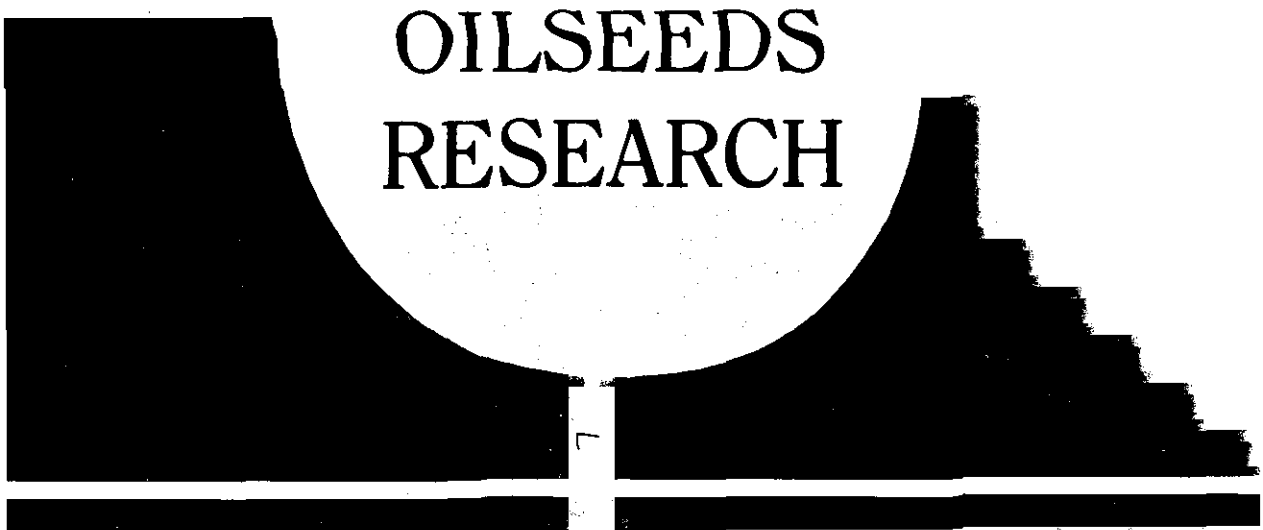
VOLUME 7 JUNE 1990 NUMBER 1

DOR- 335

# JOURNAL OF OILSEEDS RESEARCH



INDIAN SOCIETY OF OILSEEDS RESEARCH
DIRECTORATE OF OILSEEDS RESEARCH
RAJENDRANAGAR, HYDERABAD - 500 030 INDIA

---


**Journal of Oilseeds Research** is the official organ of the Indian Society of Oilseeds Re published half yearly. It is sent free to the members but for others the annual subscription is Rs. 250=00 in India and U.S. $ 50=00 abroad. Subscription should be sent with an order to the General Secretary, The Indian Society of Oilseeds Research Directorate of oilseeds Research, Rajendranagar, Hyderabad--500 030, India.

# Journal of Oilseeds Research

Volume 7 June 1990 Number 1


CONTENTS DOR-335

## SHORT COMMUNICATIONS

J. Oilseeds Res. 7 (1990) 1-5
*ISSN* 0970—2776

# STUDIES ON CROP GEOMETRY AND INTERCROPPING IN IRRIGATED SPANISH GROUNDNUT

V.S. SELVAM, A. SAMBASIVA REDDY and M.S. SOUNDARA RAJAN
Department of Agronomy, Regional Agricultural Research Station,
Tirupati, Andhra Pradesh, India.

**ABSTRACT**

Field experiments were conducted in Summer Seasons of 1981-82 and 1982-83 to study the feasibility of intercropping in irrigated spanish groundnut. There were nine treatments comprising uniform rows, one and two rows of groundnut skipped, with and without intercrops. The intercrops were greengram, blackgram and gingelly. Maximum inter-row plant spread and dry matter of groundnut was with uniform rows compared to skip-rows with and without intercrops. Pod yield of groundnut was more with uniform rows compared to skip-rows. The grain yield of intercrops was more with two skip-rows of groundnut than one skip-row . Groundnut equivalents and net returns was more with groundnut uniform rows than skip-rows. A sole crop of spanish groundnut (TMV 2) with a uniform spacing of 22.5 x 10 cm was more remunerative compared to intercropping under irrigated conditions.

**KEY WORDS** Crop geometry ; Intercropping; skip-row.

## INTRODUCTION

Groundnut (*Arachis hypogaea L.*) in Andhra Pradesh is recommended to be grown at 22.5 cm interrow spacing during Rabi and summer seasons but this row width is too narrow for intercropping. This disadvantage can be obviated by "skipping' the rows leaving a wider inter-row distance for planting intercrops. The loss of population due to skip rows can be compensated by narrowing the intra-row spacing. But the yield loss may occur due to intra-row competition. The intercrop population should be less than the recommended sole crop population so that the competitive effects of the base crop and intercrop can be minimised. In such a system, the yield loss of base crop has to be compensated by intercrop yield to obtain advantage due to intercropping. Hawkins and Peacock (1968) reported that average lint yield of eight varieties of upland cotton showed significant increase in 2 x 2 skip-row compared to solid row planting on sandy loam soil of Georgia. On the contrary, Yadav and Singh (1973) reported that skip-row planting of castor had no beneficial effect either on yield of any crop or total produce in terms of returns per unit area. Such an information is lacking with groundnut. Studies were, therefore, conducted to find out whether skip-row planting of the base crop of groundnut is superior to uniform row planting at the same plant population and to find out the feasibility of raising an intercrop with groundnut under irrigated conditions.

## MATERIALS AND METHODS

Field experiments were conducted during summer seasons of 1981-82 and 1982-83 on Alfisols of Tirupati in the Southern Agro-climatic zone of Andhra Pradesh. There were nine treatments comprising uniform rows, one and two rows of groundnut skipped for every two rows with and without intercrops (Table 1). Treatments were arranged in a randomised block design with four replications. Plant population of the base

Received on March 13, 1989

**TABLE 1 Growth characters of irrigated groundnut as influenced by different treatments**

| Treatment | | Total dry matter (g plant-1) | | | | Plant spread (cm) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 1981—82 | | 1982—83 | | 1981—82 | | 1982—83 | |
| | | 75 DAS | Maturity | 75 DAS | Maturity | 75 DAS | Maturity | 75 DAS | Maturity |
| $T_1$ | Groundnut uniform rows (22.5 x 10 cm) | 8.24 | 10.35 | 8.25 | 9.67 | 27.0 | 36.0 | 27.2 | 29.7 |
| $T_2$ | Groundnut skipped in one row for every two rows (6.7 cm between plants) and no intercrop in skip rows | 7.79 | 9.02 | 8.12 | 9.40 | 25.7 | 34.5 | 26.5 | 29.0 |
| $T_3$ | Groundnut skipped in two rows for every two rows (5 cm between plants) and no intercrop in skip rows | **7.67** | **8.30** | 8.02 | 9.22 | 25.2 | 32.2 | 25.5 | 31.2 |
| $T_4$ | $T_2$ + greengram (8.9 cm between plants) in skip rows | 6.94 | **7.47** | **7.55** | **8.37** | **23.5** | **29.0** | 23.5 | 28.0 |
| $T_5$ | $T_2$ + Blackgram (8.9 cm between plants) in skip rows | 6.72 | 7.02 | 7.05 | 8.12 | 22.7 | 27.5 | 22.2 | 24.5 |
| $T_6$ | $T_2$ + gingelly (13.3 cm between plants) in skip rows | 7.25 | 8.00 | 7.30 | 8.77 | **20.2** | **30.0** | 20.7 | 25.0 |
| $T_7$ | $T_3$ + green gram (13.3 cm between plants) in skip rows | 6.99 | 7.30 | 6.72 | 8.40 | 23.7 | 25.0 | 23.0 | 24.5 |
| $T_8$ | $T_3$ + Blackgram (13.3 cm between plants) in skip rows | 6.55 | 7.50 | 6.87 | 8.30 | 21.7 | 26.0 | 22.7 | 23.5 |
| $T_9$ | $T_3$ + gingelly (20 cm between plants) in skip rows | 7.15 | 7.25 | 7.00 | 8.65 | 20.0 | 28.0 | 21.0 | **24.2** |
| | SEm± | 0.20 | 0.67 | 0.18 | 0.23 | 1.3 | 2.1 | 1.2 | **1.8** |
| | CD at 5% | 0.57 | 1.95 | 0.53 | 0.67 | 3.9 | **6.0** | **3.4** | 5.3 |

DAS : Days after sowing

crop of groundnut was 100 per cent (4.44 lakhs ha-$^{1}$) and that of intercrops were 50 per cent of the recommended population (greengram and blackgram 1.67 lakhs ha-$^{1}$ and gingelly 1.11 lakhs ha-$^{1}$). The soil of the experimental field was sandy loam with a pH of 7.1. It contained 0.12% organic carbon, 21 kg available $P_2O_5$ ha-$^{1}$ and 216 kg available $K_2O$ ha-$^{1}$. Varieties of groundnut, greengram, blackgram and gingelly used in the experiment were TMV 2, PS-16, T 9 and Madhavi, respectively. Crops were sown on 12-12-1981 and 25-12-1982.

## RESULTS AND DISCUSSION

### Growth characters

Dry matter production per plant was maximum with groundnut sown in uniform rows followed by one and two rows of groundnut skipped without intercrops (Table 1). Due to less competition for light, the plants in uniform rows might have produced more photosynthates which resulted in more dry matter. Lowest amount of dry matter was with intercropped treatments which might be due to shading and root effect resulting in low production of dry matter.

Inter-row plant spread was maximum in sole crop of groundnut sown in uniform rows at 75 days after sowing and maturity and it was at par with one and two rows of groundnut skipped without intercrops. In intercropped treatments, plants grow vertically due to shading of groundnut by intercrops both at one and two skip-rows. Shading increased the internodal length which inturn increased the plant height and reduced the lateral spread.

### Yield and economics :

Pod yield obtained with sole crop of groundnut either sown in uniform rows or skip-rows was more compared to intercropped treatments (Table 2). The reduction of pod yield in intercropped treatments compared to sole crops was due to competition effects of intercrops on base crop of groundnut for growth factors. Among sole crops, groundnut sown in uniform rows gave maximum pod yield compared to one and two rows of groundnut skipped. The per cent reduction in one and two skip-rows of groundnut compared to uniform rows was 2.3 and 5.2 in 1981-82 and 3.8 and 8.0 in 1982-83. The decrease in pod yield of base crop of groundnut was highest when blackgram was intercropped. The per cent reduction in pod yield of groundnut with blackgram as an intercrop compared to uniform rows was 12.5 and 18.3 in 1981-82 and 28.1 and 34.4 in 1982-83 in one and two rows of groundnut skipped, respectively. Similar reduction in pod yield of groundnut with intercrops of finger millet or greengram was also reported by Krishnaswamy and Palaniappan (1979).

Seed yield of intercrops in two skip-rows was more compared to one skip-row, though the plant population was equal in one and two skip-rows. This was due to less competition among the plants of intercrops in two skip-rows as the intra-row spacing of the intercrops was more in two skip-rows than in one skip-row. Haulm yield with groundnut uniform rows was more compared to groundnut sown in skip-rows with and without intercrops. Higher haulm yield with groundnut uniform rows was due to more dry matter production and inter-row plant spread.

**TABLE 2. Yield, groundnut equivalents and net returns as influenced by different treatments**

| | Yield (q ha -1) | | | | | | | | Groundnut equivalents (q ha -1) | | Net returns (Rs ha -1) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Groundnut | | | | Intercrop | | | | | | | |
| | 1981—82 | | 1982—83 | | 1981—82 | | 1982—83 | | | | | |
| | Pod | Haulm | Pod | Haulm | Seed | Haulm | Seed | Haulm | 1981—82 | 82—83 | 1981-82 | 82—83 |
| $T_1$ | 34.19 | 38.19 | 33.86 | 32.41 | — | — | — | — | 34.19 | 33.86 | 15278 | 14964 |
| $T_2$ | 33.42 | 36.76 | 32.61 | 31.25 | — | — | — | — | 33.42 | 32.61 | 14787 | 14191 |
| $T_3$ | 32.50 | 35.85 | 31.35 | 30.67 | — | — | — | — | 32.50 | 31.35 | 14217 | 13423 |
| $T_4$ | 30.89 | 32.41 | 27.00 | 28.35 | 5.18 | 11.25 | 3.27 | 7.30 | 35.33 | 30.27 | 14884 | 11475 |
| $T_5$ | 30.39 | 31.44 | 26.44 | 25.46 | 3.87 | 9.92 | 2.97 | 6.17 | 33.23 | 29.23 | 13897 | 10920 |
| $T_6$ | 31.87 | 33.80 | 27.21 | 27.19 | 1.61 | 2.92 | 1.50 | 2.65 | 34.40 | 29.81 | 14408 | 11470 |
| $T_7$ | 29.97 | 28.95 | 25.76 | 28.01 | 5.52 | 11.70 | 3.71 | 7.45 | 34.71 | 29.53 | 14438 | 10975 |
| $T_8$ | 28.89 | 28.49 | 25.19 | 24.87 | 4.19 | 10.32 | 3.10 | 6.25 | 32.18 | 28.09 | 13102 | 10223 |
| $T_9$ | 29.47 | 29.87 | 25.96 | 24.31 | 1.85 | 3.20 | 1.75 | 2.75 | 32.38 | 28.08 | 13129 | 10812 |
| SEm ± | 1.13 | 1.27 | 0.79 | 0.83 | — | — | — | — | NS | 0.79 | — | — |
| CD at 5% | 3.29 | 3.70 | 2.30 | 2.41 | — | — | — | — | — | 2.30 | — | — |

NS : Not significant

When intercrop yields were converted into groundnut equivalents, maximum groundnut equivalents were with groundnut uniform rows. Minimum groundnut equivalents were with blackgram as an intercrop in both the years. Economics of different treatments (Table 2) indicated that the maximum net returns was with groundnut sown in uniform rows. Minimum net returns was with blackgram as an intercrop. Gorfu (1987) also reported that sole crop of groundnut was more advantageous than intercropping system.

The present study has revealed that sole crop of spanish groundnut (TMV 2) with a spacing of 22.5 x 10 cm was more remunerative under irrigated conditions. There was no advantage due to change of crop geometry and/or intercropping.

## LITERATURE CITED

HAWKINS, B.S. and PEACOCK A.H., (1968). Effect of skip-row culture on organic and fibre propreties on upland cotton varities. Agron.J. **60**(2) : 180-191.

GORFU, A. (1987). Intercropping studies in sorghum. M.Sc. Thesis. A.P. Agricultural University, Rajendranagar, Hyderabad.

KRISHNASWAMY, M. and PALANIAPPAN, S. (1979). Complementary and competitive effect of associated crops in a groundnut based intercropping system. Madras agric J. **66**(1); 757-759.

YADAV, S.C. and SINGH, A. (1973). Studies on skip-row techniques in castor with different inter crops. Indian J. Agron. **18**(4): 520-521.

J. Oilseeds Res. 7 (1990) 6-9
*ISSN* 0970—2776.

# RESPONSE OF SOYBEAN TO NITROGEN AND PHOSPHORUS APPLICATION

R.C. MISRA, P.K. SAHU and S.K. UTTARAY
Regional Research Station, Semiliguda, Post Box No. 10,
Sunabeda—763 002, Dist. Koraput (Orissa).

