revealed that of the nutrients phosphorus was most limiting followed by potassium and sulphur. Increased levels of P_2O_5 upto 100 Kg./ha and K_2O upto 50 kg/ha resulted in improvement in yield and yield attributes and quality of groundnut. Sulphur application improved yield and yield components except kernels/pod. Haulm yield was not significantly influenced by S. Interaction between P and S on pod yield and kernel yield was significant.

Keywords : Groundnut, Phosphorus, Potassium, Sulphur.

INTRODUCTION

The shortfall in per capita consumption of edible oil is gradually increasing. The increase in production of oil by horizontal expansion has been ruled out. Increase in productivity of oilseeds is the only alternative. Groundnut occupies highest area among oilseeds in the country. Any endeavour to increase edible oil should include primarily groundnut. The quickest possible way of increasing productivity of groundnut is the replacement of variety and use of chemical fertilizers. Groundnut though cultivated in small areas of West Bengal, has tremendous potential. In groundnut phosphorus deficiency decreased shoot length, number of leaves, and protein content (Basha and Rao, 1980) and its presence is important for lecithin (Miller, 1938) -a compound in which oils occur in plants. Potassium is important for photosynthesis and pod development in groundnut (Burkhart and Collins, 1941), and a substantial increase in protein and S-amino acids in groundnut due to potassium application has been reported by several workers (Pasricha and Aulakh, 1986). S is directly involved in the biosynthesis of oil (Verma and Bajpai, 1964). The present investigation was carried out to study the response of wet season groundnut to levels of P K, S and their combinations.

MATERIALS AND METHODS

Field experiments were conducted at the Kalyani C-Block farm of Bidhan Chandra Krishi Viswavidyalaya during wet season of 1991 and 1992. The soil was medium in fertility status (organic C-0.42%, total N-0.05%, 24.4 kg/ha available P, 164.4 kg/ha available K and 12.46 ppm available S.) and with a pH of 7.52. The experiement was laid out in a randomized block design with factorial concept in three re;ications. The treatments include three levels each of P_2O_5 and K_2O @ 0,50 and 100 kg/ha, and two levels of Sulphur-0,40 kg/ha. The source of N,P was Diammonium Phosphate, K-muriate of potash and S-gypsum. The variety used was JL-24. The crop was sown in the first week of July and harvested in the first week of October. The seeds were treated with Dithane M-45 prior to sowing. The plot size was 3m x5m and extreme two rows from both sides were used for biometric observations and destructive sampling. Oil extraction was done by soxhlet method.

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Table 1: - Effect of P,Kand S and their combinations on yield components, oil and protein content in groundnut.

Treatments	Pods/Plant		Kernels/Pod		100 Kernel weight (g)		Shelling%		Oil content%		Protein %	
	1991	1992	1991	1992	1991	1992	1991	1992	1991	1992	1991	1992
P_2O_5(kg/ha)												
0	12.56	12.90	1.587	1.602	39.80	42.08	61.64	61.30	40.95	41.61	21.12	22.56
50	15.96	17.34	1.628	1.642	42.15	44.68	64.06	63.08	43.71	43.61	22.53	23.56
100	18.96	19.10	1.668	1.668	43.75	45.70	63.26	63.19	44.40	44.58	23.39	23.05
C.D. (0.05)	1.76	1.63	0.043	0.052	0.702	0.888	0.78	1.08	0.625	0.786	0.531	0.690
K_2O(kg/ha)												
0	13.77	15.21	1.577	1.598	39.90	42.29	61.55	61.41	41.50	41.90	21.66	22.8
50	16.02	16.97	1.637	1.648	42.16	44.54	63.32	62.82	43.54	43.08	22.44	23.44
100	17.7	18.6	1.669	1.685	43.63	45.63	64.09	63.85	44.02	44.71	22.94	24.92
C.D. (0.05)	1.76	1.63	0.43	0.052	0.702	0.888	0.78	1.08	0.625	0.786	N.S.	0.690
S (kg/ha)												
0	12.42	13.64	1.616	1.632	40.11	41.99	62.22	62.65	41.97	42.55	21.42	22.42
40	19.24	20.22	1.640	1.655	43.66	46.31	63.74	63.73	44.07	43.91	23.27	25.02
C.D. (0.05)	1.56	1.51	NS	NS	0.628	0.752	0.681	1.111	1.156	0.632	0.489	0.632

Table 2: - Effect of P,Kand S on yield of groundnut. (kg/ha)

Treatments	Pod Yield		Kernel Yield		Haulm yield		Oil yield	
	1991	1992	1991	1992	1991	1992	1991	1992
P_2O_5(kg/ha)								
0	1693.39	1980.94	1048.81	1185.30	5684.78	6300.83	426.48	490.20
50	2183.67	2465.05	1343.07	1550.23	6336.50	6686.72	585.05	674.05
100	2309.16	2567.27	1470.20	1625.20	6587.66	6951.66	657.76	729.51
C.D. (0.05)	120.61	97.36	92.28	106.32	149.34	163.45	63.75	61.20
K_2O(kg/ha)								
0	1847.66	2149.0	1121.95	1290.58	5759.16	6336.83	468.60	545.75
50	2110.83	2391.11	1329.57	1486.40	6346.16	6713.27	575.89	657.43
100	2227.72	2479.66	1416.63	1584.24	6503.61	6889.11	624.80	690.67
C. D. (0.05)	120.61	97.36	92.28	106.32	149.34	163.45	63.75	61.20
S (kg/ha)								
0	1900.44	2101.18	1164.17	1183.20	6128.63	6624.22	491.60	501.45
40	2283.70	2689.66	1414.54	1724.24	6277.33	6668.59	621.26	761.05
C.D. (0.05)	104.27	88.71	83.67	76.68	NS	NS	58.90	54.91

Table 3-1: P xK interaction on pod yield (kg/ha)

	1991				1992		
	P_0	P_{50}	P_{100}		P_0	P_{50}	P_{100}
K_0	1605.0	1782.6	2156.0	K_0	1806.5	2195.16	2426.33
K_{50}	1703.0	2339.0	2290.5	K_{50}	2007.83	2464.0	2701.5
K_{100}	*1772.16*	*2430.0*	*2481.0*	*K_{100}*	*2128.5*	*2736.0*	*2574.05*

CD (0.05) =183.23 CD (0.05) = 137.21

Table 3-2: P xK interaction on kernel yield (kg/ha)

	1991				1992		
	P_0	P_{50}	P_{100}		P_0	P_{50}	P_{100}
K_0	980.15	1113.55	1271.75	K_0	1057.6	1323.9	1490.25
K_{50}	1055.95	1390.55	1542.23	K_{50}	1185.7	1558.25	1715.25
K_{100}	1109.95	1543.11	1596.83	K_{100}	1312.6	1768.48	1671.25

CD (0.05) =156.40 CD (0.05) = 139.25

Table 3-3: P x S interaction on shelling percentage

	1991				1992		
	P_0	P_{50}	P_{100}		P_0	P_{50}	P_{100}
S0	60.52	63.13	63.02	S0	60.85	61.30	62.80
S40	62.76	64.98	63.50	S40	62.75	64.86	63.59

CD (0.055) =1.67 CD (0.05) = 1.83

RESULTS AND DISCUSSION

Results revealed that while hundred kernel weight was significantly higher with 100 kg/ha of both P_2O_5 and K_2O over 50 kg/ha, the kernels per pod were significantly higher with 50 kg level of P_2O_5, and K_2O compared to control (Table 1). The number of pods per plant and shelling percentage were significantly higher with 100 kg level of P_2O_5 over 50 kg level but significant response to K_2O was at 50 kg level only. Pod yield and kernel yield showed similar trends (Table-2). Thanzuala and Dahiphale (1988) obtained significant response upto 80 kg P_2O_5. Loganathan and Krishna moorthy (1982) obtained response upto 50 kg P_2O_5.The oil content and oil yield also has comparable trends. Protein content was significantly higher with 100 kg P_2O_5, over 50 kg P_2O_5 level. Potassium did not influence the protein content in 1991 but in 1992, 100 kg level proved superior to control. Haulm yields were higher with 100kg/ha of both P_2O_5 and K^2O over 50 kg level. Sulphur additionproved significantly better for all the attributes except kernels per pod and haulm yield.The results are in agreement with that reported by Patra *et al.* (1995).

In both the years Px K interaction effects contributed significantly towards the pod yield of groundnut. In 1991 P_2O_5 and K_2O at 100 kg was the best combination (Table 3) but in 1992 100 kg P_2O_5 and K_2O at 50 kg/ha gave the best combination which was at par with K_2O at 100 kg. PxK interaction poved to be significant with kernel yield also. The results (Table 3.2) revealed that there was no significant difference in kernel yield between 50 and 100 kg K_2O level for each level of P. Application of 100 kg P_2O_5 also did not significantly increase kernel yield at each level of K_2O. PxS interaction significantly influenced shelling percentage (Table 3.3). For each level of increase in P_2O_5 upto 50 kg, application of sulphur resulted in significant increase of shelling percentage in both the years.

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SCREENING OF SOIL TEST METHODS FOR SUNFLOWER

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ABSTRACT

Soil Test Crop Response (STCR) correlation studies were conducted with sunflower (MSFH-8) as test crop in a vertisol of Nandyal during kharif 1996. Available soil N, P and K were estimated with different methods. Soil N availability was estimated by organic carbon,alkaline permanganate and nitrate nitrogen tests. Soil P availability was estimated by ammonium acetate and HNO_3 extraction methods. The soil test values of N, P and K from 30 plots based on these methods were correlated with sunflower seed yield. Based on the magnitude and significance of correlations alkaline permanganate method for N, modified Olsen's method for P and ammonium acetate method for K were found to be the best methods since they were highly and significantlycorrelated with sunflower seed yield and plant uptake of N, P and K.

Key Words : Sunflower, Soil Test Crop Response, Targetted yield, Fertilizer adjustment equations.

INTRODUCTION

In India sunflower is cultivated in 1.7m ha with 0.94 million tonnes of production and 549 kg/ha yield in 1997-98. In Andhra Pradesh it has an area of 0.34 million ha with a production of 0.22 million tonnes and productivity of 659 kg ha $^{-1}$ (DOR, 1999) which is considered to be low. In Andhra Pradesh, major area of sunflower is found in Kurnool district where it is grown extensively under rainfed situation. Systematic study has not been conducted so far on N, P and K fertilizer requirement based on soil test values for sunflower grown under rainfed situation. Considering the necessity for conducting such systematic research on soil testing, the present study was under taken. The main aim of this study was to screen and select the best soil test method for its calibration and making use of the soil test values for fertilizer optimisation.

MATERIALS AND METHODS

A field experiment was conducted during *kharif* 1996 at Regional Agricultural Station, Nandyal in Kurnool district with sunflower (MSFH-8) as test crop. This experiment was conducted as a part of the All India Coordinated Project for Investigations on Soil Test Crop Response Correlation (ICAR) at Hyderabad centre. In the present investigation the variation in soil fertility levels was obtained by creating it in one and the same field experiment in order to ensure homogeneity in soil population, management practices and prevailing climatic conditions.

The area of the field was divided into four strips and labeled a 0X, ½ X, 1X and 2X. The fertility gradient was created by applying graded doses of fertilizer to each of the four strips. While 0X received no fertilizer, ½ X, 1 X and 2 X strips have received ½, 1 and 2 times of the standard doses of N, P and K nutrients respectively. The doses of P fertilizer applied were calculated to give an available P content of 5, 10 and 20 ppm in ½ X, 1X and 2X strips respectively taking into consideration the initial available P content (3.78 kg P ha^{-1}) and the P fixation capacity (60%) of the soil.

Each strip was divided into 30 sub-plots in

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order to have a total of 120 sub-plots in the four strips. The area of each subplot was 3m X 5.4m. N @ 30, 60 and 90 kg ha^{-1}, P@0, 30 and 60 kg ha^{-1}, and K @ 0, 15 and 30 kg ha^{-1}, were applied in the experiment. There were 27 treatments in different combinations and three controls in the experiment. Entire quantities of P and K were applied as basal, and N was applied in two equal splits viz., as basal and at 35 days after sowing.

In the present study, soil samples were collected from each plot of 0 X strip at a depth of 0-15 cm and analysed for available N, P and K . Organic carbon was determined by the method of Walkley and Black (1934) as described by Jackson (1973). Available nitrogen was determined by alkaline permanganate method as given by Subbaiah and Asija (1956). Nitrate nitrogen in soil was determined by Phenol disulphonic acid method (IARI, 1983).

Olsen *et al.*, (1954) method was used for determining available soil P. The available phosphorus was extracted using 0.5 M Na HCo_3 (pH 8.5) at a soil solution ratio of 1:20 after shaking for 30 minutes and employing stannous chloride (Sn Cl2) blue colour development. The available phosphorus in soil was also determined by extracting the soil sample with 0.5 M Na HCo_3 (pH 8.5) at a soil solution ratio of 1:20 after shaking for 30 minutes and employing ascorbic acid method for P determination in the extract. A 0.02 N Calcium lactate +0.02 N Hcl solution adjusted to pH 3.8 was also used for extracting available P at a soil solution ratio of 1:2 after shaking for four hours (Matar *et al.*, 1988).

The available soil potassium was extracted by using two different methods viz., neutral normal ammonium acetate (Hanway and Heidal, 1952) and boiling HNO_3 method.

The leaf, seed and stalk samples were analysed for N, P and K contents. The nitrogen content of grain and straw samples were estimated by micro-kjeldahl method (AOAC, 1970). The plant samples were digested in a mixture of nitirc, sulphuric and perchloric acids in the ratio of 10:0.5: 2. Phosphorus in the digested material was determined colorimetrically by the vanadomolybdo phosphoric yellow colour method (Koeing and Johnson, 1942.) Potassium was estimated by using flame-photometer. The total uptake of each nutrient was calculated. Using seed yield and nutrient uptake data, soil test values and applied fertilizer doses of treated and control plots, the basic data for making fertilizer recommendations were calculated folowing the procedure adopted in STCR Project (Ramamoorthy *et al.* 1967).

RESULTS AND DISCUSSION

Estimates of available nutrients

Results indicated that organic carbon ranged between 0.02 and 0.28% in 0X with a mean of 0.17%. The Kmn O_4 - N ranged between 92 and 186 kg ha^{-1} in 0X with a mean of 126 kg N ha^{-1}. The soil NO_3-N in 0X ranged between 19 and 40 kg ha^{-1} with a mean of 27.9 kg ha^{-1} (Table 1).

The available P based on Olsen's method ranged between 5.4 and 9.9 kg ha^{-1} with a mean of 7.9 kg ha^{-1} . The available P based on modified Olsen's method ranged between 7.1 and 15.2 kg ha^{-1} with a mean 9.7 kg ha^{-1} in the O X strip. The soil P content extracted with calcium lactate in O X strip ranged between 9.2 and 19.1 kg ha^{-1} with a mean of 12.1 kg ha^{-1}.

Soil available K determined by ammonium acetate method ranged between 237 and 489 kg ha^{-1} with a mean of 383 kg ha^{-1}. The potassium extracted with HNO_3 in O X strip ranged between 495 and 795 kg ha^{-1} with a man of 614 kg ha^{-1}.

Correlation with seed yield

Simple correlations were derived between seed yield and different soil test values. The estimates

Table 1. Initial soil test values of N, P and K and seed yield of sunflower in strip - I (0 X)

Plot	OC	KM-N	NIT-N	OL-P	MO-P	CA-P	AM-K	HN-K	Seed yield (kg/ha)
1	0.11	92	21.0	5.8	7.1	9.4	300	532	717
2	0.12	93	25.4	5.4	7.3	11.5	243	508	779
3	0.12	103	21.5	6.3	7.9	9.5	257	508	788
4.	0.20	101	22.5	7.2	7.5	12.0	251	541	903
5.	0.14	114	25.5	8.3	9.2	10.1	291	511	941
6.	0.20	108	26.0	8.2	8.9	14.2	254	510	911
7.	0.17	120	27.5	8.3	9.0	11.0	248	630	979
8.	0.19	120	25.0	8.5	10.1	9.9	237	570	911
9.	0.19	104	29.6	6.3	7.5	10.8	444	761	902
10.	0.16	119	27.0	8.3	11.5	11.9	489	656	952
11.	0.15	114	26.0	6.5	9.1	12.1	471	666	922
12.	0.20	142	22.6	6.3	8.1	9.5	438	710	903
13.	0.14	169	28.0	9.0	9.5	14.0	438	690	1295
14.	0.16	136	34.0	9.6	10.5	10.1	450	720	1250
15.	0.12	132	32.0	8.6	10.3	13.0	419	650	1210
16.	0.18	141	34.5	9.0	10.1	12.9	381	750	1253
17.	0.18	104	34.0	9.0	11.2	19.1	463	790	1264
18.	0.11	131	33.0	8.7	10.5	13.5	400	605	1215
19.	0.17	120	27.5	8.3	10.9	12.5	482	795	1041
20.	0.17	126	28.5	9.9	10.2	12.5	444	710	1095
21.	0.11	125	19.0	8.4	9.2	12.3	393	560	1073
22.	0.16	186	29.0	8.5	10.2	12.1	476	650	1122
23.	0.14	130	32.0	8.7	10.3	13.4	482	510	1211
24.	0.26	147	36.0	9.0	9.3	14.2	419	519	1272
25.	0.19	166	40.0	8.2	12.1	10.2	476	625	1372
26.	0.22	129	30.5	8.6	10.4	14.2	419	535	1203
27.	0.23	182	39.5	9.9	9.8	15.1	458	670	1343
28.	0.06	101	19.5	6.6	15.2	11.2	395	520	347
29.	0.17	109	20.1	5.4	10.5	9.2	325	495	486
30.	0.26	110	21.2	5.6	8.5	12.1	395	535	415
Mean	0.17	126	27.9	7.9	9.7	12.1	388	614	1068

OC (%) : Organic Carbon (%) KM-N : Alkaline permanganate N (kg/ha) NIT-N : Nitrate N (kg/ha)
OL-P : Olsen's P (kg/ha) MO-P : Modified Olsen's P (kg/ha) CA-P : Calcium lactate P (kg/ha)
AM-K : Ammonium acetate K (kg/ha) HN-K : Nitric acid K (kg/ha)

of correlation between seed yield and soil N were found to be 0.24 for organic carbon, 0.51** for $KmnO_4$-N and 0.48 for NO_3-N methods in O X strip. The correlation between uptake of N and Soil organic carbon, $KmnO_4$-N and NO_3-N were 0.16, 0.52** and 0.41** respectively. The seed yield and uptake of N were significantly correlated with $KmnO_4$-N and NO_3-N. There was no

Table 2. Relationship between sunflower yield and uptake of nutrients with soil test values and fertilizer nutrients in 0 X strip

Nutrient	Soil test method	Correlation coefficient with		
		Fertilizer N	Seed yield	Nutrient uptake
N	OC	-0.21	0.24	0.16
	KMnO4-N	-0.14	0.51**	0.52**
	NO3-N	0.07	0.48**	0.41*
P	Olsen-P	-0.15	0.46**	0.52**
	Mod.Olsen-P	0.09	0.57**	0.55**
	Ca-Lactate P	-0.05	0.29	0.32*
K	NH4OAC	-0.01	0.48**	0.50**
	HNO3	-0.04	0.40*	0.38*

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

significant correlation between N uptake and organic carbon.

The correlation between organic carbon (%) and $KmnO_4$-N, organic carbon (%) and NO_3-N, $KmnO_4$-N and NO_3-N were found to be 0.52**, 0.49** and 0.46** respectively. Thus there is a significant relationship between organic caron $KmnO_4$ and NO_3 - N. The correlation between seed yield and soil P were found to be 0.46** for Olsen's method, 0.57** for modified Olsen's method and 0.29 for calcium lactate method in O X strip. The correlation between P uptake and available soil P estimated by Olsen's modified Olsen's and calcium lactate methods and 0.52**, 0.55** and 0.32** respectively. Both Olsen's and modified Olsen's P were highly correlated with seed yield and P uptake. The values of correlation between Olsen's P and modified Olsen's P, Olsen's P and calcium lactate method, modified Olsen's P and calcium lactate methods were 0.90**, 0.31 and 0.26 respectively. Hence, there is a significant relationship between Olsen's P and modified Olsen's P.

The correlation between seed yield and soil K were found to be 0.48** for ammonium acetate method and 0.40* for boiling HNO_3 method. Both methods were significantly correlated with seed yield. The correlation between K uptake and avilable soil K estimated by ammonium acetate and boiling HNO_3 methods were 0.05* and 0.38* respectively. The values of correlation between ammonium acetate K and boiling HNO_3 was found to be 0.59**.

Correlation of soil test methods with nutrient uptake

The correlation results of different methods of soil N estimate with N uptake indicated that $KmnO_4$-N was highly correlated with N uptake (0.52**) followed by nitrate nitrogen (0.41**). KmnO4 - N was also significantly correalted with seed yield. $KmnO_4$-N method is a better index of N availability. The superiority of $KmnO_4$ oxidisable N was also reported by Prasad (1994).

The Olsen's method, modified Olsen's method and calcium lactate methods where used in to evaluate the soil test methods for available

P. Both modified Olsen's and Olsen's P were significantly correlated with P uptake (0.52** and 0.55** respectively) and seed yield (0.46** and 0.57** respectively). The results indicate the superiority of modified Olsen's method even though Olsen's and modified Olsen's methods were on par with each other. Ayodele and Agboola (1981) also found that there was a significant correlation between relative maize yield and modified Olsen's P. Since method of extracton is the same for Olsen's P and modified Olsen's P, the latter may be used in place of Olsen's P becuase of its advantage of stability of colour even 24 hours after development. The critical limit of available P for sunflower grown in vertisols of Nandyal was 8.2, 9.0 and 12.0 kg P ha for Olsen's, modified Olsen's, calcium lactate methods respectively.

Ammonium acetate method was highly correlated with seed yield (0.48**) and K uptake (0.05**). These results indicate the superiority of ammonium acetate method over boiling HNO_3 method. Similar results were also reported by Vinay Singh *et al* (1992), Panda and Panda (1993) and Prasad (1994).

Thus alkaline permaganate method for N, modified Olsen's method for P and ammonium acetate method for K were found to be highly and significantly correlated with both sunflower seed yield and plant uptake of nutrients. Hence, these methods are suitable for the vertisols of Nandyal for better estimation of the soil test values and their further use for fertilizer optimisation.

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SEED SOAKING OF SOME XENOBIOTICS TO INDUCE RESISTANCE AGAINST *Aspergillus niger* IN GROUNDNUT

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ABSTRACT

A number of non conventional chemicals such as Barium nitrate, Barium Sulphate, Cupric sulphate, Cupric chloride, Zinc sulphate, Zinc chloride, Manganese sulphate, Ferric chloride and Mercuric chloride having potential to accumulate phenolic substances commonly known as phytoalexins, were tested at different concentrations for their possible effect in defence mechanism in groundnut against collar rot infection caused by *Aspergillus niger* van. Teighem. Results revealed that all the nine chemicals provide significatnt protection. Best results were obtained with mercuric chloride followed by Barium sulphate. Biochemical changes of infected plants recorded higher levels of phenolics and peroxidase activity, and reduced activity of PG enzymes as compared to untreated plants. Treated plants also showed increased yield attributing characters and pod yield.

Key Words : Groundnut, *Aspergillus niger*, Xenobiotics, Phytoalexin, Bichemical changes, yield.

INTRODUCTION

Information on the effectiveness of various chemicals in inducing defence mechanism in host crop against their potential pathogens as a possible disease control measure, not directly toxic to plants is now available (Lazarovits, 1988; Sinha, 1989). Copper salt, usaually fungitoxic in nature has been used in cereals as antimildew chemical (Bryde *et al.* 1953). Seed treatment with Copper sulphate and Boric acid reduced brown spot in rice seedlings (Bouchereall and Atkin, 1950.) Seed treatment with Manganese sulphate gave effective control of *Fusarium* wilt of pigeonpea (Carorasco *et al.*, 1978). Wet seed treatment with dilute concentrations of some phytoalexin inducing chemicals can provide rice plants a substantial protection from brown spot and blast (Sinha and Hait, 1982; Sinha and Sengupta, 1986). In this context, it seemed that some chemicals which are known to induce phytoalexin might be useful in the control of collar rot of groundnut, caused by *Aspergillus niger* which causes an estimated loss of 50% in India (Anonymous, 1993).

It was, therefore aimed to study the effect of widely divergent group of chemicals for the control of collar rot infection in grouundnut and their biochemical changes, yield and yield attributing characters.

MATERIALS AND METHODS

The Pathogen *Aspergillus niger* was isolated from infected groundnut plant in pure form and maintained on potato dextrose agar (PDA) medium. The pathogen was then grown in sand maize meal (3:1) medium in 250 ml conical flask and kept in BOD incubator at 28 ± 1°C. After 10 days a profuse growth was observed. The whole medium was used as inoculum. Seeds of groundnut (cv. JL-24) were sown in 2x5m2 plots in a randomized block design with three replications. Nine chemicals viz. Barium nitrate and Barium sulphate, Zinc chloride and Zinc sulphate, cupirc chloride and cupric sulphate, mangenese sulphate, Ferric chloride and Mercuric chloride were used at certain concentrations. The concentrations which proved better under controlled condition in reducing disease incidence were selected for this experiment. For pre-sowing

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treatment, seeds were surface sterilized and then soaked for 24h in dilute solutions of test chemicals in distilled water. Seeds soaked in only distilled water were used as control. In field, land preparation was done after initial application of decomposed compost @ 12 t/ha during ploghing. Recommend doses of N, P and K @ 30, 60 and 30 kg/ha respectively were applied. P & K were broadcast before final harrowing in the form of single super phosphate and murate of potash respectively. N was applied in two equal split doses, half as basal and half at the time of earthing up. Inoculation of plants with *Aspergillus niger* was done in collar region of 10 day old crop in the plot. The disease incidence was recorded upto 45 days after sowing by counting the number of seeds germinated (pre-emergence damping off%) and percent of plants infected. Analysis of different compounds or enzymes was done using infected plants in treated and untreated plots.

Extraction of Phenol was done following the procedure of Biehn *et al.* (1968) and estimated by the method of Bray and Thorpe(1954). Results were expressed as mg/g of fresh tissue weight.

Polygalacturonase (PG) enzyme acitivity was measured by viscosimetrically (Bell *et al.*, 1955) with some modification by Hancock *et al* (1964). The enzyme activity was determined from the formula 1/tx 100 where 't' is the time required in minutes for 50% reduction in viscosity.

Peroxidase activity was measured following the method of Addy and Goodman (1972). Results were expressed as unit of activity/ g of tissue/minute.

Growth characters viz. plant height, root length and number of leaflets, root nodules and yield attributing characters like number of pegs, pods, flower and finally pod yield/plant were assessed in both treated and untreated plants.

RESULTS AND DISCUSSION

Resistance induction in groundnut plants

All the treatments at all concentrations significantly reduced disease incidence of collar rot as well as intensity of the disease as compared to untreated control. (Table 1). Best results were obtained when the seeds were treated with mercuric chloride (10^{-4} M) which reduced 69.01% collar rot disease incidence and 18.18% reduction of disease severity by reducing the mortality percentage over untreated control. Barium nitrate (10^{-4} M) and Barium sulphate (10^{-2} M) also showed a good protection from collar rot disease (56.34 and 59.15% respectively) as well as reduction of disease severity (25.8 and 24.14% respectively). Zinc sulphate (10^{-3} M) also gave good results in reducing the disease incidence (58.45%) as well as good protection from collar rot disease severity (22.03%) over control. Other chemicals also showed a significant protection and reduction of disease severity over untreated control.

Biochemical changes associated with defence mechanism

Total Phenol: In healthy plants it was revealed that all the treatments increased total phenol content over control except Barium nitrate, Manganese sulphate, Ferric chloride and Barium sulphate.

In case of inoculated plants it was observed that maximum amount of total phenol was accumulated in Manganese sulphate treated plants (123.18%) followed by Ferric chloride (101.44%), and Barium sulphate (10^{-2} M) (92.5%) (Table 2).

As regards Polygalacturonase activity (PGA), plants in all treatments showed significant reduction over control. Maximum reduction of PGA activity was noticed in Mercuric chloride

Table 1. Effect of seed treatment with selected chemicals on collar rot disease of Groundnut (Pooled data of two years).

Treatments	Conc. (M)	Disease incidence (%)	Disease control (%)	Dead plants (%)	Severity checked over disease incidence (%)
Barrium nitrate	10^{-4}	31.0 (33.81)	56.34	23.0 (29.66)	25.80
Barium sulphate	10^{-2}	29.0 (32.57)	59.15	22.0 (27.98)	24.14
Zinc chloride	10^{-4}	35.0 (36.27)	50.70	27.0 (32.32)	22.86
Zinc sulphate	10^{-3}	29.5 (32.89)	58.45	23.0 (28.59)	22.03
Cupric chloride	10^{-4}	36.5 (37.14)	48.59	26.0 (31.66)	28.77
Cupric sulphate	10^{-4}	39.0 (38.64)	45.07	27.0 (31.85)	30.77
Manganese sulphate	10^{-2}	42.5 (40.68)	40.14	32.0 (35.45)	24.70
Ferric chloride	10^{-4}	49.0 (44.42)	30.98	34.5 (36.97)	29.59
Mercuric chloride	10^{-4}	22.0 (27.94)	69.01	18.0 (26.11)	18.18
Control (untreated)	-	71.0 (57.42)		69.0 (55.89)	
S Em±		1.59		2.49	
CD (P=0.05)		3.34		5.23	

Figures in the Parenthesis are average angular transformed values.

(10^{-4} M) treated plants followed by Manganese sulphate (10^{-3} M), and Ferric chloride (10^{-4} M). Decreased PGA was due to metabolic changes in host tissue and suppression of fungal growth and consequent fall in enzyme production. Increased accumulation of phenol oxidase (PO) may also cause inhibition of PG enzyme activity.

