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# DETERMINATION OF THE DEGREE OF ASSOCIATION OF MUSTARD APHID POPULATION WITH VARIOUS CULTURAL PRACTICES ON INDIAN MUSTARD

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ABSTRACT

A field experiment was conducted during 1976–77 to study the degree of association of the important cultural practices i.e. date of sowing (early, normal and late), nitrogen levels (0.30 and 60 kg N/ha), number of irrigations (0, 1 and 2) and row spacing (30, 45 and 60 cm) with aphid population on Indian mustard (*Brassica juncea*) Highly significant positive correlation between aphid population and each of these cultural practices except row spacing, were observed. In the 1977–78 repeat experiment, the factor row spacings (which proved statistically at par) was replaced by two levels of insecticidal sprays. The multiple regression equation $Y = b_0 + b_2 X_2 + b_2 X_3 + b_4 X_4 + b_5 X_5$ was found to be the best fit and equations for each observation have been worked out. To study combined effect of these cultural practices on aphid population, the coefficients of determination ($R^2$) were worked out and the variation in the aphid population, accounted for by its association with these cultural practices, was above 80 per cent.

**Key words** : Cultural practices; multiple regression equation; multiple correlation coefficients; *Brassica juncea.*

## INTRODUCTION

Excessive use of insecticides, which provide the most effective and immediate control of insect-pests, pose serious threat to the ecological balance in nature. Therefore, an integrated approach, for controlling the pests of crops, involving cultural practices and chemical control measures, is needed to be adopted. Some of these cultural practices have been tried individually by various workers (Rawat *et al.*, 1968; Pal *et al*; 1976) against mustard aphid, *Lipaphis erysimi* Kalt., a major insect pest of mustard. However, the persual of the literature reveals that efforts have not been made to study the combined effect of cultural practices and their relationship with aphid population in mustard crop. An experiment, therefore, was conducted, to study the degree of association of the important cultural practices i.e., date of sowing, nitrogen application, irrigation and row spacing with the aphid population.

## MATERIALS AND METHODS

During 1976-77, a field experiment using var. Prakash of Indian mustard, *Brassica juncea* (*L.*) Czern and Coss involving three dates of sowing viz., early September 25), normal (October 10) and late (October 25); three levels of irrigation, 0, 1 and 2; three levels of nitrogen (0, 30 and 60 kg/ha) and three row spacings i.e. 30, 45 and 60 cm, was laid out in a split plot design. Dates of showing were randomized in main plots and the levels of irrigation in sub plots. The nine combinations of nitrogen and spacings ($3 \times 3$) were randomized in sub-sub plots of size $4.5 \times 3.6$m (gross) ($4.5 \times 3$m net) and replicated thrice. Based on the data obtained during 1976-77, no significant differences in the aphid population in once and twice irrigated crop was observed.

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**TABLE 1.** *Total correlation coefficients of aphid population with different cultural practices on weekly observations*

| No. of observation | Date of sowing ($X_2$) | | Nitrogen levels ($X_3$) | | Irrigation levels($X_4$) |
|---|---|---|---|---|---|
| | (1976–1977) | (1977–1978) | (1976–1977) | 1977–1978) | (1976–1977) |
| 1. | .9950** | .3387** | .1700 | .7990** | .9951** |
| 2. | .000 | −.9992** | −.8660** | .8090** | .1723 |
| 3. | .9370** | .257 | .9965** | .9330** | .8626** |
| 4. | .9850** | −.5381** | .9360** | .9990** | −.9823** |
| 5. | .9330** | .8592** | .9950** | .9999** | .7810** |
| 6. | .9980** | .9978** | .9990** | .9940** | .1383 |
| 7. | .9780** | .6429* | .9990** | .9930** | .7030* |
| 8. | .9830** | .9874** | .9990** | .9960** | .6411* |
| 9. | .9950** | .9141** | .9999** | .9800** | .9072** |
| 10. | .3690 | .9895** | .9990** | .9999** | .8362** |
| 11. | .6800 | | .9930** | | .8354** |
| 12. | −.9959 | | .9990** | | .8325** |

Similarly, the aphid population on crop sown with different row spacings was also statistically at par. Therefore, in the 1977-78 repeat experiment the levels of irrigation were reduced to two (0 and 1) and the factor row spacing was replaced by two levels of insecticidal sprays. Six combinations of dates of sowing and insecticidal sprays were kept as main plots, irrigation levels as sub plots and nitrogen levels were randomised in subplots. The aphid population was recorded on thirty randomly selected plants from each treatment (10 from each replicate) at weekly intervals with the help of indices standardized by actually counting the number of aphids present on five twigs of equal size as described by Kalra and Gupta (1983).

## RESULTS AND DISCUSSION

The aphid Population data of both the years revealed that the infestation began during last week of November on the early sown crop and it spread to normal and late sown crops within a fortnight. Maximum population (6010 aphids/plant) was recorded in the end of January when relative humidity was about 65 per cent. The aphid population was significantly higher on the irrigated late sown crop which was heavily fertilized with nitrogen and was not sprayed with insecticides (Kalra and Gupta-1983). To determine the degree of association of aphid population with date of sowing, nitrogen fertilization and irrigation, correlation ceofficients were worked out. The results presented in Table 1 showed that a highly significant positive correlation existed

**TABLE 2. Multiple regression equations and multiple correlation coefficents for different sets of cultural practices under different sets of climatic conditions**

| 1976–77 | Multiple regression equations | Multiple correlation coefficents |
|---|---|---|
| Y = | $35.2926 + 1.1155\ X_2 - 0.3734\ X_3 + 0.2759\ X_4$ | $R^2 = 0.0399$ |
| Y = | $25.2889 + 0.0400\ X_2 + 0.0059\ X_3 + 0.1993\ X_4$ | $R^2 = 0.0009$ |
| Y = | $71.2533 + 3.6911\ X_2 + 0.3732\ X_3 + 11.2477\ X_4$ | $R^2 = 0.7800$ |
| Y = | $175.0772 + 15.3857\ X_2 + 2.1826\ X_3 + 65.7549\ X_4$ | $R^2 = 0.9512$ |
| Y = | $280.6365 \times 3.3009\ X_2 + 6.1629\ X_3 + 185.4984\ X_4$ | $R^2 = 0.4451$ |
| Y = | $779.0745 + 48.4278\ X_2 + 2.8410\ X_3 + 241.1021\ X_4$ | $R^2 = 0.9424$ |
| Y = | $1214.33 + 54.6002\ X_2 + 15.4624\ X_3 + 64.4248\ X_4$ | $R^2 = 0.9534$ |
| Y = | $965.2366 \times 28.4860\ X_2 + 14.1428\ X_3 + 93.1772\ X_4$ | $R^2 = 0.8715$ |
| Y = | $649.2519 + 25.1950\ X_2 + 13.1893\ X_3 + 397.0278\ X_4$ | $R^2 = 0.9310$ |
| Y = | $789.4192 + 11.5339\ X_2 + 11.7550\ X_3 + 354.0205\ X_4$ | $R^2 = 0.7380$ |
| Y = | $790.9019 + 9.0666\ X_2 + 9.4635\ X_3 + 285.1348\ X_4$ | |
| Y = | $530.6259 + 28.5542\ X_2 + 4.5566\ X_3 + 126.2815\ X_4$ | |
| 1977–78 | | |
| Y = | $27.3850 \times 0.3213\ X_2 + 0.3020\ X_3 + 19.0344\ X_4 - 2.2488\ X_5$ | $R^2 = 0.4600$ |
| Y = | $160.6125 + 3.7303\ X_2 + 0.6036\ X_3 + 31.7000\ X_4 - 15.7537\ X_5$ | $R^2 = 0.2485$ |
| Y = | $354.6448 - 1.7193\ X_2 + 0.2401\ X_3 + 62.2928\ X_4 - 9.5919\ X_5$ | $R^2 = 0.0519$ |
| Y = | $1550.7416 + 1.8708\ X_2 + 5.1297\ X_3 - 277.1494\ X_4 - 418.4948\ X_5$ | $R^2 = 0.2447$ |
| Y = | $-708.6215 + 37.0600\ X_2 + 58.4884\ X_3 + 1491.5962X_4 - 7493\ X_5$ | $R^2 = 0.5789$ |
| Y = | $-5277.536 + 103.7168\ X_2 + 10.1080\ X_3 + 48.9806\ X_4 - 1614.7829X_5$ | $R^2 = 0.8625$ |
| = | $5460.9506 + 101.0428X_2 + 23.3204X_3 + 519.9390\ X_4 - 1095.3220\ X_5$ | $R^2 = 0.6009$ |
| Y = | $5366.1415 + 103.7085\ X_2 + 7.1192X_3 + 48.9234X_4 - 1614.7858X_5$ | $R^2 = 0.9930$ |
| Y = | $5821.3600 + 48.0018\ X_2 + 15.1572\ X_3 - 553.555\ X_4 - 1468.4175\ X_5$ | $R^2 = 0.9510$ |
| Y = | $4714.8966 + 23.2507\ X_2 + 14.5972\ X_3 + 135.0123\ X_4 - 1580.1149X_5$ | $R^2 = 0.8112$ |

Y = Aphid population; $X_2$ = Date of sowing; $X_3$ = Nitrogen fertilization; $X_4$ = Irrigation; $X_5$ = Insecticidal spray

between aphid population and each of these factors, which implied that the mustard aphid population increased with an increase in these factors.

A regression analysis was done to derive a relationship of aphid population (response variable) with that of date of sowing ($X_2$), nitrogen application ($X_3$), irrigation ($X_4$) and insecticidal spray ($X_5$) (predictor variables). The following multiple regression equation $Y=b_0+b_2\ X2+b_3\ X_3+b_4\ \ X_4+b_5\ X_5$ was found to be the best fit. The equations for each observation (creating thereby different sets of climatic conditions) for both the years have been presented in Table 2.

The determination of the combined effect of these practices on aphid population was undertaken by working out the coefficient of determination i.e.

$$R^2 = \frac{\text{Regression sum of squares}}{\text{Total sum of squares}}$$

The coefficient of determination, involving different sets of cultural practices, for each observation on aphid population (creating thereby different sets of climatic conditions) have also been presented in Table 2. It was observed that these cultural practices and aphid population were significantly correlated. Coefficients of determination ($R^2$) gave the proportion of variability in aphid population accounted for by its association with characters $X_2$, $X_3$, $X_4$, and $X_5$ and it worked out to be more than 0.80 in most cases. It implied that 80 per cent of the variation in aphid population had been explained by these characters and less than 20 per cent of the variation had not been accounted for.

It could be concluded that the date of sowing, nitrogen fertilization, irrigation and insecticidal sprays, when studied together, had a significant effect on the population of *L. erysimi* on Indian mustard. These factors brought above 80 per cent change in aphid population.

## ACKNOWLEDGEMENTS

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## LITERATURE CITED

CROXTON, F.E. and COWDEN, D.J. 1966. Applied general statistics. New Delhi: Prentice Hal of India (Pvt.) Ltd.

KALRA, V.K. and GUPTA, D.S. 1983. Chemical control of mustard aphjd. (*Lipaphis erysimi* Kalt.) *Indian J. Ent.* (In press).

KALRA, V.K. and GUPTA. D.S. 1983 Integrated control of mustard aphid, *Lipaphis erysimi* Kalt. Proceedings of 10*th International Congress of Plant Protection.* Brighton, England, p. 1198.

PAL S.R., NATH, D.K. and SAHA, G.N. 1976. Effect of time of sowing and aphid infestation on 'Rai' (*Brassica juncea* Coss.) *Indian Agric.* **20**(1):27–34.

RAWAT, R.R., MISRA, U.S., THAKUR, A.V. and DHAMDHERE, S.E. 1968. Preliminary studies on the effect of different doses of nitrogen on the incidence of major pests of mustard. *Madras agric. J.* **55**:363–366.

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# INFLUENCE OF TIME OF SOWING ON INCIDENCE OF PEST COMPLEX OF INDIAN MUSTARD.

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ABSTRACT

The insects recorded on Indian Mustard (*Brassica juncea* Coss)var. 'Baruna' during the crop season of 1984–85 were *Athalia lugens-proxima* Klug., *Corcidolomia binotalis* Zell., *Diacrisia obliqua* Walk., *Lipaphis erysimi* Kalt., *Phylotretta* sp. and *Plutella xylostella* Linn. Among these *C. binotalis*, *P. xylostella* and *L. erysimi* occurred almost throughout the crop season. The first two species were more active during late January to February but high incidence of aphid was found during late December and January. *A. lugens-proxima* and *Phyllotretta* sp. are late invaders and infested crops sown late on November 12 and 29, 1984. *D. obliqua* population was low and scattered but was relatively high on crop sown on November 29. Aphid incidence index showed gradual increase with deffered dates of sowing from 26 September, 1984 though the mean population score was high on crops sown on October 11, 23 and November 12, 1984. Activity of coccinellid predators of aphid was more during early crop season in November-December and honeybee visitation was more during late November to December. The congenial atmospheric conditions for early sown crops coupled with low pest incidence and high predator and pollinator activities led to better seed yield realisation of early sown crops.

**Key words** : Indian mustard; *Brassica juncea*; pests; time of sowing.

## INTRODUCTION

Time of sowing of season bound crops has profound effect on the incidence of pests which affect them. This is particularly true for seasonally occurring pests as in the case of mustard (Bhattacharjee, 1961; Maini, 1965; Pal *et al*,. 1976; Ghosh and Ghosh, 1981) with respect to *Lipaphis erysimi* Kalt. Reports are also available regarding the meteorological factors influencing incidence of *Athalia lugens proxima* Klug. (Srivastava and Srivastava, 1972; Bogwat, 1968), *Bagrada cruciferarum* Kirk. (Srivatava and Srivastava, 1972) and *Lipaphis erysimi* Kalt. (Sethi and Atwal, 1963). At present some other insects have gained local importance and therefore, it becomes imperative to investigate the effects of sowing time on the incidence of pest complex of crop in view of the present day concept of pest management. The present report deals with the incidence of insects on the crop under deferred sowing at Kalyani, West Bengal.

## MATERIALS AND METHODS

The experiment was laid out in Randomised Block Design replicated foure times with "Varuna", a high yielding variety or *rai*. The available soil moisture was utilised for the first date of sowing but for subsequent dates the plots were irrigated prior to land preparation. Land preparation done with deshi plough to obtain proper tilth of soil. N, P, K were applied as urea at 50 kg/ha, muriate of potash at 25 kg/ha and single superphosphate at 25 kg/ha. 50% of the required quantity of urea was applied as basal dose during finall and preparation. Irrigation was given as and when

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necessary Seeds were sown in rows at 35 cm distance in plots of 3m × 4m The treatments included five dates of sowing as September 26, October 11, October 23, November 12 and November 29, 1984.

The incidence of all pests was recorded for the first time after 25 days of germination and then at seven days interval till the crop matured. Five spots in a plot were selected at random and in each such spot 5 contiguous plants in a row were included for observing the pest / insect incidence. Care was taken to select the spots at 50 cm inside from the border of the plots to avoid mechanical interference on the incidence of pest/insects. Actual counting of all the insects present in the samples was done for larvae of *Athalia lugens-proxima* Klug., *Crocidolomia binatalis* Zell,. *Diacrisia obliqua* Walk., *Plutella xylostella* Linn. and adults of *Phyllotertta* sp. Incidence of aphid was done by scoring the incidence as followed by Mukhopadhyay and Ghosh (1979). Total counts were taken for the adults of coccinelid predators on aphid and of honeybee present in each plot. First and mass flowering, time of crop maturity and seed yield per net plot of 3m × 2m at harvest were recorded. The other plant characters like height of plant at maturity, number of primary branches and number of siliqua were recorded from twenty randomly selected plants from each plot. All the data were statistically analysed.

The meteorological data of the period during the experiment has been furnihed in Table 1.

**TABLE 1. Metrological data durin crop season of 1984-85**

| Factors | Temperature (°C) | | Relative humidity (%) | |
|---|---|---|---|---|
| Month | Maximum | Minimum | Maximum | Minimum |
| September 1984 | 33.85 | 25.65 | 83.92 | 59.44 |
| October 1984 | 30.19 | 23.26 | 82.66 | 48.1 |
| November 1984 | 30.06 | 13.76 | 82.48 | 36.41 |
| December 1984 | 27.10 | 11.27 | 82.17 | 36.36 |
| January 1985 | 23.20 | 11.73 | 84.15 | 52.12 |
| February 1985 | 24.50 | 14.77 | 80.56 | 46.40 |

## RESULTS AND DISCUSSIONS

**Sowing time of crop and insect incidence :** Initiation of aphid infestation occurred between 23 and 47 days after owing. The peak of incidence attained earlier in late dates of sowing than on plants in earlier dates of sowing. Growth of population of aphid was relatively slow in crops sown upto October 23, 1984 and was much speedy on crops of later two dates of sowing. Population at peak of incidence excepting that of first date of sowing was considerably high (Fig. 1). The mean of aphid population scores of all observations during period of its incidence on plants of different dates of sowing indicated that it was quite low on plants sown on September 26, 1986 as compared

to the same on plants in the subsequent for dates of sowing. But the aphid incidence index calculated as per formula :

$$\frac{\text{Total of population scores of all observations} \times 100}{\text{No. of observations} \times \text{Duration (days) of incidence}}$$

showed significiantly gradual increase of the index with deferred dates of sowing (Tabel 2). The growth of population seemed to be influenced more by abiotic factors during the initial stage but the decline in population was a function of crop maturity. Pal *et al.* (1976) indicated that population thershold of aphid at least for one year of their studies attained much later in the early sown cro s than on the late sown ones as has also been found during the present investigation.

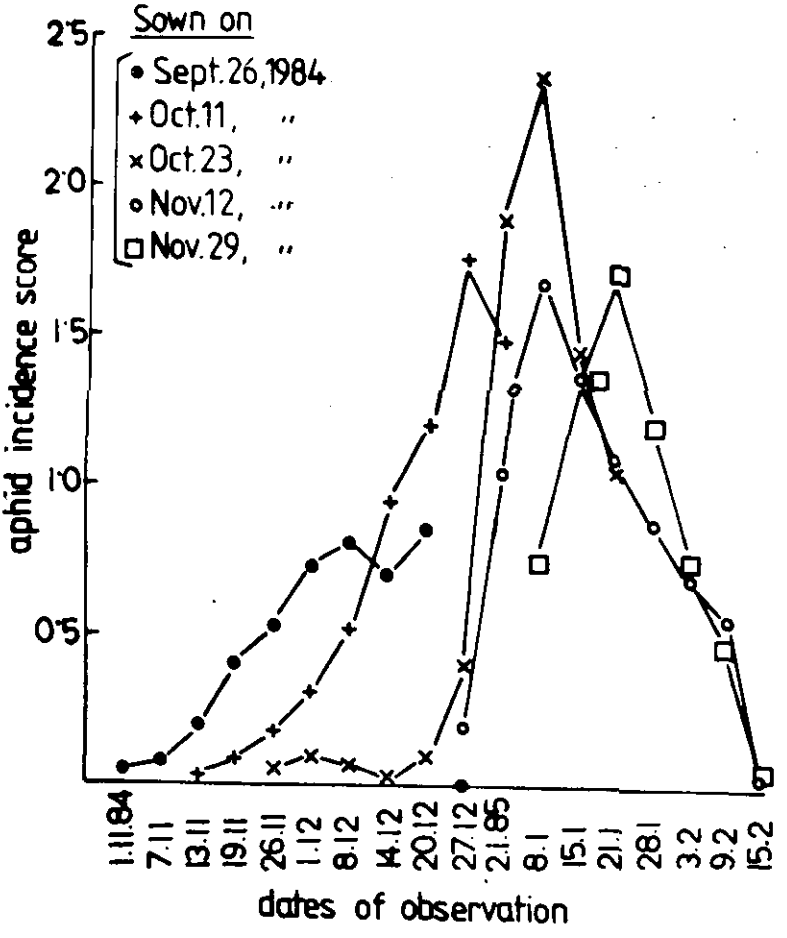


Fig. 1. Aphid incidence as influenced by sowing time

*C. binotalis* and *P. xylostella* larvae could simultaneously be recorded from November 19, 1984 on plants of first two dates of sowing (September 26 and October 11, 1984). These never asumed any serious proportion till. *C. binotalis* disppeared after

**TABLE 2. Summarised data of observations on pests/predators/honey bees**

| Date of sowing | Aphid | | Crocido-lomia | Plutella | Athalia | Phyllotretta | Predator | Honey bee | | Diacrisia |
|---|---|---|---|---|---|---|---|---|---|---|
| | Index | Score (10 obs. test) | | | | | | At mass flowering | During whole flowering | |
| Sept. 26 | 0.28 | 4.60 | 44.50 | 0.92 | 0.71 (0.00) | 0.71 (0.00) | 4.17 | 11.00 | 28.00 | 0.71 (0.00) |
| Oct. 11 | 1.14 | 6.67 | 46.25 | 0.36 | 0.71 (0.00) | 0.71 (0.00) | 2.44 | 11.25 | 38.00 | 0.75 (0.07) |
| Oct. 23 | 1.07 | 7.43 | 58.50 | 0.29 | 0.71 (0.00) | 0.71 (0.00) | 1.49 | 15.25 | 56.00 | 0.75 (0.04) |
| Nov. 12 | 1.54 | 7.54 | 93.50 | 1.39 | 1.12 (3.48) | 1.99 | 0.375 | 4.50 | 14.25 | 0.87 (0.24) |
| Nov. 29 | 2.08 | 6.65 | 192.00 | 0.75 | 1.45 (6.63) | 2.67 | 0.450 | 5.25 | 12.25 | 1.88 (4.24) |
| S.Em ± | 0.151 | | 16.472 | 0.0707 | 0.04 | 0.0591 | 0.218 | 0.798 | 1.6795 | N.S. |
| C.D. (P=0.05) | 0.329 | | 35.934 | 0.218 | 0.0972 | 0.1288 | 0.475 | 1.739 | 3.6597 | |

N.S. = Not significant.

December 1, 1984 from plants sown on September 26 and on December 20 from plants sown on October 11, 1984. *P. xylostella*, however, once shoot up to some high incidence on December 20 on plants of first date of sowing. On plants of third date of sowing (October 23, 1984) both these insects though occurred were never high. Larvae of *C. binotalis* could be recorded a week earlier on January 2, 1985 than that of *P. xylostella* on plants of fourth date of sowing (Nobemver 12, 1984), the former attained peak on January 28, 1985 and the later on February 15, 1985. These two insects appeared simultaneously on plants of last date of sowing (November 29, 1984) but the population of *C. binotalis* was considerably high all through and *P. xylostella* population was high only on the last day of observation (February 15, 1985).

Sawfly larvae and flea beetle occurred only on plants on the last two dates of sowing. Sawfly larvae was recorded first on January 21 on plants of fourth date of sowing but on plants of fifth date of sowing it was on January 8, 1985 Flea beetles infested the plants of fourth date of sowing from January 28 and the plants of fifth date of sowing from January 15, 1985 onwards. Inspite of occurrence of the two insects in negligible proportions relatively high population of sawfly larvae was recorded from January 28 to February 9, 1985 and that flea beetle extended little further up to February 15, 1985.

Scattered population of the larvae of *D. obliqua* was found on plants of all dates of sowing excepting those of first date of sowing. The occurrence was more frequent on plants of the last date of sowing when relatively higher population could be recorded on February 3, 1985. The puoplation, however, was never in any pest proportion.

Adult coccineild predators of aphid was found in association aphid on plants of all dates of sowing. However, relatively high population of this insect was recorded for a very limited period from last week of November to last week of December, 1984 with aphid on plants of first date of sowing. At low aphid population level during period on plants of second and third dates of sowing the predator population was relatively high, it never occurred in any remarkable numbers during the succeeding period inspite of aphid population growing much higher.

Intensified activities of honey bees was associated with mass flowering of plants of different dates of sowing. But the activities of these insects were more intense for about a month from late November 1984 within which period mass flowering of plants of three early dates of sowing occurred. Maximum activities of honey bees could be found on December 14, 1984 when mass flowering of plants of third date of sowing occurred (Fig. 2) which was significantly higher than on plants of other dates of sowing.

**Yeild attributing characters and seed yield:** The yield attributing characters like final height of the plants, number of primary branches per plant and number of siliqua per plant varied significantly with the date of sowing (Table 3). All characters in plants from first date of sowing were much superior to those on the last two dates of sowing (November 12 and 29, 1985) and significantly better than second and third dates of sowing (October 11 and 23, 1984) which among themselves did not differ

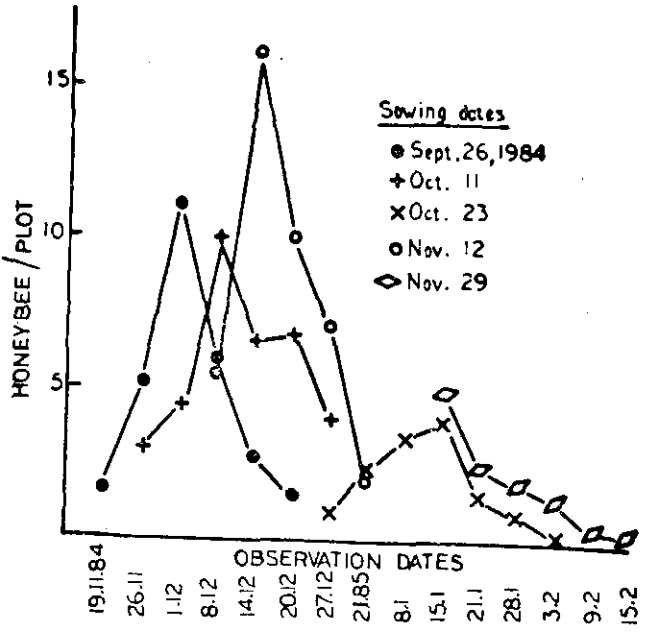


Fig. 2. Honey bees visitiation on plants sown on different dates

significantly. The seed yield also followed the same trend but the yields obtained from first three dates of sowing were not mutually significantly different but was significantly superior to that from the last two dates of sowing. These coroborate the findings of Bhattacharjee and Paul (1973), Sen and Sur (1961) and Pal *et al.* (1976). While it appears from the present investigation that sowing of mustard upto third week of October would be much profitable. Pal *et al.* (1976) indicated, it can sometimes be deferred even up to fourth week of November. This no doubt depends on the pevailing agroclimatic situation of a particular season.

Incidence of multiple pests on a crop often creates difficult situations for crop raising. But sometimes manipulation of time of sowing of crops like rape and mustard may yield encouraging result to minimise or evade avoidable loss due to pests. Though sporadic and potential pests like *Crocidolamia binotalis*, *Plutella xylostella*, *Aihalia lugens-proxima* and *Phylloteretta* sp. may sometimes pose serious problem to mustard (Ghosh, 1979) activity of all these is usually intensified towards the end of

**TABLE 3. Some plant characters and seed yield as influenced by sowing time (mean of four replicates)**

| Date of sowing | Plant height (in cm) | No. of primary branches | No. of seliqua | Seed yield* g/plot |
|---|---|---|---|---|
| Sept. 26, 1984 | 156.50 | 23.77 | 153.25 | 8.73 |
| Oct. 11, 1984 | 135.00 | 88.57 | 114.00 | 8.25 |
| Oct. 23, 1984 | 139.50 | 17.07 | 99.00 | 7.75 |
| Nov. 12, 1984 | 63.00 | 12.67 | 29.25 | 3.00 |
| Nov. 29, 1984 | 69.25 | 10.25 | 25.25 | 1.75 |
| S. Em + | 5.6309 | 0.4460 | 13.4889 | 0.830 |
| C.D. (P=0.05) | 12.2699 | 0.9719 | 29.3923 | 1.809 |

* values espressed as 1/100th of actual yield

the season from February onwards. Aphid infestation may start quite early during the season and depending on climatic condition it may occur in high proportion even on crop sown relatively earlier during October (Pal *et al.* 1976; Ghosh and Ghosh, 1979) Inspite of this the congenial climatic factors boost up vegetative growth of early sown crops leading to better seed yield. In addition to this agronomic advantage of early sown crops, the relatively warm conditions of October-November are not so favourable for growth of aphid population as during cooler conditions of late December-January. By this time the period of mass flowering of early sown crop is almost over, thus the vulnerable vegetative phase of crop growth escapes ravage due to aphid (Bhattacharjee 1961; Maini, 1965; Pal *et al.* 1976). The unfavourable abiotic factors for aphid during this period appears to be favourable for its coccinelid predators which may also exert its repressive force on aphid population as has been found during this investigation which vindicate the findings, of Sethi and Atwal (1963).

The late sown crops on the one hand have restricted growth due to not so favourable climatic factors on the other hand various pests including aphids become more active which interfere with the proper realisation of productivity of the crop. So the late sown crops require specific attention to obviate the avoidable loss of seed yield to the the tune of about 85% (Pal *et al.*, 1976, 1983)

*LITERATURE CITED*

BHATTACHARJEE, B. and PAL, S.R. 1973. Effect of time of sowing on yield of different varieties of *Barssica* spp. in West Bengal. *Indian Agric.* 10 : 323-326

BHATTACHARJEE, N. S. 1961, Control of mustard aphid by cultural practices. *Indian Oilseeds J* 5 : 133—138.

BOGAWAT, J. K. 1968. Effects of temperature on the development of mustard sawfly. *Athalia proxmm* Klug. (Hymenopetra : Tenthirdinidae)· *Indian J. Ent*· 30: 80-82.

GHOSH, A.K. and CHOSH, M.R. 1981. Effect of time of sowing and insecticidal treatments on the pests of Indian mustard. *Entomon.* **6**:357–362.

GHOSH, M.R. 1979. Comparative efficacy of some systemic insecticides to control mustard aphid, *Lipaphis erysimi* (Kalt.) and notes on some related problems. *Pesticides* **13**:13-17.

MAINI, N.S. 1965. A review of research work done at Regional Research Centre Oilseeds (PIRRCOM) Patiala. *Indian Oilseeds J.* **9**:138–145.

MUKHOPADHYAY, D. and GHOSH, M.R. 1979. Effect of phased application of formothion andmethyl demeton on the incidence of *Lipaphis erysimi* (Kalt.) and yield of rape seed. *Indian J. agric. Sci.* **40**:898–900.

PAL, S.K., BANDHYOPADHYAY, B. and GHOSH, M.R. 1983. Comparative efficacy of some insecticides to control aphid, *Lipaphis erysimi* (Kalt.) on late sown Indian mustard. *Brassica juncea L. Orient. Zool.* **3**:69–73.

PAL, S.R., NATH, D.K. and SAHA, G.N. 1976. Effect of time of sowing and aphid infestation on Rai *(Brassica juncea Coss) Indian Agaricul,* **20**:27-34,

SEN, S. and SUR, S. 1964. The optimum time of sowing of *rai* and toria in West Bengal. *Indian Oilseeds J.* **8**:232–236.

SETHI, S.L. and ATWAL, A.S. 1963. Influence of temperature and humidity on development of different stages of ladybird beetle, *Cooccinella septempunotata* L. (Coleoptera: Coccinalidae). *Indian J. agric. Sci.* **34**:166–171.

SRIVASTAVA, A.S. and SRIVASTAVA, J.L. 1972. Ecological studies on the aphid, painted bug sawfly attacking mustard and rape in India. *FAO Plant Prot. Bull.* **20**:136–140.

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# EFFECT OF IRRIGATION SCHEDULING ON YIELD OF SAFFLOWER VARIETIES

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## ABSTRACT

The effects of scheduling of irrigation on the basis of critical growth stage approach on yield of safflower (*Carthamus tinctorius L.*) varieties were studied during the *rabi* seasons of 1981–82, 1982–83 and 1983–84 on vertisol. It was observed that scheduling of three irrigations each at sowing, branching and flowering stages gave maximum yield. If only two irrigations are available these should be applied at sowing and branching. Variety Bhima gave maximum yield. However, the varieties Tara and N-62-8 were equally better. Variety Bhima with three irrigations gave maximum yield. Maximum consumptive use of moisture was observed where three irrigations were applied. Irrigation only at sowing recorded lowest consumptive use of moisture with highest water use efficiency. Variety Bhima recorded 20.53 cm of consumptive use of moisture with highest WUE of 77.42 kg/ha-cm. The variety NSH-1 gave lowest yield, maximum consumptive use of moisture and lowest water use efficiency.

**Key words :** Safflowers; Irrigation; *Carthamus tinctorius.*

## INTRODUCTION

Safflower (*Carthamus tinctorius* L.) is the important *rabi* oilseed crop of Maharashtra mostly grown on conserved moisture on black soil area. It is predominantly grown in drought prone areas. It occupies an area of 5.15 lakh ha with the average production of 4.74 q/ha. The low yields are mainly due to the fact that the safflower is grown on receding soil moisture condition coupled with minimum use of the inputs. This crop is irrigated rarely. Studies conducted at number of locations revealed that application of irrigation to safflower increases the yield substantially over unirrigated control (Suryanarayana, 1975; Bhan, 1976; Rao *et al.*, 1977; Bajpai *et al.*, 19780; Raghu and Sharma, 1978; Singh and Singh, 1980 and Anonymous, 1981/83). Safflower is mainly grown in drought prone areas where irrigation facilities are limited. Under such circumstances scheduling of irrigation on the basis of critical growth stage approach would be more appropriate. There are stray reports indicating that if one or two irrigations are applied at critical growth stages the yield of safflower can be increased to large extent. In view of this, the present investigation was undertaken under semi-arid climate and vertisol soil conditions.

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## MATERIALS AND METHODS

The studies were conducted at Water Management Project Mahatma Phule Agricultural University, Rahuri (India) during three successive *rabi* seasons of 1981–82 to 1983–84. There were sixteen treatment combinations due to four varieties (Tarą, Bhim, N. 62–8 and NSH–1) and four schedules of irrigations (1. Irrigation at sowing only, 2. Irrigation at sowing and branching, 3. Irrigation at sowing and flowering and 4. Irrigation at sowing, branching and flowering.) These treatments were replicated three times. The design of experiment during 1981–82 was randomised block. However, during 1982–83 and 1983–84 the design of experiment was split-plot with irrigations as main plot treatments and varieties as sub-plot treatments. The gross and net plot size was 6.0 × 4.5 $m^2$ and 4.5 × 2.7$m^2$, respecitvely. The seeds of the safflower were dibbled at 45 × 25 $cm^2$ on 23.10.1981, 13.10.1982 and 20.10.1983. The first irrigation of 10 cm depth was applied immediately after dibbling. However, one light common irrigation was applied at 10 days after sowing only during 1982.–83. The successive irrigations were of 6 cm. The quantity of water applied was measured at the plot head with the help of 90° V–notch.

The soil of the experiments was clayey, medium black with depth more than 100 cm. The textural composition of the soil consisted of 17.2 per cent sand, 24.6 per cent silt and 58.2 per cent clay. The field capacity of soil was 38 per cent and the permanent wilting point was 20 per cent with a bulk density of 1.20 g/ $cm^3$. Thus the available soil moisture in 100cm depth was 216 mm. The soil was medium in total nitrogen (0.029%) and available phosphors (0.005%) and high in available potassium (0.122%) content with pH 8.3. The soil samples were taken from 0–15, 15–30, 30–45 and 45–60 cm depth just before and two days after each irrigation to monitor the soil moisture changes during each irrigation cycle. The last sample was taken at the time of harvesting. The soil moisture was determined by gravimetric method (Dastane 1972). The seasonal consumptive use was estimated as suggested by Michael *et al.* (1977).

## RESULTS AND DISCUSSION

### Grain yield

The data on grain yield of safflower as influenced by various treatments for individual seasons, mean of three seasons and pooled mean for last two seasons are presented in Table 1. The pooled data are based on only last two years as the design of experiment during first year was different than that of last two years.

*i) Effect of irrigation schedule*

The data presented in Table 1 would reveal that the differences in grain yield due to scheduling of irrigation were statistically significant during 1981–82, 1983–84 and on pooled mean basis. However, during, 1982–83 these differences were not statistically significant. During 1981–82 and 1982–84 it was observed that application of three irrigations i.e. each at sowing, branching and flowering gave maximum yield. The

**TABLE 1. Yield of safflower (kg/ha) as influenced by irrigation and varieties**

| Treatment | Season | | | Mean of three seasons | Pooled mean of 1982–83 and 1983–84 |
|---|---|---|---|---|---|
| | 1981–82 | 1982–83 | 1983–84 | | |
| | | | | (Weighted mean) | |
| **A. Irrigation Schedule** | | | | | |
| $I_1$ — Irrigation at sowing only | 1029 | 1111 | 1215 | 1118 | 919 |
| $I_2$ — Irrigation at sowing and branching | 1415 | 979 | 2088 | 1494 | 1111 |
| $I_3$ — Irrigation at sowing and flowering | 1086 | 1128 | 1502 | 1239 | 1009 |
| $I_4$ — Irrigation at sowing, branching & flowering | 1572 | 985 | 2356 | 1638 | 1179 |
| S.E. ± | 65 | 77 | 147 | — | 58 |
| C.D. (p = 0.05) | 190 | N.S. | 509 | — | 179 |
| **B. Varieties** | | | | | |
| $V_1$ — Tara | 1514 | 1053 | 1923 | 1497 | 1098 |
| $V_2$ — Bhima | 1457 | 1333 | 1910 | 1553 | 1236 |
| $V_3$ — N–62–8 | 1111 | 1193 | 1749 | 1351 | 1118 |
| $V_4$ — NSH–1 | 1021 | 593 | 1580 | 1064— | 766 |
| S.E. ± | 65 | 84 | 92 | — | 51 |
| C.D. (P = 0.05) | 190 | 245 | 269 | — | 145 |

grain yield from application of two irrigations, one at sowing and the other at branching was at par with the yield from three irrigations. However, this was significantly superior to the treatment where irrigations were applied at sowing and flowering. During 1982–83 there were no differences in grain yield due to irrigation treatments. This was due to the rainfall received during the crop growth period. When the data on effective rainfall was scrutinised. It was observed that there was 4.48, 6.06 and 1.78 cm of effective rainfall during crop growth period of 1981–82, 1982–83 and 1983–84 respectively. Thus during 1982–83, there was more effective rainfall as compared to other two years. This might have nullified the effects of irrigation. Further, one additional irrigation of 5 cm depth was applied after 10 days from sowing to all the treatments during 1982–83. Hence, due to these facts there was no difference in the yield, during 1982–83.

From the pooled means it was observed that maximum yield of 11.79 q/ha was observed due to three irrigations. However, both the treatments of two irrigations were on par with this. The yield from irrigation at sowing only was significantly less than three irrigations and two irrigations treatments of sowing and branching and one par with that of two irrigations each at sowing and flowering. Thus, if two irrigations are available these should only be applied at sowing and branching instead of at sowing

and flowering. The irrigation at branching is more important than the irrigation at flowering under the constraint of irrigation. This is due to the fact that at later stage, safflower turns into xerophytic and hence sustain the moisture stress.

When the yield data on the basis of mean of all the three seasons were compared it was observed that highest yield (16.38 q/ha) was obtained where three irrigations were applied. Similar results have been reported at Delhi by Mahapatra and Singh (1975) and at Parbhani (Anonymous 1981-83). The next best treatment was observed where two irrigations were applied each at sowing and branching (14.94 q/ha). Two irrigations applied at sowing + flowering gave only 12.39 q/ha of grains. In case of one irrigation only at sowing gave mean grain yield of 11.18 q/ha.

Further, when situation of less rainfall of 1981-82 and 1983-84 is compared it was noted that there was an increase in yield of safflower to the tune of nearly 82 and 64% due to three irrigations viz. each at sowing, branching and flowering and two irrigations each at sowing, and branching, respectively. The application of irrigation at branchings was better as compared to its application at flowering observed during 1983-84. Rao *et al.* (1977) also reported that moisture stress during initiations of branching to flowering reduced the yield of safflower drastically.

*ii) Effect of varieties*

*The differences in grain yield of safflower due to different varieties were statistically* significant during all the three years and also on the basis of pooled means. During 1981-82 the varieties Tara and Bhima were at par with each other and significantly superior to both N-62-8 and NSH-1. While during 1982-83 variety Bhima was significantly superior to Tara and NSH-1 but at par with the variety N-62-8. During 1983-84 it was observed that varieties Tara, Bhima and N-62-8 were at par with each other. While lowest yield was recorded from NSH-1 during all the three years. On the basis of mean yield of three years it was observed that the grain yield of 15.53, 14.97 13.51, and 10.64 q/ha were obtained from the varieties Bhima, Tara, N-62-8 and NSH-1 respectively. When the data were pooled over two seasons of 182-83 and 1983-84, it was observed that highest yield of 12.36 q/ha was observed from the variety Bhima. The varieties Tara and N-62-8 were at par with Bhima. Significantly lowest yield of 7.66 q/ha was recorded from NSH-1.

*iii) Effect of interaction*

The interaction between scheduling of irrigation and varieties was absent during the individual years. However, when the data were pooled over for two years of 1982-83 and 1983-84 the interaction was found to be significant. The data for the same are presented in Table 2. When the performance of different varieties was compared at the same level of irrigation, it was observed that at one irrigation at sowing and two irrigations each at sowing and at branching, variety Bhima gave maximum yeild. This was siginificantly superior only to NSH-1 and at par with rest of the combinations. Application of two irrigations each at sowing and flowering to variety N-62-8

TABLE 2. Effect of irrigation varieties interaction on grain yield of safflower (kg/ha)

| Treatments | $V_1$ | $V_2$ | $V_3$ | $V_4$ | Mean |
|---|---|---|---|---|---|
| $I_1$ | 926 | 1140 | 954 | 655 | 919 |
| $I_2$ | 1229 | 1216 | 1113 | 883 | 1111 |
| $I_3$ | 1005 | 1151 | 1325 | 556 | 1009 |
| $I_4$ | 1228 | 1437 | 1079 | 970 | 1179 |
| Mean | 1098 | 1236 | 1118 | 766 | |

| | | S.E. ± | C.D. (P = 0.05) |
|---|---|---|---|
| 1) | To compare the varieties at the same level of irrigation treatments | 101 | 287 |
| 2) | To compare irrigation treatments at the same level of variety | 117 | 361 |
| 3) | To compare the combinations | 211 | 435 |

gave maximum yield. This was significantly su erior to Tara and NSH-1 but at par with Bhima. At three irrigation levels variety Bhima gave maximum yield of 14.37 q/ha. This was significantly superior to N-62-8 and NSH-1 and at par with Tara. At all the levels of irrigation NSH-1 gave lowest yield. When the effect of irrigation treat ment at same variety was compared then it was observed that there was no variation in the yield of Tara and Bhima varieties due to different irrigation teratments. The yeild due to either two or three irrigation levels was at par in case of N-62-8 . In case of NSH-1 application of three irrgations gave maximum yield which was significantly more than due to two irrigations, one at sowing and the other at flowering while other two irrigation treatments were at par with three irrigation treatments.

The combination of variety Bhima with three irrigation gave maximum yield of 14.37 q/ha. This was significantly more than the combinations of Tara and N-62-8 with one irrigation at sowing and NSH-1 with all the irrigation levels.

**Moisture studies**

The moisture studies in respect of consumptive use and water use efficiency (WUE) were conducted. The data for the same are presented in Table 3. On the basis of mean values of three years it would be seen that the consumptive use of water range from 13.75 to 26.20 cm due to irrigation treatments. The maximum was where three irrigations were applied and minimum being only one irrigation at sowing was applied. In case of two irrigations it was 20.08 and 20.92 cm. Due to frequent irrigations wet surface was maintained for large periods and consequently greater would

TABLE 3. Consumptive use of water (cm) and water use efficiency (kg/ha-cm) as influenced by irrigation and varieties of safflower

| Treatment | Consumptive use of water (cm) | | | | Water use efficiency (kg/ha-cm) | | | |
|---|---|---|---|---|---|---|---|---|
| | 1981–82 | 1982–83 | 1983–84 | Mean | 1981–82 | 1982–83 | 1983–84 | Mean |
| *A. Irrigation schedule* | | | | | | | | |
| $I_1$ — Irrigation at sowing only | 11.42 | 14.47 | 15.35 | 13.75 | 90.10 | 63.59 | 81.63 | 78.44 |
| $I_2$ — Irrigation at sowing and branching | 17.32 | 23.10 | 19.81 | 20.08 | 81.60 | 42.38 | 105.45 | 76.48 |
| $I_3$ — Irrigation at sowing and flowering | 16.97 | 23.35 | 22.45 | 20.92 | 64.00 | 48.31 | 66.90 | 59.74 |
| $I_4$ — Irrigation at sowing, branching & flowering | 24.43 | 26.30 | 27.88 | 26.20 | 70.90 | 36.31 | 84.51 | 63.91 |
| *B. Varieties* | | | | | | | | |
| $V_1$ — Tara | 16.74 | 22.60 | 21.58 | 20.31 | 90.50 | 46.59 | 89.11 | 74.40 |
| $V_2$ — Bhima | 17.04 | 23.13 | 21.43 | 20.53 | 85.50 | 57.63 | 89.13 | 77.42 |
| $V_3$ — N-62-8 | 16.55 | 22.13 | 20.70 | 19.84 | 67.10 | 53.55 | 84.49 | 68.35 |
| $V_4$ — NSH-1 | 17.82 | 23.21 | 21.78 | 20.94 | 57.20 | 25.55 | 72.54 | 51.76 |

*Note* : 1) One light irrigation was applied to all the treatments at 10 days after sowing only during 1982–83.

2) There was effective rainfall of 4.48, 6.06 and 1.78 cm during 1981–82, 1982–83 and 1983–84, respectively. The mean effective rainfall comes to 4.11 cm.

be loss due to evaporation (Anonymous, 1973) and transpiration. The WUE of 78.44, 76.48, 50.74 and 63.91 kg/ha-cm was recorded from the irrigation treatments of one, two, and three irrigation treatments, respectively. Thus the highest WUE was observed where only one irrigation at sowing was applied.

In case of varieties the mean consumptive use of 20.31, 20.53, 19.84, and 20.94, cm with WUE of 75.40, 77.42, 68.35 and 51.76 kg/ha-cm was observed from the varieties Tora, Bhima, N-62-8 and NSH-1 ,respectively. Thus in case of Bhima which have yielded maximum have recorded the consumptive use of moisture of 20.53 cm with highest WUE of 77.42 kg/ha-cm.