**ABSTRACT**

In order to study the response of soybean to Nitrogen and Phosphorus application and to determne its optimum N and P requirement, field trials were conducted in split-plot design wih N-levels (0, 20, 40 and 60 kg/ha) in main-plots and P-levels (0, 40, 80 and 120 kg/ha) in sub-plots. Application of 60 kg N/ha resulted in 69.2% (5.58 q/ha) yield increase, while that for 120 kg P/ha was 41.8% (3.78 q/ha). Average yield increase for kg of nitrogen and phosphorus application were 9.3 and 3.15 kg/ha respectively. The yield increase due to N application was mainly due to increase in pods/plant, while increments in seeds/pod, 1000-seed wt. and pods/plant were factors of yield incease due to P application. The balanced dose of N and P fertiliser requirement of the crop was 60 kg N and 80 kg P/ha and it resulted in average yield of 14.79 q/ha showing an increase of 8.13 q/ha over no application of nitrogen and phosporus.

**Key words** : Soybean, Nitrogen, Phosphorus, N x P interaction.

## INTRODUCTION

Now a days greater emphasis is being laid on increasing oilseed production. Among the oilseeds crops soybean has the highest yield potential and presently serious attempt is being made for popularising the crop in -non-traditional areas. Adoption of improved varieties coupled with suitable crop management practices are the most important factors for improving productivity of crop plants. As Orissa is a non-traditional area for soybean cultivation, information on optimum fertiliser requiremnnt of the crop in the region would help in improving the productivity of the crop. So, the present investigation was undertaken to study the response of the crop to Nitrogen and Phosphorus application.

## MATERIAL AND METHODS

Field trials were conducted at Regional Research Station, Semiliguda, Koraput (Orissa) during *Kharif*, 1985 and 1986. During 1985 the soil was red clay loam with pH 5.2, total N 0.05%, available P 8 kg and K 360 kg/ha. In 1986, the soil was red loam with pH 5.6, total N 0.09%, available P 16 kg and K 280 kg/ha. The test variety was T-49. The trials were laidout in split-plot design with three replications. The N-levels (0, 20, 40 and 60 kg/ha) were taken in main-plots and P-leaevels (0, 40, 80 and 120 kg/ha) in sub-plots. Trials were sown on 25th June, 1985 and 5th July, 1986. The trials were conducted during *Kharif* seasons under rainfed conditions. The net plot size and spacing were 45 sq.m. and 45 cm x 10 cms respectively. Nitrogen, Phosphorus and Potash were applied in the form of Urea, S.S.P. and M.O.P. Half of N, all P (as per treatment) alongwith 40 kg $K_2O$/ha was applied basally. F.Y.M was applied @ 5t/ha to all treatments (only in 1986). Hoeing and seeding were done at 20-22 days followed by top dressing with half the dose of nitrogen. Second weeding (only in 1986) was done at 40-42 days of crop. For control of leaf-weber and other folier insect pests,

Received on March 24, 1989.

one spray of quinalphos was applied during 1985, while in 1986 one spray with quinalphos and two dusting with B.H.C 10% dust (@ 25 kg/ha) were applied. Observations on days to maturity, 1000- seed wt. and seed yield were taken on plot basis and data on plant hieght, branches/plant, pods/plant and seeds/pod were recorded on ten random plants per plot. Pooled analysis of data for both years was done for all the characters.

## RESULTS AND DISCUSSION

### Effect of Nitrogen

Pooled analysis indicated significant differences among the N-levels for plant height, branches/plant, pods/plant and yield (Table-1). Though maturity was slightly delayed due to N-application, the differences were not significant. There was a conspicuous and significant increase in plant height, branches/plant and pods/plant with increase in N-level and 60 kg N/ha showed 57.0%, 45.0% and 60.4% increase in these characters over no nitrogen application. There was slight increase in seeds/pod and 1000-seed wt. with increase in N-levels but the differences were not significant. During 1985 and 1986, application of 60 kg N/ha produced 9.67 and 17.60 q/ha respectively which were significantly higher than yield at all other levels of N application (Table-2). Pooled data indicated that highest average yield of 13.64 q/ha was obtained with 60 kg N, which was 5.58 q/ha (69.2%) more than yield at no nitrogen application (8.06 q/ha). Application of 60 kg N/ha resulted in average yield increase of 9.3 kg of seeds per kg of nitrogen applied. Bhangoo and Albritton (1972) in a study with soybean observed 10-15% yield increase due to application of 112 kg N/ha. Watanabe *et al.* (1983) observed that yield increase in soybean due to N application was more in least fertile soils. The observed high response to N application in the study might be due to very low N-status (Total N-0.05, 0.09%) of the soil. Considering all the traits it was observed that the increase in yield due to nitrogen application was mainly due to increase in plant height, branches/plant and pods/plant.

### Effect of Phosphorus

Pooled analysis showed significant differences among P-levels for all the characters, except for days to maturity (Table-1). Plant height, branches/plant and pods/plant were highest 120 kg P/ha, which were at par with 80 kg P/ha. The increase in these traits due to application of 120 kg P/ha were 24.7%, 25.0% and 20.3% respectively, which were less than the increase due to application of 60 kg N/ha. Highest value of seeds/pod and 1000-seed wt. were observed for 120 kg (p/ha which were significantly higher than those at other P-levels (Table-1). The increase in seeds/pod and 1000-seed weight due to 120 kg P/ha application were 16.2% and 13.8% respectively. During 1985 and 1986, application of 120 kg (P/ha produced yield of 8.60 and 17.06 q/ha respectively (Table-2), which were significantly higher than the yield at all other P-levels. Pooled data indicated that highest yield of 12.83 q/ha was obtained with 120 kg P/ha, which was 3.78 q/ha (41.8%) more than yield with no P application (9.05 q/ha). Application of 120 kg P/ha showed average yield increase of 3.15 kg of seeds per kg P applied. Increase in the yield of soybean upto 100 kg P/ha in acidic soil have been observed by Kalia *et al.* (1984). The observed high response to P application might be due to acidic pH (5.2, 5.6) and low available P (8, 16 kg/ha) in the soil. In

**TABLE 1. Effect of Nitrogen and Phosphorus application on yield components and seed yield of soybean, Pooled over 1985 and 1986**

| Treatments | Days to Maturity | Plant ht. (cm) | Branches/ plant | Pods/ plant | Seeds/ pod | 1000-seed wt.(g) | Seed yield (q/ha) |
|---|---|---|---|---|---|---|---|
| N — Levels | | | | | | | |
| 0 kg | 108.3 | 39.1 | 4.0 | 28.8 | 2.24 | 119.6 | 8.06 |
| 20 kg | 109.0 | 50.1 | 4.8 | 33.1 | 2.31 | 121.4 | 11.07 |
| 40 kg | 110.8 | 59.0 | 5.4 | 40.5 | 2.30 | 121.4 | 12.48 |
| 60 kg | 111.3 | 61.4 | 5.8 | 46.2 | 2.34 | 122.9 | 13.64 |
| C.D. (5%) | N.S | 3.84 | 0.49 | 3.32 | N.S. | N.S. | 0.51 |
| P — Levels | | | | | | | |
| 0 kg | 109.3 | 46.1 | 4.4 | 33.0 | 2.10 | 112.3 | 9.05 |
| 40 kg | 109.0 | 52.4 | 4.9 | 36.8 | 2.29 | 120.2 | 11.08 |
| 80 kg | 110.3 | 54.6 | 5.3 | 39.0 | 2.36 | 125.0 | 12.29 |
| 120 kg | 110.8 | 57.5 | 5.5 | 39.8 | 2.44 | 127.8 | 12.83 |
| C.D. (5%) | N.S. | 3.12 | 0.46 | 2.84 | 0.07 | 2.48 | 0.41 |
| N X P | | | | | | | |
| C.D. (5%) | N.S. | N.S. | 0.79 | 4.28 | N.S. | N.S. | 0.65 |

acidic soils Phosphorus gets fixed in soil in various ways resulting in its non-availability. Increased P application, therefore, becomes essential to exploit the potential of the crop as observed by Shivashankar *et al.* (1974), Roy and Mishra (1975) and Kalia *et al.* (1984). Considering all the traits it was observed that the increase in yield due to P application was due to increase in seeds/pod, 1000-seed wt. and pods/plant, as also observed by Kalia *et al.* (1984).

**Nitrogen x Phosphorus interaction**

The interaction of N-levels with P-levels was not significant for days to maturity plant height, seeds/pod and 1000-seed wt. (Table-1). The significant N x P interaction for branches/plant and pods/plant indicated differential effect of one nutrient at different level of other, on the expression of these traits. Yearwise and pooled data showed significant N x P interaction for seed yield (Table-2). During 1985 the highest yield of 11.33 q/ha was obtained with the application of 60 kg N and 120 kg P/ha, which was at par with yield with 60 kg N and 80 kg P/ha (i.e. 10.92 q/ha). In 1986, application of 60 kg N and 120 kg P/ha produced the highest yield of 18.82 q/ha and this yield was statistically at par with yield at 60 kg N and 80 kg P (18.66 q/ha) and 40 kg N and 120 kg P (18.52 q/ha). Two years pooled data indicated that though application of 60 kg N and 120 kg P/ha produced the highest average yield of 15.08 q/ha, this yield was at par with that obtained by application of 60 kg N and 80 kg P/ha (14.79 q/ha). Application of 60 kg N and 80 kg P/ha to soybean crop showed yield increase of 8.13 q/ha against no application of nitrogen and phosphorus (6.66 q/ha). Thus balanced

**TABLE 2. Seed yield (q/ha) of soybean as influenced by Nitrogen and Phosphorus levels during 1985 & 1986**

| Treatments | Phosphorus levels (kg $P_2O_5$/ha) | | | | Average |
|---|---|---|---|---|---|
| | 0 | 40 | 80 | 120 | |
| | | | 1985 | | |
| Nitrogen levels (kg N/ha) | | | | | |
| 0 | 3.54 | 3.62 | 3.71 | 4.25 | 3.78 |
| 20 | 5.29 | 7.08 | 8.17 | 8.75 | 7.32 |
| 40 | 5.08 | 9.08 | 9.58 | 10.08 | 8.46 |
| 60 | 7.08 | 9.33 | 10.92 | 11.33 | 9.67 |
| Average | 5.25 | 7.28 | 8.09 | 8.60 | |
| | C.D. (5%) for N = 0.39, P = 0.37 and N x P = 0.46 | | | | |
| | | | 1986 | | |
| 0 | 9.78 | 11.55 | 13.81 | 14.20 | 12.34 |
| 20 | 11.95 | 14.70 | 15.93 | 16.70 | 14.82 |
| 40 | 14.37 | 15.63 | 17.52 | 18.52 | 16.51 |
| 60 | 15.29 | 17.64 | 18.66 | 18.82 | 17.60 |
| Average | 12.85 | 14.88 | 16.48 | 17.06 | |
| | C.D. (5%) for N = 0.58, P = 0.44 and N x P = 0.78 | | | | |
| | | | 1985 and 1986 Pooled | | |
| 0 | 6.66 | 7.59 | 8.76 | 9.22 | 8.06 |
| 20 | 8.62 | 10.89 | 12.05 | 12.73 | 11.07 |
| 40 | 9.73 | 12.35 | 13.55 | 14.30 | 12.48 |
| 60 | 11.19 | 13.49 | 14.79 | 15.08 | 13.64 |
| Average | 9.05 | 11.08 | 12.29 | 12.83 | |
| | C . D. (5%) for N = 0.51, P = 0.41 and N x P = 0.65 | | | | |

fertilization with 60 kg N and 80 kg P/ha results in substantial increase of productivity of soybean.

## LITERATURE CITED

BHANGOO, M.S. and ALBRITTON, D.J.1972. Effect of Fertiliser Nitrogen Phosphorus and Potassium on yield and nutrient content of Lee soybeans. *Agron. J.* 64:743-746.

KALIA, B.D., AWASTHI, O.P and SINGH, C.V. 1984. Response of soybean to Nitrogen, Phosphorus, liming and inoculation under mid-hill condition of Kangra Valley. *Indian J. Agron.* 29:199-204.

ROY, B. and MISHRA, S. 1975. Effect of Phosphorus fertilisation on yield and other characteristics of soybean in North Bihar. *Indian J. Agric Sci.* 45 : 136-138.

SHIVSHANKER, K., VEERANNA, V.B. and KRISHNAMURTHY, K. 1974. Response of soybean to Phosphorus and Zinc application. *Mysore J. Agric. Sci.* B : 370-375.

WATANBE, I., NAKANO, H. and TABUCHI, K. 1983. Supplimental nitrogen fertiliser to soybeans *Japanese J. Crop Sci.* 52 : 291-298.

J. Oilseeds Res. 7 (1990) 10-15
*ISSN* 0970—2776

# MOISTURE, DRY WEIGHT AND LIPID COMPOSITION AS INFLUENCED BY CAPSULE POSITION IN DEVELOPING SEEDS OF SESAME (SESAMUM INDICUM L.)

S.K. GUPTA
Department of Plant Breeding, Haryana Agricultural University, Hisar-125 004

**ABSTRACT**

The changes in the levels of moisture, dry weight, total lipids, lipid classes and fatty acid composition of seeds of sesamum (Var. HT-1) during development, taken from the capnsules located at different portions (basal, intermediate and apical) on the main shoot of the plant were studied. Seeds samples from the capsules were collected at an interval of 7 days after capsule initiation (DAC). Moisture continued to decrease upto last stage of sampling. Dry weight, total lipids, and neutarl lipids increased while phospho-and glycolipids decreased at initial stages and were constant thereafter. Stearic acid remained constant, palmitic, oleic and linolenic acids declined while linoeilc acid increased at initial stages and were constant at later stages. The positional effect was that the basal and intermediate capusles had heavier seeds, more total lipids, neutral lipids and less phospho-and glycolipids than the apical ones. In the initial stages palmitic acid decreased from basal towards apical portion. Stearic acid was almost similar. Seeds of basal capusules had less of oleic acid and more of linoeic acid at all the stages of development in comparison to apical. In the initial stages linolenic acid was considerably higher in apical capsules than that of basal and intermediate, at later stages it levelled off.

## INTRODUCTION

There are reports which indicate the presence of variation in chemical composition of seeds within the plants in different crops. Collins and Carter (1956) observed that in soybean, seed from the lower half of the plants were higher in oil and lower in protein content than in seeds from the upper half. In maize (Lambert *et al.*, 1967) kernel located at mid ear position had highest oil content while kernel (Jellum, 1967) from upper ear, had consistently more oleic acid and less linoleic acid than those from lower ears. Gupta and Wagle (1986) reported that in sunflower seeds, the content of linoleic acid increased and oleic acid decreased from periphery towards the centre of the head. In sesamum, Gangrade *et al.* (1973) observed that oil content was higher in seeds from capsules attached to the middle node than in the basal and apical. These studies were, however, conducted at maturity, but a systematic and detailed study on lipid composition in sesamum with respect to positional effect during development of seeds is lacking. Therefore, the present investigation was undertaken to study the changes in total lipids, fatty acid composition and lipid classes occuring due to position of capsules during development of sesamum seeds.