In case of Peroxidase activity (PA) it was observed that increase in PA was recorded in Barium sulphate (10^{-2} M) (212.76%) followed by Barium nitrate (10^{-4} M) 184.95%). Lower PA was observed in Mercuric chloride treated plants (Table 2)

It was observed that most of the test compounds provided good protection to groundnut plants infected by *Aspergillus niger* by simply seed soaking at extremely low concentrations. The biochemical studies indicated that the treated infected plants had higher post infectional total phenol content as compared with untreated ones. It seems that in treated plant, there was rapid accumulation of more phenolic substances at the site of infection within a short period which caused reduction in PG enzyme activity. It is thus evident that the increased biosynthesis of phenolics and reduction in PGA that leads to greater accumulation of quinones at the infection site. Vance *et al* (1980) reported enhanced lignification in infection site that reduced the infection frequency by the pathogen.

Growth, yield and yield attributing characters

Plant height increased significantly when seeds were treated with Barium nitrate, Barium sulphate, Zinc sulphate, Zinc chloride and Manganese sulphate over control. Treatment with Cupric sulphate, Ferric chloride, Cuprice chloride and Mercuric chloride had no significant effect. Whereas Mercuric chloride, Ferric chloride and Cupric chloride treated seeds showed reduction in plant height over control (Table 3)

Maximum root length was observed in Barium sulphate treated plants followed by Cupric sulphate and Manganese sulphate.

Table 2. Biochemical changes in response to seed treatment with some chemicals infected with *Aspergillus niger* in groundnut (cv. JL-24)

Treatment	Conc (M)	Polygalacturonase activity		Peroxidase activity		Total Phenol mg/g of tissue		
		Unit activity/g of fresh tissue/min.	%reduction over control	Unit activity/g of fresh tissue/min.	%increase over control	Healthy plant	Inoculated plant	% increase
Ba (NO_3)	10^{-4}	15.1	63.8	37.5	184.95	0.84	1.49	77.38
$BaSo_4$	10^{-2}	15.0	63.9	41.1	212.76	0.8	1.54	92.5
$ZnCl_2$	10^{-4}	22.8	45.3	29.0	120.36	1.26	1.58	25.34
$ZnSo_4$	*10^{-3}*	*16.5*	*60.4*	*33.0*	*150.75*	*1.05*	*1.48*	*40.95*
$CuCl_2$	10^{-4}	18.6	55.4	31.6	140.54	1.15	1.62	40.86
CuSo4	10^{-4}	19.7	52.7	29.8	126.67	1.27	1.66	30.70
MnSo4	10^{-3}	13.0	68.8	27.8	111.47	0.69	1.54	123.18
FeCl3	10^{-3}	14.9	64.3	26.8	103.87	0.67	1.35	101.44
Hg Cl2	10^{-4}	11.4	72.7	42.5	22.94	1.13	1.74	53.98
Control (Water)	-	41.7		13.6		0.85	0.873	2.70
S. Em ±		2.49		0.53	Seed treatment = 0.026			
CD (P=0.05)		5.23		1.11	Healthy/Inoculated = 0.012 Seed treatment with health = 0.038			

Number of leaflets and dry weight of leaflets were also increased in manganese sulphate treated seeds followed by Zinc chloride and Barium sulphate.

Number of root nodules and dry weight of root nodules were increased in Manganese sulphate treated plants. Number of pegs increased in Zinc sulphate followed by Zinc chloride. Number of pods and number of flowers were maximum in Manganese sulphate followed by zinc chloride treated seeds. The dry weight of stem and root was also more in Manganese sulphate treated seeds followed by Zinc chloride.

It is evident that the chemicals have significantly influenced the plant structure, which ultimately resulted in greater yield of the crop,. The chemicals had given good protection to groundnut crop against *Aspergillus niger* and significantly increased pod yield. The maximum pod yield /plant was observed in Barium sulphate (10^{-2} M) followed by Zinc chloride (10^{-4} M), Zinc sulphate (10^{-3} M) and Barium nitrate (10^{-4} M) (Table 3)

It is therefore suggested that seed soaking with xenobiotics compounds could be used in the control of collar rot pathogen (*A.niger.)* and increase the pod yield of groundnut.

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Table 3. Effect of seed treatment with various chemicals on growth and yield attributes of Groundnut (cv. JL 24) at 75 DAS

Treat-ment	Conc (M)	Plant height (cm)	Root length (cm)	No.of leaflets	Dry wt.of leaflets (g)	No.of root nodules	Dry wt. of root nodules (g)	No.of Pegs	No.of Pods	No.of flowers	Dry wt. of stem (g)	Dry wt of root (g)	Yield (g/Plant)
$Ba(NO_3)_2$	10^{-4}	40.33	26.33	178.5	6.2	338.66	0.279	6.66	6.83	4.83	11.0	0.512	27.52
$ZnSo_4$	10^{-3}	41.33	18.0	211.33	9.26	629.83	0.431	25.83	10.66	7.5	12.83	0.659	29.92
$Cuso_4$	10^{-4}	36.16	30.16	303.83	10.75	306.50	0.331	18.66	11.83	7.66	13.33	0.805	26.50
$Baso_4$	10^{-2}	42.33	31.16	306.83	13.66	467.16	0.367	10.0	6.66	5.0	16.66	0.988	30.17
$Mnso_4$	10^{-3}	41.0	30.5	432.83	14.41	751.00	1.02	15.33	19.16	23.5	23.5	1.156	24.92
$FeCl_3$	10^{-4}	27.5	19.0	197.33	3.54	165.83	0.153	9.83	6.0	6.0	5.25	0.362	16.17
$CuCl_2$	10^{-4}	32.0	24.5	217.16	6.25	362.50	0.729	14.0	11.0	12.83	9.66	0.912	26.33
$ZnCl_2$	10^{-4}	39.66	29.16	324.33	14.03	560.83	0.657	22.66	17.83	19.33	19.16	1.012	31.50
$HgCl_2$	10^{-4}	30.66	25.0	319.16	10.53	310.66	0.250	14.5	21.5	9.33	14.75	1.00	24.42
Control (Water)	-	34	27.83	314.83	9.58	237.00	0.271	10.33	8.33	10.66	10.41	0.721	23.00
S Em ±		2.59	1.36	24.43	0.83	54.69	0.04	1.90	2.43	1.93	1.73	0.08	0.77
CD (0.05)		5.45	2.86	55.63	1.73	114.92	0.093	4.004	5.10	4.05	3.63	0.179	1.63

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VARIETAL PREFERENCE AND ECONOMIC INJURY LEVEL OF BUD FLY (*Dasyneura lini* Barnes) IN LINSEED

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ABSTRACT

Field screening of linseed varieties against bud fly (*Dasyneura lini* Barnes) during 1995-96 and 1996-97 revealed that none of the test varieties possessed high resistance to this pest, however Jawahar-1 and Neela varieties appeared moderately resistant with significantly low bud infestation of 14.34 and 16.60 per cent, respectively. Twenty two varieties were categorized as moderately susceptible, whereas five varieties (LC-54, Hira, Pusa-2, Pusa-3 and Neelum) showed susceptibility to bud fly. Only Local variety was grouped as highly susceptible having 66.06 percent infestation along with the lowest seed production of 500 kg/ha. Improved varieties reduced 19.66 to 78.29 per cent bud infestation over local with 46.67 to 173.33 per cent enhancement in seed yield. The economic injury level was 10.50 and 11.90 per cent in respective years with their mean value of 11.20 per cent bud infestation. Average loss in seed yield was 69.00 per cent due to this pest.

Keywords : Linseed, Bud fly, resistance, Infestation, Economic injury level, Loss.

INTRODUCTION

Linseed is an important oilseed crop having immense industrial utility, which is grown in Gangetic plains, central and peninsular region of the country. Its national productivity is quite low against global level due to non-adoption of improved technology for its cultivation. Biotic and abiotic constraints constitute the platform for its low productivity and bud fly (*Dasyneura lini* Barnes) is the dreaded pest among the biotic factors, which causes upto 62.54 percent loss in seed yield (Malik *et al.*, 1998). A number of insecticides have been recommended for the control of bud fly (Singh and Mathur, 1986; Singh *et al.*, 1991; Singh *et al.*, 1995 and Malik *et al.*, 1996a), but their indiscriminate application may create deleterious effects on the environment including resistance in insects. Host plant resistance being an integral part of integrated pest management (IPM) may be the way-out for eco-friendly and sustainable agriculture. Thus, present studies were undertaken on the varietal preference and economic injury level of bud fly in linseed.

MATERIALS AND METHODS

Thirty varieties of linseed were sown during November end following randomizsed block design replicated thrice in 3x3 m plots during 1995-96 and 1996-97. The crop was raised by following recommended agronomical practices except plant protection measures. Bud fly infestation was recorded at dough stage of the crop as per Malik (1993). Data obtained on bud infestation and seed yield for each year were pooled for statistical analysis and the varieties were categorized into different groups on the basis of their infestation range. For economic injury level, phosphamidon 85 SL (0.03%) was applied at weekly intervals to create varying levels of bud fly infestation. The loss caused by the pest under complete protection was considered as unavoidable loss. Economic injury level (EIL) was determined as per Stone and Pedigo (1972) and Atwal and Singh (1989).

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RESULTS AND DISCUSSION

Varietal Preference

Among the varieties tested, none of the cultivar showed resistance to bud fly, however, Jawahar-1 had significantly low bud infestation of 14.34 percent, which was at par with Neela (16.60%). Both these varieties were least preferred by this pest and rated as moderately resistant (Table -1 & 2). Twenty two varieties including Gaurav, Sheetal, Nagarkot, Jawahar-17, Himalini, Janki, Shubhra, Garima, Flake-1, Jawahar-7, Chambal, Jeevan, Surabhi, Shikha, Sweta, Laxmi-27, T-397, Mukta, LC-185, Jawahar 23-10, R-552 and Kiran were categorized as moderately susceptible varieties, as they harboured 25.01 to 40.00 per cent bud infestation. Only Local variety was ranked as highly susceptible with 66.06 per cent bud infestation, whereas remaining five cultivars (LC-54, Hira, Pusa-2 and Neelum) behaved as susceptible with 40.01 to 60.00 per cent infestation. Improved varieties showd 19.66 to 78.29 per cent reduction in bud fly infestation over Local variety. Views of Jakhmola and Yadav (1983), Sing *et al.*, (1990) and Malik *et al.*, (1996b), indicating Jawahar-1 and Neela as moderately resistant varieties, corroborate with these results.

Grain yield of different varieties varied from 500 kg/ha (Local) to 1366.67 kg/ha (garima and Shubhra). Significantly superior yields between 1100 to 1366.67 kg/ha were provided by Garima, Shubhra, Nagarkot, Sheetal,Shikha, Flake-1, Pusa-2, T-397 and Himalini varieties. Improved varieties produced 46.67 to 173.33 per cent higher yield in comparison to Local variety.

Economic Injury Level (EIL)

Different levels of bud fly infestation were created by applying phosphamidon 85 SL (0.03%) at weekly intervals starting from the bud initiation stage. Spraying of the crop at zero days exposure period could not protect the crop completely having 8.89 and 10.37 percent bud infestation during 1995-96 and 1996-97, respectively, which were considered as unavoidable losses (Table 3). Yield losses in untreated crop were 66.67 and 71.32 percent in respective years with the average of 69.00 per cent. Relationship between bud fly infestation (X) and yield (Y) were computed as Y=2276.75 - 25.46X and Y = 2143.14-26.75X for these years with 41.00 kg/ha gain threshold for each year. Economic injury level was 1.61 and 1.53% bud infestion on the basis of gain thershold and regression coefficient. Since, there were 8.89 and 10.37 per centunavoidable losses during these years, the actual EIL will be the sum of calculated EIL and unavoidable loss for each year, which is 10.50 and 11.90per cent bud infestation for the respective years with their mean value of 11.20 per cent. The economic threshold level of any

Table 2. Categorization of linseed varieties into different groups

Infestation range (%)	Symbol	Varieties
0 to 10.00	R	None
10.01to 25.00	MR	Jawahar-1 and Neela
25.01 to 40.00	MS	Gaurav, Sheetal, Nagarkot, Jawahar-17, Janki, Himalini, Shubhra, Garima, Flake-1, Jawahar -7, Chambal, Jeevan, Surabhi, Shikha, Laxmi-27, T-397, Mukta, LC-185, Jawahar 23-10, R-552 and Kiran.
40.01 to 60.00	S	LC-54, Hira, Pusa-2, Pusa-3 and Neelum
60.01 and above	HS	Local

R = Resistant, MR =M oderately resistant, MS = Moderately susceptible, S = Susceptible, HS = Highly susceptible.

Table 1 : Bud fly infestation and yield of different varieties of linseed

Varieties	Bud fly infestation (%)		Infestation decrease over local (%)	Yield (kg/ha)	Yield increase over local (%)
T-397	33.92	(35.62)*	48.65	1116.67	123.33
Neelum	53.07	(46.76)	19.66	875.00	75.00
Hira	42.18	(40.75)	36.15	983.33	96.67
Mukta	35.73	(36.71)	45.91	875.00	75.00
Garima	29.63	(32.98)	55.15	1366.67	173.33
Sweta	33.13	(35.14)	49.85	1045.83	109.17
Shubhra	28.50	(32.27)	56.86	1366.67	173.33
Gaurav	26.53	(31.00)	59.84	1054.17	110.83
Laxmi-27	33.85	(35.58)	48.76	825.00	65.00
Shikha	32.95	(35.03)	50.12	1162.50	132.50
Jawahar-1	14.34	(22.25)	78.29	733.33	46.67
Jawahar-7	30.91	(33.78)	53.21	991.67	98.33
Jawahar-17	27.85	(31.85)	57.84	945.83	89.17
Jawahar 23-10	37.21	(37.59)	43.67	954.17	90.83
R-552	38.26	(38.21)	42.08	958.33	91.67
Kiran	38.26	(38.21)	42.08	1041.67	108.33
Sheetal	26.60	(31.05)	59.73	1175.00	135.00
Himalini	28.22	(32.09)	57.28	1100.00	120.00
Jeevan	32.11	(34.52)	51.39	970.83	94.17
Surabhi	32.31	(34.64)	51.10	1095.83	119.17
Nagarkot	26.68	(31.10)	59.61	1216.67	143.33
Janki	28.46	(32.24)	56.92	1012.50	102.50
Chambal	32.10	(34.51)	51.41	937.50	87.50
Neela	16.60	(24.04)	74.87	837.50	67.50
Pusa-2	42.71	(40.81)	35.35	1125.00	125.00
Pusa-3	42.83	(40.88)	35.17	1066.67	113.33
Flake-1	29.65	(32.99)	55.12	1137.50	127.50
LC-54	41.44	(40.07)	37.27	1083.33	116.67
LC-185	36.85	(37.38)	44.22	866.67	73.33
Local	66.06	(54.37)	-	500.00	-
C.D. (p=0.05)		3.20		166.37	

* Figures in parentheses are angular transformed values.

pest depends upon the economic injury level and the multiplication rate of the pest, which will be below the EIL and decision making factor for insecticidal application. Malik *et al.*, (1996c) reported 2.67 per cent bud infestation as EIL of this pest, which does not signify the proper time of insecticidal application owing to the change in EIL based on the cost of insecticidal treatment and price of linseed.

Table 3 : Bud infestation and yield with different exposure periods to bud fly in linseed

Exposure period (days)	Bud fly infestation (%)	Seed Yield (kg/ha)		Computation of EIL
			1995-96	
0	8.89	1972.22	(i)	Gain threshold = 41.00 kg/ha
7	14.62	1879.63	(ii)	Y=2276.75-25.46x
14	25.97	1694.44	(iii)	Calculated EIL = 1.61%
21	30.56	1583.33	(iv)	Unavoidable loss = 8.89%
28	*54.58*	*888.89*	*(v)*	*Actual EIL = 10.50%*
35	58.27	740.74		
42	63.21	657.41		
			1996-97	
0	10.37	1884.26	(i)	Gain threshold =41.00 kg/ha
7	17.08	1662.22	(ii)	Y=2143.14 - 26.75x
14	26.60	1537.78	(iii)	Calculated EIL = 1.53%
21	32.74	1148.33	(iv)	Unavoidable loss = 10.37%
28	48.59	825.92	(v)	Actual EIL = 11.90%
35	58.28	603.15		
42	60.58	540.33		

Cost of treatment for two sprays of phosphamidon : Rs. 574/ha, market value of linseed : Rs. 14/kg.

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ECONOMIC ANALYSIS OF GROUNDNUT CULTIVATION IN GORANTLAPALLE WATERSHED PROJECT OF CHITTOOR DISTRICT IN ANDHRA PRADESH*

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ABSTRACT

The economics of groundnut cultivation under watershed technology implemented farms revealed higher *total costs*, gross returns and net returns when compared with non-watershed farms. The various farm efficiency measures computed also confirmed the same. There is significant difference in the yield of groundnut crop between watershed and non-watershed farms.

Keywords : Groundnut, costs, returns, yield, watershed.

INTRODUCTION

The Indian oilseeds scenario has undergone a significant transformation from a net importer status during eighties to a net exporter status during early nineties. With an estimated production of about 24.46 million tonnes during 1996-97 (Oil World, 1998), the country accounts for 9.7 per cent of the global oilseeds production (about 250 million tonnes). Despite achieving the near targeted production during 1996-97, the import of vegetable oils is estimated to have crossed 15 lakh tonnes as against the officially estimated shortage of eight lakh tonnes (Virupakshappa and Kiresur, 1997).

The role of technology in fostering and sustaining the oilseeds production needs more emphasis. Unless the technology is economically viable and sustainable, any amount of pressure from the other relevant factors would not help sustain the growth that has been achieved. Since the annual oilseeds are mostly grown under resource poor conditions, achieving sustainability becomes still more difficult. With hardly 25 per cent of the area under irrigation, oilseeds are subjected to vagaries of monsoon resulting in lower yields compared to irrigated crops like wheat and rice. Since two-thirds of the cropped area falls under the rainfed areas, water shed management is one of the critical factors for improving the crop productivity.

The improved oilseeds crop production technologies have tremendous productivity potentials, which was currently under-exploited on commercial scale. As per a study based on the Frontline Demonstrations Project under the Oilseeds Production Programme (OPP) pertaining to the peroid from 1988-89 to 1995-96 (Reddy *et al*, 1997) there exits a wide commercially exploitable yield reservoir which would be much larger if one compares the realizable yield levels of improved technologies with the average yield levels, and more so if one considers the highest yield recorded from demonstation plots. The mean yield of improved technology of groundnut, a major oilseed crop realizable on farmers' fields is 1958 kg/ha while the national average yield is of the order of 993 kg/ha. There exists a realizable yield gap of 965 kg/ha, which accounts for 97.18

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per cent of the existing national average yield. In the present paper, efforts have been made to assess the impact of watershed technology on the overall economics of groundnut cultivation.

MATERIALS AND METHODS

The data required for the present study were obtained from 80 sample beneficiary farmers comprising 17 marginal, 26 small and 37 large farmers who were selected using proportionate random sampling technique in the Gorantlapalle watershed development area of Chittoor district of Andhra Pradesh. For better comparison data from same number of farmers were also obtained who are residing in the non-watershed area where except for implementation of watershed technology all other conditions are same as that of watershed area.

The data collected includes the input-output coefficients of groundnut crop and the prices at which the farmers market their produce in both watershed and non-watershed areas. The data obtained were analyzed using simple tabular or conventional analysis. The significance of the groundnut yield differences between watershed and non-watershed farms was tested using t-test and also few crop efficiency measures were computed to draw valid conclusions.

RESULTS AND DISCUSSION

Groundnut is the predominant crop grown with red gram as inter crop on rainfed farms of the study area. No crop rotations are followed in these drylands. Groundnut is being raised year after year since it is a commercial crop of this tract. The soils of the area are highly congenial for groundnut crop. TMV-2 and JL-24 are the two popular groundnut varieties grown in this area.

The different watershed technological activities or components implemented and adopted by the farmers in the watershed area and not observed in non-watershed area includes engineering and mechanical measure like contour bunds and gully plugging works like loose boulder checks. Among the vegetative barriers established *khus* grass production on small earthen bunds across the slope was more prominent. Agronomic measures included deep ploughing, cultivation across the slope, formation of dead furrows etc. Besides, the sample watershed beneficiary farmers were also encouraged to adopt strictly 7:1 groundnut + red gram intercroppingsystem in the form of crop demonstrations by providing *incentives worth of Rs. 400/- per plot of 0.50* hectares at 50 percent subsidy in kind such as 5 kg of red gram seed, 40 kg of DAP, 25 kg of MOP, 6 kg of urea, 200 g of Dithane M-45, 0.50 of Monocrotophos and 250 kg of Gypsum. Under organic farming system with a view to provide balanced nutrition 50 kg of super phosphate along with a cash incentive of Rs. 50/- for digging out compost pit was also provided for each beneficiary.

Cost Structure

The cost structure of groundnut cultivation on different size groups of farms in both watershed and non-watershed areas is presented in Table 1(a). Except on marginal farms, the total cost of production of groundnut per hectare was maximum on watershed farms compared to non-watershed farms. The total cost of production was higher by Rs. 670, Rs. 441 and Rs. 419 respectively on large, small and pooled watershed farms than that on their counterparts in non-watershed area. The component-wise investment pattern showed that with respect to variable cost, the investment on fertilizers and seed were higher by 80.49 and 16.24 percent on pooled watershed farms compared to pooled non-watershed farms. Thus the data confirmed the incurrence of higher expenditure on the main yield attributing resources like seed and fertilizers by watershed farmers than the non-watershed farmers. The supply of quality

Table 1(a) : Cost structure of groundnut according to farm size in chittoor district of Andhra Pradesh.

	Marginal farms			Small farms			Large farms			Pooled farms		
	Water-shed	Non-water shed	Difference	Water-shed	Non-water shed	Difference	Water-shed	Non-water-shed	Difference	Water-shed	Non-water shed	Difference
A. Variable cost												
1. Tractor power	93.75 (1.06)*	266.67 (2.99)*	-172.92 (-184.45)**	244.20 (2.85)*	165.23 (2.09)*	78.77 (32.26)**	433.10 (4.76)*	359.08 (4.15)*	74.03 (17.09)**	299.60 (3.37)*	270.51 (3.20)*	29.09 (6.95)**
2. Cattle power	782.50 (8.86)	1025.00 (11.50)	-242.50 (-30.99)	878.99 (10.22)	1097.23 (13.83)	-218.23 (-24.83)	938.46 (10.31)	861.14 (9.94)	77.32 (8.24)	885.99 (9.98)	980.64 (11.59)	-94.65 (-22.61)
3. Human power	1437.61 (16.28)	1712.16 (19.21)	-274.50 (-19.10)	1594.63 (18.54)	1442.82 (18.19)	151.82 (9.52)	1807.71 (19.86)	1820.50 (21.02)	-12.79 (-0.71)	1659.81 (18.69)	1663.94 (19.66)	-4.13 (-0.99)
4. Seed	2177.09 (24.66)	2041.67 (22.90)	135.42 (6.22)	1778.28 (20.68)	1779.24 (22.43	-0.96 (-0.05)	2037.10 (22.38)	1959.13 (22.62)	77.97 (3.83)	1982.73 (22.32)	1914.74 (22.63)	67.99 (16.24)
5. FYM	657.00 (7.64)	850.00 (9.53)	-175.00 (-25.93)	631.73 (7.34)	681.45 (8.59)	-49.72 (-7.87)	608.43 (6.68)	950.54) (10.97)	-342.11 (-56.23)	630.15 (7.10)	833.74 (9.85)	-203.59 (-48.64)
6. Fertilizers	1273.92 (14.43)	656.25 (7.36)	617.67 (48.49)	771.85 (8.97)	261.39 (3.30)	510.46 (66.13)	596.09 (6.55)	520.47 (6.01)	75.62 (12.69)	797.25 (8.98)	460.34 (5.44)	336.91 (80.49)
7. Plant Protection	178.13 (2.02)	170.23 (1.91)	7.90 (4.43)	116.77 (1.36)	118.23 (1.49)	-1.46 (-1.25)	116.99 (1.29)	75.90 (0.88)	41.09 (35.13)	129.91 (1.46)	111.94 (1.32)	17.97 (4.29)
8. Transportation	23.77 (0.27)	21.25 (0.24)	2.52 (10.60)	23.75 (0.28)	21.25 (0.27)	2.50 (10.52)	27.50 (0.30)	20.82 (0.24)	6.68 (24.31)	25.49 (0.29)	21.07 (0.25)	4.42 (1.06)
9 Interest on variable cost	149.44 (1.69)	151.72 (1.70)	-2.28 (-1.53)	135.90 (1.58)	125.26 (1.58)	10.64 (7.83)	147.72 (1.62)	147.77 (1.71)	-0.05 (-0.03)	144.25 (1.62)	140.78 (1.66)	3.47 (0.83)
B. Fixed cost												
1. Rent/Rent Value of owned land	1583.33 (17.93)	1535.62 (17.23)	47.71 (3.01)	1533.33 (17.83)	1416.97 (17.86)	116.66 (7.61)	1712.36 (18.81)	1390.43 (16.05)	321.88 (18.80)	1626.76 (18.32)	1432.28 (16.93)	194.48 (46.46)
2. Depreciation	118.64 (1.34)	144.50 (1.62)	-25.86 (-21.80)	191.31 (2.22)	178.29 (2.25)	13.02 (6.81)	136.77 (1.50)	124.02 (1.43)	12.75 (9.32)	150.64 (1.69)	147.62 (1.74)	3.02 (0.72)
3. Land revenue & Cesses	1.83 (0.02)	2.10 (0.02)	-0.27 (-14.75)	2.04 (0.02)	2.43 (0.03)	-0.39 (-19.12)	1.74 (0.02)	1.68 (0.02)	0.06 (3.45)	1.86 (0.02)	2.04 (0.02)	-0.18 (-0.04)
4. *Interest on* Capital	335.01 (3.79)	337.68 (3.79)	-2.67 (-0.80)	698.25 (8.12)	641.24 (8.09)	57.01 (8.16)	537.63 (5.91)	429.55 (4.96)	108.08 (20.10)	546.77 (6.16)	482.97 (5.71)	63.80 (15.24)
Total Fixed Cost	2038.81 (23.09)	2019.90 (22.66)	18.91 (0.93)	2424.93 (28.19)	2238.63 (28.23)	186.30 (7.68)	2388.50 (26.24)	1945.73 (22.47)	442.77 (18.54)	2226 06 (26.19)	2064.91 (24.40)	261.12 (62.38)
Total cost (A+B)	8830.20 (100.00)	8914.85 (100.00)	-84.83 (-0.96)	8601.03 (100.00)	7930.93 (100.00)	670.10 (7.79)	9101.60 (100.00)	8661.08 (100.00)	440.52 (4.84)	8881.21 (100.00)	8462.61 (100.00)	418.60 (100.00)

** Figures in parentheses are percentage differences over corresponding watershed figures., * Figures in parentheses are percentages to their respective totals.

seed, fertilizers and pesticides by the project officials to the beneficiaries under project at subsidised rates may be the main reason for investing more on these inputs. Among the farms, this difference of higher investement on these farms was found mainly on marginal farms i.e., Rs. 618 with fertilizers and Rs. 135 with seed accounting for 48.49 per cent and 6.22 per cent respectively. The maximum difference in both absolute (Rs. 194.48) and relative (46.46%) terms observed with rentalvalue of owned land on pooled watershed farms is also in agreement with the expected result of higher productivity on watershed technology implemented farms. This difference is mainly because the value of gross output obtained per hectare in watershed area was higher than that of non-watershed area.

Further, as the cost of cutivation of a crop is not uniquely defined due to the fact that various components of cost differ in their economic significance, it becomes necessary to workout aggregate costs differing in composition. The production costs were analyzed following *methodology adopted in various farm* management studies by ICAR and computed the four costs viz., Cost A_1, Cost A_2, Cost B and Cost C of groundnut crop and presented in Table 1(b). Here Cost A_2 is equal to Cost A_1 because no sample farmer had leased in land during the study period. On the whole, all the costs i.e., Cost A_1 (Rs.6245), Cost B (Rs.8419) and Cost C (Rs. 8881) for groundnut production were higher on watershed farms compared to non-watershed farms (Rs.5960, Rs.7875 and Rs.8463 respectively) barring Cost C on marginal watershed farms which was lower than its counterpart in non-watershed area, while small farms revealed maximum difference with regards to all the three costs.

Yield

The yield of the crop forms an important indicator of efficient management. Yields of both the varieties of groundnut i.e., JL-24 and TMV-2 realized by the sample farmers were higher on watershed farms as compared to non-watershed farms. Higher investment towards production by watershed farmers along with recommended technology adoption, mainly the application of gypsum during pod formation stage which has direct influence on the yield levels are the main reasons for higher yields on their farms (Table 2).

Higher yield difference of 1.50 q/ha (13.64%) with JL-24 and 1.78 q/ha (16.29%) with TMV-2 varieties was recorded by watershed large farms as compared to non-watershed large farms. Greater yield on watershed farms can be attributed to higher investment and better adoption of improved technology by these farms compared to other two size groups. These yield differences were also tested for significance using t-test and found significant at 1 per cent level of significance barring JL-24 yield difference on marginal farms

Table 1(b) : Cost of cultivation according to cost concepts

(Rupees per hectare)

Size group	watershed			Non-watershed		
	A_1	B	C	A_1	B	C
Marginal farms	6505.33	8423.67	8830.02	6488.46	8361.76	8914.85
Small farms	5838.18	8060.76	8601.03	5361.76	7419.67	7930.93
Large farms	6412.16	8662.15	9101.60	6173.27	7993.30	8661.08
Pooled farms	6245.42	8418.95	8881.21	5960.16	7875.43	8462.61

Table 2. Groundnut yields according to farm size (Rs/ha).