## LITERATURE CITED

ANONYMOUS, 1974. Effect of three moisture conditions on yield of relay *rabi* crops for safflower and chickpea, Hyderabad. Annual Report, 1973–1974. International Crops Research Institute for the Semi-Arid Tropics. PP. 49.

ANONYMOUS, 1977. Safflower variety trial. Agril. Research Committee Report, Mahatma Phule Agril. Univeristy, Rahuri, pp. 137–140.

ANONYMOUS, 1982. Studies on irrigation requirement of gram and safflower. Agril. Research Review Sub–committee for Agronomy Report, MPAU, Rahuri, pp. 18–21.

ANONYMOUS 1981–83. Irrigation scheduling and water use. Oilseeds. Research on Water Management. Progress Report of Coordinated Project for Research on Water Management, 1981–83. ICAR, NEW Delhi. p. 47.

BAJPAI, M.R., PARIHAR, R.L. and DESHMUKH, M.T. 1978. Fertility and water management for safflower. *Annals of Aridzone.* **17**(3):298-303.

BHAN, S. 1976. Water management problems in Uttar Pradesh, *Indian Fmg.* **26**(2):11–13.

MAHAPATRA, I.C. and SINGH, N.P. 1975. Water Management practices for safflower. *Indian Fmg.* **25**(2):13–14.

RAGHU, J.S. and SHARMA S.R. 1978. Response to irrigation and fertility levels of safflower. *Indian J. Agron.* **23**(2):93–99.

RAM MOHAN RAO, M.S., SESHACHALAM, N., RANGA RAO, V. and RAMACHANDRAM, M. 1977. Critical stages of moisture stress in different crops. *Mysore J. Agril. Sci.* **11**(4):495–500.

SINGH, U.B. and SINGH, R.M. 1980. Effect of graded levels of moisture regimes, N and P fertilization on seed yield, oil content and NPK uptake by safflower. *Indian J. Agron.* **25**(1):9–17.

SURYANARAYANA, B.C. 1975. Scheduling of irrigation to safflower (*Carthamus tinctorius*, L.). *Mysore J. Agric. Sci.* **10**:510–511.

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# STUDIES ON GROWTH AND YIELD OF SUNFLOWER VARIETIES IN RELATION TO NITROGEN RATES

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**ABSTRACT**

Field studies on growth and yield of sunflower varieties in relation to nitrogen rates were carried out at the Crop Research Centre of Govind Ballabh Pant University of Agriculture and Technology, Pantnagar (Nainital). Varieties did not differ for plant height, number of green leaves and stem diameter at physiological maturity stage except stem diameter during 1974-75, where varieties UPS-2 and EC 68414 recorded higher stem diameter. Crop growth rate and total dry matter production per plant differed significantly at various growth stages. Varieties UPS-2 and EC 68414 produced higher crop growth rate and total dry matter production. Seed yield per hectare did not differ significantly among varieties, however, UPS-2 produced maximum seed yield followed by EC 68414. Under various rates of nitrogen application, plant height increased upto 80 kg N/ha. Number of green leaves did not differ significantly by nitrogen rates. Stem diameter increased upto 120 kg N/ha but thereafter increase was marginal. Crop growth rate and total dry matter accumulation increased linearly upto 120 kg N/ha; and 80 to 120 kg N/ha, respectively at most of growth stages and thereafter increase was nonsignificant. A significant increase in seed yield per hectare was recorded upto 80 kg N/ha.

**Key words** : Sunflower; *Helianthus annuus*; varieties; growth; nitrogen.

## INTRODUCTION

Sunflower (*Helianthus annuus* L.) is important oil seed crop. The exploitation of yield potential of sunflower varieties depends upon many factors. Nutririent supply is one of the important factor and the success of fertilizer application depends on harvest of good yield. This is closely connected to the proper growth and development of the crop plants. Mineral nutrition of crop plant is intimately related to the growth and yield of crops (Carpenter, 1952). Among various plant nutrients, nitrogen is one of the important nutrient. The information on nutritional requirement of sunflower in our country is meagre, therefore, a trial was conducted to study the growth and yield of sunflower varieties in relation to nitrogen fertilization.

## MATERIALS AND METHODS

Field experiments were conducted to study the growth and yield of sunflower (*Helianthus annuus* L.) varieties in relation to nitrogen fertilization at the crop research centre of Govind Ballabh Pant University of Agriculture and Technology, Pantnagar (Nainital). In all five varieties (UPS-2, UPS-5, UPS-6, UPS-8 and EC 68414) and five nitrogen rates (0, 40, 80, 120 and 160 kg N/ha) were tested in randomized block design

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with four replications during rabi seasons of 1974-75 and 1975-76. Phosphorus and Potash at the rate of 60 kg $P_2O_5$/ha and 40 $K_2O$/ha respectively as uniform application along with 2/3rd of nitrogen as per treatment was made as basal dressing. The remaining 1/3rd of the nitrogen was top dressed at bud initiation stage. Crop was sown on 3rd December and 5th November during 1st year and 2nd year, respectively. Soils of experimental plot during 1974–75 were medium in organic carbon and potassium and high in phosphorus content, where as these of 1975–76 were poor in organic carbon and rich in phosphorus and potassium contents.

Observations were recorded to measure the growth and development of plant at various stages of crop growth i.e. 4-6 leaf, 10-12 leaf, bud initiation, 75 percent bloom and physiological maturity (yellowing of back side of the disc). The plant height was measured at physiological maturity stage, from ground level to the neck of head. The number of fully expanded green leaves were counted at physiological maturity stage. The diameter of the stem was measured with the help of vernier calliper at three places i.e. bottom (2nd true leaf), middle (12th node) and top (below the head) at the time of harvest only, and averaged out for stem diameter. The observation on plant height, number of green leaves and stem diameter were recorded of five plants tagged at random in central rows of net plot. For dry matter accumulation, five plants were sampled out from the specified area marked for the purpose at 4-6, 10-12 leaf, bud initiation, 75 percent bloom and physiological maturity stages of crop growth. These plants were partitioned into stem, leaves and thallamus as the case may be and kept in the drier after chopping for drying at a constant temperature of 70°C. for a period of 48 hours to get a constant weight. Weight of each component was added to get total dry matter accumulation. Crop growth rate (CGR) was calculated and computed. Seed yield per unit area was calculated after harvesting, threshing, cleaning and weighing of seed of each net plot.

## RESULTS AND DISCUSSION

### Effect of varieties

Varieties did not differ significantly for plant height, number of leaves and stem diameter during both the years (Table 1) except stem diameter during 1974–75. Variety EC 68414 attained maximum average stem diameter (top+middle+bottom portion) and that was at par with UPS–2. Reddi *et al.* (1975) also reported at Thirupati a non significant difference in plant height under different varieties. Crop growth rate increased with advancement in crop age and reached to maximum at bud initiation stage and decline thereafter during both the years (Table 2). Variety EC 68414 produced maximum crop growth rate at 10-12 leaf stage during both the years but it was at par with UPS-2 during 1974–75 while during 1975-76, at par with UPS-2, UPS-6 and UPS-8. At bud initiation stage UPS-5 produced maximum crop growth rate which was significantly higher than UPS-6 and UPS-8 while EC 68414 produced significantly higher crop growth rate at 75 percent bloom over rest of the varieties during 1974-75. Total dry matter (stem+leaves+thallamus+seed, as per stage) accumulation per plant increased linearly with advancement in age of the plant and the maximum was recorded at

**TABLE 1. Effect of varieties and nitrogen rates on height (cm), number of green leaves and stem diameter/plant (cm) at physiological maturity stage**

| Treatment | Height (cm) | | Number of green leaves | | Stem diameter(cm) | |
|---|---|---|---|---|---|---|
| | 1974–75 | 1975–76 | 1974–75 | 1975–76 | 1974–75 | 1975–76 |
| *Varieties* | | | | | | |
| UPS–2 | 200.6 | 242.7 | 14.2 | 16.3 | 1.59 | 1.66 |
| UPS–5 | 203.1 | 244.9 | 14.3 | 16.0 | 1.51 | 1.63 |
| UPS–6 | 207.0 | 243.0 | 18.7 | 15.5 | 1.38 | 1.62 |
| UPS–8 | 207.3 | 242.8 | 14.0 | 15.7 | 1.41 | 1.62 |
| EC 68414 | 208.2 | 242.3 | 14.7 | 15.7 | 1.60 | 1.62 |
| S.Em ± | 2.8 | 3.0 | 0.5 | 0.4 | 0.03 | 0.02 |
| C.D. (P=0.05) | – | – | – | – | 0.08 | – |
| *Nitrogen rates (kg N/ha)* | | | | | | |
| 0 | 173.2 | 215.0 | 13.8 | 15.3 | 1.24 | 1.47 |
| 40 | 191.7 | 233.6 | 14.2 | 16.0 | 1.40 | 1.56 |
| 80 | 218.2 | 253.9 | 14.5 | 15.9 | 1.52 | 1.63 |
| 120 | 221.1 | 255.4 | 14.5 | 15.9 | 1.63 | 1.73 |
| 160 | 221.9 | 257.9 | 14.7 | 15.9 | 1.67 | 1.75 |
| S.Em. ± | 2.8 | 3.0 | 0.5 | 0.4 | 0.03 | 0.02 |
| C.D. (P=0.05) | 7.9 | 8.5 | – | – | 0.08 | 0.06 |

physiological maturity stage during both the years (Table 3). Variety EC 68414 accumulated maximum total dry matter which was significantly higher over UPS-6 and UPS-8. Varieties UPS-2, UPS-5 and EC 68414 were at par with each other at 4-6 leaf, bud initiation, 75 percent bloom and physiological maturity stages during 1974–75. Variety UPS-2 produced higher dry matter at physiological maturity stage during 1975–76 and par with UPS-5. At 10-12 leaf stage during 1975-76, UPS-5 produced higher dry matter was at but was at par with UPS-2 and EC 68414. Seed yield did not differ significantly among varieties (Table 3). Maximum seed yield was recorded by UPS-2 followed by EC 68414, UPS-5, UPS-8 and UPS-6. A cumulative effect of various growth parameters viz. plant height, number of green leaves, crop growth rate and dry matter production must have added to yield superiority of UPS-2 and EC 68414, of course not significantly higher than other varieties. Similar results were also recorded by Singh (1974). Singh *et al.* (1971) Patil and Vyahalkar (1975), and Reddi *et al.* (1975).

**Effect of nitrogen**

Nitrogen application influenced significantly plant height and stem diameter but number of green leaves were not influenced significantly at physiological maturity stage during both the years (Table 1). Plant height increased linearly upto 80 kg N/ha while average stem diameter increased upto 120 kg N/ha and thereafter increase was marginal. Similar results were also reported by Massey (1970); Gaur *et al.* (1973); Shariff (1973); Singh (1974) and Quadri (1975). Crop growth rate increased with increasing N rates (Table 2).

TABLE 2. Effect of varieties and nitrogen rates on crop growth rate (g/day/plant) at different growth stages

| Treatment | Growth stages | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 4-5 leaf stages | | 10-12 leaf stage | | Bud initiation | | 75 percent bloom | |
| | 1974–75 | 1975–76 | 1974–75 | 1975–76 | 1974–75 | 1975–76 | 1974–75 | 1975–76 |
| *Varieties* | | | | | | | | |
| UPS–2 | 0.070 | 0.074 | 0.58 | 0.61 | 2.78 | 3.17 | 1.44 | 1.89 |
| UPS–5 | 0.068 | 0.078 | 0.51 | 0.55 | 2.91 | 3.20 | 1.44 | 2.00 |
| UPS–6 | 0.064 | 0.069 | 0.52 | 0.61 | 2.53 | 2.89 | 1.29 | 1.81 |
| UPS–8 | 0.063 | 0.070 | 0.51 | 0.61 | 2.37 | 2.63 | 1.34 | 1.92 |
| EC 68414 | 0.065 | 0.071 | 0.60 | 0.66 | 2.63 | 3.01 | 1.65 | 1.88 |
| S.Em. ± | 0.004 | 0.002 | 0.02 | 0.02 | 0.10 | 0.09 | 0.06 | 0.08 |
| C.D. (P = 0.05) | — | — | 0.06 | 0.06 | 0.30 | 0.27 | 0.17 | — |
| *Nitrogen rates (kg N/ha)* | | | | | | | | |
| 0 | 0.047 | 0.057 | 0.31 | 0.37 | 1.94 | 2.30 | 1.04 | 1.60 |
| 40 | 0.061 | 0.067 | 0.49 | 0.56 | 2.27 | 2.57 | 1.37 | 1.93 |
| 80 | 0.072 | 0.076 | 0.60 | 0.67 | 2.91 | 3.23 | 1.54 | 2.05 |
| 120 | 0.080 | 0.081 | 0.65 | 0.70 | 2.96 | 3.32 | 1.58 | 1.98 |
| 160 | 0.070 | 0.082 | 0.67 | 0.73 | 3.14 | 3.49 | 1.63 | 1.94 |
| S.Em. ± | 0.004 | 0.002 | 0.02 | 0.02 | 0.10 | 0.09 | 0.06 | 0.08 |
| C.D. (P = 0.05) | 0.012 | 0.006 | 0.06 | 0.06 | 0.30 | 0.27 | 0.17 | 0.24 |

**TABLE 3. Effect of varieties and nitrogen rates on total dry matter (g) per plant at different growth stages and grain yield (g/ha)**

| Treatment | Growth stages | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 4-6 leaf stage | | 10–12 leaf stage | | Bud initiation | | 75 percent bloom | | Physiological maturity | | Grain yield (q/ha) | |
| | 1974–75 | 1975–76 | 1974–75 | 1975–76 | 1974–75 | 1975–76 | 1974–75 | 1975–76 | 1974–75 | 1975–76 | 1974–75 | 1975–76 |
| *Variety* | | | | | | | | | | | | |
| UPS–2 | 0.629 | 0.719 | 2.59 | 2.82 | 19.44 | 20.38 | 93.11 | 104.39 | 144.66 | 172.00 | 17.86 | 18.47 |
| UPS–5 | 0.605 | 0.711 | 2.52 | 2.88 | 18.33 | 19.95 | 95.38 | 103.82 | 143.05 | 169.29 | 17.29 | 17.89 |
| UPS–6 | 0.524 | 0.671 | 2.34 | 2.65 | 17.43 | 20.14 | 88.30 | 101.11 | 131.11 | 161.62 | 15.97 | 16.94 |
| UPS–8 | 0.556 | 0.686 | 2.36 | 2.68 | 17.42 | 20.64 | 90.01 | 101.29 | 132.46 | 161.60 | 16.91 | 17.25 |
| EC 68414 | 0.642 | 0.723 | 2.66 | 2.77 | 19.68 | 21.32 | 93.53 | 105.80 | 146.78 | 166.65 | 17.26 | 18.03 |
| S.Em. ± | 0.018 | 00.20 | 0.09 | 0.05 | 0.56 | 0.43 | 1.70 | 1.61 | 2.18 | 1.78 | 0.55 | 0.48 |
| C.D.(P=0.05) | 0.052 | — | — | 0.14 | 1.58 | — | 4.82 | — | 6.18 | 5.05 | — | — |
| *Nitrogen rates (kg N/ha)* | | | | | | | | | | | | |
| 0 | 0.482 | 0.476 | 1.81 | 2.09 | 10.18 | 12.31 | 62.82 | 74.75 | 97.20 | 127.20 | 13.56 | 14.19 |
| 40 | 0.554 | 0.615 | 2.23 | 2.48 | 16.10 | 18.28 | 80.84 | 91.34 | 124.40 | 152.65 | 15.66 | 16.11 |
| 80 | 0.605 | 0.752 | 2.63 | 2.90 | 20.58 | 22.60 | 102.26 | 112.30 | 153.07 | 179.78 | 18.67 | 18.93 |
| 120 | 0.639 | 0.842 | 2.87 | 3.10 | 22.16 | 24.01 | 105.66 | 117.75 | 159.78 | 185.33 | 18.90 | 19.50 |
| 160 | 0.675 | 0.826 | 2.92 | 3.23 | 23.28 | 25.22 | 108.75 | 120.27 | 164.44 | 186.18 | 19.05 | 19.88 |
| S.Em. ± | 0.018 | 0.020 | 0.09 | 0.05 | 0.56 | 0.43 | 1.70 | 1.66 | 2.18 | 1.78 | 0.55 | 0.48 |
| C.D. (P=0.05) | 0.052 | 0.058 | 0.26 | 0.14 | 1.58 | 1.22 | 4.82 | 4.55 | 6.18 | 5.05 | 1.45 | 1.35 |

Crop growth rate increased linearly upto 120 kg N/ha at most of the growth stages except 75 percent bloom during 1975–76 (Table 2). Total dry matter (stem, leaf, thallamus and seed) production increased linearly upto 80 and 120 kg N/ha at most of the growth stages and thereafter increase was non significant (Table 3). Shariff (1973) and Quadri (1975) also reported similar results. In general maximum dry stage during both years. The percent contribution by these plant parts to the total dry matter was 40.00, 25.27, 18.2 and 16.53, respectively (Fig. 1 and Fig .2). Seed yield per hectare increased significantly upto 80 kg N/ha during both the years and thereafter increase was marginal (Table 3). Dimancea and Budoi (1970), and Jocic (1973) also reported Similar results.

## LITERATURE CITED

CARPENTER, R.W. 1952. Nitrogen up take by wheat in relation to nitrogen content of soils. *Agron. J.* *44*(8):420–423.

DIMANCEA, S. and BUDOI, I. 1970. Investigation of the effect of chemical fertilizers on Sunflower on tne red brown forest soil of Baneasa Bucuresti. *Field Crop Abstr.* *26*(1):40.

GAUR, B.L., TOMAR, D.S. and TREHAN K.B. 1973. A note on the effect of different levels of nitrogen and phospharus on the yield of sunflower. *Ind. J. Agron.* **18**(1):109–110.

JACIC,B. 1973 Relationships among leaf area, content of some elements in plant tissues and yield of sunflower at various leves. *Field Crop Abstr.* **28**(7):389.

MASSEY, J.H. 1970. Effect of nitrogen rates and plant spacing on sunflower seed yields and other characteristics. Proceedings of fourth International Sunflower Conference, June 23–25 *1970.*

PATIL, V.D. and VYAHALKAR, G.R. 1975. Sunflower-A crop for round the year cultivation in Marathawada. *Oilseed J.* *5*(2):9–10.

QUADRI, S.J.S. 1975. Effect of rate and time of nitrogen application on the performance of sunflower (*Helianthus annuus* L.). M.Sc. thesis submitted to G.B. Pant Univ. of Agric. and Tech. Pantnagar (Nainital).

REDDI, S.G.H., REDDY, K.G. and RAO, Y.Y., 1975. Effect of seeding rates and methods of application of nitrogen on sunflower varieties. *Oilseed J.* *5*(2):15-16.

RED FORD,P.J. 1971. Growth analysis formula - their use and ause. *Crop Sci.* *7*:171–175.

SHARIFF, M.R. 1973. Effect of different rates of nitrogen application on yield and quality of sunflower under varying plant densities. M.Sc. thesis submitted to G.B. Pant Univ. Pant Univ. of Agric. & Tech., Pantnagar (Nainital).

SINGH, B. SACHAN, J.N. and SINGH, D. 1974. Advance varietal trial on promising sunflowvr strains. Ann. Report Expt. Stn., G.B. Pant Univ. of Agric. & Tech., Pantnagar (Nainital).

SINGH, R.C.P. 1974. Effect of nitrogen and phosphorus rate on yield and nutrient uptake pattern in sunflower. M.Sc. thesis submitted to G.B. Pant Univ. of Agric. & Tech., Pantnagar (Nainital)

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# INTERCROPPING OF OILSEED CROPS WITH GROUNDNUT IN DROUGHT PRONE REGION OF SEMI ARID ZONE

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**ABSTRACT**

An experiment on intercropping of sunflower, sesamum, safflower and linseed with groundnut under rainfed conditions was conducted during 1981-82, 1982-83 and 1983-84 at the Directorate of Oilseeds Research, Rajendranagar, Hyderabad. The planting patterns of different crops produced almost same yield; paired row provides more space for intercropping without any significant reduction in yield. Based on three years performance, sole crop of sunflower - regular sowing was found to be more productive, profitable, stable and sustainable as compared to other crops on red sandy soils under semi-arid conditions of Hyderabad. Its performance was best when rainfall was poor and erratic and was on par with groundnut during the year of sufficient and well distributed rainfall. Simultaneous sowing of sunflower as an intercrop in groundnut gave best yield and net return during normal rainfall year (1983-84). However, during erratic rainfall years sunflower inter-cropping in groundnut minimised the losses when groundnut alone resulted in economic loss particularly during 1981-82. Based on three years average, maximum oilseeds production and groundnut equivalent yield and gross income was recorded with groundnut + sunflower simultaneous intercropping system. However, with regard to average net return this combination was second best after sunflower as sole crop.

**Key words :** Intercropping; groundnut; sunflower; safflower; linseed; paired row.

## INTRODUCTION

The annual rainfall of Hyderabad region is 735 mm, most of which (about 90%) is received from middle of June to end of September. Moreover, rainfall is erratic and water holding capacity of red sandy loam soils is very poor (21 cm/m). Groundnut is the major crop grown under rainfed conditions in semi-arid zone in India, however, failure of rainfall during critical growth stages of crop may result in failure of crop or affect the crop yield adversely. Virginia bunch had a higher percentage of extra large kernel, SMK and total protein and market value than Spanish florigiant, Double row system increased yield and value in Virginia bunch than Spanish florigiant. (Monzingo and Coffelt, 1984).

Studies indicate that pearl millet could be planted in paired and treble rows to provide additional space for better growth of intercrop and for higher interception of solar radiation (De *et al.*, 1978). Intercropping of sorghum + pigeonpea gave 57 and 79% more gross return as compared to sole crop of sorghum and pigeonpea, respectively (Krishna Murthy *et al.*, 1978). Higher total production and LER was recorded with intercropping of groundnut and pearl millet as compared to sole crop (Reddy *et al.*, 1980). Bunch groundnut is a narrow spaced crop, hence paired row planting provides opportunity for intercropping. Sunflower is a photo-insensitive crop well adapted to a wide range of environments (Daulay *et al.*, 1974).

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The importance of crop because of its wide adaptability to various types of soils and climate, high yield potential and quality oil per unit area was also stated by Shukla, (1972).

Intercropping of sunflower in groundnut not only increase the gross income but also cover the risk of failure of groundnut crop during erratic rainfall season. Intercropping of sunflower in widely spaced groundnut (90cm) in Saurashtra region of Gujarat have been reported remunerative as compared to pure crop of groundnut (Modha, 1984). Sesamum, safflower and linseed are other crops which are worth testing as intercrops with groundnut. The present study was undertaken to study the production potential of intercropping of sunflower (*Helianthus annus* L.), sesamum (*Sesamum indicum* L.). safflower, (*Carthamus tinctorius* L.) and linseed (*Linum usitatissimum* L.) with groundnut (*Arachis hypogaea* L.) under rainfed condition.

## MATERIALS AND METHODS

The experiment was conducted at the Directorate of Oilseeds Research, Rajendranagar, Hyderabad during 1981–82, 1982–83, and 1983–84. The soil of the experimental plot was red sandy loam in texture with pH 6.7, E.C. 1.14 mmhos, poor in O.M. (1.8%), medium in available phosphorus (22 kg/ha) and potash (170 kg/ha). The experiment was carried out in randomized block design with three replications during 1982–83 and 1983–84 and four replications during 1981–82. Fifteen treatment combinations during 1981–82 and eighteen treatment combinations during 1982–83 and 1983–84 involving groundnut as main crop and sunflower, sesamum, safflower and linseed as pure and intercrops in regular and paired row sowing systems were evaluated. Varieties, recommended doses of fertiliser and spacings adopted for different crops are given in Table 1. The full dose of P and K and 20 kg of N/ha was placed uniformly at the time of sowing to all the crops and remaining nitrogen as per treatment was applied at 20–25 days after sowing. Fertiliser application to intercrops was made on the basis of plant density. The crop was sown on 9th July, 27th May and 11th July during 1981, 1982 and 1983, respectively. Need based plant protection measures were taken as and when required. Two weedings were done to maintain the field weed free i.e., first at 20-25 days after sowing and second at 40–45 days after sowing.

Rainfall and other weather parameters recorded during 1981–82, 1982–83 and 1983–84 (May to April) are given in Table 2. In general, rainfall was erratic particularly during 1981–82 and 1982–83, when drought spells of upto 20 days duration were recorded during crop season which coincided with critical crop growth stages either at crop establishment or seed development stages.

## RESULTS AND DISCUSSION

Data on pod/grain, and groundnut pods equivalent yield, gross and net income as influenced by differeut treatments are presented in Tables 3 and 4.

**TABLE 1. Different crop varieties, fertilizer dose and spacings**

| Crops | Varieties | Fertilizer (kg/ha) | | | | Spacing row to row | | Plant to plant spacing (both systems) |
|---|---|---|---|---|---|---|---|---|
| | | N Basal | N Top * dressed | $P_2O_5$ | $K_2O$ | regular sowing | paired row sowing | |
| Groundnut | TMV–2@/JL–24 | 20 | | 40 | 20 | 30 cm | 20 : 40 cm | 15 cm |
| Sesamum | Gauri | 20 | 20 | 40 | 20 | 30 cm | 20 : 40 cm | 15 cm |
| Sunflower | EC 68414 | 20 | 40 | 40 | 20 | 60 cm | 40 : 80 cm | 30 cm |
| Safflower | Manjira | 20 | 20 | 40 | 20 | 45 cm | 30 : 60 cm | 15 cm |
| Linseed | SPS–77–49–2 | 20 | 40 | 40 | 20 | 30 cm | 20 : 40 cm | 10 cm |

* Topdressing of urea was done at 20–30 days after sowing depending upon soil moisture.

@ 1981—82.

**TABLE 2. Weather parameters during the crop period.**

| Month | Rainfall (mm) | | | Rainy days | | | Temperature ($^0$C) | | | | | | Humidity (%) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1981–82 | 1982–83 | 1983–84 | 1981–82 | 1982–83 | 1983–84 | 1981–82 | | 1982–83 | | 1983–84 | | 1981–82 | 1982–83 | 1983–84 |
| | | | | | | | Max. | Min. | Max. | Min. | Max. | Min. | | | |
| May | 3.8 | 24.8 | 34.8 | 4 | 5 | 6 | 38.8 | 26.4 | 37.2 | 24.7 | 39.6 | 25.5 | 56.2 | 61.7 | 60.0 |
| June | 156.3 | 179.1 | 55.3 | 12 | 12 | 10 | 34.3 | 23.7 | 33.8 | 23.7 | 36.2 | 24.8 | 80.5 | 76.6 | 79.0 |
| July | 73.9 | 79.0 | 148.4 | 10 | 18 | 17 | 31.6 | 33.0 | 31.8 | 22.6 | 32.3 | 23.2 | 84.9 | 84.8 | 87.6 |
| August | 147.2 | 41.1 | 259.7 | 14 | 11 | 26 | 29.2 | 21.9 | 31.1 | 22.6 | 29.7 | 22.6 | 91.6 | 84.9 | 89.8 |
| September | 364.7 | 175.1 | 267.1 | 17 | 18 | 20 | 29.5 | 22.1 | 30.5 | 22.8 | 29.1 | 22.2 | 93.7 | 88.8 | 91.8 |
| October | 116.9 | 37.5 | 141.8 | 11 | 6 | 8 | 30.1 | 18.8 | 30.5 | 10.8 | 27.8 | 18.3 | 91.8 | 92.8 | 98.0 |
| November | 0.0 | 18.3 | 5.7 | 0 | 6 | 1 | 29.1 | 14.8 | 28.4 | 16.2 | 28.1 | 13.6 | 81.7 | 96.1 | 90.5 |
| December | 0.0 | 0.0 | 4.9 | 0 | 0 | 3 | 27.7 | 13.6 | 28.4 | 18.0 | 25.8 | 13.5 | 88.5 | 93.1 | 92.5 |
| January | 0.0 | 0.0 | 0.0 | 0 | 0 | 0 | 29.3 | 14.8 | 29.2 | 12.1 | 28.9 | 15.6 | 88.5 | 88.5 | 89.2 |
| February | 2.8 | 0.0 | 0.0 | 1 | 0 | 0 | 32.7 | 18.3 | 32.8 | 17.0 | 30.3 | 17.4 | 76.6 | 78.8 | 84.0 |
| March | 0.0 | 14.8 | 23.2 | 0 | 1 | 2 | 35.4 | 21.0 | 36.8 | 20.0 | 34.8 | 18.7 | 70.9 | 62.0 | 70.3 |
| April | 34.2 | 0.2 | 22.9 | 6 | 1 | 6 | 37.1 | 21.5 | 38.0 | 24.0 | 37.4 | 23.0 | 64.8 | 57.0 | 65.9 |
| Total | 889.0 | 587.9 | 963.8 | | | | | | | | | | | | |

TABLE 3. Podss/grain yield (kg/ha) as influenced by different treatments.

| Sl. No. | Treatments | 1981–82 Main crop | 1981–82 Inter crop | 1982–83 Main crop | 1982–83 Inter crop | 1983–84 Main crop | 1983–84 Inter crop | Mean of 3years Main crop | Mean of 3years Inter crop | Groundnut pods equivalent (kg/ha) 3 yrs. av. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. | GU 30 cm | 365 | — | 952 | — | 1218 | — | 845 | — | 845 |
| 2. | SU 30 cm | 158 | — | 363 | — | 43 | — | 188 | — | 333 |
| 3. | SuU 60 cm | 1499 | — | 1315 | — | 1317 | — | 1377 | — | 1003 |
| 4. | SaU 45 cm | 309 | — | 771 | — | 56 | — | 379 | — | 322 |
| 5. | LU 30 cm | — | — | 257 | — | 109 | — | 183* | — | 235 |
| 6. | GP 20 : 40 cm | 382 | — | 954 | — | 1163 | — | 833 | — | 833 |
| 7. | SP 20 : 40 cm | 164 | — | 355 | — | 44 | — | 188 | — | 333 |
| 8. | SuP 40 : 80 cm | 1583 | — | 1321 | — | 1162 | — | 1355 | — | 987 |
| 9. | SaP 30 : 60 cm | 285 | — | 724 | — | 51 | — | 353 | — | 300 |
| 10. | LP 20 : 40 cm | — | — | 261 | — | 108 | — | 185* | — | 237 |
| 11. | GP+SSi(2:1) | 235 | 145 | 846 | 264 | 1061 | 44 | 715 | 151 | 981 |
| 12. | GP+SuSi (2:1) | 153 | 1041 | 830 | 515 | 1007 | 998 | 663 | 851 | 1283 |
| 13. | GP+Su 30 DAS (2:1) | 239 | 452 | 1060 | F | 1095 | 320 | 798 | 257 | 985 |
| 14. | GP+Su 60 DAS (2:1) | 185 | F | 952 | 627 | 1086 | 249 | 734 | 292 | 947 |
| 15. | GP+Su 90 DAS (2:1) | 205 | F | 899 | 635 | 1020 | F | 708 | 212 | 862 |
| 16. | GP+Sa 75 DAS (2:1) | 190 | F | 1024 | 351 | 1063 | F | 759 | 117 | 859 |
| 17. | GP+Sa 90 DAS (2:1) | 270 | 157 | 961 | 501 | 1005 | F | 745 | 219 | 932 |
| 18. | GP+L 90 DAS (2:1) | — | — | 910 | 86 | 1054 | F | 982 | 43* | 1037 |

G = Groundnut
S = Sesamum
Su = Sunflower
Sa = Safflower
L = Linseed

U = Uniform
P = Paired
Si = Simultaneous sowing
DAS = Days after sowing
F = Failed
So = Sole crop

Rate (Rs./q)
G = 412
S = 730
Su = 300
Sa = 350
L = 530

* Crop was evaluated for 2 years.

TABLE 4. Gross and net income (Rs./ha) as influenced by different treatments.

| Sl. No. | Treatment | Gross income(Rs./ha) | | | | Net income (Rs./ha) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 1981–82 | 1982–83 | 1983–84 | Mean | 1981–82 | 1982–83 | 1983–84 | Mean |
| 1. | GU 30 cm | 1540 | 3922 | 5018 | 3481 | −1456 | 962 | 2058 | 521 |
| 2. | SU 30 cm | 1153 | 2650 | 314 | 1372 | − 617 | 880 | −1456 | − 398 |
| 3. | SuU 60 cm | 4497 | 3945 | 3951 | 4131 | 2587 | 2035 | 2041 | 2221 |
| 4. | SaU 45 cm | 1081 | 2699 | 196 | 1325 | − 869 | 749 | −1754 | − 625 |
| 5. | LU 30 cm | — | 1362 | 578 | 970 | — | − 428 | −1212 | − 820 |
| 6. | GP 20 : 40 cm | 1574 | 3930 | 4792 | 3432 | −1332 | 970 | 1832 | 472 |
| 7. | SP 20 : 40 cm | 1197 | 2592 | 321 | 1370 | − 573 | 822 | −1449 | − 400 |
| 8. | SuP 40 : 80 cm | 4749 | 3963 | 3486 | 4066 | 2839 | 2053 | 1576 | 2156 |
| 9. | SaP 30 : 60 cm | 998 | 2534 | 179 | 1237 | − 952 | 584 | −1771 | − 713 |
| 10. | LP 20 : 40 cm | — | 1383 | 572 | 978 | — | − 407 | −1218 | − 813 |
| 11. | GP+S Si (2:1) | 2019 | 5412 | 4692 | 4041 | −1546 | 1847 | 1127 | 476 |
| 12. | GP+SuSi (2:1) | 3753 | 4965 | 7143 | 5287 | − 647 | 565 | 2743 | 887 |
| 13. | GP+Su 30 DAS (2:1) | 2341 | 4367 | 5471 | 4060 | −2059 | 957 | 1071 | − 10 |
| 14. | GP+Su 60 DAS (2:1) | 762 | 5803 | 5139 | 3901 | −2648 | 1403 | 739 | − 169 |
| 15. | GP+Su 90 DAS (2:1) | 845 | 5609 | 4202 | 3552 | −2565 | 1209 | 792 | − 188 |
| 16. | GP+Sa 75 DAS (2:1) | 783 | 5447 | 4380 | 3537 | −2522 | 1317 | 1075 | − 43 |
| 17. | GP+Sa 90 DAS (2:1) | 1662 | 5713 | 4141 | 3839 | −2468 | 1583 | 836 | − 16 |
| 18. | GP+L 90 DAS (2:1) | — | 4205 | 4342 | 4274 | — | 580 | 1132 | 856 |
| C.D. | (0.05) | 590 | 1042 | 461 | — | 590 | 1042 | 461 | — |

**Planting pattern :**

The planting patterns did not influence the yield and income of different crops during all the three seasons. However, during 1983-84, regular planting of sunflower gave 154 kg more grain yield resulting in significantly more income as compared to paired row planting. While during 1981–82 paired row planting gave 84 kg more grain yield as compared to regular planting of sunflower. Since regular and paired row plantings produced more or less same groundnut pods yield during all the three crop seasons, paired rows planting pattern provides opportunity for intercropping.

**Cropping systems :**

**Yield**

Sole crop of sunflower gave consistently good performance irrespective of different rainfall pattern recorded during three crop seasons. However, best performance was recorded during 1981-82 with an average yield of 1499 kg/ha in regular sowing and 1583 kg/ha with paired row pattern. It maintained its superiority as an intercrop with groundnut (simultaneous sowing) during all the three crop seasons. Performance of other crops during first year of experimentation was poor, while during second year of experimentation, groundnut was second best crop and other crops also recorded the normal yields. During third year when sufficiant and well distributed rainfall was received, performance of groundnut and sunflower was more or less same. During 1983–84, intercropping of groundnut and sunflower (simultaneous sowing) in 2:1 ratio produced the maximum yield of 1007 kg and 998 kg/ha, respectively.

Based on three years average the total oil seed production (groundnut pods equivalent) was maximum with intercropping system of groundnut and sunflower-simultaneous sowing (1283 kg/ha). However, inclusion of sunflower as an intercrop in groundnut increased the total oilseed production, irrespective of time of planting of sunflower, as compared to sole crop of groundnut. Nikam *et al.* (1984), Singh and Singh (1977), and Desai and Goyal (1980) also reported the higher total productivity with intercropping system as compared to pure crop of sunflower.

Groundnut and sunflower grown in the ratio of 6:2 produced the highest grain (1270 kg/ha) followed by groundnut + sunflower (941 kg/ha) at Coimbatore (Anonymous, 1982). Among sole crops, maximum total oilseed production was recorded with sunflower regular sowing (1003 kg/ha).

**Gross income**

The monetary returns showed significant differences in all the three years (Table 4). During 1981–82, paired row and regular sowing of sunflower gave the gross income of Rs. 4749 and Rs. 4497/ha, respectively which did not differ significantly among themselves but differed significantly from rest of the treatments. Intercropping of groundnut and sunflower was also promising with a gross income of Rs. 3755/ha. During 1982–83, the highest gross income (Rs. 5803/ha) was recorded with intercropping of

groundnut and sunflower sown after 60 days of groundnut sowing. Among sole crops, groundnut and sunflower sown either in regular or paired row systems gave more or less same gross income. In the third year of experimentation intercropping of groundnut and sunflower-simultaneous sowing gave the maximum gross income of Rs. 7143/ha which was significantly superior to remaining treatments. Among pure crops groundnut gave significantly higher gross income over rest of the crops irrespective of method of planting The second best crop was sunflower. Linseed, sesamum and safflower did not show good performance during all the three years of experimentation. In general, intercropping of groundnut and sunflower-simultaneous sowing gave better gross income as compared to sole crop of groundnut during all the three years of experimentation. Similar results were reported by Modha (1984) wherein 81 demonstrations conducted in various villages of Rajkot district of Gujarat during 1983 gave Rs. 2430/ha gross income as compared to Rs. 1905/ha recorded with sole crop of groundnut.

**Net income**

The significant differences were recorded for net return during all the three years of experimentation. Maximum net return of Rs. 2839/ha was recroded with sole crop of sunflower paired row followed by sunflower-regurlar sowing (Rs. 2587/ha). However, none of the other crops, either sole or grown in combination could meet the cost of cultivation during first year of experimentation. During 1982–83 also sole crop of sunflower–paired row gave maximum net return of (Rs. 2053/ha) closely followed by sunflower-regular sowing Rs. 2035/ha. The next best treatment was intercropping of groundnut+sesamum-simultaneous sowing (Rs. 1847/ha). During 3rd year of experimentation (1983–84) intercropping of groundnut+sunflower-simultaneous sowing gave the maximum net return of Rs. 2743/ha which was significantly superior to rest of the tratments. Among sole crops groundnut and sunflower-regular sowing gave more or less same return followed by their paired row sowing. Based on three years average sole crop of sunflower-regular sowing gave the maximum net return of Rs. 2221/ha followed by sole crop of sunflower-paired row (Rs. 2156/ha) and intercropping of groundnut + sunflower-simultaneou sowing (Rs. 887/ha).

In general, sole crop of sunflower either regular or paired row gave more or less same yield and was observed to be more stable during all the three years of experimentation. It was observed to be the best during 1st two years of experimentation, when all the other crops gave either poor or average yield because of erratic rainfall pattern and on par with groundnut during 3rd year of experimentation when good and well distributed rainfall was recroded. During 1981–82, all the crops except safflower were sown on 9th July and thereafter a continuous drought spell of 12 days in July (21 rainless days) was recorded. The crop condition was further deteriorated due to 17 rainless days observed during August. This was coupled with outburst of diseases in groundnut (bud necrosis and leaf spot) and sesamum (powdery meldew) resulting in very poor performance of these two crops. In spite of abnormal rainfall sunflower gave best performance which indicates the suitability of sunflower under drought prone areas of semiarid region. During 1982–83, the crops were sown on 27th June. The crops

did not suffer due to moisture stress during establishment time and grain development stage. Though 20 rainless days in August were observed but all the crops produced normal yield. During 1983–84, all the *kharif* crops were sown on 11th July. The crop season of 1983–84 was best as far as the rainfall and its distribution is concerned. The crops did not suffer due to moisture stress at any stage of crop growth. The groundnut performance was best during 1983–84 as compared to 1st two years of experimentation. The performance of sunflower was also good. However, other crops did not perform well due to excess rain received during August which affected the establishment of seedlings.

Based on three years of experimentation sole crop of sunflower-regular sowing was found to be more productive, profitable, stable and sustainable as compared to other crops on red sandy soils under semi-arid conditions of Hyderabad. Similar results were recorded at Coimbatore (Anonymous, 1982). Sunflower also maintained its superiority in intercropping system of groundnut + sunflower. Based on three years average, total oilseed production, groundnut, equivalent yield and gross income was maximum with groundnut + sunflower-simultaneous sowing. This system was second best after sunflower alone as regard the net income is concerned. However, suitable variety of groundnut and its spacing for different agro-climatic condition to make this system feasible under farmers conditions is of prime importance for future studies.

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## LITERATURE CITED

ANONYMOUS 1978. Annual Progress Report. Twefth Annual Kharif Oilseeds Workshop, April 24–27, 1978 Vol. II.

ANONYMOUS 1982. Annual Progress Report. Annual Kharif Oilseeds Workshop, May 7–11, 1982.

DAULAY, M.S., SINGH, R.P. and SINGH, K.C. 1974. Sunflower – a potential crop for drylands of Rajasthan. *Indian Fmg.* 23(10):21–22.

DE, R. GUPTA, R.S., SINGH, S.P.,PAL, M., SINGH, S.N., SHARMA, S.N. and KAUSHIK, S.K. 1978. Intercropping maize, sorghum and pearl millet with short duration grain legumes. *Indian J. agric. Sci.* 46:132–140.

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

KRISHNAMURTHY Ch., CHOUDHARY ,S.L. and ANDERSON, D.T. 1978. Intercrop systems with particular reference to pigeon-pea sorghum: Present practices and new recommendation. Presented at the National Symposium on Intercropping of Pulse Crops in India, IARI, New Delhi.

MODHA, V.C., 1984. Saurashtra farmers can increase oilseed production without changing their traditional method of groundnut cultivation. SOUVENIR, Directorate of Oilseeds Research, Rajendranagar, Hyderabad 1984:13-16.

MONZINGO, R.W. and COFFELT, T.A. 1984. Row pattern and seeding rate affects on value of Virginia peanuts. *Agron. J.* 76(3):460–462.

NIKAM, S.M., PATIL, V.G. and DEOKER, A.B. 1984. Intercropping sunflower with groundnut under rainfed conditions. *J. Oilseeds Res.* **1**(1):29–36.

REDDY, M.S., FLOYD, C.N. and WILLEY, R.W. 1980. Groundnut in intercropping system. Proceedings of the International Workshop on Groundnut. October 13–17 1980, Patancheru A.P., India, pp: 133–141.

SHUKLA, H. 1972. Will sunflower win the oil race? *Intensive Agric.* **19**(3):25.

SINGH, K.C. and SINGH, R.P. 1977. Intercropping of annual grain legumes with sunflower. *Indian J. agric. Sci.* **47**(11):533–537.

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# EFFECT OF PLANT POPULATION AND FERTILITY LEVELS ON THE GROWTH AND YIELD OF SUNFLOWER

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**ABSTRACT**

Investigations carried [illegible] '5 crop seasons revealed that optimum plant population [illegible] er (*Helianthus annuus* L.) is around 1,11,111 plants pe[illegible] Apl [illegible] + 80 kg $P_2O_5$ per hectare resulted in significantl[illegible] kg N + 40 kg $P_2O_5$ or no fertilizer. At bo[illegible] + 80 kg $P_2O_5$ per hectare optimum plant [illegible] fo[illegible] was around 1,11,111 plants per ha.

Key wo[illegible] [illegible]ility levels; leaf area duration; *Helianthus*

## INTRODUC[illegible]

Sunflow[illegible] *s annuus* L.) although introduced recently has slowly settled down as an [illegible]ant crop under rainfed conditions. Due to short duration nature, photo-insens[illegible]iveness and drought tolerance characteristics this crop is gaining importance and has replaced many uneconomical traditional crops in Karnataka and Maharashtra. In a successful crop production adoption of optimum plant population and fertilizer is necessary. Many research workers have reported the effect of plant population and fertility levels on the seed yield of Sunflower (Zubriski and Zimmermann, 1974; Singh and Kaushal, 1975; Srinivas and Patil, 1977). Jones (1974) was of the opinion that sunflower compensates within a widerange of population for too thick or too thinstands by adjusting headsize, seedsize and seed number. Although location specific fertilizer doze and spacing have been recommended but the crop performance under varied plant population and fertility levels is lacking. Hence this study was initiated to understand in detail the performance of Sunflower under varied plant population and fertility levels.

## MATERIALS AND METHODS

The experiment was conducted during the *Kharif* season of 1984 and 1985 at the Main Research Station, University of Agricultural Sciences, Hebbal, Bangalore. Soil of the experimental site was sandy loam with pH of 5.6, Available nitrogen (166 kg/ha) was in the low range and available phosphorus (28.3 kg per ha) and available potash (156 kg per ha) were in the medium range.

Treatments included eight plant population levels i.e. 27,777 (60 × 60cm), 55,555 (60 × 30cm), 83,333 (60 × 20cm) 1,11,111 (45 × 20cm), 1,38,888 (45 × 17cm), 1,66,666 (45 × 13cm), 1,94,443 (30 × 17 cm) and 2,22,222 (30 × 15cm) plants per ha and three fertility levels i.e. 0 + 0 (Fo) 40 + 40 ($F_1$) and 80 + 80 ($F_2$), N + $P_2O_5$ kg

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per ha. Split plot design was adopted with plant population levels in mainplot and fertility levels in subplots. During both the seasons to facilitate germination one presowing irrigation was given, otherwise crop was raised purely under rainfed conditions. Hand pollination was undertaken on alternate days for 10 days period during flowering.

## RESULTS AND DISSCUSSION

Plant population levels significantly influenced the seed yield of sunflower (Table 1). With increase in plant population level from 27,777 per ha 1,66,666 plants per ha seed yields increased. Significantly higher seed yield was recroded at 1,38,888 per ha (1501 kg/ha) in 1984 as compared to other plant population levels but was on par with 1,66,666 plants per ha., 1,11,111 plants per ha and 83,333 plants per ha. In 1985, 1,66,666 plants per ha recordeds significantly superior seed yields (1481 kg/ha) as compared to others except 1,38,888 plants per ha and 1,11,111 plants per ha. Significantly lowest seed yield was noted at the plant population of 2,22,222 plants per ha in 1984 (1097 kg/ha), which however was on per with 1,94,443 plants per ha (1147 kg/ha). In 1985, lowest yield was noted at 27,777 plants per ha (1181 kg/ha) which was on par with 55,555 plants per ha., 1,94,442 plants per ha and 2,22,222 plants per ha. These results were in line with the reports of chidananda (1974), Srinivas and Patil (1977) and Rao and Reddy (1977).