## MATERIALS AND METHODS

Sesamum variety 'HT-1' was raised under field conditions. Flowering was initiated 30rdays after planting and was uniform with more than 50 per cent of the plants in full bloom within 5 days. The initiation of capsule was observed after 5-7 days of initiation of flowering. About 200 plants were tagged at the initiation of capsule. First sampling of capsules was taken at 7 days after capsule initiation (DAC) and subsequent samplings were taken at 7 days interval. The last sampling was taken

Received on April 15. 1989

at 56 DAC. The main shoot bearing capsules was clipped and divided into three equal portions-basal, intermediate and apical. For each portion 50 capsules were removed from 30 plants at 7 DAC and from 15 plants at every subsequent stage. Seeds from capsules were taken out manually. Moisture and dry weight contents were determined according to the method described in A.O.A.C. (1960). The total lipids were extracted as per the procedure of Folch *et al.*, (1957). Neutral lipids and phospholipids were estimated by the methods of Nichols (1964) and Brockhyuse (1968) respectively. Glycolipids were hydrolyzed (Joseph, 1954) and were determined on the basis of galactose (Trevelyan and Harrison, 1952). Fatty acid methyl esters were prepared (Luddy *et al.*, 1968) and separated in a Hewlett Packard (Model No. 5730 A) gas chromatograph equipped with flame ionization detector. A stainless steel column (305 cm x 3.175 mm), packed with 20% diethylene glycol succinate (DEGS) on 60-80 mesh Chromosorb W. was used. Column temperature of 190oC and nitrogen (carrier-gas) flow rate of 35 ml $min^{-1}$ were maintained. The individual peak was identified by comparison of its retention time with those of standard fatty acid methyl ester, obtained from Sigma Chemical Company, U.S.A. The area under the individual peak was calculated and converted directly into relative percentage.

## RESULTS AND DISCUSSION

The moisture content of seeds continued to decrease in all the portions upto the last stage of sampling (Table 1). Dry weight of seeds increased in basal capsules from 7 to 35 DAC (days after capsule initiation), in intermediate and apical capsules upto 49 DAC after these stages it was found to be constant. Total lipids accumulation was rapid upto 21 DAC in basal and intermediate and upto 35 DAC in apical portions. Lipid formation reached to its maximum level at 28 DAC, 35 DAC and 42 DAC in the seeds from basal, intermediate and apical portions respectively after which it was constant. Dry weight, however, continued to increase until 35 DAC in basal capsules and 49 DAC in intermediate and apical capsules. As regards lipid classes, neutral lipids content was observed to increase continuously upto 28 DAC in basal, upto 35 DAC in intermediate and upto 42 DAC in apical portions, thereafter, it was stable. Phospholipids and glycolipids decreased from maximum level at 7 DAC continuously upto 28 DAC in basal and intermediate and upto 35 DAC in apical portions. At 7 DAC the ratio of phospholipids to glycolipids was about 3:1 while at maturity the ratio was about 2:1 in all the positions. Similar decrease in the phospho-and glycolipids and increase in the neutral lipids during development of soybean seeds was observed by Privett *et al.* (1973) and in peanut seeds by Sanders (1980). They also reported that phospholipids fraction was much higher than that of glycolipids fraction. At 7 DAC phospho-and glycolipids together accounted for about 25 per cent of total ilpids which towards maturity came down to about 1.5 per cent in all the positions. In rapeseed (Appelqvist, 1975) observed that at the early stage of seed development a major portion of the total lipids was phospho-and glycolipids which at later stages decreased substantially.

Fatty acid composition (Table 2) during seed development showed considerable variations. Total lower fatty acids (fatty acids < palmitic acid) appeared at initial stage only in all the positions. Palmitic and linolenic acids decreased consistently upto 35

**TABLE 1: Moisture, dry weight, total lipids and lipid classes of developing seeds of sesame as affected by capsule position.**

| DAC | Position | Moisture (%) | Dry weight (mg/100 seeds) | Total lipids (% dry wt) | Lipid classes (% total lipids) | | |
|---|---|---|---|---|---|---|---|
| | | | | | Neutral Lipids | Phospho-Lipids | Glyco-Lipids |
| 7 | A | 87.4 | 68.4 | 3.55 | 72.53 | 18.42 | 6.54 |
| | I | 86.3 | 120.7 | 8.74 | 76.47 | 16.15 | 5.71 |
| | B | 84.3 | 157.1 | 13.56 | 78.14 | 13.53 | 4.32 |
| 14 | A | 83.7 | 118.3 | 7.42 | 83.56 | 11.65 | 3.98 |
| | I | 75.1 | 177.6 | 30.45 | 94.38 | 2.23 | 1.94 |
| | B | 69.8 | 214.1 | 40.71 | 96.17 | 1.71 | 1.33 |
| 21 | A | 81.97 | 155.0 | 20.62 | 93.36 | 3.17 | 1.98 |
| | I | 73.45 | 257.7 | 46.30 | 94.82 | 1.41 | 1.23 |
| | B | 58.68 | 296.5 | 48.84 | 96.15 | 1.27 | 1.12 |
| 28 | A | 64.50 | 217.7 | 40.81 | 95.14 | 1.28 | 0.82 |
| | I | 50.58 | 283.1 | 50.52 | 97.35 | 0.87 | 0.52 |
| | B | 37.85 | 303.2 | 52.30 | 97.28 | 0.85 | 0.48 |
| 35 | A | 61.72 | 238.1 | 45.16 | 96.13 | 1.07 | 0.56 |
| | I | 43.10 | 310.3 | 52.10 | 97.82 | 0.95 | 0.45 |
| | B | 31.04 | 320.1 | 52.23 | 97.56 | 0.85 | 0.43 |
| 42 | A | 46.30 | 247.3 | 49.75 | 96.53 | 1.15 | 0.54 |
| | I | 24.64 | 318.4 | 52.43 | 97.65 | 0.85 | 0.46 |
| | B | 16.05 | 321.4 | 52.80 | 97.78 | 0.85 | 0.46 |
| 49 | A | 43.92 | 254.6 | 49.65 | 96.78 | 1.10 | 0.57 |
| | I | 22.28 | 318.7 | 52.35 | 98.05 | 0.91 | 0.43 |
| | B | 13.39 | 320.5 | 52.63 | 97.68 | 0.84 | 0.45 |
| 56 | A | 42.34 | 253.8 | 49.87 | 96.63 | 1.12 | 0.56 |
| | I | 20.37 | 319.4 | 52.56 | 97.42 | 0.86 | 0.47 |
| | B | 11.51 | 319.8 | 52.78 | 97.56 | 0.87 | 0.45 |

DAC = Days after capsule initiation; A=Apical; I=Intermediate; B=Basal.

DAC after which these were constant. Stearic acid nearly remained constant at all the stages. Oleic and linoleic acids were the major acids. Oileic acid decreased upto 21 DAC in basal and intermediate portions but was observed to increase a little at 28 DAC in former and upto 42 DAC in latter portion, thereafter it became constant. In apical portion, however, it decreased upto 28 DAC, increased marginally at 35 and 42 DAC and then became constant. A reverse trend was observed in case of linoleic acid in comparison to oleic acid. It increased upto 21 DAC in basal, upto 28 DAC

in intermediate and upto 35 DAC in apical portions. It became constant after showing a little decrease at 28 DAC in basal, at 35 and 42 DAC in intermediate and at 42 DAC in apical portions. These results suggest a negative relationship between oleic and linoleic acids in developing sesamum seeds, generally in all the positions. In maturing sunflower seeds, Gupta and Wagle (1986) also observed a negative relationship between these two acids.

**TABLE 2. Fatty acid composition (per cent) of total lipds of developing seeds of sesame as affected by capsule position**

| DAC | Position | Fatty acids | | | | | |
|---|---|---|---|---|---|---|---|
| | | LA | Palmitic | Stearic | Oleic | Linoleic | Linolenic |
| 7 | A | 2.52 | 19.57 | 4.48 | 41.26 | 24.10 | 8.07 |
| | I | 1.93 | 18.84 | 4.36 | 40.51 | 27.43 | 6.48 |
| | B | 1.54 | 17.28 | 4.34 | 40.23 | 32.77 | 3.40 |
| 14 | A | 0.65 | 17.65 | 4.34 | 41.24 | 30.31 | 5.85 |
| | I | T | 14.49 | 4.74 | 38.64 | 40.29 | 1.08 |
| | B | T | 12.57 | 4.60 | 38.51 | 42.57 | 0.81 |
| 21 | A | T | 15.25 | 5.00 | 39.96 | 37.14 | 1.73 |
| | I | T | 12.15 | 4.69 | 37.50 | 44.18 | 0.99 |
| | B | T | 11.78 | 4.30 | 37.24 | 46.01 | 0.70 |
| 28 | A | T | 11.45 | 5.05 | 38.83 | 43.29 | 0.92 |
| | I | T | 11.41 | 4.69 | 38.82 | 44.62 | 0.72 |
| | B | T | 11.71 | 4.36 | 38.10 | 45.05 | 0.70 |
| 35 | A | T | 10.57 | 4.22 | 39.66 | 44.19 | 0.80 |
| | I | T | 10.55 | 3.17 | 40.42 | 44.27 | 0.67 |
| | B | T | 10.84 | 3.78 | 38.62 | 45.83 | 0.60 |
| 42 | A | T | 10.29 | 4.90 | 40.94 | 43.27 | 0.81 |
| | I | T | 10.44 | 3.44 | 41.76 | 43.89 | 0.66 |
| | B | T | 10.46 | 3.50 | 39.90 | 45.21 | 0.62 |
| 49 | A | T | 10.31 | 4.40 | 40.94 | 43.77 | 0.76 |
| | I | T | 10.71 | 3.41 | 41.46 | 43.84 | 0.57 |
| | B | T | 10.78 | 3.47 | 40.10 | 45.21 | 0.51 |
| | A | T | 10.35 | 4.57 | 40.81 | 43.46 | 0.78 |
| | | T | 10.36 | 3.48 | 41.33 | 43.67 | 0.54 |
| | B | T | 10.63 | 3.54 | 39.86 | 45.14 | 0.53 |

DAC = Days after capsule initiation; LA = Lower fatty acids (<Palmitic acid);
A = Apical; I = Intermediate; B = Basal; T = Traces.

Positional effect was that the moisture content decreased from apical towards basal portion at all the stages of development (Table 1). Dry weight and total lipids of seeds increased from apical towards basal portion upto 42 DAC and 35 DAC respectively. Towards maturity seeds from basal and intermediate portions were found to have almost similar dry weight and oil content but were appreciably heavier and had about 3 per cent higher oil content than that of apical portion. Gangrade *et al.* (1973), however, observed that oil content was higher in the seeds from middle portion than the basal and apical portions in sesamum. Neutral lipids were observed to increase from apical towards basal portion upto 21 DAC while phospho and glycolipids decreased. At later stages basal and intermediate portions had more of neutral lipids and less of phospho-and glycolipids as compared to apical portion. From these results it appear that the seeds which are smaller in size (less dry weight) have more phospho- and glycolipids and less neutral lipids. The reverse is true in case of larger seeds (more dry weight). The reason for smaller seeds to contain more phospho-and glycolipids seems to be the higher quantity of membraneous material because it has been suggested that surface to volume ratio in larger seeds is relatively lower as compared to that in smaller seeds (Brown *et al.*, 1975) and also that phospholipid content increases with the increase in membrane content (Williams and Chapman, 1970).

Capsule position along the plant was found to have an effect on the fatty acid composition (Table 2). Percentage of palmitic acid decreased from apical towards basal portion until 21 DAC. At later stages it levelled off in all the portions. Stearic acid at 7 and 14 DAC was almost equal in all the portions, thereafter it was marginally higher in apical portion than basal and intermediate. Oleic acid was observed to decrease from apical towards basal portion while linoelic acid increased, upto 28 DAC. At later stages oleic acid was lower while linoleic acid was higher in basal as compared to apical portion. Further, the level of oleic acid was slightly higher in intermediate portion in comparison to apical portion while these two portions were nearly similar with respect to linoleic acid. With respect to capsule position also negative relationship seems to exist between the oleic and linoleic acids. Variations in chemical composition of seeds within plant are suggested by these results which might be due to the environment since the capsule formation was initiated at basal portion which progressed towards apical portion. Therefore, the individual capsule might have developed and matured under somewhat different climatic conditions. Gupta and Wagle (1986) reported similar changes in fatty acid composition due to position of seeds within sunflower head during maturation.

## LITERATURE CITED

A.O.A.C. (1960). *Official Methods of Analysis. Association of Official Agricultural Chemists.* Ed. William Horwitz. Washington 4, D.C. P. 283.

APPELQVIST, I.A. (1975). Biochemical and structural aspects of storage and memberane lipids in developing oilseeds. In "Recent Advances in Chemistry and Biochemistry of Plant lipids". Eds. T. Galliard and E.I. Mercer. Academic Press, New York P. 251.

BROCKHUYSE, R.M. (1968). Phospholipids in tissue of the eye. Isolation, characterization and quantitative analysis by two dimentional thin layer chromatography of diacyl and vinyl either phospholipids. Biochem. Biophys. Acta 152 : 307-315.

BROWN, D.F. CARTER, C.M., MATTIL, C.F. and DARROCH, J.G. (1975). Effect of variety, growing location and their interaction on the fatty acid composition of peanuts. J. Food sci. 40: 1055-1060.

COLLINS, F.F. and CARTTER, J.L. (1956). Variability in chemical composition of seed from different positions of the soybean plant. Agron J. 48 : 216-219.

FOLCH, J., LESS M. and STANLEY, G.H.S. (1957). A simple method for the isolation and purification of total lipids from animal tissues. J. Biol. Chem. 226: 497-509.

GANGRADE, S.K., KAUSHAL, R.K. and SHRIVAS, S.R. (1973). A note on variation in oil and protein content in seeds of capsule born at different nodes of sesamum plant. Jawahar Lal Nehru Krishi Vishwa Vidyalaya Res. J. 7: 190-191.

GUPTA, S.K. and WAGLE D.S. (1986). Fatty acid composition of developing seeds of sunflower (*Helianthus annuus L.*) as influenced by seed position within the head and season. Ann. Biol. 2: 143-150.

JELLUM, M.D. (1967). Fatty acid composition of corn (*Zea mays* L.) oil as influenced by kernel position on ear. Crop Sci. 7: 593-595.

JOSEPH, H.R. (1954). The determination of dextran in blood and urine with anthrone reagent. J. Biol. Chem. 208 : 889-896.

LAMBERT, R.J. ALAXANDER, D.E. and RODGERS, G. (1967). Effect of kernel position an oil content in corn. Crop Sci. 7: 143-144.

LUDDY, F.E., BARFORD, R.A. HERB, S.F. and PAUL, M. (1968). A rapid quantitative procedure for the preparation of methyl esters of butter fat and other fats. J. Amer. Oil Chem. Soc. 45: 549-552.

NICHOLS, B.W. (1964). "New Biochemical Separations." Eds. A.J. James and L.J. Morris. Van Nostrand Co., London. pp. 321.

PRIVETT, O.S., DOUGHERTY, K.A., ERDAHL, W.L., and STOLYHWO, A. (1973). Studies on the lipid composition of developing soybean.J. Amer. Oil Chem. Soc. 50: 516-520.

SANDERS, T.H. (1980). Effect of variety and maturity on lipid class composition of peanut oil. J. Amer. Oil Chem. Soc. 57 : 8-12.

TREVELYAN, W.E. and HARRISON, I.S. (1952). Studies on yeast metabolism I. Fractionation and microdetermination of cell carbohydrates. Biochem. J. 50: 298-303.

WILLIAMS, R.D. and CHAPMAN, D. (1970). Phospholipids, liquid crystals and cell membranes Prog. Chem. Fats 10 : 3-6.