Size group	JL-24 variety				TMV-2 variety			
	Watershed	Non-watershed	Difference	t-value	Watershed	Non-Watershed	Difference	t-value
Marginal farms	9.00	8.50	0.50 (5.56)	1.970*	10.00	8.75	1.25 (12.50)	3.262**
Small farms	9.50	7.80	1.70 (17.89)	8.736**	8.90	7.50	1.40 (15.73)	11.209**
Large farms	11.00	9.50	1.50 (13.64)	8.073**	10.93	9.15	1.78 (16.29)	9.514**
Pooled farms	10.09	8.68	1.41 (13.97)	-	10.07	8.48	1.59 (15.79)	-

Figures in parentheses are percentage differences over corresponding watershed figures
** Significant at 1 per cent level of significance, * Significant at 5 per cent level of significance

was significant at 5 per cent level.

Returns

It is evident from the data (Table 3) that the groundnut farmers in watershed area had realised greater gross and net returns higher by Rs. 1482.39 (13.63%) and Rs. 1063.79 (53.30%) when compared with farmers in non-watershed area through incurring Rs. 418.60 (4.17%) higher total costs in groundnut cultivation. Among the farms, the difference in net returns was highest Rs. 1749.23 (73.65%) on large farms followed by marginal Rs. 651.56 (37.51%) and small Rs. 420.18 (25.85%) farms. This may perhaps be due to lower gross returns on the non-watershed farms when compared with gross returns of watershed farms.

Crop income measures

The different crop income measures computed (Table 4) revealed better performance of groundnut under watershed farms compared to

Table 3. Costs and returns of groundnut on the selected farms (Rs/ha).

Size Group	Total costs			Gross returns			Net returns		
	Watershed	Non-watershed	Difference	Watershed	Non-watershed	Difference	Watershed	Non-watershed	Difference
Marginal farms	8830.02	8914.85	-84.83 (-0.96)	10566.91	10000.18	96.87 (0.96)	1736.89	1085.33	651.56 (37.51)
Small farms	8601.03	7930.93	670.10 (7.79)	10226.25	9135.97	1090.28 (10.66)	1625.22	1205.04	420.18 (25.85)
Large farms	9101.60	8661.08	440.52 (4.84)	11476.73	9286.98	2189.75 (19.08)	2375.13	625.90	1749.23 (73.65)
Pooled farms	8881.21	8462.61	418.60 (4.71)	10876.99	9394.60	1482.39 (13.63)	1995.78	931.99	1063.79 (53.30)

Figures in parentheses are percentage differences over corresponding watershed figures.

Table 4. Crop income measure of groundnut cultivation on the selected farms

Farm income measures	*Marginal farms*			*Small farms*			*Large farms*			*Pooled farms*		
	Water-shed	Non-water shed	Difference	Water-shed	Non-water shed	Difference	Water-shed	Non-water-shed	Difference	Water-shed	Non-water shed	Difference
Gross income	10566.91	10000.18	96.87	10226.25	9135.97	1090.28	11476.73	9286.98	2189.75	10876.99	9394.60	1482.39
			(0.96)			(10.66)			(19.08)			(13.63)
Crop business income	4061.58	3511.72	549.86 (13.54)	4388.07	3774.21	613.86 (13.99)	5064.57	3113.71	1950.86 (38.52)	4631.57	3434.44	1197.13 (25.85)
Family labour income	2143.24	1638.42	504.82 (23.55)	2156.49	1716.30	440.19 (20.41)	2814.58	1293.68	1520.90 (54.04)	2458.04	1519.17	938.87 (38.20)
Net income	1736.89	1085.33	651.56	1625.22	1205.04	420.18	2375.13	625.90	1749.23	1995.78	931.99	1063.79
			(37.51)			(25.85)			(73.65)			(53.30)
Crop investment income	3655.23	2958.63	696.60 (19.06)	3856.80	3262.95	593.85 (15.40)	4625.12	2445.88	2179.24 (47.12)	4169.31	2847.24	1322.07 (31.71)
Benefit-cost ratio	0.20	0.12	0.08	0.19	0.15	0.04	0.26	0.07	0.19	0.22	0.11	0.11
			(40.00)			(21.05)			(73.08)			(50.00)

Figures in parentheses are percentage differences over corresponding watershed figures.

non-watershed farms. The crop business income, family labour income and crop investment income on pooled watershed farms were higher by 25.85%, 38.20 and 31.71 per cent respectively than that on non-watershed farms. Large watershed farms offered higher benefit-cost ratio of 0.26 as against 0.07 by large non-watershed farms.

It can be concluded that adoption of watershed technology had a positive impact on the overall economics of groundnut cultivation. This is evident from the higher gross and net returns realised on watershed farms than that from non-watershed farms through increased productivity. However, adoption of improved watershed technology on groundnut farms made the farmers to invest more on main yield attributing resources like seed and fertilizers.

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GENERATION MEAN ANALYSIS IN INDIAN MUSTARD

In Indian mustard, *Brassica juncea,* the genetic variability is limited for several characters (Rai, 1989), and particularly for seed yield (Uddin *et al.,* 1983). Lack of variability is the limiting factor in the productivity advances (Singh and Chauhan, 1984). To breed an efficient genotype the knowledge of nature of gene action is required to be well known to design a breeding scheme. The present study is an attempt in this direction.

A mustard genotype, YSRL-10 moderately resistant to Alternaria blight was crossed with two agronomically superior varieties viz., Varuna and Kranti. Reciprocal crosses were also made. The F1s of all the crosses were backcrossed with their respective parents to get seeds of BC_1 and BC_2 generations and also selfed to obtain F_2 seeds. The experiment with nineteen entries (3 parent, $4F_1$s, $4F_2$s, $4BC_1$s and $4BC_2$s) representing six generations of the four crosses (Varuna and YSRL-10, Kranti x YSRL-10, YSRL-10 x Varuna and YSRL-10 x Kranti) was laid out in randomized block design with three replications. The parents and F_1s were grown in 4- and 10-row plots of 3 meter length, respectively. The crop was raised as per the recommended package of practices under normal conditions. Observations on seven quantitative traits were recorded in 15 random plants in the parents and F_1s, 30 plants in each backcross populations, and 100 plants in each F_2 populations. Means and variances were computed for each generation irrespective of replications, using the data recorded on individual plants. The data were then subjected to joint scaling test (Cavalli, 1952) and scaling tests (Mather, 1949) to detect epistasis. The gene effects for each trait were estimated as per Hayman (1958).

The scaling tests A, B, C and D revealed significant deviation from zero in all the crosses for all the characters except in YSRL-10 x Varuna for siliqua length. The significance of any one of four scales is taken to indicate the presence of non allelic interactions. Joint scaling tests were highly significant in all the crosses for all the seven traits except two crosses YSRL 10X Varuna and YSRL-10 x Kranti for primary branch per plant and Kranti x YSRL-10 (significant at 5% level) YSRL-10 x Varuna and YSRL-10 x Kranti for siliqua length and seeds per siliqua, respectively (non-significant). The non-significance of joint scaling test for siliqua (YSRL-10 x Kranti) clearly showed a good fit of the additive dominance model for the respective characters, but at the same time significance of A, B, C and D scales (except siliqua length in cross YSRL-10 x Varuna) showed the presence of digenic or still higher order interaction and or linkage in the inheritance of these traits (Table 1).

Partitioning of the genetic components of variances indicated that mean values were highly significant for all the characters in all the crosses (Table-2). The estimates of additive (d), dominance (h) and interaction effects have been presented in Table-2. The estimate of d component was significant for primary branches, siliqua length, seeds/siliqua and seed yield per plant in cross Varuna x YSRL-10. Whereas, h component was significant only for 1000 seed weight. Among the epistatic components in Varuna x YSRL-10 additive x additive (i) component was significant for siliqua/main raceme and 1000 seed weight; additive x dominance (j) was significant for secondary branches/plant, siliqua/main raceme, seeds/siliqua and seed yield/plant and dominance x dominance (l) component was significant for secondary branches and seeds/siliqua only. In its reciprocal i.e., YSRL-10 x Varuna a different scenario of gene effects for respective traits were observed viz., for primary branches h and d component, for secondary

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Table - 1 : Scaling tests and joint scaling tests in respect of seed yield and some of yield attributing traits in four varietal crosses of Indian mustard.

Crosses	Scaling tests				Joint scaling test
	A	B	C	D	χ^2 at 3 df
			Primary branches/plant		
Varuna x YSRL-10	3.01**	-0.06	2.99**	0.2	28.13**
Kranti x YSRL-10	1.59**	2.99**	4.74**	0.8	42.85**
YSRL-10 x Varuna	0.81	-0.93	2.07**	1.43**	11.67*
YSRL-10 x Kranti	-0.01	1.73**	2.26**	0.37	11.27*
			Secondary branches/plant		
Varuna x YSRL-10	-1.29	7.26**	2.15	-1.91**	856.73**
Kranti x YSRL-10	3.61**	1.80	14.87**	4.79**	89.73**
YSRL-10 x Varuna	5.81**	-15.06**	-11.07**	-0.91	183.60**
YSRL-10 x Krant-	7.13**	12.66**	9.73**	-5.23**	114.68**
			Siliquae/main raceme		
Varuna x YSRL-10	5.06*	-0.86	12.42**	4.11**	29.57**
Kranti x YSRL-10	24.08**	8.20**	32.20**	-0.04	1650.55**
YSRL-10 x Varuna	4.07*	18.27**	0.72	-10.81**	106.21**
YSRL-10 x Kranti	26.94**	-8.00**	-1.80	-10.27**	1544.59**
			Siliqua length		
Varuna x YSRL-10	-1.21**	-0.59	-2.12**	-0.16	19.55**
Kranti x YSRL-10	-0.12	-0.25	-1.51**	-0.57*	8.30
YSRL-10 x Varuna	-0.43	-0.43	-0.80	-0.03	3.54
YSRL-10 x Kranti	-0.49	-0.58	-1.07*	-0.41	159.20**
			Seeds/siliqua length		
Varuna x YSRL-10	-6.48**	-0.93	-7.54**	-0.20	71.71**
Kranti x YSRL-10	0.05	2.51*	3.90**	0.67	27.43**
YSRL-10 x Varuna	0.13	0.03	-5.02**	-2.59**	13.11**
YSRL-10 x Kranti	1.71*	1.99*	2.46*	-0.62	9.67
			1000-Seed weight		
Varuna x YSRL-10	-2.08**	-2.22**	-6.46**	-1.08*	96.45**
Kranti x YSRL-10	-0.93*	-0.66	-7.51**	-2.96**	127.45**
YSRL-10 x Varuna	-0.06**	-1.77**	-6.43**	-1.30**	79.10**
YSRL-10 x Kranti	-2.10**	-1.01*	-7.47**	-2.18**	134.47**
			Seed yield/plant		
Varuna x YSRL-10	-8.38**	7.06**	-0.66	0.33	31.05**
Kranti x YSRL-10	23.37**	-1.61	31.90**	5.07*	293.79**
YSRL-10 x Varuna	7.58**	-5.56**	-3.94*	-2.98*	418.26**
YSRL-10 x Kranti	7.73**	-3.53*	-11.58**	-7.89*	31.86**

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

Table - 2 : Estimates of gene effects for seed yield and some of yield attributing traits in four inter varietal crosses of Indian mustard.

Crosses	Gene effects ± S.E.					
	m	d	h	i	j	l
			Primary branches/plant			
Varuna x YSRL-10	6.08±0.14**	1.60±0.41**	0.31±1.04	-0.04±1.0	1.56±0.43	-2.91±1.85
Kranti x YSRL-10	6.87±0.14**	-0.60±0.49	0.21±1.16	-0.16±1.13	-0.70±0.50	-4.42±2.11*
YSRL-10 x Varuna	6.35±0.14**	0.47±0.45	-2.13±1.10**	2.86±1.06**	0.54±0.46	3.65±1.97
YSRL-10 x Kranti	6.68±0.14**	-0.87±0.49	0.49±1.16	-0.74±1.13	-0.77±0.50	-0.78±2.1
			Secondary branches/plant			
Varuna x YSRL-10	17.62±0.32*	0.09±0.75	-0.35±2.05	3.82±1.98	-4.28±0.82**	-9.79±3.47**
Kranti x YSRL-10	20.43±0.36**	1.67±0.79*	-7.35±2.18**	9.58±2.40**	0.91±0.84	4.17±3.56
YSRL-10 x Varuna	14.18±0.24**	6.07±0.88**	–2.62±2.10	1.82±2.02	10.44±0.94**	7.43±3.85
YSRL-10 x Kranti	17.65±0.33**	*3.33±0.84**	9.77±2.20**	10.46±2.14**	–2.57±0.88**	–30.65±3.77**
			Siliquae/main raceme			
Varuna x YSRL-10	41.12±0.44**	1.73±1.05	-2.39±2.85	-8.22±2.73**	2.94±1.16*	4.02±4.84
Kranti x YSRL-10	45.08±0.42**	11.94±1.01**	-6.54±2.73*	0.08±2.65	7.94±1.10**	-32.36±4.61**
YSRL-10 x Varuna	36.53±0.36**	-5.87±1.10**	24.12±2.72**	21.62±2.64**	-7.10±1.21**	-43.96±4.82**
YSRL-10 x Kranti	41.48±0.41**	13.47±1.16**	23.94±2.93**	20.74±2.85**	17.47±1.23**	-39.68±5.11**
			Siliqua length			
Varuna x YSRL-10	3.78±0.10**	-0.50±0.24*	0.08±0.76	0.32±0.63	-0.31±0.27	1.48±1.12
Kranti x YSRL-10	3.73±0.10**	-0.41±0.20**	1.07±0.59	1.14±0.57*	0.07±0.23	0.77±0.96
YSRL-10 x Varuna	4.17±0.10**	0.19±0.26	-0.18±0.68	-0.06±0.66	0.00±0.29	0.92±1.17
YSRL-10 x Kranti	3.71±0.10**	-0.03±0.24	0.49±0.65	0.82±0.63	-0.45±0.27	-0.57±1.10
			Seeds/siliqua			
Varuna x YSRL-10	10.39±0.22**	-2.54±0.55**	-2.23±1.48	0.40±1.41	-2.64±0.57**	6.74±2.52**
Kranti x YSRL-10	13.06±0.17**	-1.75±0.55**	-3.11±1.36*	-1.34±1.30	-1.23±0.58*	-1.22±2.44
YSRL-10 x Varuna	11.64±0.17**	-0.05±0.49	3.79±1.26*	5.18±1.20**	0.05±0.52	-5.34±2.21
YSRL-10 x Kranti	13.41±0.17**	0.38±1.31	0.89±1.34	1.24±0.97	-0.14±0.57	-4.94±2.39
			1000-seed weight			
Varuna x YSRL-10	2.26±0.14**	0.14±0.33	3.71±0.89**	2.16±0.87*	0.07±0.35	2.14±1.50
Kranti x YSRL-10	1.70±0.14**	0.26±0.22	6.43±0.76**	5.92±0.72**	-0.14±0.25	-4.33±1.15**
YSRL-10 x Varuna	2.24±0.14**	-0.28±0.22	4.17±0.76**	2.60±0.72**	-0.15±0.24	1.23±1.17
YSRL-10 x Kranti	1.09±0.14**	-0.94±0.28	4.83±0.82**	4.36±0.80**	-0.55±0.30	-1.25±.1.32
			Seed Yield / Plant			
Varuna x YSRL-10	17.78±0.40**	-7.95±1.35**	-1.15±2.89	-0.66±3.14	-7.72±1.41**	1.98±5.77
Kranti x YSRL-10	23.90±0.50**	11.19±1.20**	-12.53±3.19**	-10.14±3.13**	12.49±1.26**	-11.62±5.36*
YSRL-10 x Varuna	17.38±0.33**	6.80±1.20**	6.31±2.83*	5.96±2.74*	6.57±1.27**	-7.98±3.16**
YSRL-10 x Kranti	15.38±0.41**	6.93±1.20**	18.09±2.99**	15.78±2.91**	5.62±1.26**	-19.98±5.26**

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

branches d and j, for siliqua/main raceme all the components, for siliqua length none of the components, for seeds/siliqua h, i and l for 1000 seed weight h and i and for seed yield/plant all the components i.e., d, h, i, j and l were significant.

The cross Kranti x YSRL-10 showed significant d and h gene effects for the expression of secondary branches/plant, siliqua/main raceme, seeds/siliqua and seed yield/plant. Though, the gene effects were either positive or negative for different traits, this cross exhibited significant d gene effect for siliqua length and only h gene effects for 1000 seed weight. Among epistatic gene effects all the components were significant only for seed yield/plant. l type of epistatic gene effect was observed for primary branches per plant. i component was significant for secondary branches/plant, siliqua length and 1000 seed weight. j component was significant for siliqua/main raceme and seeds/siliqua. The reciprocal of this cross i.e. YSRL-10 x Kranti showed non significance of any of the component gene effects for primary branches/plant, siliqua length and seeds/siliqua. Whereas, all the components were significant for secondary branches/plant, siliqua/main raceme and seed yield/plant. In reciprocal non significance of the studied interaction components showed either higher order of epistasis involved or there is maternal effects in expression of respective traits and digenic interaction model may also be insufficient to explain the genetic situation in the respective crosses.

The findings of Verma *et al.*, (1992) well corroborate with present findings in reference to primary branches, secondary branches, siliqua/main raceme and seed yield/plant.

The additive effect and gene interaction (i) or any other digenic complementary gene interaction which are fixable and thus can be exploited effectively for the improvement of characters through pedigree method of selection. Use of reciprocal recurrent selection has been suggested to improve the characters when both additive and non additive gene effects are involved in the expression of traits (Comstock *et al.*, 1949).

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COMPARISON OF VARIABILITY IN HOMOZYGOUS AND HETEROZYGOUS GROUNDNUT GENOTYPES BY INDUCED MUTAGENESIS*

The highly self fertilized nature of groundnut *Arachis hypogaea* L. and limited genetic variability in the gene pool restrict the scope for improvement by selection. Recombination breeding has brought limited progress in improvement of groundnut. The scope of groundnut improvement by induced mutagenesis has been immense (Norden, 1973). It has relatively well developed in the dormant seed with potential mutational sites. The greater mutability of hybrids over inbreds as found by Gustaffson (1954) suggested a new approach in this aspect of plant breeding. Irradiation of hybrids might generate greater variability than the variation of the irradiated parents and non-irradiated hybrids in groundnut (Gregory 1955). The bringing together of the gene complexes of both the parents in the hybrids and subjecting the heterozygous material to irradiation might produce considerable variability for effective selection. In this context, a detailed investigation was undertaken to compare the variability hybridization and gamma irradiation of parents and hybrids in groundnut.

Crosses were effected using three virginia bunch lines viz., VB 26, VB 54 and VB 83 as pollen parents and three spanish bunch lines viz., VRI2, VRI3 and Co2 as ovule parents. Totally nine cross combinations were effected adopting the technique advocated by Norden (1973). Seeds of all six parents and crossed seeds of nine combinations were subjected to 20 Krad of gamma rays.

Sowing was done during *kharif* 1994 on the day of irradiation in the experimental fields of School of Genetics, TNAU, Coimbatore. A factorial randomized design with two replications was adopted. In each of the treatments in a replication, 36 seeds were sown in three rows of 3.6 meter long adopting a uniform spacing of 30 x 30 cm. The biometrical observations were recorded on ten random competitive plants in each treatment.

All the available plants at harvest in first generation viz., M_1, F_1 and F_1M_1 were forwarded to second generation as plant to row basis. A total of 12 plants in a row of 3.6 m length were raised for each available single plant of first generation. During *kharif* 1995, the population size of F_2 was 4193 and F_2M_2 was 3821. For studies on quantitative characters all the available plants leaving morphological deviants in each single plant progenies were used. The biometrical observations like length of primary branch, number of secondary branches, number of matured pods, pod yield, shelling out turn, 100 kernel weight and reproductive efficiency were recorded in advanced generation.

The variability existing in parents was considered as environment variance and that among the segregation progenies in second generation as phenotypic variance. The difference between phenotypic and environment variance was taken as genotypic variance (Goulden, 1952). Comparison of relative efficiency of induced mutation, hybridization and hybridization followed by irradiation was based on the over all genotypic variance of all the parents and hybrid progenies considered together at the second generation.

Comparison of the relative efficiency of induced mutations, hybridization and hybridization followed by irradiation in groundnut with regard to release of variability was made by Gregory (1961) and Dorairaj (1979). Such a comparison based on the over all genotypes variance of all the parents and hybrid progenies

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considered together was made at the second generation and the data are presented in Table - 1.

The data revealed that, irradiation of hybrid seeds produced wide variability in F_2M_2 for all the characters studied. Further, the superiority of hybridization over variety irradiation was evident as the genotypes variance in the F_2 was higher than in the M_2 for all the characters, except length of primary branch, number of secondary branches and pod yield. Dorairaj (1979) concluded similar pattern of variation in groundnut and reported that irradiation of heterozygous genotypes created *greater variability. Ratnaswamy (1980) recorded* superior segregants from double crosses coupled with mutagenesis compared with normal double crosses in groundnut.

Gregory (1968) found that the magnitude of variance present in the progenies of irradiated parents was higher than those obtained in the progenies resulted from hybridization for pod yield in groundnut. A similar irradiation of heterozygous genotypes created greater variability in the present study also.

In all the nine crosses for length of primary branch and shelling out turn and most of the crosses for number of secondary branches and weight of 100 kernels. The variance of F_2M_2 was less than the sum of variance of F_2 and M_2 in that radiation treatment might have destroyed some of the latent variance in the heterozygous population (Table 2).

Comparing genetic variability produced by irradiation of hybrid seeds with that due to irradiation of parents, the variability in F_2M_2 was more than in M_2 for all the characters except *secondary branches and kernel weight.* An increased variance in F_2M_2 was observed when compared to F_2 generation for all the traits, except number of secondary branches and reproductive efficiency. The variance of F_2M_2 was greater than sum of variances of F_2 and M_2 for number of matured pods in all the crosses except CO2 X VB 26 and for pod yield in five crosses. Hence it is concluded that irradiation of hybrid maintain highest variability for number of matured pods and pod yield rather than irradiation or hybridization alone.

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Table 1.Comparison of variability in second generation.

Characters	Genotypic variance		
	M_2	F_2	F_2M_2
Length of primary branch	6.13	5.68	7.10
Number of secondary branches	1.97	1.25	2.12
Number of matured pods	10.31	13.38	29.24
Pod yield	21.07	16.12	23.21
Weight of 100 kernel	1.72	3.23	3.41
Shelling out turn	3.46	5.87	7.72
Reproductive efficiency	2.09	4.41	20.73

Table 2. ***Comparison of simple and cumulative variability in second generation.***

Character	CO 2 X VB 26		CO 2 x VB 54		CO 2 x VB 83		VRI 2 x VB 26		VRI 2 x VB 54		VRI 2 x VB 83		VRI 3 x VB 26		VRI 3 x VB 54		VRI 3 x VB 83	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Length of Primary Branch	9.01	6.82	17.09	9.17	11.16	6.91	9.31	7.04	11.73	3.64	10.04	7.69	11.91	7.32	14.77	5.20	11.34	10.11
No. of Secondary branches	2.07	1.28	3.27	2.47	4.90	2.02	4.93	1.64	2.85	1.60	3.12	3.47*	1.79	2.71*	4.01	1.73	2.05	2.10*
No. of matured pods	41.64	27.02	26.62	32.94*	26.63	30.37*	19.22	21.16*	23.82	41.24*	18.19	23.43*	15.68	26.27*	18.25	57.72*	25.19	26.99*
Pod yield	36.63	18.74	25.04	35.37*	26.91	37.74*	44.92	13.50	37.51	13.87	20.08	15.42	23.18	24.71*	26.80	41.16*	15.30	25.50*
Weight of 100 kernel	3.38	1.71	6.09	5.20	2.48	4.31	8.12	2.00	2.60	1.63	3.81	2.93	3.16	2.64	8.97	4.61	6.16	6.80
Shelling out turn	4.26	1.73	5.88	2.86	19.59	19.55	9.41	7.74	11.38	7.54	2.97	2.93	4.99	3.63	20.69	19.44	4.80	4.07
Reproductive efficiency	2.32	6.64*	5.19	24.58*	4.12	23.17*	9.39	21.19*	8.14	47.38*	8.01	19.45*	8.84	6.68	4.66	29.10*	7.77	9.19*

Sum of variance of M_2 and F_2 (A) = $\frac{(\sigma^2 g P_1 M_2 + \sigma^2 g P_2 M_2)}{2} + \sigma^2 g F_2$

Variance of F_2M_2(B) = $\sigma^2 g F_2M_2$

B* = B>A

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ASSESSMENT OF ADAPTABILITY OF ETHIOPIAN MUSTARD (*Brassica carinata* BRAUN) GENOTYPES IN NORTH-WESTERN HIMALAYAS.

Ethiopian mustard or *karan sarson* has special features such as tolerance to drought, shattering and birds attack, which enable it to be successful in hills where such problems are limiting brassica production. Therefore, in the present study an attempt was made to identify some promising genotypes of this crop for different agroclimatic conditions of mid and foot-hills of Himachal Pradesh.

In the present investigation, 15 genotypes of Ethiopian mustard were raised in a Randomized Block Design, replicated thrice, during 1993-94 to 1995-96 at Kangra, and from 1994-95 to 1995-96 at Regional Research Station, HPKV, Bajaura and in 1995-96 at Regional Research Station, HPKV, Dhaulakuan. All the recommended cultural practices were followed for raising the crop. Data were recorded on plot basis in each replication. Linear (b_i) and non-linear (S^2di) components of genotype-Environment (G x E) interactions were calculated according to Eberhart and Russell (1966) and coefficients of determination (r^2) of regression coefficients were estimated as suggested by Bilbro and Ray (1976).

Location wise analysis for seed yield showed significant differences among the genotypes at each location/season. However, joint regression analysis indicated non-significant differences for genotypes and significant G x E interactions. This recorded narrow genetic variability among the genotypes under study and differential response of the lines to varied agroclimatic conditions. Based on the average performance over six environments, varieties HPC 9003 and DIRA 1522 recorded the highest per se performance of 1269 kg/ha, closely followed by PCC 5 and PCC 8 (Table 1). Except PBC 9222, JC 16 and DIRA 1519 all genotypes were statistically at par. Based on the average performance over three years, varieties PBC 9221, PCC 5 and HPC 1 in the order were the best genotypes suitable for the agroclimatic conditions of Kangra valley where winter rains are sufficient and well distributed over the entire cropping season (321.8 mm). Variety HC 9001 and CAR 6A exhibited consistent and superior performance in Kullu valley (1300 m above msl) where winter rains are also good (450 mm). During one year of testing variety HC 9001 also recorded the highest yield at Dhaulakuan, of zone I (350 m above msl) with an average rainfall of 180-225 mm during October -May.

A stable genotype should have bi value near unity, least deviation from regression (Eberhart and Russell, 1966) and r^2 value also near unity (Bilbro and Ray, 1976). A perusal of the table 1 showed that variety PBC 9222 is the most stable genotype followed by DIRA 1522. Both these genotypes fall within the limits of all the three stability parameters. Variety DIRA 1522 is also one of the two top yielders (1269 kg/ha) whereas PBC 9222 recorded slightly lower average yield (1013 kg/ha) over the years and locations. Thakur *et al.* (1992 and 1997). Labana *et al.* (1980) also indentified stable genotypes suitable for specific locations.

Correlation coefficients among the three parameters of stability (Table1) indicated the possible presence of linkage governing these parameters. Correlations between X b*i* and S^2di were found significant and positive, while non-significant association was observed between X and S^2di, suggesting for simple use of mean performance only to some extent. The consideration of other parameters especially regression coefficient (b_i value) and coefficient of determination (r^2 value) is also essential while selecting genotypes for any specific agroclimatic condition.

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Table 1.Mean seed yield and estimates of stability parameters of Ethiopian mustard genotypes.

S. No.	Genotypes	Mean seed yield (kg/ha)	bi	s2di	r2
1	HC 9001	1223	0.62**	8.7	0.39
2	HC 9003	1269	1.18	17.8	1.39
3	PCC 2	1243	1.51**	11.9	2.27
4	PCC 5	1267	0.89	32.7**	0.80
5	PCC 8	1253	0.73*	10.8	0.54
6	NPC 6	1164	0.93	15.3	0.86
7	DIRA 1519	1077	0.58**	6.5	0.34
8	DIRA 1522	1269	1.13	4.8	1.29
9	JC 16	1061	1.40*	1.6	1.98
10	JCY	1113	0.74*	1.0	0.55
11	DLSC-1	1153	0.98	25.8**	2.36
12	PBC 9221	1204	1.54**	35.1**	2.36
13	PBC 9222	1013	1.08	5.3	1.16
14	CAR 6A	1197	0.36**	33.4**	0.13
15	HPC-1	1140	1.32*	15.1	1.74
	CD (0.05)	180			

r (x.b) = 0.94**; r (x s2di) = 0.07; r (b s2di) = 0.73**

* and ** = significant at 5% and 1% respectively.

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GENETIC VARIABILITY AND CORRELATION STUDIES IN SOYBEAN(*Glycine max.* (L.) MERRIL.)

For the improvement of yield in any crop, it is desirable to know nature and magnitude of genetic variation present in the population. Heritability along with genetic variability provides a clear picture of the extent of genetic advance to be expected from selection. Similarly knowledge of correlation helps to identify the real components of yield and provides an effective basis of selection. The present study was therefore undertaken involving thirty diverse genotypes of soybean evaluated in RBD with two replications at PAU Regional Research Station, Gurdaspur during *kharif* 1995. Each genotype in a replication comprised of a two row plot of 2.5 metre length with inter row spacing of 45 cm. and intra row spacing of 5-7 cm. Recommended package of practices and plant protection measures were followed to raise a healthy crop. Data were recorded on five random and competitive plants with respect to yield and its components (Table 1). Coefficients of variability, heritability and genetic advance were calculated using standard formulae. Correlation coefficients among all possible combinations of characters were determined.