Yield parameters like seed yield per plant, number of filled seeds per plant and 100 seed weight were higher at lower plant population, still yield realised was highest at higher plant population. This was mainly because of the very fact that the increase in yield per plant owing to increased number of seed per head and other parametere could not compensate for the loss in yield due to reduced plant population. Growth parameters like LAI and LAD were significantly higher at higher plant populations at all the stages of growth (Table 2,3). Leaf area duration at seed filling stage was maximum at closer spacings and this was one of the main growth parameters which influenced higher yields. Rawson and Turner (1983) indicated the close relationship between the total green leaf area carried by the crop at anthesis and the crop seed yield. Decrease in yield at plant populations 27,777 plants per ha and above 1,66,666 plants per ha i.e. at 1,94,443 and 2,22,222 plants per ha was mainly due to lodging. At the plant population of 27,777 plants per ha head diameter and drythalamus weight were comparatively higher as compared to other plant population levels and due to higher head weight plants lodged. At plant population of 1,94,443 and 2,22,222 plants per ha plants lodged due to weak stem and over crowding. This can be substantiated by the stem girth recorded at these plant populations where it was considerably lower compared to other plant population levels.

Application of 80 kg N + 80 kg $P_2O_5$ per ha recorded significantly higher yields over 40 kg N + 40 kg $P_2O_5$ per ha and no fertilizer. Similar results of yield variation at different fertility levels has been reported by Mukundan (1972) and Daulay and Singh (1980). Yield parameters like seed yield per plant, number of filled seeds and test weight of seeds contributed to a greater extent for increase in yields at higher fertility levels. The seed yield per plant at 80 kg N + 80 kg $P_2O_5$ per ha was higher

**TABLE 1. Seed yield and yield attributes of sunflower as influenced by plant population and fertility levels**

| Treatments | Seed yield (kg/ha) | | Number of total seeds per plant | | Percent seed filling | | Test weight (g) | | Dry thalamus weight (g/plant) | | Stem girth (cm) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1984 | 1985 | 1984 | 1985 | 1984 | 1985 | 1984 | 1985 | 1984 | 1985 | 1984 | 1985 |
| *Plant population levels per ha* | | | | | | | | | | | | |
| $P_1$ — 27,777 | 1233 | 1181 | 799 | 806 | 88.5 | 88.4 | 5.36 | 5.33 | 31.81 | 31.47 | 5.46 | 5.21 |
| $P_2$ — 55,555 | 1331 | 1254 | 567 | 565 | 86.7 | 86.5 | 5.26 | 5.27 | 25.35 | 24.29 | 5.37 | 5.30 |
| $P_3$ — 83,333 | 1392 | 1332 | 427 | 435 | 85.8 | 87.1 | 5.10 | 5.14 | 20.43 | 20.32 | 5.28 | 5.24 |
| $P_4$ — 1,11,111 | 1441 | 1409 | 345 | 345 | 85.0 | 86.0 | 4.97 | 4.94 | 16.79 | 16.38 | 4.92 | 4.93 |
| $P_5$ — 1,38,888 | 1501 | 1450 | 287 | 278 | 81.1 | 81.8 | 4.91 | 4.92 | 15.08 | 15.47 | 4.87 | 4.88 |
| $P_6$ — 1,66,666 | 1480 | 1481 | 254 | 255 | 81.2 | 81.1 | 4.81 | 4.86 | 14.03 | 14.29 | 4.63 | 4.60 |
| $P_7$ — 1,94,443 | 1147 | 1209 | 226 | 220 | 81.2 | 81.0 | 4.76 | 4.82 | 11.69 | 11.90 | 4.57 | 4.57 |
| $P_8$ — 2,22,222 | 1097 | 1204 | 225 | 219 | 82.4 | 81.4 | 4.75 | 4.82 | 11.35 | 11.80 | 4.53 | 4.55 |
| CD (P = 0.05) | 131.77 | 76.97 | 20.20 | 14.56 | 3.51 | 2.76 | 0.02 | 0.04 | 1.45 | 1.45 | 0.02 | 0.06 |
| *Fertility levels* (N + $P_2O_5$kg/ha) | | | | | | | | | | | | |
| $F_0$ — 0 + 0 | 568 | 626 | 249 | 253 | 74.6 | 74.7 | 4.09 | 4.18 | 9.64 | 9.43 | 4.44 | 4.42 |
| $F_1$ — 40 + 40 | 1609 | 1601 | 439 | 438 | 86.8 | 83.8 | 5.26 | 5.26 | 21.49 | 21.71 | 5.18 | 5.14 |
| $F_2$ — 80 + 80 | 1782 | 1717 | 485 | 481 | 90.5 | 90.2 | 5.36 | 5.39 | 23.81 | 23.58 | 5.24 | 5.24 |
| CD (P = 0.05) | 96.04 | 53.35 | 12.07 | 8.97 | 1.57 | 1.46 | 0.02 | 0.02 | 0.75 | 0.83 | 0.02 | 0.02 |

**TABLE 2. Dry matter production of sunflower as influenced by plant population and fetriltiy levels**

| Treatments | Dry Matter Production (g/lpnt) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1984 | | | | 1985 | | | |
| | I | II | III | IV | I | II | III | IV |
| *Plant population leels (Plants per ha)* | | | | | | | | |
| $P_1$ — 27,777 | 16.71 | 32.60 | 86.01 | 146.03 | 16.36 | 31.22 | 78.96 | 149.21 |
| $P_2$ — 55,555 | 15.40 | 30.79 | 73.78 | 115.09 | 15.26 | 30.31 | 73.90 | 117.55 |
| $P_3$ — 83,333 | 14.01 | 29.48 | 71.32 | 95.62 | 14.04 | 28.94 | 70.51 | 94.72 |
| $P_4$ — 1,11,111 | 12.87 | 24.70 | 61.94 | 82.04 | 12.66 | 23.86 | 61.87 | 81.74 |
| $P_5$ — 1,38,888 | 11.90 | 23.29 | 57.64 | 73.24 | 11.80 | 23.24 | 57.88 | 72.06 |
| $P_6$ — 1,66,666 | 10.14 | 21.69 | 51.30 | 67.34 | 9.97 | 21.56 | 50.26 | 67.37 |
| $P_7$ — 1,94,443 | 9.07 | 21.10 | 46.57 | 60.00 | 9.30 | 21.02 | 46.44 | 59.17 |
| $P_8$ — 2,22,222 | 9.13 | 20.45 | 44.82 | 57.11 | 9.02 | 20.86 | 44.75 | 58.45 |
| CD (P = 0.05) | 1.28 | 0.77 | 39.94 | 3.58 | 1.52 | 3.58 | 10.09 | 2.28 |
| *Fertiiity levels* (N $+_2PO_5$kg/ha) | | | | | | | | |
| $F_0$ — 0 + 0 | 8.75 | 14.97 | 39.94 | 46.48 | 8.70 | 15.57 | 40.15 | 46.25 |
| $F_1$ — 40 + 40 | 13.7 | 29.05 | 68.23 | 101.07 | 13.52 | 28.45 | 64.76 | 101.62 |
| $F_2$ — 80 + 80 | 14.75 | 31.51 | 76.86 | 112.35 | 14.69 | 31.36 | 75.54 | 111.63 |
| CD (P = 0.05) | 0.65 | 1.01 | 0.44 | 2.21 | 0.63 | 1.34 | 5.98 | 2.85 |

I = Vegetative Phase; (Sowing to 21 DAS) II = Early flowering; (22-43 DAS) III = Late flowering; (44-65 DAS) IV = Seed filling stage (65 DAS - harvest)

TABLE 3. Leaf area duration of Sunflower as influenced by plant Population and Fertility levels

| Treatments | LAD Days | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1984 | | | | 1985 | | | |
| | I | II | III | IV | I | II | III | IV |
| *Plant Population levels (Plants per ha)* | | | | | | | | |
| $P_1$ — 27,777 | 6.4 | 10.1 | 16.6 | 15.3 | 6.4 | 9.9 | 16.3 | 15.0 |
| $P_2$ — 55,555 | 12.2 | 19.4 | 32.5 | 29.9 | 12.2 | 19.3 | 32.4 | 36.0 |
| $P_3$ — 83,333 | 16.7 | 26.9 | 47.2 | 43.0 | 17.4 | 27.1 | 46.9 | 47.2 |
| $P_4$ — 1,11,111 | 20.4 | 30.8 | 56.2 | 50.0 | 20.6 | 30.0 | 35.2 | 54.5 |
| $P_5$ — 1,38,888 | 24.7 | 37.4 | 66.5 | 59.2 | 24.6 | 37.1 | 65.6 | 63.0 |
| $P_6$ — 1,66,666 | 26.6 | 41.2 | 75.7 | 66.9 | 26.5 | 40.9 | 74.4 | 65.8 |
| $P_7$ — 19,4443 | 28.1 | 44.1 | 78.7 | 69.6 | 28.0 | 43.7 | 77.9 | 68.7 |
| $P_8$ — 2,22,222 | 30.5 | 46.7 | 85.3 | 73.9 | 30.9 | 46.8 | 86.2 | 74.5 |
| CD (P = 0.05) | 0.26 | 0.31 | 0.37 | 0.32 | 0.32 | 0.43 | 0.63 | 0.49 |
| *Fertility levels* (N + $P_2O_5$ kg/ha) | | | | | | | | |
| $F_0$ — 0 + 0 | 14.3 | 22.6 | 38.6 | 36.2 | 14.2 | 22.4 | 38.5 | 37.6 |
| $F_1$ — 40 + 40 | 21.6 | 35.0 | 64.0 | 56.3 | 21.9 | 35.1 | 63.1 | 58.4 |
| $F_2$ — 80 + 80 | 26.2 | 38.6 | 69.5 | 60.4 | 26.5 | 38.3 | 68.9 | 63.3 |
| CD (P = 0.05) | 0.12 | 0.16 | 0.38 | 0.25 | 0.20 | 0.19 | 0.31 | 0.27 |

I = Vegetative phase; II = Early flowering; III = Late flowering; IV = Seed filling.

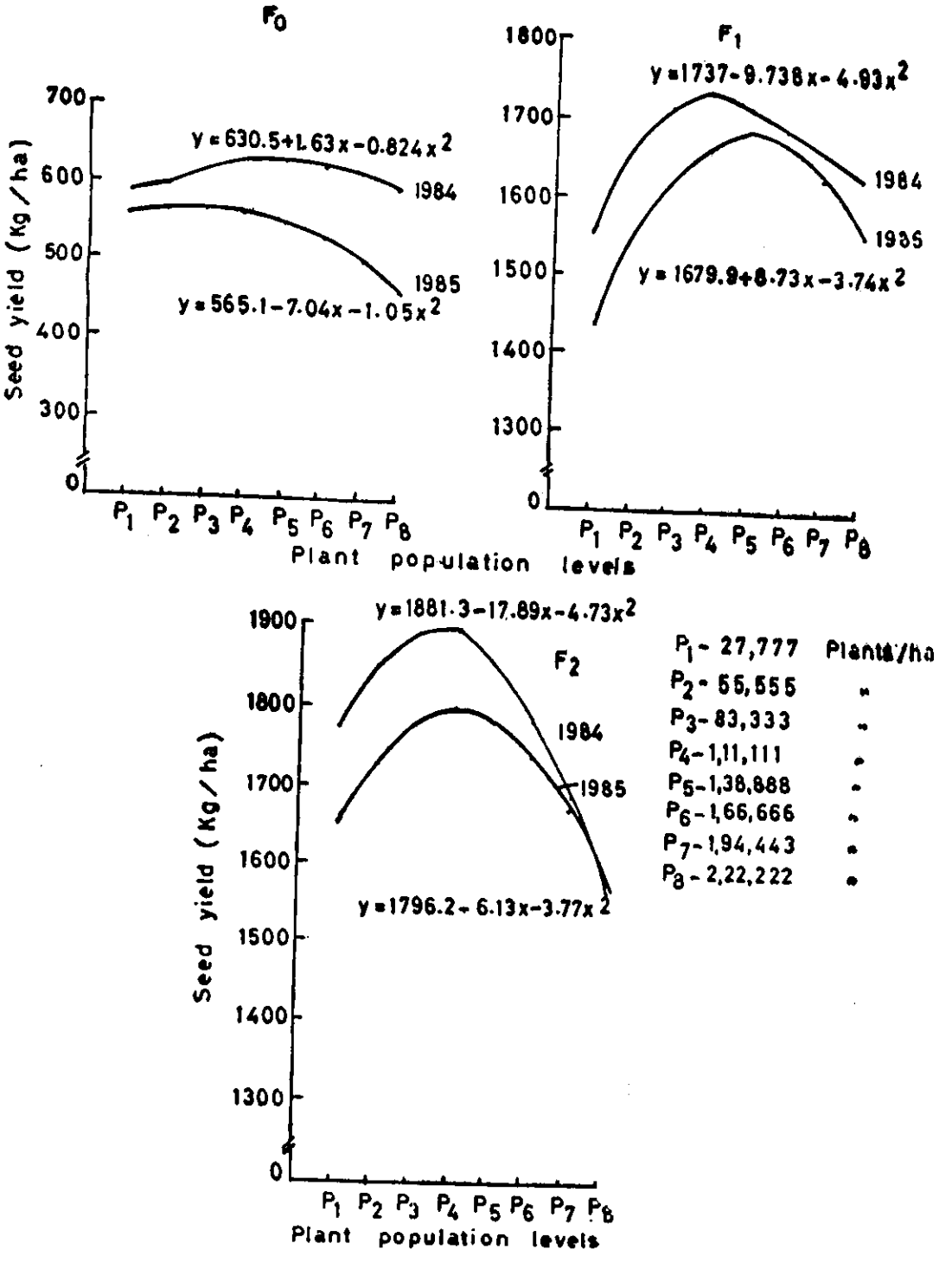


Fig. 1. Response curves showing yield of sunflower as influence by various plant population and fertility levels.

as compared to 40 kg N + 40 kg $P_2O_5$ per ha and no fertilizer. Test weight of seeds was considerably lower at no fertilizer (4.09 g in 1984 and 4.18 g in 1985) as compared to 80 kg N + 80 kg $P_2O_5$ per ha (5.36 g in 1984 and 5.39 g in 1985). Steer and Hocking (1982) opined that consequent to low nitrogen supply the percentage of seed weight that is in the kernel decreases because hull weight is already determined and remain high. At higher fertility levels growth parameters like LAI and LAD were significantly superior, which inturn helped to realise higher yield and yield parameters.

Interaction of plant population and fertility level on the seed yield of Sunflower was significant during 1985 crop season. Where significantly higher yield was recorded at 1,66,666 plants per ha and 80 kg N + 80 $P_2O_5$ per ha (1921 kg/ha) as compared to other treatment combinations except $P_5F_2$, $P_6F_1$ and $P_5F_1$. Similar results of higher yields at higher plant population and fertility levels has been reported by Srinivas and Patil (1977) and Choudhary *et al.* (1978). At plant population of 27,777 per ha and no fertilizer seed yield realised was significantly lowest (576 kg/ha).

Response curves (Fig. 1) indicated that optimum plant population for realising higher yields at both 40 kg N + 40 kg $P_2O_5$ per ha and 80 kg N + 80 kg $P_2O_5$ per ha is around 1,11,111 plants per ha.

The results of this study revealed that present day varieties/hybrids with little seed setting problem, respond to higher population under optimum fertility conditions. For all practical purpose adoption of 1,11,111 plants per ha (45 cm × 20 cm) and application of 80 kg N + 80 kg $P_2O_5$ per ha found to step up the unflower yields considerably.

## LITERATURE CITED

CHIDANANDA, G., 1974. Agronomic investigations in Sunflower (Helianthuus annus L). MSc (Agri) thesis submitted to University of Agricultural Sciences, Bangalore, India.

CHOUDHARY, C.S., MAHAJAN, A.G. and PATRUDE, T.T. 1978. Effect of plant population and fertility levels on Sunflower. *Indian. J. Agron.* **23**:153–156.

DAULAY, M.S. and SINGH, K.C. 1980. Fertilizer use in rainfed sunflower. *Indian. J. Agric. Sci.* **50**:825–828.

JONES, O.R. 1974. Yield, water use efficiency, oil concentration and quality of sunflower grown in the southern high plains. *Agron. J.* **76**:229–234.

MUKUNDAN, P. 1972. Studies on the influence of N and P on the growth and yield of two sunflower varieties. MSc (Agri) thesis submitted to Tamilnadu Agricultural University, Coimbatore, India.

RAO, N.N. and REDDY, S.N. 1982. Effect of plant density and time of application of N and P on the growth and yield of Sunflower. *Indian. J. Agron.* **27**:475–477.

RAWSON, H.M. and TURNER, N.C. 1983. Irrigation timing and relationship between leaf area and yield in Sunflower. *Irrigation. Sci.* **4**:167–175.

SINGH, P.P. and KAUSHAL, P.K. 1975. Effect of Nitrogen and phosphorus rates and spacings on yield and quality of Sunflower. *Biol. Abstr.* **38**:525.

SRINIVAS, K. and PATIL, S.V. 1977. Effect of spacing and fertility level on the growth and yield of sunflower. *Mysore J. Agric. Sci.* **11**:41–45.

STEER, B.T. and HOCKING, P.J. 1983. Leaf and floret production in Sunflower as affected by nitrogen supply. *Ann. Bot.* **52**:267–277.

ZUBRISKI, J.C. and ZIMMERMANN, D.C. 1974. Effect of nitrogen, phosphorus and plant density on Sunflower. *Agron. J.* **66** 78–780.

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# YIELD RESPONSE OF SESAME CULTIVARS TO GROWING SEASON AND POPULATION DENSITY

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## ABSTRACT

Six sesame (*Sesamum indicum*L.) cultivars varying in maturity period were compared in a field experiment for their response to three seasons (post-monsoon, monsoon and summer) and three population densities (16, 33 and 66 plants $m^{-2}$). The interaction effects of cultivar × population density, cultivar × season and season × population density were also studied. Cultivars NP-6, T-12 and TMV-3 required 66 plants $m^{-2}$ whereas cvs Gowri and Madhavi required 33 plants $m^{-2}$ for maximum grain yield. However, cv Patan-64 which was a non-branching type did not respond to the population densities. The percentage of yield contribution in the main stem increased with increase in population density in all cvs except in Patan-64. The variations in grain yield did not follow the trend of no. of capsules $m^{-2}$. Population density had no influence on the number of seeds per capsule and seed size, but the higher density decreased the capsule size. Maximum yield was recorded during summer season in all six cvs. Cv TMV-3 seems to be highly adapted to low temperature (post-monsoon season) as far as grain yield is concerned. During summer the yield contribution by the main stem was far superior to that of branches. In general the six cvs showed better seed size when grown during post-monsoon season indicating the importance of low temperature for seed filling. The grain yield increased with increase in population density. The yield contribution by the main stem also increased with increase in population density during the three seasons. The increase in total grain yield was attributed to the total number of plants per unit area at higher population density. The number of capsules $m^{-2}$ was markedly reduced during monsoon season at 16 and 33 plants $m^{-2}$.

**Key words :** Sesame; population density; seasons; grain yield; yield components; *Sesamum indicum.*

## INTRODUCTION

Large number of cultivars of sesame (*Sesamum indicum* L.) has been released by plant breeders to suit various agro-climatic regions of India. It has been observed that the average yield of this crop is ranging from 350 to 770 kg $ha^{-1}$ (Narayanan and Reddy, 1982). Sesame is basically a short day plant. Early maturing cultivars of this crop are less sensitive to day length than late ones. Therefore, most of the released cultivars are early duration ones which are generally grown during monsoon, post-monsoon and summer seasons in India. However, cultivars respond differently to these seasons during which the photoperiod and temperature vary considerably. These two factors generally affect the vegetative growth, flowering time and also the grain yield. Therefore, it becomes necessary to find out the cultivar suitable for a particular season and also the optimum population density required for each cultivar. Based on this objective the present study was initiated to compare six cultivars varying in maturity period in response to the three growing seasons and three population densities. The main effects due to these factors have been already reported (Narayan and Narayanan

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1984). In the present paper we report the interaction effects of cultivar and population density, cultivar and season and season and population density.

## MATERIALS AND METHODS

A field experiment was carried out at the Commercial Farm of College of Agriculture, Hyderabad (17° 19′ N; 79° 23′ E) India from 1979 to 1980. Six cultivars of sesame, Paten-64, Madhavi, Gowri, NP-6, T-12 and TMV-3 were sown in Alfisol in a randomized block design with four replications. The plot size was 5 m × 4 m. A basal application of 30 kg N $ha^{-1}$ as single super phosphate was given.

Three population densities of 16, 33 and 66 plants $m^{-1}$ (PD 1, PD 2 and PD 3) were tested by giving a row to row spacing of 30 cm. The experiment was conducted during the post-monsoon, summer, and monsoon seasons and the planting dates were November 6, 1979, February 19, 1980 and July 6, 1980 respectively.

The management practices and yield analysis were carried out as described by Narayan and Narayanan (1984). The average meteorological data for the three seasons are given in Table 1.

**TABLE 1. Meteorological data during the growth period of sesame**

| Seasons | Temperature (oC) | | Relative humidity(%) (at 1414 h) | Sunshine (h) | Total rain fall (mm) |
|---|---|---|---|---|---|
| | Maximum | Minimum | | | |
| Post-monsoon | 29.1 | 16.1 | 43 | 9.1 | 28.0 |
| Summer | 37.2 | 23.0 | 24 | 9.3 | 44.7 |
| Monsoon | 30.5 | 22.0 | 61 | 4.8 | 249.1 |

## RESULTS AND DISCUSSION

### Meteorological Data

The difference between maximum and minimum temperatures among seasons was considerable (Table 1). The temperature differences between post-monsoon and summer seasons were 13° to 14.2°C whereas for monsoon season it was only 8.5°C. The relative humidity was lowest for summer season and the sunshine hours were only 4.8 for monsoon season. Maximum rainfall was received during monsoon season. The very low sunshine hours or more hours of cloudiness and high rainfall were the environmental factors which caused the incidence of diseases and pests during monsoon season.

**TABLE 2. Response of sesame cultivars to growing seasons for yield components**

| Cultivar | SEASONS | | |
|---|---|---|---|
| | Post-monsoon | Summer | Monsoon |
| | *Number of capsules* $m^{-2}$ | | |
| Patan–64 | 360 | 413 | 250 |
| Madhavi | 429 | 435 | 359 |
| Gowri | 479 | 436 | 349 |
| NP–6 | 351 | 523 | 248 |
| T–12 | 485 | 511 | 235 |
| TMV–3 | 735 | 501 | 442 |
| LSD (0.05) 118 | | | |
| | *Number of seeds per capsule* | | |
| Patan–64 | 15.2 | 41.3 | 7.9 |
| Madhavi | 20.8 | 47.5 | 22.3 |
| Gowri | 17.9 | 43.8 | 11.6 |
| NP–6 | 15.7 | 35.9 | 10.6 |
| T–12 | 19.8 | 37.8 | 6.6 |
| TMV–3 | 27.2 | 42.3 | 18.6 |
| | *Seed size* (g 100 $ml^{-1}$) | | |
| Patan–64 | 61.3 | 60.6 | 59.6 |
| Madhavi | 62.4 | 61.4 | 61.2 |
| Gowri | 63.7 | 61.6 | 60.0 |
| NP–6 | 63.2 | 59.0 | 59.0 |
| T–12 | 62.0 | 59.8 | 59.7 |
| TMV–3 | 62.3 | 60.3 | 59.2 |
| LSD (0.05) 1.4 | | | |
| | Capsule size (mg capsule$^{-1}$) | | |
| Patan–64 | 195 | 290 | 208 |
| Madhavi | 133 | 214 | 148 |
| Gowri | 139 | 236 | 141 |
| NP–6 | 136 | 238 | 168 |
| T–12 | 194 | 267 | 164 |
| TMV–3 | 164 | 259 | 145 |
| LSD (0.05) 17 | | | |

## Population densities and cultivars

Grain yield of sesame was shown to increase in general as the population density was increased (Mazzani and Cobo, 1956; Mazzani, 1964; Narayan and Narayanan 1984). Such relationship is governed by the nature of genotypes to withstand the crop competition. Thus cultivars having non-branching, less brnaching or more-branching habit differ in their response to higher population densities. The grain yield of cultivars varied considerably with reference to the three population densities tested (Fig. 1A). The population densities did not bring about a change in yield for cv Patan-64. Because of its non-branching nature cv Patan-64 becomes a non-plastic type. Mazzani (1964) also arrived at similar conclusion in his studies with sesame. The grain yield was significantly higher for PD 3 for other cvs but it was not so between PD 1 and PD 2 in the case of cvs Gowri, NP-6, T-12 and TMV-3. However cv Madhavi gave significantly

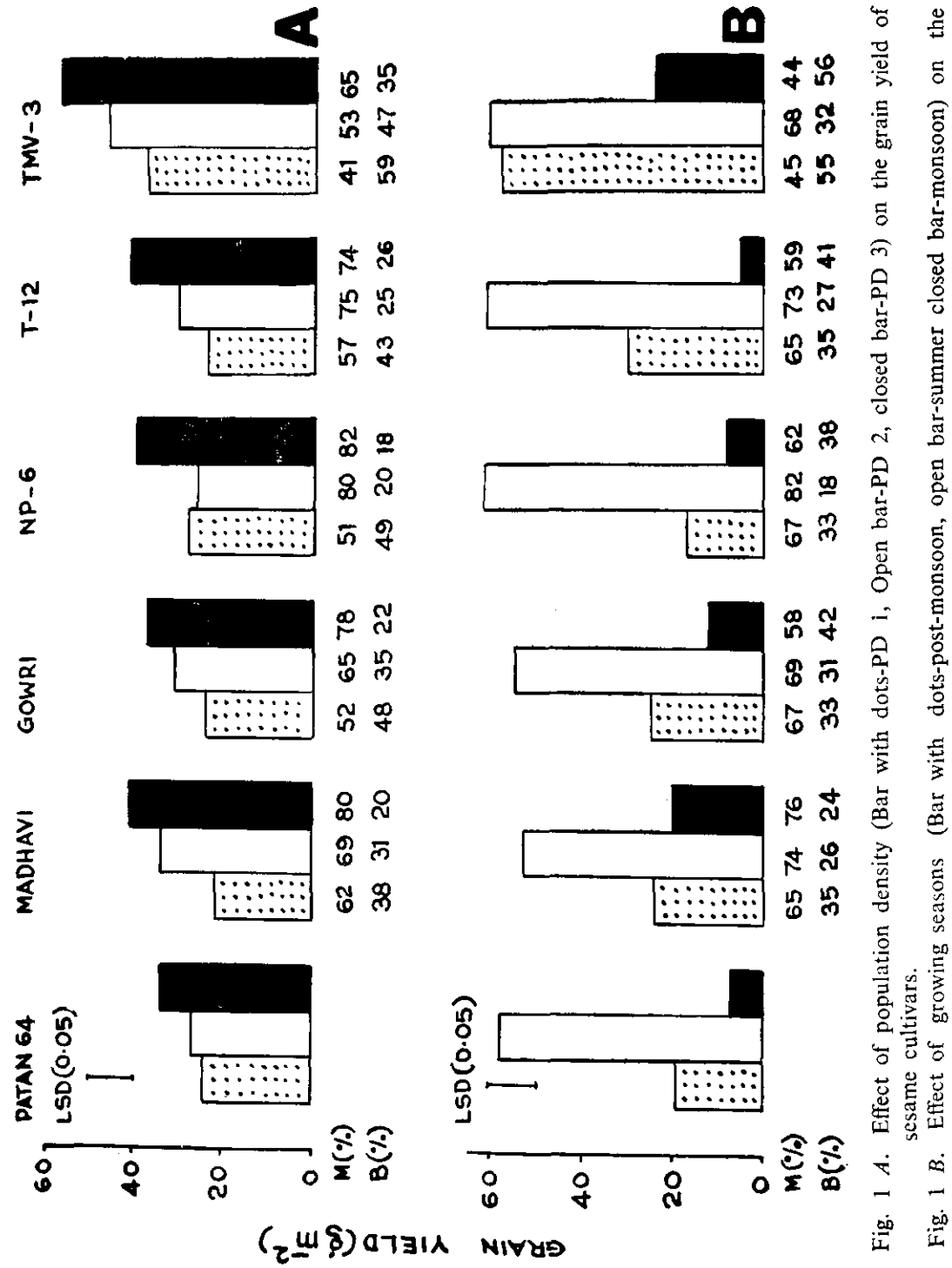


Fig. 1 *A*. Effect of population density (Bar with dots-PD 1, Open bar-PD 2, closed bar-PD 3) on the grain yield of sesame cultivars.

Fig. 1 *B*. Effect of growing seasons (Bar with dots-post-monsoon, open bar-summer closed bar-monsoon) on the grain yield of sesame cultivars.

more yield even at PD 2 and PD 1. Therefore, it is evident that cvs NP-6, T-12 and TMV-3 require 66 plants $m^{-2}$, cvs Gowri and Madhavi require 33 plants $m^{-2}$ for producing maximum grain yield.

The grain yield contribution by the main stem at PD 3 was the lowest (65%) for cv TMV-3 whereas it was ranging from 74 to 82% for others. It was chiefly because of the profuse branching nature which is evident both from branch contribution and the large number of branches per plant (Narayan, 1983).

The percentage of yleid contribution in the main stem increased with increase in population density in all cvs except in Patan-64 where the yield contribution was entirely from the main stem obviously because of the number of plants. A reverse trend of yield contributed by branches was observed with increases in population density as a result of suppression of branches which was caused by inter-plant competition especially for light.

The number of capsules is the major yield component in sesame. This component increased with increase in population density. The increase was significant between PD 1 and PD 3 in all cvs but between PD 2 and PD 3 all cvs except Patan-64 showed significant difference. The capsule number did not vary between PD1 and PD 2 in cvs Patan-64, Gowri and T-12. However the variations in grain yield due to increase in population density did not follow the trend of number of capsules $m^{-2}$. Therefore, it is possible that the influence would have been due to the number of seeds per capsule or the seed size. Cv Patan-64 did not respond to the population densities for grain yield between PD 1 and PD 3 but the capsule number $m^{-2}$ was significantly more for PD 3. It might be due to the less number of seeds per capsule of this cv at PD 3. The yield increase between PD 2 and PD 3 in cvs NP-6, T-12 and TMV-3 is mainly due to the significant increase in capsule number $m^{-2}$, however this relationship did not hold good for cvs Madhavi and Gowri.

The population density had not much influence on the number of seeds per capsule and the seed size but it was shown that higher density decreased the capsule size (Table 3). It may be attributed to interplant competition resulting in reducing the size of capsules.

**Seasons and cultivars**

Maximum grain yield was obtained during summer season in all cultivars (Fig. 1 B). However, the yield did not vary among cultivars in this season. The yield of cv TMV-3 was not significantly different between post-monsoon and summer seasons. Similarly the yield of cvs Madhavi and NP-6 did not significantly differ between post-monsoon and monsoon seasons. Thus cv TMV-3 was able to yield maximum during post-monsoon season as in summer whereas other cvs were not satisfactorily yielded during the post-monsoon season. It might be due to the response of these cvs to low temperature regimes existed during their growth period (Table 1). Cv TMV-3 seems to be highly tolerant to low temperature as yield is concerned.

**TABLE 3. Response of sesame cultivars to population densities for yield components**

| Cultivars | Population density (plants $m^{-2}$) | | |
|---|---|---|---|
| | 16 | 33 | 66 |
| | *Number of capsules* $m^{-2}$ | | |
| Patan–64 | 247 | 341 | 435 |
| Madhavi | 272 | 408 | 543 |
| Gowri | 337 | 398 | 529 |
| NP–6 | 239 | 387 | 495 |
| T–12 | 276 | 359 | 596 |
| TMV–3 | 432 | 561 | 685 |
| LSD (0.05) 107 | | | |
| | *Number of seeds per capsule* | | |
| Patan–64 | 24.5 | 20.4 | 19.5 |
| Madhavi | 29.1 | 31.4 | 30.2 |
| Gowri | 24.1 | 25.4 | 24.9 |
| NP–6 | 21.9 | 18.6 | 22.0 |
| T–12 | 21.9 | 22.6 | 19.8 |
| TMV–3 | 30.8 | 27.7 | 29.6 |
| | *Seed size* (g 100 $ml^{-1}$) | | |
| Patan–64 | 59.3 | 61.6 | 60.6 |
| Madhavi | 61.7 | 61.7 | 61.6 |
| Gowri | 61.5 | 61.3 | 62.6 |
| NP–6 | 60.1 | 60.4 | 60.7 |
| T–12 | 60.8 | 60.9 | 59.7 |
| TMV–3 | 61.0 | 60.4 | 60.6 |
| LSD (0.05) 1.4 | | | |
| | *Capsule size* (*mg capsule*$^{-1}$) | | |
| Patan–64 | 241 | 245 | 206 |
| Madhavi | 174 | 134 | 156 |
| Gowri | 188 | 171 | 167 |
| NP–6 | 191 | 178 | 176 |
| T–12 | 216 | 207 | 200 |
| TMV–3 | 202 | 188 | 177 |
| LSD (0.05) 14 | | | |

The main stem contribution to yield was high during summer for cvs NP-6, T-12 and TMV-3. Although the yield contribution by branches was quite high during monsoon season for cvs Gowri, NP-6, T-12 and TMV-3, it did not reflect on the total yield. During summer the yield contribution by the main stem was far superior to that of the branches.

The number of capsules $m^{-2}$ did not vary significantly among cvs during summer (Table 2). Cultivar TMV-3 produced maximum number of capsules during post-monsoon season which was significantly more than that of summer season but the grain yield was same for both seasons.It might be due to the lower seed number per capsule during post-monsoon season as compared with the summer season. Similarly the yield difference of cv Patan-64 was significant between post-monsoon and summer season but the capsule number was not significant which also was due to the lower number of seeds per capsule during post monsoon season.

Although the number of capsules $m^{-2}$ was not significantly different between monsoon and summer for cvs Madhavi, Gowri and TMV-3, the yield was considerably low during monsoon season because of the very less number of seeds per capsule during monsoon season.

The response of cvs to the three seasons for seed size was quite varying. All cvs showed in general a better seed size when grown in post-monsoon season which obviously indicates that sesame requires cooler temperature for seed filling. Cvs TMV-3, T-12, NP-6 and Gowri showed a significant increase in seed size during post-monsoon whereas Patan-64 and Madhavi did not show the changes in seed size due to seasons. As indicated earlier the monsoon crop was affected to an appreciable extent by disease and pests which may be one of the major reasons for the reduction in capsule size during this season However the capsule size of cvs Patan-64 and Gowri, did not differ between monsoon and post-monsoon season. Other cvs except Madhavi and NP-6 produced bigger capsules during monsoon season. The reasons for such an effect are not known.

**Seasons and population densities**

The grain yield of sesame is influenced by seasons at three population densities (Fig. 2). Maximum yield was recorded in all three population densities during summer followed by post-monsoon and monsoon seasons. The yield increased with increase in

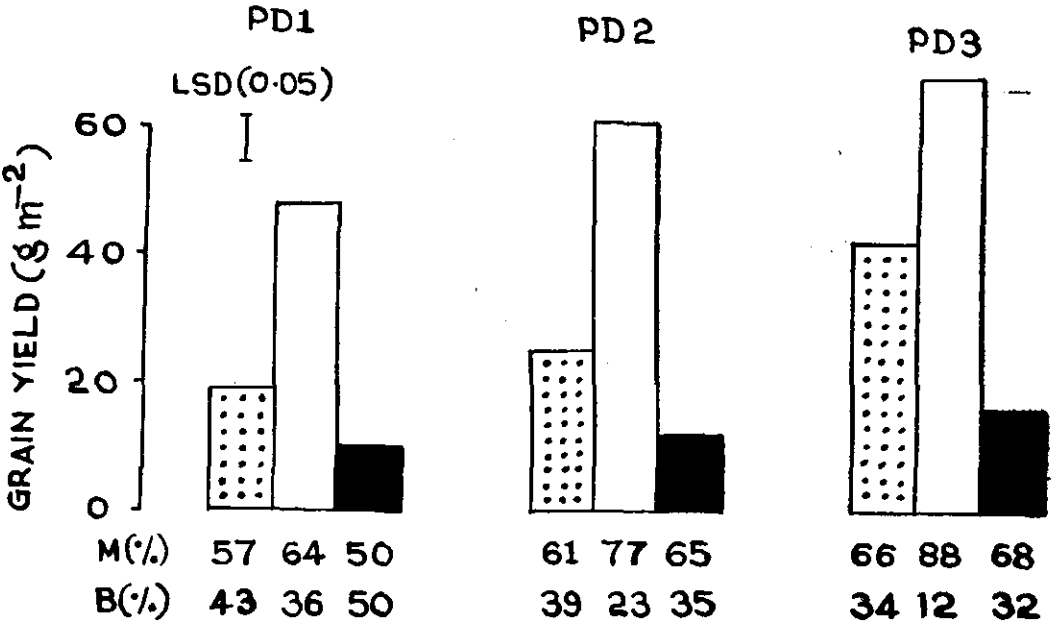


Fig. 2. Effect of growing seasons (Bar with dots-post-monsoon; open bar - summer closed bar-monsoon) on the grain yield of sesame.

population density. The yield contribution by the main stem also increased with increase in population density during all three seasons whereas the contribution by branches showed a reverse trend. During summer the main stem contribution of yield was greatest at three population densities. It brings out the fact that at high plants population the branching is suppressed because of aerial competition for light and thus the contri bution by branches is considerably reduced. The increase in total yield can thus be attributed to the total number of plants per unit area at higher population density.

The number of capsules $m^{-2}$ did not differ significantly between post-monsoon and summer seasons at 16 and 33 plants $m^{-2}$ but the number of capsules was markedly reduced during monsoon season (Table 4), but 66 plants $m^{-2}$ produced significantl higher number of capsules $m^{-2}$ than in summer which was followed by monsoon season. Although the number of capsules was lesser in summer season as compared with post-monsoon season the grain yield was more during summer at PD2 which was evidently due to the very big capsule size and number of seeds per capsule, which reflects highly on the grain yield obtained during the three seasons. However the seed size increased markedly for the post-monsoon crop at all levels of population. The capsule size was decreased by the PD3 treatment during summer, however at all population densities the capsule size was maximum as compared to that of other two seasons.

**TABLE 4. Effect of seasons on population density with reference to yield components of sesame**

| Population density (Plants $m^{-2}$) | Seasons | | |
|---|---|---|---|
| | Post-monsoon | Summer | Monsoon |
| | | *Number of capsules $m^{-2}$* | |
| 16 | 322 | 372 | 208 |
| 33 | 428 | 492 | 307 |
| 66 | 670 | 546 | 426 |
| **LSD (0.05) 83** | | | |
| | | *Number of seeds per capsule* | |
| 16 | 19.0 | 42.7 | 14.2 |
| 33 | 19.0 | 40.8 | 12.7 |
| 66 | 20.4 | 40.7 | 11.9 |
| | | *Seed size (g 100 $ml^{-1}$)* | |
| 16 | 62.4 | 60.0 | 59.8 |
| 33 | 62.8 | 60.8 | 59.5 |
| 66 | 62.3 | 60.6 | 60.0 |
| **LSD (0.05) 1.0** | | | |
| | | *Capsule size (Mg capsule$^{-1}$)* | |
| 16 | 166 | 260 | 166 |
| 33 | 150 | 249 | 159 |
| 66 | 148 | 132 | 147 |
| LSD (0.05) 12 | | | |

## LITERATURE CITED

MAZZANI, B. and COBO, M. Effect of different spacings on some characteristics of branched varie ties of sesame, *Agronomia Trop. Venuzuela* 6:3–14.

MAZZANI, B. 1964. Sesamum improvement in Venezuela. *Oleagineux* 19:775–782

NARAYANAN, A. and *Balakrishna Reddy, K.* 1982. Growth, development and yield of sesame (*Sesamum indicum* L.) cultivars. *Field Crops Res.* 5:217–224.

NARAYAN, V. 1983. Physiological basis of yield variations in sesame (*Sesamum indicum* L.). Ph.D. Thesis, Andhra Pradesh Agricultural University, Hyderabad.

NARAYAN, V. and NARAYANAN, A. 1987. Yield variations caused by cultivar, season and population density of *Sesamum* L. *indicum J. Oilseeds Res.* 4:19–27.

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# EFFECT OF IRRIGATION AND FERTILIZATION ON YIELD AND ECONOMICS OF INDIAN MUSTARD

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ABSTRACT

A field experiment conducted during rabi 1983–84 and 1984–85 on sandy loam soil with low fertility status to study the effect of irrigation and NP fertilization on the yield of Indian mustard (*Brassica juincea* (L) (zern. & Coss.) revealed that irrigation at 0.6 IW/CPE and 0.3 IW/CPE produced 17.9 and 16.4 q/ha while the unirrigated treatment gave 15 q/ha seed. Application of nitrogen and phosphorus increased the yield linearly upto 80 kg N and 30 kg P per ha respectively. The response to phosphorus was linear in unirrigated condition as well as at 0.6 IW/CPE whereas it was quadratic when irrigation was applied at 0.3 IW/CPE. The economic dose being 18.5 kg P/ha. The highest cost benefit ratio was obtained when 80 Kg N + 30 kg P/ha was given with irrigation at 0.6 IW/CPE.

**Key words** : Irrigation; fertilizer; *Brassica juncea*

## INTRODUCTION

The fertilization and irrigation cause great variation on yield of mustard (*Brassica juncea* (L) Czern & Coss). The positive response of mustard to nitrogen fertilization has been reported by many workers (Jana, 1963; Vidhyapathi roy *et al.*, 1981; Singh and Rathi 1985). Similarly, the importance of phosphorus fertilization to *Brassica* has been emphasised by Pathak *et. al.* 1963 and Vir and Verma 1981. Scheduling irrigation at 0.4 to 0.6 IW/CPE proved beneficial in mustard (Khan and Agarwal 1985). Keeping in view, the importance of fertilization and irrigation, the present investigation was undertaken to study the effect of irrigation, nitrogen and phosphorus fertilization on yield, its attributes and economics of the Indian mustard.

## MATERIALS AND METHODS

A field experiment was conducted during *rabi* seasons of 1983–84 and 1984–85 at the Research Farm of the Division of Agronomy, Indian Agricultural Research Institute, New Delhi. The soils were sandy loam having a pH 7.6, low in organic carbon (0.42%), low in total nitrogen (0.045%), low in available phosphorus (7.6 kg/ha) and medium in potash (160 kg/ha). The depth of ground water table from the soil surface was below 2 meters during both the years.

The experiment was laid out in split-plot design with irrigation and nitrogen allocated to main plot and phosphorus levels in sub-plots. There were three irrigation treatments (No irrigation, irrigation at 0.3 IW/CPE, and irrigation at (0.6 IW/CPE), three nitrogen doses (0,40 and 80 kg N/ha) and three phosphorus levels (0,15 and 30 kg P/ha). The plot size was 4.05 m × 3.60 m. The mustard seeds (Var. Pusa bold) were sown in 29th and 20th October in 1983 and 1984, respectively in rows 45 cm apart and plant to plant spacing of 15 cm was maintained by thinning done at 15 days after sowing.

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A basal application of 40 kg $K_2O$/ha and the entire N and P as per treatment were applied at sowing. Irrigations were given based on the evaporation from USWB Class 'A' pan. One and three irrigations were applied in treatments 0.3 IW/CPE and 0.6 IW/CPE ratio, respectively. The low temperature comparatively high humid conditions prevailed during 1983–84 with a meagre rainfall of 10.6 mm. The weather during 1984–85 was fairly dry. While in 1983–84 the crop received 4.2 mm rain at flowering and 6.4 mm rain at pod development stages, as a result of which it increased the yield. Due to 41.6 mm rain during second week of October in 1983–84, the crop was sown without presowing irrigation while the crop sown during 1984–85 received one presowing irrigation. Response curves were fitted using orthogonal polynomials by the method of least square. The optimum economic dose was worked out for quadratic response curve. The economics of fertilization computed based on the prevailing prices for each of the items of cost of cultivation. The market price for mustard seed was Rs. 455.00 per quintal and Rs. 400.00 per quintal during 1983–84 and 1984–85 respectively. The selling price for the stalk was Rs. 5.00 per quintal during both the years.

## RESULTS AND DISCUSSION

### Effect of nitrogen :

Application of nitrogen favourably influenced the growth and yield attributes of mustard during both the seasons (Table 1).

The plant height, number of primary branches/plant increased upto 80 kg N/ha, although differences between 40 and 80 kg N/ha were not significant except for plant height in 1983-84. There was significant increase in number of secondary branches with successive dose of N applied.

The number of siliquae/plant increased upto 80 kg N/ha during 1983–84. However, the differences between 40 kg and 80 kg N/ha were not significant. During 1984-85, each successive dose of nitrogen significantly increased the number of siliquae/plant. Likewise, the weight of seed/plant was significantly higher than those in control treatment, but the increase due to 80 kg/ha was not significant over 40 kg N/ha in any of the two seasons. Increase in yield attributes was due to high levels of N fertilization resulting in adequate supply of photosynthates for the formation of branches, siliquae and development of seeds (Gangwar and Kumar, 1986).

All these yield attributes reflected on the total seed yield and the effect of nitrogen application was well marked. The response to nitrogen was linear each year as evident from the response equation (Table 2). These results are in confirmity with the findings of Jana (1963), Vidyapathi roy *et al.* (1981) and Singh and Rathi (1985) who obtained nitrogen response beyond 80 kg N/ha.

### Effect of phosphorus :

The plant height in 1984–85 and the number of secondary branches/plant during both the seasons showed significantly higher values only at 30 kg P/ha over no phos-

phorus. Although there was a clear trend of increase in the number of siliquae/plant with the increase in the levels of phosphorus from 0 to 30 kg P/ha, only the higher dose i.e., 30 kg P/ha proved to be significantly superior to control and the increase due to 30 kg P/ha over 15 kg P/ha did not reach the significance level in both the years (Table1).