J. Oilseeds Res. 7 (1990) 16-23
*ISSN* 0970—2776

# GENETICAL ANALYSIS OF HARVEST INDEX, BIOLOGICAL YIELD AND SEED YIELD IN INDIAN MUSTARD (*BRASSICA JUNCEA* L. CZERN AND COSS)

A.K. YADAV, HARI SINGH and I.S. YADAV
Department of Plant Breeding, Haryana Agricultural University, Hisar-125 004 (India)

**OBSTRACT**

In present study six generations ($P_1$,$P_1$,$F_2$,$F_2$,$BC_1$ and $BC_2$) of four crosses namely; RH-30 x Domo, RH 785 x YRK2, Prakash x RC-1425 and RH 30 x RC 781 were studied for the genetic control of biological yield, Harvest index and seed yeild in Indian Mustard. Correlations among the traits were also worked out. Harvest index and biomass production had shown positive and significant relationship with seed yield. On the contrary, they had no correlation with each other suggesting that only on a desirable level of biomass production, harvest index should be aimed at for increasing seed yield through selection. Genetic control of these three characters revealed the manifestation of mainly dominant gene effects and epistatic effect of additive x additive (i) and dominance x dominance (l) types. However, in the segregating population of RH30 x Domo, pedigree selection may prove to be worthwhile for simultaneous improvement of both seed yield and harvest index.

**Key words** : Indian mustard, gene effects, Harvest index, biological yield.

## INTRODUCTION

Harvest index is a valuable criterian for an improved plant type because the morphological frame of the plant must be so constructed that the total drymatter produced is efficiently partitioned between grains and vegetative parts (Jain, 1975). The major break through in cereal grain yield has been largely due to the improvement of source to sink relationship without an increase in total drymatter production (Singh and Stokopf, 1971; Donald and Hamblin, 1976). Kulshrestha and Jain (1977) proposed that existing barriers to higher grain yields in cereals may be broken by increasing the dry matter production while maintaining high value of harvest index. The same may be suited to Indian Mustard where such information is still meagre.

The present experiment was, therefore, undertaken to obtain information on the inter-relationships among harvest index, biological yield and seed yield and their genetic controls in this crop.

## MATERIALS AND METHODS

A set of six generations, $P_1$,$P_2$,$F_1$,$F_2$,$BC_1$ and $BC_2$ of four crosses viz; RH 30 x Domo, RH 785 X YRK $_2$, Prakash x RC1425 and RH 30 x RC 781, of Indian Mustard, was grown in a randomized block design with three replications at Haryana Agricultural University Research farm, Hisar (India) during winter season of 1982. Sowing was done with inter-row spacing of 30 cm. and intra row spacing of 15 cm. Observations were recorded on ten competitive plants from non-segregating generations ($P_1$, $P_2$ and $F_1$); thirty plants from each of back cross generations and forty five plants from each of the $F_2$ generations for the characters biological yield and seed yield. Harvest index was worked out on the same samples as the ratio of economic yield (seed

Received on April 20, 1989.

yield/plant) to biological yield (total plant dry weight). Coefficients of correlations, at phenotypic and genotypic levels were computed among these traits in the non-segregating generations of all the four crosses which had fixed genotypic constitution according to the formulae given by Fisher (1954) and Al-Jibouri *et al.*, (1958).

Gene effects were estimated from the six generations of the above mentioned four crosses by the method or least squares as per Hayman, 1958. Prior to it, scaling test as advocated by Nather (1949) was applied.

## RESULTS AND DISCUSSION

*Inter-relationship between characters* : Coefficients of correlations both at phenotypic and genotypic level among harvest index, biological yield and seed yield have been presented in Table-1. The correlation studies were thought to be relevant in non-segregating populations, ($P_1$,$P_2$, and $F_1$) which were genetically stable because of their fixed genetic constitution as against the segregating generations where the plants were yet to become homozygous and stable. The values inserted in the table clearly indicated that at phenotypic level, harvest index and biological yield exhibited positive and significant correlations with seed yield in the non-segregating generations of all the four crosses. However, harvest index when correlated with biological yield showed no significant relationship in all the crosses. A significant positive correlation between seed yield and harvest index in Brassica spp, was also reported by Thurling (1974), Mehrotra *et al*; (1976). Varshney and Singh (1982) and Singh et al, (1985).

**TABLE 1 : Genotypic (G) and phenotypic (P) correlations of harvest index (H.I), biological yield and seed yield in non segregating generations of four crosses in Indian mustard.**

| S.No. | Crosses | | Harvest Index vs Biol. Yield | Harvest Index vs seed yield | Blol. yield Vs Seed yield |
|---|---|---|---|---|---|
| 1. | RH 30 x Domo | G | 0.479 | 0.895 | 0.586 |
| | | P | 0.377 | 0.644** | 0.518* |
| 2. | RH 785 x YRK2 | G | 0.310 | 0.787 | 0.861 |
| | | P | 0.300 | 0.649** | 0.830** |
| 3. | Prakash x RC 1425 | G | 0.240 | 0.931 | 0.990 |
| | | P | 0.182 | 0.831** | 0.912** |
| 4. | RH 30 x RC 781 | G | 0.229 | 0.775 | 0.670 |
| | | P | 0.118 | 0.700 | 0.570 |

* P = .05
** P = .01

From these relationships it appeared that alongwith high yield, harvest index appeared to be important criteria which can be helpful in increasing the seed yield even at constant biological yield. However, for total increase in seed yield, total biomass should also be increased either by agronomic manipulation or by genetic amelioration.

*Genttic control* : From scaling tests, three parameter model (m,d,h) was found to be inadequate for all the characters and crosses and hence six parameter model was applied. The estimates of gene-effects of biological yield, harvest index and seed yield for all the four crosses have been given in Table-2. Significant dominance gene effects (h) were the main cause for genetic variation for biological yield in all four crosses.

**TABLE 2. Estimates of gene effect for harvest index, (%) biological yield (g) and seed yield (g) in four crosses of Indian mustard**

| Characters | Crosses | Gene effects | | | | | | Epistasis |
|---|---|---|---|---|---|---|---|---|
| | | (m) | (d) | (h) | (i) | (j) | (l) | |
| Biological yield | RH30 x Domo | 43.77 ± 2.20 | 4.63 ± 5.55 | 38.20** ± 14.51 | 22.33 ± 14.19 | 10.90 ± 5.83 | 34.40 ± 24.69 | |
| | RH785 x RYK-2 | 49.33 ± 1.69 | 3.85 ± 2.24 | -16.69* ± 8.19 | 22.20* ± 8.12 | -3.67 ± 2.35 | 53.93** ± 11.47 | D |
| | Prakash x RC1425 | 56.92 ± 1.64 | 5.63 ± 3.14 | 10.67** ± 3.36 | 6.00 ± 3.09 | 11.90** ± 3.34 | 17.40 ± 14.86 | |
| | RH30 x RC781 | 43.02 ± 2.01 | 5.67 ± 3.34 | 56.37** ± 10.99 | 47.13** ± 10.43 | 6.77 ± 3.68 | 0.80 ± 1.70 | |
| Harvest Index | RH 30 x Domo | 0.16 ± 0.01 | 0.07** ± 0.01 | 0.07* ± 0.03 | 0.06* ± 0.03 | 0.02 ± 0.03 | -0.02 ± 0.04 | |
| | RH 785 x YRK-2 | 0.19 ± 0.02 | 0.01 ± 0.01 | 0.12** ± 0.02 | 0.09** ± 0.02 | 0.01 ± 0.01 | -0.13** ± 0.03 | D |
| | Prakash x RC 1425 | 0.17 ± 0.03 | 0.01 ± 0.03 | 0.21** ± 0.02 | 0.15** ± 0.03 | 0.01 ± 0.01 | -0.18** ± 0.04 | D |
| | RH30 x RC 781 | 0.18 ± 0.05 | 0.03** ± 0.01 | 0.13** ± 0.03 | 0.11** ± 0.03 | 0.04** ± 0.01 | -0.24** ± 0.05 | D |
| Seed yield | RH 30 x Domo | 7.57 ± 0.52 | 2.66** ± 0.94 | 3.90 ± 2.85 | 1.48 ± 2.81 | 0.82 ± 0.99 | 10.11* ± 4.44 | |
| | RH785 x YRK-2 | 7.53 ± 0.26 | 1.04** ± 0.27 | 4.72** ± 0.45 | — — | — — | — — | |
| | Prakash x RC1425 | 8.52 ± 0.39 | 0.08 ± 0.81 | 14.50** ± 2.28 | 8.80** ± 2.25 | -1.12 ± 0.84 | **2.41** ± 3.66 | |
| | RH30 x RC 781 | 7.98 ± 0.47 | 0.43 ± 0.83 | 17.83** ± 2.59 | 13.78** ± 2.50 | -1.65 ± 0.89 | -13.63** ± 4.03 | D |

D = Duplicate epistasis

* P = .05
** P = .01

Manifestation of additive x additive (i) portion of interaction was more important for this character. However, dominance x dominance (l) and (j) portions were also noticed for the crosses, RH 785 x YRK $_2$ and Prakash x RC 1425, respectively. Judging the sign of (h) and (l) estimates, duplicate epistesis was revealed by the cross RH 785 x YRK $_2$ for this trait.

Genetic variation in seed yield for the cross RH 30 x Domo was mainly due to additive gene effect and epistatic effect of dominance x dominance (l) type. For the crosses Prakash x RC 1425 and RH 30 x RC 781, dominance components were found to be significant. Epistatic effects of additive x additive (i) and dominance x dominance (l) were exhibited for the cross RH 30 x RC 781 while for Prakash x RC 1425 additive x additive (i) type was responsible for the genetic variation. Duplicate type of interaction was noticed for seed yield in cross RH 30 x RC 781.

For harvest index, dominance effect as well as additive x additive (i) and dominance x dominance (l) portions of interactions were the possible cause of genetic variation in this trait for the crosses RH 785 x YRK 2 and Prakash x RC 1425. Both the crosses also exhibited duplicate type of interactions. For the other two crosses additive and dominance gene effects jointly influenced the genetic variations. The magnitude of dominance gene effects were higher with positive direction as compared to additive ones. For the cross RH 30 x Domo, significance interactions were ascribed to additive x additive (i) and additive x dominance (j) types while for the cross RH-30 x RC 781, all the three types of interactions made significant contributions for this character.

In essence, it could be pointed out that the dominance gene effects epistatic effects as well were more prevalent than other effects for the characters studied. Similar results were also reported in this crop by Labana *et al.*, 1978 and Singh *et al.*, 1981. Gamble (1962) also suggested that when inheritance of quantitative characters becomes more complex, the contribution of dominance gene effects to their inheritance becomes greater.

Heterosis breeding may be most desirable approach to exploit these characters in the four crosses studied. However, simple pedigree selection in the segregating generations of the crosses like RH 30 x Domo and RH 785 x YRK-2 for seed yield and RH 30 x Domo for harvest index would be most effective. It is because of the significant contribution of the additive effects also for these two characters.

## ACKNOWLEDGEMENT

The Senior author is highly grateful to Council of Scientific and Industrial Research, New Delhi for providing financial aid, for conducting the present investigation, in the form of senior fellowship.

## LITERATURE CITED

AL-JIBOURI H.A., R.A. MILLER and H.P. ROBINSON (1958). Genotypic and environmental variances and covariances in an upland cotton cross of interspecific origin. Agron. J. **50**; 633-37.

DONALD? C.M. and J. HAMBLIN (1976). The biological yield and harvest index of cereals as agronomic and plant breeding criteria. Adv. Agron. **28** : 361-405

FISHER, R.A. (1954). Statistical methods for research workers. 12th ed. Oliver & Boyd. Ltd., London.

GAMBLE, E.E. (1962). Gene effects in corn (*Zea mays* L.). I. Separation and relative importance of gene effects for yield. Gen. J. Plant Sci., **48** 339-48.

HAYMAN, B.I. (1958). The separation of apistatic from additive and dominance variation in generation means. Heredity, **12** : 371-90.

JAIN, H.K. (1975). Breeding for yield and other attribution in grain legumes. Indian J. Genet. **35**: 169-87.

KULSHRESTHA, V.P. and H.K. JAIN (1977). Breeding for yield in dwarf wheats. 3rd International Congress SABRAO **3** (**9**): 22.

LABANA, K.S., T. RAM, S.S. BADWAL and D.K. MEHAN (1978). Combining ability analysis in the Indian Mustard. Crop Improv. **5** : 37-44.

MATHER, K. (1949). Biometrical Genetics (Ist Ed.). Methuen, London.

MEHROTRA, O.N., H.K. SAXENA, and M. MOOSA (1976). Physiological analysis differences in seed yield of Indian Mustard (*Brassica Juncea* L. Czern & Coss.) Indian J. Pl Physiol., **19** : 139-46.

SINGH, A.B., YSS. CHAUHAN and P. SINGH (1981). Genetics of yield in Indian Mustard. Indian J. Genet. 41: 130-136.

SINGH, I.D. and N.C. STOSKOPF, (1971). Harvest index in cereals. Agron. J. **63** : 224-26.

THURLING, N. (1974). Morpho-physiological determinent of yield in rape seed (*Brassica campestris* and *Brassica napus* L.); II. Yield components, Aust. J. agric. Res., **25**: 711-21.

VARSHNEY, S.K. and B. SINGH (1982). Inter-relationship among harvest index and other quantitative traits in Toria (*Brassica campestris* L. var. Toria). SABROA **14**: 89-92.

SINGH, H., A.K. YADAV, T.P. YADAVA and V.P. LATHER (1985). Morpho-physiological attributes in relation to seed yield in Indian mustard. Haryana agric. Univ. J. Res. **15** : 295-99.

J. Oilseeds Res. 7 (1990) 21-24
*ISSN* 0970—2776

# MATURITY TRAITS AND THEIR PREDICTION THROUGH GENOTYPES X ENVIRONMENT INTERACTIONS IN OLEIFEROUS *BRASSICAE*

RAVINDER KUMAR, A.K. YADAV and I.S. YADAV
Department of Plant Breeding, Haryana Agricultural University, Hisar-125 004 (India)

**ABSTRACT**

*Genotype x environment interactions for days to flowering and days to maturity* were studied in oleiferous Brassicas by growing 12 genotypes in 14 environments over 2 years. Genotype-environments interactions were found to be significant for both the traits. Both linear and non-linear components of genotype-environment interactions were significant for both the traits. Among the genotypes under test T-9 of toria was the earliest to flower and to mature. RH-7859 and HC-2 were most responsive for days to flowering and maturity, respectively. None of the genotypes was stable for both the traits.

## INTRODUCTION

Assessment of genotype-environment interactions is assuming special significance in breeding crop plants for evaluating varieties for adaptability (Breese, 1969). Headway in this direction could be made only after the development of methods to provide reliable estimates of stability (Finlay and Wilkinson, 1963; Eberhart and Russell, 1966). Maturity traits of a crop fluctuate considerably especially under rainfed conditions, with change in the environment. Rapeseed and mustard group is an important group of crops of Rabi oilseeds adapted to rainfed conditions, low inputs and poor management. There is limited information pertaining to stability for maturity in these crops. An attempt has, therefore, been made to assess stability parameters of these crops under fourteen different environments.

## MATERIALS AND METHODS

The experimental material consists of twelve different genotypes namely, T-9 and Sangam from *Brassica campestris* L. var. toria; BSH-1 and Bele (exotic) from *B. campestris* L. var. brown sarson; Tower from *B. napus* L; RH-7859, RH-781, RH-785, Varuna, Kranti and RH-30 all from *B. juncea* L. and HC-2 from *B. carinata* L. These genotypes were grown at Haryana Agricultural University, Hisar on seven different dates starting from mid September to mid December at fortnightly intervals during 1984-85 and 1985-86. Thus, the fourteen independent environments were created (Table-1). Each genotype was accommodated in a plot of 9 rows of 6 m length keeping row to row spacing of 30 cm and between plants within a row of 15 cm. The experiment was laid out in a randomized block design with 3 replications. Pre-sowing irrigation was applied followed by another irrigation at siliqua formation stage.