Significant genotype differences were observed for all the characters. There was substantial genetic variability for all the characters as evidenced in the ranges of phenotypic expression (Table 1). The highest genotypic coefficient of variation was recorded for the character nodule weight/plant (37.68), followed by pods/plant (28.06), yield/plant (23.71) and nodule number/plant (23.21). Plant height and 100 seed weight recorded low GCV. High coefficient of variation for pods/plant was also reported by Xue, Li and Wang (1987).

Maximum heritability was recorded for pods/plant (99.8%) and nodule no./plant (98.85) followed by yield/plant (95.88%), nodule weight/plant (91.89%) and plant height (88.84%). High heritability for plant height was also reported by Diaz *et al.*, (1985) and Pushpendra and Ram (1987), and for nodule weight/plant by Ghai *et al.*, (1975). The trait 100 seed weight recorded moderate estimates of heritability. Genetic advance as percentage of mean was maximum for nodule weight/plant (50.82) followed by pods/plant (39.24), yield/plant (32.51) and nodule no./plant (32.29). Plant height and 100 seed weight recorded low estimates of genetic advance. Rajput, Sarwar and Tahir (1987) also reported high heritability and genetic advance for pods/plant. High heritability associated with high genetic advance was observed for pods/plant, nodule no./plant and grain yield/plant. This indicated that the characters were controlled by additive genes. According to Panse (1957) high genetic advance coupled with high to moderate heritability would give better scope for selection.

In general genotypic correlation coefficients were higher than phenotypic correlation coefficients (Table 2.). Grain yield/plant was positively and significantly correlated with nodule no./plant (0.572) and pods/plant (0.673). Nodule weight/plant and 100 seed weight were positively correlated with grain yield/plant but this association is non significant. Plant height had negative and non significant correlation with grain yield. Yao, *et al.*, (1987); Rajput *et al.*, (1986); Sharma (1979) and Amarnath and Vishwanatha (1990) reported high genotypic correlation of pods/plant with grain yield. Nodule no./plant had positive and significant association with nodule weight/plant and pods/plant. Positive association between nodule no./plant and nodule weight/plant was also reported by Ghai *et al.*, (1975).

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Table 1. Variability parameters in soybean.

Character	Mean	Range	Genotypic variance	Phenotypic variance	GCV	PCV	Heritability (%)	Genetic advance (as %age of mean)
Grain yield/plant	18.21	9.75 - 25.35	18.64	19.44	**23.71**	**24.72**	95.88	32.51
Nodule No./plant	21.96	13.0 - 33.1	25.98	26.28	23.21	23.48	98.85	32.29
Nodule wt./plant	0.15	0.07 - 0.26	0.0034	0.0037	37.68	39.44	91.89	50.82
Plant height	70.00	62.2-86.0	24.62	27.71	7.08	7.92	88.84	9.36
Pods/plant	80.08	34.9-141.45	504.75	505.86	28.06	28.12	99.80	39.24
100 seed wt.	10.55	9.5 - 11.75	0.33	0.47	5.44	7.37	70.20	6.35

Table 2. Phenotypic (P) Genotypic (G) and Environmental (E) correlation coefficients in soybean.

		Grain Yield/plant	Nodule no. /plant	Nodule wt. /plant	Plant height	Pods /plant
Grain Yield /plant	P					
	G					
	E					
Nodule no. /plant	P	0.548*				
	G	0.572*				
	E	0.125				
Nodule wt. /plant	P	0.244	0.455*			
	G	0.249	0.475*			
	E	0.195	0.141			
Plant height	P	-0.082	0.119	0.024		
	G	-0.066	0.117	0.055		
	E	-0.198	0.226	-0.177		
Pods /plant	P	0.641*	0.465*	0.293	-0.229	
	G	0.673*	0.473*	0.310	-0.250	
	E	-0.171	-0.105	-0.161	-0.199	
100 Seed weight	P	0.051	0.219	0.218	0.082	0.035
	G	0.050	0.310	0.339	0.136	0.060
	E	0.083	-0.067	-0.104	-0.025	-0.197

* Significant at 5%

On the basis of variability and correlations the present study revealed the importance of pods/plant, nodule no./plant and nodule weight/plant. Hence due consideration should be given to these characters while planning a breeding strategy.

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RESPONSE OF CASTOR *(Ricinus communis)* TO AZOSPIRILLUM AND PHOSPHOBACTERIA INOCULATION

Castor is a non-edible oilseed crop and fetches a sizeable amount of foreign exchange to the country (Tewari, 1994). Of late, cultivation of castor has been attracting the attention of Andhra Pradesh farmers as the crop is becoming more remunerative. But the productivity of castor in A.P. is low (273 kg/ha). Any strategy to enhance the productivity will indirectly contribute to a boom in castor oil exports. In this context, investigation was carried out by integrating inorganic fertilizers with organic manure and biofertilizers (*Azospirillum* and Phosphobacteria) to know their effect on castor growth and seed yield. Associative diazotroph, *Azospirillum*, exerts beneficial effects on plant growth and yield of many crops of agronomic importance (Doberiner and Pedrosa, 1987). Phosphobacteria improves the availability of phosphorus to the crop by solubilising the unavailable form of phosphorus into available form (Sundara Rao, 1965). Combined inoculation of *Azospirillum* and Phosphobacteria has resulted in higher yield than with the inoculation of either of them (Alagwadi and Gaur, 1989). Lately, integrated nutrient management (INM) practices are recommended for many crops for sustainable high crop yields. So the present investigation was taken up.

A field experiment was conducted during late *rabi* season of 1996-97 under irrigated condition at the Nagarjuna Agricultural Research and Development Institute farm, Wargal, Medak District, Andhra Pradesh to study the effect of combined inoculation of *Azospirillum brazilense* and phosphobacteria (*Bacillus megatherium* var phosphaticum) in castor,variety Aruna. The farm is located about 50 km from Hyderabad, at 17° N latitude and 780° E longitude. The soil of the experimental field was sandy loam analysing low in available nitrogen (145 kg/ha) and medium in available phosphorus (20 kg/ha) and potassium (250 kg/ha). The experiment was laid out in Exploded Block Design (EBD). In EBD, each treatment is evaluated in a relatively large plot without replication (Anon, 1974). There were two treatments : T1: 100% recommended NPK and T2 : 100% recommended NPK + FYM @ 10 t/ha + Azospirillum (Seed dressing and Soil application) and Phosphobacteria (Soil application). The recommended level of fertilizers @ 30 kg N, 40 kg P_2O_5, 30 kg K_20)/ha were applied basally. The remaining dose of 30 kg N was applied at 30 DAS. Seeds of castor were sown after seed bacterization with *Azospirillum* @ 600 g/ha of seeds in large plots of size 25 x 4 m each with 60 x 30 cm spacing. For soil application equal quantity of lignite based *Azospirillum* and Phosphobacteria (each @ 2.0 kg/ha) were used on 30 DAS. Farm yard manure was incorporated at 10t/ha in the last ploughing. Biometric observations on length of primary spike, number of capsules on primary raceme, total number of spikes/plant and node number upto primary raceme were recorded. 100 seed weight, seed yield and oil content were recorded after harvest. Marginal Benefit Cost Ratio (MBCR) was calculated by dividing additional income due to treatment by additional expenditure for the treatment.

Application of recommended NPK plus organic manure and biofertilizers gave substantially higher yield of castor than 100% recommended NPK alone. Uninoculated plot recorded 1420 kg seed/ha whereas INM plot recorded 1745 kg seed/ha (Table 1.). Thus there was 22.8% increase in yield over control plot, which was statistically significant. This type of response could be ascribed to significant improvement in the test weight, number of

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capsules in the primary raceme and length of primary spike. The percentage increase in test weight, no. of capsules on primary raceme and length of primary spike were 9.15, 24.2 and 15.8 respectively. These differences were statistically significant. The higher yield parameters in INM plots could be due to atmospheric nitrogen fixation (Doberenier and Pedrosa, 1987), phosphorus solubilisation and promotion of root growth by secretion of growth promoting substances (Tien *et al.*, 1980) or indirect effects by the interaction of *Azospirillum* and Phosphobacteria with organic manure and inorganic fertilizers, ultimately leading to higher yield. There was no significant difference in oil content due to treatments.

Economics

Under prevailing market prices of inputs and produce, application of 4.6 kg of biofertilizers/ha (@ Rs.30/kg) and FYM 10t/ha (@ Rs.1600/t) along with inorganic fertilizer would fetch an additional income of Rs.1362/ha. over fertilizer application alone. These results indicate the need to modify the fertilizer management practices for higher castor yield and farmers' income.

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Table 1 Effect of *Azospirillum* and Phosphobacteria inoculation on growth and yield parameters of Castor

Treatments	Length of primary spike (cm)	No: of capsules on Primary raceme	100 seed weight (g)	seed yield (kg/ha)	%increase over uninoculated	MBCR	Oil content (%)
1. Recommended fertilizer (60-40-30 NPK/ha)	14.5b	17.2b	15.3b	1420	-	-	48.4
2. INM practice (100% NPK+ FYM 10t/ha +Bio fertilizers)	16.8a	22.7a	16.7a	1745	22.8	1.72	49.4

Values with a common letter are not significantly different (P<0.05)

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EFFECT OF ORGANIC MANURES AND FERTILIZER LEVELS ON NUTRIENT UPTAKE, SOIL NUTRIENT STATUS AND YIELD OF GROUNDNUT (*Arachis hypogaea* L.)

Groundnut is confined to marginal and less fertile lands, even though it is energy rich crop. Therefore the nutritional requirement of this crop cannot be met under these situations. Inspite of this established fact, groundnut is grown without addition of adequate inputs like chemical fertilizers and organic manures. India has made spectacular progress in production and consumption of chemical fertilizers during last few decades. But consumption of chemical fertilizers will be a limiting factor for increasing agricultural production in future. The imbalanced and continuous use of chemical fertilizer in intensive cropping system is leading to reduction in crop yields, imbalance of soil nutrients which has adverse effect on soil physical and chemical properties. Therefore, integrated use of various sources such as chemical fertilizers, organic manures and biofertilizers is needed to maintain soil productivity.

A field experiment was conducted at R.R.S., Raichur, Karnataka in alfisols during *Kharif* 1994 to study the response of groundnut to organic manures and fertilizers. The soil of the experimental site was red sandy loam in texture, slightly alkaline in reaction (PH 8.15) and low in available Nitrogen (187.88 kg/ha), available P_2O_5 (18.04 kg/ha), available K_2O (192.50 kg/ha) available sulphur (31.17 ppm) and DTPA extractable Zn (0.80 ppm). The treatments consisted of three levels of organic manures (M1 = FYM @ 10 t/ha,; M2 = vermicompost @ 1 t/ha, M3 = vermicompost @ 2 t/ha) and five levels of fertilizers (F0 = No fertilizer, F1 = RDF (25:75:25 N, P, K Kg/ha), F2 = 50% RDF, F3 = RDF + $ZnSO_4$, F4 = RDF + S). Thus fifteen treatment combinations with a control were tested in a randomized block design replicated thrice. $ZnSO_4$ and elemental sulphur were applied @ 25 kg/ha at the time of sowing. The organic manures were applied one week before sowing and entire N, P, K were applied in the form of urea, Single super phosphate and Muriate of Potash, respectively at the time of sowing. The seeds of Cv.JL-24 were dibbled @ 100 kg/ha in 30x10cm spacing. Total of 466.50 mm rainfall was received during the crop growth period. The yield per plot was recorded and expressed on hectare basis. The total nutrient uptake was calculated by multiplying the concentration of nutrients in haulm and kernel with their respective weights and expressed in Kg/ha. The nutrient status of soil was analyzed by taking random samples from each plot and analysis of different nutrient was done by adopting standard methods and was expressed in kg/ha.

The highest N, P, K, S and Zn (182.31, 13.87, 96.34, 24.24, 0.145 kg/ha respectively) uptake was recorded in treatment receiving vermicompost @ 2 t/ha which was followed by FYM @ 10 t/ha (Table-1). Increased uptake of nutrients with application of vermicompost was also reported by several workers (Kale *et al.*, 1991 in Paddy and Stephens *et al.*, 1994 in wheat). The increase in uptake of nutrients viz., N, P, K, Zn and S may be due to the presence of higher amount of nutrients, N fixers, P solubilizers, mycorrhizae etc., in vermicompost (Kale *et al.*, 1991).

A significant difference in pod yield was noticed among the organic manure treated plots. The highest pod yield of 27.84 q/ha was recorded in treatment receiving vermicompost @ 2 t/ha, while higher organic carbon, available nitrogen, P_2O_5, K_2O, S and Zn (0.61%, 253.79 kg/ha, 27.33 kg/ha, 209.19 kg/ha, 34.15 ppm) were recorded in treatment receiving FYM @ 10 t/ha (Table-2).

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Table 1 : Total uptake of Nitrogen, Phosphorus, Potash , Sulphur and Zinc (kg/ha) at harvest as influenced by organic manures and fertilizer in groundnut

Fertilizer levels	Organic manures											
	Nitrogen				Phosphorus				Potash			
	M1	M2	M3	Mean	M1	M2	M3	Mean	M1	M2	M3	Mean
No Fertilizers	123.01	97.68	134.69	118.46	8.52	6.74	9.35	8.20	61.09	48.58	68.21	59.29
RDF (25:75:25 NPK/ha)	163.79	133.47	183.05	160.10	13.04	9.94	15.23	12.74	91.05	73.75	104.56	89.78
50% RDF	133.45	118.29	159.07	136.93	10.15	7.91	10.95	9.67	69.46	59.14	83.98	70.86
RDF+$ZnSO_4$	202.78	158.48	227.87	196.37	15.29	11.40	17.04	14.58	105.54	82.09	114.70	100.77
RDF+S	186.46	145.74	206.86	179.68	15.20	10.77	16.80	14.26	102. 64	79.88	110.25	97.58
Mean	161.89	130.73	182.31		12.44	9.35	13.87		85.95	68.68	96.34	
	SEm±	CD at (0.05)			SEm±	CD at (0.05)			SEm±	CD at (0.05)		
Manures (M)	6.02	17.99			0.22	0.65			3.01	8.99		
Fertilizers (F)	7.56	22.60			0.29	0.84			4.34	12.99		
Interaction (MXF)	12.15	36.32			.50	1.45			.20	21.52		
Control vs Rest												

Table 1 continued.,

Fertilizer levels	Organic manures							
	Sulphur				Zinc			
	M1	M2	M3	Mean	M1	M2	M3	Mean
F_0-No Fertilizers	17.24	14.54	18.71	16.83	0.087	0.070	0.090	0.082
F_1-RDF (25:75:25 NPK/ha)	22.12	19.03	24.84	21.99	0.135	0.102	0.148	0.128
F_2-50% RDF	18.97	16.14	21.88	18.99	0.112	0.085	0.144	0.114
F_3-RDF+$ZnSO_4$	25.95	21.64	28.18	25.25	0.170	0.130	0.178	0.159
F_4-RDF+S	26.04	20.85	27.59	24.82	0.147	0.109	0.164	0.140
Mean	22.06	18.44	24.24		0.130	0.099	0.145	
	SEm±	CD at (0.05)			SEm±	CD at (0.05)		
Manures (M)	0.52	1.55			0.001	0.003		
Fertilizers (F)	0.81	2.42			0.002	0.004		
Interaction (MXF)	1.10	NS			0.003	0.008		
Control vs Rest								
Control Mean	12.31				0.058			
Rest Mean	*21.58*				*0.125*			
SEm±	0.92				0.020			
CD at (0.05)	2.64				0.065			

M1-FYM 10t/ha, M2-Vermicompost 1t/ha, M3-Vermicompost 2t/ha.

The increase in organic carbon, available nitrogen and phosphorus content of soil with application of FYM was also reported by Ramaswamy *et al.* (1979) and Ravikumar and Krishnamoorthy (1980). The higher soil nutrient status with the application of FYM may be due to the slow release of nutrient during crop growth and also the quantity applied was more than that of vermicompost. Though the nutrient content was more in vermicompost but release of nutrient during crop growth was faster than FYM.

Significant difference was noticed among fertilizer treatments with respect to total uptake of nutrients. The highest uptake of N, P, K, S & Zn (196.37, 14.58, 100.77, 25.25 and 0.159 kg/ha respectively) were recorded in treatment receiving RDF + $ZnSO_4$ followed by RDF + S (Table-1). The higher uptake of N,P,K,S and Zn in RDF + Zn treated plot may be due to the production of higher biomass and the synergistic effect of these nutrients at optimum level.

Significant difference in pod yield was noticed among fertilizer treatments. The highest pod yield of 29.68 q/ha was recorded in treatment receiving RDF + Zn followed by RDF + S. Soil analysis after harvest of crop indicated that organic carbon content did not differ significantly with variation in fertilizer levels. However higher

Table 2 : Nutrient status of soil after harvest of groundnut as influenced by organic and inorganic sources of nurtrients

Treatment	Organic carbon(%)	Available Nitrogen (kg/ha)	Available Phosphorus (kg/ha)	Available Potassium (kg/ha)	Sulphur (kg/ha)	Zinc (PPM)	yield (q/ha)	
							Haulm	Pod
Fertilizer levels								
F_0 - No Fertilizers	0.580	219.51	22.75	198.05	31.51	1.23	32.07	21.51
F_1 - RDF (25:75:25 NPK/ha)	0.605	235.33	26.43	209.73	31.95	1.28	37.72	25.85
F_2 - 50% RDF	0.593	222.26	24.13	205.16	31.61	1.26	33.77	23.41
F_3 - RDF+$ZnSO_4$	0.603	236.54	27.15	210.53	34.18	1.48	41.60	29.68
F_4 - RDF+S	0.606	236.50	26.75	209.66	35.68	1.32	40.28	27.50
SEm±	0.019	2.15	0.80	1.83	0.85	0.07	0.89	0.92
C. D. at (0.05)	NS	6.22	2.31	5.31	2.47	0.19	2.57	2.67
Manure levlels								
M_1 - Fym lot/ha	0.612	235.79	27.33	209.19	34.15	1.39	37.52	26.03
M_2 - Vermi comopst 1t/ha	0.580	222.96	22.69	202.12	31.86	1.23	33.08	22.90
M_3 - Vermi compost 2t/ha	0.601	231.34	26.31	208.60	32.96	1.33	40.67	27.84
SEm±	0.012	1.67	0.62	1.42	0.66	0.05	0.69	0.71
CD at (0.05)	NS	4.82	1.79	4.11	1.82	0.14	1.99	2.07
Control V/S Rest								
Control Mean	0.500	201.00	17.25	180.00	28.00	0.88	27.82	16.58
Rest Mean	0.594	230.03	24.44	206.63	32.99	1.30	37.09	25.59
SEm±	0.032	3.72	1.91	3.17	1.47	0.11	1.53	1.59
CD at (0.05)	0.092	10.71	5.51	9.13	4.25	0.31	4.42	4.60

available N,P,K,S and Zn were recorded with increase in fertilizer levels (Table-2). The treatments receiving RDF + S and RDF + Zn respectively recorded higher available Sulphur and Zinc in soil. This may be due to residual effect of the applied sulphur and zinc to the soil.

The interaction effect of organic manure and fertilizer was significant with respect to total uptake of nitrogen, phosphorus and zinc. The highest uptake of N,P,K & Zn (227.87, 17.04, 114.70 and 0.178 kg/ha respectively) was observed with the combination of vermicompost @ 2 t/ha and RDF + Zn (Table-1). This might be due to higher total biomass.

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EFFECT OF NITROGEN FERTILIZATION AND ROW SPACING ON GROWTH AND YIELD OF SESAME

Optimum plant population and nitrogen application besides other agronomic practices is of paramount importance (Gnanamurthy *et al.*, 1992). The information on these aspects during *kharif* season in southern zone of Andhra Pradesh is meagre. Hence, an attempt was made to determine the optimum nitrogen and spacing requirement for sesame to realise higher yield.

A field experiment was conducted during *kharif* 1992 on a sandy loam soil at Tirupati campus of ANGRAU. The treatments consisted of four levels of nitrogen (0, 30, 60, and 90 kg/ha) and four spacings (Table 1). Thus 16 treatment combinations were laid out in factorial randomized block design with three replications. The plot size was 5.0 x 4.5 m. The soil was slightly acidic in nature (pH 5.7) having low organic carbon (0.26%) and nitrogen (113.2 kg/ha), medium in available phosphorus (298 P_2O_5 kg/ha) and potassium (168 kg/ha). Nitrogen was applied as per treatment through urea in 2 splits, half as basal and the other half at 30 days after sowing. Phosphorus and potassium were uniformly applied in the form of single super phosphate and muriate of potash, respectively each @ 30 kg/ha basal. The sesame (var. Madhavi) was sown on 10.6.92. The rainfall received during the crop growing season was 138.6 mm spread over 19 rainy days. The crop was harvested on 10.9.92.

The seed yield increased significantly with every successive increase in nitrogen level and was the highest (564 kg/ha) with 90 kg N/ha but the yield difference between 60 and 90 kg N/ha was not significant (Table 1). The beneficial effects of N on seed yield can be traced to improved growth (plant height, LAI, dry matter/plant) and yield attributes (capsules/plant, seeds/capsule and test weight) with increase in levels. Similar observations were also recorded by Singh *et al.* (1987). The response to nitrogen was worked out by establishing the functional relationship between seed yield and N application under each spacing.

$S1 = Y = 330 + 4.10 x - 0.025 X^2$ ... (1)

$S2 = Y = 353 + 7.66 x - 0.046 X^2$ ... (2)

$S3 = Y = 338 + 7.47 x - 0.052 X^2$ ... (3)

$S4 = Y = 334 + 3.06 x - 0.014 X^2$ ... (4)

Where,

Y = Seed yield (kg/ha)

X = Nitrogen (kg/ha)

The response was found to be quadratic i.e., the seed yield increased with an increase in nitrogen application but at higher levels the response was at a diminishing rate to N applied. The maximum seed yield was predicted to be 671.9 (S2), 606.3 (S3), 501.2 (S4), 498.1 (S1) kg/ha with 83.9, 71.8, 109.3 and 82.0 kg N/ha, respectively. All the functions exhibited a positive intercept suggesting that it is the amount of seed yield one can realise without any nitrogen application i.e., from native fertility. The most profitable input level (N) which optimizes yield would be less than that associated with maximum yield.

Spacings also exhibited significant influence on seed yield of sesame. Sowing the crop at 30 x 10 cm spacing resulted in higher seed yield (553 kg/ha), which was significantly superior to other spacings. Higher seed yield under 30 cm x 10 cm spacing might be due to competition free environment enabling the crop for the use of growth limiting resources efficiently which contributed to improved crop performance. On the other hand at higher plant population

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intense competition for growth resources decreased yield per plant significantly, hence more number of plants per unit area could not compensate for the yield loss per plant. The findings are in conformity with Ramana (1989).

On the basis of the above experimental results it can be indicated that application of N at 85 kg/ha with 30 x 10 cm spacing may be optimum for realizing optimum yield of rainfed sesame in southern zone of A.P.

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Table 1 : Growth and yield of rainfed sesame as influenced by different levels of nitrogen and spacings

Treatments	plant height (cm)	LAI	Dry matter/ plant (g)	No. of capsules/ plant	No. of seeds/ capsule	1000-seed weight (g)	Seed yield (kg/ha)	Stalk yield (kg/ha)	Harvest index
N levels (kg/ha)									
0	56.95	0.235	8.41	18.22	32.78	2.34	338	648	34.20
30	61.53	0.428	10.08	19.82	39.44	2.42	479	896	34.76
60	66.26	0.533	10.71	21.35	41.05	2.43	546	1235	30.60
90	68.98	0.603	11.80	22.92	41.38	2.45	564	1510	27.12
S. Em.±	0.75	0.058	0.13	0.48	0.69	0.04	9	10	0.46
C. D. at (0.05)	2.17	0.167	0.36	1.37	2.01	NS	29	32	1.34
Spacing (cm)									
22.5 x 10	68.74	0.770	5.63	18.46	32.41	2.12	436	1135	28.55
30.0 x 10	64.70	0.490	9.90	20.07	39.44	2.48	553	1102	33.93
37.5 x 10	61.47	0.380	10.66	21.29	40.97	2.52	509	1076	32.78
45.0 x 10	58.81	0.160	11.61	22.49	41.84	2.54	421	976	31.41
S.Em.±	0.75	0.058	0.13	0.48	0.69	0.04	9	10	0.46
C. D. at (0.05)	2.17	0.167	0.36	1.37	2.01	0.12	29	32	1.34

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INTEGRATED NUTRIENT MANAGEMENT IN RICE - MUSTARD CROP SEQUENCE UNDER IRRIGATED CONDITIONS

Organic materials such as farm yard manure (FYM) and green manure (GM) alongwith inorganic fertilizers have been established as important sources for sustained rice production (*Jana and Ghosh, 1996*). The organic fertilizers not only benefit the crop to which it is applied, but also leave the residue for succeeding crop. Proper utilization of residues by succeeding crop invited less attention in the past and fertilizer schedule was mainly based on nutrient requirement of individual crop. Attempt was therefore, made to find out suitable fertilizer schedule for rice-mustard crop sequence.

An experiment on rice-mustard sequence was conducted during the *kharif* and *rabi* seasons of 1995-96 at Indira Gandhi Agricultural University, Raipur, Madhya Pradesh. The soil was clay-loam with pH of 6.6, having available N 220 kg/ha, P_2O_5 22 kg/ha and K_2O 342 kg/ha. The treatments for rice consisted of 100:60:40 kg NPK/ ha, (100% recommended dose of fertilizer)100% RDF+FYM 5t/ha, 100% RDF + 3 tonnes GM/ha and 150% RDF. The treatments for mustard comprised of 4 residual levels of rice (main plot) and 4 levels of direct application of P and K (sub plot), i.e., 0:0, 15:15, 30:30, and 60:60 kg/ha. The randomized block design for rice and split plot design for mustard with 3 replications was adopted. A uniform level of 100 kg N/ha was applied to mustard in all the treatments. The rice variety "Mahamaya" and mustard variety "Pusa bold" was taken as test crop.

Application of 3 t/ha of green manure or 5 tonnes of FYM alongwith 100% RDF and inorganic fertilizer of 150% RDF alone was found to be equally effective for grain and straw yield and N uptake by grain and straw and K uptake of straw in rice (Table 1). Increased yield due to incorporation of green manure and FYM was also reported by Mehta *et al.*, (1996). Moreover, application of 100% RDF + 3 t GM and 150% RDF being at par had significantly higher P uptake both by grain and straw and K uptake by grain as compared to 100% RDF and 100 RDF + 5 t FYM/ ha. The N status in soil increased significantly due to 100% RDF + 3 t GM as compared to 100% and 150% RDF alone. The beneficial role of GM and FYM to raise soil N status was reported earlier also.

The residue of organic fertilizers (GM/ FYM) alongwith 100% RDF and inorganic fertilizer of 150% RDF alone increased seed and straw yield of mustard, which was significantly superior over residuals of 100% RDF applied as inorganic fertilizers alone (Table 2). The significant increase in N,P,K uptake by seed and stover affected the overall crop performance and increased seed and straw yield. This could be due to residual effect of the nutrients available through organic sources to the succeeding crop as also reported by Jana and Ghosh (1996).

The direct level of 100:60:60 kg, NPK/ha significantly increased seed and straw yield and NPK uptake as compared to other treatments. The supply of these nutrients not only increased their concentration in plants but also resulted in enhanced seed yield. Similar findings were also reported by Rana and Singh (1992).

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Table 1 : Yield and nutrient uptake of rice and nutrient status in soil as influenced by integrated nutrient management

Treatment	Yield (q/ha)		N uptake, (kg/ha)		P uptake (kg/ha)		K uptake (kg/ha)		Available nutrient in soil at harvest (kg/ha)		
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	N	P_2O_5	K_2O
100% RDF	50.89	60.84	61.08	36.50	10.60	2.19	55.98	36.58	218	21.98	338
100% RDF + 5t, FYM/ha,	55.88	66.13	68.12	43.42	12.65	2.64	61.64	39.20	230	22.14	336
100% RDF + 3t, GM/ha,	63.55	74.35	82.61	52.05	17.53	3.27	70.61	39.53	240	22.04	339
150% RDF	61.28	71.48	77.83	47.18	16.58	3.00	68.63	40.26	229	22.19	340
CD at (0.05)	8.26	8.87	6.76	5.64	2.16	0.29	4.17	2.46	10	NS	NS

* RDF - Recommended dose of fertizer (100:60:40: kg_1 NPK/ha)

Table 2 : Yield and nutrient uptake of mustard as influenced by residuals of preceeding crop nutrient management and direct application of P and K

Treatment	yield (q/ha)		Nutrient uptake by seed (kg/ha)			Nutrient uptake by stover (kg/ha)		
	Seed	Stover	N	P	K	N	P	K
Residual of kharif								
100% RDF	9.02	31.46	21.78	2.94	6.72	16.91	2.29	29.82
100% RDF + 5t, FYM/ha.	11.82	40.94	28.63	4.26	9.53	22.11	3.80	40.47
100% RDF 3t, GM/ha.	11.37	39.24	27.69	4.30	9.35	21.46	3.74	39.32
150% RDF	11.77	41.41	27.62	4.28	9.71	22.39	3.83	40.76
CD at (0.05)	1.71	4.03	1.39	0.51	0.83	1.07	0.34	1.88
Fertility to mustard (kg/ha)								
P : K								
00 : 00	8.84	32.37	20.61	2.33	5.75	15.87	1.54	28.20
15 : 15	10.50	37.30	25.04	3.34	9.96	19.53	3.01	34.85
30 : 30	11.83	40.27	28.94	4.42	9.88	22.12	4.30	41.69
60 : 60	12.82	43.12	31.13	5.69	11.72	25.36	5.31	46.61
CD at (0.05)	*0.67*	*2.70*	*0.64*	*0.25*	*0.37*	*0.41*	*0.15*	*0.89*

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EFFECT OF ORGANIC MANURES AND NITROGEN ON YIELD, QUALITY AND ECONOMICS OF SUNFLOWER

The high domestic oilseed requirement can be met either by increasing the area under oilseed crops or by increasing productivity of the crops. Increase in the productivity of oilseeds and the quality in terms of consumer's liking are important factors. Sunflower is an exhaustive oilseed crop, giving good response to applied fertilizers. Use of proper N rate in this crop assumes greater significance since high dose of N may result in excess growth with reduced oil content. Continuous use of chemical fertilizers may, in some situations, have detrimental effects on soil properties. Therefore, to maintain soil fertility and productivity for long, use of organic manures is essential. Thus, any attempt made to increase productivity of sunflower can satisfy both the need of high oil production alongwith quality parameters. Keeping these facts in view, an experiment was carried out to investigate the effect of application of organic manures and nitrogen on yield, quality and economics of sunflower.