The maximum seed weight/plant recorded was 13.8 g and 12.7 g in 1983–84 and 1984–85 respectively against 30 kg P/ha. Under control the seed weight/plant was very low in the corresponding years. In either of the two characters studied, the differences due to levels of phosphorus were significant.

Due to marked response of phosphorus on the above yield attributes there was beneficial effect on seed yield due to phosphorus application.

The beneficial effect of phosphorus on seed yield is also reported by Pathak *et. al.* (1963), Mudholkar and Ahlawat (1981) upto 80 kg $P_2O_5$/ha.

**Effect of nitrogen and phosphorus**

The significant interaction between nitrogen and phosphorus showed that the response to nitrogen was higher with the application of 30 kg P/ha (Table 3). The response at 80 kg N/ha was almost the same at lower levels of P i.e. 15 kg/ha and control. The response equation for phosphorus at various levels of nitrogen indicated that the effect of phosphorus was well marked in the presence of nitrogen. The magni tude of response to P was higher at higher levels of N and yields were almost doubled with combination of 80 kg N + 30 kg P/ha as compared to 30 kg P/ha alone. Therefore, application of N and P in adequate quantities is essential to increase the mustard yields. The importance of balanced fertilization in mustard is also emphasised by Pathak *et al.* (1963) and Tomar *et al.* (1980).

**Effect of moisture**

The differences in seed yield due to moisture regimes were significant in 1983-84 only. Irrigation at 0.6 IW/CPE produced significantly higher yield over no irrigation, but the difference in seed yield between 0.3 IW/CPE and 0.6 IW/CPE was not significant. Similarly, the difference in yield between 0.3 IW/CPE over no irrigation treatment was also not significant. It was the combined effect of increased number of siliqua/plant, number of seeds/siliqua and seed yield/plant which resulted in higher seed yield under irrigation. One irrigation at 0.3 IW/CPE, which coincided with siliqua formation stage, was found critical for moisture. Thus, irrigation at this stage mainly increased the siliqua size and seed size boosting total seed yield. Emphasis of one irrigation at 0.4 IW/CPE for economically higher yield was also advocated by Khan and Agarwal (1985) as, at this moisture regime, water use efficiency also increased to a greater extent.

**Effect of phosphorus and moisture**

The interaction of phosphorus and moisture regimes was significant during 1984-85

**TABLE 1. Influence of irrigation, nitrogen and phosphorus fertilization on growth, yield attributes and seed yield of mustard**

| Treatments | Plant height(cm) | | Number of branches/plant | | | | Number of siliquae/plant | | Weight of seeds/plant | | Seed yield (q/ha) | | Pooled |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1983–84 | 1984–85 | 1983–84 | | 1984–85 | | 1983–84 | 1984–85 | 1983–84 | 1984–85 | 1983–84 | 1984–85 | |
| | | | P | S | P | S | | | | | | | |
| *Irrigation levels* | | | | | | | | | | | | | |
| No Irrigation | 171 | 147 | 4.1 | 5.8 | 4.5 | 6.4 | 153 | 154 | 9.6 | 9.7 | 18.3 | 11.8 | 15.0 |
| Irrigation at 0.3 IW/CPE | 174 | 150 | 4.2 | 6.4 | 4.8 | 6.6 | 184 | 156 | 13.1 | 10.5 | 20.0 | 12.7 | 16.4 |
| Irrigation at 0.6 IW/CPE | 179 | 149 | 4.7 | 7.6 | 5.1 | 9.6 | 195 | 184 | 15.2 | 12.7 | 21.6 | 14.2 | 17.9 |
| C.D at P = 0.05 | 5.56 | NS | NS | 1.39 | NS | 1.19 | 32.46 | NS | 2.69 | 1.73 | 2.33 | NS | 1.98 |
| *Nitrogen levels (kg/ha)* | | | | | | | | | | | | | |
| 0 | 160 | 126 | 3.7 | 4.6 | 4.2 | 4.3 | 118 | 92 | 8.2 | 6.4 | 14.2 | 8.0 | 11.1 |
| 40 | 178 | 160 | 4.6 | 6.5 | 5.1 | 8.8 | 192 | 185 | 13.6 | 12.7 | 19.7 | 13.6 | 16.6 |
| 80 | 186 | 160 | 4.8 | 8.7 | 5.2 | 9.5 | 222 | 217 | 16.1 | 13.9 | 26.0 | 17.1 | 21.6 |
| C.D at P = 0.05 | 5.56 | 7.92 | 0.74 | 1.39 | 0.66 | 1.19 | 32.46 | 28.68 | 2.69 | 1.73 | 2.33 | 2.85 | 1.98 |
| *Phosphorus levels (kg/ha)* | | | | | | | | | | | | | |
| 0 | 172 | 143 | 4.3 | 6.0 | 4.9 | 6.2 | 166 | 147 | 11.5 | 9.8 | 19.3 | 11.3 | 15.3 |
| 15 | 176 | 152 | 4.4 | 6.6 | 4.8 | 7.5 | 176 | 160 | 12.7 | 10.5 | 19.1 | 12.9 | 16.0 |
| 30 | 177 | 151 | 4.3 | 7.2 | 4.8 | 8.9 | 190 | 187 | 13.8 | 12.7 | 21.5 | 14.5 | 18.0 |
| C.D at P = 0.05 | NS | 5.48 | NS | 0.36 | NS | 2.29 | 16.13 | 18.15 | 1.36 | 1.13 | 1.91 | 0.87 | 1.01 |

N.S = Not significant P = Primary S = Secondry

**TABLE 2. Response equations**

| | | | 1983–84 | 1984–85 | Pooled |
|---|---|---|---|---|---|
| a) | Response to nitrogen : | | Y = 14.0617 + 0.1476X | Y= 8.3100+0.1142X | Y=11.1883+0.1309X |
| b) | Response to phosphorous: | | Y=18.8317+0.757X | Y=11.3100+0.1047X | Y=15.0733+0.0900X |
| c) | Response to nitrogen at various levels of phosphorus. | P 0: | Y=13.3733+0.1472X | — | Y=10.110+0.1295X |
| | | P15: | Y=14.7333+0.1095X | — | Y=11.6133+0.1092X |
| | | P30: | Y=14.0833+0.1860X | — | Y=11.8350+0.1539X |
| d) | Response to phosphorus at various levels of nitrogen | N0 : | Y=13.1450+0.0703X | — | Y=9.8400+0.0827X |
| | | N40: | No response | — | Y=16.083+0.0397X |
| | | N80: | Y=23.4017+0.1737X | — | Y=19.3350+0.1477X |
| e) | Response of mustard to phosphorus at various levels of irrigation | I 0: | | Y=10.8733+0.0593X | |
| | | I 1: | | Y=11.3600+0.2130X – 0.0049X$^2$ | |
| | | I 2: | | Y=11.3217+0.1890X | |

**TABLE 3. Interaction effect of nitrogen and phosphorus on seed yield (q/ha) of mustard**

| Phosphorus levels (kg/ha) | 1983–84 Nitrogen levels (kg/ha) | | | Pooled Nitrogen levels (kg/ha) | | |
|---|---|---|---|---|---|---|
| | 0 | 40 | 80 | 0 | 40 | 80 |
| 0 | 13.0 | 20.0 | 24.8 | 9.8 | 16.0 | 20.1 |
| 15 | 14.4 | 19.7 | 23.2 | 11.2 | 16.8 | 20.0 |
| 30 | 15.1 | 19.4 | 30.0 | 12.2 | 17.2 | 24.6 |
| C.D. at P = 0.05 | | | | | | |
| 1) C.D. for Comparison of means of Phosphorus levels at the same level of Nitrogen | | 3.31 | | | 2.48 | |
| 2) C.D. for comparison of means of Nitrogen at same or different levels of Phosphorus | | 3.20 | | | 2.85 | |

**TABLE 4. Interaction effect of irrigation and phosphorus on seed yield (q/ha) of mustard (1984-85)**

| Irrigation levels | Phosphorus levels (kg/ha) | | |
|---|---|---|---|
| | 0 | 15 | 30 |
| No Irrigation | 11.2 | 11.0 | 11.3 |
| Irrigation at 0.3 IW/CPE | 11.4 | 13.4 | 14.1 |
| Irrigation at 0.6 IW/CPE | 11.3 | 13.3 | 17.0 |
| C.D. at P = 0.05 | | | |
| 1) C.D. for comparision of means of phosphorus levels at the same level of irrigation | | 7.75 | |
| 2) C.D. of comparision of means of irrigation at same or different levels of phosphorus | | 7.24 | |

**TABLE 5. Correlation coefficients (r) between ancillary characters and seed yield of mustard**

| Year | Number of siliquae per plant | Number of seeds per siliqua | Weight of siliqua per plant | Weight of seed per plant | Number of primary branches per plant | Number of secondary branches per plant | Leaf area index at flowering stage |
|---|---|---|---|---|---|---|---|
| 1983–84 | 0.752** | 0.295* | 0.744** | 0.752** | 0.419** | 0.651** | 0.667** |
| 1984–85 | 0.830** | 0.403** | 0.818** | 0.868** | 0.432** | 0.653** | 0.590** |

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

**TABLE 6. Influence of irrigation, nitrogen and phosphorus fertilization on economics of mustard**

| Treatments | 1983–84 | | | | 1984–85 | | | |
|---|---|---|---|---|---|---|---|---|
| | Gross returns (Rs/ha) | Total cost of cultivation (Rs/ha) | Net returns (Rs/ha) | Net return per rupee investment | Gross returns (Rs/ha) | Total cost of cultivation (Rs/ha) | Net returns (Rs/ha) | Net returns per rupee investment |
| *Irrigation levels* | | | | | | | | |
| No Irrigation | 8673 | 2678 | 5995 | 2.24 | 5212 | 2731 | 2481 | 0.91 |
| Irrigation at 0.3 IW/CPE | 9491 | 2731 | 6760 | 2.47 | 5635 | 2784 | 2851 | 1.02 |
| Irrigation at 0.6 IW/CPE | 10203 | 2837 | 7366 | 2.60 | 6289 | 2198 | 3399 | 1.17 |
| *Nitrogen levels* (kg/ha) | | | | | | | | |
| 0 | 6740 | 2527 | 4213 | 1.67 | 3521 | 2580 | 941 | 0.36 |
| 40 | 9320 | 2749 | 6571 | 2.39 | 6025 | 2802 | 3223 | 1.15 |
| 80 | 12307 | 2970 | 9337 | 3.14 | 7590 | 3023 | 4567 | 1.51 |
| *Phosphorus levels* (kg/ha) | | | | | | | | |
| 0 | 9127 | 2520 | 6607 | 2.62 | 5032 | 2573 | 2458 | 0.95 |
| 15 | 9055 | 2749 | 6306 | 2.29 | 5711 | 2802 | 2910 | 1.04 |
| 30 | 10185 | 2977 | 7208 | 2.42 | 6393 | 3030 | 3363 | 1.11 |

only (Table 4). The relationship between seed yield and phosphorus at different moisture regime indicated that the response was linear in unirrigated and adequate water supply and it was quadratic with one irrigation. The optimum economic dose was 18.5 kg P/ha. The linear relationship in unirrigated and adequate water supply conditions clearly showed that the application of phosphorus is a must for achieving higher yield. A positive linear relationship between soil water content and phosphorus uptake is reported by Olsen *et al.* (1961). Strong and Barry (1980) stated that drying did not decrease crop uptake of fertilizer phosphorus in P deficient soil, though it reduced native soil P uptake due to stunted root system. Therefore, phosphorus application is necessary both under unirrigated and irrigated conditions.

It is clear from the correlation studies (Table 5) that the various yield attributes were significantly correlated with seed yield during both the years. The growth characters like number of productive primary and secondary branches per plant at harvest and leaf area index at flowering have clearly shown positive and high correlation with seed yield during both the years. Fertilization and irrigation had significant bearing on growth and yield attributes which ultimately affected the seed yield.

**Economics :**

The data on economics of various treatments (Table 6) revealed that the maximum net returns and net returns per rupee investment were obtained at 30 kg P/ha compared to other levels of phosphorus. Application of 80 kg N/ha registered maximum net returns while irrigation at 0.6 IW/CPE resulted in the highest net returns as well as net returns per rupee investment.

Thus an application of balanced fertilization (80 kg N + 30 kg/ha) is essential especially with high yielding variety like 'Pusa Bold' and supply of one irrigation at post flowering stage results in substantial increase in the productivity of mustard.

## LITERATURE CITED

GANGWAR, K.S. and KUMAR, A. 1986. Nitrogen fertilization and plant density levels in relation to yield, its attributes and quality of toria. *J. Oilseeds Res.* **3**:151–157.

JANA, P.K. 1963. Studies on nitrogen and phosphorus levels on growth, yield and quality of raya. M.Sc. thesis Indian Agricultural Research Institute, New Delhi.

KHAN, G.M. and AGARWAL. S.K. 1985. Water use, water use efficiency and soil moisture extraction pattern of mustard in relation to water stress and sowing methods *Indian J. Agron.* **30**:23–26.

MUDHOLKAR, N.J. and AHLAWAT, I.P.S. 1981. Response of mustard to plant density and fertilisation. *Indian J. Agron.* **26**:184–188.

OLSEN, S.R., WATANABE, F.S. and DANIELSON, R.F. 1961. Phosphorus absorption by corn-roots as effected by moisture and phosphorus concentration. *Pr. Soil. Sci. Soc. Am.* **25**:289–294.

PATHAK, G.N., VERMA, G. and SINGH, D.N. 1964. Response of yellow sarson and rai to different dose of nitrogen and phosphatic fertilizers. *Indian Oilseed J.* **1**(1):10–19.

SINGH, R.A. and RATHI, K.S. 1985. Studies on nitrogen requirement of mustard. *Indian J. Agron.* **30**:257–259.

STRONG, W.M. and BARRY, G. 1980. The availablility of soil and fertilizer phosphorus to wheat and rape at different water regimes. *Aust. J. S. Soil Res.* **18**:353–362.

TOMER, N.K., CHAHAL, R.S. and KHANNA, S.S. 1980. Balanced nutrition A key to raise yield of mustard under dryland. *Fertl. News.* **25**(10):31–33.

ROY, V., MAITI, S. and CHATTERJEE, B.N. 1981. Growth analysis and fertilizer response of Varuna Indian mustard. *Indian J. Agric. Sci.* **51**:173–180.

VIR, P. and VERMA, B.S. 1981. Effect of nitrogen phosphorus and row spacing on yield, yield attributes and oil content of rainfed mustard. *Indian J. Agron.* **26**:37–41.

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# THE INTRINSIC RATE OF NATURAL INCREASE OF *BAGRADA HILARIS* BURMEISTER ON RAPESEED CROP

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ABSTRACT

Life and fertility table studies on *Bagrada hilaris* Burm. were carried out for two years (1981-82 and 1982-83) at I.A.R.I., New Delhi in order to find out its intrinsic rate of natural increase (rm) on rapeseed variety *toria*-Assam Mass Selection. The bug showed a relatively higher rate of natural increase during August to October. The maximum rm was found to be 0.1885 in the first year and 0.2011 females per female/day in the second year. The rm values showed a declining trend afterwards. Amongst the weather parameters, maximum and minimum mean temperatures showed a significant and positive correlation with rm whereas number of rainy days, morning and evening mean relative humidities showed significant negative correlation. About 68 per cent of variation in the rm value was attributed to weather parameters.

**Key words** : *Bagrada hilaris; toria;* Intrinsic rate of natural increase; weather factor

## INTRODUCTION

Rapeseed (*Brassica campestris* L.) which includes *toria* is often attacked by painted bug, *Bagrada hilaris* and at times the population becomes serious enough to result in complete failure of the crop. *B. hilaris* is also a pest of yellow and brown *sarson* and mustard crop, normally sown after *toria* in the middle of October. The damage is done initially in the early crop phase. Thus being a pest of economic significance, a thorough knowledge of its ability to increase in numbers under the prevailing environmental conditions during the crop growth period is very much essential for effective pest management.

## MATERIALS AND METHODS

A continuous stock of *B. hilaris* was maintained by rearing the insects in glass jars. The insects were provided with *toria* leaves of variety Assam Mass Selection (AMS). Ten pairs of newly emerged adults were then placed in jars (20 × 15 cm) along with leaves and water soaked cotton piece. The jar was then covered with muslin and placed outside near the base of the plants (AMS) grown in the pots. Each release constituted one set of experiment and in all 13 such experiments were carried out in the first year and 21 in the second year. Observations were recorded daily on the number of surviving females, number of eggs laid and continued till last female died. Life and fertility tables were prepared for each set of experiment, following the method used by Birch (1948) and Southwood (1978). The survival values (lx) of the adult females in the initial stage at the start of each experiment was estimated on the basis of number of adults emerged from 25 eggs kept for life table studies. From these life and fertility

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tables, values of growth parameters like net reproductive rate (Ro), generation time (Tc), intrinsic rate of natural increase (rm) and finite rate of increase ($\lambda$) were determined using micro-computer which helped in avoiding elaborate graphical and iterative technique of calculating correct value of rm as described by Watson (1964), Laughlin (1965) and Whyatt and White (1977).

## RESULTS AND DISCUSSION

The summarised values estimated for different growth parameters are given in Tables 1 and 2. In the first year (Table 1) it is seen that rm values were relatively higher in two phases, one during the period from August 17, 1981 to October 15, 1981 (Expt. 2-5) and the other during the period from September 28, 1981 to December 2, 1981. (Expt. 8-10). The rm values during two phases ranged from 0.1020 to 0.1885 and from 0.0952 to 0.1481 females per female per day. Similarly in the second year (Table 2) the first phase was observed during the period from August 29, 1982 to November 15, 1982 (Expt. 18-22) and again from October 10, 1982 to December 1, 1982 (Expt 24). The rm values during these two phases were from 0.1439 to 0.2011 and 0.1619 respectively. The two years data showed that generally rm values remained relatively higher during the period from August to November and were low after this period. It was observed that the experiments those passed through the months of January, February and early March gave negative growth rate suggesting that during these winter months the population of the bug dwindle down. In general the mean generation time (Tc) of the bug had increased from August onwards in both the years.

The corresponding values of net reproductive period (Ro), generation time (Tc) and finite rate of increase ($\lambda$) are also given in the Table 1 and 2.

**TABLE 1. Values of growth paramaeters of *B. hiaris* estimated from life and fertility tables (1981-82)**

| Expt. No. | Period | Ro | Tc | rm | $\lambda$ |
|---|---|---|---|---|---|
| 1. | August 10 — September 15, 1981 | 1.1520 | 7.5271 | 0.0192 | 1.0194 |
| 2. | August 17 — September 24, 1981 | 2.2960 | 8.3590 | 0.1020 | 1.1074 |
| 3. | August 24 — September 29, 1981 | 2.4480 | 6.7680 | 0.1373 | 1.1472 |
| 4. | September 1 — October 9,1981 | 3.9099 | 7.5140 | 0.1885 | 1.2073 |
| 5. | September 7 — October 15, 1981 | 3.5119 | 9.2346 | 0.1416 | 1.1521 |
| 6. | September 14 — October 27, 1981 | 0.8359 | 10.1555 | -0.0176 | 0.9827 |
| 7. | September 21 — November 7, 1981 | 0.9260 | 9.8078 | -0.0078 | 0.9922 |
| 8. | September 28 — November 17, 1981 | 4.9699 | 10.8289 | 0.1481 | 1.1740 |
| 9. | October 5 — December 2, 1981 | 4.8299 | 12.2202 | 0.1376 | 1.1476 |
| 10. | October 12 — December 4, 1981 | 3.0399 | 12.0855 | 0.0952 | 1.1000 |
| 11. | October 19 — December 20, 1981 | 1.5199 | 13.5421 | 0.0315 | 1.0320 |
| 12. | October 26 — January 6, 1982 | 0.2040 | 15.4117 | -0.0949 | 0.9095 |
| 13. | November 2 — January 17, 1982 | 0.1400 | 16.1428 | -0.1092 | 0.8966 |

TABLE 2. Values of growth parameters of *B. hilaris* estimated from life and fertility tables (1982-83)

| Expt. No. | Period | Ro | Tc | rm | λ |
|---|---|---|---|---|---|
| 14. | August 1 — September 5, 1982 | 0.5880 | 6.8537 | -0.0755 | 0.9273 |
| 15. | August 8 — September 16, 1982 | 1.3040 | 7.5123 | 0.0359 | 0.0366 |
| 16. | August 16 — September 23, 1982 | 0.6140 | 7.9967 | -0.0601 | 0.9417 |
| 17. | August 22 — October, 1, 1982 | 0.6960 | 8.0661 | -0.0438 | 0.9571 |
| 18. | August 29 — October 7, 1982 | 4.6319 | 8.1213 | 0.1995 | 1.2208 |
| 19. | September 5 — October 17, 1982 | 3.5360 | 9.1380 | 0.1439 | 1.1548 |
| 20. | September 12 — October 24, 1982 | 4.1899 | 9.7327 | 0.1552 | 1.1679 |
| 21. | September 19 — November 4, 1982 | 5.0400 | 8.7698 | 0.2011 | 1.2227 |
| 22. | September 26 — November 15, 1982 | 3.9840 | 10.3855 | 0.1454 | 1.1565 |
| 23. | October 3 — November 21, 1982 | 1.8960 | 10.1076 | 0.0649 | 1.0671 |
| 24. | October 10 — December 1, 1982 | 5.7680 | 11.5267 | 0.1619 | 1.1557 |
| 25. | October 17 — December 15, 1982 | 2.576 | 12.36960 | 0.0803 | 1.0836 |
| 26. | October 24 — December 30, 1982 | 2.1000 | 14.4143 | 0.0535 | 1.0550 |
| 27. | October 31 — January 15, 1983 | 0.9760 | 14.7049 | -0.0016 | 0.9984 |
| 28. | November 7 — January 31, 1983 | 0.3760 | 17.6170 | -0.0515 | 0.9498 |
| 29. | November 14 — February 15, 1983 | 0.3280 | 21.7073 | -0.0480 | 0.9531 |
| 30. | November 21 — March 1, 1983 | 0.3420 | 18.7018 | -0.0529 | 0.9485 |
| 31. | November 28 — March 13, 1983 | 0.1800 | 22.8667 | -0.0691 | 0.9332 |
| 32. | December 5 — March 12, 1983 | 0.6720 | 14.5357 | -0.0266 | 0.9738 |
| 33. | December 12 — March 13, 1983 | 0.3640 | 15.1099 | -0.0641 | 0.9379 |
| 34. | December 19 — March 10, 1983 | 0.4860 | 13.5226 | -0.0517 | 0.9466 |

The effect of weather factors on rm values was further studied. The data for both the years were pooled and simple correlations were worked out (Table 3). Maximum temperature, minimum temperature and mean temperature were found to have highly significant and positive correlation with the intrinsic rate of increase of the bug. The number of rainy days, morning relative humidity and mean relative humidity were found to be highly significant but negative correlation with rm. The evening relative humidity had significant negative correlation with rm. But the total rainfall during the period of study did not have any significant correlation with rm.

The negative growth rate of the bug in some of the experiments during August to November in both the years could be due to more number of rainy days. This could

**TABLE 3. Correlation coefficients between intrinsic rate of natural increase (rm) and weather parameters.**

| S.No. | Variable | Regression coefficient | Correlation coefficient |
|---|---|---|---|
| 1. | Intrisnic rate of increase | — | 1.000 |
| 2. | Mean Maximum teperature (°C) | -0.0029 | 0.5699** |
| 3. | Mean minimum temperature (°C) | -0.0923 | 0.4633** |
| 4. | Mean temperature (°C) | 0.1125 | 0.5384** |
| 5. | Number of rainy days | -0.0059 | -0.6537** |
| 6. | Total rainfall (mm) | -0.0003 | -0.2837 |
| 7. | Mean morning RH | 0.0161 | -0.5712** |
| 8. | Mean evening RH | 0.0190 | -0.3674* |
| 9. | Mean Relative humidity | -0.0272 | -0.6003** |

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

reduce the possibility of immature stages of the bug to become adults, thereby reducing the survival values of the adult females.

The weather parameters accounted for about 68 per cent of variation in the rm values (R2 = 67.68).

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## LITERATURE CITED

BIRCH, L.C. 1948. The intrinsic rate of natural increase of an insect population. *J. Anim. Ecol.* **17**:15-26.

LAUGHLIN, R. 1965. Capacity for increase : a useful population statistic *J. Anim. Ecol.* **34**:77-91.

SOUTHWOOD, T.R.E. 1978. *Ecological Methods with Particular Reference to the Study of Insect Populations.* Chapman and Hall, London pp. 524.

WATSON, T.F. 1964. Influence of host plant conditions on population increase of *Tetranychus telarius* (Linn) (*Acarina*: *Tetranychidae*). *Hilgardia* **35**:273-322.

WYATT, I.J. and WHITE, P.F. 1977. Simple estimation of intrisic increases rates for aphids and tetranychid mites. *J. appll. Ecol.* **34**:757-766.

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# INFLUENCE OF VARIOUS VEGETATIVE AND REPRODUCTIVE ATTRIBUTES ON YIELD IN VIRGINIA RUNNER GROUNDNUT

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ABSTRACT

In 28 virginia runner varieties of groundnut (*Arachis hypogaea* L.) the coefficient of variability, heritability, genetic advance, correlations and path co-efficients of different yield components were investigated. High genetic coefficient of variation, high heritability and high genetic advance was observed for 100-pod weight suggesting predominant additive gene action. Number of secondary branches, number of mature pods per plant, 100-pod weight and 100-kernel weight showed significant positive correlation with pod yield and also had high direct positive effects. Indirect effects of 100-kernel weight and shelling per cent *via* 100-pod weight were considerably high. It was concluded that selection for more number of secondary branches, number of mature pods per plant besides higher 100-pod and 100-kernel weight would help in breeding productive cultivars in the virginia runner group of groundnut.

**Key words** Groundnut; Variability; correlation coefficient; path analysis; *Arachis hypogeaa*

## INTRODUCTION

Among the different habit groups of groundnut (*Arachis hypogaea* L.) grown in India, virginia runner alone occupies 49 per cent of the total area. Despite this situation there was little effort to breed improved varieties under this habit group and consequently amongst the groundnut varieties released during the last one decade runner accounted for 12 per cent. This varietal imbalance limiting the production to a considerable extent could be minimized by breeding more and more improved runner varieties. In doing so the information on the extent of genetic variability, heritability of various metric traits and their association with pod yield and oil within this habit group is a prerequisite The investigation reported herein presents information on these parameters in the runner habit group.

## MATERIALS AND METHODS

Twenty five virginia runner groundnut varieties of India and abroad viz. Chandra, GAUG 10, Karad 4–11, Kadiri 71-1, M 13, M 145, M 37, PG 1, RS 1, S 230, TMV 3, TMV 4, T 28, Early runner, Florunner, Florigiant, NC 6, Chitra, V 72 R, Dixie Runner, V 61 R, 56 R, TMV 1, GK 1A, GK 3, were grown in a randomized block design with 3 replications during *Kharif* 1986 at Punjabrao Krishi Vidyapeeth, Akola. Seeds of each entry were dibbled in 3 rows of 5m length spaced at 45 cm between rows and 10cm between plants within the row. Normal package of practices were followed to raise a healthy crop. Observations were recorded from 10 randomly selected plants on (i) days to first flowering, (ii) days to 50% flowering, (iii) height of main stem (cm), (iv) number of primary branches, (v) number of secondary branches, (vi) number of

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mature pods per plant, (vii) 100-pod weight (gm), (viii) 100-kernel weight (gm), (ix) shelling percentage, (x) oil percentage and pod yield (kg). The oil content was estimated from the total sample drawn from 10 plants by the Pulsed Nuclear Magnetic Resonance Spectrometer (NMR). Mean of 10 plants was used to compute the coefficient of variability, heritability and genetic advance by using the standard methods. Correlations and path analysis were computed as per the methods given by Panse and Sukhatme (1967) and Dewey and Lu (1959) respectively.

## RESULTS AND DISCUSSION

A significant variation was observed among the strains for all the eleven attributes studied. The phenotypic and genotypic coefficients of variation heritability and genetic advance are presented in Table 1. Phenotypic coefficient of variation (PCV) although was higher than genotypic coefficient of variation (GCV) for all the characters, the difference was remarkably low for 100-pod weight and shelling percentage suggesting direct selection response on the basis of their phenotypic expression. No linear relationship among genetic coefficient of variation, heritability and genetic advance was observed except for 100-pod weight. High genetic coefficient of variation along with high heritability and high genetic advance was observed for 100-pod weight which is indicative of the predominant role of additive gene action in manifestation of the trait.

**TABLE 1. Estimates of coefficient of variability, heritability and genetic advance for yield and its components in virginia runner groundnut**

| Characters | Phenotypic coefficient of variation | Genotypic coefficient of variation | Heritability | Genetic advance |
|---|---|---|---|---|
| Days to 1st flowering | 6.69 | 4.88 | 53.12 | 2.29 |
| Days to 50% flowering | 7.29 | 4.27 | 34.37 | 2.36 |
| Height of main stem | 16.99 | 13.40 | 62.23 | 5.44 |
| Number of Primary branches | 15.86 | 10.86 | 46.93 | 1.79 |
| Number of secondary branches | 24.97 | 14.39 | 33.19 | 1.99 |
| Number of mature pods/plant | 39.10 | 22.86 | 34.19 | 3.42 |
| 100 pod weight | 21.55 | 19.91 | 85.35 | 33.47 |
| 100 kernel weight | 22.14 | 19.15 | 74.81 | 13.63 |
| Shelling percentage | 6.98 | 5.90 | 71.45 | 7.19 |
| Oil percentage | 5.28 | 2.76 | 25.49 | 1.11 |
| Pod yield | 33.57 | 17.41 | 26.90 | 51.92 |

The correlation coefficients among different character combinations to genotypic (G) and phenotypic (P) levels are presented in Table 2. The genotypic correlations,

**TABLE 2. Genotypic and phenotypic correlations of yield and its components in virginia runner groundnut**

| Characters | | (2) | (3) | (4) | (5) | (5) | (7) | (8) | (9) | (10) | (11) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Days to 1st flowering | G | 0.714** | −0.547** | 0.614** | 0.645** | 0.034 | −0.202 | −0.410* | 0.237 | −0.561 | −0.568** |
| | P | 0.447* | −0.538** | 0.251 | 0.289 | 0.079 | −0.147 | −0.335 | 0.055 | −0.198 | −0.242 |
| 2. Days to 50% flowering | G | | −0.518* | 0.290 | 0.626** | 0.203 | −0.807** | −0.937** | 0.704** | −0.374 | −0.922** |
| | P | | −0.330 | 0.161 | 0.198 | 0.149 | −0.494* | −0.472* | 0.368 | 0.013 | −0.382 |
| 3. Height of main stem | G | | | −0.467* | −0.594** | −0.346 | 0.181 | 0.368 | −0.786** | −0.059 | 0.235 |
| | P | | | −0.178 | −0.314 | −0.403 | 0.170 | 0.288 | −0.451* | 0.047 | 0.116 |
| 4. Number of primary branches | G | | | | 0.678** | 0.269 | −0.300 | −0.460* | 0.218 | −0.803** | −0.376 |
| | P | | | | 0.537* | 0.075 | −0.174 | −0.247 | 0.056 | −0.479* | −0.152 |
| 5. Number of secondary branches | G | | | | | 0.056 | −0.640** | −0.808** | 0.469* | −0.766** | 0.894** |
| | P | | | | | 0.286 | −0.360 | −0.424* | 0.112 | −0.381 | 0.764** |
| 6. Number of mature pods per plant | G | | | | | | −0.162 | 0.128 | 0.763** | 0.357 | 0.801** |
| | P | | | | | | −0.140 | 0.074 | 0.253 | 0.159 | 0.718** |
| 7. 100 pod weight | G | | | | | | | 0.973** | 0.673** | 0.264 | 0.934** |
| | P | | | | | | | 0.836** | 0.486* | 0.148 | 0.580** |
| 8. 100 kernel weight | G | | | | | | | | 0.698** | 0.351 | 0.967** |
| | P | | | | | | | | 0.430* | 0.229 | 0.594** |
| 9. Shelling per cent | G | | | | | | | | | 0.253 | −0.302 |
| | P | | | | | | | | | 0.190 | −0.143 |
| 10. Oil per cent | G | | | | | | | | | | 0.472* |
| | P | | | | | | | | | | 0.131 |
| 11. Pod yield | G | | | | | | | | | | — |
| | P | | | | | | | | | | — |

G = Genotypic correlation P = Phenotypic correlation, *, ** = Significant at 5% and 1% level respectively.

**TABLE 3. Direct (diagonal) and indirect effect of different characters on pod yield in virginia runner groundnut**

| Characters | Days to 1st flowering | Days to 50% flowering | Height of main stem | No. of primary branches | No. of secondary branches | No. of mature pod/plant | 100-pod weight | 100-kernel weight | Shelling percentage | Oil percentage |
|---|---|---|---|---|---|---|---|---|---|---|
| Days to 1st ffowering | **-0.407** | -0.294 | 0.122 | -0.250 | -0.262 | -0.050 | 0.082 | 0.167 | 0.096 | 0.228 |
| Days to 50% flowering | 0.205 | **-0.402** | -0.357 | 0.116 | 0.220 | 0.081 | -0.352 | -0.414 | 0.231 | -0.250 |
| Height of main stem | -0.227 | 0.170 | **-0.414** | 0.194 | 0.246 | 0.143 | -0.075 | -0.152 | 0.326 | 0.024 |
| No. of primary branches | 0.048 | 0.019 | **-0.081** | **0.066** | 0.044 | -0.078 | -0.062 | -0.080 | -0.094 | -0.158 |
| No. of secondary branches | 0.165 | 0.225 | -0.202 | 0.175 | **0.407** | -0.023 | -0.210 | 0.329 | 0.191 | -0.193 |
| No. of mature pods/plant | -0.016 | -0.095 | 0.162 | 0.138 | 0.126 | **0.467** | 0.176 | 0.160 | -0.207 | -0.110 |
| 100 pod weight | 0.269 | -0.410 | -0.098 | 0.164 | 0.249 | 0.388 | **0.545** | -0.530 | 0.357 | 0.144 |
| 100-kernel weight | -0.172 | -0.135 | 0.194 | -0.193 | 0.339 | 0.252 | 0.408 | **0.419** | -0.293 | 0.147 |
| Shelling percentage | -0.185 | -0.309 | 0.613 | -0.170 | -0.336 | -0.505 | 0.523 | 0.544 | **-0.280** | -0.198 |
| Oil percentage | -0.163 | -0.112 | -0.018 | -0.105 | -0.150 | 0.197 | 0.179 | 0.169 | 0.176 | **0.300** |

Residual – 0.091

in general, were greater than their corresponding phenotypic correlations. These data suggest that though there was a strong inherent association between various characters studied the phenotypic expression of the correlations was depressed due to environmental influence. The pod yield was found to be significantly and positively associated with number of secondary branches, number of mature pods per plant, 100-pod weight and 100-kernal weight whereas with regards to days to 1st flowering and days to 50% flowering the associations were significant but negative. Since the pattern of positive correlations at phenotypic and genotypic level were similar, the phenotypic values can safely be considered as criteria for selection. None of the attributes, on the other hand, showed significant positive correlation with oil percent except with pod yield at 5% level. The correlations having low $r^2$ value ($r^2 < 0.50$) appeared to be of little importance in determining selection criteria (Cofelt *et al.*, 1974). Days to 50% flowering although was negatively correlated for majority of the traits, a positive association, however, was evident with shelling per cent. Shelling percentage was also found to be correlated positively with number of mature pods, 100-pod weight and 100-kernel weight. It is thus evident from the study that any improvement towards number of mature, pods per plant, 100-pod weight and 100-kernel weight would lead to increased pod yield in virginia runner groundnut.

The genotypic correlations were partitioned into direct effect of each component and its indirect contribution through other yield components (Table 3). Interestingly, the attributes viz. number of secondary branches, number of mature pods per plant, 100-pod weight and 100-kernel weight which were having high positive correlations with pod yield also had high direct positive effects on yield. The magnitude of direct effect of all these characters was less than their respective correlations with pod yield. Indirect effects of 100-kernel weight and shelling per cent *via* 100-pod weight were positive and considerably high.

The results, thus, suggest that there is ample scope for the improvement of pod yield in virginia runner groundnut by exerting selection pressure for more number of secondary branches, number of mature pods per plant besides higher 100-pod as well as 100-kernel weight.

## LITERATURE CITED

COFELT, T.A. and HAMMONS, R.D. 1974. Correlation and heritability studies of nine characters in parental and interaspecific cross population of *Arachis hypogaea* L. *Oleagineux*. **29**:23-28.

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

PANSE, V.G. and SUKHATME, P.V. 1967. Statistical methods for agricultural workers. ICAR Pub., New Delhi.

## Short Communication

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# A SMALL LEAF MUTANT IN GROUNDNUT

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Spontaneous mutations for vegetative and reproductive characters in groundnut variety Phule Pragati (JL-24) have been reported by Bhole *et al.* (1984) and Desale (1985).

During the summer season of 1983 in the population of Phule Pragati variety, recommended for *kharif* cultivation, a single plant with small leaflets, short stature and profuse branching was noticed. This plant was harvested separately and its progeny was grown in the *kharif*, 1983. It was found to be true breeding for characters of leaf size, branching habit and pod size etc. The true breeding nature of the mutant was confirmed in the subsequent seasons. The details of various characters in the progeny of this plant in comparison with Phule Pragati are given in table 1.

There is reduction in size of various plant characters including pod and kernel size. The period of maturity, pod surface and average number of one, two and multi-seeded pods per plant have not changed much in the mutant as compared to the parent variety. Each of the two cotyledonary primaries bore a pair of secondary branched at the lowermost suppressed nodes. However, it differs from the mutants reported earlier in parent variety for plant and pod characters. The reduced leaflet size ans increase in number of secondary branches of the mutant are worth exploiting in further breeding programmes.

BHOLE, G.R., PATIL, S.S. and DEOKAR, A.B. 1984. *J. Oilseeds Res.* 1:85-87.

DESALE, S.C. 1985. *Curr. Res. Reporter of MPAU.* 1:92-94.

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**TABLE 1. Characters of the parent and mutant**

| Characters | Phule Pragati (JL-24) | Mutant |
|---|---|---|
| Growth habit | Bunch | Bunch |
| Height (cm) | 26.8 ± 0.53 | 21.5 ± 0.48 |
| Length of longest cotyledonacy branch(cm) | 33.1 ± 1.12 | 26.6 ± 0.66 |
| Number of branches | | |
| Primary | 4.3 ± 0.15 | 5.0 ± 0.00 |
| Secondary | 1.9 ± 0.50 | 4.6 ± 0.34 |
| Number of nodes on stem | 18.3 ± 0.25 | 21.1 ± 0.31 |
| Lable size on stem (mm) | | |
| Lenth | 66.1 ± 0.99 | 38.9 ± 0.69 |
| Width | 29.2 ± 0.91 | 16.8 ± 0.42 |
| Branch | | |
| Length | 65.1 ± 1.41 | 37.5 ± 0.62 |
| Width | 34.4 ± 0.88 | 18.7 ± 0.36 |
| Petiole length (mm) | 51.2 ± 1.18 | 38.6 ± 0.56 |
| Rachis Length (mm) | 17.8 ± 0.53 | 11.6 ± 0.34 |
| Number of pods/plant | | |
| One seeded | 2.0 ± 0.73 | 1.8 ± 0.45 |
| Two seeded | 13.5 ± 0.59 | 16.4 ± 2.12 |
| Three seeded | 0.9 ± 0.12 | 1.0 ± 0.21 |
| Pod surface | Smooth | Smooth |
| Broken pod | Prominent | Very prominent |
| 100 kernel weight (g) | 46.0 | 28.0 |
| Maturity period (days) | 85–90 | 85–90 |

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# SEGREGATION OF CHLOROPHYLL DEFICIENCY IN INTRA SPECIFIC CROSSES OF GROUNDNUT

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In groundnut two sub species namely sub sp. *hypogaea* and sub sp. *fastigiata* were recognised by groundnut workers (Gibbons *et al.*, 1971). For groundnut improvement. the inter sub specific crosses involving the two sub species are preferred as they would result in realisation of superior derivatives, because the desirable attributes are clustered separatly in each group giving scope for recombination. However, in such inter-sub-specific crosses segregation of chlorophyll deficient plants in $F_2$ generation is of common occurrence. The segregation pattern of chlorophyll deficiency is examined in the present study and reported herein.

Two cross combinations involving R 33-1 (sub sp. *hypogaea*) as ovule parent and VG 18 and VG 19 (sub sp. *fastigiata*) as pollen parents and their reciprocal crosses were effected. The $F_1$ generation and subsequently $F_2$ generation was raised on single plant basis. Chlorophyll deficient seedlings were observed along with normal green seedlings. The seedlings were examined from 8th to 15th day after sowing and classified as proposed by Gustafsson (1940). Samples in each group were analysed for chlorophyll. content by the method described by Arnon (1949). One gram of fresh leaves was macerated in a pestle and mortar using acetone, filtered and made upto 100 ml read in double cell photo electric collorimeter using red filter. The chlorophyll content was expressed as mg/g of fresh leaf tissue.

Frequency of chlorophyll deficient seedlings in $F_2$ generation based on $F_1$ and $F_2$ plant basis are tabulated and presented in Table 1. The ratio between normal green and chlorophyll deficient seedlings remains in the ratio of 15:1 in both direct and reciprocal crosses (Vindhiya Varman *et al.*, 1984).

The spectrum of chlorophyll deficiency includes *albina*, *viridis* and *chlorina*, among them, the occurrence of *albina* dominates in all the cross combinations (Table 2). In $F_2$ the occurrence of *albina* ranged from 42.9 to 76.9 per cent, whereas the *viridis* ranged from 10.3 to 40.0 per cent and the *chlorina* ranged from 7.7 to 17.1 per cent.

The association of chlorophyll deficiency in single and multiple types are presented in Table 3. Number of plants segregated for single type of deficiency was higher than multiple types. Among the single type, percentage of plants that segregated for *albina* was higher in all the crosses (37.5 to 66.6 per cent) followed by *viridis* (5.6 to 16.8 per cent) and *chlorina* (5.6 to 12.5 per cent). Among the multiple types, the association between *albina* and *viridis* is common in all the crosses (5.6 to 33.3 per cent). The association of *viridis* and *chlorina* is specific to the cross where, R 33-1 was used as pollen parent. Occurrence of all the three types together was a rare phenomenon.

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TABLE 1. Frequency of chlorophyll defficiency in $F_2$ generation.

| Name of the cross | Number of plant examined in | | Occurrence of Chlorophyll deficiency | | | |
|---|---|---|---|---|---|---|
| | $F_1$ | $F_2$ | $F_1$ plant basis | | $F_2$ plant basis | |
| | | | Segregating $F_1$ | Percentage | No. of deficient plants | Percentage |
| R33-1 × VGI8 | 26 | 766 | 15 | 57.6 | 52 | 6.8 |
| VGI8 × R33-1 | 34 | 685 | 18 | 52.9 | 39 | 5.7 |
| R33-1 × VGI9 | 46 | 1105 | 27 | 58.7 | 63 | 5.7 |
| VGI9 × R33-1 | 31 | 680 | 16 | 51.6 | 35 | 5.1 |

TABLE 2. Spectrum of chlorophyll deficiency in the $F_2$ generation

| Name of the cross | Total No. of *Chloro* phyll deficient plants | No. of plants | | | Percentage | | |
|---|---|---|---|---|---|---|---|
| | | *albina* | *viridis* | *chlorina* | *albina* | *viridis* | *chlorina* |
| R33-1 × VGI 8 | 52 | 38 | 10 | 4 | 73.1 | 19.2 | 7.7 |
| VGI8 × R33-1 | 39 | 30 | 4 | 5 | 76.9 | 10.3 | 12.8 |
| R33-1 × VGI 9 | 63 | 44 | 9 | 10 | 69.8 | 14.3 | 15.9 |
| VGI9 × R33-1 | 35 | 15 | 14 | 6 | 42.9 | 40.0 | 17.1 |

TABLE 4. Extent of chlorophyll deficiency in various types

| Types of chlorophyll deficiency | Chlorophyll content (mg/g) | Percentage of deficiency compare to normal |
|---|---|---|
| Normal green | 0.67 | — |
| *chlorina* | 0.42 | 37.3 |
| *viridis* | 0.10 | 85.2 |
| *albina* | 0.05 | 92.5 |

The extent of chlorophyll deficiency was estimated by analysing for the chlorophyll content and the results are presented in Table 4. The normal green seedlings recorded a chlorophyll content of 0.67 mg/g of fresh leaf, whereas *chlorina* (0.42 mg/g), *viridis* (0.10 mg/g) and *albina* (0.05 mg/g). The extent of chlorophyll deficiency

**TABLE 3. Association of single and multiple chlorophyll deficiency on F1 plants basis**

| Name of the cross | Total $F_1$ plants segregated for chlorophyll deficiency | No. of F1 plants segregated fro | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | single type | | | multiple types | | | |
| | | *albina* | *viridis* | *chlorina* | *albina* and *viridis* | *albina* and *chlorina* | *vtridis* and *chlorina* | *albina, viridis* and *chiorina* |
| R33–1 × VGI8 | 18 | 8 (53.3) | 1 ( 6.7) | 1 ( 6.7) | 5 (33.3) | – – | – – | – – |
| VGI8 × R33–1 | 18 | 12 (66.6) | 1 ( 5.6) | 1 ( 5.6) | 1 ( 5.6) | 2 (11.0) | 1 ( 5.6) | |
| R33–1 × VGI9 | 27 | 15 (55.6) | 4 (14.8) | 2 ( 7.4) | 4 (14.8) | 2 ( 7.4) | – – | – – |
| VGI9 × R33–1 | 16 | 6 (37.5) | 2 (12.5) | 2 (12.5) | 3 (18.7) | – – | 2 (12.5) | 1 ( 6.3) |

In parenthesis : Percentage occurrence

was 37.3, 85.2 and 92.5 per cent respectively in *chlorina*, *viridis* and *albina*. Since the extent of deficiency is higher in *viridis* and *albina*, the survival of the seedlings beyond 15-20 days is not possible. However the *chlorina* type plants were survived for 30 days and degenerated without producing reproductive organs or flowers.