The data for days to flowering and maturity were analysed for stability parameters according to Eberhart and Russell (1966).

Received on May 26, 1989.

TABLE 1. Mean and range of days to flowering and days to maturity of Oleiferous *Brassicae* in fourteen environments

| Environments | | Days to flowering | Days to maturity |
|---|---|---|---|
| $E_1$ + | Mean | 43.42 | 127.58 |
| | Range | 30.67-73.00 | 108.33-164.67 |
| $E_2$ | Mean | 43.93 | 129.67 |
| | Range | 32.33-73.67 | 102.67-158.67 |
| $E_3$ | Mean | 48.14 | 138.47 |
| | Range | 33.67-89.67 | 111.67-158.00 |
| $E_4$ | Mean | 53.69 | 138.39 |
| | Range | 38.33-97.33 | 120.00-160.67 |
| $E_5$ | Mean | 64.69 | 131.69 |
| | Range | 46.67-96.67 | 116.67-150.33 |
| $E_6$ | Mean | 64.42 | 121.50 |
| | Range | 51.00-89.33 | 112.00-138.33 |
| $E_7$ | Mean | 60.38 | 111.89 |
| | Range | 52.00-78.33 | 103.67-127.67 |
| $E_8$ | Mean | 44.22 | 126.32 |
| | Range | 31.33-73.67 | 89.67-157.33 |
| E9 | Mean | 43.61 | 132.92 |
| | Range | 31.00-69.33 | 101.67-162.00 |
| $E_{10}$ | Mean | 45.39 | 133.19 |
| | Range | 33.00-74.00 | 112.00-159.00 |
| $E_{11}$ | Mean | 50.80 | 135.55 |
| | Range | 36.00-85.67 | 113.67-164.67 |
| $E_{12}$ | Mean | 55.11 | 129.41 |
| | Range | 40.33-89.33 | 110.00-152.67 |
| $E_{13}$ | Mean | 60.50 | 122.22 |
| | Range | 46.00-82.67 | 105.67-136.00 |
| $E_{14}$ | Mean | 57.61 | 117.42 |
| | Range | 47.33-76.77 | 102.67-130.67 |

+ Date of sowing

$E_1$ September 16, 1984; $E_2$ October 1, 1984; $E_3$ October 16, 1984; $E_4$ November 1, 1984; $E_5$ November 16, 1984. $E_6$ December 1, 1984; $E_7$ December 16,1984; $E_8$ September 16, 1985; E9 October 1, 1985; $E_{10}$ October 16 1985; $E_{11}$ November 1, 1985; $E_{12}$ November 16,1985; $E_{13}$ December 1, 1985; and $E_{14}$ December 16, 1985.

## RESULTS AND DISCUSSION

The highest mean value for days to flowering was recorded in $E_5$ (64.69 days) followed by $E_6$ (64.42 days) whereas for days to maturity, it was maximum in $E_3$ (138.47 days) followed by $E_4$ (138.39 days) Table-1). The genotypes, sown after mid-October flowered late but took less days to mature. The highest range for days to flowering was in $E_4$ (38.33-97.33 days) and for days to maturity in $E_8$ (89.67 - 157.33 days.)

Pooled analysis of variance (Table-2) indicated significant difference due to genotypes and environments suggesting the existance of enormous variability amongst the genotypes and the environments used. Significant mean square values observed for genotype-environment interactions revealed that the genotypes behaved differently in different environments. The linear component of genotype x environment was also significant, reflecting that the prediction of most of the genotypes was possible (Perkins & Jinks, 1968). Similar results for maturity traits were given by Yadav and Kumar (1984) in Taramira. On the contrary Ram (1970) reported that genotype x environment interaction and its linear component were non-significant for days to flowering in brown sarson. Significant pooled deviation for both the traits indicated that the genotypes differed significantly for their stability with respect to days to flowering and maturity.

**TABLE 2 : Analysis of variance for stability of days to flowering and days to maturity**

| Source | d.f. | Days to flowering | Days to maturity |
|---|---|---|---|
| Genotypes | 11 | 2512.86** | 2144.18** |
| Environments | 13 | 763.81** | 730.84** |
| Genotype x Environment | 143 | 17.38** | 29.97** |
| Env. + (Gens x Env) | 156 | 79.58 | 88.38 |
| Env. (Linear) | 1 | 9929.12** | 9493.90** |
| Geno x Env. (Linear) | 11 | 31.58* | 64.79** |
| Pooled deviation | 144 | 14.85** | 24.88** |
| Pooled error | 308 | 0.31 | 0.33 |

* Significant at 0.05

** Significant at 0.01

The data on three parameters viz; mean performance (m), regression coefficient (bi) and deviation from regression ($Sdi^2$) have been presented in Table-3.

Eight genotypes namely, T-9, Sangam, Bele, BSH-1RH-7859, RH-30, Kranti and RH-781 flowered earlier whereas Varuna flowered in average time (51.90 days) and rest of the three genotypes viz; RH-785, HC-2 and Tower flowered late when they were compared against overall mean. The genotype T-9 flowered earliest (39.26 days) and Tower was last to flower (79.81 days) over all the fourteen environments. The significant values of $Sdi^2$-indicated the unstability of all the genotypes for this trait (Table-3). Ten genotypes viz; T-9, Sangam, BSH-1, Bele, Tower, RH-781, RH-785, Kranti, RH-30 and HC-2 recorded average response showing their suitability over a wide range of environments. The remaining two genotypes i.e. RH-7859 and Varuna had above average response and were considered responsive to better environment.

As regards days to maturity, the toria genotypes T-9 and Sangam were found to be earliest (107.67 and 113.14 days, respectively) followed by brown sarson cultivars

**TABLE 3. Estimates of stability parameters for days to flowering and days to maturity**

| S. No. | Genotype | Days to flowering | | | Days to maturity | | |
|---|---|---|---|---|---|---|---|
| | | Mean (*m*) | bi | Sdi – ² | Mean (m) | bi | Sdi – ² |
| 1. | T--9 | 39.26 | 0.94 ± 0.08 | 5.43** | 107.67 | 0.47* ± 0.16 | 51.15** |
| 2. | Sangam | 42.52 | 0.93 ± 0.09 | 6.54** | 113.14 | 0.64 ± 0.16 | 19.42** |
| 3. | BSH-1 | 43.17 | 0.71 ± 0.07 | 4.38** | 121.26 | 0.92 ± 0.16 | 20.16** |
| 4. | Bele | 42.71 | 0.96 ± 0.09 | 5.96** | 120.50 | 0.91 ± 0.13 | 13.16** |
| 5. | Tower | 79.81 | 0.69 ± 0.34 | 96.04** | 150.64 | 1.23 ± 0.29 | 66.97** |
| 6. | RH-7859 | 48.00 | 1.23** ± 0.07 | 3.94** | 129.00 | 1.11 ± 0.08 | 50.29** |
| 7. | RH-781 | 50.74 | 1.17 ± 0.09 | 6.75** | 130.07 | 1.03 ± 0.12 | 10.32** |
| 8. | RH-785 | 57.00 | 1.13 ± 0.08 | 5.21** | 133.60 | 1.06 ± 0.12 | 10.78** |
| 9. | Varuna | 51.90 | 1.20** ± 0.06 | 2.43** | 128.60 | 0.96 ± 0.12 | 11.65** |
| 10. | Kranti | 48.74 | 1.13 ± 0.07 | 3.88** | 128.69 | 0.99 ± 0.15 | 18.66** |
| 11. | RH-30 | 48.10 | 1.11 ± 0.07 | 3.44** | 129.00 | 1.04 ± 0.14 | 15.01** |
| 12. | HC-2 | 78.83 | 0.77 ± 0.19 | 30.50** | 147.98** | 1.63 ± 0.26 | 52.28** |
| | Mean | 52.57 | 1.00 | | 128.35 | 1.00 | |
| | SE m ± | 1.07 | SE (b) ± 0.13 | | SE (m) ± 1.38 | SE (b) ± 0.17 | |

* *Significant at 0.05*
** Significant at 0.01

Bele (120.50 days) and BSH-1 (121.26 days). The mustard group comprising RH-7859, Varuna, RH-30 and Kranti took average period (128.35 days) to mature, whereas the genotypes RH-785, RH-781, HC-2 and Tower were categorized as late maturing genotypes (Talbe-3). None of the genotypes was found to be stable for days to maturity as indicated by significant values of $Sdi^{-2}$. Above average response was exhibited by HC-2, while T-9 and Sangam showed below average response and rest of the genotypes were found to be average responsive for this trait which indicated their suitability for favourable, poor and over a range of environments, respectively.

## LITERATURE CITED

BREESE, E.L. (1969). The measurement and significance of genotype-environment interactions in grasses. Heredity 24 : 27-44.

EBERHARD, L. and RUSSELL, W.A. (1966). Stability parameters for comparing varieties, crop Sci. 6: 36-40.

FINLAY, R.W. and WILKINSON, G.M. (1963). The analysis of adaptation in a plant breeding programme. Aust. J. Agril. Res. 14: 742-754.

PERKINS, J.M., and JINKS, J.L. (1968). Environmental and genotype environmental components of variability III. Multiple lines and crosses. Heredity 23: 339-355.

RAM, J. (1970). Stability of performance of some strains derived from disruptive selection from flowering time in *Brassica campestris* var. brown *sarson*. Indian J. Genet. 30 (1): 116-125.

SINGH, D., GUPTA P.K. and SINGH, F. (1984). Stability of days to maturity in toria. Indian J, Genet. 44 : 259-261.

YADAV, I.S. and KUMAR, D. (1984). Stability for maturity traits in taramira under rainfed conditions. Trop. Plant Sci. Res. 1: 349-350.

J. Oilseeds Res. 7(1990): 26-32
*ISSN* 0970—2776

# RESPONSE OF SAFFLOWER TO DIFFERENT MOISTURE REGIMES AND NITROGEN LEVELS IN SEMI - ARID TROPICS

A. ZAMAN[1] and P.K. DAS[2]
Department of Agronomy, Faculty of Agriculture,
Bidhan Chandra Krishi Viswavidyalaya, West Bengal

**ABSTRACT**

Safflower (*Carthamus tinctorius* L.) grown with different moisture regimes and nitrogen fertilisation under limited water supply on a sandy loam soil in SAT Zone of Bengal responded upto 148 kg N/ha and 42.9 cm of water/ha at seed yield levels of 14.28 and 20.73 q/ha, respectively, on an average, in trials conducted for two consecutive years. However, maximum response of safflower to nitrogen and irrigation obtained at immediate higher level of application (40 kg N/ha and 7.5 cm of water, respectively) over control were 5.65 and 5.88 kg seeds per kg of applied N and per mm of irrigation water, respectively.

**Key words** : Safflower; Moisture regimes; Nitrogen levels.

## INTRODUCTION

Safflower (*Carthamus tinctorius* L.) can safely be introduced in lateritic tract of West Bengal where at present only one crop is usually taken during *Kharif* season and majority of cultivable lands remain fallow during *rabi* season due to lack of irrigation facilities (Zaman, 1986). Safflower responds well to levels of irrigation (Erie and French, 1969; Abel, 1976; Chordia and Gaur, 1986; Pawar *et al.*, 1987) and application of nitrogen (Jones and Tucker, 1968; Sharma and Verma, 1982; Sagare *et al.* 1986) though it is regarded as a crop of less water and nutritional requirement. The responses varied widely under different agro-climatic situations. There is a great scope of undertaking location specific experiments, precisely, to ascertain the response of safflower to irrigation and nitrogen levels to optimise production of safflower and recommending the correct doses of N and irrigation levels to formulate a guideline on improved agronomic practices under limited water resources. Hence, the present investigation was conducted to evaluate the optimum dose of nitrogen and irrigation water to get maximum seed yield of safflower in semi-arid lateritic tract of West Bengal.

## MATERIALS AND METHODS

The field trials were conducted in lateritic tract of West Bengal at the Regional Research Farm of Bidhan Chandra Krishi Viswavidyalaya located at Jhargram during *rabi* seasons of 1983-84 and 1984-85. The soil was sandy loam in texture (sand 44.5%, silt 29.2% and clay 25.3%) having field capacity (W/W), permanent wilting point (W/W) and bulk density of 17.08%, 7.08% and 1.51 g $cm^{-3}$, respectively upto 15 cm layer. The total N, available $P_2O_5$ and $K_2O$ content in this soil layer were 65, 31 and 110 kg/ha, respectively. The soil pH was 5.7 (1:2 soil:water suspension). The treatment comprised of four levels of irrigation each of 75 mm depth (no irrigation, one irrigation at flowering, two irrigations one each at branching and flowering and three irrigations

1 Reader in Agronomy (Res) and 2 Post-graduate student, B.C.K.V., Kalyani-741 235, West Bengal.

Received on July 11, 1989.

one each at branching, flowering and seed development stages) in main plots and four levels of nitrogen (0,40,80 and 120 kg N/ha) in sub-plots in a split plot design with three replications.

The experimental crop of safflower (cv A 300) was sown using seed rate of 20 kg/ha having a spacing of 50 cm x 20 cm on October, 29 and 19 in respective years after *Kharif* rice harvested. The land received sufficient rainfall in both the years during land preparation so no pre-sowing irrigation was applied. A measured quantity of irrigation was applied at 75 mm depth each in accordance with treatment in addition to seasonal rainfall of 30.6 and 10.0 mm in respective years. A uniform dose of nitrogen according to treatments as urea, 40 kg each of $P_2O_5$ and $K_2O$/ha as single super phosphate and muriate of potash, respectively, was applied during land preparation to the soil. Adequate plant protection measures were taken to save the crop from insect-pests, disease and weeds infestation.

A quadratic response curve from the regression equation, $Y=a+bx+cx^2$ was fitted by method of orthogonal polynomials to study the relationship between seed yield and levels of applied nitrogen and irrigation water, where, Y=expected seed yield of safflower in q/ha due to application of x unit of input (nitrogen or irrigation). The most profitable and optimum dose was derived by model $X = \frac{1}{2c}\left(\frac{q}{p} - b\right)$ where, q and p represents the cost of unit fertiliser (one unit of nitrogen equal to 10 kg at the cosl of Rs. 4.90/kg of N from Urea) or irrigation water (one unit of irrigation water equal to 1cm at the cost of Rs. 28/cm) and unit of produce (q/ha at the sale price of Rs. 450/ q), respectively. The dose for maximum production was calculated by employing formula $X = -b/2c$.

The cost of irrigation water application, nitrogen and sale price of safflower seeds has been calculated considering the prevailing market price as on April, 1986.

## RESULTS AND DISCUSSION

### Seed and Stalk yield

The levels of irrigation as well as nitrogen influenced the seed and stalk yield of safflower significantly during both the years of experimentation. The pooled data also indicated the similar trend. The influence of irrigation levels was more pronounced to give rise in seed yield and only one irrigation at flowering stage (100 DAS) doubled the seed yield where three irrigations one each at branching, flowering and seed development stages (40,100 and 130 DAS, respectively) increased the seed yield about 200 per cent over control. Maximum seed yield of safflower obtained with 120 kg N/ha which was 61 per cent more than that of control (Table 1). Similar results on effect of irrigation levels has been reported by Dastane *et al.*, 1971 and Rajput *et al.*, 1981. Singh *et al.*, (1983) and Ahmed *et al.*, (1985) reported the response of safflower to higher levels of nitrogen in increasing the seed yield.