A field experiment was conducted during *rabi* season of 1993-94 at the Agronomy Farm, Rajasthan College of Agriculture, Udaipur. The experiment was laid out in a factorial randomized block design with 16 treatments, each replicated thrice. The treatments include combinations of organic manures (control, FYM @ 5.0 t/ha, gobar gas slurry @ 1.66 t/ha and celrich @ 2.5 t/ha) and nitrogen levels (0, 40, 80, and 120 kg N/ha). The quantity of organic manures was fixed on the equal nitrogen basis where FYM, gobar gas slurry and celrich contains 0.50, 1.50, and 1.10 per cent nitrogen, 0.20, 0.94, and 1.20 per cent phosphorus and 0.50, 0.83 and 1.00 per cent potassium, respectively. The soil of experimental field is clay loam in texture with alkaline reaction (pH 8.10). It was medium in available nitrogen (278.34 kg/ha) and available phosphorus (16.75 kg/ha) while rich in available potassium (386.10 kg/ha). The sunflower cv. "Morden" was sown on 11 November, 1993 and harvested on 15 March, 1994. The oil content was extracted using soxhlet extractor apparatus and the protein content was computed by mutiplying N content in seed with factor 6.25 (A.O.A.C., 1970).

The crop under the influence of organic manures viz., FYM and gobar gas slurry produced significantly higher seed and oil yield than no manuring. Among the sources, gobar gas slurry produced maximum seed and oil yields (23.04 and 9.48 q/ha, respectively) which were superior to all other sources. Application of organic manures significantly increased the protein content and decreased the oil protein ratio. The maximum protein content (18.14%) and minimum oil protein ratio (2.28) were estimated with the application of gobar gas slurry. Improvement in seed and oil yield due to application of organic manures was also reported by Mathers and Stewart (1982). The superiority of gobar gas slurry used on equal nitrogen basis seems to be on account of higher nutrient contents and reduced quantity of carbon compounds which hastens the process of immobilization and results in higher availability of nitrogen which ultimately improved the yield.

The crop fertilized with 80 kg N/ha produced significantly higher seed and oil yields of 49.75 and 44.92 per cent, respectively than in control plot. Increase in N level from 80 to 120 kg/ha did not improve these parameters significantly. Nitrogen application @ 120 kg/ha resulted in significant improvement in protein content of seed while, significant reduction in oil protein ratio was noticed only upto 80 kg N/ha application. These results are in conformity with the findings of Sharma and Gaur (1988) and Rao and Saran (1991).

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Table 1 : Effect of organic manures and nitrogen levels on sunflower yield, quality and economics.

Treatments	Seed Yield (q/ha)	Oil Yield (q/ha)	Oil Content (%)	Protein Content (%)	Oil/ Protein Ratio	Net Return (Rs/ha)	B : C Ratio
Organic Manures							
Control 1	5.00	6.03	41.60	15.19	2.77	5554	1.02
FYM @ 5.00 t/ha	19.62	8.09	41.35	17.71	2.33	7647	1.13
Slurry @ 1.66 t/ha	23.04	9.48	41.28	18.14	2.28	10561	1.67
Celrich @ 2.50 t/ha	17.57	7.23	41.25	17.15	2.40	6681	1.07
S. Em.±	1.047	0.374	0.545	0.160	0.042	741.4	0.122
CD (0.05)	3.026	1.081	NS	0.464	0.121	2141.4	0.353
Nitrogen (kg/ha)							
0	14.03	5.83	41.56	15.84	2.67	4633	0.81
40	17.43	7.20	41.41	16.65	2.50	7659	1.13
80	21.10	8.45	41.35	17.47	2.37	9036	1.43
120	22.76	9.35	41.15	18.24	2.26	10014	1.51
S.Em.±	1.047	0.374	0.545	0.160	0.042	741.4	0.122
CD (0.05)	3.026	1.081	NS	0.464	0.121	2141.4	0.353

Table 2 : Combined effect of organic manures and nitrogen levels on protein content in seed, oil/protein ratio, net return and B:C ratio.

Treatment Combinations Manures - Nitrogen	Protein Content in Seed (%)	Oil : Protein Ratio	Net Return (Rs/ha)	B:C Ratio
Control - 0	12.54	3.33	4080	0.823
Control - 40	14.89	2.79	4881	0.927
Control - 80	15.89	2.61	6633	1.197
Control - 120	17.46	2.37	6622	1.133
FYM - 0	16.96	2.44	4413	0.767
FYM - 40	17.10	2.42	5732	0.883
FYM - 80	18.33	2.25	9708	1.427
FYM - 120	18.46	2.23	10733	1.510
GG Slurry - 0	17.25	2.42	5807	1.000
GG Slurry - 40	17.87	2.31	10319	1.696
GG Slurry - 80	18.25	2.26	12919	2.023
GG Slurry - 120	19.20	2.14	13197	1.977
Celrich - 0	16.60	2.49	4233	0.743
Celrich - 40	16.75	2.47	6102	1.017
Celrich - 80	17.41	2.37	6886	1.090
Celrich - 120	17.83	2.29	9503	1.440
S.Em.±	0.321	0.084	1482.8	0.244
CD (0.05)	0.928	0.242	NS	NS

It is apparent from data presented in Table 1 that application of organic manure and nitrogen failed to bring significant variation in oil content of seed. Improvement in protein content and reduction in seed oil content due to application of nitrogen was also reported by Krishna Reddy *et al.*, (1992). The decrease in oil content with increasing N levels might be due to degradation of carbohydrates in tri-carboxylic acid (TCA) cycle to acetyl Co-A, whereby reductive amination and transamination process form more amino acids causing increased seed protein content with corresponding decrease in seed oil content.

The increase in protein content in seed and reduction in oil protein ratio was due to combined use of organic manures and nitrogen (Table 2). The maximum protein content of 19.20% and minimum oil protein ratio of 2.14 were estimated under the influence of gobar gas slurry @ 1.66 t/ ha + 120 kg N/ha.

Application of gobar gas slurry resulted in maximum net returns of Rs.10,561/- per ha and a B:C ratio of 1.67 which were significantly higher than with FYM, celrich and control. Nitrogen application @ 80 kg N/ha significantly increased the net returns and B:C ratio over control. Combined use of 1.66 t/ha gobar gas slurry and 80 kg N/ha fetched the net returns of Rs.12,919/- per ha with the B:C ratio of 2.023. On the basis of B:C ratio, application of gobar gas slurry alongwith 120 kg N/ha proved to be the second best treatment combination as it gave maximum net returns of Rs.13,917/- per ha with the B:C ratio of 1.977 (Table 2).

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EFFECT OF NITROGEN AND PHOSPHORUS ON MUSTARD UNDER LIMITED IRRIGATION

A field experiment was conducted at Regional Research Station, Gujarat Agricultural University, Arnej during winter season of 1993-94 to study the effect of supplemental irrigation and graded levels of nitrogen and phosphorus on growth and yield of mustard (*Brassica juncea* (L) Czern & Coss). The experiment was conducted in a split plot design with two levels of irrigation (no irrigation and one irrigation of 50 mm at 30 DAS) in main plot and combinations of four levels of nitrogen (0, 20, 40 and 60 kg N/ha) and two levels of phosphorus (0 and 20 kg P_2O_5/ha) as sub plot treatment. The treatments were replicated four times. Whole quantity of fertilizer was applied as basal. Urea and single super phosphate were used to supply N and P_2O_5 respectively. Mustard "GM-1" was sown on 29 October, 1993 and harvested on 14 February, 1994. The soil was clayey in texture with 0.324 per cent organic carbon, 13.60 kg/ha available P_2O_5 and 880.53 kg/ha available K_2O. The soil was alkaline in nature having 0.64 ds/m EC and 8.24 pH. During monsoon 530.3 mm rainfall was received in 27 rainy days but no rain was received during winter.

Seed and stalk yield of mustard increased significantly when one supplemental irrigation of 50 mm was applied at 30 DAS. The increase in seed and stalk yield over no irrigation was 59 and 68 per cent respectively. This was the result of improved growth and yield attributes like plant height, number of siliquae/plant, seeds/siliqua, length of siliqua and 1000 seed weight (Table 1). This is in agreement with the finding of Agarwal and Gupta (1991).

Nitrogen fertilization showed an overall increase in seed and stalk yield as well as growth and yield attributes like plant height, total and effective branches/plant, siliquae/plant, seeds/siliqua, length of siliqua and 1000 seed weight. Further the seed and stalk yield increased significantly with each successive increase in nitrogen levels from 0 to 60 kg/ha. Increase in seed yield due to N application at 60 kg/ha has also been reported by Manohar (1981) and Agarwal and Gupta (1991). Phosphorus application @ 20 kg P_2O_5/ha failed to produce significant effect on seed and stalk yield of mustard. The growth and yield attributes also remained unaffected due to phosphorus application. This might be due to high P fixing capacity of soil. Because of this major portion of applied P got fixed and contributed very little to the available P sink.

There was an interaction between irrigation and N levels on the seed and stalk yield as well as yield component like siliquae/plant (Table 2). Seed yield of mustard increased with increase in nitrogen level upto 40 kg/ha under conserved moisture and up to 60 kg/ha under limited irrigation. The highest seed yield of 1226 kg/ha was obtained when crop received a supplemental irrigation along with 60 kg N/ha.

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Table 1 : Growth, Yield attributes and yield of mustard as influenced by irrigation, nitrogen and phosphorus.

Treatment	Plant height (cm)	Effective branches/ plant	Silique/ plant	Length of Siliqua, (cm)	Yield (kg/ha)	
					Seed	Stalk
Irrigation						
No irrigation	144.2	5.72	217	4.77	627	823
One irrigation at 30 DAS	174.4	6.23	301	5.23	994	1385
C.D. (P=0.05)	5.7	NS	38	0.28	100	150
N (kg/ha)						
0	151.5	5.55	217	4.63	618	925
20	156.5	5.99	248	4.96	764	1059
40	162.9	6.15	280	5.14	900	1186
60	166.4	6.21	290	5.28	961	1248
C.D. (P=0.05)	7.0	0.40	17	0.17	56	76
Sig. interaction	-	-	IxN	-	IxN	IxN

Table 2 : Seed yield of mustard as influenced by IxN interaction

Irrigation treatments	Nitrogen levels (kg/ha)			
	0	20	40	60
No irrigation	520	615	676	697
One irrigation at 30 DAS	716	912	1123	1226
C.D. (0.05)	78			

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CORRELATION AND PATH COEFFICIENT ANALYSIS OF VARIOUS COMPONENTS ON SEED YIELD OF SUMMER SESAME

The knowledge of interrelationship of yield attributes with grain yield and among the attributes themselves is of importance for making improvement in complex character like yield for which direct selection is not a reliable approach. It also provides estimates of the degree of association among various components of yield. Path coefficient analysis provides an effective means of partitioning direct and indirect causes of association with yield. It also reveals the magnitude of contribution made by different plant characters towards yield thereby imparting confidence in selection of important yield attributes. Informations on such aspects of summer sesame in Chattisgarh region are very rare. Therefore, the present investigation was undertaken to gather information on these aspects in summer sesame.

The present experiment was carried out at the Instructional Farm, IGAU, Raipur during summer season of 1997. The soil of the experimental field was sandy loam in texture. The soil was neutral in pH and had low nitrogen and medium phosphorus and potassium contents. The experiment was laid out in randomized block design with three replications. The treatments consisted of 12 irrigation schedules viz., IW:CPE ratio of 0.3, 0.5, 0.7, 0.3+0.5, 0.3+0.7, 0.5+0.3, 0.5+0.7, 0.7+0.3, 0.7+0.5, three irrigations (35, 48 and 64 DAS), four irrigations (20, 35, 48 and 64 DAS) and five irrigations (20, 35, 48, 64 and 76 DAS). The two values of IW:CPE ratio taken together indicate that the 1st value was considered for first irrigation and 2nd value was considered for second and onward irrigations. Sesame variety "TKG-21" with a seed rate of 5 kg/ha was sown on February 26, 1997 with a row spacing of 30 cm. Harvesting was done on May 26, 1997. Correlation coefficients were determined according to the procedures specified by Panse and Sukhatme (1967) and direct and indirect effects were calculated by the formula outlined by Dewey and Lu (1959).

The dependence of seed yield on various growth and yield parameters as well as interdependence among growth and yield parameters were evident from the positive and significant correlation (Table 1). The correlation coefficients of seed yield with number of branches/plant, dry matter accumulation/plant, capsule/plant, seeds/capsule and 1000-seed weight were significant at 1% probability level, whereas, the seed yield was also significantly correlated with plant height at 5% level. These results are in conformity with the reports of Krishnadoss and Kadambavanasundaram (1986) and Rao et al (1994) who observed that yield attributes such as capsule/plant (r-0.956**), seeds/plant (r-0.952**) and 1000-seed weight (r-0.842**) showed positive and significant interdependence.

Results of path analysis (Table 2) revealed that capsule/plant had high positive direct effect on seed yield followed by seeds/capsule and 1000-seed weight. Number of branches and dry matter accumulation also showed considerable direct effect on seed yield of sesame. The characters 1000-seed weight, seeds/capsule, branches/plant, dry matter accumulation/plant and plant height exerted high positive indirect effect through capsule/plant and negative indirect effect through plant height/plant on seed yield.

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Table 1 : Correlation matrix among growth, yield components and seed yield of summer sesame as affected by different irrigation schedules

Character	Branches/ plant	Dry matter accumulation/pl.	Capsule /Plant	Seeds /Capsule	1000-seed weight	Seed yield/ha
Plant height/plant	0.607**	0.665**	0.422*	0.377*	0.557**	0.371*
Branches/plant		0.679**	0.661**	0.536**	0.599**	0.612**
Dry matter accumulation/plant			0.572**	0.299	0.698**	0.488**
Capsule/plant				0.762**	0.802**	0.843**
Seeds/capsule					0.648**	0.729**
1000-seed weight						0.731**

* Significant at 5% level, ** Significant at 1% level

Table 2 : Path coefficient analysis indicating direct and indirect effects of various components on seed yield of summer sesame

Character	Plant population	Plant height	Branches	Dry matter accumulation	Capsule plant-1	Seeds capsule-1	1000-seed weight	total correlation with seed yield
Plant population	***-0.067***	-0.031	0.074	0.007	0.237	0.087	0.062	0.368*
Plant height	-0.024	***-0.086***	0.083	0.010	0.222	0.079	0.087	0.371*
Branches	-0.036	-0.052	***0.137***	0.010	0.347	0.112	0.094	0.612**
Dry matter accumulation	-0.035	-0.057	0.093	***0.014***	0.300	0.062	0.109	0.488**
Capsule plant-1	-0.030	-0.036	0.091	0.008	***0.526***	0.159	0.126	0.843**
Seeds capsule-1	-0.028	-0.032	0.074	0.004	0.401	***0.209***	0.102	0.729**
1000-seed weight	-0.027	-0.048	0.082	0.010	0.422	0.135	***0.157***	0.731**

* Significant at 5% level, ** Significant at 1% level

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YIELD AND QUALITY OF SAFFLOWER (*Carthamus tinctorius* L.) AS AFFECTED BY N AND P APPLICATION

Madhya Pradesh has good prospects for cultivation of safflower. Fertilizer is one of the important inputs for increasing safflower yields (Sharma, 1993, and Jadhav, 1994).

An experiment was conducted during the *rabi* season of 1996-97 at Research Farm of College of Agriculture, Gwalior (Madhya Pradesh) to study the effects of nitrogen and Phosphorus on seed yield and quality of safflower. The treatment combinations of four levels of nitrogen (0, 20, 40 and 60 Kg N/ha) and three levels of phosphorus (0, 20 and 40 Kg P_2O_5/ha) were tested in a factorial randomized block design with 3 replications.

The experimental soil was sandy loam, slightly alkaline (pH 7.5) low in available nitrogen (140 Kg/ha), high in phosphorus contents (27.44 Kg/ha) and medium in potash (160 Kg/ha). Nitrogen was applied as urea and phosphorus as single super phosphate as basal dose. The crop was sown on 12 October, 1996 and harvested on 19 April, 1997. Oil content of seeds was determined.

The results revealed that application of graded levels of nitrogen significantly increased seed yield (Table 1). Application of 60 and 40 Kg N/ha recorded significantly higher seed yield over control. The effect of P and its interaction with nitrogen was not found significant. But maximum seed yields were obtained when 60 Kg N/ha was applied along with 20 Kg P_2O_5/ha. These findings are in accordance with that of Veer *et al.*, (1992), Purvimath *et al.*, (1993) and Mane and Jadhav (1994).

The oil and protein contents in seed increased with increase in nitrogen application from 0 to 60 Kg/ha (Table 2). Application of phosphorus at the rate of 20 Kg/ha decreased the oil and protein content with various doses of nitrogen as compared to 0 Kg P_2O_5/ha and 40 Kg.P_2O_5/ha. However it again increased with 40 kg/ha phosphorus. Effect of nitrogen and phosphorus was found significant for both oil and protein contents. Where as effect of interaction between N and P was significant for oil content only. Higher oil and protein percentage were recorded when 60 Kg N/ha was applied in combination with 40 Kg P_2O_5/ha. These results were in line with the findings of Ahmed *et al.*, (1985), Purvimath et al., (1993) and Sharma (1993).

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Table 1 : Effect of N and P levels on Seed yield, Oil (%) and Protein contents in Safflower Seed.

Treatment	Seed yield (q/ha)	Oil content (%)	Protein content (%)
Nitrogen (kg / ha)			
0	23.33	29.44	19.20
20	24.51	30.90	19.40
40	28.54	31.54	19.63
60	31.91	32.96	20.23
C. D. (0.05)	5.16	0.29	0.50
Phosphorus (kg / ha)			
0	25.39	31.39	19.40
20	28.06	30.65	19.37
40	27.77	31.60	20.07
C. D. (0.05)	N S	0.25	0.44

Table 2 : Interaction effect of N and P levels on Oil content (%) in Safflower Seed.

Treatment	Nitrogen (kg / ha)				
	0	20	40	60	Mean
***Phosphorus* (kg / ha)**					
0	29.34	34.36	31.39	33.28	31.39
20	29.15	30.03	30.95	32.47	30.65
40	29.85	31.31	32.10	33.14	31.60
Mean	29.44	30.90	31.54	32.96	32.96
	N	P	Interaction (NxP)		
C. D. (0.05)	0.29	0.25	0.50		

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RESPONSE OF SUMMER GROUNDNUT TO COMBINED APPLICATION OF GREEN LEAF MANURES AND FERTILIZERS UNDER INTERCROPPING WITH TEAK (*Tectona grandis*)

Groundnut is an important oilseed crop of the country and is largely cultivated as rainfed crop besides occupying considerable area under irrigated conditions. The anticipated demand for oilseeds by 2000 A.D. is 26 mt, which may go up further with increasing per capita income (Reddy, 1995). Since there is hardly any scope to bring additional land under oilseeds, newer approaches to extend their cultivation under different cropping/farming situations become imperative. In India 45 mha are available with widely spaced crops/trees where introduction of oilseeds as an intercrop is possible. There is also greater scope for green leaf manuring of irrigated crops like groundnut from the loppings of various multipurpose trees that are now being popularized through afforestation and agro-forestry systems in watershed development programmes (Singh, 1996). Pod yield of groundnut was increased in association with *Dalbergia Sessoo* and *Sesbania egyptica* (Patil *et al.*, 1979). Further, the pod yield of groundnut declined with the application of fertilizers in association with *Leucaena*, but application of *Leucaena prunings* alone could maintain groundnut yields for 3 years (Tonye, 1995). Ranganayakulu *et al.*, (1985) reported that applied 'P' had no effect on yield of *rabi* groundnut and concluded that there was no correlation between available 'P' and pod yields.

Therefore, the present study was initiated during Summer 1997 at Students' Farm, College of Agriculture, Rajendranagar. The site of the experimental area was under five years old Teak plantation which was medium in organic carbon and available nitrogen and high in available phosphorus and potassium.

The treatments comprised of six cropping systems viz., sole cropping and intercropping with teak (*Tectona grandis*) with no green leaf manuring, neem (*Azadirachta indica*) green leaf manuring and *Leucaena leucocephala* green leaf manuring as main treatments and two levels of nitrogen (0, 20 kg N/ha) and three levels of phosphorus (2,40,60 kg P_2O_5/ha) as subplots. All the treatments were replicated thrice in split-plot design. Groundnut variety Vemana (K-134) was sown at a spacing of 30 x 10 cm under five year old Teak plantation spaced at 4 x 2 m and as sole crop in nearby open area. Green leaf material of neem and *subabul* was incorporated at the rate of 5 t/ha by opening furrows, 15 days before sowing of the crop both in sole cropped and intercropped area.

Nitrogen was applied as per the treatments after 15 days of sowing, while phosphorus was applied as per the treatments as basal along with green leaf manure application for better decomposition of green leaf material applied. The plot sizes were 4 x 3 m and 3 x 3 m in intercropping and sole cropping, respectively. Irrigation was provided at an interval of 10 days. The groundnut crop was sown on 3 January, 1997 and harvested on 15 April, 1997.

The growth and yield of groundnut was influenced significantly by all the treatments under study (Table-1). The plant height of groundnut was more under intercropping (32.7 cm) as compared to sole cropping (28.3 cm). However, superior plant height of 37.2 cm was obtained with intercropping + Leucaena green leaf manuring. The increase in plant height under intercropping might be due to shade effect of teak trees during early

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stages and also due to additional effect of green manures.

But the haulm yield was more under sole cropping of groundnut with the value of 3157 kg/ha when compared to intercropping (2090 kg/ha) which is attributed to lanky plants under intercropping. Application of green leaf manuring of Leucaena resulted in significantly higher haulm yields of 3399 kg/ha under sole cropping, while neem green leaf manuring did not give any additional haulm yield compared to no green leaf manuring which might be because of very low mineralisation of neem leaves due to higher fibre content.

Pod yield of groundnut was significantly higher under sole cropping (2161 kg/ha) when compared to intercropping (1693 kg/ha) which might be due to lower haulm yield and less pod number under intercropping. Under sole cropping situation, application of green leaf of Leucaena significantly increased the pod yield of groundnut (2350 kg/ha), while neem leaf manuring (2065 kg/ha) did not give additional yield as compared to no green leaf (2060 kg/ha). However, the beneficial effect of green leaf manuring on pod yields of groundnut either with Leucaena (1765 kg/ha) or with neem (1647 kg/ha) was not observed under intercropping. The lower pod and haulm yields under teak plantation could not be compensated by the beneficial effect of green leaf manuring which might be due to severe competition of teak trees for all the applied and natural resources because of closer spacing of teak. Similar reduction in yields with intercropped teak was reported by Nadagoudar *et al.*, (1988).

Irrespective of the cropping systems, application of 20 kg N/ha resulted in significantly higher plant height (32.3 cm), pods/plant (25), pod yield (1944 kg/ha) and haulm yield (2904 kg/ha) as compared to no nitrogen (28.7cm, 21,1743 kg/ha and 2343 kg/ha respectively). On the otherhand, response to applied phosphorus was significant only upto 40 kg P_2O_5/ha (31.75 cm 24, 1983 kg/ha and 2790 kg/ha of plant height, pods/plant, pod yield and haulm yield respectively). The increased growth and yield of groundnut at higher doses of fertility might be due to increased availability of nutrients through better root proliferation. Since the soils are high in native 'P', there was no response to higher dose of P beyond 40 kg P_2O_5/ha.

Interaction effects of cropping systems, nitrogen levels and phosphorus levels were not significant.

The results amply indicated that inter cropping of groundnut under five year old teak plantations was not beneficial showing the competitive effects of teak. Even the application of green leaf manures and fertilizers did not reduce the suppressive effects of teak.

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Table : 1 Growth and Yield of groundnut as influenced by cropping system and fertilizers

Treatments	Plant height (cm)	No. of pods/plant	Haulm yield (kg ha^{-1})	Pod yield (kg ha^{-1})
Cropping system				
C_1 + (IC + no GLM)	30.4	18.5	2153	1667
C_2 (IC + Neem)	30.6	22.5	1831	1647
C_3 + (IC + Leucaena)	37.2	26.0	2287	1765
Mean	32.9	22.3	2090	1693
C_4 (SC + no GLM)	26.5	21.2	3071	2060
C_5 (SC + Neem)	27.7	25.8	3001	2065
C_6 + (SC + Leucaena)	30.7	27.3	3391	2359
Mean	28.3	25.8	3157	2161
SE m ±	1.96	1.73	152.0	89.8
CD (0.05)	6.19	5.45	379.0	282.9
Nitrogen (kg ha^{-1})				
0	28.7	21.2	2343	1743
20	32.3	25.9	2904	1944
SE m ±	0.44	0.37	58.0	25.5
CD (0.05)	1.24	1.05	164.1	72.2
Phosphorus (kg ha^{-1})				
20	26.6	18.9	2239	1589
40	31.8	24.1	2790	1983
60	33.2	27.7	2842	2060
SE m ±	0.54	0.45	71.1	31.3
CD (0.05)	1.52	1.29	201.0	88.4

IC - Intercropping; SC - Sole Cropping; GLM - Green leaf manuring

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AN IMPROVED SCREENING TECHNIQUE FOR COLLAR ROT RESISTANCE IN GROUNDNUT

Collar rot caused by *Aspergillus niger* van Tieghem has been a major threat to groundnut (*Arachis hypogea* L.) as both germination and overall plant stand are adversely affected by this disease. Losses to the extent of 50 per cent have been reported (Chohan, 1969; Bakhetea, 1983). Development of an efficient and quick method of artificial inoculation and creating epiphytotic conditions was strongly felt for screening the resistant sources since long.

A virulent strain of *A. niger* isolated from collar region of diseased groundnut plant was used in the present studies. Highly susceptible cultivar 'Chandra' was sown in 30 cm earthen pots containing sterilized soil. Different levels of inoculum i.e., dry seed treatment with fungal spore raised on potato dextrose agar medium, seed treatment with fungal spore @ 25,50,100 and 200 g fungal spore and mycelial suspension per litre of water alone or in combination with Triton AE were tried. Each treatment was replicated five times. One set of plants was kept inoculated to serve as control. Observations on germination percentage and plant mortality were recorded in different treatments.

The results (Table 1) indicated that all the inoculum levels induced collar rot incidence. Seed treatment with mycelial and spore suspension @ 25 g/l of water provided maximum collar rot (60%) in comparison to nil in untreated control. However, the disease incidence in inoculum threshold from the particular level had no influence on disease incidence. The disease incidence was only 30 per cent in seed treatment with fungal spore and mycelial suspension @ 200 g/l of water. Similar findings were also reported by Nagarajan et al., (1983) in many rust fungi. They have stated that rust fungi at higher spore concentration levels water soluble self-inhibitors reduce germination and subsequently the infection with other fungi. Higher spore concentration results in multiple infection, competition for site and ultimately less proportionate increase in disease. Baker (1968), however, reported that the inoculum densities are known to be directly proportional to the disease severity. Significant reduction at higher inoculation dose could be due to either the water soluble self inhibitor or competition for site as earlier reported in many rust fungi. It was further noticed that seed treatment with Triton AE prior to mycelial and fungal spore suspension and additional inoculum apart from seed treatment did not have any effect on disease incidence.

It is inferred from the present study that the technique used by us is simple, less time consuming and highly effective. It gives consistent and reproducible results. In this technique much less inoculum is required than in other techniques. The results from whole experiment from planting to recording data on plant mortality are obtained within a week time. The technique therefore, is much faster than those used by other workers.

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Table 1 : Effect of different methods of seed treatment with Aspergillus niger on disease production

S. No.	Treatment	Germination (%)	Collar rot (%)
1.	Dry seed treatment (ST) with fungal spore	96	25
2.	ST with Triton AE followed by T1	88	30
3.	ST with fungal spore and mycelia @ 25 g/l of water	92	60
4.	ST with Triton AE followed by T3	80	60
5.	ST with fungal spore and mycelia @ 50 g/l of water	88	20
6.	ST with Triton AE follwed by T5	85	20
7.	ST with fungal spore and mycelia @ 100 g/l of water	86	30
8.	ST with Triton AE followed by T7	85	30
9.	ST with fungal spore and mycelia @ 200 g/l of water	90	30
10	ST with Triton AE followed by T9	90	30
11.	Control (without any fungal treatment)	92	0
	SEm ±	2.99	
	CD (P=0.05)	8.77	

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BIO-POTENTIALITY OF *Chrysoperla carnea* STEPHENS A PREDATOR OF SORGHUM AND SAFFLOWER APHIDS

Chrysoperla carnea Stephens is an important neuropteran predator which is playing an important role in checking the population of aphids and mites in cotton field in U.S.S.R. (Ishankulieva, 1979). Biology and feeding capacity study helps to know the efficiency of predator. The reproductive capacity can be known on different hosts. Hence the hosts *Corcyra cephalonica* eggs and first instar larvae, sorghum aphid *Melanaphis sacchari* and safflower aphid, *Uroleucon compositae* nymphs were selected to know the biopotentiality of *Chrysoperla carnea*.