Raman (1976) suggested that the abnormalities by way of *albinas* noticed in the $F_2$ indicate some amount of differentiation between the sub species, though not any large or cryptic structural differences may exist. Further mutations leading to the recessives producing chlorophyll deficiencies in the duplicate loci also could have occurred and persisted. Coffelt and Hammon (1971) have also viewed that the chlorophll abnormalities demonstrate how undesirable recessive alleles can accumulate in a self pollinating species if there are traits controlled by duplicate factors.

ARNON, D.I., 1949. *Plant physiol.* **24**:1-15.

COFFELT TERRY, A., and HAMMONS. R.O. 1971. *Crop Sci.* **11**:753-55.

GIBBONS, R.W., BUNTING., A. H. and SMARTT. J. 1971. *Pl. Breed. Abst.* **42**:8901.

GUSTAFSSON, A. 1940. *Lunds Univ. Arsskr.* **36**:1-10.

RAMAN, V.S. 1976. *Cytogenetics* and *Breeding in Arachis.* Today and Tomorrow's Printers and Publishers, New Delhi. Page 21.

VINDHIYA VARMAN, P., RATHINASAMY, R. SETHUPATHI RAMALINGAM R. and VAMAN BHAT. M. 1984. *Madras agric. J.* **71**:812-814.

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# EFFECT OF SULPHUR FERTILIZATION ON YIELD AND QUALITY OF MUSTARD

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Mustard (*Brassica juncea* (L.) Czern & Coss.) is one of the important oil seed crops in India next only to groundnut. It plays an important role in agricultural economy of our country. But average yield of mustard in India is very low. This low yield is because of no or very little fertilization in this crop. Response of mustard to sulphur in addition to major nutrients has been reported by many workers (Singh *et al.*, 1970; Pathak and Tripathi, 1979). But very little information is available on response of sulphur fertilization on newly introduced high yielding varieties of mustard. Therefore, present investigation was undertaken to evaluate the effect of sulphur application on yield and quality characters of newly introduced high yielding varieties of mustard.

A field trial was conducted during *Rabi* 1983-84 at Regional Agricultural Research Station, Tikamgarh (M.P.). The physico-chemical properties of experimental area were determined by conventional methods. Soils were clayey loam in texture, slightly alkaline in reaction, (pH 7.7), medium in available nitrogen (315 kg/ha) and potassium (240 kg $K_2O$/ha) and low in available phosphorus (8 kg $p_2 0_5$/ha) and sulphur (9 ppm). Ten different treatment combinations from five levels of sulphur (0, 15, 30, 45, 60 kg S/ha) and two mustard varieties (Varuna and RW 351) were used in a RBD. Required quantity of sulphur for 5 × 4 sqm (gross) plot was applied through ammonium sulphate and basal application of nitrogen was adjusted to 60 kg/ha through urea. Basal application of phosphate @ 30 kg/ha was applied through triple super phosphate. Sowing of experiment was done on November 1, 1983 and crop was harvested on March 14, 1984.

After recording yield data mustard seed samples were drawn for chemical analysis. Oil was estimated by Soxhlet extraction Method (Kanwar and Chopra, 1967). The sulphur content of seeds was determined by the method of Bardsley and Lancaster (1960). Nitrogen content was determined by micro kjeldahl method (AOAC, 1960) and was multiplied by 6.25 factor for crude protein content.

**Mustard seed and oil yield**

Data presented in Table 1 indicated that Varuna variety responded more to sulphur application compared to RW 351, although the difference was not significant. Seed yield increased significantly with increasing levels of sulphur upto 45 kg S/ha but nonsignificant reduction was observed at highest sulphur level (60 kg S/ha). This increase in yield with 45 kg S/ha over control was about 350 and 300 kg/ha in case of Varuna and RW 351 respectively. Increase in yield due to sulphur application might be due to response of sulphur to mustard and reduction with highest level of sulphur

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might be due to toxic effect of higher sulphur concentration due to interionic effect. Response of mustard to sulphur application has been reported by many workers (Singh *et al.*, 1970; Pathak and Tripathi, 1979). Reduction in seed yield at higher level of sulphur application was also reported by Singh and Singh (1977).

Oil yield data (Table 1) indicated that effect of sulphur application on oil yield was very similar to effect on seed yield except that seed yeld increased upto 45 kg S/ha level of sulphur application and reduction was observed at highest level while oil yield increased upto highest level of sulphur application (60 kg S/ha). The reduction in seed yield and increase in oil yield at highest level might be due to increase in oil content due to sulphur application. Increase in oil yield due to sulphur application is also reported by Pathak and Tripathi (1979).

**TABLE 1. Effect of sulphur fertilization on mustard seed and oil yield**

| Variety | Sulphur levels (kg S/ha) | | | | | Average | C.D. (P = 0.5) |
|---|---|---|---|---|---|---|---|
| | e | 15 | 30 | 45 | 60 | | |
| | Mustard seed yield (kg/ha) | | | | | | |
| Varuna | 1455.77 | 1461.58 | 1683.04 | 1819.71 | 1802.82 | 1680.58 | S = 210.81 |
| RW 351 | 1359.02 | 1561.73 | 1620.16 | 1770.57 | 1603.19 | 1582.93 | V = N.S. |
| Average | 1407.39 | 1601.00 | 1651.60 | 1706.70 | 1703.00 | | Int = NS |
| | Oil yield (kg/ha) | | | | | | |
| Varuna | 585.94 | 689.79 | 729.26 | 778.83 | 800.81 | 715.25 | S = 110.43 |
| RW 351 | 552.42 | 668.04 | 703.58 | 729.85 | 767.20 | 673.37 | V = N.S. |
| Average | 569.42 | 668.04 | 303.58 | 729.85 | 767.20 | | Int = 156.17 |

**Protein, oil and sulphur content**

Protein content of mustard seed decreased significantly with increasing sulphur levels (Table 2). This reduction was from 18.85 to 17.48 per cent with 60 kg S/ha over control. The reduction in protein content might be due to increase in oil content due to sulphur application. Similar increase in protein content due to sulphur application was reported by Singh and Singh (1977).

Oil content of mustard increased significantly with increasing levels of sulphur. This increase was from 40.46 to 45.05 per cent with 60kg S/ha over control. However there was no variety effect on oil content. Increase in oil content of mustard with sulphur application was also reported by Singh and Singh (1977).

Sulphur content of mustard remained unaffected with increasing level of sulphur. This unexpected behaviour might be due to more and more absorption utilization and transformation of absorbed sulphur in plant resulted in continuous increase of seed and oil yield. This resulted in keeping sulphur cencentration more or less constant.

**TABLE 2. Effect of sulphur fertilization on quality of mustard varieties**

| Variety | Sulphur levels (kg S/ha) | | | | | Average | C.D. (P = 0.05) |
|---|---|---|---|---|---|---|---|
| | 0 | 15 | 30 | 45 | 60 | | |
| | | | Oil content (per cent) | | | | |
| Varuna | 40.25 | 42.02 | 43.33 | 42.80 | 44.42 | 42.56 | S = 1.176 |
| RW 351 | 40.68 | 41.40 | 41.69 | 43.28 | 45.68 | 42.54 | V = N.S. |
| Average | 40.46 | 41.71 | 42.51 | 42.78 | 45.05 | | Int = 1.77 |
| | | | Protein content (per cent) | | | | |
| Varuna | 18.43 | 18.76 | 18.29 | 18.77 | 17.65 | 18.39 | S = 0.993 |
| RW 351 | 19.20 | 17.45 | 16.33 | 16.44 | 17.30 | 17.34 | V = 0.269 |
| Average | 18.84 | 18.10 | 17.31 | 17.60 | 17.48 | | Int = 1.405 |
| | | | Sulphur content (per cent) | | | | |
| Varuna | 0.30 | 0.27 | 0.29 | 0.29 | 0.25 | 0.28 | S = 0.0171 |
| RW 351 | 0.37 | 0.30 | 0.24 | 0.24 | 0.27 | 0.26 | V = 0.0108 |
| Average | 0.28 | 0.28 | 0.26 | 0.26 | 0.26 | | Int = 0.0242 |

A.O.A.C. 1960. Official methods of analysis of the Asseciation of Agricultural Chemists Washingtan D.C.

BARDSLEY, C.E. and LANCASTER, J.D. 1960. *Proc. Soil Sci. Sec. Am.* **24**:265–268.

KANWAR H.S. and COPRA, S.L. 1967. Practical Agricultural Chemistry S. Chandra & Co.

PATHAK, R.K. and TRIPATHI, R.D., *Indian J. Agric. Chem.* **12**:151-157.

SINGH, N., SUBBIAH B.V. and GUPTA V.P. 1970. *India J. Agric.* **15**:24-28.

SINGH, N. and SINGH, M. 1977. *Zeitschrift fur Pflarizenernahruny* and *Benderhunde* 140:609-616.

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# PARALLEL CROPPING OF REDGRAM WITH GROUNDNUT UNDER RAINFED SITUATION

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The practice of mixed cropping or intercropping with redgram (*Cajanus cajan* (L) Millsp) is widely prevalent in the rainfed areas of India. Besides offering an insurance against the crop failure due to natural hazards such as drought, frost, incidence of pests and diseases etc., the practice enables the cultivator to obtain a variety of harvests from the same piece of land instead of occupying the field for a full year under only one crop (Pathak, 1970). Srivastava and Verma (1985) reported that the growing of groundnut with redgram was beneficial under rainfed condition. Since information on various aspects of intercropping of redgram with erect groundnut (*Arachis hypogaea* L.) cvs. is needed in this area, an experiment was conducted to work out suitable row adjustment of redgram with groundnut under rainfed condition during rainy season of 1984-85.

The experiment was conducted at Oilseeds Research Farm of the Chandra Shekhar Azad University of Agriculture and Technology, Kanpur during *kharif* 1984-85. The experiment consisted of 10 treatments tested in a RBD with four replications. Redgram genotypes used were, T-21 (short duration), T-7 (long duration and compact), and T-17 (long duration and open) and groundnut variety was G-201 (Kaushal). Pure crop of redgram T-21 was planted at $75 \times 20$ cm, whereas T-7 and T-17 were planted at $90 \times 25$ cm and groundnut was sown at $30 \times 10$ cm spacing. In intercropping system groundnut and redgram were sown in 3:1 and 6:1 row ratios.

The experimental site was a sandy loam soil with pH 7.2, and contained 0.43% organic carbon, 8.5 kg/ha available $P_2O_5$ and 210 kg/ha $K_2O$. The crops received fertilizer dose of 15 kg N+30 kg $P_2O_5$+45 kg $K_2O$/ha as basal before sowing. Sowing of both crops was done simultaneously on 23rd June, 1984. Groundnut crop was harvested in the month of November and redgram T-21 was harvested in the month of December, while T-7 and T-17 were harvested in the month of April.

The weather parameters given in Table 1 indicate that the rainfall was not sufficient for normal growth and development of groundnut crop, particularly at pod development stage. Besides this, severe infection of bud necrosis was also a major focto for poor pod yield, whereas crop season was favourable for redgram crop, because water requirement of redgram is less than groundnut. Besides this, incidence of pests and diseases were also less in redgram.

Results revealed that the pod yield of groundnut was significantly higher in pure crop than in intercropping (Table 2). Reduction of groundnut yield in inter-

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**TABLE 1. Weather parameters during the crop period**

| Month | | Rainfall (mm) | Rainy days | Temperature oC | | Relative Humidity (%) |
|---|---|---|---|---|---|---|
| | | | | Max. | Min. | |
| June | 84 | 95 | 6 | 36.8 | 27.8 | 63.9 |
| July | 84 | 310 | 16 | 32.9 | 26.4 | 78.8 |
| August | 84 | 207 | 17 | 31.7 | 26.0 | 87.9 |
| Sept. | 84 | 117 | 10 | 31.6 | 23.7 | 77.5 |
| Oct. | 84 | 8 | 1 | 32.7 | 19t1 | 58.8 |
| Nov. | 84 | – | – | 27.6 | 11.4 | 55.6 |
| Dec. | 84 | – | – | 24.2 | 8.7 | 55.5 |
| Jan. | 85 | 19. | 4 | 20.5 | 7.9 | 71.9 |
| Feb. | 85 | – | – | 24.6 | 8.6 | 50.9 |
| March | 85 | – | – | 32.8 | 14.6 | 39.7 |
| April | 85 | 3 | 2 | 37.1 | 21.7 | 29.1 |

**TABLE 2. *Yield, total monetary return and L.E.R. affected by different cropping system***

| Cropping system | Yield | | Total monetary returns | | | Land Equivalent Ratio | | |
|---|---|---|---|---|---|---|---|---|
| | Groundnut | Redgram (kg/ha) | Groundnut | Redgram (Rs/ha) | Total | G.Nut | Redgram | Total |
| Pure redgram | | | | | | | | |
| T-21 | | 2228 | — | 6684 | 6684 | — | 1.00 | 1.00 |
| T-7 | | 3152 | — | 9456 | 9456 | — | 1.00 | 1.00 |
| T-17 | | 3455 | — | 10365 | 10365 | — | 1.00 | 1.00 |
| Pure Groundnut | 1058 | — | 3703 | — | 3703 | 1.00 | — | 1.00 |
| *Inter-crops* (groundnut redgram) | | | | | | | | |
| 3 : 1 | 605 | 1538 | 2117 | 4614 | 6731 | 0.57 | 0.69 | 1.26 |
| 6 : 1 | 867 | 1109 | 3035 | 3327 | 6361 | 0.82 | 0.52 | 1.32 |
| 3 : 1 | 464 | 2533 | 1624 | 7599 | 9223 | 0.44 | 0.80 | 1.24 |
| 6 : 1 | 760 | 2264 | 2660 | 6792 | 9452 | 0.72 | 0.72 | 1.44 |
| 3 : 1 | 450 | 2781 | 1575 | 8343 | 9918 | 0.43 | 0.80 | 1.23 |
| 6 : 1 | 680 | 2500 | 2380 | 7500 | 9880 | 0.64 | 0.72 | 1.36 |
| C.D.(P=0.05) | 124 | — | — | — | 1006 | — | — | — |

*Market rate Rs./*

Redgram 300.00
Groundnut 350.00

cropping, has been reported by Mehta *et al*, (1985). The maximum yield reduction (57.7 %) was record when 3 rows of groundnut were sown beetween two rows of redgram T-17. It is perhaps due to (j) greater shading effect of T-17 which produced much larger canopy and (ii) due to much duper root system than other redgram varieties.

Data indicated that the number of primary branches, canopy width and yield per plant of redgram increased significantly with increasing row spacing, while plant height and number of dead primary branches increased by decreasing row spacings. Similar results were reported by several workers (Chauhan and Singh, 1981; Ahlawat *et al.*, 1975; Dhingra *et al.* 1980). The reaction of redgram to row spacing has also been observed here. The higher grain yield was recorded with closer row spacing of redgram.

The monetary returns (Table 3) showed significant differences among different systems. Maximum returns were recorded with pure crop of redgram T-17. The intercropping system of 3 groundnut : 1 redgram gave the highest returns followed by 6:1 with the same variety. Yadahalli (1978) found 2:1 and Veerswamy *et al.* (1974) reported 6:1 ratio of groundnut + redgram was more profitable than growing pure crop of either redgram or groundnut.

**TABLE 3. Morphological characters and grain yield/plant of redgram**

| Cropping system | At flowering stage | | | | Grain yield/ plant (gm) |
|---|---|---|---|---|---|
| | Height(cm) | No. primary branches / plant | No. primary dead bran./ plant | Canopy width/ plant (cm) | |
| *Pure redgram* | | | | | |
| T-21 | 205 | 22.7 | 7.9 | 85.3 | 33.8 |
| T- 7 | 229 | 26.7 | 4.4 | 89.8 | 71.0 |
| T-17 | 214 | 26.5 | 4.5 | 100.0 | 78.0 |
| *Inter-crops* (groundnut : redgrams) | | | | | |
| 3 : 1 | 191 | 25.8 | 2.6 | 101.0 | 37.8 |
| 6 : 1 | 180 | 26.7 | 2.4 | 125.0 | 49.1 |
| 3 : 1 | 197 | 31.8 | 2.1 | 106.2 | 75.9 |
| 6 : 1 | 193 | 33.8 | 1.8 | 128.2 | 119.1 |
| 3 : 1 | 194 | 33.2 | 2.4 | 124.2 | 85.1 |
| 6: 1 | 182 | 37.4 | 1.9 | 134.0 | 131.7 |
| C.D. (P=0.05) | 16.8 | 6.0 | 1.4 | 18.5 | 4.6 |

In the present study, mean Land Equivalent Ratio (L.E.R.) was maximum (1 44) in 6 rows of groundnut planted altering one row of redgram. cv. T-17.

The study has clearly brought out the benefits of intercropping groundnut and redgram in comparison to pure cropp of groundnut under rainfed condition.

AHLAWAT, I.P.S., SARAF, S.C. and SINGH, A. 1975. *Indian J. Agron.* 20:245-247.

CHAUHAN, R.S. and SINGH, K.B. 1981. *Indian J. Agron.* **26**(1):49-52.

DHINGRA, K.K., SINGH, S. and TRIPATHI, H.P. 1980. Phenological behaviour and yield of pigeon pea genotype under different dates of planting and row spacing. Proc. International Workshop on pigeon pea, held at ICRISAT Hyd. on 15-19 Dec. vol. 2 pp 229-233.

MEHTIA, O.P., BHOLA, A.L., TOMER, D.P.S. and YADAV, T.P. 1985. *J. Oilseeds Res.* 2:45-49.

PATHAK, G.N. 1970. Redgram, Pulse crops of India, I.C.A.R. pp. 14-53.

SRIVASTAVA, A.N. and VERMA, K.P. 1985. *J. Oilseeds Res.* 2:156-159.

VEERSWAMY, R., RATHANSWAMY, R., SELVA KUMARI, G. and BADRI NARAYAN, P. 1974. *Madras Agric. J.* **61** 801-802.

YADAHALLI, Y.H. 1978. Report on Research work on Pulses, AICP main cente, Banglore 1977-87.

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# LIFE BUDGET ANALYSIS OF *BAGRADA HILARIS* ON RAPESEED CROP

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Rapeseed, *Brassica campestris* (L) var. *toria*, normally recommended to be sown in the second fortnight of September, is often attacked by *Bagrada hilaris* Burm. for major part of the plant growth. Ecological studies of the insect pest over a period of time in successive months, not only give surviving trends at each age/stage interval, but when these measurements are considered in relation to mortality, from a budget leading to identification of critical age/stage interval when mortality factors in nature operate atmost for regulations of population trends.

Studies on life budget analysis of *B. hilaris* were conducted on rapeseed crop var. *toria* (Assam Mass Selection) during 1981-82 at Indian Agricultural Research Institute, New Delhi. The stock culture of the bug was maintained on the leaves of *toria* plants in the laboratory. Twenty five freshly laid eggs were released every week from August to first week of November near the base of the *toria* plants grown in pots and covered with muslin cage. Observations on the number of nymphs emerged and their subsequent survival were taken daily till their developing into adults. Life budget analysis from the individuals surviving at each stage was then made to identify critical stage interval wherein natural mortalities occured at maximum (Varley and Gradwell, 1960 and 1965).

The results show that in general number of survivors from an initial cohort of 25 eggs suddenly fell down from I to II instar followed by II to III instar period suggesting that these two stages were most vulnerable to natural environmental factors (Table 1).

In order to confirm critical stage interval, individual mortalities (k's) of different stages obtained in each experiment carried out were plotted on a graph along with their respective total mortalities (K's) (Fig. 1). The graph shows that the mortalities at K2 and $K_3$ i.e. during first and second instar stages are relatively higher and at the same time approximated closely to total mortalities. This showed that early nymphal stages of the bug are more vulnerable to natural mortalities as observed by Batra (1958). The mortality of the first and second instars was found to be relatively high during the middle of September. This could be due to the coincidence of rains with the early developmental stages of the bug. It was also observed that the mortalities during egg stage and fourth and fifth instar stages of the bug were low. It is suggested that detailed investigations on natural abiotic and biotic factors that cause mortality of the bug particularly at these early nymphal stages and their relative susceptibility

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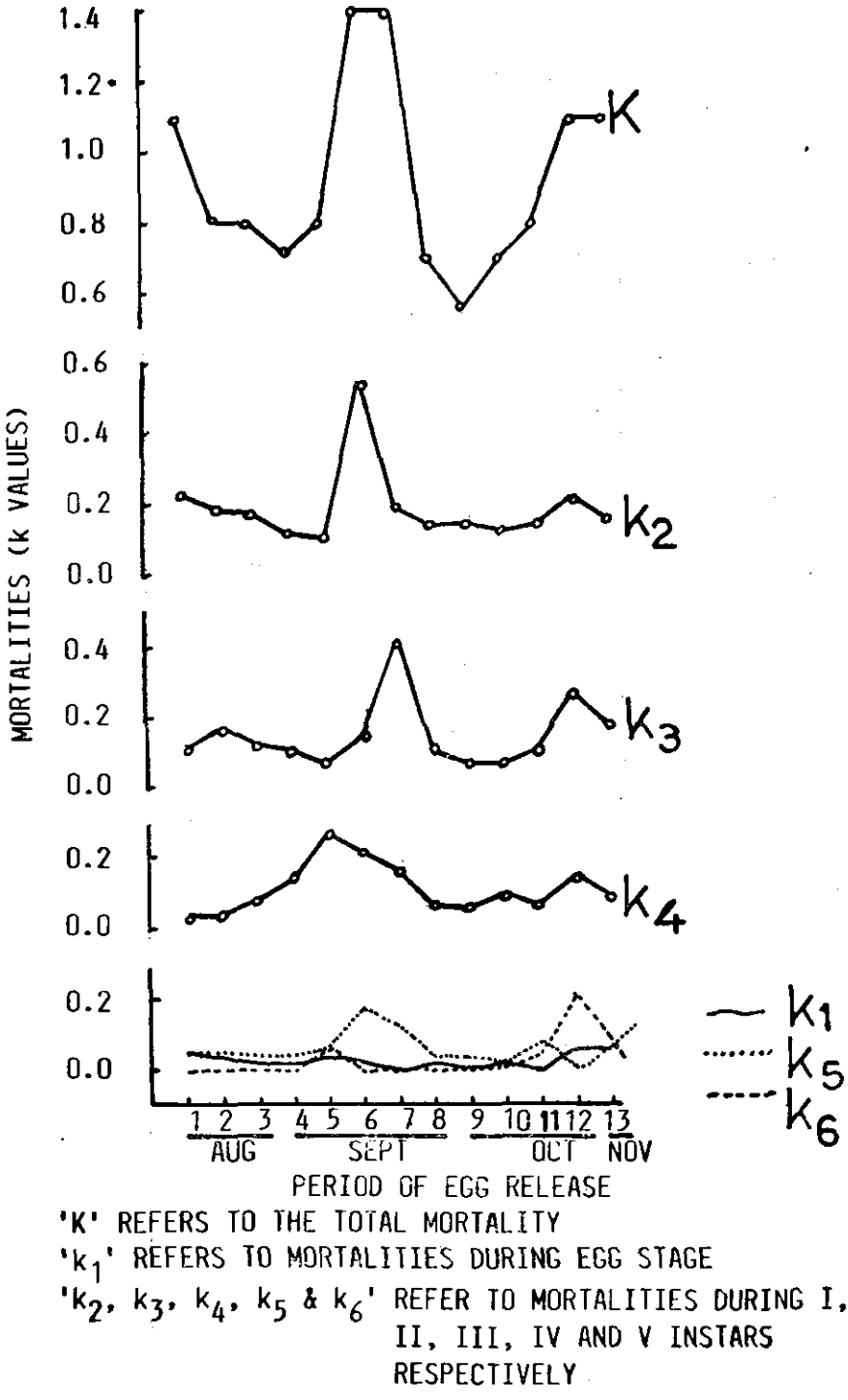


Fig. Relationship between total mortalities (k's) and individual mortalities (k's) in different stages of *B. hilaris*

**TABLE 1. Mortalities in different stages of *Bagrada hilaris***

| Stage | Date of release of the eggs and their development | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | August | | | September | | | | | October | | | November | |
| | 10th | 17th | 24th | 1st | 7th | 14th | 21st | 28th | 5th | 12th | 19th | 26th | 2nd |
| Egg | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| I Instar | 22 | 23 | 24 | 24 | 23 | 24 | 25 | 24 | 25 | 24 | 25 | 22 | 22 |
| II Instar | 13 | 14 | 16 | 18 | 18 | 7 | 16 | 17 | 18 | 18 | 18 | 13 | 15 |
| III Instar | 10 | 10 | 12 | 14 | 15 | 5 | 6 | 13 | 15 | 15 | 14 | 7 | 10 |
| IV Instar | 9 | 9 | 10 | 10 | 8 | 3 | 4 | 11 | 13 | 12 | 12 | 5 | 8 |
| V Instar | 8 | 8 | 9 | 9 | 7 | 2 | 3 | 10 | 12 | 12 | 10 | 5 | 7 |
| Adults emerging | 8 | 8 | 9 | 9 | 6 | 2 | 3 | 10 | 12 | 11 | 9 | 3 | 6 |

to various insecticides should be taken up intensively in order to manage the pest at low profile effectively.

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BATRA, H.N. 1958. *Indian Jour. Ent.* 20(2):130-135.

VARLEY, G.C. and GRADWELL, G.R. 1960. *J. Anim. Ecol.* 29:399-401.

VARLEY, G.C. and GRADWELL, G.R. 1965. Interpreting winter moth population changes. Proc. XII *Int. Congr. Ent.* p. 377-378.

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# COMBINING ABILITY FOR YIELD IN SESAME

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Sesame (*Sesamum indicum* L.) is a self pollinated crop. However, reports on occurrence of cross pollination to the extent of 65.0% (Brar and Ahuja, 1979) have been made. The $F_1$ population showing both positive heterosis (Srivastava and Prakash, 1977) and negative heterosis (Shrivas and Singh, 1981) have been noticed. It is essential to find out the best parents to get higher heterotic value and hence a study was made to find out the combining ability for yield in sesame.

Twenty four stabilized lines were crossed with three released varieties viz.,Co. 1, TMV 3 and TMV 6 during 1984. During summer 1985 the F1's were grown in RBD with two replications. Each treatment was represented by 50 plants with a spacing of 45 cm × 15 cm. The per plant yield was assessed in five randomly selected plants in each treatment and the data were subject to combining ability analysis of Kempthorne (1957).

The analysis of variance and proportional contribution of the lines, testers and line × tester are given in Table 1. The highly significant variance indicated by line, tester and line × tester exhibited the prevalence of high variation and high heterotic nature for yield potential. The significance of line × tester interaction also indicated the importance of specific combining ability. The proportional contribution to the total variance by lines and testers (Table 1) revealed that the lines and line × tester have contributed more than the testers. This corroborated with the findings of Ananda Kumar and Sree Rangasamy (1984) in rice.

The relative estimates of variance due to specific combining ability were higher than general combining ability (Table 1) indicating the importance of specific combining ability and predominant nature of non-additive gene action for yield, thus indicating the high scope for exploitation of heterosis in hybrid sesame. Similar findings were reported in mungbean (Gupta *et al.*, 1978; Luthra *et al.*, 1979) and in rice (Singh *et al.*, 1980).

The general combining ability and specific combining ability for yield are given in Table 2. Out of the three tester varieties, the two testers, Co. 1 and TMV 3 alone, showed positive significant gca. With respect to the lines, all excepting HD 22, HD 23, HD 31, HD 47 and HD 68, showed significant gca. But among the remaining ones, only 10 lines showed positive significant gca viz., HD 11, HD 16, HD 27, HD 32, HD 38, HD 43, HD 44, HD 45, HD 62 and HD 65. The maximum positive gca was exhibited by HD 11 and HD 62 with values of 3.50 and 3.28 respectively. So, these ten lines showing positive significant variance can be used as parents with good general combining ability for yield. The specific combining ability estimates brought out that

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a minimum of eight crosses showed positive significant value with each tester. The lines HD 31, HD 47, and HD 68 combined very well with Co. 1 and TMV 3. Similarly, HD 16 and HD 62 showed positive significant combination with TMV 3 and TMV 6, while HD 24 and HD 45 performed better when combined with Co. 1 and TMV. 6.

**TABLE 1.** ***Anova for combining ability in line × tester for yield***

| Sources of variation | df | MSS | Proportional contribution (%) |
|---|---|---|---|
| Replication | 1 | 0.017 | |
| Treatment | 71 | 11.511** | |
| Line | 23 | 19.486** | 54.81 |
| Tester | 2 | 13.442** | 3.28 |
| Line × Tester | 46 | 7.455** | 41.94 |
| Error | 71 | 0.129 | |
| *Estimated variance* | | | |
| gac Line | | 2.0052 | |
| gac Tester | | 0.1247 | |
| gca Average | | 0.0493 | |
| sca | | 6.0156 | |

** Significant at P = 0.01

Other combinations showed only non-significant or negative values. The above fourteen combinations may, therefore, be advocated for the production of hybrid sesamum. The yield per plant ranged from 3.70 g in HD 24 × TMV 6 to 8.75 g in HD 45 × Co.1 among these fourteen crosses (Table 3).

**TABLE 2. GCA and SCA in line × tester for yield ability in sesame**

| Cultures | General combining ability | Specific combining ability of hybrids with | | |
|---|---|---|---|---|
| | | Co. 1 | TMV 3 | TMV 6 |
| *Line* | | | | |
| HD 5 | -2.63** | -0.18 | -0.27 | 0.46 |
| HD 6 | -2.71** | 0.05 | -0.44 | 0.38 |
| HD 8 | -0.73** | -0.08 | -2.07 | 2.26** |
| HD 11 | 3.50** | -2.66** | 0.79** | 1.87** |
| HD 16 | 1.17** | -0.48 | -1.07** | 1.55** |
| HD 22 | -0.33 | -1.18** | -1.37** | 2.55** |
| HD 23 | -0.27 | 0.97** | 0.63 | -1.59** |
| HD 24 | -0.91** | 1.00** | -2.29** | 1.28** |
| HD 27 | 0.88** | 1.00** | 0.06 | -1.06** |
| HD 30 | -1.18** | -1.48** | 1.63** | -1.14 |
| HD 31 | 0.40 | 1.03** | 0.79* | -1.83** |
| HD 32 | 1.38** | -0.19 | 3.11** | -2.91** |
| HD 33 | -1.43** | -0.38 | -0.02 | 0.70 |
| HD 38 | 1.34** | -0.55 | 0.26 | 0.29 |
| HD 43 | 1.07** | 0.12 | 3.28** | -3.39** |
| HD 44 | 2.22** | 2.37** | -1.67** | -0.69 |
| HD 45 | 1.00** | 3.58** | -4.31** | 0.72* |
| HD 47 | -0.13 | 0.87* | 0.87* | -1.74** |
| HD 48 | -1.23** | -1.18** | 1.93** | -0.74** |
| HD 62 | 3.28** | -2.79** | 1.01** | 1.78** |
| HD 65 | 1.12** | 0.02 | -0.52 | 0.1 |
| HD 68 | -0.13 | 0.82* | 0.87* | -1.69** |
| HD 74 | -3.01** | -0.25 | -0.09 | 0.34 |
| HD 94 | -2.71** | -0.29 | -1.09** | 1.39** |
| *Tester* | | | | |
| Co. 1 | 0.23** | — | — | — |
| TMV 3 | 0.37** | — | — | — |
| TMV 6 | -0.61** | — | — | — |
| gca SE (Line) | 0.147 | | | |
| gca SE (Tester) | 0.052 | — | — | — |
| sca SE | 0.254 | — | — | — |

* Significant at p=0.05
** Significant at p=0.01

**TABLE 3. Performance of the best fourteen crosses (mean yield/plant)**

| Sl. No. | Crosses | Mean yield per plant |
|---|---|---|
| 1. | HD 31 × Co 1 | 5.60 g |
| 2. | HD 47 × Co 1 | 4.90 g |
| 3. | HD 68 × Co 1 | 4.85 g |
| 4. | HD 31 × TMV 3 | 5.50 g |
| 5. | HD 47 × TMV 3 | 5.05 g |
| 6. | HD 68 × TMV 3 | 4.40 g |
| 7. | HD 16 × TMV 3 | 4.40 g |
| 8. | HD 16 × TMV 6 | 6.06 g |
| 9. | HD 62 × TMV 3 | 8.60 g |
| 10. | HD 62 × TMV 6 | 8.40 g |
| 11. | HD 24 × TMV 6 | 3.70 g |
| 12. | HD 24 × Co 1 | 4.25 g |
| 13. | HD 45 × TMV 6 | 5.05 g |
| 14. | HD 45 × Co 1 | 8.75 g |

ANANDA KUMAR, C.R. and SREE RANGASAMY, S.R. 1984. *Oryza* **21**:218-224.

BRAR, G.S. and AHUJA, K.L. 1979. Sesame : Its culture, genetics, breeding and biochemistry. Annual Rev. Plant Sciences C.P. Malik, Kalyani Publishers.

GUPTA, S.N., ARORA, N.D., SINGH, R.K. and CHAUDHARY, B.D. 1978. *J. Hered.* 10,59-66.

KEMPTHORNE, O. 1957. *An introduction to genetic statistics*, John Wiley and Sons, New York, PP. 510.

LUTHRA, O.P., ARORA, N.D., SINGH, R.K. and CHAUDHARY, B.D. 1979. *Haryana Agric Univ. J. Res.* **9**:18-24.

SHRIVAS, S.R. and SINGH, S.P. 1981. *Indian J. Genet.* **41**:1-4.

SINGH, S.P., SINGH, R.R., SINGH, R.P. and SINGH, R.V. 1980. *Oryza*, **17**:104-108.

SRIVASTAVA, S.C. and PRAKASH, R. 1977. *Curr. Res.* 6:49-51.

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# HETEROSIS FOR SEED SIZE AND OIL CONTENT IN LINSEED

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In linseed heterosis for yield and its components has been reported by Neelam (1978), Shrivas (1979) and Rao (1980). However, such informations for the quality characters of linseed are limited. Hence, this investigation was undertaken to study the extent of heterosis for seed size components, developmental period of seed and oil content in linseed.

Sixteen divergent genotypes of linseed grouped into four clusters using $D^2$ analysis by Neelam (1978) were utilized as basic material. The varieties belong to the groups 1, 2 and 3 were evolved through hybridization and selection while those of group 4 were exotic cultures. Each of the 16 genotypes were crossed with other genotypes as per fractional diallel mating design IV given by Fyfe and Gilbert (1963). The 48 $F_1$'s and 16 parents were grown in a randomized complete block design with four replications. Each entry was grown in two row plot, each of 2.5 m long. All entries were grown in continuous rows. Row to row distance was 35 cm apart with the plant to plant distance of about 5 cm. The experiment was conducted in light soil having poor in nitrogen content with pH as 6.8. Recommended dose of 30 Kg N and 20 Kg $P_2O_5$ per hectare was given as basal dose. Ten competitive plants (5 plants/row) were used to record period from flowering to maturity. The bulk samples of ten plants produce was used to record 1000 seed weight and Oil estimation (%). Oil content in each entry was estimated by Soxhlet extraction using petroleum ether. Seed length and width were recorded in mm by using plastic scale of ten seeds randomly drawn from the bulk of each entry of each replication. Seed density was calculated by finding of volume of 5 g seed and seed density was expressed in g/cc. Heterosis of $F_1$ over better parent were calculated.

As heterosis over superior parents will be of much practical significance, the results of the present investigation are discussed in the light of available literature. The percentage of $F_1$ over better parent from the period from flowering to maturity, seed size components and oil % of 48 hybrids are presented in Table 1.

**Period from flowering to Maturity**

Positive heterosis was desirable and observed in most of the hybrids. The range of heterosis was observed from -9.71 to 21.69%. Negative heterosis was observed in 13 crosses. Significant positive heterosis was observed in Neelam × NP (RR) 412 (21.69%) followed by Afg 8 × T 477 (20.72%), IPl 6 × Neelam (15.87%), T 477 × Neelam (14.97%) and EC 22609 × NP (RR) 412 (14.96%). In all 23 crosses showed significant positive heterosis.

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**TABLE 1. Heterosis (%) for seed size and oil content over better parent in linseed**

| | Cross | Period from flowering to maturity | Seed length | Seed width | 1000-seed weight | Oil(%) |
|---|---|---|---|---|---|---|
| 1. | EC 22585 × T 397 | -3.66** | -8.38** | 8.30** | -2.86** | -2.39** |
| 2. | EC 22585 × Afg 8 | -1.68** | -2.48 | 0.70 | 20.99** | -2.80** |
| 3. | EC 22585 × T 477 | 6.82** | -2.41 | -1.07 | -7.07 | -3.53** |
| 4. | EC 22585 × R 17 | 4.55** | -3.01 | -3.78 | 5.63 | -4.02** |
| 5. | EC 22585 × IPI 6 | 1.09 | -5.47** | -1.39 | 6.06 | 3.46** |
| 6. | EC 22585 × Hira | -4.67 | -8.19** | -6.12** | -13.72 | 3.91** |
| 7. | T 397 × Afg 8 | 0.49 | -14.89** | -4.63 | 3.13** | -4 05** |
| 8. | T 397 × T 477 | -1.93 | -2.23 | -1.07 | 13.72 | 1.11** |
| 9. | T 397 × Mukta | 1.58 | -5.03** | -0.24 | 2.59* | -0.74** |
| 10. | T 397 × NP (RR) 9 | 7.03** | -11.54** | 1.17 | 9.89** | 2.48** |
| 11. | T 397 × EC 22609 | 0.22 | 1.67 | 2.12 | 10.08 | -4.88** |
| 12. | Afg 8 × T 477 | 20.72** | 7.24** | -0.36 | 17.39** | 3.53** |
| 13. | Afg 8 × EC 9832 | -1.15 | 9.07** | 8.67** | 1.09 | 5.02** |
| 14. | Afg 8 × GLC 6 | 4.31** | -4.45* | -3.64 | -4.16** | 9.30** |
| 15. | Afg 8 × GLC 2-1 | -0.08 | -9.16** | 5.67* | -14.29** | 4.95** |
| 16. | T 477 × No. 55 | 4.08 | 3.62 | -2.50 | 9.78** | 0.27** |
| 17. | T 477 × Neelam | 14.97** | 1.77 | 3.93 | -0.67 | -4.29** |
| 18. | T 477 × NP (RR) 412 | 4.51* | 2.62 | 3.21 | 10.46** | 1.02** |
| 19. | R 17 × Mukta | 6.65** | 1.13 | -7.19 | 10.61** | -4.80** |
| 20. | R 17 × EC 9832 | 2.82 | -9.22** | 4.76 | -3.70 | -5.17** |
| 21. | R 17 × No. 55 | -1.94 | -3.95* | 3.80 | -7.62** | -5.50** |
| 22. | R 17 × IPI 6 | 2.94 | -11.09** | -3.82 | 7.14** | -1.15** |
| 23. | R 17 × Hira | 10.26** | 8.56** | 7.91** | -4.09 | -6.65** |
| 24. | Mukta × EC 9832 | -3.04** | 2.55 | -14.04** | -13.33** | -14.02** |
| 25. | Mukta × No. 55 | 3.69 | 0.78 | -5.14** | 14.27** | -4.72** |
| 26. | Mikta × NP (RR) 9 | 0.85 | 2.55 | -6.51** | 4.60** | -7.11** |
| 27. | Mukta × EC 22609 | 2.05 | 0.19 | -3.77 | 5.66** | -9.52** |
| 28. | EC 9832 × No. 55 | 7.42** | 2.84 | 3.42 | 1.39 | -3.93** |
| 29. | EC 9832 × GLC 2-1 | -9.71** | -25.31** | -14.57** | -36.09** | 8.74** |
| 30. | EC 9832 × GLC 6 | -1.89* | -5.03** | -1.09 | -14.68** | -1.71 |
| 31. | No. 55 × Neelam | 13.01** | -8.14** | 11.41** | -7.70* | -1.19** |

| | Cross | Period from flowering to maturity | Seed length | Seed width | 100-seed weight | Oil (%) |
|---|---|---|---|---|---|---|
| 32. | No. 55 × NP (RR) 412 | 10.12** | -2.23 | 6.81** | 4.85** | 1.89** |
| 33. | IPI 6 × NP (RR) 9 | 8.46** | -5.20** | -3.82 | 23.96** | -0.67** |
| 34. | IPI 6 × GLC 6 | 13.20** | 3.12 | -3.81 | 31.68** | 1.78** |
| 35. | IPI 6 × Neelam | 15.87** | 2.25 | 5.55** | 1.93 | 0.14 |
| 36. | PI 6 × Hira | 4.75** | 0.00 | 5.21* | 1.60** | 0.48** |
| 37. | NP (RR) 9 × GLC 6 | -0.74 | -4.26* | 9.39** | 6.75** | 0.68** |
| 38. | NP (RR) 9 × Neelam | 7.07** | -8.32** | 3.61 | -8.19** | -1.10** |
| 39. | NP (RR) 9 × EC 22609 | -6.26** | 9.33** | -2.12 | 17.97** | -1.39** |
| 40. | GLC 6 × Neelam | 6.69** | -2.48 | -2.18 | -4.24** | -0.65** |
| 41. | GLC 6 × GLC 2-1 | -1.94 | -2.51 | 4.36* | 3.10** | 2.45** |
| 42. | Neelam × NP (RR) 412 | 21.69** | -15.93** | 4.26 | -17.44** | 7.68** |
| 43. | Hira × EC 22609 | -3.18 | -15.48** | -4.59 | -6.60** | -2.63** |
| 44. | Hira × GLC 2-1 | 4.26** | 0-.72 | -7.90** | 4.15** | 5.70** |
| 45. | Hira × NP (RR) 412 | 8.33** | -8.20** | 11.15** | -11.17** | -0.14* |
| 46. | EC 22609 × GLC 2-1 | 4.70 | -8.00** | -2.83 | 12.98** | 1.71** |
| 47. | EC 22009 × NP (RR) 412 | 14.96** | 2.38 | 5.65** | 1.67** | 2.40** |
| 48. | GLC 2 - IX NP(RR) 412 | 11.52** | -8.62** | 34.41** | 2.94** | |

* Significant at P=0.05

** Significant at P=0.01

**Seed Length**

Haterosis ranged from -25.31 to 9.33 (%). Thirty crosses showed negative heterosis for this character. Twenty two crosses showed significant negative heterosis, whereas only three showed significant positive heterosis. However, the highest negative heterosis for this character was observed in EC 9832 × GLC 2-1 (-25.3%) followed by Neelam × NP (RR) 412 (15.93%) and Hira × EC 22609 (-15.48%). On the other hand, the highest positive heterosis was observed in NP(RR)9 × EC 22609 (9.33%).

**Seed Width**

Significant positive heterosis was observed in only 13 crosses. The heterosis values ranged from -14.57 to 34.41%. The highest positive heterosis was observed in GLC 2-1 × NP(RR) 412 (34.41%) followed by No. 55 × Neelam (11.41%). The highest negative heterosis was observed in EC 9832 × GLC 2-1 (-14.57%) followed by Mukta × EC 9832 (-14.04%).

***1000*—Seed Weight**

The magnitude of heterosis ranged from - 36.19 to 31.68%. Nineteen crosses had negative heterosis. Significant positive heterosis was observed in 23 crosses. The highest significant positive heterosis for 1000-seed weight was observed in IPI 6 × GLC 6 (31.68%) followed by IPI 6 × NP(RR)9 (23.96%) and NP(RR)9 × EC 22609 (17.97 %). EC 9832 × GLC 2-1 recorded the highest significant negative heterosis (-36.19%) followed by Neelam X NP(RR) 412 (-17.44%).

**Oil (%)**

Heterosis values ranged from—14.02 to 9.3%. The highest positive significant heterosis of 9.3% was observed in Afg. 8 × GLC 6 followed by EC 9832 × GLC 2-1 (8.74%) and Neelam × NP(RR)412 (7.68%). The highest significant negative heterosis was also observed in Mukta × EC 9832 (-14.02%) followed by Mukta × EC 22609 (-9.52%).

The degree of heterosis for different characters varied considerably with maximum heterosis in desirable direction, for seed size and seed developmental period. The bolder seed fetch high premium in the market, hence heterosis for seed size had a practical value for the breeder. Apart from this, heterosis for seed development had some impact on the seed filling during the developmental stages of seed components. Some crosses viz. Neelam × NP(RR)412, EC 9832 × GLC 2-1, Afg 8 × GLC 6 had significant positive heterosis for oil content indicated the possibility of increase in seed size and oil content. In Neelam × NP(RR)412 which had highly significant negative heterosis for seed size coupled with the heterosis for oil content indicated that it was not possible to continue the bold seed size with high oil content in linseed hybrid through heteresis breeding.

FYFE, J.L. and GILBERT, N. 1963. *Biometrics* **19**:286-298.

NEELAM SINGH 1978. *Genetic studies in linseed* (*Linum usitatissimum* L.) Unpublished Ph.D. Thesis, University of Jabalpur, Jabalpur, India.

RAO, S.K. 1980. *Genetic improvement of yield in linseed*. Unpublished Ph.D. Thesis, JNKVV, Jabalpur.

SHRIVAS, S.R. 1979. Genetic analysis of yield and its components in linseed (*Linum usitatissimum* L.) Unpublished Ph.D. Thesis, JNKVV Jabalpur, India.

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# EFFICACY OF VARIOUS FUNGICIDES TO CONTROL ANTHRACNOSE OF SOYBEAN

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Anthrancose incited by *Colletotrichum dematium* f. sp. *truncata* is one of the momentous diseases of soybean (*Glycine max* L. Merrill) as it attacks all above ground plant parts except roots (Tiffany, 1951). The percentage of infection on various plant parts varies from 0.8-3.17, 12.36-18.82 and 21.59-37.03 on seed, pod and whole plant respectively (Thakur, 1984). Nicholson (1973) while studying anthracnose observed for the first time that the germination and field emergence of soybean was reduced by 25% and 80% at pre and post emergence stages respectively. The pre- and post-emergence mortality due to *C. truncatum* on mungbean varied from 17 - 13 per cent (Singh 1977). Thus, the infection caused by *C. dematium* f. sp *truncata* is very severe and hence it is essential to evaluate several fungicides to cope up the problem of anthracnose.

Twelve systemic and non systemic fungicides-Captafol, Captan, Carbendazim, Carboxin, Chlorothalonil, Copperoxy chloride, Ferbam, Mancozeb, Thiophanate methly, TMTD, Triforine, Zineb were evaluated *in vitro* by posioned food technique The seeds with natural infection were treated with Baytan (0.2%), Baytan+ TMTD (0.2%), Benomyl (0.2%), Captan (0.3%), Carboxin (0.2%), Chlorothalonil (0.3%), Ferbam (0.3%), Thiophanate methyl (0.3%), TMTD (0.3%) following standard blotter method. Observations were recorded on the eighth day of incubation.