### Response to nitrogen levels

Production function between levels of nitrogen and seed yield of safflower for both the years was characterised by the quadratic relationship (Table 2) where the opti-

TABLE 1. Effect of nitrogen and irrigation levels on seed and stalk yield of safflower

| Treatment | Seed yield (kg/ha) | | | Stalk yield (kg/ha) | | |
|---|---|---|---|---|---|---|
| | 1983-84 | 1984-85 | Pooled | 1983-84 | 1984-85 | Pooled |
| Irrigation at B F S | | | | | | |
| O O C | 509 | 610 | 560 | 963 | 1265 | 1114 |
| O X O | 958 | 1044 | 1001 | 1931 | 2194 | 0263 |
| X X O | 1313 | 1432 | 1373 | 2957 | 3218 | 3088 |
| X X X | 1628 | 1702 | 1665 | 3412 | 3750 | 3581 |
| SEm (±) | 10.02 | 4.70 | 7.82 | 28.64 | 3.23 | 6.80 |
| CD at 5% | 34.69 | 16.30 | 27.07 | 99.24 | 11.18 | 23.53 |
| N-levels (kg/ha) | | | | | | |
| 0 | 840 | 882 | 861 | 1543 | 1932 | 1736 |
| 40 | 1035 | 1139 | 1087 | 2328 | 2566 | 2447 |
| 80 | 1205 | 1331 | 1268 | 2585 | 2856 | 2721 |
| 120 | 1328 | 1437 | 1383 | 2811 | 3072 | 2942 |
| SEm (±) | 5.23 | 7.74 | 6.60 | 11.64 | 8.07 | 10.02 |
| CD at 5% | 15.23 | 22.55 | 19.24 | 33.90 | 23.51 | 29.22 |

B = branching, F = flowering and S = seed development stages ;
O = no irrigation and X = irrigation applied.

mum doses of nitrogen were 179.8 and 130.7 kg/ha in 1983-84 and 1984-85, respectively with an average of 148.2 kg/ha (Fig. 1) to expected seed yield levels of 14.37, 14.50 and 14.28 q/ha, respectively. However, response of safflower to nitrogen in kg seed/kg N-applied under immediate higher dose (40 kg N/ha) over control were 4.88 and 6.43 kg seed/kg N-applied in respective years (Table 3) which was comparatively high at low level of nitrogen than at higher levels. Although the total seed yield of safflower increased with increasing levels of applied nitrogen. The doses of nitrogen for maximum production of safflower seed was calculated as high as 177.5 kg/ha with expected seed yield of 14.44 q/ha.

**Response to irrigation levels**

Input-output relationship between levels of irrigation water and seed yield of safflower for both the years were worked out by the orthogonal polynomial methods and production function was characterised by quadratic relationship (Table 2) where optimum doses of irrigation water were 46.23 and 39.83 cm in 1983-84 and 1984-85, respectively with an average of 42.85 cm (Fig. 2) to expected seed yield of 21.20, 20.40 and 20.73 q/ha, respectively. However, like nitrogen levels, response of safflower to irrigation at immediate higher level of application (7.5 cm, one irrigation) over control were 5.99 and 5.79 kg seed/mm of irrigation water in respective years (Table 3) which was also comparatively higher at lower levels of irrigation. Although increased levels of irrigation increased the total seed yield of safflower. The irrigation water required

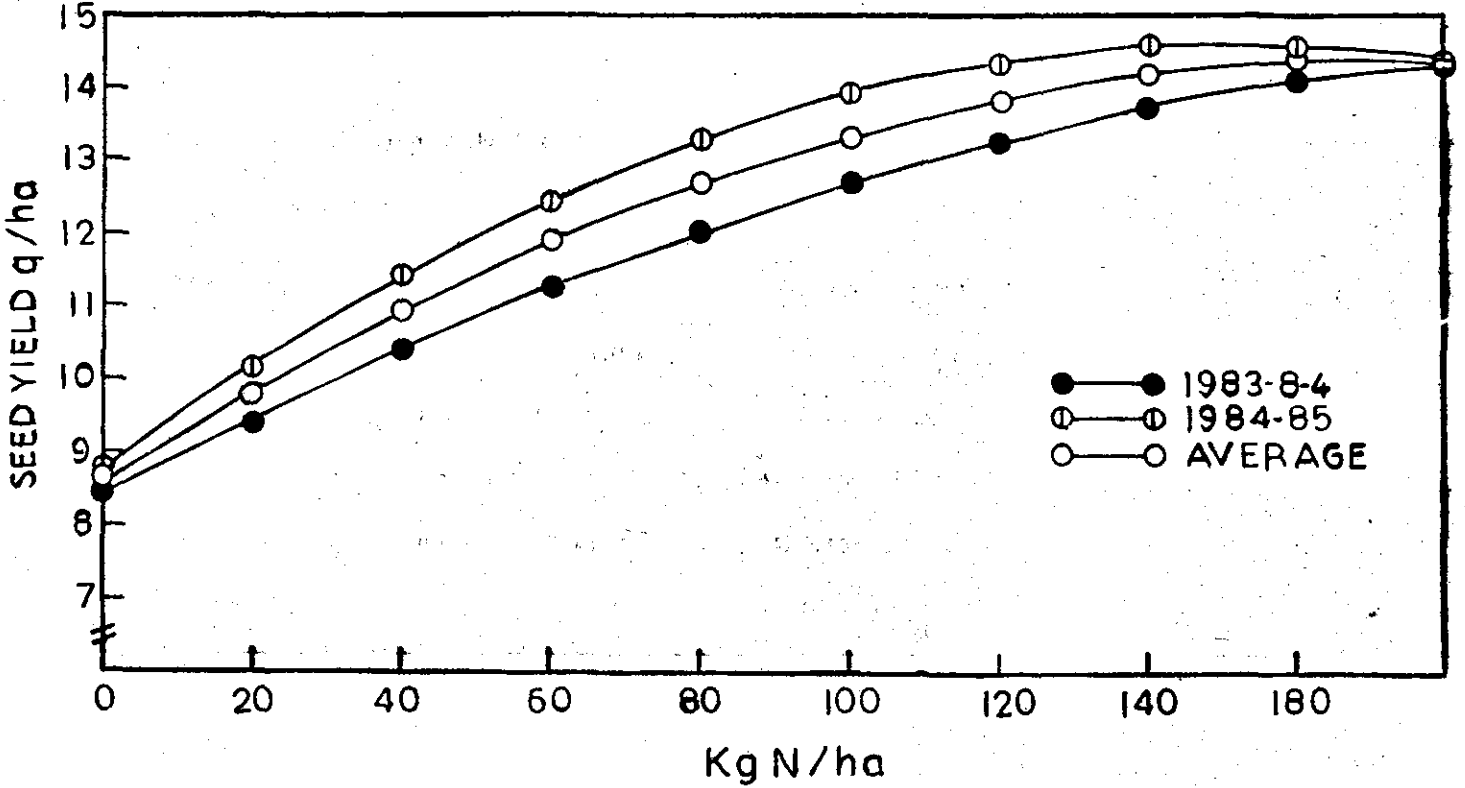



**Fig.1** RESPONSE OF SAFFLOWER TO NITROGEN LEVELS

**Table 2. Functional relationship between the levels of inputs (nitrogen and irrigation) and seed yield of safflower**

| Treatment | Year | Regression equation (Y = ) | Optimum dose (kg N or cm/ha) | Expected yield (kg/ha) | Doses for maximum yield (kg N or cm/ha) | Expecetd yield (kg/ha) |
|---|---|---|---|---|---|---|
| N-levels | 1983-84 | $8.37 + 0.5584x - 0.0125x^2$ $R^2 = 0.99805$ | 179.8 | 1437 | 223.4 | 1461 |
| | 1984-85 | $8.79 + 0.7651x - 0.0251x^2$ $R^2 = 0.99215$ | 130.7 | 1450 | 152.4 | 1462 |
| | Average | $8.58 + 0.6602x - 0.0186x^2$ $R^2 = 0.99201$ | 148.2 | 1428 | 177.5 | 1444 |
| Irrigation levels | 1983-84 | $5.105+0.63405x-0.006185x^2$ $R^2 = 0.99981$ | 46.23 | 2120 | 51.26 | 2135 |
| | 1984-85 | $6.090+0.007457.\times 007457x^2$ $R^2 = 0.97569$ | 39.83 | 2040 | 44.01 | 2053 |
| | Average | $5.585+0.6447x-0.00679x^2$ $R^2 = 0.99894$ | 42.85 | 2073 | 47.46 | 2088 |

**Where,** Y = Expected seed yield of safflower q/ha due to application of x unit of input (nitrogen/irrigation); where one unit of nitrogen = 10 kg and one unit of irrigation water = 1 cm, considering prices of safflower seed at Rs. 450/q, prices of irrigation water (estimated) at Rs. 28-/ per cm and prices of nitrogen (from urea) at Rs. 490/q.

for maximum seed production was calculated as high as 47.46 cm with expected seed yield of 20.88 q/ha.

TABLE 3. **Response of safflower to nitrogen and irrigation in kg/ha N-applied and kg/mm of water applied**

| Year | Dose of N (kg/ha) | kg seeds/kg N applied | | Dose of irrigation (mm/ha) | kg seeds/mm of water | |
|---|---|---|---|---|---|---|
| | | Actual | Expected | | Actual | Expected |
| 1983—84 | 40 | 4.88 | 5.05 | 75 | 5.99 | 6.29 |
| | 80 | 4.25 | 3.98 | 150 | 4.73 | 4.72 |
| | 120 | 3.08 | 2.90 | 225 | 4.20 | 4.20 |
| 1984—85 | 40 | 6.43 | 6.65 | 75 | 5.79 | 5.79 |
| | 80 | 4.80 | 4.65 | 150 | 5.17 | 5.17 |
| | 120 | 2.65 | 2.15 | 225 | 3.60 | 3.64 |
| Average | 40 | 5.65 | 6.33 | 75 | 5.88 | 5.89 |
| | 80 | 4.52 | 4.55 | 150 | 4.96 | 4.95 |
| | 120 | 2.88 | 2.75 | 225 | 3.89 | 3.63 |

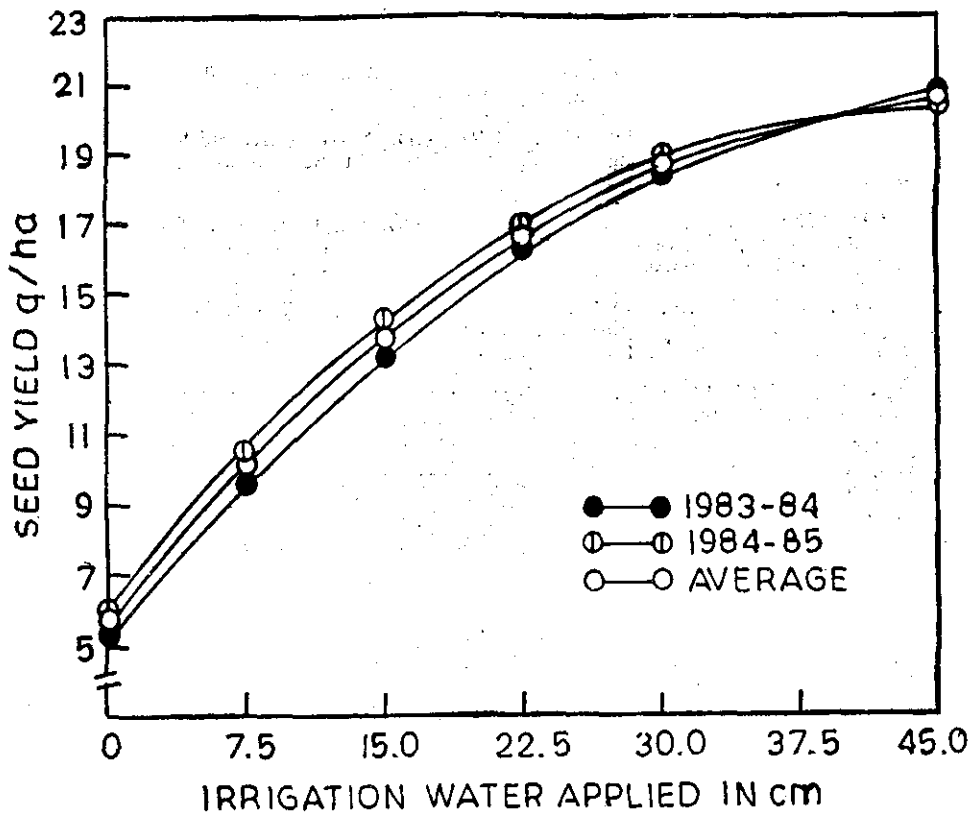



**Fig.2** RESPONSE OF SAFFLOWER TO IRRIGATION LEVELS.

Thus the result revealed that though the optimum doses of nitrogen and irrigation were higher to obtain economic seed yield of safflower under abundance of resources, the farmers of semi-arid tropics with restricted resources can grow safflower at any lower levels of nitrogen (atleast with 40 kg N/ha) and under atleast one irrigation of 7.5 cm depth at flowering stage.

## LITERATURE CITED

ABEL, G.H. 1986. Effect of irrigation regimes, planting dates, nitrogen levels and row spacing on safflower cultivar. Agron. J. **68**(3): 448-486.

AHMED, Z., MEDEKKAR, S. and MOHMMAD, S. 1985. Response of safflower to nitrogen and phosphorus. Indian J. Agron. **30**(1): 128-130.

CHORDIA, R.K. and GAUR, B.L. 1986. Effect of irrigation and mulches on seed yield of safflower (*Carthamus tinctorius* L.) Indian J Agron. **31**(3): 298-299

DASTANE, N.G., YUSUF, M. and SINGH, N.P. 1971. Performance of different *rabi* crops under varying frequencies and timing of irrigation. Indian J. Agron. **16**(4): 483-486.

ERIE, L.G. and FRENCH, C.F. 1969. Growth, yield and yield components of safflower as affected by irrigation regimes. Agron J. **61**(1): 111-113.

JONES, J.P. and TUCKER, T.C. 1968. Effect of nitrogen fertiliser on yield, nitrogen content and yield components of safflower Agron. J. **60** (4): 363-364.

PAWAR, H.K. PATIL, B.R. KHADE, K.K. MORE, V.D., NAIK, G.K. and SINDHE, S.H. 1987. Effect of irrigation scheduling on yield of safflower varieties. Journal of Oilseed Research **4**(2): 162-168.

RAJPUT, RK., SINGH, S.N, YADAV, J.P.S, and SHARMA, B.M. 1981. Effect of irrigation practices and methods of sowing cum-irrigation In the performance of safflower India, J. agric sci. **51**(5): 316-320.

SAGARE, B.N., HONDE, H.W. and DESHMUKH, V.A. 1986. Effect of nitrogen and phosphate levels on yield, monetary returns and nutrient uptake by safflower (*Carthamus tinctorius* L.) P K V Research Journal **10**(2): 96-98.

SHARMA, V.D. and VERMA, B.S. 1982. Effect of nitrogen, phosphorus and row spacing on yield. attributes and oil content of safflower under rainfed conditions. Indian J. Agron. **27**(1): 28-33.

SINGH, P.P., DUBEY, K.M. and KAUSHAL, P.K. 1983. Effect of nitrogen and phosphorus on the seed yield of safflower (*Carthamus tinctorius* L.). J N K V V Research Journal. **17**(1/2): 1-3.

ZAMAN, A. 1986. Water management of safflower in drought affected region of West Bengal. Seeds and Farms.**12**(8):6-9.

J. Oilseeds Res. 7 (1990): 33-35
*ISSN* 0970—2776.

# INHERITANCE OF GOLDEN YELLOW MUTANT IN GROUNDNUT (*ARACHIS HYPOGAEA* (L.)

S.L. DWIVEDI, S.N. NIGAM and V. RAMANATHA RAO
International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru P.O., Andhra Pradesh 502 324, India.