The biology and feeding capacity of *C. carnea* on different hosts viz., *C. cephalonica* eggs and I instar larvae, nymphs of sorghum aphid, *M. sacchari* and safflower aphid, *U. compositae* was studied in the laboratory at temperature ranging from 20.71 to 26.65°C and relative humidity from 67.14 to 92.14 per cent. Eggs of *C. carnea* were kept individually in specimen tubes. After hatching, food was given to each larva. Every day fresh food was provided. Observations on incubation period, larval duration of first, second and third instar, pupal period, adult longevity of both female and male and sex ratio were recorded. Then eggs were taken to study the biology on different hosts. For studies relating to feeding capacity, a set of ten first instar larvae were taken and placed individually in specimen tubes. Every day known number of each host material was given to the larvae. After the first day the number of host material was increased gradually. Finally, the total number of each host consumed during the complete larval duration was calculated. Each set was replicated five times. Data were subjected to ANOVA for completely randomized design.

The incubation period of *C. carnea* ranged from 3.61 days on *M. sacchari* to 3.77 days on early instar larvae of *C. cephalonica*. This is in accordance with the studies made by Varma and Sheenmar (1983) and Jai Rao *et al.*, (1986) who reported incubation period to be 3.00 days on *C. cephalonica* eggs and larvae and 4.8 days on *A. gossypi* (Afzal and Khan, 1978). The larval duration of first, second and third instars (Table-1) are in conformity with the work of Varma and Sheenmar (1983), who recorded the larval period to be 8.3 days on *C. cephalonica* eggs, 9.77 days on *C. cephalonica* early instar larvae (Jai Rao, *et al.*, 1986) and 12.9 days on *A. gossypi* (Afzal and Khan, 1978).

The pupal period of *C. carnea* was maximum (9.38 days) on *M. sacchari* and minimum (6.78 days) on *U. compositae*. However, it was found to be 8.90 and 8.36 days on *C. cephalonica* eggs and larvae, respectively. The results are in agreement with the investigations of earlier workers who reported pupal duration of 8.5 days on *C. cephalonica* eggs (Varma and Sheenmar, 1983), 7.8 days on *A. gossypi* (Afzal and Khan, 1978) 6.13 days on *C. cephalonica* early instar larvae (Jai Rao *et al.*, 1986).

Maximum adult longevity of female (53.12 days) and male (50.36 days) was recorded on M. *sacchari*. The maximum number of eggs were laid by a single female i.e., 104.03 when reared on M. *sacchari*. However the female *C. orestes* laid 86.33 eggs when reared on *M. sacchari* (Patnaik and Bhagat, 1989). Sharma and Sheenmar (1983) observed that a single female laid an average of 51.9 eggs.

A single larva of *C. carnea* consumed an average of 683.83 eggs or 64.50 first instar larvae of *C. cephalonica* or 286.02 nymphs of M. sacchari or 236.44 nymphs of *U. compositae*. Patnaik and Bhagat (1989) reported that the *C. carnea* larvae consumed 273.4 aphids at 30°C

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temperature and 85 per cent relative humidity, at 20°C consumption was reduced to 232.6 (Zaki, 1987). Sengonca and Grootermorst (1985) reported that a larvae of *C. carnea* can consume 426.2 eggs of *Barathra brassicae* as compared to 982.9 eggs of *Spodoptera littoralis*.

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Table 1a. Biology and feeding potentiality of *C. carnea* on different hosts

T. No.	Hosts*	Incubation period (days)	Larval peroid (days)			Pupal Period (days)	Adult longevity (days)		Fecundity	Sex -* ratio	*Number consumed by a single
			First instar	Second instar	Third instar		Female	Male			
T1	C. cephalonica eggs	3.4 (2.18)	3.17 (2.04)	3.38 (2.09)	3.80 (2.19)	8.9 (3.15)	46.54 (6.89)	45.73 (6.84)	65.57 (8.16)	0.88	683.83 (26.32)
T2	C. *cephalonica* I instar larvae	3.77 (2.18)	2.76 (1.94)	3.63 (2.15)	3.35 (2.08)	8.36 (2.99)	46.78 (6.91)	47.12 (6.95)	59.95 (7.81)	0.61	611.50 (24.74)
T3	M. sacchari nymphs	3.61 (2.15)	2.92 (1.96)	3.64 (2.15)	3.84 (2.20)	9.38 (3.22)	53.12 (7.36)	50.36 (7.17)	104.03 (10.25)	0.60	286.02 (16.93)
T4	U. compositae nymphs	3.72 (2.17)	2.87 (1.98)	2.81 (1.95)	3.50 (2.12)	6.78 (2.79)	52.72 (7.33)	48.85 (7.06)	79.22 (8.96)	0.69	239.44 (15.50)
S.Em.±		0.01	0.01	0.01	0.24	0.02	0.02	0.02	0.13	-	0.15
C. D. (0.01)		NS	0.03	0.03	0.97	0.09	0.06	0.08	0.53	-	0.64

Figures in the paranthesis $\sqrt{X+1}$ values

*- Number of females per male adult

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USE OF MUSTARD STRAW AS SUBSTRATE FOR OYSTER MUSHROOM (*Pleurotus* spp.) PRODUCTION

Madhya Pradesh is one of the major mustard producing states in India. Large amount of straw is produced during its cultivation which is either buried in field or composted. For effective utilization, studies have been conducted on compost preparation for cultivation of white button mushroom (Saini, 1994; Rana and Goyal, 1994). Several straws from cereals, oilseeds, pulses have been tried for cultivation of oyster mushroom (Jandik, 1974; Rangaswami *et al.*, 1975; Zadrazil and Scheneidereit, 1972; Dwivedi and Singh, 1994; Ram, 1996; Manjula, 1997; Gokhle, 1997), but there is no literature available on utilization of mustard straw for cultivation of oyster mushroom. An experiment was therefore conducted at mushroom research laboratory, Department of Plant Pathology, College of Agriculture, Raipur. Six cultures of *Pleurotus* spp. viz., *P. florida, P. sajor-caju, P. platypus, P. salmoneostramineus, P. membranaceus* and P. 503 were procured from All India Coordinated Mushroom Improvement Project Centre, Raipur, multiplied on malt extract agar medium. Mother spawn and spawn were prepared on wheat grains as described by Kumar and Suman (1986). Freshly harvested mustard straw was used as substrate for production of oyster mushrooms. Substrate was steeped in the solution of carbendazim 75 ppm + formaldehyde 500 ppm for 18 hrs following the method of Vijay (1990). Excess water was drained off, dried under shade to maintain about 70% moisture, then seeded with 4% spawn on wet weight basis and filled in polythene bags (12 x 18"). Each bag contained 1/2 kg dry substrate and replicated 5 times. The mouth of bags was closed with rubber band and 8-10 holes were made for aeration. The bags were kept on hangs in mushroom house for spawnrun. After spawnrun the bags were removed and sprinkled with tap water thrice a day. The number of days taken for spawnrun, days taken for harvest of first flush and flush weight were recorded in each bag. Four flushes were obtained in a period of 50 days and bioefficiency was calculated using formula given by Chang et al., (1981). The whole process was carried out at temperature 20-30°C and 80% relative humidity. The experiment was conducted in the month of November-December, 1995.

On mustard straw, all *Pleurotus* spp. grew well. Among the species P. 503 gave the highest (87.4%) bioefficiency followed by *P. platypus* (83.4%) and *P. florida* (80.6%) whereas, least (55.6%) bioefficiancy was recorded in *P. salmoneostramineus* (Table 1). Similarly, comparative study was made for number of days taken for complete spawnrun and harvesting of first flush. It is evident from Table 1, that *P. salmoneostramineus* took less time (15 days and 4 days) for spawnrun and harvesting period for first flush respectively, while other species took more period ranging from 18-28 days for spawnrun and 7-11 days for harvesting of first flush. Based on the results, it can be concluded that mustard straw reutilized from mushroom cultivation, not only reduce cost benefit ratio of mustard, but also releases pressure on environmental pollution and helps to alleviate health hazards.

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Table 1 : Yield performance of *Pleurotus* spp mushroom grown on mustard straw.

Treatment	Spawn-run Peroid (days)	Time for first flush harvest (days)	Yield (g)	Biocfficiency (%)
Pleurotus salmoneostramineus	15	4	278	55.6
P. Platypus	20	7	417	83.4
P. 503	28	9	437	87.4
P. florida	18	8	403	80.6
P. Sajor-caju	26	11	317	63.4
P. membranaceus	23	7	299	59.8
C D (0.05)	2.08	1.35	52.93	

* Average of 5 replications.

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STUDIES ON SEED CROP PROTECTION ON FIELD PERFORMANCE OF GROUNDNUT CUTIVARS*

Among the foliar diseases affecting groundnut (*Arachishypogaea* L.) late leaf spot (*Cercospora personata* (Berk. & Curt) Von. Arx.) and rust (*Puccinia arachidis* Speg.) are most common and destructive. Due to leaf spot, losses in yields were around 15 to 59 per cent (Ramakrishna and Apparao, 1968). These losses in yield are primarily associated with the reduction in leaf area index. The loss in yield components as a result of diseases revealed severe reduction in pods per plant (19.01%) and shelling percentage (3.9%) (Hegde *et al.*, 1996). Significant reduction of both late spot and rust intensity resulted in significant increase in groundnut yield (Patil et al., 1983).

Benagi (1995) reported that the late leaf spot disease of groundnut can be managed effectively with the spray of Chlorothalonil at 30 and 60 days after sowing. Thus an attempt was made to study the effect of Chlorothalonil on seed crop performance in different popular groundnut varieties.

The experiment was conducted at main research station of the University of Agricultural Sciences, Dharwad during *kharif* 1996. Sowing was done on 9 July 1996, with the spacing of 30 cm x 10 cm. Before sowing seeds were treated with Captan (2 g kg^{-1} of seeds). Field screening for rust and late leaf spot was done by following the modified 9-point scale of Subramanyam *et al.* (1995). The experiment was laid out in split-split plot design with spraying as main factor, cultivars in subplot and harvesting dates in sub-sub plot. At the end of the growing season, four rows of 1.2 m length were harvested in each plot at crop maturity (normal harvesting) followed by delayed harvesting of the remaining rows 10 days later. Number of pods per plant, sound mature kernel percentage, shelling percentage and yield per plot were assessed for both the harvesting dates to know their effect.

Effect of foliar diseases

Both late leaf spot and rust diseases were observed in all the plots. But the intensity of these two diseases was maximum in the unsprayed plots. The late leaf spot and rust severity at 85 DAS were maximum in the varieties TMV-2, DH-40 and JL-24, recording 5.22, 5.10 and 4.88 score, respectively.

At harvest, late leaf spot and rust score was minimum under protected condition and in normal harvesting dates. These results revealed the effective control of the diseases with fungicidal spray. In the absence of fungicidal spray, prolonged exposure of plants and favourable conditions for disease development at late harvest resulted in higher scores of both late leaf spot and rust as also reported by Pixley *et al.* (1990) and Gangopadhyay *et al.* (1996).

Table 1 : Influence of spray of Chlorothalonil and different varieties of groundnut on late leaf spot.

Varieties	Late leaf spot score at 85 DAS		
(V)	C_0	C_1	Mean
TMV-2	8.07	2.37	5.22
Dh-40	8.53	1.67	5.10
Dh 3-30	7.93	1.80	4.87
JL-24	7.47	2.30	4.88
TAG-24	7.40	1.27	4.33
R-8808	6.27	2.03	4.15
Mean	7.61	1.91	4.76

For comparing	SEm±	CD (0.05)
Spraying (C)	0.14	0.87
Varieties (V)	0.12	0.36
C x V	0.17	0.51

C_0 = Water spray
C_1 = *Chlorothalonil spray @ 2g^{-1} at 15 days interval beginning* 35 DAS till a week prior to H_1.

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Effect on yield components

Number of pods per plant, sound mature kernel percentage, shelling percentage and yield per plot recorded significant differences with respect to disease protection, varieties and harvesting dates. The protected condition resulted in the highest number of pods per plant (24.21), sound mature kernel percentage (80.56), shelling percentage (73.51) and yield per plot (1.65 kg) compared to unprotected condition. Patil et al., (1983) also reported significant yield increase by significant reduction of both late leaf spot and rust intensity.

Among the cultivars, TAG-24 recorded the higher number of pods per plant (26.40) and sound mature kernel percentage (86.12), while JL-24 recorded the highest shelling percentage (73.80). Highest yield per plot was recorded by TAG-24 (1.59 kg). This increased yield parameters may be due to inherent nature of varieties (Hegde *et al.*, 1996).

Table 2 : Influence of sprays of Chlorothalonil and different varieties of groundnut on rust.

Varieties	Rust score at 85 DAS		
(V)	C_0	C_1	Mean
TMV-2	3.67	1.73	2.70
Dh-40	4.33	2.33	3.33
Dh 3-30	3.50	1.87	2.68
JL-24	4.80	1.87	3.33
TAG-24	3.33	1.60	2.47
R-8808	3.93	1.07	2.50
Mean	3.93	1.74	2.84

For comparing	SEm±	CD (0.05)
Spraying (C)	0.07	0.45
Varieties (V)	0.13	0.38
C x V	0.18	0.54

C_0 = Water spray
C_1 = Chlorothalonil spray @ $2g^{-1}$ at 15 days interval beginning 35 DAS till a week prior to H_1.

At first harvest (H1) all the varieties performed best for all the yield components, with significant reduction of number of pods, sound mature kernel percentage, shelling percentage and yield in delayed harvesting. The loss in these yield parameters at delayed harvesting may be due to increased presence of diseases on plants and early formed pods (Knauft *et al.*, 1988).

Interaction effects revealed that Variety TAG-24 under protected condition with normal harvesting date recorded the highest number of pods per plant, sound mature kernel percentage and yield per plot, where as JL-24 recorded the highest shelling percentage. All the varieties under unprotected condition coupled with delayed harvesting recorded low number of pods per plant, sound mature kernel percentage, shelling percentage and yield per plot. This may be due to reduced rate of seed development in unprotected condition (Jayasekharan and Rajsekharan, 1986).

In this study, the plots of all groundnut cultivars which were protected from foliar diseases through the Chlorothalonil spray coupled with timely harvesting recorded less late leaf spot and rust diseases and produced highest number of pods per plant, sound mature kernel percentage, shelling percentage and yield per plot.

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Table 3 : Effect of Chlorothalonil on late leaf spot and rust after different days of harvesting in groundnut.

Varieties (V)	Harvesting dates	Late leaf spot			Rust		
		C_0	C_1	Mean	C_0	C_1	Mean
TMV-2	H_1	8.00	3.27	5.63	5.33	3.20	4.27
	H_2	8.87	4.20	6.53	6.07	3.73	2.90
	Mean	8.43	3.73	6.08	5.70	3.47	4.58
Dh-40	H_1	8.13	3.47	5.80	6.07	2.60	4.33
	H_2	8.93	4.07	6.50	6.60	2.93	4.77
	Mean	8.53	3.77	6.15	6.33	2.77	4.55
Dh 3-30	H_1	7.87	3.60	5.73	5.46	2.93	4.20
	H_2	8.33	4.27	6.30	6.13	3.47	4.80
	Mean	8.10	3.93	6.02	5.80	3.20	4.50
JL-24	H_1	8.40	3.74	6.07	6.33	3.53	4.93
	H_2	9.00	5.33	7.17	7.40	3.93	5.67
	Mean	8.70	4.53	6.62	6.87	3.73	5.30
TAG-24	H_1	7.27	3.13	5.20	4.67	2.33	3.50
	H_2	8.07	4.73	6.40	5.20	2.80	4.00
	Mean	7.67	3.93	5.80	4.93	2.57	3.75
R-8808	H_1	6.87	2.80	4.83	5.20	2.93	4.07
	H_2	7.87	3.93	5.93	5.60	3.27	4.43
	Mean	7.37	3.37	5.37	5.40	3.10	4.25
Mean	H_1	7.76	3.33	5.54	5.51	2.92	4.22
	H_2	8.51	4.42	6.47	6.17	3.36	4.76
	Mean	8.13	3.88	6.01	5.84	3.14	4.49

For comparing

	SEm±	CD (0.05)	SEm±	CD (0.05)
Spraying (C)	0.02	0.15	0.02	0.15
Varieties (V)	0.04	0.13	0.07	0.21
Date of Harvest (H)	0.02	0.07	0.03	0.09
CxV	0.06	0.18	0.09	0.29
CxH	0.03	0.11	0.04	0.13
HxV	0.06	0.23	0.09	NS
CxHxV	0.36	1.10	0.47	NS

C_0 = Water spray
C_1 = Spray of Chlorothalonil (Kavach) @ $2gl^{-1}$ at 15 days interval beginning 35 DAS till one week prior to H1.
H_1 = Timely harvest (at maturity)
H_2 = Delayed harvest 10 days after H_1.

Table 4 : Effect of Chlorothalonil on number of pods/plant and sound mature kernel percentage as influenced by varieties and harvesting dates.

Varieties (V)	Harvesting dates	Number of pods/plant			Sound mature kernel (%)		
		C_0	C_1	Mean	C_0	C_1	Mean
TMV-2	H_1	18.55	25.53	22.04	68.84	75.62	72.23
	H_2	13.17	22.00	17.58	61.76	73.90	67.57
	Mean	15.86	23.77	19.81	65.30	74.50	69.90
Dh-40	H_1	20.15	26.98	23.56	70.94	76.90	73.92
	H_2	16.13	23.17	19.65	65.15	72.40	68.78
	Mean	18.14	25.07	21.61	68.05	74.65	71.35
Dh 3-30	H_1	18.40	23.33	20.87	68.46	75.98	72.22
	H_2	15.63	21.13	18.38	64.96	71.35	68.16
	Mean	17.02	22.23	19.62	66.71	73.61	70.19
JL-24	H_1	21.21	27.65	24.43	81.85	88.94	85.40
	H_2	15.15	23.13	19.32	78.53	84.20	81.37
	Mean	18.36	25.40	21.87	80.19	86.57	73.38
TAG-24	H_1	23.58	29.37	26.48	86.00	90.12	88.06
	H_2	13.50	23.43	18.47	80.41	87.95	84.18
	Mean	18.54	26.40	22.47	83.31	86.04	86.12
R-8808	H_1	21.03	24.53	22.78	81.31	86.85	84.08
	H_2	17.50	20.30	18.90	79.13	83.02	81.08
	Mean	19.27	22.42	20.84	80.22	84.94	82.58
Mean	H_1	20.49	26.23	23.36	76.24	82.40	79.32
	H_2	15.24	22.20	18.72	71.66	78.72	75.19
	Mean	17.86	24.21	21.04	73.95	80.56	77.25

For comparing	SEm±	CD (0.05)	SEm±	CD (0.05)
Spraying (C)	0.16	0.97	0.05	0.31
Varieties (V)	0.14	0.43	0.11	0.31
Date of harvest (H)	0.08	0.24	0.04	0.13
CxV	0.20	0.60	0.15	0.44
CxH	0.12	0.35	0.06	0.18
HxV	0.20	0.75	0.15	0.49
CxHxV	1.28	4.51	0.71	2.21

C_0 = Water spray

C_1 = Spray of Chlorothalonil (Kavach) @ 2g l^{-1} at 15 days interval beginning 35 DAS till one week prior to H_1.

H_1 = Timely harvest (at maturity)

H_2 = Delayed narvest 10 days after H_1.

Table 5 : Effect of Chlorothalonil on shelling percentage and yield plot^{-1} as influenced by varieties and harvesting dates

Varieties (V)	Harvesting dates	Shelling percentage			Yield plot^{-1} (kg)		
		C_0	C_1	Mean	C_0	C_1	Mean
TMV-2	H_1	71.96	74.34	73.15	0.95	1.57	1.26
	H_2	68.65	71.65	70.15	0.80	1.22	1.01
	Mean	70.31	73.00	71.65	0.86	1.40	1.14
Dh-40	H_1	74.33	76.20	75.27	1.05	1.76	1.41
	H_2	69.45	73.47	71.46	0.81	1.22	1.02
	Mean	71.89	74.83	73.36	0.93	1.49	1.21
Dh 3-30	H_1	71.51	74.40	72.95	0.97	1.53	1.25
	H_2	67.51	72.27	69.89	0.81	1.22	1.01
	Mean	69.51	73.34	71.40	0.88	1.38	1.13
JL-24	H_1	73.98	76.65	75.31	1.37	2.15	1.76
	H_2	70.19	74.39	72.29	1.04	1.78	1.41
	Mean	72.08	75.52	73.80	1.20	1.97	1.58
TAG-24	H_1	73.34	75.83	74.59	1.42	2.13	1.78
	H_2	69.43	70.40	69.92	1.13	1.67	1.40
	Mean	71.39	73.12	72.25	1.28	1.90	1.59
R-8808	H_1	70.13	72.27	71.20	1.33	2.07	1.70
	H_2	64.97	70.27	67.62	1.08	1.43	1.26
	Mean	67.55	71.27	69.41	1.21	1.75	1.48
Mean	H_1	72.54	74.95	73.75	1.18	1.87	1.52
	H_2	68.37	72.07	70.22	0.95	1.42	1.19
	Mean	70.45	73.51	71.98	1.06	1.65	1.36

For comparing	SEm±	CD (0.05)	SEm±	CD (0.05)
Spraying (C)	0.04	0.13	0.005	0.02
Varieties (V)	0.11	0.34	0.02	0.05
Date of harvesting (H)	0.06	0.19	0.009	0.030
CxV	0.16	0.48	0.020	0.070
CxH	0.15	0.46	0.010	0.040
HxV	0.16	0.59	0.020	0.060
CxHxV	0.90	2.66	0.13	0.39

C_0 = Water spray

C_1 = Spray of Chlorothalonil (Kavach) @ 2gl^{-1} at 15 days interval beginning 35 DAS till one week prior to H_1.

H_1 = Timely harvest (at maturity)

H_2 = Delayed harvest 10 days after H_1.

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EFFECT OF CHEMICALS AS SEED SOAKING ON ROOT-KNOT NEMATODE, *Meloidogyne incognita* INFECTING SOYBEAN

Soybean (*Glycine max*) is an important oilseed and pulse crop which possesses very high nutritional value. It is the most important cash crop in U.S.A which accounts for over two-third of world production. Much of the crop is processed for oil which provides some 35% of the nation's total oil and fat in U.S.A. The protein in the seeds of all varieties of soyabean is highly nutritious and for this reason and because of high iron, calcium and vitamin contents, it can be a good food for developing and under-nourished countries. The soybean is probably the richest of all natural vegetable food. It is used in the preparation of a large number of Indian and Western dishes such as chapati, bread, milk, sweets etc. Root-knot, nematodes, *Meloidogyne* spp. have been identified as one of the major limiting factors in the production of this crop (Sikora, 1972; Raut, 1979; Choudhary, 1969).

The present investigation was undertaken to study the effect of chemicals used as seed soaking on the development of *Meloidogyne incognita* and growth of soybean cv. Pusa 16 under green-house conditions. Three chemicals viz., Tirazophos (40 EC), Carbosulfan (25 EC) and Monocrotophos (36% SL) were tested as seed soaking against *M. incognita* infecting soybean. The experiment was conducted in 10 cm earthen pots filled with 500 g of sterilized soil and sand in the ratio of 3:1. Seeds of soybean cv. Pusa 16 were soaked in 400, 200 and 100 ppm of each chemical for 24 hrs in laboratory conditions. After 24 hrs of exposure in different concentrations of chemicals, one seed was sown in each earthern pot. Each treatment including check (seed soaked in water) were sown in three replications. Ten-day old seedlings were inoculated with $3J_2$/g of soil. After 45 days of sowing the plants were harvested and observations with respect to nematode populations and plant growth parameters were recorded.

The results indicated that among the chemicals, soaking of soybean seed in 200 ppm Monocrotophos provided maximum shoot length, while maximum root length was observed at 100 ppm. Control of root-knot nematode, *M. arenaria* infecting groundnut by seed soaking has been suggested by Prasad and Sethi (1984), where they have used Metasystox, Monocrotophos, Phenamiphos and Oxamyl as seed soaking. They found a significant increase of shoot and root weight with Metasystox at 250 ppm. But in the present investigation, maximum fresh shoot weight was found in Carbosulfan at 100 ppm (Table 1).

In general, higher concentration of all the chemicals (i.e. 400 ppm) was found most effective in reducing nematode population both in root and soil as indicated by minimum number of root-knot galls on roots and least population of second-state juveniles in soil. Maximum number of root-knot galls was recorded in check which was significantly different from all the treatments. Minimum number of root-knot galls was observed in Triazophos followed by Monocrotophos and Carbosulfan (@ 400 ppm). However, Triazophos, Carbosulfan and Monocrotophos @ 200 ppm also provided good reduction in number of root-knot galls and were statistically at par but were inferior to 400 ppm.

Observations recorded on the number of bacterial nodules indicated that Triazophos @ 100 ppm supported maximum number of bacterial nodules. Carbosulfan @ 200 ppm, 100 ppm and Monocrotophos @ 100 ppm were observed to be next in the order of efficacy.

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Data presented in Table 1 with respect to the number of juveniles in soil revealed that all the treatments significantly reduced the juvenile population in soil. Maximum reduction was observed in Triazophos (400 ppm) and Monocrotophos (400 ppm) followed by Carbosulfan 400 ppm.

Prasad and Gill (1986) tested Metasystox, Monocrotophos, Zolone, Carbosulfan, Hostathion, Oxamyl, Oncol and Phenamiphos @ 125, 250, 500 ppm as seed soaking of groundnut for 12 hours and found 500 ppm of all the chemicals as the most effective in reducing penetration of *M. arenaria* larvae and providing better plant growth. In the present investigation, Triazophos and Carbosulfan treatment as seed soaking @ 400 ppm for 24 hours exhibited good nematicidel action against *M. incognita*.

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Table 1. Effect of chemicals used as seed soaking on soybean against *Meloidogyne incognita*

Treatment	Dose (ppm)	Shoot length (cm)	Root length (cm)	Fresh shoot weight (g)	Fresh root weight (g)	No. of root-knot galls	No. of bacterial nodules	No. of J_2 in soil (100g)
Triazophos	100	15.53	5.70	7.43	6.10	35.00	10.33	39.33
(40 EC)	200	14.66	7.80	3.66	3.26	14.00	6.33	20.00
	400	11.20	7.10	4.96	3.76	4.60	2.66	4.00
Monocrotophos	100	16.30	10.36	3.53	1.96	42.33	7.33	48.00
(30% SL)	200	22.10	6.70	5.36	3.30	20.00	4.33	20.33
	400	12.50	4.76	3.06	1.90	8.66	1.66	6.00
Carbosulfan	100	14.43	6.73	7.56	3.36	70.33	7.33	68.00
(25 EC)	200	17.46	5.66	4.26	2.50	32.00	8.33	32.33
	400	13.60	6.06	3.63	3.40	15.00	3.33	12.00
Inoculated check		14.40	7.93	3.90	4.40	142.66	6.00	145.00
C. D. (0.05)								
Dose		1.58	1.91	1.91	1.18	11.06	1.10	1.02
Chemical		-	1.65	1.65	1.02	9.57	0.95	0.63
Dose x Chemical		-	-	3.31	-	19.15	-	-

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SCREENING GROUNDNUT ENTRIES AGAINST BUD NECROSIS VIRUS IN KARNATAKA

Groundnut (*Arachis hypogaea L.)* is an important oil seed crop of our country. One of the biotic stresses affecting productivity has been the diseases and in recent years, apart from leaf spots and rust, bud necrosis disease caused by groundnut bud necrosis virus has become an important constraint causing severe losses in pod yields. Threatening a total crop failure if infected at early stages of the crop growth, bud necrosis virus disease exhibits chlorotic and necrotic ring spots, drooping and necrosis of petiole, bud necrosis, stunting and bushy appearance symptoms (Prasad Rao *et al.*, 1979). The disease vectored by thrips in fields poses a threat for a successful groundnut cultivation and disease management aspects are difficult to devise except for looking for resistant source.

A total of 56 and 131 entries were screened against bud necrosis virus disease of groundnut over four seasons, viz., *Kharif* 1993, Summer 1993, *Kharif* 1994 and Summer 1994 at MRS, Dharwad and RRS, Raichur respectively. The groundnut cultivar JL 24 was used as a susceptible check during *Kharif* season and KRG-1 was used as a susceptible check during summer season. Each test entry was replicated twice and grown in 5m row with a spacing of 45 cm x 20 cm. After every four test entries, a row of susceptible check was sown to create high disease pressure. The entries were evaluated as per the methods of AICORPO and ICRISAT (Anon, 1994 and Anon, 1980). The percent incidence of bud necrosis virus disease (BND) in test entries and susceptible checks was recorded at 90 days after planting. Based on the performance of entries over the seasons, they were categorised into four reaction groups namely, Highly Resistant (0 to 5 percent), Resistant (5.1 to 10.0 percent), Moderately susceptible (10.1 to 20.0 percent) and Highly susceptible (20.1 percent and above).

Of the 131 entries screened at Raichur (Table-1), none of the entries showed highly resistant reaction over the seasons. But during *Kharif* 1993, 101 entries showed highly resistant reaction, 23 resistant reaction, five moderately susceptible and two highly susceptible reaction. The susceptible check recorded BND upto 40 per cent. In *Kharif* 1994, only one entry, viz., R 9015 recorded highly resistant reaction, 24 resistant, 56 moderately susceptible and 50 highly susceptible reaction. BND was as high as 63.6 per cent in the susceptible check JL 24 under natural disease pressure. In summer 1993-94, 34 entries recorded highly resistant, 42 resistant, 42 moderately susceptible and 13 highly susceptible reactions with susceptible check KRG 1 exhibiting 32.0 per cent BND. During summer

Table - 1 : Screeing of groundnut entries against bud necrosis virus disease (BND) at Raichur

Sl. No.	Percent BND	category	No. of entries in seasons at Raichur				Overall Seasonal
			K93	K94	S93	S94	
1.	0 to 5.0	Highly Resistant	101	01	34	05	---
2.	5.1 to 10.0	Resistant	23	24	42	25	5**
3.	10.1 to 20.0	Moderately susceptible	05	56	42	69	51
4.	20.1 and above	Highly susceptible	02	50	13	32	---

Note : Out of these 131 entries, five entries (**) viz., ICG 3587; Sel.2; Sel.3; Sel.29 and Sel.53 showed consistent resistance and were found promising. Pedigree of selected entries is recorded in the text.