In pot (*in vivo*) study, same seed sample and fungicides were used. The experiment was conducted under simple randomized block design with ten treatments and four replications. One hundred seeds were treated with each fungicide. Field soil was filled in 30 pots of 60 cm diameter. In each pot, 25 treated seeds were sown. pots with untreated seeds served as control. Observations on percentage germination and post-emergence mortality were recorded after 10 days from the date of sowing and after 30 days of sowing respectively.

*In vitro* study, it was observed that both systemic and non systemic fungicides viz. Ferbam, TMTD and Triforine at 500 ppm concentration were most effective in inhibiting the complete growth of *C. dematium* f. sp. *truncata*. while other worker such as Chacko (1977) reported these fungicides to be most effective at 2000 ppm concentration *in vitro*. The reduced concentration of these fungicides against *C. dematium* f. sp *truncata* is the new achievement in the present experiment.

Seed treatment with various fungicides clearly indicated that Baytan+TMTD (1:1-0.2%), Ferbam (0.3%) and TMTD (0.3%) were best as the seeds were free from infection of *C. dematium* f. *sp. truncata*. The percentage of seed germination was maximum in case of Ferbam (96.6%) followed by Baytan+TMTD (1:1-0.2%), TMTD, TMTD, Thiopnanate methyl (93.3%) and minimum in Carboxin (80.0%) as compared. to control (73.0%). Singh *et al.* (1973) reported TMTD @ 4.5g/Kg of seed in soybean to be best in controlling *Colletotrichum* spp. and other seed borne fungi. It also resulted

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in improving the emergence and showed no significant reduction in nodulation (Nane *et al.*, 1973). Chacko (1977) reported seed treatment with TMTD to be most effective against *C. dematium* f. sp. *truncata*.

The result of pot experiment are presented on Table 1. It is clear from the table that there is significant increase in germination by seed treatment with Baytan+ TMTD (1:1) followed by TMTD, Ferbam and Carboxin as compared to control. The per cent emergence in these treatments are 70.0, 65.0, 60.6 and 60.0 respectively. The Percentage of pre-emergence mortality was higher due to field soil taken from the section of plant pathology while in earlier experiment the fungicides effectivity were tested by standard blotter method in which seeds were found free from *C. dematium* f. sp. *truncata*, and other seed-borne fungi. Even then, the percentage of pre-emergence mortality was less in above treatments in comparison to control. No post-emergence mortality was recorded in these treatments. Triforine was not included in pot experiment. Chacko (1977) also reported similar findings. Hence, Baytan+TMTD, Ferbam and TMTD proved to be the best fungicides against *C. dematium* f. sp. *truncata* causing anthracnose in soybean.

**TABLE 1. Efficacy of fungicides as sead treatment against *Colletotrichum dematium* f. sp. *truncata* associated with soybean seeds in pots (%)**

| Fungicides | Percentage of seed Germination | Percent mortality | |
|---|---|---|---|
| | | pre-emergence | post-emergence |
| Baytan | 50.00 (45.00) | 50.00 (45.00) | 3 |
| Benomyl | 46.50 (42.99) | 53.5 (47.00) | 3 |
| Baytan + TMTD | 70.00 (56.80) | 30.00 (33.20) | 0 |
| Captan | 40.00 (39.08) | 60.00 (50.70) | 1 |
| Chlorothalonil | 46.25 (42.84) | 53.75 (47. 1) | 2 |
| Ferbam | 60.00 (50.77) | 40.00 (39.20) | 0 |
| TMTD | 65.00 (53.46) | 40.00 (39.10) | 0 |
| Thiophanate methyl | 38.50 (38.33) | 61.50 (51.60) | 1 |
| Carboxin | 60.00 (52.77) | 40.00 (39.10) | 4 |
| Control | 30.00 (33.17) | 70.00 (56.80) | 7 |
| C.D. (P = 0.05) | 4.63 | 3.62 | |

* Average of four replicates
Figures in parentheses are transformed values

CHACKO, S. 1977. Study on anthrachose disease oI soybean caused by *Colletorichum dematium*. *Thesis* M. Sc. (Ag.), Plant Pathology JNKVV, Jabalpur.

NENE, Y.L., THAPLIYAL, P.N., SHRIVASTAVA, S.S.L., SORBHOY A.K. and KHARE, M.N. 1973.

NICHOLSON, J.F. 1973. The effect of internally seed-borne microorganisms on soybean seed quality. Ph.D. *Thesis*, Illionois, 41 pp.

SINGH, O.V., AGRAWAL V.K., and NENE, Y.L., 1973. *Indian Phytopath.* **26**:(2):260-267

SCHMITZ, H. 1930. Indust. Engin. Chem. Analyst. Ed. 2, 361

SINGH, V. 1977. Studies on *Collectotrichum* species associated with urid seeds. *Thesis* M.Sc. (Ag.) Plant Pathology, JNKVV, Jabalpur, 54 pp.

TIFFANY, L.H. 1951. *Phytopathology* **41**:975-985.

THAKUR, M.P. 1984. Epidemiological studies on the seed-borne fungi of soybean with special reference to *Colletotrichum dematium* f. sq. *truncata*. *Thesis*, M.Sc. (Ag.) Plant Pathology, JNKVV, Jabalpur, 93 pp.

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# ESTIMATION OF HETEROSIS IN INFRA-SUBSPECIFIC CROSSES OF GROUNDNUT

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Information on magnitude and direction of heterosis is of value in evaluating the hybrids for their genetic potential. The $F_1$ hybrids having low probability of producing high yielding lines can be discarded to allow the extension of the better crosses to further generation testing.

In their genetic divergence studies Arunachalam *et al.* (1980) concluded that the divergence among the Spanish and Valencia varieties was substantial enough to suggest Spanish × Spanish or Valencia × Valencia crosses as possible starting points of groundnut breeding programme. Similarly Wynne *et al.* (1970), Parker *et al.* (1970) observed evidence of heterotic response in crosses between Valencia and Spanish parents of groundnut.

Two parents belonging to Spanish (J11 and TMV 2) and three parents belonging to Valencia (Acholiwhite, EC 21083-A and Gangapuri) were crossed in a diallel set. The ten $F_1$ hybrids derived were evaluated for heterotic response over better parent.

Heterosis was positive for pod yield per plant in all $F_1$ hybrids except in crosses Acholiwhite × EC 21083-A (both are Valencia types). The highest percent heterosis over better parent (72%) was seen in a Valencia × Spanish (Acholiwhite × J11) combination. Similarly crosses J11 X Gangapuri and J11 X EC 21083-A too exhibited high percent heterosis over better parent. The study is in agreement with the observations made by Isleib and Wynne (1980), Garet (1976), Wynne *et al.* (1970).

The cross (J11 X TMV 2) showing high mean performance exhibited low percent heterosis. This would indicate that crosses between parents having high mean value may result in hybrids with high mean performance but need not necessarily show high percent heterosis. An over all examination of percent heterosis for this trait clearly revealed that the three Valencia parents appeared to be genetically more divergent with J11 than TMV2. The cultivars EC 21083-A and Gangapuri appeared to be genetically divergent though both of them belong to same botanical group. Similar tendency was observed for number of kernels per plant where J11 × EC 21083-A was observed to be divergent cross.

For Sound Mature Kernels (SMK) two best performing parents (J11 and EC 21083-A) gave a hybrid with high mean value, but not high percent heterosis. While, a hybrid between two intermediate parents (J11 X TMV 2) exhibited high mean as well as high percent heterosis. Crosses of this kind need more attention, because they are likely to throw more promising seggregants for a wider choice.

Narrow range of heterosis was observed for shelling percentage and 100-kernel weight as reported by other workers (Srivasthava and Singh, 1968; Singh *et al.*, 1974). Probably infra specific crosses may be of more use for improving these characters.

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**TABLE 1. Heterosis over better parent for five characters studied in a 5×5 diallel set of crosses in groundnut**

| Parents and $F_1$ hybrids | No. of mature pods per plant | | weight of SKM(g) per plant | | Shelling % | | 100-kernel weight (g) per plant | | Pod yield (g) per plant | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | $H_2$% | Mean | $H_2$% | Mean | $H_2$% | Mean | $H_2$% | Mean | $H_2$% |
| Acholiwhite | 19.46 | — | 12.99 | — | 66.35 | — | 25.84 | — | 20.84 | — |
| J 11 | 29.93 | — | 15.09 | — | 75.75 | — | 28.24 | — | 20.84 | — |
| TMV 2 | 39.00 | — | 16.58 | — | 67.76 | — | 24.03 | — | 25.68 | — |
| EC 21083-A | 25.93 | — | 20.50 | — | 73.59 | — | 42.75 | — | 28.81 | — |
| Gangapuri | 15.93 | — | 10.48 | — | 65.69 | — | 25.82 | — | 17.45 | — |
| 1 × 2 | 45.40 | 51.69 | 21.75 | 44.14 | 63 97 | 15.85 | 29.98 | 6.16 | 35.94 | 72.46 |
| 1 × 3 | 42.07 | 7.87 | 20.05 | 20.93 | 63.07 | - 6.92 | 30.50 | 18.04 | 31.82 | 23.91 |
| 1 × 4 | 29.13 | 12.34 | 13.30 | -35.12 | 61.56 | -16.35 | 30.33 | -29.05 | 22.85 | -20.68 |
| 1 × 5 | 23.03 | 18.35 | 17.51 | 34.79 | 68 89 | 3.82 | 28.81 | 11.49 | 26.79 | 28.55 |
| 2 × 3 | 45.73 | 17.26 | 24.94 | 50.42 | 72.28 | - 4.58 | 30.97 | 9.67 | 36.23 | 41.08 |
| 2 × 4 | 46.20 | 54.36 | 28.93 | 41.12 | 74.25 | - 1.98 | 36.94 | -13.59 | 42.62 | 47.93 |
| 2 × 5 | 38.20 | 27.63 | 19.45 | 28.89 | 65.47 | -13.57 | 32.74 | 15.94 | 31.52 | 51.25 |
| 3 × 4 | 32.00 | -17.95 | 20.57 | 0.34 | 71.00 | - 3.51 | 37.99 | -11.13 | 29.97 | 4.03 |
| 3 × 5 | 37.87 | - 2.89 | 19.86 | 19.78 | 64.56 | - 4.72 | 31.92 | 23.62 | 32.15 | 25.19 |
| 4 × 5 | 39.87 | 53.76 | 18.07 | -11.85 | 59.36 | -19.34 | 32.60 | -23.74 | 32.21 | 11.80 |
| SE | ±5.33 | — | ±3.41 | — | ±3.67 | — | ±3.33 | — | ±4.94 | — |
| CD (P ≈ 0.05) | 10.91 | — | 6.99 | — | 7.52 | — | 6.81 | — | 10.13 | — |
| CV % | 19.20 | — | 23.39 | — | 6.66 | — | 13.01 | — | 20.86 | — |

H2% = Heterosis over better parent

ARUNACHALAM, V., BANDYOPADHYAY, A., NIGAM, S.N. and GIBBONS, R.W. 1980. Some basic results of applied value in groundnut breeding. National seminar on the applications of genetics to improvement of groundnut. Tamil Nadu Agricultural University. p 1-19.

GARET, B. 1976. *Oleagineux* **31**:435-442.

ISLEIB, T.G. and WYNNE, J.C. 1980. *APRES proc.* **12**(1): p. 74.

PARKER, R.C., WYNNE, J.C. and EMERY, D.A. 1970. *Crop. Sci.* **10**:429-432.

SINGH, T.P., SINGH, K.B. and BRAR, J.S. *Indian J. Genet.* **34**:427-432.

SRIVASTHAVA, D.P. and SINGH, S.N. 1968. *J. Indian Bot. Sci.* **47**:79-88.

WYNNE, J.C., EMERY, D.A. and RICE, D.W. 1970. *Crop Sci.* **10**:713-715.

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# COMBINING ABILITY AND HETEROSIS STUDIES FOR YIELD AND ITS COMPONENTS IN SOYBEAN.

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Combining ability analysis is a useful technique to assess the nicking ability of the parents in the self-pollinated crop like soybean and this helps in selecting desirable parents and crosses for further exploitation. Besides, the testing of such breeding material under diverse agro-climatic conditions gives information on genotype × location interaction. The present studies on 6×6 diallel cross were conducted to gather information about the general and specific combining ability of the parents. Estimation of heterosis will give an idea to screen some of the crosses in $F_1$ generation and to proceed further with the promising crosses to isolate the desirable transgressive segregants for economic traits.

Six genotypes of soybean of diverse geographical origin viz; JS2 and JS75-1 (M.P.), T49 (U.P.), Kalitur (Maharashtra) and improved Pelican and Cocker Stuart (USA) with their 15 one way $F_1$'s in all possible combinations were evaluated in a randomized complete block design with three replications at two locations viz; (i) Jabalpur having medium clay soils with high rainfall (1500 mm) and (ii) Badnawar having heavy black cotton soils with low rainfall (1000mm) during khurif 1981. Each plot consisted of 3 m row length with row and plant spacing of 50 and 15 cm, respectively. The observations were recorded on nine quantitative traits (Table 1) from 10 competetive plants selected randomly. Mean values of each genotypes of each replication were subjected for combining ability analysis (Griffing, 1956) and heterobeltosis was worked out.

Results of pooled estimates of combining ability variances (Table 1) and its effects (Table 2) alongwith heterobeltosis have been discussed.

In general, the estimates of GCA variances over SCA variances were of higher magnitude for all the traits except days to maturity, primary branches/plant and number seed/pod. Mean squares due to GCA and SCA variances were highly significant for all the characters with the exception of primary branches/plant and seed/pod which indicated equal contribution of both additive and non-additive genetic variances. GCA × Location and SCA × Location interactions were highly significant for days to 50% flowering, days to maturity, 100-seed weight and protein percentage (Table 1).

Estimates of GCA effects indicated that three parents viz; JS2, T49 and Cocker Stuart showed consistent negative values for days to flowering suggesting that these parents were the best general combiners for inducing early flowering and dwarf plant height. T49 appeared to be a good combiner for primary branches/plant, seed yield/plant, 100-seed weight and protein percentage. Kalitur, JS 75-1 and Improved Pelican proved to be better combiners for all tall plant height and seeds/pod. Improved Pelican and Cocker Stuart were found to be good combiners for high oil content.

Days to 50% flowering and days to maturity showed predominant role of additive and dominance variances, respectively. All the four combinations with T49

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**TABLE 1. Pooled estimates of mean sum of squares of general and specific combining ability and their interactions with locations for nine quantitative characters in parents and $F_1$ diallel crosses of soybean**

| Source of variation. | Days to 50% flowering. | Days to maturity. | Plant height. | No. of primary branches. | Seed yield/ pant· | 1000-seed weight. | No. of seed/pod | Protein (%) | Oil(%) |
|---|---|---|---|---|---|---|---|---|---|
| GCA | 99.29 | 11.21** | 1711.57** | 1.33 | 383.30** | 43.60** | 0.03 | 5.88** | 5.84** |
| SCA | 80.98** | 18.66** | 847.23** | 1.62** | 171.75** | 15.05** | 0.04** | 2.45** | 4.01** |
| Location | 15.75** | 34.41** | 108.44 | 56.23** | 483.28** | 45.82** | 0.22** | 0.06 | 25.30** |
| GCA × Location | 32.96** | 5.67** | 23.21 | 0.17 | 113.28* | 1.56* | 0.01** | 0.80* | 1.12 |
| SCA × Location | 8.70** | 3.70** | 49.36 | 0.40 | 54.12 | 1.64** | 0.02 | 0.91** | 1.26** |
| Error | 2.03 | 1.45 | 55.53 | 0.58 | 44.65 | 0.60 | 0.01 | 0.03 | 0.52 |
| GCA : SCA | 1.23:1 | 0.60:1 | 2.02:1 | 0.83:1 | 2.38:1 | 2.90:1 | 0.74:1 | 2.40:1 | 1.46:1 |

* Sgnificant at P = 0.05.

** Sgnificant at P = 0.01.

**TABLE 2. Pooled estimates of general combining ability and specific combining ability effect in nine characters in parents and $F_1$ of diallel crosses alongwith heterobeltosis for seed yield of soybean**

| Sl. No. | Parents/ Crosses. | Days to 50% flowering | Days to maturity. | No. of primary branches. | Plant height. | Seed Yield/ plant. | 100-seed weight. | No. of seed/ pod. | Protein (%) | Oil(%) | Heterobeltosis for seed yield (%) L-I | L-II |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *PARENTS* | | | | | | | | | | | |
| 1. | JS-2 | -0.55** | -1.03 | -0.75** | -5.79 | -8.36** | 1.32** | -0.02** | -0.44** | -0.42** | — | — |
| 2. | T-49 | -0.68** | -0.49 | 0.44** | -7.10* | 5.71* | 0.60** | -0.04** | 1.09** | -0.19** | — | — |
| 3. | Kalitur | 2.93** | 1.26 | 0.05 | 12.89** | -0.60 | -2.27** | 0.03** | 0.19** | -0.45** | — | — |
| 4. | JS 75-1 | 1.43** | -0.15 | 0.08* | 8.11** | 2.05 | -1.40* | 0.06** | -0.09** | -0.50** | — | — |
| 5. | Improve ' Pelican. | 1.76** | 0.70 | 0.06 | 5.60 | 3.08 | -0.50** | 0.01** | -0.12** | 0.62** | — | — |
| 6. | Cocker Stuart. | -1.94** | -0.30 | -0.30** | -13.70** | -2.90 | 2.15** | -0.04** | -0.63** | 0.89** | — | — |
| | *CROSSES* | | | | | | | | | | | |
| 1. | 1 × 2 | 11.38** | 7.70** | 1.50** | 50.85* | 1.60 | -6.63** | 0.03** | -0.54** | 0.40 | 103.68** | 9.66 |
| 2. | 1 × 3 | 2.13** | -0.05 | 1.21** | 15.79 | 8.13 | -2.27** | 0.16** | 0.45** | -0.85** | 17.57 | 49.82 |
| 3. | 1 × 4 | 9.63** | 1.70** | -0.79** | 1.99 | - 2.48 | -2.19** | -0.06** | 1.11** | -0.41** | -6.88 | 85.61* |
| 4. | 1 × 5 | 1.87* | 1.84** | -0.50* | 13.44 | 4.19 | -1.16** | 0.09** | 0.09** | 1.14** | 64.94 | 20.31 |
| 5. | 1 × 6 | -5.82** | 0.34 | -1.40** | -15.13 | - 8.05 | 3.95** | 0.06** | -2.16 | 1.10** | 6.59 | 10.46 |
| 6. | 2 × 3 | -7.28** | -1.93** | -1.30** | -10.92 | 6.42 | 2.25** | 0.01* | 0.56** | 0.62** | -25.11 | -23.29 |
| 7. | 2 × 4 | -3.95** | -1.85** | -0.74** | -13.40 | - 5.61 | 2.23** | -0.12** | 0.62** | 0.39 | -10.94 | 7.99 |
| 8. | 2 × 5 | -5.62** | -1.37* | -0.24 | - 5.95 | 4.85 | 1.36** | 0.09** | -2.08** | 1.27** | 18.35 | - 7.82 |
| 9. | 2 × 6 | -3.74** | -4.53** | -0.28 | -25.25 | -19.71 | 2.53** | 0.01 | 0.08 | -1.70** | 23.47 | -15.88 |
| 10. | 3 × 4 | -0.18 | -0.76 | 0.65** | -5.46 | - 2.35 | 0.45 | -0.02** | -0.10 | -0.93** | -23.93 | 43.13 |
| 11. | 3 × 5 | 1.49 | 2.22* | 0.30 | -1.54 | - 2.25 | -0.82** | -0.04** | 0.99** | -1.41** | -0.83 | 4.95 |
| 12. | 3 × 6 | 4.86** | 0.88 | 0.76** | -2.74 | 1.82 | -0.59** | 0.01 | 0.41** | 1.02** | -7.78 | 98.70** |
| 13. | 4 × 5 | -4.85** | -0.53 | -0.45* | 13.02 | - 1.18 | -0.32 | 0.09** | 0.11 | 1.35** | 22.72 | 32.10 |
| 14. | 4 × 6 | -2.30** | 0.47 | -0.22 | 1.66 | 15.35 | -0.15 | 0.14** | 1.17 | -1.12** | -24.89 | 7.34 |
| 15. | 5 × 6 | 9.53** | 0.61 | 0.40 | -9.86 | -22.85 | 0.37 | -0.37** | -0.11 | -2.99** | 35.63 | 15.29 |
| | SE (Sig) | 0.11 | 0.75 | 0.03 | 2.94 | 12.33 | 0.03 | 0.01 | 10.02 | 0.03 | 7.99 | 10.71 |
| | SE (Sij) | 0.80 | 0.57 | 0.23 | 22.21 | 17.64 | 0.24 | 0.05 | 0.13 | 0.21 | — | — |

* Significant at p=0.05.
** Significant at p=0.01.
L-I = Location-I (Jabalpur)
L-II = Location-II (Badnawar)

exhibited significant negative values for both these traits suggesting that these crosses were good for inducing earliness.

For plant height, three parents viz, JS2, T49 and Cocker Stuart were identified as short statured types as compared to the rest. Similarly, three genotypes viz; T49, Kalitur and JS75-1 appeared to be better for yield and its component. JS2 × T49 showed tall plant height and more primary branches/plant and seeds/pod. Substantial contribution of additive genetic variances was observed for plant height, which was in agreement with the results reported by Singh *et al.* (1974). Significant contribution of additive and dominance variances was observed for major yield in contributing characters like seed yield/plant and 100-seed weight. Similar results have been reported by Shrivastava *et* al (1975) and Kaw and Menon (1981). Four crosses viz; JS2 × T49, JS2 × Kalitur, Kalitur × JS75-1 and Kalitur × Cocker Stuart were the good specific combiners for number primary branches/plant. Similarly, five combinations viz; JS2 × Cocker Stuart, T49 × Kalitur, T49 × JS75-1, T49 × Improved Pelican and T49 × Cocker Stuart proved to be good combiners for bold seed size while rest of the crosses were better for smaller seed size. Three crosses viz; JS2 × Improved Pelican. T49 × Kalitur and Kalitur × Cocker Stuart appeared to be better specific crosses for high protein and oil content.

The estimated values of heterobeltosis for most of the characters were in the either directions viz; positive or negative with the exception of 100-seed weight which, exhibited negative heterosis in all the crosses at Jabalpur and in eleven combinations at Badnawar. Majority of the crosses showed high magnitude of positive heterosis for most of the yield contributing attributes indicating the presence of genetic diversity amongst the parents selected for the studies. Similar results have been reported by Paschel and Wilcox (1975), Chaudhary and Singh (1974) and Tiwari *et al.* (1982).

Based on the above results, it could be concluded that pooled estimates of general and specific combining ability variances showed equal contribution of both additive and non-additive genetic variances for all the characters except primary branches and seed/pod. Estimates of GCA effects showed that JS2, T49 and Cocker Stuart were the earliest types while T49 was good general combiner for seed yield. Three combinations viz; JS2 × T49, JS2 × Kalitur ans JS2 × Improved Pelican possessed higher SCA effect for seed yield. Similarly, two crosses viz; JS2 × T49 (103.68%) and JS2 × Improved Pelican (64.94%) at Jabalpur and JS2 × JS75-1 (85.61%) and Kalitur × Cocker Stuart (98.70%) at Badnawar exhibited high magnitude of heterosis. Such crosses having high SCA effects and high heterotic values may be handled by (i) Intermating the best crosses for seed yield and its components and (ii) by selecting transgressive segregants using Pedigree method of breeding aimed to develop suitable strains of soybean.

CHAUDHARY, D.N. and SINGH, B.B. 1974. *Indian J. Genet.* **34**:69-74.

GRIFFING, B. 1956 *August. J. Biol. Sci.* **9**:463-493.

KAW, R.N. and MENON, P.M. 1981. *Indian J. Genet.* **41**:303-308.

PASCHAL, E.H. and WILCOX, J.R. 1975. *Crop. Sci.* **15**:344-349.

SHRIVASTAVA R.L., ZIAUDDIN, AHMAD, SINGH, H.G. and SAXENA, J.K. 1975. *Indian agric. Sci.* **48**:148-155.

SINGH, T.P., SINGH, K.B. and BRAR, J.S. 1974. *Indian J. Genet.* **34**:427-432.

TIWARI, SHARAD, TAWAR, M.L. and MISHRA, Y. 1982. *J.N.K.V.V. Res. J.* **16**:17-19.

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# ASSOCIATION AND PATH ANALYSIS OF ECONOMIC TRAITS IN YELLOW SARSON

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Yellow *sarson* (*Brassica campestris* (L.) Var. Yellow *sarson*) is an important oilseeds crop grown in India, Pakistan, Bengladesh and Nepal. Lilttle amount of information is available in the literature regarding the systematic approaches applied in this crop for bringing about improvement in its seed yield. The knowledge about character association is imperative for a breeder to start with any systematic improvement programme. To work out the cause and effect relationship, use of path analysis method is of considerable importance in selecting genotypes possessing main yield determinants. Keeping this in view the present investigation was undertaken to identify the disirable yield correlations in some genotypes of Yellow *sarson* with respect to aforesaid objective.

Fifty three genotypes of Yellow *sarson* (*Brassica campestris* L. var. Yellow *sarson*) were grown in augmented design at the Experimental Area of the Department of Plant Breading, Haryana Agricultural University, Hisar. Spacing of 30 cm and 10 cm was kept between rows and plants, respecrively. Observations on five randomly selected plants from each plot were recorded on days to first flowering, days to 50 per cent flowering, days to maturity, plant height (cm), primary and secondary branches, length of main raceme (cm), siliquae on main raceme, siliqua length (cm), seeds per siliqua and seed yield (g). Correlation coefficients and path analysis were worked out following Johnson *et al.* (1956) and Dewey and Lu (1959), respectively.

The estimates of correlations are presenred in Table 1. Seed yield was positively and highly significantly associated with secondary branches followed by primary branches, days to first and 50 per cent flowering and plant height. The aforesaid results were in partial conformity of the previous results of Rai and Ramanujan (1963), Singh and Singh (1974) and Kumar and Yadava (1978) in Yellow *sarson*. While positive association of seed yield with plant height was contarary to Singh and Singh (1974) but in conformity with Kumar and Yadava (1978). Similarly, positive association of seed yield with days to 50 per cent flowering was contrary to the findings of Kumar and Yadava (1978). This might be due to strong positive correlation of plant height witn primary branches, length of main raceme and siliquae on main raceme which are considered as main seed yield determinants. Days to first flowering and 50 per cent flowering were positively associated with plant height and primary branches which is also supported by Banerjee *et al.* (1968) in Yellow *sarson*. Primary branches were positively correlated with secondary branches which were in turn positively associated with seed yield.

The correlation coefficients were partitioned into direct and indirect effects and presented in Table 2. A persual of data indicated that the secondary branches,

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**TABLE 1. Correlation coefficients of different traits in *Brassica campestris* var. Yellow *sarson***

| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Days to first flowering | — | 0.9508** | 0.2655 | 0.7460** | 0.4684 | 0.1867 | 0.2630 | 0.0648 | 0.3836** | 0.0231 | 0.3605** |
| 2. | Days to 50% flowering | | — | 0.2305 | 0.7440** | 0.4312** | 0.1491 | 0.2742* | 0.0703 | 0.3869** | 0.8420 | 0.3728** |
| 3. | Days to maturity | | | — | 0.3103* | 0.1245 | -0.0891 | 0.0639 | 0.1256 | 0.0279 | -0.3173* | -0.0837 |
| 4. | Plant height | | | | — | 0.4819* | 0.1535 | 0.5442* | 0.2943* | 0.2583 | -0.1028 | 0.2886* |
| 5. | Primary branches per plant | | | | | — | 0.4615** | 0.0622 | -0.0552 | 0.0272 | -0.0448 | 0.3911** |
| 6. | Secondary branches per plant | | | | | | — | -0.1343 | 0.1551 | -0.1589 | -0.1675 | 0.4468** |
| 7. | Length of main raceme | | | | | | | — | 0.7295** | 0.1842 | 0.0892 | 0.0998 |
| 8 | Siliqua on main raceme | | | | | | | | — | -0.1344 | 0.0859 | 0.0220 |
| 9. | Siliqua length | | | | | | | | | — | 0.3749** | 0.0291 |
| 10. | Seed per Siliqua | | | | | | | | | | — | 0.1872 |
| 1. | Seed yield/plant | | | | | | | | | | | — |

* Significant at P = 0.05

** Significant at P = 0·01.

**TABLE 2. Direct (Diagonal) and indirect effects (off diagonal) of different yield components**

| | Characters | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | Correlation with seed yield |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Days to first flowering | -0.0893 | 0.3729 | 0.0123 | 0.0067 | 0.0448 | 0.0733 | 0.0022 | 0.0045 | -0.0489 | 0.0065 | 0.3605** |
| 2. | Days to 50 % flowering | -0.0849 | **0.3922** | -0.0107 | 0.0060 | 0.0413 | 0.0585 | 0.0023 | 0.0049 | -0.0493 | 0.0119 | 0.3728** |
| 3. | Days to maturity | -0.0237 | 0.0903 | **-0.0463** | 0.0028 | 0.0119 | -0.0349 | 0.0005 | 0.0089 | -0.0036 | -0.0896 | -0.0837 |
| 4. | Plant height | -0.0667 | **0.2918** | -0.0144 | 0.0089 | 0.0462 | 0.0602 | 0.0038 | 0.0208 | -0.0329 | -0.0290 | 0.2886* |
| 5. | Primary branches per plant | -0.0418 | 0.1691 | -0.0058 | 0.0043 | **0.0958** | 0.1889 | 0.0005 | -0.0039 | -0.0035 | -0.0026 | 0.3911** |
| 6. | Secondary branches per plant | -0.0167 | 0.0585 | 0.0041 | 0.0014 | 0.0461 | **0.3924** | -0.0011 | -0.0109 | 0.0203 | 0.0473 | 0.4468** |
| 7. | Length of main raceme | -0.0236 | 0.1075 | -0.0029 | 0.0041 | 0.0059 | -0.0527 | **0.0083** | 0.0515 | -0.0235 | 0.0252 | 0.0998 |
| 8. | Siliqua on main raceme | -0.0058 | 0.0276 | -0.0058 | 0.0026 | -0.0053 | -0.0609 | 0.0061 | **0.0706** | 0.0171 | -0.8242 | 0.0220 |
| 9. | Siliqua length | -0.0343 | 0.1517 | -0.0013 | 0.0023 | 0.0026 | -0.0624 | 0.0015 | -0.0095 | **-0.1271** | 0.1058 | 0.0291 |
| 10. | Seeds per siliqua | -0.0021 | 0.0165 | 0.0147 | -0.0009 | -0.0043 | -0.0657 | 0.0007 | -0.0061 | -0.0478 | **0.2822** | 0.1872* |

Residual effects : 0.6152

seeds per siliqua and days to 50 per cent flowering were main seed yield determinants as these characters possessed high direct effects and also the strong positive associations with seed yield. Similar observations have been made by Chauhan and Singh (1977), Singh *et al.* (1975), Labana *et al.* (1977) and Kumar and Yadava (1978). The plant height contributed indirectly through days to maturity while primary branches through days to maturity and secondary branches, resulting into positive association with seed yield.

The characters, secondary branches per plant, seeds per siliqua and days to 50 per cent flowering are considered to be the main seed yield determinants. The number of primary branches and plant height are also important in contributing towards seed yield via other characters resulting into positive association with seed yield and thus making the main selection criteria in Yellow *sarson.*

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BANERJEE, H.T., BHATTACHARJEE, B. and DASS, M. 1968. *Indian J. Agrin.* 13:203-220.

CHAUHAN, Y.S. and SINGH P. 1977. Path analysis in Indian mustard. Report of the University of Agricultural Sciences, Hebbal, Bangalore, India.

DEWEY, D.R. and LU, K.H. 1959. *Agron. J.* **51**:515-518.

OHNSON, G.R. and FRAY, K.R. 1977. *Crop. Sci.* 7:44-66.

KUMAR, P.R. and YADAVA, T.P. 1979. Delection criteria for seed yield in *Brassica campestris* L Proceedings of the 5th International Rapeseed Conference held at Malmo, Sweeden vol. I pp. 63-65.

LABANA, K.S. BADWAL S.S. and GUPTA M.R. 1977. Path analysis of yield and its componen, traits in *Brassica juncea* L. XI Report of University of Agricultural Science, Hebbal, Bangalore India.

RAI, B. and RAMANUJAM S. 1963. *Indian J. Genet.* **23**:312.

SINGH, D., YADAVA, T.P. and GUPTA, V.P. 1975. *SABRAO* 7:85-89.

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# ESTIMATION OF LOSSES IN YIELD OF RAPESEED AND MUSTARD DUE TO MUSTARD APHID

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The mustard aphid, *Lipaphis erysimi* (Kaltenbach) causes major damage to rapeseed-mustard crops every year unless controlled through appropriate measures. Based on already published reports, Bakhetia (1983) calculated the mean yield loss of 54.2 per cent on all India basis, which varied from 35.4 to 73.3 per cent in different varieties under different agro-ecological conditions. Under the Punjab conditions average yield loss was 80.6 per cent in brown *sarson* var, BSH-1 and 22.5, 36.1 and 26.5 per cent in *raya* varieties RLM 198, RLM 514 and RL 18 respectively (Bakhetia, 1984). In Haryana, the yield losses were 27.5 per cent in *raya* and 63.5 per cent in *toria* (Singhvi *et al.* 1973). Similarly Prasad and Phadke (1984) found that under Delhi conditions mustard aphid caused 40.9 to 52.5 per cent loss in different varieties of *raya*; 57.8 to 77.1 per cent in brown *sarson* and 72.2 to 79.3 per cent in yellow *sarson*.

Experiments were conducted for three years to study the losses in yield of different varieties of rapeseed and mustard caused by the aphid (*L. erysimi*). The losses were estimated on the basis of yields obtained in treated versus untreated plots of *B. juncea* Cv. RLM 619 for there years (1983-84 to 1985-86) at Ludhiana, and on *B. napus* Cv. GSL 1 for two years (1984-85 and 1985-86) at Ludhiana and for one year (1983-84) at Faridkot. The experiments were conducted in randomized block design with three replications and plot size of 7.0 m × 2.70 m. The aphid population was recorded on randomly selected 10 cm long five shoots per plot. Observations were repeated at 7-10 days interval. The seed yield in each plot was recorded at harvest.

The aphid incidence varied from year to year on different *Brassica* species. During 1983-84 (Table 1) the mean aphid population in unprotected plots ranged from 127 to 138 aphids on GSL 1 at Faridkot. In general the aphid numbers reached upto 263.5 aphids shoot on RLM 619 and upto 980 aphids on GSL 1.

During 1984-85 (Table 2), the aphid population in unprotected plots varied from 7.8 to 195.6 aphids (mean = 84.0) per shoot in RLM 619 and from 7.1 to 220.7 aphids (mean=78.8) per shoot in GSL 1. The corresponding values were 0.4 to 213.6 aphids (mean=71.8) and 6.1 to 300.0 aphids (mean=106.7) during 1985-86.

It is thus apparent that the aphid infestation in experimental fields during the years of study was appreciably high. It truely reflected in drastically reduced yields obtained in untreated plants as against those receiving suitable aphid control treatments (Table 1 and 2).

In *B.juncea* cv RLM 619, the loss was 28.8 to 52.5 per cent (mean 35.4%) during

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**TABLE 1. Yield losses in cultivars of *Brassica juncea* and *B. napus* caused by the mustard aphid in the Punjab during 1983-84**

| Variety | Trial | Number of aphids per 10 cms shoot (Range) and mean in perentheses** | | Mean yied (Kg/ha) | | Avoidable loss in yield (%) |
|---|---|---|---|---|---|---|
| | | Protected | Unprotected | Protected | Unprotected | |
| *Brassica juncea* Var. | I | 0–2.2 (0.6) | 14.3–26.5 (67.2) | 1476 | 701 | 5.5 |
| RLM 619 | II | 0.5–10.1 (4.4) | 7.5–54.5 (29.7) | 1622 | 1119 | 31.0 |
| | III | 0–13.3 (2.5 | 6.8–101.6 (51.1) | 1579 | 1118 | 29.2 |
| | IV * | 0–16.7 (5.2) | 10.0–65.0 (39.8) | 1852 | 1319 | 28.8 |
| | | | | | Mean | 35.4 |
| *B. napus* Var. GSL 1 | I | 0–26 (5.48) | 0–950 (127.0) | 2034 | 1420 | 30.2 |
| | II | 0–4 (0.8) | 0–980 (138.2) | 1860 | 1440 | 22.6 |
| | | | | | Mean | 26.4 |

* Per cent shoots infested by the aphid, based on 6 observations recorded at 7-10 days interval and 10 plants per plot were observed.

** 2 Based on 6 observations, recorded at 7-10 days interval.

**Note :** Experiments on *B. juncea* were conducted at Ludhiana and on *B. napus* at Faridkot.

TABLE 2. Losses in yield of *B. napus* and *B. juncea* due to mustard aphid at Ludhiana (the Punjab) during 1984-85 and 1885-86

| Variety | Treatment | Number of aphids per 10 shoot (Ranges) and mean in parentheses | | Mean yield (kg/ha) | | | Avoidable loss in yield (%) | | | Cost/ benefit ratio |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 1984–85 | 1985–86 | 1984–85 | 1985–86 | Mean | 1984–85 | 1985–86 | Mean | |
| | Sprays[1] | 1.4–12.9 (4.6) | 0–2.3 (1.1) | 2187 | 952 | 1559.5 | 36.3 | 39.9 | 40 65 | 1:4.38 |
| *Brassica juncea* | Granules[3] | 1.5–16.7 (6.0) | 0–28.7 (11.3) | 2246 | 735 | 1490.5 | 38.6 | 22.2 | 37.90 | 1:7.37 |
| Var. TLM 619 | Control | 7.8–195.6 (84.0) | 0.4–213.6 (71.8) | 1379 | 572 | 925.5 | — | — | — | — |
| | Sprays[2] | 0.8–17.2 (5.6) | 0.1–6.5 (2.9) | 2197 | 607 | 1402.0 | 31.3 | 51.7 | 35.69 | 1:4.56 |
| *Brassica napus* | | | | | | | | | | |
| Var. GSL 1 | Granules[3] | 2.0–32.0 (9.1) | 0.9–15.0 (7.5) | 2143 | 437 | 1290.0 | 29.5 | 32.9 | 30.11 | 1:4.70 |
| | Control | 7.1–220.7 (78.8) | 6.1–300.0 (116.7) | 1510 | 293 | 901.5 | — | — | — | — |

1. Based on six and five observations during 1984-85 and 1985-86 respectively, recorded at fortnightly intervals.

2. Three sprays of oxydemeton methyl 25 EC @ 0.25 per cent.

3. Phorate 10 G applied @ 1 kg a.i./ha after the appearance of the aphid.

1983-84 (Table 1) and 36.3 and 39.9 per cent during 1984-85 and 1985-86 respectively with sprays of oxydemeton methyl (Table 2). Whereas, the corresponding loss was 38.6 and 22.2 per cent in the treatment with phorate granules.

In *B.napus* cv. GSL 1, the loss in yield was 22.6 to 30.2 per cent (mean 26.4%) at Faridkot during 1983-84 (Table 1). However, it was 31.3 and 51.7 per cent during 1984-85 and 1985-86 respectively at Ludhiana with sprays of oxydemeton methyl (Table 2), and 29.5 and 32.9 per cent with the application of phorate granules in soil.

The economics of aphid control was worked out for the experiments conducted during 1984-85 and 1985-86 (Table 2). The cost and benefit ratio was higher (1:7.37) in phorate granules as compared with sprays of oxydemeton methyl (1:4.38) in case of *B.juncea* cv. RLM 619. It was, however, more or less the same (1:4.56 and 1:4.70) in the two insecticidal treatments in *B.napus* cv. GSL 1. Thus both the treatments proved cost effective.

In fine, the avoidable losses in yield of *Brassica* species caused by the mustard aphid varied from 28.8 to 52.5 per cent in *B.juncea* cv. RLM 619 and 22.6 to 51.7 per cent in *B.napus* cv. GSL 1. These estimates are quite alarming. Apparently the yield losses varied in different *Brassica* species from year to year and even in different fields at the same locatin. Also the variations in losses were quite evident in different insecticidal treatments for aphid control.

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BAKHETIA, D.R.C. 1983. Losses in rapeseed-mustard due to *Lipaphis erysimi* (K
A literature study, Proc. *6th Intern. Rapeseed Conf. Paris*, May 16-20 1983, p 1142-1147.

BAKHETIA, D.R.C. 1984. *J. Res. Punjab Agric. Uvni.* **21**(1):63-75.

PRASAD, S.K. and PHADKE, K.G. 1984. *Indian J. Int.* **46**(2):250-252.

SINGHVI, S.M., VERMA, N.D. and YADAVA, T.P. 1973. *H. A. U. J. Res.* 3(1):5-7.

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# INHERITANCE OF NON-WAXINESS AND TOLERANCE TO APHIDS IN INDIAN MUSTARD

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Susceptibility of rapeseed-mustard crops to diseases and pests is one of the major causes for their low yields (Anand and Rawat, 1984). Aphids, *Lipaphis erysimi* Kalt are the most serious pests on these crops and have been reported to cause yield losses upto 77.5% under heavy infestation (Prasad and Phadke, 1983). Association of a morphological trait with tolerance to aphid infestation could be of great use in resistance breading programmes, as it simplifies the identification and screening of resistant plants. Such desirable association between non-waxy or glossy nature of plants and aphid tolerance has been observed by Thompson (1963), Malik (1978) and Yadav *et al.*, (1985). As the information on inheritance of non-waxiness is scarce, present study was taken up to determine the exact nature of its inheritance in a set of five intervarietal crosses of Indian mustard (*Brassica juncea* (L) Czern & Coss).

A spontaneous non-waxy mutant with clear, shiny green stem, branches, leaves and siliquae and purple splash on the stem, spotted in the variety B-85 and was found to breed true was crossed with the five varieties, viz., T-6342, RLM-514, Seeta, PR-18 and TM-7. The $F_1$s were selfed and also back-crossed to both normal ($BC_1$) and mutant parents ($BC_2$). The $F_2$, $BC_1$ and $BC_2$ progenies were raised in the winter of 1985-86. At peak flowering, when the plants were succulent and were easily prone to aphid infestation, fifty plants each in waxy and non-waxy categories were randomly chosen for counting the number of aphids on them. Soon after the siliqua formation stage, plants in waxy and non-waxy categories were counted. Chi-square analysis was also done seperately for $F_2$ segregants of each individual cross and those of $BC_1$ and $BC_2$. Pooled chi-square analysis was also done for the total number of plants in each category over the crosses.

All $F_1$ plants were non-waxy suggesting to its dominance over waxiness.

Segregation pattern in $F_2$, $BC_1$ and $BC_2$ (Tables 1 and 2) revealed the character to be under monogenic control. In BC progency, (involving non-waxy parent), all the plants were non-waxy. The ratio of non-waxy to waxy, in the pooled $F_2$ progenies was a good fit to 3:1. Thus it can be concluded that non-waxiness is governed by a single dominant gene.

Non-waxy plant, on an average had ten to twenty aphids per plant as compared to 80 to 100 of the waxy.

Thompson (1963) observed that the cabbage aphid, *Brevicoryne brassicae*

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developed large colonies on normal waxy plants of narrow-stem kale, *Brassica oleracea* var. *acephala* but did not colonize non-waxy plants. He attributed this difference to the nature of surface waxes, which affected the rate of initial infestations (Thompson, 1967 in Martin and Juniper). Non-waxy plants harbouring less number of aphids in the early stages of growth was attributed to the slippery nature of the plants (Malik, 1978). Results of the present investigation confirm the previous reports with regard to tolerance of non/waxy plants to aphids.

**TABLE 1. Segregation pattern in $F_2$ generation for non waxiness in intervarietal crosses of mustard**

| Cross | Total $F_2$ plants counted | $F_2$ segregation observed | | P (3:1) expected | | $X^2$ |
|---|---|---|---|---|---|---|
| | | Non-waxy | Waxy | Non-waxy | Waxy | |
| T6342 X B-85 | 655 | 485 | 170 | 491.25 | 163.75 | 0.317 |
| RLM 514 × B-85 | 530 | 400 | 130 | 397.50 | 132.50 | 0.063 |
| Seeta × B-85 | 495 | 367 | 128 | 371.25 | 123.75 | 0.195 |
| PR-18 × B-85 | 580 | 425 | 155 | 435.00 | 145.00 | 0.919 |
| TM-7 × B-85 | 735 | 560 | 175 | 551.25 | 183.75 | 0.556 |
| Total | 2995 | 2237 | 758 | 2246.25 | 748.75 | 0.152 |

Table $X^2$ value at 1 d.f. and 5% is **3.841**

**TABLE 2. Segregation in backcross generations for non-maxiness in mustard**

| Cross | Generation | Observed P (1:1) | | $X^2$ |
|---|---|---|---|---|
| | | Non-waxy | waxy | |
| RLM 514 × B-85 | $BC_1$ | 100 | 87 | 0.452 |
| | $BC_2$ | 170 | — | |
| PR-18 × B-85 | $BC_1$ | 136 | 128 | 0.121 |
| | $BC_2$ | 182 | — | |
| TM-7 × B-85 | $BC_1$ | 98 | 104 | 0.890 |
| | $BC_2$ | 146 | — | |

Gene symbol of *W1W1* (Waxless) is proposed for the first time, for non/waxiness and *w1w1* for waxiness. As non-waxiness is monogenically dominant and is associated with tolerance to aphid infestation, the possibilities of its use in future resistance breeding programmes need to be explored.

ANAND, I.J. and RAWAT, D.S. 1984. Proc. of the symposium on oilseed production and utilization - constraints and opportunities, September, 1984. New Delhi.

MARTIN, J.T. and JUNIPER, B.E. 1970. The cuticles of plants. St. Martin's Press, New York, p. 347.

PRASAD, S.K. and PHADKE, K.G. 1983. *Pranikee* 4:283-87.

THOMPSON, K.F. 1963. *Nature* 198:209.