ABSTRACT

The parents, $F_1$s, $F_2$s, and $F_3$ progenies of six crosses, including three reciprocal crosses, were studied for the inheritance of golden yellow foliage in groundnut (*Arachis hypogaea* L.). The golden yellow foliage character was recessive, and it was controlled by independent duplicate genes, giving a ratio of 15 normal green : 1 golden yellow foliage in the $F_2$ generation.

**Key words** : Peanut, Aureus mutant, Genetic studies

## INTRODUCTION

The aureus mutant, possessing Golden yellow colored foliage (leaves and stems) in groundnut, was first reported in a population of PI 268637 grown in an experimental plot at Oklahama Agricultural Experiment Station in Stillwater, Oklahama (Stone, 1968). The aureus cotyledons were reported to be golden yellow in color initially during cracking time, but after exposure to light they turned green. However, the chlorophyll pigment decomposed in 2 weeks, resulting in a whole plant with golden yellow foliage till maturity. A groundnut genotype, ICG 10148, maintained in the germplasm collection at ICRISAT Centre, possesses similar characteristics; it probably was brought to India and ICRISAT Centre from USA. ICG 10148 has leaves and branches of golden yellow color, In limited genetic studies, (Tai et al., 1970, 1977) reported duplicate recessive inheritance for this character in the $F_2$ population in a cross of Aureus x Green Krinkled mutant.

In the present study, the inheritance of golden yellow foliage of the mutant was further studied in the $F_1$, $F_2$, and $F_3$ generations of six crosses, including three reciprocal crosses.

## MATERIALS AND METHODS

Three groundnut genotypes, ICG 221, ICG 799, and ICG 2405 were crossed reciprocally with ICG 10148. While ICG 221 belongs to subsp. *fastigiata* var. *vulgaris*, the other two genotypes are from subsp. *hypogaea* var. *hypogaea*. ICG 799 has a spreading bunch growth habit, and ICG 2405 is a runner type. ICG 10148 is erect in growth habit and belongs to subsp. *fastigiata* var. *vulgaris*.

Parents, $F_1$s, and $F_2$s of the six crosses were grown together during the 1986 rainy season at ICRISAT Center. Observations on the foliage color (golden yellow or green) were recorded in the $F_1$ and $F_2$ generations. All the plants with golden yellow foliage, and a random sample of 50 plants with green foliage in the $F_2$ generation in each cross, were individually harvested and grown as $F_3$ plant progenies in the 1987 rainy season. Individual plants in the $F_3$ progenies were observed for foliage color.

Received on September 1, 1989

$\chi^2$ test was applied to test the validity of different genetic ratios. Wherever the frequency in a particular class was less than five, the Yates (1934) correction factor was applied before estimating $X^2$ values.

## RESULTS AND DISCUSSION

The $F_1$s of the six crosses, including reciprocals, had normal green foliage, indicating that the golden yellow foliage character is recessive in nature.

The $F_2$ plant data on green and golden yellow foliage were subjected to chi-square test to various digenic ratios, and the $X^2$ values for the genetic ratio showing best fit are presented (Table 1). The $X^2$ value in five crosses showed a good fit to a 15:1 digenic ratio for greenversus golden yellow foliage, whereas in the case of ICG 10148 x ICG 799 the fit was not good at 0.05 probability. However, the total and pooled $X^2$ values were nonsignificant, which indicated an overall good fit to a 15.:1 genetic ratio.

**TABLE 1. Chi-square tests for the segregation of normal (green) and golden yellow foliage in $F_2$ generation of six crosses in groundnut.**

| Crosses | Frequency of $F_2$ phenotypes | | $X^2$ | |
|---|---|---|---|---|
| | Normal plant | Golden yellow | (15:1 ratio) | Probability |
| ICG 221 x ICG 10148 | 133 | 11 | 0.47 | 0.492 |
| ICG 10148 x ICG 221 | 812 | 46 | 1.16 | 0.281 |
| ICG 799 x ICG 10148 | 1294 | 77 | 0.94 | 0.332 |
| ICG 10148 x ICG 799 | 984 | 49 | 4.00* | 0.045 |
| ICG 2405 x ICG 10148 | 782 | 59 | 0.84 | 0.359 |
| ICG 10148 x ICG 2405 | 822 | 50 | 0.39 | 0.532 |
| Total (6 d.f) | — | | 7.80 | 0.252 |
| Pooled (1 d.f.) | 4827 | 292 | 2.60 | 0.106 |
| Heterogeniety (5 d.f.) | — | | 5.20 | 0.392 |

* Significant at 0.05 probability

Tai et al., (1970) reported the gene symbol, $au_1$ $au_1$ $au_2$ $au_2$, for aureus mutant (golden yellow foliage), and $AU_1AU_1AU_2AU_2$ for the krinkled green color genotype. Based on a 15:1 $F_2$ ratio and the gene symbols as assigned for the genotypes of the aureus and green plant, the $F_3$ progenies having green foliage with the genotype, $AU_1$ $au_1AU_2au_2$, $AU_1au_1au_2au_2$ and $au_1au_1AU_2au_2$ will segregate, whereas progenies with other genotypes will breed true. The green color $F_3$ progenies with $AU_1au_1$ $AU_2au_2$ will segregate in a 15:1 ratio of green versus golden yellow foliage, whereas those having $AU_1au_1au_2au_2$ and $au_1au_1AU_2au_2$ will segregate into a 3:1 ratio.

$F_3$ families derived from golden yellow $F_2$ plants bred true. Among the $F_3$ families derived from green $F_2$ plants, a good fit to 7:8 ratio of true breeding (green) versus segregating (green and golden yellow) was observed (Table 2).

**TABLE 2. Chi-square test of F3 green families breeding true and those segregating for green and golden yellow foliage in a 7:8 ratio.**

| Cross | $F_3$ green families breeding true (NSG) and those segregating (SG) | | $X^2$ | Probability |
|---|---|---|---|---|
| | NSG | SG | (7:8 ratio) | |
| ICG 799 x ICG 10148 | 21 | 19 | 0.540 | 0.538 |
| *ICG 10148 x ICG 799* | *14* | *25* | *1.817* | *0.822* |
| *ICG 2405 x ICG 10148* | *20* | *20* | *0.000* | *0.000* |
| ICG 10148 x ICG 2405 | 15 | 25 | 1.350 | 0.755 |
| ICG 221 x ICG 10148 | 24 | 15 | 3.465 | 0.937 |
| ICG 10148 x ICG 221 | 29 | 19 | 3.641 | 0.944 |
| Total | 123 | 123 | 0.00 | |

The individual segregating $F_3$ plant progenies (derived from green $F_2$ plants) in each cross were subjected to $X^2$ tests for both ratios and were separated to the class showing best fit to either the 15:1 or the 3:1 ratio. Under situations where $X^2$ value was nonsignificant for both the ratios, the best fit was considered to be the ratio that had the least $X^2$ value. Seventy-two $F_3$ progenies gave a good fit to a 15:1 ratio of green versus golden yellow foliage, and 51 progenies to the ratio of 3:1, which did not show significant deviation from a 1:1 ratio of lines segregating into the two categories. $X^2$ values for the above segregating progenies for a 15:1 or a 3:1 ratio ranged from 0.0 to 3.6. The pooled analysis also showed a good fit for the respective ratios, except for cross ICG 10148 x ICG 221, which had less recovery of golden yellow foliage plants.

These results confirm the earlier observation of Tai et al., (1970, 1977) that the golden yellow foliage character is recessive in nature and is controlled by a pair of independent duplicate genes. However, the present study confirms this using larger populations as well as normal parents (not mutants). The golden yellow foliage trait as such may not have practical significance in applied plant breeding because the yield potential of the mutant is inherently low due to its lack of chlorophyll pigmentation. But it may have a limited use as a marker trait in genetic studies because of its recessive nature.

## LITERATURE CITED

STONE, E.G. (1968). Genetic, agronomic, botanical, physical, chemical, and organoleptic evaluation of peanuts, *Arachis hypogaea* L., Ph.D. Thesis, Oklahoma State University, Stillwater.

TAI, Y.P., KIRBY, J.S. and MATLOCK, R.S. (1970). Chlorophyll mutations in peanuts, *Arachis hypogaea* L. II. Genetic analysis Agron. Abstrs., Amer. Soc. Agron. P.21 (Abstr).

TAI, Y.P., HAMMONS, R.O., and MATLOCK, R.S. (1977). Genetic relationships among three chlorophyll-deficient mutants in peanut. *Arachis hypogaea* L. Theor. Appl. Genet. 50 : 35-40

YATES, F. (1934). Contingency tables involving small numbers and the $X^2$ test .J Roy, Soc. Suppli 1:2 17-235.

J.Oilseeds Res. 7 (990) 36-41
*ISSN* 0970—2776.

# *IN VIVO* AND *IN VITRO* SCREENING OF GERMPLASM AGAINST SESAME LEAF ROLLER AND POD BORER

R.K. MURALI BASKARAN, N.R. MAHADEVAN, P. SRIDHAR, G. KANDASAMY and S. THANGAVELU
Regional Research Station, Vridhachalam 606 001, Tamil Nadu.

ABSTRACT

Twenty promising less susceptible sesame entries and one wild species were screened against sesame leaf roller and pod borer *in vivo* and *in vitro* and compared with five local varieties. In *in vivo* condition, twelve entries viz., SI 1004, SI 1029, SI 3315/11, SI 3315/6, SI 53, SI 882, 020-3-1, 59-1-1, PDK 31, SI 889, SI 990 and SI 964 were moderately resistant with grade 5, however, only seven entries viz., SI 3315/11, SI 53, SI 882, 59-1-1, PDK 31 SI 889, and SI 990 were identified as moderately resistant in *in vitro* condition. The wild species, *Sesamum alatum* and two entries viz., ES 22 and SI 250 were highly resistant with grade 1 and 3 respectively under both conditions.

**Key words** : Sesame germplasm; wild species; leaf roller; pod borer.

## INTRODUCTION

Sesame leaf roller and pod borer, *Antigastra catalaunalis* Duphonchel (*Pyraustidae : Lepidoptere*) is considered to be the most destructive pest and has been causing considerable damage to the crop (Abraham *et al.*, 1977). This pest during its larval stage damages the leaves, buds, flowers and pods till harvest of the crop (Mahadevan and Mohanasundaram, 1986). Murali Baskaran *et al.* (1989) screened 1200 sesame entries against leaf roller under field condition and reported 16 entries as field resistant. In the present investigation, 20 promising less susceptible sesame entries reported earlier by Mahadevan (1988), one wild species, *S.alatum* and five local varieties were screened in *in vivo* and *in vitro* conditions.

## MATERIALS AND METHODS

The experiment was conducted in *in vivo* condition at Regional Research Station, Vridhachalam during 1988 rainy season. The germplasm tested were SI 935, SI 1004, SI 1029, SI 1671, SI 3315/11, SI 3315/6, SI 53, SI 882, SI 1002, 020-3-1, 59-1-1, PDK 31, SI 889, SI 990, SI 75, SI 964, SI 968, SI 953, SI 250 and ES 22 as compared with *S. alatum* and five local varieties viz., TMV 3, TMV 4, TMV 5, TMV 6 and CO 1. Each entry was raised in a single row of 4 m length with 15 cm between plants and replicated thrice in Randomized block design. The percent leaf damage was recorded on 45 DAS by counting number of affected leaves to the total number of leaves (Anon., 1987). At 70 DAS, the per cent internal content of capsule fed by larva was observed in 20 capsules randomly collceted from each entry. The intensity of feeding on capsule was quantified as per the method given below.

Received on November 18, 1989.

| Number of locule fed by larva | % |
|---|---|
| 1 | 25 |
| 2 | 50 |
| 3 | 75 |
| 4 | 100 |

In the case of multilocular capsule, whole capsule was considered as 100 per cent and percentage of damage was given accordingly. Based on two types of data collected, score was given to categorise germplasm entries into either resistant or susceptible. The method of scoring is given below.

| Score | % leaf damage | % internal content of capsule fed |
|---|---|---|
| 1 | 0.0—10 | 0.0—5 |
| 3 | 0.1—20 | 5.1—10 |
| 5 | 20.1—30 | 10.1—15 |
| 7 | 30.1—40 | 15.1—20 |
| 9 | >40 | >20 |

$$\text{Cumulative score} = \frac{a + b}{2}$$

where, a = corresponding score for % leaf damage

b = corresponding score for % internal content of capsule fed

| Cumulative score | Grade | Mechanism |
|---|---|---|
| 0—1 | 1 | Highly resistant (HR) |
| >1—3 | 3 | Resistant (R) |
| >3—5 | 5 | Moderately resistant (MR) |
| >5—7 | 7 | Susceptible (S) |
| >7—9 | 9 | Highly susceptible (HS) |

In *in vitro* condition, each entry was grown individually in a separate pot during 1988 cold weather season and replicated thrice. Two day old laboratory cultured leaf roller larvae were artificially inoculated two times on 30 and 60 DAS at the rate of one larva per plant. A week after first inoculation and fifteen days after second inoculation, the percent leaf damage and the internal content of capsule fed by larva were recorded respectively and the degree of resistance of each entry was calculated as per the above said method.

## RESULTS AND DISCUSSION

The data on the reaction of different germplasms to sesame leaf roller and pod borer in *in vivo* and *in vitro* are given in Table, 1 and 2 respectively. In *in vivo* condition, *S. alatum* was highly resistant to this pest with grade 1 followed by ES 22 and SI

**TABLE 1.** ***In vivo*** **screening of germplasm against** *A. catalaunalis*

| Entry | Leaf damage* (%) | Internal content of capsule fed* (%) | Grade | Remark |
|---|---|---|---|---|
| SI 935 | 40.0 (39.15) | 10.3 (17.13) | 7 | S |
| SI 1004 | 30.0 (33.00) | 14.3 (21.83) | 5 | MR |
| SI 1029 | 33.3 (35.22) | 8.6 (17.14) | 5 | MR |
| SI 1671 | 40.0 (39.23) | 10.5 (17.56) | 7 | S |
| SI 3315/11 | 24.7 (28.52) | 8.2 (15.88) | 5 | MR |
| SI 3315/6 | 28.3 (31.91) | 12.4 (20.04) | 5 | MR |
| SI 53 | 23.5 (28.94) | 11.8 (19.83) | 5 | MR |
| SI 882 | 27.8 (30.58) | 9.3 (17.33) | 5 | MR |
| SI 1002 | 66.7 (54.78) | 28.6 (31.11) | 9 | HS |
| 020-3-1 | 22.4 (27.33) | 6.4 (14.09) | 5 | MR |
| 59-1-1 | 33.3 (35.28) | 5.8 (12.33) | 5 | MR |
| PDK 31 | 16.7 (23.85) | 10.4 (18.25) | | MR |
| SI 889 | 30.0 (33.21) | 5.9 (13.73) | 5 | MR |
| SI 990 | 38.0 (37.44) | 6.9 (15.11) | 5 | MR |
| SI 75 | 60.0 (50.77) | 22.2 (27.49) | 9 | HS |
| SI 964 | 30.0 (33.21) | 12.5 (19.76) | 5 | MR |
| SI 968 | 43.3 (41.22) | 6.3 (13.39) | 7 | S |
| SI 953 | 35.3 (35.88) | 19.7 (26.04) | 7 | S |
| ES 22 | 7.4 (15.13) | 6.1 (14.21) | 3 | R |
| SI 250 | 11.4 (18.23) | 5.2 (12.99) | 3 | R |
| *Sesamum alatum* (Wild species) | 6.3 (13.33) | 2.3 ( 8.91) | 1 | HR |
| TMV 4 | 46.7 (43.08) | 14.2 (21.34) | 7 | S |
| TMV 3 | 40.0 (39.23) | 16.6 (23.61) | 7 | S |
| CO 1 | 43.3 (41.15) | 11.8 (19.84) | 7 | S |
| SE (d) | 2.9 | 1.9 | | |
| CD (P = 0.05) | 5.8 | 4.0 | | |