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1994-95, five entries recorded highly resistant, 25 resistant, 69 moderately susceptible and 32 highly susceptible reactions. Considering the overall performance of the entries over the seasons, none of the entries exhibited highly resistant or immune reaction whereas five showed resistant reaction, 51 moderately susceptible and 75 highly susceptible reaction to BND. The five entries which recorded consistently resistant reaction were ICG 3597, Sel.2 (FDRF-6-165x ICGV 86055 x ICGV 86694), Sel .3 (FDRF 8-55 x Nc Ac 15989 x JL 24), Sel. 39 (ICGV 86517 x GBFDRS-66) and Sel.53 [FDRF 8-32 (JL 16-13 x ICGS 8-21)]

Fifty six entries were screened at Dharwad and the incidence of BND in the susceptible entries over the seasons ranged from 4.8 to 26.8 per cent. On the basis of overall performance over the seasons, four entries recorded highly resistant reaction, 25 resistant, 19 moderately suspectible and seven entries highly susceptible reaction. The entries exhibiting highly resistant reaction were (ICGV 86012x ICGV 86030) T, ICGV 89280, 2192-8, 85/203-3-5-1 and 85/169-7 (Table-2).

Management of bud necrosis virus disease through host plant resistance is an ecofriendly, long lasting and cost effective approach. The entries identified as resistant or promising in the present studies have shown consistently resistant reaction over four seasons under high disease pressure. These entries offer a great promise for their use as a source of resistance in resistant breeding programmes.

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Table - 2 : Screeing of groundnut entries against bud necrosis virus disease (BND) at Dharwad

Sl. No.	Percent BND	category	No. of entries in seasons at Dharwad				Summer 1993 (at Raichur)	Overall Seasonal Perfor-mance
			K93	K94	S93	S94		
1.	0 to 5.0	Highly Resistant	45	39	45	45	06	32
2.	5.1 to 10.0	Resistant	08	09	05	01	07	08
3.	10.1 to 20.0	Moderately susceptible	03	08	06	08	37	14
4.	20.1 and above	Highly susceptible	0	0	0	2	6	2

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STUDIES ON THE HOST RANGE OF PEANUT BUD NECROSIS VIRUS IN KARNATAKA

Peanut bud necrosis disease is an economically important disease causing heavy losses in the pod yields of groundnut in Karnataka and its incidence is increasing in recent years (Siddaramaiah et al., 1980, Kulkarni, M.S., 1996). Information on the characterization of the virus and its host range and other biological properties in Karnataka is lacking. In order to know the survival of the virus in various crops, a study was undertaken to know its host range.

Twenty seven host species belonging to 21 genera in 9 families (Amaranthaceae, Commelinaceae, Chenopodiaceae, Compositae, Cucurbitaceae, Euphorbiaceae, Fabaceae, Poaceae and Solanaceae) were tested in order to find out the host range of PBNV-D and PBNV-R isolates by mechanical sap inoculation. The inoculum was prepared using prechilled 0,05M potassium phosphate buffer (pH 7.0) containing sodium sulphite (PPBS). The young quadrifoliate leaves from infected groundnut plants were collected and macerated in pre chilled sterile mortar and pestle using PPBS @ 1 ml per gram of infected leaf sample. Celite was added @ 0.025 $g.ml^{-1}$ of inoculum and the plants to be inoculated were kept in darkness for 24 h. prior to inoculation. The test plants were inoculated with the help of sterilized cotton wool soaked in chilled inoculum by gently rubbing unidirectionally on the upper surface of the young fully expanded primary leaves of cowpea. The inoculated leaves were washed a few minutes after inoculation to remove excess of inoculum on the leaves with a jet of sterile water from a squeeze bottle. The inoculated plants were kept under observation in the insect proof cages in the glass house of Department of Plant Pathology, University of Agricultural Sciences, Dharwad for expression of symptoms upto 40 days.

The host range studies were conducted by raising seedlings of various plant species through seed. Species of Nicotiana and Chenopodium were incoluated at 6-8 leaf stage, whereas Cucurbits and legumes were incoluated at primary leaf stage and others at 2-4 leaf stage. Observations were recorded daily after mechanical inoculation for symptom expression upto 30 days. Similar procedure was followed for determining the host ranges of both isolates of PBNV. The plants which exhibited symptoms after inoculation were recorded and those which did not express visible symptoms even after 30 days of inoculation were indexed back on local lesion assay host cowpea (Cv. C152) to test if they were symptomless carriers.

Both PBNV-D and PBNR-R isolates could infect members of all the families tested except *Poaceae*. However, there were small differences with respect to production of symptoms (Table 1). PBNV-R isolate could produce either local lesions or systmeic symptoms comparatively earlier in the host species like *Chenopodium amaranticolor* L., *Commelina bengalensis* L., *Crotolaria juncea* L., *Chrysanthemum* sp., *Macrotyloma uniflorum* (Lam) Verced., *Ricinus communis* L., and *Zinnia elegans* L. The PBNV-D isolate produced symptoms comparatively earlier in the host species, viz., *Carthamus tinctorius* L. The distinctive symptoms produced by both the isolates on various host species are recorded in Table 2.

The PBNV-D isolate produced small translucent chlorotic local lesions on *Chenopodium amaranticolor* L. and C. *quinoa* whereas the PBNV-R isolate produced distinctively bigger chlorotic/necrotic spots. The PBNV-R produced distinctive chlorotic spots and silver streaking symptoms on *Cucumis sativus*

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whereas the PBNV-D produced only diffused chlorotic speckling and mosaic mottling on the same host.

The PBNV-D isolate produced clear tip necrosis in *Lycopersicon escunlentum* Mill cv. L-15 unlike PBNV-R. PBNV-R isolate produced distinct bud blighting in case of *Glycine max* (L) Merr., while PBNV-D isolate showed only systemic mottling. The PBNV-D isolate produced only chlorotic spots on *Ricinus communis* L., whereas the PBNV-R isolate produced both chlorotic and necrotic spots on primary leaves of castor. *Ricinus communis* L. and *Carthamus tinctorius* L. are the new hosts reported to be infected by peanut bud necrosis virus in this investigation.

Totally 25 host species from 19 genera and eight families could be infected by PBNV-D and PBNV-R. In general, it is observed that both the isolates could infect most of the field crops, viz., *Cajanus cajan* L., *Carthamus tinctorius* L., *Glycine max* (L). Merr., *Macrotyloma uniflorum* (Lam) Verdec. and *Ricinus communis* L. These crops are grown alongwith the groundnut crop in rainy and post rainy seasons in parts of Karnataka and are invariably infected by vector thrips. The isolates could also infect vegetable crops like *Lycopersicon esculentum* Mill, *Tagetes minuta*, L., *Phaseolus vulgaris* L., *Cucumis sativus* L. and ornamental and weed hosts like *Zinnia elegans* L., *Tagates minuta* L., *Amaranthus* sp. and *Commelina bengalensis* L. The vegetable host species and ornamental plants are grown round the year nearby groundnut fields and these could harbour vectors carrying the virus. The weed plants also harbour the virus as well as the vectors. All these plant species could serve as a good reservoir of virus inoculum as well as vector mediators for the onset of epiphytotics of peanut but necrosis disease year after year.

Halliwell and Philley (1974) listed 200 species of plants covering 34 families as hosts of tomato spotted wilt virus (TSWV). Recently German *et al.*, (1992) have listed more than 500 species of plants in more than 50 families to be infected by tospoviruses. Our results also support the fact that peanut bud necrosis virus, a tosporvirus, has a wide host range. The survival of virus on various alternative hosts through vectors seems to be a probable reason for its appearance in high proportions on groundnut in Karnataka and other parts of India in recent years.

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Table -1 : Host range of PBNV-D and PBNV-R isolates of bud necrosis virus of groundnut

Sl.	Name of the host	No of plants				Per cent infection		No. of days required for expression of symptoms	
		Inoculated		Infected					
		PBNV-D	PBNV-R	PBNV-D	PBNV-R	PBNV-D	PBNV-R	PBNV-D	PBNV-R
1.	*Amaranthus retroflexus* L. (Amaranthaceae)	10	10	10	10	100	100	10-12	8-10
2.	*Cajanus cajan* L. cv. PT-221 (Fabaceae)	10	10	10	10	100	100	15-17	13-15
3.	*Capsicum annuum* L. cv. Byadagi Kaddi (Solanaceae)	10	10	2	8	20	80	15-18	17-20
4.	*Carthamus tinctorius* L. cv. A-1 (Compositae)	10	10	9	10	90	100	12-16	10-12
5.	*Chenopodium amaranticolor* L. (Chenopodiaceae)	5	5	5	5	100	100	6-8	8-10
6.	*Chenopodium quinoa* L. (Chenopodiaceae)	5	5	5	5	100	100	7-9	5-7
7.	*Commelina bengalensis* L. (Commellinaceae)	10	10	10	10	100	100	10-12	14-15
8.	*Crotolaria juncea* L. (Fabaceae)	10	10	9	10	90	100	10-12	18-20
9.	*Chrysanthemum* sp. (Compositae)	10	10	4	8	40	80	10-12	12-14
10.	*Cucumis pepo* L. (Cucurbitaceae)	5	5	4	4	80	80	12-14	12-15
11.	*Cucumis sativus* L. (Cucurbitaceae)	5	5	4	4	80	80	12-15	10-12
12.	*Glycine max* L. Cv. Hardy (Fabaceae)	10	10	10	10	100	100	8-10	8-10
13.	*Cycopersicon esculentum*, Mill. cv. L-15 (Solanaceae)	10	10	8	8	80	80	18-20	18-20
14.	*Macrotyloma uniflorum* (Lam) verdec. *Syn. Dolichos biflorus* L. (Fabaceae)	10	10	9	10	90	100	10-12	12-14
15.	*Nicotiana glutinosa* L. (Solanaceae)	10	10	7	7	70	70	20-22	18-20
16.	*Nicotiana glutinosa* L. (Solanaceae)	10	10	9	9	90	90	25-28	26-30
17.	*Nicotiana tabacum* L. (Solanaceae)	10	10	9	9	90	90	20-25	20-22
18.	*Pennisetum typhoides* L. (Poaceae)	10	10	-	-	-	-	-	-
19.	*Petunia hybrida* L. Cv. Coral satin (Solanaceae)	10	10	10	10	100	100	5-7	5-8

Table 1 contd.,

Table 1 continued.,

Sl.	Name of the host Inoculated	No of plants Infected		Per cent infection		No. of days required for expression of symptoms			
		PBNV-D	PBNV-R	PBNV-D	PBNV-R	PBNV-D	PBNV-R	PBNV-D	PBNV-R
20.	*Phaseolus vulgaris* L., Cv. Top Crop. (Fabaceae)	10	10	9	8	90	80	12-14	12-14
21.	*Pisum sativum* L., Cv. Bonneville (Fabacea)	10	10	10	10	100	100	8-10	12-14
22.	*Ricinus Communis* L. (Euphorbiaceae)	10	10	8	7	80	70	12-16	16-18
23.	*Vigna mungo* (L) Heper, Cv. UPU-1(Fabaceae)	10	10	9	9	90	90	10-14	10-12
24.	*Vigna radiata* (L). Wilczek Cv. China moong (Fabaceae)	10	10	10	10	100	100	10-12	8-10
25.	*Vigna unguiculata* (L) Walp., Cv. C-152 (Fabaceae)	15	15	15	15	100	100	4-6	4-5
26	*Zinnia elegans* L. (Compositae)	10	10	9	9	90	90	10-12	12-14
27.	*Sorghum bicolor* L. (Poaceae)	10	10	-	-	-	-	-	-

Table - 2 : Symptoms produced by isolates of peanut bud necrosis vrius on different hosts

Sl. No.	Hosts inoculated	Symptoms noticed	
		PBNV-D	PBNV-R
1.	*Amaranthus retroflexus* L.	Distinct chlortic spots with mild mottling	Faint chlorotic spots later turn into necrotic spots
2.	*Cajanus cajan* L. cv. PT-221	Chlorotic spots later turning to necrotic spots	Chlorotic spots persist, mosaic mottling also observed
3.	*Capsicum annuum* L. Cv. Byadagi Kaddi	Chlorotic ring spots, leaf distortion and leathery leaves	Chlorotic ring spots with mosiac mottling
4.	*Carthamus tinctorius* L. Cv. A-1	Chlorotic spots later turning to necrotic spots	Chlorotic spots later turning to necrotic spots
5.	*Chenopodium amaranticolor* L.	Minute translucent chlorotic local lesions with grey margins	Comparatively bigger chlorotic local lesions later turning to distinct necrotic spots
6.	*Chenopodium quinoa* L.	Small chlorotic lesions which are very distinct	Bigger chlorotic ring spots later turning necrotic
7.	*Chrysanthemum* sp. L.	Localised chlorotic specks later turning necrotic	Chlorotic and necrotic ring spots, necrosis of tip of branch
8.	*Commelina bengalensis* L.	Mosaic mottling and yellowing	Mild mottling and stunting
9.	*Crotolaria juncea* L.	Chlorotic flecks all along leaves and mottling	Chlorotic streaks more in interveinal areas
10.	*Cucumis pepo* L.	Chlorotic spots and mosaic mottling	Chlorotic specks and leaf yellowing
11.	*Cucumis sativus* L.	Diffused chlorotic speckling, systemic mosiac mottling	Distinct chlorotic spots, silver streaking
12.	*Glycine max* (L.) Merr. cv. Hardy	Chlorotic and necrotic ring spots, darkening of midrib and Veins, systemic mottling	Chlorotic and necrotic lesions followed by bud blighting
13.	*Lycopersicon esculentum* Mill. cv. L-15	Bronzing on undersurface of young leaflets, stunting, tip necrosis	Bronzing, veinal necrosis of leaflets and stunting.
14.	*Macrotyloma uniflorum* (Lam) Verdec. (Syn. Dolichos biflorus L.)	Mosiac streaking, tip yellowing	Necrotic spots on older leaves, mosaic streaking on all leaves
15.	*Nicotiana tabacum* L.	Chlorotic and necrotic spots stunting	Chlorotic and necrotic spots, leathery leaves
16.	*Nicotiana glutinosa* L.	Localised chlorotic spots, later turn necrotic	Chlorotic and necrotic ring spots with brown margin
17.	*Nicotiana glutinosa* L.	Chlorotic and necrotic ring spots, leaves brittle	Chlorotic lesions later turning to necrotic ones, leaves misshaped
18.	*Petunia hybrida* L. cv. Coral satin spots distinct and minute	Chlorotic specks turning to necrotic spots,	Chlorotic and necrotic ring spots, spots bigger and more along veins

Table 2 contd.,

Table 2 Continued

Sl. No.	Hosts inoculated	Symptoms noticed	
		PBNV-D	PBNV-R
19.	*Pisum sativum* L. Cv. Bonneville	Chlorotic streaking on leaves, flaccidity of young leaves and young growth	Chlorotic flecks with systemic mottling and drying of tip
20.	*Phaseolus vulgaris* L. Cv. "Top crop"	Chlorotic spots followed by systemic mottling	Chlorotic and necrotic spots, mosaic mottling
21.	*Ricinus communis* L. Cv. Aruna	Small, faint, chlorotic spots on primary leaves	Chlorotic and necrotic spots on primary leaves
22.	*Vigna mungo* (L) Heper. Cv. UPU-1	Chlorotic specks, mosaic mottling	Chlorotic spots, mild mottling
23.	*Vigna radiata* L. Cv. China moong	Chlorotic and necrotic spots	Chlorotic spots, leaves reduced in size, distorted,tip blighting
24.	*Vigna unguiculata* (L) Walp. cv. c-152	Chlorotic ring spots turning necrotic, small and distinct	Chlorotic andnecrotic spots bigger in size, leathery, deformed trifoliate leaves
25.	*Zinnia elegans* Benth	Chlorotic and necrotic local lesions	Chlorotic and necrotic ring spots, mild mottling

PBNV-D : Peanut bud necrosis virus - Dharwad isolate, PBNV-R : Peanut bud necrosis virus - Raichur isolate

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INCIDENCE OF DISEASES AND INSECT PESTS IN GROUNDNUT IN BARAK VALLEY ZONE OF ASSAM

Groundnut *(Arachis hypogaea)* is the most important oilseed crop in India. Groundnut is a new crop in Assam and it was cultivated during 1985-86 for the first time in an area of 386 ha. The area under this crop is showing an increasing trend. In Barak Valley Zone of Assam it was cultivated even late and very recently some of the prospective farmers are showing interest for cultivation of this crop after observing different demonstration plots. Groundnut is attacked by a number of diseases and insect pets causing heavy yield loss. Ghuge *et al* (1981) reported that tikka disease only can account for 43 percent pod loss. According to Vidyasekaran (1981) tikka disease in association with rust disease can cause up to 70 percent loss in yield. In Assam hardly any attention has been paid to acertain the diseases and pest complex of groundnut specially in Barak valley Zone. Hence, the present observations were made to acertain the diseases and insect pests complex of groundnut.

The observations were made on CV. JL 24 at the instruction cum demonstration field of Krishi Vigyan Kendra, Assam Agricultural University, Arunachal, Cachar under rainfed condition. The crop was sown on 10 October, 1996 and a uniform dose of 20 kg. N, 40 kg P_2O_5 and 30 kg K_2 0 per hectare was applied. The observations were made at ten days interval.

Four diseases and seven insect pests were recorded on groundnut variety JL-24. The diseases recorded were Tikka disease *(Cercospora arachidicola* and *Phasoisariopsis personata)*, Rust of groundnut *(Puccinia arachidis)*; Collar rot (*Aspergillus niger*, *Aspergillus pulverulantus*) and Peanut bud necrosis disease (PBND). Among the four diseases observed in groundnut, the intensity of tikka and rust diseases was high as compared to other two diseases. The first symptom of tikka was observed 40 days after seed sowing and the disease development was continued upto the pod formation stage. The appearance of rust disease coincided with the appearance of tikka disease. These two diseases are widely distributed throughout the groundnut cultivating pockets of Assam. In the experimental farm of Krishi Vigyan Kendra, Cachar, Assam 70-80 percent leaves were infected by these two diseases. Peanut bud necrosis disease was observed towards the later stage of plant growth with low incidence and about 2 percent plants were affected by this disease. The disease is sparsely distributed in Assam with respect of time and place.

In the controlled plot, for tikka and rust diseases Bavistin 0.05 percent +Indofil M-45 0.2 percent was sprayed immediately after initial symptom appearance followed by a second spray after 15 days which gave effective control of these two diseases.

The insect pests observed were Termite *(Odontotermes obesus)*; Groundnut blackaphid *(Aphis craccivora)*; Jassids *(Empoasca flavescens Flab)*; Groundnut Stemborer *(Sphenoptera perotetti* Guerin); Thrips *(Scirtothrips dorsalis* Hood). ; leaf miner *(Aproaerema modicella* Dev) and redant. Among the insect pests appeared, the intensity of termite, groundnut black aphid and thrips was high as compared to other insects. Groundnut black aphid started feeding on young shoots and their peak infestation was during the flowering stage of the crop.

Similarly the population build up of thrips was high during the younger stage of the crop. About 70 percent of the plants was attacked by these two insects. The crop was severely attacked by termites. Their attack started from the very early stage of the crop and continued up to the harvest stage. In the early stage of attack they

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feed on the roots which results in withering of the plants. In later stages of attack they feed on the pod and damage the shells. About 90 percent kernels was damaged by termites. Red ants appeared after planting and also at pod maturity stage which destroyed the kernels. In the controlled plot, for Aphids, Jassids, Thrips and Leafminer Dimethoate 30 EC was sprayed @ 0.5 ml per liter of water which gave good control of these insects. For termite and Red ants Malathion 5 percent dust applied in the soil failed to control these two insects. Termite is not only a major pest of groundnut but also a serious pest of other *Rabi* crops of Assam in general and Barak Valley Zone in particular.

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DOWNY MILDEW INCIDENCE IN SUNFLOWER AS INFLUENCED BY CROPPING SYSTEMS AND FERTILIZER

In recent years, the contribution of sunflower (*Helianthus annuus* L.) to the national vegetable oil pool is significant. Attractive market prices coupled with promising production technology and special features of the crop such as short duration, photo-insensivity, drought tolerance, wider adaptability for various agrocliamtic conditions and cropping systems, have increased the crop area. There has been a decline in crop productivity in traditional areas due to sub-optimal agro-ecological conditions for the crop and increased biotic stresses. Among the diseases, downy mildew caused by *Plasmopara halstedii* is of serious concern because it is soil and seed borne in nature. Mayee and Patil (1987) reported the occurrence of downy mildew of sunflower for the first time in India. During the same period the disease was reported in Ranga Reddy district of Andhra Pradesh. Due to heavy infestation, in some parts of Maharashtra in Latur region, the crop was a total failure. The management of this disease by chemical means is effective only as a seed treatment to control seed borne infection. Evolving genotypes with resistance to downy mildew and / or identifying proper crop rotations are the other plausible options to avoid the disease.

The incidence of downy mildew disease on sunflower was studied at the end of three cropping years (1992 to 1994) in different sunflower based crop rotations under three fertilizer levels (F_1 : 37.5 : 45 : 15 ; F_2 : 75: 90 : 30 and F_3 : 112.5 : 135 : 45 kg N : P_2O_5 : K_2O/ ha). The succeeding rainy season crops viz., sorghum (CSH-6), pigeonpea (ICPL-87), groundnut (ICGS-11), sunflower (MSFH-17 upto 1993 and KBSH-1 during 1994) and castor (Aruna) were grown in the same plots with their respective recommended fertilizer levels. The base crop of sunflower was raised with three fertilizer levels and 15 replications using randomized block design. The succeeding rainy season crops formed the main plots with three residual fertility as sub plots in spilt plot design with three replications. In both the seasons, the same plots were maintained without disturbance. The soil was low in nitrogen (organic carbon = 0.48), medium in available phosphorus (18.6 kg/ ha) and high in available potassium (425 kg/ha) with slightly acidic pH (6.2). The incidence of downy mildew was observed first in the fifth crop of sunflower in the summer 1994 on KBSH-1. The number of plants affected by downy mildew were counted in each plot (23 m2 ; 60 x 30 cm spacing = 115 plants/plot) and the data were subjected to statistical analysis after angular transformation.

The incidence of downy mildew disease varied significantly due to different sunflower based crop sequences (Table 1). Averaged over three fertilizer levels for the base crop, highest incidence (8.04%) was recorded in sunflower-sunflower crop sequence which was significantly higher than other crop sequences which in turn were at par with each other. The least incidence (0.2%) was observed in sunflower-groundnut sequence which was found to be the most productive and profitable sequence (Reddy and Sudhakara Babu, 1996). Advantage of crop rotation with legumes like pigeonpea and groundnut have been reported to have low incidence of the disease in sunflower compared to continuous cultivation of sunflower (Raoof 1994, Appaji *et al.* 1996). Fertilizer levels did not significantly differ with respect to the disease incidence. However, it was observed that the disease incidence was lower under higher fertilizer levels. This is in variance with the general cause and effect relationship of a disease incidencein relation to fertilizer levels, which

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needs further investigation with particular referenceto downy mildew disease. Thus, wherever downy mildew incidence is high, continuous cropping of sunflower needs to be discouraged and rotation with groundnut may be recommended to contain the downy mildew disease for sustainable system productivity.

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Table 1. Incidence of downy mildew disease in sunflower in summer sunflower based cropping system under different fertilizer levels.

Crop sequence	Percent downy mildew affected plants (Angular transformed values)			
	Fertilizer levels			
	50% RD	100% RD	150% RD	Mean
Sunflower - Sorghum	0.03 (3.24)	0.03 (3.24)	1.28 (6.48)	0.75
Sunflower - Pigeonpea	1.03 (6.10)	0.77 (5.62)	0.57 (3.46)	0.79
Sunflower - Groundnut	0.54 (4.27)	0.03 (3.24)	0.03 (3.24)	0.20
Sunflower - Sunflower	10.77 (18.52)	8.72 (16.13)	4.64 (10.65)	8.04
Sunflower - Castor	2.34 (7.68)	2.85 (7.15)	0.54 (5.62)	1.91
Mean	7.96	7.15	5.62	6.91
	Crops	Fertilizer levels		Interaction
CD (P=0.05)	4.72	NS		NS

RD = Recommended dose (75 : 90 : 30 kg N:P_2O_5 : K_2O/ha)
NS = Not significant
Figures in parenthesis indicate angular transformed values.

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Summaries of Research Papers

Jayalakshmi, V, Rajareddy, C., Reddy, P.V. and Nageswar Rao, R.C. 1999. Genetic analysis of Carbon Isotope discrimination and Specific Leaf area in groundnut (Arachis hypogaea L.). J. Oilseeds Res. 16 (1): 1-5.

Studies carried out at S.V. Agricultural College, Tirupati on combining ability analysis of seven parent half diallel set of groundnut showed predominant additive genetic effects for carbon isotope discrimination Δ and specific leaf area. Parental genotypes ICG 2716 and TMV-2 NLM for Δ and TMV-2 NLM and ICGV 86031 for SLA were identified as good general combiners. Carbon isotope discrimination showed a significant positive genotypic association with SLA in parents and hybrids. SLA and Δ had positive association with harvest index. Δ had significant negative asociation with root dry mass. Breeding for drought tolerance in groundnut should consider association between traits confering water use efficiency and harvest index/kernel yield.

KAVANI, R. H., SHUKLA, P.T. AND DHADUK, H.L. 1999. Stability parameters in Safflower (*Carthamus tinctorius*.L.) J.Oilseeds Res. 16(1) : 6-9.

The Phenotypic stability of 35 genotypes of safflower grown over eight environments was studied for six characters viz. no. of primary branches/pl,no. of secondary branches/pl, no. of capitula/pl, seeds/cpitulum, 100 seed weight and yield/pl. Variance due to genotypes, environments, GXE interactions, environment (linear), GXE (linear) and pooled deviation were significant for all the characters. Both linear and non linear components of GXE interaction were present for all the characters. The stability parameters revealed that genotype Co-1 was most stable for yield, while Bhima, S-144, No83, APPA-1 and 352-6 were found below average stable.

VANI SREE, G and PRASAD, MVR. 1999. Inheritance of canopy compaction in groundnut (*Arachis hypogaea* L.). J. Oilseeds Res.16(1): 10-17

Studies were made at Hyderabad on genetics of canopy compaction in 45 crosses involving genotypes categorised for canopy development as compact, medium,medium spreading and spreading. Trigenic segregation was in greater proportion for extreme canopy types. Digenic segregation was observed in crosses with intermediate parental canopy combinations (70%) and extreme canopy(30%). Monogenic segregation was confined only to crosses involving both the parents with intermediate canopy. The study showed that intermediate canopy types represent intermediate level of genetic divergence, while extreme canopy types are characterised by genetic modifiers including zygotic and developmental lethals.

PADMAVATHI, N. 1999. Heterosis in relation to combining ability for seed yield and its contributing traits in Sesame (*Sesamum indicum* L). J. Oilseeds Res. 16(1) : 18-21.

Six diverse genotypes were crossed with five testers in a line x tester mating design resulting in 30 hybrids at Directorate of oilseeds Research, Hyderabad. The *GCA, SCA* and heterosis over mid parent and better parent for different traits were estimated. The good general combiners for seed yield and yield components were SI-44, INST-15/3, Rajeswari, Vinayak. The crosses S1-44 x Rajeswari, S1-44xSVPR-1, which showed highest Sca and heterosis for yield, no. of branches, no. of capsules/pl can be considered as best combinations among 30 crosses evaluated.

SHARMA, S.R. 1999. Nature of gene action for yield attributes and protein content in Soybean. J. Oilseeds Res. 16 (1): 22-26.

Studies were conducted at Ludhiana on diallel analysis with nine parents to determine genetic control of yield attributes and protein in Soybean. The estimates of genetic components of variance showed the presence of additive and non-additive gene effects, but the latter were more predominant for these traits under study except days to maturity. An ambidirectional dominance with greater frequency of favourable dominant alleles among parents was observed for plant height, no.of branches, no. of pods, test weight, yield/pl and protein content. Dominant alleles appeared to increase pod number and branches, while recessives led to increase in days to maturity and protein content.

KAVITHA, M; SETHUPATHI RAMALINGAM, R. and RAVEENDRAN, T.S. 1999. Combining ability in sesame (*Seamum indicum* L.) J. Oilseeds Res. 16(1): 27-31.

Investigations were made at Coimbatore on line x tester cross of 7 parents and 12 crosses in Sesame. The character no. of capsules/pl had a fixable additive genetic variance which can be improved by simple selection. The characters days to flowering, branches, seed yield/pl and oilcontent showed preponderance of non-adititive gene action which can be improved by biparental mating. The parents CMS-C1 and Paiyur were good general combiners for most of the characters. The crosses CMS-T6 x Si 1525 and CMS - c x Paiyur which show high *Sca* and high mean performance were the best.