YADAV, A.K.; HARVIR SINGH; and YADAVA, T.P. 1985. *J. Oilseeds. Res.* 2:120-123.

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# PRODUCTION POTENTIAL AND ECONOMIC FEASIBILITY OF INTERCROPPING IN CASTOR WITH VARYING PLANTING GEOMETRY

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Castor (*Ricinus communis* L.) is well known for its hardiness and thrives well under rainfed situations. In Andhra Pradesh, it is usually grown as a sole crop often with wider row spacings. There exists, therefore, a strong case to examine the possibility of growing a suitable companion crop so as to increase the total grain yield and or economic value of the system. Hence, a field experiment was taken up at the Agricultural College Farm, Rajendranagar during *kharif*, 1978. The soil was sandy loam in texture, medium in available nitrogen (320.8 kg/ha) and phosphorus (20.1 kg/ha) while rich in potassium (315.8 kg/ha). A total of 707.3 mm rainfall was received during the crop growth period. The trial was laid out in a split plot design. Planting geometry treatments i.e. spacing of castor at 60×30 m, 90×20 and 120×15cm were assigned to the main plots. The sub plots included the sole crop of castor Cv. Aruna and six intercrop treatments. One and two rows each of green gram (*Vigna radiata* (L) Wilczek) Cv Ps - 16 Cow pea (*Vigna unguiculata* (L) Walp.) Cv. C-152 and sorghum (*Sorghum bioclor* (L) Moench) Cv. CSH 6 were the intercrop components. The treatments were replicated thrice. A uniform fertilizer dose of 40 kg N, 30 kg $P_2O_5$ and 30 kg $K_2O$ per hectare was applied to all the treatments at the time of sowing.

The results indicated that the performance of castor was immensely influenced by the planting geometry, intercrop treatments and interaction (Table 1). The mean yield increased significantly with increase in the row width and was maximum (20.72 q/ha) in castor spaced 120×15cm. Intercrops had an adverse effect on castor and the reduction in yield was more severe with two rows of the intercrop components than with one row. Amongst the intercrops sorghum was the most strong competitor which smothered the base crop more drastically than the cow pea or green gram. One row of sorghum reduced the yield of castor by 32.53% while two rows accounted for a reduction of 58.42%. Reduction in the yield of castor when intercropped with cow pea (Ganga Saran and Giri, 1983), sorghum or green gram (Prasad and Verma, 1986) was also reported in earlier studies.

The effect of interactions was found to be significant. Maximum yield (30.61 q/ha) was obtained from the sole crop of castor spaced at 60×30 cm. The yield was however significantly reduced to 25.33 and 24.94 q/ha with the manipulation of spacing to 90×20 cm and 120×15 cm respectively. This may be ascribable to the increased intra species competition for the available resources owing to the overcrowding of plants within the row with reduced plant spacing. But, this trend was reverse in the intercrop treatments. Cultivation of intercrops in the narrow widths excercised a more drastic effect on castor than in the wider row width treatments. This indicates that the inter-

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**TABLE 1. Grain yield of castor and intercrops (q/ha) and the monetary returns (Rs/ha) as influenced by planting geometry and intercropping**

| Treatment | Yield (q/ha) 60 × 30 cm | | 90 × 20 cm | | 120 × 15 cm | | Mean | Monetary returns (Rs/ha) 60 × 30 cm | 90 × 20 cm | 120 × 15 cm | Mean |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | castor | Intercrop | castor | Intercrop | castor | Intercrop | | | | | |
| Castor alone | 30.61 | — | 25.33 | — | 24.94 | — | 26.96 | 6122.00 | 5066.00 | 4988.00 | 5392.00 |
| Castor + 1 row of green gram | 21.48 | 6.11 | 23.88 | 8.83 | 24.17 | 8.60 | 23.18 | 6129.00 | 7425.00 | 7569.00 | 7041.00 |
| Castor + 1 row of cowpea | 18.22 | 9.70 | 20.63 | 13.59 | 21.52 | 14.32 | 20.12 | 6068.00 | 7523.00 | 7883.00 | 7158.00 |
| Castor + 1 row of sorghum | 14.28 | 35.72 | 19.83 | 39.87 | 20.44 | 43.94 | 18.19 | 6428.00 | 7952.00 | 8482.00 | 7621.00 |
| Castor + 2 rows of green gram | 17.87 | 9.64 | 20.11 | 9.77 | 20.83 | 10.38 | 19.60 | 6466.00 | 6952.00 | 7280.00 | 6899.00 |
| Castor + 2 rows of cow pea | 13.90 | 13.94 | 15.30 | 15.42 | 17.74 | 18.67 | 15.64 | 6266.00 | 6915.00 | 8216.00 | 7132.00 |
| Castor + 2 rows of sorghum | 7.79 | 54.14 | 10.41 | 49.80 | 15.43 | 54.02 | 11.21 | 6972.00 | 7062.00 | 8488.00 | 7507.00 |
| Mean | 17.74 | | 19.36 | | 20.72 | | 19.27 | 6350.00 | 6985.00 | 75558.00 | 6964.00 |

| | Yield | | | | Monetary returns | | | |
|---|---|---|---|---|---|---|---|---|
| | spacing | Intercropping | spacing in intercropping | Intercropping in spacing | spacing | Intercropping | spacing in Intercropping | Intercropping |
| SEm ± | 0.09 | 0.16 | | | 24.89 | 55.40 | | |
| CD ($P = 0.05$) | 0.24 | 0.32 | 0.56 | 0.57 | 60.91 | 110.81 | 19.94 | 188.40 |

**Note :** Market rate of grains; Castor, Rs 200/q; green gram; Rs 300/q; cow pea, Rs 250/q; sorghum, Rs 100/q

crop competition was perhaps more severe which predominated the intra species competition was perhaps more severe which predominated the intra species competition in castor. As the row width of castor increased to 90 and 120 cm probably the mutual competitive stress was relieved and hence the yield of both the base crop as well as the intercrop components improved substantially. Although sorghum somothered the base crop particularly in the narrow row width treatments, it yielded spelndidly higher in each of the three spatial configurations.

Considering the monetary returns, the mean value of the intercrop treatments was significantly superior to the sole crop of castor. Intercropping castor with sorghum proved to be the most remunerative practice. The monetary returns were maximised to Rs 7621.00 and Rs 7507.00 with one or two rows of sorghum intercropped in castor. The planting geometry also showed a marked variarion in monetary returns. The returns increased from Rs 6350.00 to Rs 6985.00 with the widening of row width of castor from 60 to 90cm and further to Rs 7558.00 as the row width increased to 120 cm. The effects of interaction were also significant. The total returns were subsetantially enhanced in the intercrop treatments with wider row spaces of castor. Such a trend is obivious because of the increase in yield of the intercrop components *vis-a-vis* the lesser competitive stress on castor. Intercropping one row of green gram or one or two rows of cowpea in castor spaced 60 × 30 cm did not show a significant monetary advantage over the sole crop. But, sorghum as an intercrop component triggered the monetary value of the system in each of the three spatial configurations of castor. The highest returns were realised from castor spaced 120 × 15 cm and interplanted with two (Rs 8488.00) or one row (Rs 8482.00) of sorghum. Prasad and Verma (1986) on the other hand observed that sorghum intercropped in castor did not increase the monetary returns, while they reported that green gram did increase the remuneration more than the sole crop of castor.

It may be inferred that the spacing of castor can be advantageously manipulated to 120 × 15 cm to accommodate a companion crop. Intercropping of sorghum in this geometry may be a viable option. This would increase the total value of the system much higher than the sole crop.

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GANGA SARAN and GAJENDRA GIRI. 1983. *Indian J. Agron.* **28**:362-368.

PRASAD, S.N. and VERMA, B. 1986. *Indian J. Agron.* **31**:21-25.

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# EFFECT OF SOWING DATES ON GROWTH AND YIELD OF GROUNDNUT CULTIVARS IN *RABI* SEASON

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Among the various oilseeds crops, groundnut (*Arachis hypogaea* L.) is an unique crop commercially and nutritionally very important source of oil. Traditionally it is grown as a *kharif* with low productivity in view of the erratic agro-climatic conditions compled with diseases in this season. One of the strategies of improving the productivity of this crop to increase the production of edible oils is to introduce shift in cultivation of groundnut in *rabi* season under irrigated conditions. The yield obtained in *rabi* season was higher as compared to *kharif* season (Naidu, 1968). Similarly Ali *et al.* (1974) reported the higher pod yield of groundnut in *rabi* season as compared to *kharif* season. Keeping these points in view, an experiment was conducted at Marthwada Agril. University Farm to find out the suitable sowing time for groundnut cultivars during *rabi* seasons of 1983-84 and 1984-85, in factorial randomized block design with four replications. The experimental soil was medium black well drained and clayey in texture with medium in total nitrogen (0.056%), medium in available phoshorus (0.0025%) and fairly rich in available potash (0.04%). The treatment combinations were two varieties (SB-XI and M-13) and three sowing dates (October 20, 30 and November 10) during 1983-84 and during 1984-85 the two varieties (SB-XI and JL-24) and four sowing dates (October 10, 20, 30 and November 10). The sowing was done by dibbling the seed at 45×15 cm spacing during both the seasons. A uniform dose of fertilizers at 25 kg N and 50 kg $P_2O_5$/ha was applied at the time of respective sowing dates. During first season 7 and 9 irrigations were given to variety SB-XI and M-13 respectively, while during second season 8 irrigations were given to both the varieties sown.

The variety SB-XI sown at first, second and third sowing dates during first season was harvested at 141, 145 and 147 days respectively, while variety M-13 was harvested 165, 168 and 172 days after respective sowing dates. During second season, the variety SB-XI sown at first, second third and fourth sowing dates was harvested 138, 141, 144 and 148 days after sowing respectively. Similarly the variety JL-24 was harvested at 128, 131, 136 and 139 days after respective sowing dates.

The meteorological data recorded during the experimentation presented in Table 1, indicated that during both the years rainfall received was normal. Mean relative humidity was highest during first season and lowest during second season. While the reverse trend was observed in case of mean maximum and minimum temperatures. The seasons have affected the performance of crop accordingly. Comparatively more vegetative growth and yield of dry pod and haulm was observed during the year 1983-84.

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**TABLE 1. Weekly average meteorological data during 1983-84 and 1984-85**

| Month | Met. Week | Mean temperature (°C) | | | | Mean relative humidity(%) | | | | Rain fall (mm) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1983-84 | | 1984-85 | | 1983-84 | | 1984-85 | | 1983-84 | 1984-85 |
| | | Max. | Min. | Max. | Min. | Morning | Evening | Morning | Evening | | |
| October | 40 | 29.9 | 21.5 | 33.5 | 31.5 | 90 | 67 | 85 | 45 | 155.0 | 0.0 |
| | 41 | 30.9 | 21.5 | 30.8 | 19.9 | 91 | 73 | 93 | 43 | 10.0 | 84.4 |
| | 42 | 31.8 | 18.9 | 33.1 | 17.7 | 84 | 39 | 78 | 31 | 0 | 30.6 |
| | 43 | 30.7 | 15.7 | 33.6 | 20.6 | 69 | 26 | 89 | 35 | 0 | 0.20 |
| | 44 | 30.2 | 17.7 | 31.9 | 17.5 | 70 | 45 | 75 | 30 | 1.4 | 0 |
| November | 45 | 30.2 | 11.3 | 31.4 | 15.6 | 68 | 22 | 75 | 29 | 0 | 0 |
| | 46 | 29.2 | 8.9 | 31.3 | 10.7 | 67 | 19 | 75 | 17 | 0 | 0 |
| | 47 | 28.7 | 9.3 | 30.2 | 9.3 | 65 | 21 | 71 | 17 | 0 | 0 |
| | 48 | 28.4 | 14.8 | 18.0 | 8.5 | 73 | 43 | 70 | 24 | 0 | 0 |
| December | 49 | 27.6 | 10.6 | 32.4 | 16.4 | 74 | 27 | 75 | 31 | 0 | 0 |
| | 50 | 28.3 | 21.2 | 31.9 | 8.9 | 78 | 36 | 68 | 15 | 0 | 0 |
| | 51 | 28.6 | 11.2 | 30.4 | 7.9 | 70 | 26 | 71 | 18 | 0 | 0 |
| | 52 | 26.5 | 13.6 | 32.2 | 9.8 | 84 | 46 | 69 | 25 | 16.0 | 0 |
| January | 1 | 28.0 | 16.3 | 29.9 | 14.9 | 88 | 47 | 84 | 46 | 0 | 18.5 |
| | 2 | 29.4 | 15.2 | 31.1 | 15.3 | 83 | 32 | 80 | 39 | 0 | 0 |
| | 3 | 30.0 | 15.5 | 31.0 | 14.1 | 66 | 22 | 75 | 26 | 0 | 0 |
| | 4 | 31.5 | 12.9 | 32.2 | 14.8 | 61 | 24 | 73 | 27 | 0 | 0 |
| | 5 | 33.0 | 16.6 | 33.3 | 15.0 | 68 | 26 | 62 | 26 | 0 | 0 |
| February | 6 | 31.8 | 16.6 | 33.0 | 11.7 | 82 | 35 | 49 | 14 | 13.0 | 0 |
| | 7 | 28.8 | 16.6 | 33.4 | 12.0 | 83 | 43 | 43 | 13 | 26.0 | 0 |
| | 8 | 31.4 | 13.5 | 34.4 | 11.1 | 62 | 26 | 38 | 12 | 0 | 1.44 |
| | 9 | 32.7 | 11.6 | 37.8 | 12.6 | 49 | 12 | 37 | 6 | 0 | 0 |
| March | 10 | 36.2 | 17.6 | 39.7 | 15.7 | 41 | 14 | 24 | 6 | 0 | 0 |
| | 11 | 38.5 | 18.7 | 39.8 | 18.2 | 34 | 10 | 32 | 15 | 0 | 0 |
| | 12 | 38.8 | 18.5 | 39.3 | 17.4 | 32 | 6 | 33 | 13 | 0 | 0 |
| | 13 | 38.8 | 23.1 | 39.2 | 20.7 | 31 | 14 | 46 | 23 | 0 | 0 |

**TABLE 2. Dry pod yield (q/ha), haulm yield (g/ha) and ancillary data as influenced by different treatments**

| Treatments | Yield (Q/ha) | | | | Growth and yield attributes/plant. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Dry pod | | Halum | | Height(cm) | | No. of leaves | | No.of developed | | pod wt. Halum | | wt 100Kerneltw | |
| | 1983–84 | 1984–85 | 1983–84 | 1984–85 | 1983–84 | 1984–85 | 1983–84 | 1984–85 | 1983–84 | 1984–85 | 1983–84 | 1984–85 | 1983–84 | 1984–85 |
| Varieties: | | | | | | | | | | | | | | |
| SB-XI | 13.15 | 11.53 | 79.99 | 102.00 | 20.82 | 20.43 | 26.67 | 37.54 | 16.35 | 6.89 | 18.11 | 24.78 | 40.17 | 36.52 |
| M-13/JL-24 | 11.97 | 7.44 | 101.11 | 62.10 | 18.60 | 15.69 | 23.08 | 33.20 | 14.62 | 4.10 | 16.47 | 29.43 | 47.08 | 42.80 |
| SE ± P=05 | 0.73 | 0.22 | 5.49 | 1.88 | 0.09 | 0.07 | 0.17 | 0.13 | 0.08 | 0.12 | 0.14 | 0.92 | 0.84 | 0.61 |
| C.D. at P=0.05 | N.S. | 0.65 | 16.36 | 5.17 | 0.27 | 0.21 | 0.51 | 0.39 | 0.24 | 0.37 | 0.42 | 2.27 | 2.53 | 1.85 |
| Sowing date : | | | | | | | | | | | | | | |
| Oct. 10 | | 11.13 | | 96.40 | | 19.92 | | 43.33 | | 6.24 | | | | 40.11 |
| Oct. 20 | 14.51 | 10.32 | 104.94 | 88.60 | 19.43 | 18.87 | 26.50 | 37.51 | 19.98 | 5.94 | 21.56 | 19.50 | 44.12 | 39.90 |
| Oct. 30 | 13.15 | 7.86 | 96.48 | 66.80 | 20.63 | 17.40 | 25.88 | 31.46 | 13.43 | 4.75 | 15.40 | 28.60 | 43.89 | 39.50 |
| Nov 10 | 10.06 | 8.64 | 70.24 | 78.60 | 19.08 | 17.48 | 22.55 | 32.68 | 13.05 | 5.07 | 14.90 | 23.23 | 43.45 | 39.15 |
| SE ± | 0.90 | 0.28 | 6.79 | 2.66 | 0.11 | 0.10 | 0.21 | 0.19 | 0.10 | 0.17 | 0.17 | 1.14 | 1.03 | 0.86 |
| C.D. at P=0.05 | 2.72 | 0.84 | 20.25 | 8.07 | 0.33 | 0.30 | 0.63 | 0.52 | 0.29 | 0.53 | 0.52 | 3.39 | N.S. | N.S. |
| Interaction : | | | | | | | | | | | | | | |
| SE ± | 1.28 | 0.38 | 9.57 | 3.76 | 0.16 | 0.14 | 0.29 | 0.27 | 0.14 | 0.25 | 0.24 | 1.59 | 1.45 | 1.22 |
| C.D. at P= 0.05 | N.S. | 1.17 | N.S. | 11.42 | N.S. | N.S. | N.S. | N.S. | N.S. | 0.75 | N.S. | N.S. | N.S. | N.S. |
| Mean. | 12.56 | 9.48 | 90.55 | 82.60 | 19.71 | 18.26 | 24.94 | 31.37 | 15.49 | 5.5 | 17.28 | 37.11 | 43.73 | 39.66 |

N.S. = Not significant.

The data pertaining to mean dry pod and haulm yield (q/ha) and various growth attributes of groundnut as influenced by different varieties and sowing dates during both the seasons are presented in Table 2.

The data in Table 2 show that the groundnut variety SB-XI produced significantly higher dry pod and haulm yield than variety JL-24 in second season. However, it was on par with variety M-13 in respect of pod yield during first season. The variety M-13 significantly yielded more haulm yield than variety SB-XI in first season. The high yield potential of groundnut variety SB-XI have also been reported by Joshi *et al.* (1972). Similarly variety SB-XI produced higher values of all growth and yield attirbute such as, height, number of leaves, leaves,number of developed pods and dry pod weight/plant than variety M-13 and JL-24, except dry haulm weight/plant and 100-Kernel weight that were less in variety SB-XI.

Dry pod and haulm yield of groundnut was significantly influenced by sowing dates. During 1983-84, sowing on 20th and 30th October were at par with each other and produced significantly higher dry pod and haulm yield than sowing done on 10th November. During 1984-85, early sowing of 10th and 20th October produced significantly higher dry pod and haulm yields than sowing on 30th October an 10th November. This high yield might be due to sufficient rainfall, high temperature both maximum and minimum in early sown crops which was beneficial for early establishment of crop and subsequent proper growth resulting in producing more height, foliage and higher number of developed pods which ultimatly in higher yield. The higher yields of groundnut due to early sowing in October have also been reported by Gaindana (1979) and Gomez (1972).

On the basis of two years data it can be inferred that groundnut has the potential as *rabi* crop under Marathwada conditions using variety SB-XI. When it is grown in first fortnight of October.

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ALI, A.M. MOHAN, J.C. and SHANTHA, R. 1974. *Madras Agril. J.* **61**:805-806.

GAINDANA, E.H. 1970. *Field Crop Abstr.* **26**(3):130.

GOMEZ, L.G. 1972. *Field Crop Abstr.* **26**:189.

JOSHI, N.N., VAISHNANI, N.L. and KOHARIA, M.M. 1972. *Indian J. Agric. Sci.* **42**:145-147.

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# THE YIELD PERFORMENCE OF DIFFERENT VARIETIES OF GROUNDNUT UNDRE VARYING DATES OF SOWING GROWN DURING SUMMER SEASON

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Groundnut (*Arachis hypogaea* L.) is one of the important major oilseeds crop of India which alone contributes about 70 per cent of the total production of edible oil in the country. Amongst the oilseed crops of the State groundnut occupies dominant position. The average yield of groundnut during *kharif* is 0.5 tonnes/ha (1980-81). In Maharashtra groundnut is generally grown both during *kharif* as well as summer seasons. It is experienced that the yields of summer groundnut are comparatively more. Further, due to increasing irrigation facilities area under summer groundnut is increasing. However, the information on production technology of summer groundnut is yet to be developed. The present investigation was therefore, planned to find out optimum sowing time, and suitable variety for summer season.

The experiment was conducted at Post-Graduate Instructional Farm, Mahatma Phule Agricultural University, Rahuri, during summer season of 1982-83. The soil of the study area was clayey in texture. It was medium in available nitrogen, low in avilable phosphate and high in available potash and alkaline in reaction. The total rainfall received during crop growth period was 117.5mm in 28 rainy days. The treatment consists of four dates of sowing viz., 15th January, 7th February, 28th February and 21st March in main plot five varieties viz,. SB-XI, FSB-7-2, Phule Pragati (bunch type), TMV-10 (semi-spreading) and M-13 (spreading) in sub-plot laid out in split plot design replicated four times. The plot size was $2.7 \times 3.6 m^2$. The seeds were sown by hand dibbling with spacing of $30 \times 10$ cm$^2$ for bunch type and $45 \times 15$ cm$^2$ for spreading and semi-spreading types. A dose of 25 kg N+50 kg $P_2O_5$/ha was applied at the time of sowing.

The data on yield of dry pod and creepers of different varieties as influenced by various sowing dates are given in Table 1. Amongst the various sowings, 28th February gave the highest yield of dry pod (31.17 q/ha) which was on par with sowings on 7th February and 21st March but significantly superior over sowing on 15th January. Similar results were obtained by Patil (1977) in which he reported that 9th February sowing gave maximum dry pod yield than 25th January and 24th February and 10th March sowings. Krishnan (1965) observed that there was progressively decreased yield of dry pod from 1933 to 851 kg/ha with delay in sowing from mid February to mid April. Amongst the varieties M-13 found to produce maximum yield of dry pod which was significantly higher than rest of the varieties. The next higher yield of dry pod was obtained from FSB-7-2 which was at par with SB-XI but significantly more than rest of the varietics.

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**TABLE 1. Yield of dry pod and creeper (q/ha) as influenced by sowing datew and varieties**

| Sr. No. | Sowing/Varie-dates/ties | Dry pod yield (q/ha) | | | | | | haulm yield (q/ha) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | S.B.XI | FSB-7-2 | Phule Pragati | TMV-10 | M-13 | Mean | SB.XI | FSB-7-2 | Phule Pragati | TM 10 | | |
| 1. | 15th January | 21.73 | 27.37 | 9.48 | 18.06 | 37.42 | 22.81 | 51.44 | 52.78 | 46.30 | 81.02 | 87.45 | 63.79 |
| 2. | 7 th February | 27.73 | 31.14 | 25.75 | 24.01 | 42.52 | 30.35 | 68.16 | 57.87 | 86.16 | 97.74 | 91.31 | 80.25 |
| 3. | 28th February | 33.63 | 40.30 | 28.70 | 20.11 | 33.12 | 31.17 | 73.30 | 77.16 | 60.44 | 68.16 | 57.87 | 67.39 |
| 4. | 21st March | 29.55 | 27.33 | 29.42 | 15.21 | 32.10 | 26.72 | 52.73 | 43.72 | 55.30 | 56.68 | 63.53 | 54.37 |
| | Mean | 28.16 | 31.69 | 23.34 | 19.35 | 36.29 | 27.76 | 61.41 | 57.87 | 62.05 | 75.88 | 75.04 | 59.36 |

| | | 'F'test | S.E. ± | C.D. (P=0.05) | 'F' test | S.E. ± | C.D. (P=0.05) |
|---|---|---|---|---|---|---|---|
| 1. | Sowing dates | Sigt. | 1.76 | 5.63 | Sigt. | 2.07 | 6.62 |
| 2. | Varieties | Sigt. | 1.55 | 4.41 | Sigt. | 1.63 | 4.63 |
| 3. | Varieties at the same date of sowing | Sigt. | 3.09 | 8.78 | Sigt. | 3.26 | 9.26 |
| 4. | Sowing dates at the same level of varieties | Sigt. | 3.28 | 9.32 | Sit. | 3.57 | 10.15 |

**TABLE 2.** ***Mean yield attributes as affected by different sowing dates and varieties of groundnut***

| | Treatments. | Weight of Pod (g/plant) | 100 Pod weight(g) | 100 Kernel weight(g) | Shelling percentage |
|---|---|---|---|---|---|
| *Sowing dates :* | | | | | |
| 1. | 15th January | 14.37 | 93.95 | 39.45 | 71.07 |
| 2. | 7 th February | 18.54 | 104.63 | 43.93 | 72.60 |
| 3. | 28th February | 17.72 | 116.11 | 48.75 | 73.03 |
| 4. | 21st March | 18.33 | 123.10 | 51.68 | 71.78 |
| | S.E. ± | 1.00 | 2.99 | 0.96 | **0.11** |
| | C.D. (P = 0.05) | N.S. | 7.37 | 3.07 | **0.35** |
| *Varieties :* | | | | | |
| 1. | SB XI | 14.14 | 104.73 | 43.97 | 73.67 |
| 2. | FSB-7-2 | 14.47 | 102.09 | 42.86 | 74.09 |
| 3. | Phule Pragati | 11.99 | 101.60 | 42.66 | 73.55 |
| 4. | TMV-10 | 21.66 | 111.33 | 46.74 | 70.67 |
| 5. | M-13 | 23.92 | 127.49 | 53.53 | 68.64 |
| | S.E. ± | 1.03 | 2.46 | **1.03** | **0.11** |
| | C.D. (P = 0.05) | 2.93 | 6.99 | **2.93** | **0.31** |
| *Interactions :* | | | | | |
| a) | Varieties at the same date of sowing | | | | |
| | S.E. ± | 2.06 | **4.92** | **07** | **0.21** |
| | C.D. (P = 0.05) | 5.86 | **N.S.** | **N.S.** | **0.60** |
| b) | Sowing dates at the same level of variety. | | | | |
| | S.E. ± | 2.09 | **4.96** | **2.08** | **0.22** |
| | C.D. (P = 0.05) | 5.94 | **N.S.** | **N.S.** | **0.63** |

The percentage increase in dry pod yield of the varieties viz., M-13, FSB-7-2, SB-XI and Phule Pragati over that of TMV-10 were 87.55, 63.77, 45.53 and 30.62 respectively. Similar results were obtained at Agril. Res. Station, Jalgaon (Anonymous 1974 and Patil *et al.*, 1980). The maximum haulm yield was obtained when groundnut crop was sown during 7th February (80.25 q/ha), which was significantly more than rest of the sowing dates. It is in confirmity with the results obtained by Metelerkamp (1972). The variety TMV-10 has produced maximum creeper yield (75.88 q/ha) which was significantly more than rest of the varieties except the haulm yield obtained from M-13. It was also observed that the variety M-13 when sown on 7th February gave highest yield of dry pod (42.52 q/ha) which was significantly superior than rest of the combinations due to varieties and sowing dates except dry pod yield obtained due to same variety sown on 15th January and FSB-7-2 sown on 28th February. The maximum haulm yield was obtained with TMV-10 when sown on 7th February which was significantly superior than rest of the combinations due to varieties and sowing dates except the haulm yield obtained of M-13 sown on 7th February.

The data on pod weight (g) per plant, 100 pod weight (g), 100 kernel weight (g) and shelling percentage as influenced by different treatments are presented in Table 2. It would be seen that maximium pod weight per plant (18.54 g) was observed when sowing was dpne on 7th February, but, the maximum 100 pod weight (133.10 g) and 100 kernel weight (51.68 g) were observed when sown on 21st March which were significantly higher than 7th February and 15th January sowings but at par with the sowing on 28th February. Sowing on 28th February had maximum shelling percentage (73.03 per cent) which was significantly higher than other dates of sowing. The variety M-13 produced pod with maximum weight per plant (23.92g) which was sipnificantly superior over other varieties but at par with the variety TMV-10. The variety M-13 gave the maximum 100 pod weight (127.49 g) and 100 kernel weight (53.53 g) which were significantly superior over rest of the varieties, whereas the variety FSB-7-2 had maximum shelling percentage (74.09 per cent) which was significantly superior over rest of the varieties. The maximum pod weight of 28.65 g/plant was observed in TMV-10 sown on 7th February folloewd by M-13 with the same date of sowing. The variety FSB-7-2 has recorded maximum shelling percentage (75.28 per cent) when sown on 28th February which was significantly superior over rest of combinations due to varieties and sowing dates.

ANONYMOUS, 1974. A report on the Oilseeds Research Work bv Oilseeds Specialist, Mahatma Phule Krishi Vidyapeeth, Jalgaon (Unpublished).

KRISHNAN, R.H. 1965. *Madras Agri. J.* **52**:322-324.

METELERKAMP, H.R.S. 1972. *Rhodasia Agric.* **69**:87-89.

PATIL. P.S., DESALE, S.C., PATIL, G.D. and PATIL, J.R. J. *Makarashtra Agri. Univ.* **5**(1):58-60

PATIL. P.S., DESALE, S.C., PATIL, G.D. and PATIL J.R. *J. Maharashtra Agric. Univ.* **5**(1):58-60

PATIL. R.G. 1977. Investigation on time of planting and iron chlorosis on bunch groundnut varieties raised on black soil under irrigation. M.Sc. (Agri.) Thesis submitted to University of Agril. Sci. Bangalore, India.

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# SCREENING OF SAFFLOWER GENOTYPES FOR TOLERANCE TO SALINE WATER IRRIGATION

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Safflower (*Carthamus tinctorius* L. ), is an important oil seed crop of arid and semi arid regions of Karnataka, wherein salinity either in soil or in irrigation water is commonly noticed. Though saffiower is reported to be highly salt tolerant (Weiss, 1971), varietal differences have been reported by Francois and Bernstein (1964), Rai (1977) and Janardhan *et al.* (1986). Since good water for reclamation of salt affected soils is not available in this region, breeding genotypes combining high yields and tolerance to salinity is the only method of increasing safflower production. The present study was, therefore, undertaken at Main Research Station, Dharwad to screen promising genotypes of safflower for different levels of salinity in irrigation water in an attempt to identify genotypes tolerant to saline water irrigation.

Eight genotypes of safflower were evaluated during the *rabi* seasons of 1983-84, 84-85 and 85-86 at three levels of salinity in irrigation water viz., good water (GW-1 dS/m), 4 and 8 dS/m as described by Janardhan *et al.* (1986). The data in respect of plant height, number of flower heads per plant. 500 seed weight and seed yield as well as oil yield per plant were recorded on five randomly selected plants in each entry during 1985-86. The mean values of these five plants were used for further statistical analysis. Soil samples from each main plot were collected and analysed for pH, EC and SAR.

The results of soil analysis (Table 1) indicated an increase in both Electrical conductivity (EC) and Sodium absorption ratio (SAR) of soils with increase in salinity levels of water applied. The initial $EC_2$ of soil was 0.35 dS/m which increased to 0.39, 1.45 and 2.60 dS/m by application of saline water of 1.0 (GW), 4.00 and 8.0 dS/m respectively after the harvest of crop of 1985-86. However, the pH of the soil has not changed much with application of saline water.

Both seed and oil yield as well as their component characters decreased with increase in salinity levels of water applied (Table 1) confirming the report of Yermonas *et. al.* (1964). The seed yield decline in different varieties over GW ranged from 7.78 to 11.89 per cent and oil yield decline ranged from 9.37 to 12.94 per cent for every unit increase in salinity level of water applied (Table 2). This deviated from the results of Janardhan *et al.* (1986) who reported only 3.81 per cent yield decline for unit increase in salinity level.

The analysis of variance of seed yield data of *rabi* 1985-86 revealed significant differences amongst genotypes screened and salinity levels tested. The mean seed yield

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**TABLE 1. Effect ifed orent levels of salinity in irrigation water on soil properties and some Quantitative characters of Safflower during 1985-86**

| Salinity levels in in irrigation water (dS/m) | *Soil properties** | | | *Quantitative characters ***** | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | $EC_2$ | $pH_2$ | SAR | Plant height (cm) | No. of flower heads | 500 seed weight (g) | Oil content (%) | Seed yield per plant (g) | Oil yield per plant (g) |
| 1.0 (GW) | 0.39 | 8.1 | 1.20 | 63.9 | 22.9 | 20.4 | 28.16 | 17.9 | 5.1 |
| 4.0 | 1.45 | 8.0 | 11.09 | 68.6 | 22.7 | 19.1 | 25.85 | 15.4 | 3.9 |
| 8.0 | 2.60 | 8.0 | 18.81 | 58.9 | 18.5 | 16.0 | 19.01 | 5.1 | 1.0 |
| CD ( P = 0.05 ) | — | — | — | 11.3 | 5.5 | 2.6 | 3.65 | 5.9 | 1.7 |

* Mean of two depths

** Mean over genotypes

**TABLE 2.** Effect of saline water irrigation on seed and oil yield (g/plant) and their comhonent characters in different genotypes of safflower during 1985-86

| Genotype | Salinity level ** in irrigation water (sd/m) | | | * Mean seed yield (g) | MSI (%) | TIV | Mean seed yield (Average of three seasons) | MSI % | TIV | Mean* oil yield (g) | Plant height (cm) | No. of heads | 500 seed wt (g) | Oil content (-) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1.0 (GW) | 4.0 | 8.0 | | | | | | | | | | | |
| K-6 (19-185) | 14.7 | 18.1 (23.1) | 6.5 (56.6) | 13.1 (-8.6) | 83.7 | 3.3 | 18.2 | 74.5 | 3.3 | 3.6 (-10.6) | 69.0 | 26.8 | 14.9 | 26.2 |
| 9.51 | 15.1 | 14.7 (3.1) | 4.1 (72.9) | 11.3 (-10.7) | 62.0 | 2.7 | 19.3 | 64.9 | 3.1 | 2.7 (-11.9) | 64.1 | 20.6 | 17.2 | 2.25 |
| A-1 | 23.5 | 21.7 (7.5) | 4.5 (80.8) | 16.6 (-11.8) | 55.9 | 3.0 | 19.6 | 64.6 | 3.2 | 4.3 (-12.9) | 62.9 | 18.8 | 21.0 | 23.2 |
| 19-185 | 15.3 | 11.4 (25.5) | 4.7 (69.3) | 10.4 (-9.5) | 52.6 | 2.3 | 18.7 | 68.5 | 3.1 | 2.8 (-10.4) | 62.9 | 20.6 | 16.1 | 25.4 |
| Culture-83 | 22.9 | 16.9 (26.1) | 6.9 (71.5) | 15.6 (-9.6) | 51.9 | 2.9 | 19.3 | 58.2 | 3.0 | 4.1 (-11.3) | 64.7 | 21.1 | 23.5 | 24.4 |
| G-1254 | 23.8 | 17.6 (26.1) | 6.5 (72.7) | 15.9 (-10.1) | 50.6 | 2.8 | 18.4 | 55.9 | 2.9 | 3.9 (-11.4) | 65.4 | 21.0 | 21.1 | 22.9 |
| B-3-16-57 | 12.2 | 10.6 (13.1) | 4.8 (60.7) | 9.2 (-7.8) | 63.1 | 2.4 | 11.4 | 67.4 | 2.5 | 2.4 (-9.4) | 60.6 | 22.5 | 18.7 | 25.6 |
| S-144 | 15.9 | 12.2 (23.6) | 2.9 (81.8) | 10.3 (-11.9) | 47.5 | 2.2 | 12.7 | 52.9 | 2.6 | 2.8 (-12.2) | 60.8 | 19.4 | 15.7 | 24.5 |
| Mean | 17.9 | 15.4 (14.4) | 5.1 (71.5) | 12.8 (-9.9) | — | — | — | — | — | 3.1 (-11.3) | 63.8 | 21.4 | 18.5 | 24.2 |
| CD (P=0.05) | — | — | — | 3.2 | — | — | — | — | — | 1.0 | 3.5 | 3.1 | 2.4 | 2.2 |

CD ($P=0.05$) for sainity levels = 5.0, ** Figures in parentheses indicate percent decrease in yield over good water (GW)
* Figures in parentheses indicate regresion of yield on salinity levels.

over salinity levels was highest for the genotypes 'A-1' which was statistically on par with 'Culture-83' and 'G-1254 (Table 2). The mean decline in seed yield over GW was 14.4 per cent at 4 dS/m and 71.5 per cent at 8 dS/m. This deviated significantly from the report of Francois and Bernstein (1964), Mass and Hoffman (1977) and Janardhan *et al.* (1986). The genotypes 'K-6' (19-185)' and '9-51' were better at 4 dS/m with less than 5 per cent yield reduction whereas 'K-6 (19-185)' and '$B_3$16-57' fared well at 8 dS/m with less yield reduction compared to other genotypes. The Mean Salinity Index (MSI) per cent caluculated as per the methods of Giriraj *et al.*, (1976) was maximum for 'K-6 (19-185)' followed by '$B_3$16-57'. The Tolerance Index Value (TIV) was also maximum for 'K-6 (19-185)' followed by 'A-1'. The average of three years data in respect of mean seed yield, MSI per cent and TIV also confirmed the same trend. The results of regression analysis of seed and oil yield on salinity levels of water applied revealed the superiority of 'K-6 P19-185)' and 'B-16-57' which recorded lower negative regression value (Table 2) . In addition, these genotypes were reported to accumulate less of Na, more of K and maintain high K/Na ratio in leaves confirnimg their tolerant ability (Patil *et al.*, 1986) In general, based on all selection criteria, 'K-6 (19-185)' and '$B_3$-16-57' were rated as relatively tolerant compared to other genotypes screened.

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FRANCOIS, L.E. and BERNSTEIN, L. 1964. *Agron. J.* **56**:38-40.

GIRIRAJ, K., PARASHIVAMURTHY, A.S. and JANARDHAN, K.V. 1976. *SABRAO J.* **8**:47-52.

JANARDHAN, K.V., PATIL, B.N. and RAIKAR, D.S. 1986. *Indian J. Plant Physiol.* **29**:118-124.

MAAS, E.V. and HOFFMANN, G.J. 1977. *J. Irrig. Drain. Div., Proc. Amer. Soc. Civil Engg.* **103**: 115-134.

PATIL, B.C., GURIRAJA RAO, M.R., RAMAKRISHNA PARAMA, V.R. and VISHWANATH, D.P. 1986. *Abstracts of papers presented in National Seminar on Plant Physiology*, 1986. Dharwad pp. 43-44.

RAI, M. 1977. *Indian J. agric. Sci.* **47**:70-73.

WEISS, E.A. 1971. "Castor, Sesame and Sunflower", Leonard Hill, London, pp. 529-744.

YERMONAS, D.M., FRANCOIS, L.E. and BERNSTEIN. L. 1964 *Agron.J.* **56**:35-37.

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# EFFECT OF ANTI-TRANSPIRANTS ON CROP WATER USE EFFICIENCY OF RAPESEED AND MUSTARD

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Anti-transpirants viz. Silicone (Film forming), Kaolin (reflecting) and Phenyl Mercuric Acetate : PMA : (Metabolic inhibitor) with their different concentrations were sprayed on (i) *Brassica campestris* L. Var. Sarson, Prain 'SK 742' (V1) and (ii) *Brassica juncea* (L) Czern & Coss Var. 'Varuna' (V2). In both the species silicone (5%) formed stomatal plugs and greatly reduced transpiration leads to the improved WUE. However, the maximum yield (crop biomass) was obtained with kaolin (6%) due to much higher net assimilation rate than silicone and PMA.

Water Use Efficiency is a measurable menifestation for evaluation of water balance of a crop, as it reflects the yield of marketable crop produced per unit of water used in evapo-transpiration (ET). If yield is completely dependent on ET, any factor which causes an increase in yield or a decrease in ET, will have a favourable effect of WUE. ET implies loss of water, which should be reduced to lowest possible level in order to increase WUE. Earnest attention has been paid to regulate the phenomenon of water loss artificially by the use of anti-transpirants (Gale and Hagan, 1966). Looking to the importance of the anti-transpirants in improving WUE the present investigation has been executed on (i) *Brassica campestris L.* Var. Sarson Prain *'SK 742' (V1)* and (ii) *Brassica juncea* (L) Czern & Coss Variety 'Varuna' (V2) - the important oilseed of the region.

The seeds of both the species were sown in the equal sized earthen pots having mixture of soil, compost and recommended dose of fertilizers and were allowed to equillibrate by applying same quantity of water to the same environmental conditions (average maximum and minimum temparature 23°C and 10°C respectively and 93% average relative humidity). After one month of sowing five concentrations of three anti-transpirants namely Kaolin (2,3,4,5, and 6%); silicone (1,2,3,4, and 5%) and PMA (0.001, 0.002, 0.003, 0.004, & 0.005, per cent) were sprayed over crop canopy using teepol as sticker. The control pots were sprayed with water. Average loss of water (g $pot^{-1}$ $day^{-1}$) was quantified by weighing three pots of each treatment. Net assimilation rate (NAR) was determined by the formula given by Watson (1947). The ratio of crop biomass produced (g $pot^{-1}$) to total water loss during the period of experiment was recorded for computation of WUE.

The effect of various concentrations of anti-transpiarnts on $V_1$ and $V_2$ (Table 1) show that water loss was least at 5% concentration of silicone in both the species. It is also clear from the Table 1 that silicone (5% concentration) reduced water loss to about 39.7% of that of the water of control in $V_2$ as well as $V_1$. Kaolin and PMA

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TABLE 1. Effecct of anti-transpirants on transpiration and WUE of *Brassica capmestris* var. Prain 'KS 742' (V1) and *Brassica juncea* (L) Var. 'Varuna' (V2).

| TREATMENTS | | Average loss of water ( g pot$^{-1}$ day $^{-1}$) | | Percent loss of water over control | | WUE | |
|---|---|---|---|---|---|---|---|
| | | $V_1$ | $V_2$ | $V_1$ | $V_2$ | $V_1$ | $V_2$ |
| Control (sprayed water) | | 360 | 418 | 100.00 | 100.00 | 0.0053 | 0.0064 |
| Kaolin * | 2% | 280 | 319 | 77.78 | 76.30 | 0.0114 | 0.0130 |
| | 3% | 267 | 308 | 74.17 | 73.67 | 0.0135 | 0.0131 |
| | 4% | 249 | 297 | 69.17 | 71.04 | 0.0137 | 0.0144 |
| | 5% | 238 | 284 | 66.11 | 67.93 | 0.0236 | 0.0141 |
| | 6% | 231 | 263 | 64.17 | 62.91 | 0.0144 | 0.0138 |
| PMA** | 0.001% | 310 | 392 | 86.11 | 93.77 | 0.0057 | 0.0038 |
| | 0.002% | 290 | 331 | 80.56 | 79.27 | 0.0048 | 0.0052 |
| | 0.003% | 201 | 327 | 55.84 | 78.22 | 0.0054 | 0.0047 |
| | 0.004% | 293 | 342 | 81.39 | 81.80 | 0.0059 | 0.0052 |
| | 0.005% | 278 | 351 | 77.23 | 83.96 | 0.0044 | 0.0039 |
| Silicone * | 1% | 180 | 210 | 50.00 | 50.23 | 0.0241 | 0.0187 |
| | 2% | 168 | 190 | 46.67 | 45.45 | 0.0214 | 0.0171 |
| | 3% | 173 | 184 | 48.00 | 44.01 | 0.0253 | 0.0196 |
| | 4% | 159 | 179 | 44.17 | 42.82 | 0.0229 | 0.0231 |
| | 5% | 143 | 166 | 39.72 | 39.71 | 0.0283 | 0.0274 |

* P = 0.05
** P = 0.01

CD of WUE of *B. campestris* (V1) 0.002
CD for WUE of *B. juncea* (V2) 0.001

also reduced the water loss, although less than silicone. It is further noted from Table 1 that WUE values were much higher in silicone treated pots in comparison to the Kaolinand PMA. Moreover, silicone at 5% concentration gave very good results in improving the WUE value. However, the crop biomass (g pot$^{-1}$) and NAR (mg cm$^{-1}$ leaf week-$^{1}$) values were higher in kaolin treated pots than of silicone and PMA treated pots (Table 2).

TABLE 2. Effect of anti -transpirants on crop biomass and NAR of *Brassica campestris* Var. Sarson Prain 'SK (V1) and *Brassica juncea* Var. 'Varuna' (V2).

| Treatments | | NAR ( mg cm-2 leaf week-1 ) | | Crop Bimoass ( g pot$^{-1}$ ) | |
|---|---|---|---|---|---|
| | | $V_1$ | $V_2$ | $V_1$ | $V_2$ |
| Control (sprayed water). | | 17.6 | 19.2 | 24.6 | 32.8 |
| Kaolin | 2% | 21.9 | 23.4 | 30.6 | 48.7 |
| | 3% | 24.3 | 26.8 | 34.9 | 48.3 |
| | 4% | 28.5 | 30.9 | 42.6 | 59.4 |
| | 5% | 32.6 | 31.7 | 40.8 | 62.3 |
| | 6% | 30.4 | 32.9 | 52.7 | 55.8 |
| PMA | 0.001% | 21.3 | 19.4 | 10.4 | 11.8 |
| | 0.002% | 23.4 | 17.8 | 0.87 | 10.7 |
| | 0.003% | 23.7 | 17.3 | 12.6 | 17.2 |
| | 0.004% | 19.1 | 17.4 | 11.9 | 12.8 |
| | 0.005% | 18.6 | 16.4 | 17.4 | 15.3 |
| Silicone | 1% | 23.4 | 21.7 | 21.6 | 24.6 |
| | 2% | 26.7 | 21.9 | 24.7 | 27.9 |
| | 3% | 28.3 | 22.3 | 23.9 | 28.1 |
| | 4% | 28.5 | 22.7 | 27.3 | 27.2 |
| | 5% | 29.6 | 22.3 | 30.1 | 28.6 |

Reduction in the mean transpiration value by the use of chemicals resulted in the improved WUE (Davenport, 1967; Slatyer and Bierhuizen, 1964; Zelitch and Waggoner, 1962). In the present investigation all the three anti-transpirants kaolin, PMA and silicone greatly increased the WUE.

The results are in confirmity with the findings of Abou Khaled *et al.* (1970); Davenport, (1967); Sheikh and Mall (1978) and Patil and Dey, (1976). Nevertheless, silicone as anti-transpirants was found more effective inreducing the transpiration rates. Lee and Kozlowski, (1974) have reported that due to the formation of stomatal putni silicone greatlky reduced the transpiration. While Davis and Kozlowski (1974) opined that silicone adversely affect the photosynthesis. Comparatively the reflective chemical kaolin had less effect on transpiration reduction than silicone but this was only chemical which exhibited higher NAR and crop biomass values.