SHEKAR, G.C. JAYARAMAIAH,H., VIRUPAKSHAPPA, K and NEHRU, S.D. 1999. Standard heterosis of early maturing CMS lines and restorers in sunflower. J. Oilseeds Res. 16(1): 32-35

Three early maturing CMS lines and 4 restorers were crossed at Bangalore to obtain 12 hybrids which were studied for 50% flowering, seed yield/pl, test weight, oilcontent and oilyield/pl. The line CMS 338 (C) produced earliest flowering hybrids (46.5 days) in combination with RHA 274 the productivity of hybrid being 24.8g seed/pl, with 3.4g test wt, 36.3% oil content and 9g oil yield/pl. CMS 234 produced late hybrids with 28g seed yield/pl, 3.7g test weight, 35.9% oil and 10.1g oil yield/pl. The combination of CMS 338(C)xRHA 297 was the best flowering in 50 days, CMS 338(c)xRHA 84SR flowered in 50-55 days and CMS 234xRHA 83R 6 flowered in more than 55 days. These were superior to respective checks in seed and oil yield.

KRISHNAVENI, K and SIVASUBRAMANIAM, K. 1999. Effect of pollination methods on seed filling and seed quality in Sunflower CV. Morden. J.oilseeds Res 16 (1): 36-37.

Studies conducted at Madurai showed that among various methods of pollination confined honey bee pollination recorded highest seed yield of 1288 kg/ha with increased oil content over other methods. Hand pollination daily in addition to open pollination also recorded 1200 kg/ha seed yield with an oil content of 42.4 percent.

DEVINDERPAL SINGH; SINGH, S.B and RAHEJA, R.K. 1999. Combining ability analysis for seed yield, oil and oil quality in Sunflower (*Helianthus annuus* L.). J.Oilseeds Res 16(1): 38-42.

Studies made at Ludhiana on linex tester analysis of 30 hybrids obtained from 5CMS lines and 6 inbreds over two environments revealed the preponderance of non-additive gene action for yield, oil content, palmitic, stearic, oleic and linoleic acids. CMS 234A and inbred 187-333 were found to be good general combiners for yield and oil content. Good general combiners for oleic acid were poor general combiners for linoleic acid and vice versa. The CMS 300A and 207A were top combiners

for oleic acid and linoleic acid, respectively. The male inbreds 68-3 and 108-3 were good general combiners for oleic and linoleic acid, respectively. Hybrid 86A3 x 68-3 was one of the best crosses for seed yield and oil content. The hybrids of high Sca also had high per se performance for the traits. The maintainers of CMS lines and good combiners of male lines could be used in creating dynamic population for recurrent selection.

DUBEY, S.D., SHUKLA,P. and CHANDRA, R. 1999. Effect of nitrogen and sulphur on their content and uptake in linseed. J.Oilseeds Research.16(1):43-47.

Field experiments conducted at Kanpur on alluvial soils showed that the content and uptake of N and S in linseed due to application of N (0, 40, 80, 120 Kg/ha) and S (0, 20, 40, 60 Kg/ha) increased significantly. The contents of N and S were higher at 30 DAS than at 60 DAS. Oil content significantly increased upto 40 Kg S/ha, while N had reducing effect on oil content. The apparent recovery of N and S was maximum with N80 and S20 levels, respectively.

KHARE, J.P., SHARMA, R.S. and SONI, N.K. 1999. Effect of Sulphur and antitranspirants on chlorophyll content, dry matter production and oil yield of rainfed linseed. J.Oilseeds Res. 16(1): 48-50.

Studies made at Sagar (MP) revealed that increasing levels of S upto 30Kg/ha increased dry matter, LAI, and chlorophyll (a, b and total) contents but it was at par with 20 Kg S/ha. Oil content and oil yield significantly increased upto 20 Kg S/ha. Foliar application of kaolin 6%, Suncap 0.5%, and cycocel 0.5% on 30 day old crop significantly enhanced dry matter production, oil content and oil yield over control, but had no effect on chlorophyll and LAI.

BHUPALRAJ, G. and PATNAIK, M.C. 1999. Effect of Cadmium on growth, yield and nutrient composition of sunflower. *J.Oilseeds Res. 16(1):51-56.*

Pot studies conducted at Rajendranagar, Hyderabad showed that application of 80 mg Cd/Kg soil significantly reducedplant height of sunflower. There was significant reduction in dry matter yield beyond 10 mg Cd/Kg soil in red soils and beyond 40 mg Cd/kg soil in black soils. There was no further reduction in yield beyond 80 mg Cd/kg in black soils. With increased level of Cd application to soil there was yellowing of leaves due to Cd toxicity resulting in reduced yield. There was significant positive correlation between tissue Cd and Zn in sunflower grown in both red and black soils and Zn/Cd ratio narrowed down with increased Cd application. Tissue Fe content decreased with increase in Cd content. There was no correlation between Cd and Cu, Cd and Mn contents in plant tissue. Application of higher doses of Cd resulted in accumulation of Cd in soil after crop harvest.

SUBBA REDDY, G., SESHASAILASRI, P. and MARUTHI, V. 1999. Contribution of production factors to yield and income of rainfed castor. J.Oilseeds Res. 16(1):57-61.

The results of crop cutting survey in both trainee and non trainee formers fields showed that the use of improved seed (GCH 4 Hybrid) alone increased the yield of castor by 41% compared to variety Aruna, while top dressing 20 Kg N/ha offered added income of Rs.1150/ha compared to only basal application of 10-30-0 NPK/ha over years. Sowing castor in second fortnight of June gave highest yields and delay of 15, 30 and 45 days after that reduced yield by 9, 30 and 40% respectively. Control of weeds with 2 harrowings gave additional cost-benefit ratio of 11.5 against the practice of 2 harrowings + 1 hand weeding. Use of improved seed, recommended fertilizer dose and semilooper control increased the yield by 95% over farmers practices.

KHARE, J.P., SHARMA, R.S., and SONI, S.N. 1999. Influence of sulphur and antitranspirants on morphophysiological growth and yield of rainfed linseed. J.Oilseeds Res. 16(1):62-65.

Field experiments conducted at Sagar (MP) revealed that there was continuous increase in plant height, branches/pl upto 90 DAS and leaves/pl upto 60 DAS, while dry matter production increased till maturity. The crop growth rate (CGR) during growth period showed a sigmoid pattern, while relative growth rate (RGR) and net assimilation rate (NAR) reduced gradually till maturity. The rainfed linseed responded upto 20 kg S/ha in terms of increase in dry matter, plant height, branches, leaves, capsules/pl, seeds/capsule and seed yield /ha. Application of different levels of S significantly increased CGR over control and reverse was true for RGR and NAR. Foliar spray of antitranspirants at 30 DAS improved the above growth parameters and seed yield compared with control. Kaoline 6% proved superior to Cycocel 0.5% and Suncap 0.5%.

VISHWAKARMA, S.K., SHARMA, R.S. and AYACHI, A.K. 1999. Effect of sources and levels of sulphur on yield attributes, seed yield and economics of soybean. J.Oilseeds Res.16(1): 66-68.

Field trials conducted on soybean CV.JS335 on clayloam soil of Jabalpur (MP) during rainy season indicated that application of 10Kg S/ha significantly improved yield components like branches, pods, seeds/pl, seed index and yield/ha and proved more remunerative than control. Neither sources nor levels of sulphur could bring about discernible variation in yield of soybean, though there was increase upto 20 kg S/ha.

MAHALANOBIS, D. and MAITI, D. 1999. Dry matter production, nutrient content and uptake by groundnut intercropping at different levels of nitrogen and phosphorus application. J.Oilseeds Res.16(1): 69-74.

Experiments conducted at Mohanpur (W.Bengal) revealed that sole groundnut proved superior to intercropped groundnut in dry matter production. Intercropping groundnut (CV.Girnar) + Sesame (B67) in 2:1 row proportion accumulated highest N, P and K contents in plants. Application of 90 N + 75 P/ha was found superior to other levels of fertilizers at all growth stages of groundnut and in the N, P and K contents of crop.

SHANKER, H., CHANDRABHUSHAN and LALLU. 1999. Effect of levels of zinc on growth, dry matter and yield of sesame varieties. J.Oilseeds Res.16(1): 75-79.

Field experiment conducted with three sesame varieties (T4, T12, and T 78) and 4 levels of zinc (0, 10, 20, 30 kg Zn/ha) at Kanpur for 2 years showed that application of 30 kg/ha ZnSO4 significantly increased plant height, no.of leaves/pl, number of branches/pl, dry matter of leaf, stem and capsules, no.of capsules/pl, test weight and seed yield. Variety T12 out yielded T4 and T 78 varieties.

KHARE, J.P., SHARMA, R.S., SHUKLA, K.C., DUBEY, M.P. and MADARIA, S.K. 1999. Relative performance of linseed (*Linum usitassimum* L.) varieties under different sowing management in rainfed condition. J.Oilseeds Res.16(1): 80-83.

Field studies conducted on rainfed linseed in clay loam soils of Sagar (MP) for 2 years revealed that the cultivar Kiran excelled all varieties in seed yield and profit due to superiority in branches/pl and capsules/pl. Normal sowing in rows 30 cm apart using 30 kg seed rate/ha along with application of 40 kg N + 20 kg P_2O_5/ha gave significantly higher yield and profit than border sowing (leaving 4th row vacant in regular spacing) using 22.5 kg seed/ha and 40 kgN + 20 kg P_2O_5/ha or 30 kg N + 15 kg P_2O_5/ha.

BANDOPADHYAY, P and SAMUI, R.C. 1999. Response of kharif groundnut to varying levels of Phosphorus, potassium and sulphur in West Bengal. *J.Oilseeds Res.* 16(1): 82-85.

Experiments carried out at Mohanpur (W.Bengal) with differnet levels of phosphorus (0, 50, 100 kg/ ha) and potassium (0, 50, 100 kg/ha) for 2 wet seasons showed that application of phosphorus upto 100 kg/ha and potassium upto 50 kg/ha resulted in improvement in yield, yield attributes and quality of groundnut. Sulphur application improved yield, yield attributes except kernels/pod. The haulm yield was not significantly influenced by sulphur. Interaction between P and S on pod yield and kernel yield was significant.

SREEDEVI, C., RIAZUDDIN AHMED,S., CHANDRASEKHAR REDDY, K. and PRASADA RAO, B.R.C. 1999. Screening of soil test methods for sunflower. J.Oilseeds Res.16(1):86-91.

Soil test crop response correlation studies were made with sunflower Cv.MSFH 8 in vertisols at Nandyal (A.P.) during 1996. Available soil N,P,K were estimated with different methods. The soil test values of N,P, K from 30 plots based on these methods were correlated with sunflower seed yield. Based on the magnitude and significance of correlations alkaline permanganate method for N, modified olsens method for P and ammonium acetate method for K were found to be the best methods since they were highly correlated with yield and uptake of N,P, K.

DASGUPTA,S., RAJ, S.K. and SRIKANTADAS. 1999. Seed soaking of some xenobiotics to induce resistance against *Aspergillus niger* in groundnut. J.oilseeds Res. 16(1): 92-97.

A number of non-conventional chemicals having potential to accumulate phenolic substances commonly known as phytoalexeins were tested at Mohanpur (W.Bengal) on groundnut against collar rot caused by *Aspergillus niger*. Results revealed that all the nine chemicals provided significant protection. Best results were obtained with mercuric chloride and Barium sulphate. Biochemical changes in infected plants showed higher levels of phenolics and peroxidase activity and reduced activity of PG enzymes as compared with untreated plants. Treated plants also provided incresed yield and yield attributes.

MALIK, Y. P. 1999. Varietal performance and economic injury level of bud fly (*Dysyneura lini* Barnes) in linseed. J. Oilseeds Res 16 (1). 97-100.

Field screeing of linseed varieties against bud fly carried out at Kanpur for 2 years revealed that none of the test entries showed high resistance to budfly. Jawahar-1 and Neela appeared moderately resistant with significantly low bud infestation of 14.3 and 16.0% respectively. Twenty two varieties were categorised as moderately susceptible, while 5 varieties were susceptible, local variety was found highly susceptible (66.0% infestation). Improved varieties had reduced bud infestation (19.6%-78.2%) and enhanced seed yield (46.6-173.3%) over local check. The mean economic injury level was 11.2% bud infestation. The pest reduced seed yield by 69%.

VIJAYAKUMARI, R; NARENDER, I and SASTRY, T.V.N. 1999. Economic analysis of groundnut cultivation in Corantlapalle watershed project of Chittoor district in Andhra Pradesh. J. Oilseeds Res.16(1): 101-107.

The economics of groundnut cultivation under watershed technology implemented fams revealed higher total costs, gross returns, net returns when compared with non-watershed farms. The various

farm efficiency measures also confirmed the same. A significant difference in the yield of groundnut obtained from watershed and non watershed farms was observed.

SINGH, D.N. and SRI. VASTAVA, S. 1999. Generation mean analysis in Indian mustard. J.Oilseeds Res 16(1): 108-111.

Studies were conducted at Pusa with nineteen entries representing 6 generations of 4 crosses. Partitioning of genetic components of variances indicated that the mean values were highly significant for all the characters in all the crosses. The additive (d), dominance (h) and interaction effects have been estimated. The additive effect and gene interaction or any other digenic complementary gene interaction which are fixable can be exploited for the improvement of characters through pedigree method of selection.

VISWANATHAN, P.L., NADARAJAN, N. and RAMAMOORTHY, N. 1999. Comparision of variability in homozygous and heterozygous groundnut genotypes by induced mutagenesis. J.Oilseeds Res. 16 (1): 112-115.

Crosses were effected using three virginia bunch lines as pollen parents (VB26, VB54, VB83) and 3 spanish bunch lines as ovule parents (VRI-2,VRI3, Co-2). The parents and crosses were subjected to 20 krad of gamma rays. It was observed that irradiation of hybrid seeds produced wide variability in F_2 M_2 for all the characters studied. Comparison of genetic variability produced by irradiation of hybrid seeds with that of irradiated parents showed that the variability in F_2M_2 was more than in M_2 for all characters except secondary branches and kernel weight. The variance of F_2M_2 was greater than sum of variances of F_2 and M_2 for number of matured pods in all crosses except co2xVB26 and for pod yield in 5 crosses.

THAKUR, H.L., KALIA,N.R and SAGWAL, J. C. 1999. Assessment of adaptability of Ethiopian mustard (*Brassica carinata* Braun) genotypes in North-western Himalayas. J. Oilseeds Res.16(1): 116-117.

Studies made at Kangra (HP) on 15 genotypes of Ethiopian mustard over three years showed that varities PBC 9221, PCC5 and HPC-1 were suitable for Kangra valley climatic conditions. Variety HC 9001and CAR 6A exhibited consistently superior performance in Kullu valley. Variety HC9001 also gave higher yield at Dhaulakuan (350m mSL). Variety PBC 9222 was the most stable genotype followed by DIRAI 522.

INDERJIT SINGH and BALWINDER SINGH 1999. Genetic variability and correlation studies in soybean (*Glycine max* (L.) MERRIL). J. Oilseeds Res. 16(1): 118-120.

Studies conducted at Gurdaspur (Punjab) on Soybean indicated that genotypic correlation coefficients were higher than phenotypic correlation coefficients. Grain yield/pl. was positively correlated with nodules/pl and pods/pl. Plant height had negative and non significant correlation with yield. The Study revealed the importance of pods/pl and nodules/pl nodule wt/pl, warranting consideration for these characters in breeding programme.

ARANGARASAN, V., PALANIAPPAN, S.P. and CHELLIAH, S. 1999. Response of castor (*Ricinus communis*) to *Azospirillum* and phosphobacteria inoculation. J. Oilseeds Res. 16(1): 121-122.

Field experiments conducted in Rabi 1996-97 on castor revealed that application of recommended

dose of fertilizer (60:40:30kg NPK/ha) inconjunction with FYM 10t/ha +soil application of *Azospirillum* and phosphobacterium each @ 2 kg/ha gave substantially higher castor yield than recommended fertilizer alone. This was due to significant improvement in test weight, number of capsules in primary spike.

PATTAR, P.S., NADAGOUDA, V.B., SALAKINKOP, S.R., KANNUR, V.S and GADDI, A.V.1999. Effect of organic manures and fertilizer levels on nutrient uptake, soil nutrient status and yield of groundnut (*Arachis hypogaea* L.). J. Oilseeds Res. 16(1): 123-127.

Investigations carried out at Raichur during Kharif 1994 indicated that the highest pod yield of groundnut was obtained with the application of vermicompost at 2 t/ha. The highest uptake of N,P,K,S,Zn was recorded with vermicompost 2 t/ha + recommended dose of fertilizer+$ZnSo_4$. The highest pod yield (29.68 q/ha) was obtained with RDF+Zn followed by RDF+S.

HEMALATHA, S. JAGANNATHAM, A and PRAVEEN RAO, V. 1999. Effect of nitrogen fertilization and row spacing on growth and yield of sesame. J. Oilseeds Res. 16(1): 128-129.

Experiment carried out at Tirupati during 1992 showed that application of nitrogen at 85 kg/ha and sowing the crop at 30x10cm spacing is optimum for realising good yields of rainfed seasame in southern zone of Andhra Pradesh.

DHURANDHER, R.L., PANDEY, N and TRIPATHI, R.S. 1999. Integrated nutrient management in rice-mustard crop sequence under irrigated conditions. J. Oilseeds Res.16(1): 130-131.

Crop sequence trial involving rice-mustard conducted at Raipur (MP) during 1995-96 revealed that application of green manure @ 3t/ha or FYM 5t/ha along with 100% RDF and 150% RDF alone was found efffective for grain and straw yields, N uptake and K uptake in rice. The residues of organic manuring (green manure or FYM) along with 100% RDF and 150% RDF alone increased seed and straw yield of mustard and was superior to residual of 100% RDF applied.

SINGH, R.P., SHAKTAWAT and BANSAL, K.N.1999. Effect of organic manures and nitrogen on yield, quality and economics of sunflower. J. Oilseeds Res. 16(1): 132-134.

Field studies made during post-rainy season of 1993-94 at Udaipur indicated that among organic manures gobar gas slurry produced higher seed and oil yield over other sources. Organic manure addition increased protein content and decreased oil/protien ratio. The crop responded upto 80 kg N/ ha in terms of seed and oil yields. Application of gobar gas slurry and nitrogen at 80 kg/ha resulted in increased net return and benefit: cost ratio.

SONANI, V.V., PATEL, P.T and PATEL, D.D.1999. Effect of nitrogen and phosphorous on mustard under limited irrigation. J. Oilseeds Res.16(1): 135-136.

Studies conducted during winter 1993-94 at Arnej revealed that seed and stalk yield of mustard increased significantly when one irrigation was given at 30 days after sowing. Seed and stalk yield also increased significantly due to successive increments in N level from 0 to 60 kg/ha. Application of phosphorus @ 20 kg P2O5/ha had no significant influence on mustard yield.

TOMAR, H.S., SHRIVASTAVA, G.K., TIWARI, O.P. and TRIPATHI, R.S. 1999 Correlation and path coefficient analysis of various components on seed yield of summer sesame. J. Oilseeds Res.16(1): 137-138

Study carried out during summer 1997 at Raipur (MP) revealed that seed yield of sesame was significantly correlated with agronomic traits like number of branches, drymatter, capsules per plant, seeds/capsule and 1000 seed weight. The results of path coefficient analysis showed that capsules/ plant had high positive direct effect on seed yield followed by seeds/ capsule and test weight of seeds.

SUDHIR SINGH BHADAURIA. 1999. Yield and quality of safflower (*Carthamus tinctorius* L.) as affected by N and P application. J. Oilseeds Res. 16(1): 139-140.

Experiments conducted at Gwalior (MP) during Rabi 1996-97 showed that application of 60 kg N/ha recorded significantly higher seed yield over no nitrogen apart from increasing oil and protein contents Higher oil and protein contents were obtained when 60 kg N/ha was applied in combination with 40 kg P_2O_5/ha.

BHEEMAIAH, G., SUBRAMANYAM, M.V.R., SYED ISMAIL., RADHIKA, K and SRIDEVI, S. 1999. Response of summer groundnet to combined application of green leaf manures and fertilizers under intercropping with teak (*Tectona grandis*) J. Oilseeds Res. 16(1): 141-143.

Studies conducted at Rajendranagar during summer 1997 showed that intercropping of groundnut under five year old teak plantations was not beneficial showing the competitive effects of teak. Even the application of green leaf manure and fertilizers did not avert the suppressive effects of teak plants.

BHATIA, J.N. and GANGOPADHYAY, S. 1999. An improved screening technique for collar rot resistance in groundnut. J. Oilseeds Res 16(1): 144-145.

Pot experiments conducted at Sriganganagar describes an artificial inoculation technique for creating epiphytotic conditions. The technique is simple, fast and effective and gives consistant reproducible results. This consumes much less inoculum.

PATIL, R.H., HALLOLLI, S.P and JAIRAO, K. 1999. Biopotentiality of *Chrysoperla carnea* stephens a predator of sorghum and safflower aphids. J. Oilseeds Res. 16(1):146-48.

The study conducted at Dharward showed that the incubation period of *C. carnea* ranged from 3.61 days on *M. Sacchari* to 3.77 days on early instar larva of *C. cephalonica*. The larval period of first instar ranged from 2.76 to 3.17 days second instar 2.81 to 3.64 days and 3 interstar 3.35 to 3.84 days. The pupal period of *C. carnea* was maximum (9.38 days) on *M. Sacchari* and minimum (6.78 days) on *U. Compositae*. It was 8.9 and 8.3 days on *C. Cephalonica* eggs and larvae, respectively. Maximum adult longivity of female (53.1 days) and male (50.3 days) was recorded on *M. Sacchari*. A single female laid 104 eggs when reared on *M. Sacchari*. A single larva of *C. Carnea* consumed 683.8 eggs or 64.5 first instar larvae of *C. Cephalonica* or 286 nymphs of *M. Sacchari* or 236.4 nymphs of *U. Compositae*.

SHUKLA, C.S. VERMA, K.P. and AGARWAL, K.C. 1999. Use of mustard straw as substrate for oyster mushroom (*Pleurotus* sp) production. J.Oilseeds Res. 16 (1): 149-150.

Experiment conducted at Raipur (MP) in 1995 revealed that all the species of Pleurotus grew well on mustard straw. Among the oyster mushroom species, *P503 gave the maximum* bioefficiency (87.4%) followed by *P. Platypus* (83.4%) and P. florida (80.6%) while least efficiency was exhibited by *P. Salmoneostramineus*. The species took 18-28 days for spawnrun and 7-11 days for harvest of first flush. The study revealed the possibility of reutilizing mustard straw for reducing production cost.

CHETANA PATIL and NAGARAJA, A. 1999. Studies on seed crop protection on field performance of groundnut cultivars. J. Oilseeds Res 16 (1): 151-156.

Field trials conducted at Dharwad in 1996 showed that the incidence of rust and late leaf spot was maximum in unsprayed crop compared with sprayed crop. Protected crop gave more pods/pl, mature kernels, shelling percent and yield compared with unprotected crop.

ARCHANA MITTAL and PRASAD, D. 1999. Effect of Chemicals as seed soaking on root knot nematode, *Meloidogyne incognita* infecting soybean J. Oilseeds Res. 16(1): 157-158.

Pot study conducted at IARI showed that seed treatment of soybean with Triazophos and carbosulfan @ 400 ppm for 24 hours exhibited good nematicidal action against *M. incognita.*

KULKARNI, M.S., ANAHOSUR, K.H. and GIRIRAJ, K. 1999. Screening groundnut entries against bud necrosis virus in Karnataka.J. Oilseeds Res. 16(1): 159-160.

Field screening of groundnut at Dharwad and Raichur showed that the incidence of bud necrosis disease in the susceptible entries over seasons ranged from 4.8 to 26.8 percent on the basis of overall performance across seasons. The entries exhibiting highly resistant reaction were (ICGV 86012xICGV 86030), T ICGV 89280, 2192-8, 85/203-3-5-1 and 85/169-7. 25 entries showed resistant reaction, 19 moderately susceptible and 7 highly susceptible reaction.

MUKUND S. KULKARNI., *ANAHOSUR, K.H., BYADGI* A.S. and KACHAPUR M.R.1999. *Studies on the host range of* peanut bud necrosis virus in Karnataka. J. Oilseeds Res. 16(1): 161-166.

Host range studies conducted at Dharwad on various species belonging to 9 families (*Amaranthaceae, Commelinaceae, Chenopodiaceae, Compositae, Cucurbitaceae, Euphorbiaceae, Fabaceae, Poaceae* and *Solanaceae*) indicated that 25 host species from 19 genera and 8 families could be infected by PBNV-D and PBNV-R isolates. They could infect *Cajanuus cajan, Carthamus tinctorius, Glycine max, Macrotyloma uniflorum, Ricinus communis,* Vegetable crops like *Lycopersicon esculentum, Togetus minuta, Phaseolus vulgaris, Cucumis sativus,* ornamentals like *Zinnia elegans, Togates minuta, Amaranthus sp., Commelina bengalensis.*

KALITA, M.K., BARMAN, U., PATHAK, K., HAZARIKA, B.N. and PATHAK, S. 1999. Incidence of diseases and insect pests in groundnut in Barak Valley Zone of Assam. J. Oilseeds Res. 16(1): 167-168

Survey conducted at Assam Agricultural University in 1996 revealed the incidence of 4 diseases and seven insect pests on groundnut variety JL24. They are Tikka (*Cercospora arachidicola, Phasoisariopsis personata*), rust (puccinia, arachidis) collar rot (*Aspergillus niger*) *Aspergillus*

pulverulantus) and peanut bud necrosis disease (PBND). The insect pests were Termite groundnut black aphid, Jassids, Stemborer, thrips, leaf miner and red ant.

SUDHAKARA BABU, S.N., REDDY, B.N. and APPAJI, S. 1999. Downy mildew incidence in sunflower as influenced by cropping systems and fertilizer. J.Oilseeds Res.16 (1): 169-170.

Studies conducted at Directorate of Oilseeds Research, Hyderabad during 1992-94 showed that the highest incidence of downy mildew (8.04%) was observed in sunflower- sunflower sequence, while the least incidence (0.2%) was noted in sunflower - groundnut sequence which also was found to be most productive and remunerative. Downy mildew incidence was lower under higher doses of fertilizers.

ANNOUNCEMENT

The Indian Society of Oilseeds Research is happy to announce the organisation of a National Seminar on "Oilseeds and Oils - Research and Development needs in the millennium" during 2 - 4 February, 2000 at Hyderabad.

The Seminar covers ten themes, viz., Biodiversity, diversification of crops and cropping systems under different agroecological regions, Biotechnology, Hybrid research and development, input use efficiency, Biotic stresses, Abiotic stresses, quality improvement, processing, product development and value addition, and policy intervention. During the Seminar 10 plenary lectures one on each theme and 2 evening lectures will be organised on topics of interest to the oilseeds sector by eminent Scientists.

The ISOR welcomes the participation of all those involved in oilseeds research, improvement, development, production, processing, policy making, marketing, etc. Those desirous of contributing papers are requested to send an extended summary of their contribution not exceeding 2 pages including tables to :

Dr.D.M. Hegde,
Organising Secretary, ISOR National Seminar,
DOR, Rajendranagar, Hyderabad - 500 030, A.P.,

so as to reach before ***31-10-1999.*** The summary should be typed in double space on bond paper of 29 cm x 22 cm size. The typed matter including tables should be with in 22 cm x 16 cm. The title should be followed by the name of the author(s) and their affiliation. The extended summaries of invited and contributed papers will be preprinted. The registration fee is Rs.1000/- for ISOR members, Rs.500/- for students and Research Scholars, Rs.2500/- for private sector organisations. The registration form should reach the organising secretary by ***31-10-1999*** and the registration fee should reach by ***15-12-1999.*** The last date for receipt of full paper is ***15-12-1999***. The circular along with complete details will follow.

OBITUARY

The Indian Society of Oilseeds Research, Hyderabad places on record its profound grief on the untimely demise of Prof. V.J. Patel, Director of Campus, Gujarat Agricultural University, Junagadh, Gujarat. He has contributed immensely for the research and development of oilseed crops such as castor, groundnut, sesame, sunflower and mustard.

Prof. Vallabhbhai Jivrajbhai Patel was born on 14th May 1932 and obtained his Msc (Ag) from Gujarat Agrl. University, Anand Campus.For his dwarf wheat improvement work he received Mexican Govt. Medal through Dr. N.E. Borlaug. He was receipient of various awards and honours from different organisations like Gujarat Yuva Krushak Samaj in 1967, Lions club of Ahmadabad in 1968, Mexican Govt-medal in 1971, Gujarat Association of Agrl. Sciences in 1983 & 1994, ISOR shield in 1993, Prashasti Patra award of Gujarat state seed producers Association in 1996, Sardarpatel Agrl. Research Award in 1998.

Starting his career as Agricultural supervisor at Umrala (Bhavngar) in 1955 he climbed up the rungs of ladder to fame through various positions finally to become Director of Campus of Gujarat Agrl. University at Junagadh in 1992 which position he held upto 1998.

Dr. V.J. Patels outstanding achievements include release and popularisation of varieties in wheat, sesame (Mrug-1, Guj-2, Purva-1), groundnut (GG2, Somnath, GG20, GG13, GG11, GG12, GG4), Sunflower (GujSF-1), mustard (GM-1), rapeseed (Guj rapeseed-1), Castor (GCH2, GCH4), through launching massive seed production programmes in Gujarat State.

He has 37 years of experience in various capacities and guided 12 post graduate students in plant breeding and genetics. He has published 80 scientific papers in various Journals of repute.

In his demise the oilseeds fraternity lost an eminent, down to earth, practical scientist who has endearrd himself to the farming community through his contributions. The ISOR conveys its deepest condolenses to the bereaved family.

INFORMATION FOR CONTRIBUTORS

Contributions from the members only on any aspects of oilseeds research will be considered for publication in the Journal of Oilseeds Research. Papers for publication (in triplicate) and book reviews should be addressed to the Editor, Journal of Oilseeds Research, Directorate of Oilseeds Research, Rajendranagar, Hyderabad - 500 030, India.

Manuscript should be prepared strictly according to the GUIDELINES FOR AUTHORS published in Volume 12, No.1 and should not exceed 15 typed pages including Tables and Figures. Short communications should not exceed five typed pages including Tables and Figures.

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