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ABOU KHALED, A., HAGAN, R.M. and DAVENPORT, D.C. 1970. *Water Resource Res.* **6**:280 280-289

DAVENPORT, D.C. 1967. *J. Exp· Bot.* **18**:332-347.

DAVIES, W.J. and KOZLOWSKI, T.T. 1974. *J. Amer. Soc. Hort· Soc.* **99**:297-304.

GALE, J. and HAGAN, R.M. 1966. *Ann. Rev. Plant Physiol* **17**:269:282.

LEE, K.J. and KOZLOWSKI, T.T. 1974. *Plant and Soil* **40**:493-510.

PATIL, B.B. and DE, RAJAT. 1976. *Plant Physiology* **57**:941-943.

SHEIKH, A.S. and MALL, L.P. 1978. *J. Indian Bot. Soc.***57**:6-8.

SLATYER, R.K. and BIERHUIZEN, J.F 1964. *Aust J. Biol. Sci.* **17**:131-146.

WATSON· D.J. 1947. *Ann. Bot.* **11**:41-76.

ZELITCH, I. and WAGGONER, P.E. 1962. *Proc. Nat. Acad. Soc.* **48**:1297-1299.

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# STUDIES ON A MOSAIC DISEASE OF SUNFLOWER

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Sunflower (*Helianthus annuus* L.) is one of the important oilseed crops which was introduced into India in late sixties. A large number of fungal, bacterial and viral diseases were recorded on this crop (Kolte, 1985). During surveys of the Experimental plots of Directorate of Oilseeds Research and Andhra Pradesh Agricultural University, Rajendranagar, Hyderabad, a mosaic disease to the tune of 10–15% was observed. The review of literature indicates that in India, sunflower is known to suffer from mosaic, yellow ring mosaic and yellow spot viruses (Uppal, 1933; Battu and Pathak, 1965; Gupta and Gupta, 1977) on which meagre information is avilable. Therefore, present work was undertaken with a view to identify the virus causing mosaic of sunflower in Andhra Pradesh.

The virus culture collected from the field was maintained in the insect proof glasshouse on sunflower (BSH-1). *Chenopodium amaranticolor* was used as assay host throughout the studies. Earlier, this virus culture was purified by single lesion isolation, maintained on sunflower and used throughout. Mechanical inoculations were carried out with the sap extracted in phosphate buffer pH 7.0 (0.05M) containing 0.02M 2-Mercaptoethanol. For aphid transmission studies, healthy colonies of aphids viz., *Aphis gossypii*, *A. craccivora* and *Rhopalosiphum maidis* were maintained on cotton, cowpea and maize plants respectively. Aphids were then given preliminary fasting period of 1 hr, followed by acquisition and inoculation feeding periods of 15 min each and ten plants were used for each aphid species. After the expiry of test period, the inoculated plants were sprayed with Dimethoate (0.05%). For seed transmission tests, the seeds collected from the infected plants were sown in the 36 cm pots in the glasshouse and the germinated plants were observed for symptoms for a period of two months. For determining physical properties i.e., thernal inactivation point (TIP), dilution end point (DEP) and longevity in *virto* (LIV), the standard procedures described by Bos *et al.* (1960) were followed. Agar gel double diffusion technique (Ball, 1974) was employed in serological tests.

The virus was easily sap transmissible and 90% of sunflower plants, (Cv.. BSH-1) were infected when mechanically sap inoculated. Ten day old sunflower plants were more susceptible as compared to 6, 15,20, 25 and 30 days. On sunflower, within 3-4 days after inoculation chlorotic lesions were produced on inoculated leaves, later within 10-15 days mosaic mottling accompanied by concentric chlorotic rings were observed on young leaves. Reaction of different plant species is presented in Table 1. *A. gossypii, A. craccivora and R. maidis* could transmit the virus in non-perisistent manner and the percentage of transmission was 70, 50 and 30 respectively. Of the 500 seeds sown, 466 germinated and none showed viral symptoms upto two months and also indicator-inoculation tests gave negative results. The LIV of the virus was between

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**TABLE 1. Reaction of herbaceous hosts with cucumber mosaic virus**

| | HOST | REACTION |
|---|---|---|
| 1. | *Helianthus annuus* L. | Chlorotic/necrotic local lesions, chlorotic concentric rings, mosaic mottling. |
| 2. | *Zinnia elegans* Jacq. | Vein clearing, mosaic mottling |
| 3. | *Carthamus tinctorius* L. | Mosaic mottling. |
| 4. | *Gouzotia abyssinica* Cass. | Mosaic mottling. |
| 5. | *Nicotiana tabacum* L. var. Harrison's special; var. Xanthi n.c. and var. Havana 307. | Vein clearing, mosaic mottling. |
| 6. | *N. glutinosa* L. | Vein clearing, mosaic mottling, shoe string. |
| 7. | *Capsicum annuum* L. | Concentric chlorotic rings, mosaic mottling. |
| 8. | *Solanum melongena* L. | Vein clearing, mosaic mottling. |
| 9. | *Lycopersicon esculentum* Mill. | Mosaic mottling, distortion of leaves. |
| 10. | *Cucumis sativus* L. | Mosaic mottling, chlorotic ring spots. |
| 11. | *C. melo* L. | Mosaic mottling, chlorotic ring spots. |
| 12. | *Luffa acutangula* (L) Roxb. | Mosaic mottling, chlorotic ring spots. |
| 13. | *Lagenaria vulgaris* Sachrad | Chlorotic local lessions, mosaic mottling. |
| 14. | *Momordica charantia* L. | Mosaic mottling, systemic chlorotic lesions. |
| 15. | *Citrullus vulgaris* Scr. | Chlorotic local lesions, mosaic mottling. |
| 16. | *Cucurbita pepo* Duck | Yelowing mottling. |
| 17. | *Trichosanthes anguina* L. | Mosaic mottling |
| 18. | *Chenopodium amaranticoor* Coste & Reyn. | Necorotic local lesions. |
| 19. | *C. album* L. | Necrotic local lesions |
| 20. | *Gomphrena globosa* Murr. | Mosaic mottling. |
| 21. | *Dolichos lablab* L. | Concentric chlorotic rings, mosaic mottling. |

24 - 48 h at 30-33°C and 120-144 h at 6-8°C. DEP was between $10^{-3}$ and $10^{-4}$ and TIP between 55-60°C. In serological tests partially purified virus under study reacted with CMV antiserum and produced precipitin lines and no reaction was observed with extracts from healthy leaf or saline. All the six cultivars viz., BSH-1, Morden, Surya, Co-1, EC-68414 and EC-68415 screened were found to be susceptible to this virus.

The symptomatology, host range and physical properties reported for the virus under study are entirely different from the tobacco streak virus (Dijkstra, 1983), potato virus Y group (Arnott and Smith, 1967) and beet Western yellows group (Russell *et al*,. 1975). CMV strain reported from Maryland (CMV-SF) (Orellana and Quacquarelli, 1968) differed from the virus under report in not producing filiform leaves and shoe string symptoms on *N. glutinosa*, with the symptoms of Zinnia *elegans* and also

in thermal inactivation point. The host reactions and other properties reported by Wang *et al.* (1983) closely resembles with the present virus. In both the cases the characteristic symptoms on sunflower were chlorotic/necrotic local lesions on the inoculated leaves followed by ring spots and mosaic symptoms in young and matured leaves. Like the other CMV strains, the virus under study is aphid transmitted and had thermal inactivation point between 55-60°C, dilution end point between $10^{-3}$ to $10^{-4}$ and aging *in-virto* for 24 - 48 h at 30-33°C (Gibbs and Harrison, 1970; Kaper and Waterworth, 1981). Moreover, the precipitin bands in gel diffusion test met without producing spurs indicating that the virus under study is serologically related to the CMV strain isolated by Dr. D.Z. Maat, Wageningen, the Netherlands.

Based on the present studies primarily the symptom expression, host range, physical properties, aphid transmission and serological reactions, the virus inciting ring spot and mosaic symptoms on sunflower in India, is considered as a strain of CMV.

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ARNOTT, H.J. and SMITH, K. 1967. *J. Ultrasrtuct. Res.*, **19**:173-195.

BALL, E.M. 1974. Serological tests for the identification of plant viruses. ***Am. Phytopath. Soc.***, St Paul. P. 31.

BATTU, A.N. and PATHAK, H.C. 1965. *Indian Phytopath.* **18**:317.

BOS, L., HAGEDORN, D.J. and QUANTZ, L. 1960. *Tijdschr. Plzeiekt.* **66**:328-343.

DIJKSTRA, J. 1983. *Neth. J. Plant Path.* **89**:153-169.

GIBBS, A.J. and HARRISON, B.D. 1970. Cucumber mosaic virus. CMI/AAB descrip ion of plant viruses. No.1, Kew Surrey, England.

GUPTA, K.C. and GUPTA, M.N. 1977. *Curr. Sci.*, **46**:285.

KAPER, J.M. and WATERWORTH, H.E. 1981. Cucumo viruses. pp 257-332. In "Hand book of plant virus infections and comparative diagnosis." ed by Kurstak, E., Elsevier/North Holland, Biomedical press, p. 943.

KOLTE, S.J. 1985. Diseases of Annual edible oilseed crops Vol III. CRC Press, Boca Raton, Florida.

ORELLANA, R.G. and QUACQUARELLI, A. 1968. *Phytopathology* **58**:1439-1440.

RUSSELL, G.E., COOK, P.H.L. and BUTING E.S. 1975. *Plant Path.* **24**:58-59.

UPPAL, B.N. 1933. *Int. Bull. Plant Prot.*, **7(5)**:103.

WANG, X.F., TIEN, W.H., QIU, B.S. and PIE M.Y. 1983. *Acta Phytopatholgica Sinica* **13**:29-36.

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# STUDIES ON SELECTIONS BASED ON POD NUMBER, DRY MATTER, HARVEST INDEX, YIELD AND VISUAL SUPERIORITY IN $F_6$ GENERATION OF SOYBEAN

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The breeding procedure usually being folloewd in soybean has been the pedigree method of breeding where rejection of lines in early generations of a cross is often based on visual evaluation for seed yield and overall agronomic requirements. However, for maximum efficiency and progress in breeding for any characters, it would be advantageous if an efficient selection could be carried out based on certain stable criteria, in early generations so that the best lines would be retained for further testing. Theoretical evidence suggests that to prevent the loss of the high yielding genotypes, selection for yield should commence among $F_2$ derived lines (Shebeski, 1967).

In order to evalute the potential, the prospects of selection for seed yield, pods/plant, dry matter yield, and harvest index, artificial selection was carried out for these traits along with visual selection for yield in $F_2$, $F_3$, $F_4$, and $F_5$ generation of two soybean crosses viz. UPSM-534×PK-86 and UPIR-1×Bragg. Four hundred random $F_2$ plants from each of the two crosses were scored for pods/plant, dry matter, harvest index, seed yield and phenotypically superior plants during *kharif* 1980. Top 5 per cent plants (20 plants) were selected for each of 5 selected criteria in both the $F_2$ populations. These 100 $F_3$ progenies from each cross (of selected $F_2$ plants) were evaluated during *kharif* 1981 in a randomized block design with two replications along with the two parental lines and three rows of composit bulk (excluding selections). Each progeny was assigned a single row plot of 3 m length, spaced 60 cm apart and plant to plant spacing was 5 cm. From each $F_3$ row, 10 plants were evaluated (5 plants/replication) and top ranking plant was advanced to $F_4$. Similarly, a top ranking $F_4$ was advanced to $F_5$. It is clarified here that selection and evaluation for a particular trait were confined within that group only. Five selections (in $F_6$) within each category (25 progenies) both the parents, a composite bulk and two promising varieties were evaluated in compact family block design with two replications. Each progeny included a single row, 5 m long, spaced 60 cm apart and plant to plant distance was 5 cm. Bulk seed of 4 m row ecxluding border on both ends, was used to measure the yield per plot. Selection advantage S—MP/MP×100 was calculated according to Sarafi (1975).

There were no significant differences for seed yield among selections (Table1). However, the mean of the progenies derived from dry matter selection and visual selection were relatively superior to the mean yield of the progenies derived from selection for pod number/plant, yield *per se* and harvest index. Similar trend was observed earlier also in early generations in $F_3$, $F_4$, and $F_5$ (Pushpendra, 1985). Ntare *et al.* (1984) observed the significant correlation between yield performance in early and late

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**TABLE 1. Yield observed in selections carried out for various attributes in the progenies of two different crosses**

| Plant | Selections made for: Pod number/plant yield (g) | Dry matter yield (g) | Yield *per se* yield (g) | Harvest index yield (g) | Visual selection for yield (g) | Yield (g) in respect of | |
|---|---|---|---|---|---|---|---|
| | | | *UPSM* - 534 × *PK*-86 | | | | |
| 1. | 425 | 493 | 428 | 433 | 448 | UPSM 534 | : 348 |
| 2. | 463 | 468 | 440 | 400 | 473 | *PK-86* | : *410* |
| 3. | 445 | 435 | 400 | 390 | 445 | Bulk | : 388 |
| 4. | 375 | 418 | 355 | 400 | 455 | PK-262 | : 395 |
| 5. | 488 | 470 | 363 | 388 | 533 | PK-327 | : 438 |
| Mean | 439.20 | 456.80 | 397.20 | 402.20 | 470.80 | CV (%) | : 16.66 |
| % increase over bulk selection | 13.19 | 17.73 | 2.37 | 3.66 | 21.34 | CD(P=0.05) | : N.S. |
| advantage % | 15.88 | 20.52 | 4.80 | 6.12 | 24.22 | | |
| | | | *UPIR*-1 × *Bragg* | | | | |
| 1. | 355 | 260 | 355 | 365 | 348 | UPIR-1 | : 298 |
| 2. | 343 | 355 | 348 | 320 | 345 | *Bragg* | : *220* |
| 3. | 350 | 340 | 330 | 295 | 360 | | |
| 4. | 260 | 350 | 300 | 315 | 355 | PK-262 | : 333 |
| 5. | 275 | 338 | 338 | 293 | 378 | PK-327 | : 350 |
| Mean | 316.60 | 348.60 | 334.20 | 317.80 | 357.2 | CV (%) | : 14.32 |
| % increase over bulk selection | 9.93 | 21.04 | 16.04 | 10.34 | 24.02 | CD(P=0.05) | : N.S. |
| advantage % | 22.23 | 34.59, | 29.03 | 22.70 | 37.91 | | |

generations in isolating high yielding lines in cowpea. Hanson *et al.* (1962) believed that the visual discrimination supplemented by information from replicated plot should be an effective procedure for selection within families representing an extreme range of types. Schapaugh Jr. and Wilcox (*1980*) reported that yield has been highly unstable in contrast to mature plant weight in soybean and that could have been possible reason for dry matter being a better selection than seed yield in both the crosses in this study.

Selections based on dry matter and visual discrimination recorded 17.73 and 21.34 per cent superiority over bulk respectively in UPSM-534 ×PK-86 and 21.04 and 24.04 per cent superiority in UPIR-1 ×Bragg. High selection advantage was observed for dry matter selection (20.52 and 34.59%) and visual selection (24.22 and 37.91%) for both the crosses.

In view of overall result, it is calculated that selection based on dry matter and visual selection for yield of phenotypically superior plant showed marginal superiority over the selection for pod number/plant, harvest index and yield *per se* to improve yield in soybean. Greater reliance may be kept on visual selection of phenotypically superior plant as is the practice presently. However, if the facilities and resources permit or there are less number of crosses to be handled, early as well as late generations may be subjected to selection for dry matter.

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HANSON, W.D., LEFFEL, R.C. and JOHNSON, H.W. 1962. *Crop Sci.* **2**:93-96.

NTARE, B.R. REDDEN, R.J., SINGH, B.B. and AKENOVA, M.E. 1984. *Field Crop Res.* **9**:91-100.

PUSHPENDRA, 1985. Genetics of quantitative traits and selection for yield and other characters in soybean. Ph.D. thesis submitted to GBPUAT, Patnagar.

SARAFI, A. 1978. *Crop. Sci.* **18**:5-7.

SCHAPAUGH, Jr., W.T. and WILCOX, J.R. 1980. *Crop Sci.* **20**:529-533.

SHEBESKI, L.H. 1967. Wheat and breading . In: Proc. Canadian Contennial Wheat Symposium (ed.) Nelson, K.F. Modern Press, Sakatoon, Sask, 410 -415.

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# AUTOGAMY IN SUNFLOWER

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Poor seed set is one of the important constraints limiting productivity in sunflower populations. Although interaction of physiological, genetic, nutrition and environmental factors decide seed filling, it was concluded that final seed set is decided to a large extent by the population of pollinators in the vicinity, as sunflower is essentially a cross pollinated crop (Seetharam, 1982). Besides, self incompatibility of sporophytic nature is repotred in sunflower (Habura, 1957; Pinthus, 1959). One of the mean-to alleviating this problem is by identifying self-fertile lines and thus increase seed set and productivity. In the present study, open-pollinated varieties of sunflower, hybrids and their parental lines were evaluated for their autogamy.

A set of 14 genotypes comprising three populations (viz., EC 68415, CGP-1 and Morden), six hybrids and their parental lines (five inbred lines) were raised in a single row each of 5 m length during summer 1984. Before anthesis, five heads at random in each genotype were covered with cloth bag. Autogamy percentages were determined from the seed set under bagged heads divided by the mean seed set of the exposed heads and expressed in percentage (Robinson, 1980). The results obtained are given in Table 1.

The per cent seed set under open pollination ranged from 74.58 to 89.70 and as such did not vary appreciably either for populations, hybrids or the parental lines of hybrids. However, the mean values of per cent seed set under bagged condition and autogamy percentage calculated for populations, hybrids and their parents (inbreds) revealed wide variation. The highest autogamy per cent was for hybrid cultivars (52.4 per cent) followed by inbred lines (45 70 per cent) and open pollinated varieties (7.09 per cent). Amongst the three populations, Morden, which is presently widely cultivated in the country, is comparatively more self-fertile over CGP-1 and EC.68415 (Armavirikskii-3497). Amongst hybrids, CMS 234×RHA 801 combination had the highest autogamy per cent closely followed by BSH-1 with 68.65 autogamy per cent value. In the other experimental hybrids the autogamy per cent ranged from 40.53 to 48.69 . In a similar study, Robinson (1980) also observed very low autogamy for populations and high autogamy for hybrids (41 to 46 per cent) over two seasons.

Although a genotype is considered as a self fertile based on its seed production under bagged condition, George *et al.* (1980) pointed out that this procedure fails to ensure the potential self-pollination in some genotype that can be achieved by manual self-pollination and hence this should be included in self-compatibility estimations. Besides, environmental factors influence self-compatibility in sunflower (Pinthus, 1959; Vranceanu *et al.*, 1978; George *et al.*, 1980). These factors will be considered in future studies.

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TABLE 1. *Per cent seed set under bagged condition, open pollination and autogamy in sunflower genotypes*

| Genotype | % seed set under | | *Autogamy(%)* |
|---|---|---|---|
| | Bagged condition | Open Pollination | |
| *Open pollinated varieties* | | | |
| EC 68415 | 0.07 | 85.62 | 0.08 |
| CGP-1 | 4.29 | 83.05 | 5.17 |
| Morden | 13.65 | 85.18 | 16.02 |
| Mean | 6.00 | 84.62 | 7.09 |
| *Parental lines* (*Inbreds*) | | | |
| 234 B | 39.71 | 74.58 | 53.24 |
| 302 B | 22.85 | 82.37 | 27.74 |
| 308 B | 42.89 | 78.51 | 54.63 |
| *RHA 274* | 35.97 | 88.39 | 40.70 |
| RHA 801 | 46.80 | 89.70 | 52.17 |
| Mean | 37.64 | 82.71 | 45.70 |
| *Hybrids* | | | |
| 234 × 274 (BSH-1) | 55.28 | 80.53 | 68.65 |
| 234 × RMA 801 | 59.34 | 85.54 | 69.37 |
| 302 × RHA 274 | 39.61 | 81.35 | 48.69 |
| 302 × RHA 801 | 35.61 | 87.86 | 40.53 |
| 308 × RHA 274 | 36.07 | 83.37 | 43.27 |
| 308 × RHA 801 | 36.72 | 82.95 | 44.27 |
| Mean | 43.77 | 83.60 | 52.4 |
| Overall Mean | 33.49 | 83.50 | 40.33 |
| S.D. | 17.52 | 4.04 | 21.23 |

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GEORGE, D.L., SHEIN, S.E. and KNOWLES, P. F.1980. *IX Intern. Sunflower Conf.*, Makaga, Spain, p. 14.

HABURA, E.C.H. 1957. *Paraterilitat bei Sonnenblumen. Z. Pfflanzenzuecht.* **37**:280-298.

PINTHUS, M.J. 1959. *Agron. J.* **51**:626.

ROBINSON, R.G. 1980. *Crop Sci.* **20**:814-815.

SEETHARAM, A. 1982. *20th All India Convention of oilseeds and Oil trade and Industry* p. 53-5

VRANCEANU, A.V., STOENESCU, F.M. and SCARALAT, A. 1978. *VIII Intern. Sunflower Conf.* Minneapolis, U.S.A. 453-465.

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# DISEASE SYNDROME CAUSED BY *MACROPHOMINA PHASEOLINA* IN CASTOR

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Castor (*Ricinus communis* L.) is the major cash crop of the farmers of Southern Telangana Zone of Andhra Pradesh. Besides few known diseases on the crop, aerial infection of *Macrophomina* was recently reported from the state (Maiti and Raoof, 1984). However, the farmers and the extension workers often report and are more concerned with a disease locally called wilt. Hence, detailed studies were undertaken to specify the disease syndrome caused by *Macrophomina Phaseolina* (=*Rhizoctonia bataticola*) widespread occurrence and destructive nature.

The disease appears in different crop growth stages as spike blight, stem blight, twig blight, collar rot and root rot. The symptoms and epidemiology of the disease are described in detail.

*Spike blight*: The disease starts in a few capsules in a primary spike that get discoloured and later turn black; the pedicels dry up and infection reaches the peduncle which dries up in course of time. The peduncle shrinks and often breaks down. By that time, almost all the capsules are either infected or dry up prematurely.

*Stem blight*: Straw coloured discolouration appears on the stem usually at the nodes around the base of a middle leaf (leaves). The discolouration gradually enlarges into an elongated oval lesion. Several minute black dot like structres (pycnidia of the fungus) develop in concentric rings at later stages which give a black appearance to the stem lesions. The surface of the stem shrinks at this region and the plant easily breaks at this point. Stem lesions at the internodes are not uncommon.

*Twig blight*: On the twigs, the tips of terminal buds (stipule tips) get discoloured black and the youngest leaves show marginal discolouration which gradually advances further. These leaves become flaccid and droop. The affected twig gradually dries up from tip downwards. It is common to observe such dried up twigs on the otherwise green stem. Blight lesions are not uncommon on older leaves. They are dark brown to black that extend from the margins with chlorotic advancing regions.

*Collar rot* : The tips of affected plants droop with one or two young leaves hanging while the lower leaves drop down. Black discolouration is observed at the collar region which gets shrunken abnormally later. The tissues at this region remain hard in the beginning. The discolouration extends to the root system (root rot phase). The bark shreds; several minute black structures (sclerotia of the fungus) are seen on the decayed root system. The entire plant dries up and gets easily pulled up.

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Repeated isolations from different infected plant parts consistently yielded a fast growing brown coloured mycelium that turns black with the production of innumerable small black bodies, the sclerotia on PDA. The pathogen was identified as *Macrophomina phaseolina* (Tass) Goid

Several methods of pathogenicity tests were tried with only one successful. The bark on the stem is split open in a 'T' shaped cut and the fungus culture is introduced into the cut and covered with the bark flaps and finally wrapped up with a polythene ribbon. Black lesions develop 15 days after inoculation in which plenty of pycnidia are formed

Epidemiology: The disease usually starts before maturation of the primary spikes as spike blight as a result of aerial infections; the stem and twig blights follow. By this time, the crop experiences two types of moisture stress. The crop sown in June usually faces a drought spell in September - October (coinciding with spike maturity) in the Castor belt of Southern Telengana Zone thus depleting the plant moisture content. The plant also suffers moisture depletion physiologically due to spike maturation. Thus, both the moisture depletions are unfavourable for plant growth but favourable for the pathogen and the disease develops. It is also common observation that the border plants often escape the disease. However, if rains occur subsequently, sprouts develop from the stalks below infected region of stem blight plants which make good growth and thus the crop 'recovers' after a shower.

The collar rot phase also appeare at the same stage of crop growth as a result of soil borne inoculum. However, early appearance of the phase (about 40 days old) is also uncommon.

Based on the major symptoms, the disease is called stem and twig blight and his is the disease prevalent in castor belt of Southern Telengana Zone.

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Maiti, S. and Raoof, M.A. 1984. *J. Oilseeds Res.* 1:236-237

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# INHERITANCE OF SEED WEIGHT IN INDIAN MUSTARD

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Seed weight is one of the important yield contributing traits and knowledge of genetic architecture of this character is essential to formulate any useful breeding programme. Therefore, six varieties of indian mustard (*Brassica juncea* (L) Czern & Coss) i.e. RAURS-1, BR-40, Varuna, Kranti, RAURD 1002 and DIR 147 and their 15 $F_1$ constituting $6 \times 6$ half dialle set were used. Second degree statistics i.e. variance (Vr) of the parental mean and coveriance (Wr) of the off-spring of the rth array with the non recurring parents were computed. The Vr and Wr values were subjected to graphical analysis to know genetic relationship among the parents and diallel analysis was done by acepting the model suggested by Hayman (1954).

The non-significant value of uniformity test ($t^2 = 0.334$) indicated the validity of various assumptions made by Hayman (1954). The non-significant deviation of regression coefficient ($0.954 \pm 0.153$) from unity but significant from zere ($5.582 \pm 0.153$) reflected the preponderance of additive type of gene action for this character.

The regression line intercepted the Wr axis above the origin suggested that the average deminance was within the range of partial dominance while Trivedi and Mukherjee (1986) reported ever dominance for this character. All the array points were found to be scattered above the line of unit slope showing absence of non-allelic interaction. The array points for Varuna and DIR-147 fell scattered near the origin of regression line indicating thereby concentration of dominant genes in these parents fellowed by RAURD-1002 while BR 40 and Kranti had deminant and recessive aellels in equal frequencies as their points fell in the middle. The array points for RAURS-1 was found to be located at the farthest end of the regression line showing that it had most recessive alleles governing this trait (Fig. 1).

The additive component (D) was recorded to be significant reflecting thereby that additive type of gene action was important in determining the seed weight in Rai (Table1). The estimated degree of dominance $(H_1/D)^{\frac{1}{2}}$ was less than unity indicating partial deminance and thus, importance of additive type of gene action, whereas Swami Rao (1971) and Yadav *et al.* (1985) reported the impertance of both additive and non-additive gene action for seed weight in brown sarson. The estimate 0.225 of (H2/4H1) whose maximum possible value of 0.25 is expected under equal frequencies of positive and negative alleles, showed, presence of marginal degree of gene assymmetry which was in favour of recessive alleles as evident by the negative sign of F. The Vr/Wr value (0.752) also indicated the existance of partial dominance. In the present study high narrow sense heritability estimate (83.00%) reflected importance of additive gene action

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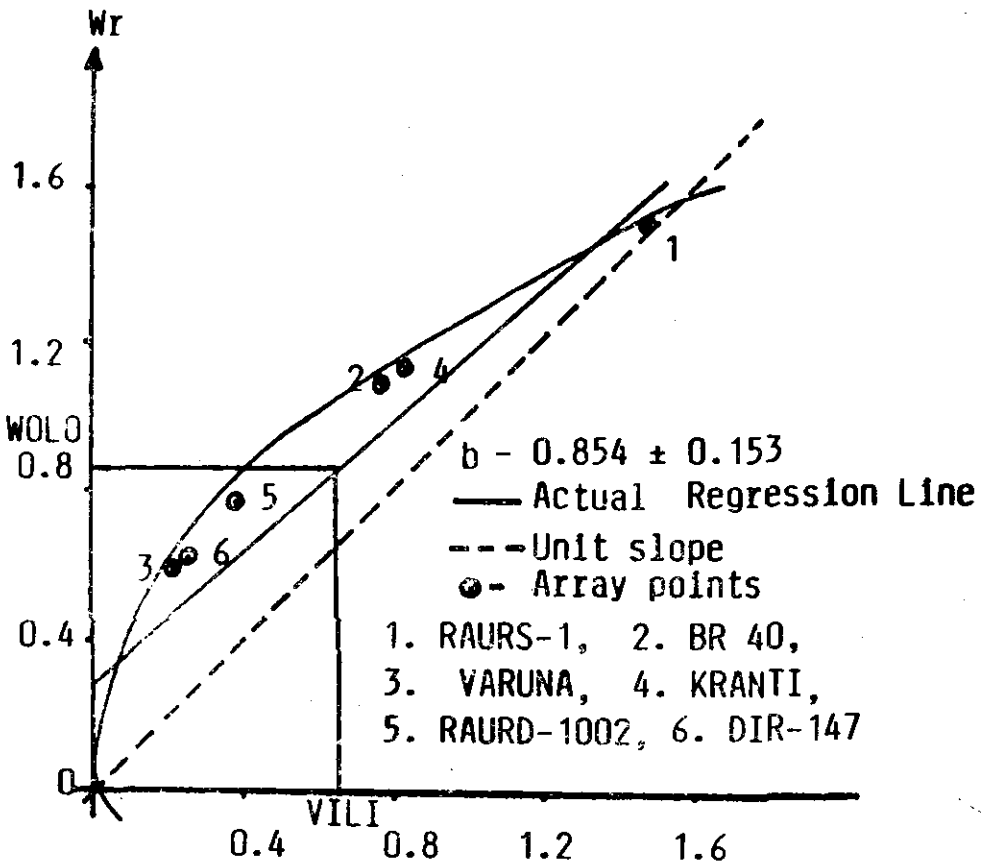


Fig. 1 Genetic relationship among parents

whereas Yadav *et al.* (1985) recorded moderate value for narrow sense heritability for seed weight in brown season. The results of the present investigation revealed that there is high degree of variability among the parents and hybride in respect of seed weight and additive type of gene action has significant role in determining this character and the selection in early generation would be effective.

**TABLE 1. Gegetic paremeters and ratio estimates for seed weigl.t in Rai (*Brassica Juncea* (L) Czern & Coss)**

| Genetic parameters | Estimates |
|---|---|
| D (additive) | 1.490 ± 0.123 |
| $H_1$ (deminance) | 0.484 ± 0.313 |
| $H_2$ (deminance( | 0.436 ± 0.279 |
| $h_2$ (deminance) | 0 222 ± 0.188 |
| F (additive, dominance and gene asymmetry) | -0.408 ± 0.301 |
| E (enivrenmental) | 0.090 ± 0.046 |
| (H1/D1/2) (average dominance) | 0.570 |
| H2/4H1 (gene asymmetry) | 0.225 |
| $h^2/H_2$ (number of gene block) | 0.509 |
| Heretability in narrow sense | 0.830 |
| Vr/Wr | 0.752 |
| $t^2$ | 0.334 |

HAYMAN, B.I. 1954. *Genetics* **39**:789-809.

SWAMI RAO, T. 1971. *Agric. Res. J. Kerala* 9(1) 63-67.

TRIVEDI H.B.P. and MUKHERJEE, B.K. 1986. *Indian J. Agric. Sci.* **56**(1) : 10-14.

YADAV, I.S., KUMAR, D and YADAVA T.P. 1985. *J. Oilseeds Res.* **2**(2) 272-276.

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# OUTBREAKS OF *BALCLUTHA HORTENSIS* LINDB - A NEW PEST SPECIES OF GROUNDNUT

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Groundnut *Arachis hypogaea* L.is attached by a variety of sucking pests belonging to the family Cicadellidae. Of these, *Empoasca kerri* Pruthi in India, *E. fabae* Harris in northern states of America, *Austroasca viridigrises* Paoli and *A. alfalfae* (Paoli) infesting groundnut in Australia and in South East Asia, *Orosius argentatus* as vactor of witch's broom disease are important pests. The importance of jassids as pests of groundnut has been recognised by farmers in recent years. A new species has been found to occur in groundnut in Junagadh as a predominant species akin to *E. kerri* which is noted pest of groundnut in Southeren parts of India. The species has been identified as *Balclutha hortensis* Lindb. by M.K.S. Ghauri of CIE London. Similarly there has been record of a different species, *B. hebe* (Kirkaddi) infecting groundnut. Both nymphs and adults desap the groundnut mainly from under surface of the leaves tender stem etc. The initial injury to groundnut appears on young leaves and the 'V' shaped yellowing appears with the tapering end towards the midrib. The jassids make a moderate appearance by August and build up by September in the monsoon season with a mean sampling population of 10.12 (range 13-22) jassides/5 sweeps/5m length of row, whereas between March and April it was 7.32 (range 9-16) jassids/5 sweeps/5m row of groundnut in post rainy season. This species was found to be a regular pest attacking about 33 field crops and vegetables in Egypt (Ammar *et al.* 1981). Two more new species of pests viz., *Exitianus Taeniaticeps* (Kirchbaum) (Cicadellidae : Homoptera) and *Trygonot ylus doddi* (Distant) (Miridae : Homoptera are also found to co-exist with a sampling population of 2-3 and 1-5 per 5 sweeps of 5m row length respectively.

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AMMAR, E.D.' EL-NAHAL, A.K.M., EL-BLOCK, M.M. 1981. *Bulletin de la societe Entomologi d' Egypts.* **61**:245-255.

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# EFFECT OF PLANTING PATTERN AND ROW RATIO ON YIELD AND PRODUCTIVITY IN CASTOR + CLUSTERBEAN INTER-CROPING SYSTEM

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Castor (*Ricinus communis* (L.) is extensively grown under rainfed conditions in red chalka soils (Alfisols) of Telengana region in Andhra Pradesh. The yield levels of this crop are very low (160-240 kg/ha) due to poor management practices adopted by the farmers. Experiments conducted on crop geometry at CRIDA Research Farm, Hyderabad have revealed that row spacing can be widened from 45 to 135 cm with populations from 50 to 100 thousand plants per hectare without much reduction in bean yield. Therefore, researches were conducted on intercropping in castor under rainfed conditions to increase and stabilise the production of castor. Among the intercrops a short duration clusterbean (*Cyamopsis tetragonoloba* (L.) Taub) variety Pusa Navbahar was found suitable in the interspaces (90 cm) of castor. The present study was undertaken with a view to finding out the optimum row ratio and planting pattern to be adopted to improve the productivity of castor+clusterbean intercropping system.

A field experiment was conducted during 1983-84 season on sandy loam soil of Hayathnagar Research Farm of Central Research Institute for Dryland Agriculture, Hyderabad. The soil was low in organic carbon (0.41%), available N (231 kg/ha) and medium in available $P_2O_5$ (23 kg/ha) and having pH 5.8. Six treatments consisted of 1) sole castor 75 cm (var. Aruna); 2) sole castor sown in paired (60-105-60 cm) rows; 3) sole clusterbean 45 cm (var. *Pusa Navbahar*) 4) castor+clusterbean (1:1) 75 cm (one row of clusterbean at 37.5 cm spacing); 5) paired row (60-105-60 cm) planting of castor+one row of clusterbean in between paired castor rows and 6) paired row (60-105-60 cm) planting of castor + two rows of clusterbean in between paired castor rows.

All the experimental plots were uniformly fertilized with 15 N and 40 kg $P_2O_5$/ha through DAP at the time of sowing. BHC (10%) was applied at the rate of 50 kg/ha in the last disc to control termite and root grub incidence. Castor and clusterbean were sown on 15th July, 1983 in sole and intercropping systems. Nitrogen at the rate of 35 kg/ha through urea was side placed 35 days after sowing. Dry pods of clusterbean were harvested on 24th November, 1983 for seed purpose. Castor was harvested into primaries and secondaries separately in different pickings and the final picking was done on 6th February, 1984. Rainfall of 752.5 and 764.6 mm was received in 45 and 46 rainy days during growth periods of clusterbean and castor, respectively.

The total capsule and bean yields of castor, seed yield of clusterbean, LER and monetary returns are presented in Table 1.

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**TABLE 1. Effect of planting pattern and row ratio on yield, LER and monetary return in sole and intercropping system.**

| Treatment | Capsule yield of castor) (kg/ha) | Bean yield of castor kg/ha) | Filled beans of castor/ sq.m | Seed yield of cluster-bean (kg/ha) | LER | Monetary return (Rs/ha) |
|---|---|---|---|---|---|---|
| Sole castor (75 cm) | 1467 | 1001 | 802.5 | — | 1.00 | 3503.50 |
| Sole castor (60-105-60 cm) | 1348 | 937 | 665.8 | — | 1.00 | 3279.50 |
| Sole clusterbean (45 cm) | — | — | — | 247 | 1.00 | 988.00 |
| Castor + clusterbean (1:1) | 1107 | 759 | 628.9 | 99 | 1.20 | 3052.50 |
| Castor + clusterbean (2:1) | 1272 | 863 | 663.1 | 55 | 1.14 | 3240.50 |
| Castor + clusterbean (2:2) | 1075 | 739 | 569.3 | 109 | 1.23 | 3022.50 |
| SEm ± | 78 | 51 | 51.5 | — | — | — |
| CD (P = 0·05) | 242 | 159 | 158.5 | — | — | — |

* Market prices : castor — Rs. 3.50 per kg

clusterbeans — Rs. 4.00 per kg

The total capsule and bean yields obtained in uniform and paired row systems of sole castor were at par, although slight advantage was noticed with uniform rows. The result is in agreement with thr findings of Umrani *et al.* (1984) who reported that there was no difference in yield between planting patterns under well distributed rainfall condition in sorghum based intercropping systems. The seed yields of castor were significantly reduced in 1:1 (24 per cent) and 2:2 (26 per cent) row ratios of castor + clusterbean intercropping systems compared to sole crop of castor in nuiform rows. This was mainly due to significant reduction in filled seeds/sq.m. in intercropped castor compared to sole castor (Table 1).

Seed yield of clusterbean was low due to poor pod filling as a result of incessant rains during pod development stage. There was a marginal increase in the productivity under 1:1 castor + clusterbean (LER = 1.20) castor + clusterbean (LER=1.23) intercropping systems compared to 2:1 castor + clusterbean intercropping system. Trials conducted in the farmers 'fields at Hyderabad Operational Research Project site, Manimuthyalammakunta have also indicated that castor + clusterbean (1:1) when sown timely gave an yield advantage of 24 per cent (LER=1.24) over sole crop of castor.

The data presented in Table 1 indicated that total monetary returns were highest in sole stand of castor. Intercroping of castor with clusterbean harvested for seed purpose was not profitable giving lower monetary returns than sole castor. The main reason for the yield reduction of castor in the intercropping was retaining clusterbean for grain purpose thus increasing the competition for longer periods. Consequently, experiments are currently under progress to see if this competition can be minimised and castor yields and LER improved by harvesting clusterbean for vegetable purpose.

UMRANI, N.K., SHINDE, S.H. and DHONDE, P.M. 1984. *Indian J. Agron.* **29**(1):27-30.

# BOOK REVIEW

**Non-Traditional Oilseeds and Oils of India** Ed. N. V. Bringi, Oxford & IBH Publishing Co. Pvt. 254 pp, price Rs. 85-00.

The minor or non-traditional oilseeds collected from forest and some avenue trees are source of oils and fats useful as raw material for cocoa butter substitutes and for wide range of industrial uses. The residual cake is useful as animal and poultry feeds and the other non-lipid constituents have several uses. It is estimated that a systematic exploitation of these sources would result in around 1 million tonne of oil, thereby reducing the import bill to a great extent.

The book is a complete review of the recent developments in the chemistry, technology and utilization of oils and their by products The editor himself is the author or one of the authors of eight of the total ten chapters of the book

The first four chapters deal with confectionary fats such as sal (*Shorea robusta* mowrah (*Mudhuca indica*), mango (*Mangifera indica*) and kokum (*Garcinia indica*), dhupa (*Vateria indica*), phulwara (*Bassia butyracea*). The chapter on sal is very exhaustive with the results from the author's laboratory. The next three capters present the informations on Karanja (*Pongamia glabra*), neem (*Azadirachta indica*) and kusum (*Schleichera trijuga*). The eighth and ninth chapters summarise the picture of pilu (*Salvadora oleoides* and *S. persica khakan*) and pisa (*Actinodaphne hookeri*) seeds, which are the sources of lauric and myristic acids. The last chapter deals with lesser known oilseeds viz., thumba (*Citrulus colocynthis*), palash (*Butea frondosa*), nahor (*Mesua ferrea*), ratna jyoti (*Jatropha curcas*), rubber (*Havea brasiliensis*), moaroti (*Hydnocarpus wightiana*), kamala (*Mallotus philippenis*), dharambe (*Garcinia cambogia*), gurginut (*Garcinia morella*) and malkanguri (*Celasturs panicultauts*). ete.

The information presented in the book includes availbility, collection, processig of seed, storge, oil recovery, oil quality and characteristics, processing and upgrading of oil and fractionation and utilizations. In addition to the chemistry and technology of oil, the non-lipid components present in the respective oils and other plant parts are discussed. The details with regard to the botancial aspects of the trees are not exhaustive.

The book is a valuable reference for scientists and techonologists in oilseed production, oil chemistry and technology, organic chemistry, agricultural chemistry, toxicology and animal nutrition.

The book is neatly bound with atrractive cover and good print. Photographs of the tree species discussed, would have enhanced the quality of the book.

M.V.R. Prasad

**Phytopathometry** by C.D. Mayee and V.V. Dattor, Technical Bulletin 1 (Special Bulletin-3), Marathwada Agricultural University, Parbhani, India, 1986 218pp, Price Rs. 70-00.

Phytopathometry, the branch of plant pathology deals with disease measurement, is the foundation of any disease management programme. The volume although gives an idea of a text book on phytopathometry by its title, does not provide detail account of recent methods of measuring diesease. However, a brief account of different modern methods like remote sensing, aerial infra red photography and video immage analysis have been touched. The main body of the text deals with disease assessment scales for important diseases in India. A uniform 0-9 scales have been given with standard area diagrams for easy assessment.

The book will serve as a field hand book to the field workers engaged in disease assessment. Quality of printing is very much unsatisfactory. A number of spelling errors, misprints could have been easily avoided. Binding and quality of paper used are also far from satisfactory. These deficiencies, however, do not reduce the importance of the book. I wish it every success.

Satyabrata Maiti

**Sunfiower** by S. S. Sindgari and K. Virupakshappa, ICAR, New Delhi, 1986 36 pp. Price Rs. 10-25

The booklet is the result of an opportune effort made by the authors to compile the Indian research findings since the start of sunflower research in 1972-73. Informamation in nutshell covers almost all the major aspects of the crop including varietal renovation and seed production. The book is divided into six chpaters. Importance of sunflower, its introduction into the country, desirable attributes of the crop etc are briefly mentioned in the first chapter : Introduction. The second chapter which includes origin, botany and breeding, contains information on domestication of sunflower, plant morphology, floral biology, followed by a brief mention about the species, selfining and crossing techniques. Under breeding, different methods being followed such as mass selection and combined-head to row and remnant seed method (Pustoviot "Method of Reserves") are given. Varietal renovation procedures for production of superelite and elite seeds are explained. Steps in hybrid development are also described. The source of cytoplasmic male sterility discovered by Leclereq and the per cent increase in yield of hybrids over the check would have been metntioned. Procedure of BSH-1 hybrid seed production does not have information on distinguishing morphological features of CMS-234 and RHA-274. A mention of research on hybrid development in progress at other centres would have been appropiate. The third chapter on crop production contains information on climatic requirements, soil and important findings on fertilizer, spacing, seed rate etc. under All India Coordinated Research Project on Sunflower. This information and the findings of yield maximisation trial pertain mostly to trials conducted at Bangalore except in a few studies. Results of other centres could have made the booklet more informative.

Under diseases and pests (Chapter 4) rust is mentioned to be server in *Kharif*. It should read as in *rabi* and the concentration (0.4%) mentioned for Dithane M 45 should be 0.25%. In leaf eating caterpillar *Diacricia obliqua* changed generic name *Spilosoma* should have been mentioned. Seed dormarcy and viability; harvesting and utilisation aspects are covered in brief in chapter 5&6. Barring a few grammatical errors the booklet serves as a useful guide to extension workers, subject matter specialists and students. In the light of the importance of sunflower crop efforts of authors need to be commended

S. P. Angadi and I. J. Anand

## ACKNOWLEDGEMENT

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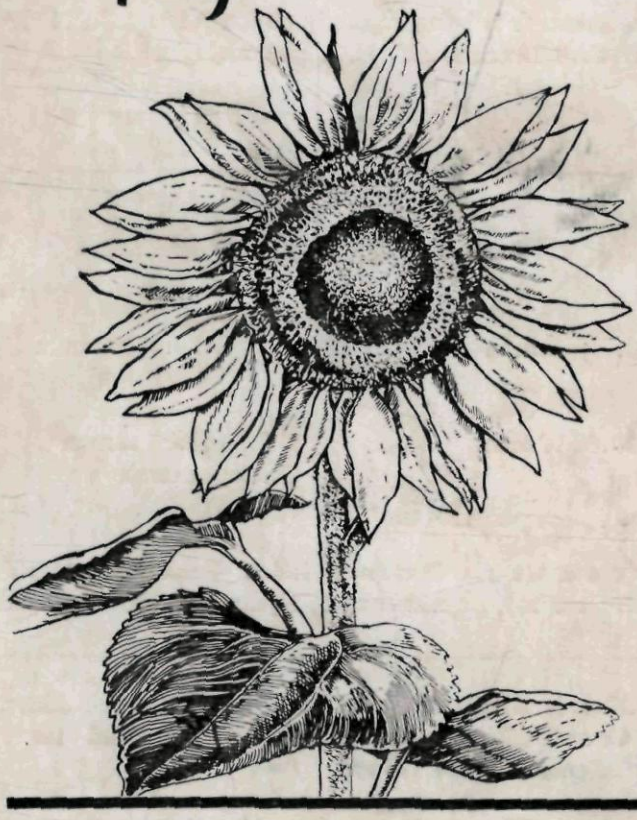

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