Figures in parentheses are arcsine values
* Mean of three replications

TABLE 2. *In vitro* screening of germplasm against *A. catalaunalis*

| Entry | Leaf damage* (%) | Internal content of capsule fed* (%) | Grade | Remarks |
|---|---|---|---|---|
| SI 935 | 22.1 (27.99) | 22.5 (27.82) | 7 | S |
| SI 1004 | 18.1 (25.07) | 21.0 (27.53) | 7 | S |
| SI 1029 | 20.8 (27.28) | 28.3 (30.93) | 7 | S |
| SI 1671 | 22.2 (28.05) | 24.4 (28.41) | 7 | S |
| SI 3315/11 | 13.6 (21.63) | 11.8 (20.13) | 5 | MR |
| SI 3315/6 | 23.8 (29.01) | 26.1 (29.68) | 7 | S |
| SI 53 | 13.9 (21.04) | 10.5 (18.05) | 5 | MR |
| SI 882 | 15.4 (22.94) | 15.6 (23.11) | 5 | MR |
| SI 1002 | 26.3 (29.84) | 36.1 (35.55) | 7 | S |
| 020-3-1 | 24.2 (29.41) | 22.8 (27.17) | 7 | S |
| 59-1-1 | 16.1 (23.61) | 16.7 (24.43) | 5 | MR |
| PDK 31 | 14.3 (22.10) | 11.9 (19.71) | 5 | MR |
| SI 889 | 14.0 21.94) | 12.5 (20.01) | 5 | MR |
| SI 990 | 15.0 (22.77) | 14.4 (21.24) | 5 | MR |
| SI 75 | 42.6 (40.43) | 20.6 (25.10) | 9 | HS |
| SI 964 | 26.3 (30.61) | 23.8 (29.39) | 7 | S |
| SI 968 | 43.0 (40.74) | 28.2 (31.82) | 9 | HS |
| SI 953 | 19.1 (25.46) | 24.4 (28.60) | 7 | S |
| ES 22 | 10.8 (19.19) | 4.3 (11.12) | 3 | R |
| SI 250 | 11.1 (19.46) | 5.9 (13.88) | 3 | R |
| *Sesamum alatu* (wld species) | 6.1 (14.30) | 0.9 ( 5.03) | 1 | HR |
| TMV 3 | 29.9 (33.11) | 31.9 (33.76) | 7 | S |
| TMV 4 | 28.6 (33.14) | 32.1 (34.18) | 7 | S |
| TMV 5 | 27.9 (31.92) | 38.8 (37.48) | 7 | S |
| TMV 6 | 28.7 (32.38) | 32.7 (34.51) | 7 | S |
| COI | 21.5 (27.11) | 17.3 (23.35) | 7 | S |
| SE d) | 4.3 | 2.4 | | |
| CD (P=0.05) | 8.7 | 4.8 | | |

Figures in parentheses are aresine values
* Mean of three replications

250 which were resistant with grade 3, also reported by Mahadevan (1988) and Murali Baskaran and Mahadevan (1989). The entries viz., SI 1004, SI 1029, SI 3315/11, SI 3315/6, SI 53, SI 882, 020-3-1, 59-1-1, PDK 31, SI 889, SI 990 and SI 964 were moderately resistant with grade 5 and the leaf damage ranged from 16.7 per cent (PDK 31) to 33.3 per cent (59-1-15 and SI 1029). SI 1002 and SI 75 were highly susceptible with grade 9 while local varieties were susceptible to this pest with grade 7 and recorded more than 40 per cent leaf damage. In *in vitro* condition, the lowest per cent leaf damage was recorded in *S. alatum* (6.1%) followed by ES 22 (10.8%), SI 250 (11.1%), SI 3315/11 (13.6%), SI 53 (13.9%), SI 889 (14.00), PDK 31 (14.3%), SI 990 15.0%) and SI 882 (15.4%) which were at par with each other. The leaf damage ranged from 18 to 26 per cent in SI 935, SI 1004, SI 1029, SI 1671, SI 3315/6, SI 1002, SI 020-3-1 and SI 964 which were at par with check varieties while the highest leaf damage of around 40 per cent was recorded in SI 75 and SI 968.

The pod borer larva did not prefer the internal content of capsule of *S. alatum* and caused only the minimum damage of 0.9 per cent which was significantly different from other entries. The entries also showed ES 22 (4.3%) and SI 250 (5.9%) less damage. The larva just nibbled the capsule and stopped the feeding indicated the presence of non preference factor in these entries while the susceptibility was observed to be more in local varieties recording more than 20 per cent damage. The entries viz., SI 3315/11, SI 53, SI 882, PDK 31, SI 889 and SI 990 were less susceptible to pod borer, ranging from 10.5 per cent (SI 53) to 15.6 per cent (SI 882). Among the germplasm entries, SI 1002 was highly susceptible with 36.1 per cent pod borer damage.

The wild species, *S. alatum* was highly resistant to sesame leaf roller and pod borer with grade 1 while SI 75 and SI 968 were highly susceptible with grade 9. The entries followed the wild species were ES 22 and SI 250 which were resistant to this pest with grade 3. Seven entries viz., SI 3315/11, SI 53, SI 882, SI 59-1-1, PDK 31, SI 889 and SI 990 were moderately resistant with grade 5 while the grade 7 was recorded in SI 935, SI 1004, SI 1029, SI 1671, SI 3315/6, SI 1002, SI 020-3-1, SI 964, SI 953, TMV 3, TMV 4, TMV 5, TMV 6 and CO 1 which were susceptible to this pest.

A perusal of the data indicated that *S. alatum*, ES 22 and SI 250 were resistant to sesame leaf roller and pod borer under both conditions. The narrow leaf blade of *S. alatum* prevented the webbing activity of this pest which is one of the factors for resistance. In some cases, the germplasms which proved moderately resistant in *in vivo* condition proved susceptible in *in vitro* condition. SI 1004, 1029, SI 3315/6, 020-3-1 and SI 990 which were moderately resistant under field condition were found to be susceptible under laboratory condition while SI 75 was highly susceptible to this pest under both conditions.

**ACKNOWLEDGEMENT**

Authors are grateful to Indian Council of **Agricultural Research for financial** assistance to conduct this investigation.

## LITRATURE CITED

ABRAHAM, E.V., NATARAJAN, K. and MURUGESAN, M., 1977. Damage by pests and phyllody to sesame in relation to time of sowing. *Madras agric. J.*, 64 : 298-301.

ANONYMOUS, 1987 Proceedings for technical programme, kharif 1987-88. Directorate of Oilseeds Research, Rajendranagar, Hyderabad.

MAHADEVAN, N.R. 1988. Screening of sesamum entries for resistance to leaf webber, *Antigastra catalaunalis* Duphonchel, *Madras agric.* J., 75 (5-6): 224

MAHADEVAN, N.R. and MOHANASUNDARAM, M., 1986. Field evaluation of insecticides for their efficicacy in the control of sesamum of leaf webber and gall midge. *Oil Crops Newsletter*, 3: 47-48.

MURALI BASKARAN, R.K. and MAHADEVAN, R.N.,R 1989. Reaction of wild species to seaseme shoot webber and pod borer, *PRI Newsletter*, 15 : 55.

MURALI BASKARAN, R.K., MAHADEVAN, N.R. and GANESH, S.K., 1989. Resistance to major pests of sesame, *PNI Newsletter*. 15 : 54.

J. Oilseeds Res. 7(1990) 42-46
*ISSN* 0970-2776

# SUNFLOWER —PIGEONPEA INTERCROPPING AS INSURANCE AGAINST UNPREDICTABLE MONSOON SITUATIONS ON DRYLANDS

N. VENUGOPAL, K.T. PUTTARANGASWAMY AND K. SEENAPPA
Peoject Co-ordinating Unit (Sunflower) U.A.S., GKVK, Bangalore-560065.

**ABSTRACT**

A field experiment on Pigeonpea intercropping in the altered stand geometry of sunflower was conducted to study the productivity and economics under rainfed conditions during Kharif 1987-88 and 1988-89 at Gandhi Krishi Vignana Kendea, University of Agricultural Sciences, Bangalore. In 1987-88, low rainfall during preflowering stages coupled with persistant showers during flowering and post flowering stages affected pollination, seed setting and drastically reduced the sunflower yields. The same late rains helped the component crop of Pigeonpea. The 1988-89 rainfall was low in the late growth stages and as such Pigeonpea suffered due to drought. However, the benefit-cost ratio in the inter-cropping system of Pigeonpea with paired row planting of sunflower (45/105 × 24 cm) was on par with that of sole Pigeonpea and sole sunflower during 1987-88 and 1988-89 in which years, the monsoon distributions were favourable to Pigeonpea and sunflower respectively. The pooled mean yield data indicated that both the intercropping systems i.e. Pigeonpea as an intercrop with paired row planting of sunflower and in alternate rows with sunflower recorded higher land equivalent ratios of 1.22 and 1.34 respectively. Thus, the intercropping system recorded higher LER values and served as some sort of insurance against total failure under unpredictable distribution of monsoon situations.

## INTRODUCTION

Karnataka accounts for 40 percent of sunflower acreage and production in India. Sunflower has been projected mainly as a *Kharif* season rainfed oilseed crop and is normally grown as sole crop. In view of remunerative prices for pulses in general, sole cropping of Pigeonpea as rainfed crop during *Kharif* is also gaining popularity in Southern parts of Karnataka. Usually the regions in and around Bangalore district receive late rains during November-December due to the development of low pressure in Arabian sea near Tamilnadu. At the flowering and fruiting stages, Pigeonpea crop sown in July normally gets the benefit of these late showers. More often these areas are charcaterised by scanty ill distributed rainfall. The drought during seedling stage of sunflower and post flowering period of Pigeonpea adversely affects the performance of these crops under dryland situations. Documentary evidences indicate that in many situations intercropping may facilitate a more efficient use of available moisture (Forhan, 1983). To safeguard the sunflower growing farmers' interest in the years of unfavourable rainfall distribution situations and to sustain their interest in this new promising oilseed crop, inter-cropping of other crops wth sunflower may be one of the possible soultions. A few studies of intercropping pulses like cowpea and green gram at Jodhpur (Singh and Singh, 1977), green gram and cluster bean at Hissar (Narwal and Malik, 1986) green gram cluster bean at Hisar (Narwal and Malik, 1986) and black gram at Belgaum (Umapathy *et al.*, 1910) with sunflower gave higher production and more returns over the respective sole crops. But studies on sunflower + pigeonpea intercropping are lacking.. With these objectives in view, an experiment on Sunflower + pigeonpea

Received for publication on Aug. 2, 1989.

intercropping in the altered stand geometry of sunflower as insurance against unpredictable monsoon situations of dryland was conducted to study the productivity and economics in situations of rainfall distribution both favourable and unfavourable to sunflower.

## MATERIAL AND METHODS

Field experiments were conducted at the University of Agricultural Sciences, GKVK, Bangalore, under rainfed conditions of Kharif 1987 and 1988 in FRBD with three replications on red loam soil. The cropping systems included were sole sunflower (variety KBSH-1) at 3 stand geometres viz., 60×30 cm, 75×24 cm and 45/105 ×24 cm and sole pigeonpea (variety TTB-7 )at 60×30 cm. The two intercropping systems consisted of growing sunflower in paired rows of 45/105 × 24 cm with a row of pigeonpea in the inter-paired space and sunflower at 75×24 cm with a row of pigeonpea between two sunflower rows. Both the systems of intercropping were repeated with additional fertilizer dose for pigeonpea. The fertilizer doses adopted per hectare were 40-50-40 and 25-50-25 kg of N, $P_2O_5$ and $K_2O$ for sunflower and pigeonpea respectively. The N was given in two equal splits. to sunflower and the entire N at basal dose itself to pigeonpea. The second split of N was given as top dressing to a month old crop. The crops were given routine cultural operations and necessary plant protection measures. The plot size adopted was $6 \times 3.6m = 21.6$ m$^2$. The crops were sown on the 5th and 8th August during 1987 and 1988 respectively.

## RESULTS AND DISCUSSIONS

The data on rainfall distribution along with number of rainy days during different crop growth periods in respect of sunflower for the years 1987-88 and 1988-89 are given in Table 1. The rainfall distribution of 1987-88 was favourable to Pigeonpea but not favourable to sunflower and the situation was reverse during 1988-89. In addition to low rainfall distribution in all the growth phases of sunflower barring seed filling stage, the number of rainy days during flowering (7) and seed filling (6) were higher in 1987-88 as compared to that of1988-89 (Table 1). The low rainfall during pre-flowering (seedling stage, primordia initiation and grand growth stage) coupled with more number of rainy days during flowering affected pollination. The higher number of rainy days during flowerring and post flowering stages (Table 1) resulted in wet weather conditions during flowering and post-flowering phases. The coincidence of rains and wet weather conditions during flowering and post flowering phases of sunflower crop has been reported to affect seed setting and result in low yields (Anon. 1989). In the same year of 1987-88, the pigeonpea crop which was in flowering stage at the time of harvest of sunflower crop was benefited by late rains due to depression during Nov. 5 to Dec. 9 Hence, the seed yield, net returns and benefit-cost ratio obtained during 1987-88 was the highest with sole pigeonpea, lowest with sole sunflower and intermediate with intercropping systems (Tables 2 and 3). The benefit-cost ratio of 1.35 observed in paired row intercropping was on par with that of sole pigeonpea (1.52).

In contrast to this, in the year 1988-89 which was a favourable year to sunflower and unfavourable to pigeonpea, the highest seed yield, net returns and benefit-cost ratio

**TABLE 1 Weekly rainfall and number of rainy days during various crop growth phases of sunflower**

| Growth phases | 1987-88 Rainfall (mm) | 1987-88 No.*of Rainy days | 1988-89 Rainfall (mm) | 1988-89 No.*of rainy days |
|---|---|---|---|---|
| 1. Seedling: I 4 weeks (28 days) | 58.6 | 7 | 161.4 | 14 |
| 2. Primordial Initiation: V week (29 to 35 days) | 21.2 | 1 | 64.8 | 3 |
| 3. Grand growth : VI and VII weeks (36 to 49 days) | 105.8 | 5 | 314.2 | 7 |
| Preflowering : total | 185.6 | 13 | 540.4 | 24 |
| 4. Flowering : VIII and IX weeks (50 to 63 dabs) | 98.7 | 7 | 125.7 | 4 |
| 5. Seed filling X to XIV weeks (64 to 98 days) | 76.4 | 6 | 22.9 | 3 |
| Post flowering: Total | 175.1 | 13 | 148.6 | 7 |

* A rainfall of more than 2.5 mm/day is considered for counting as a rainy day.

**TABLE 2 Influence of Pigeonpea as an inter crop in the altered stand geometry of sunflower on the productivity.**

| Treatments | Seed yield (Kg/ha) | | | | | |
|---|---|---|---|---|---|---|
| | Sunflower | | | Pigeonpea | | |
| | 1987 | 1988 | Pooled mean | 1987 | 1988 | Pooled mean |
| *Sole cropping* | | | | | | |
| 1. Sunflower (60×30 cm) | 374 | 1070 | 723 | — | — | — |
| 2. Sunflower (75×24 cm) | 315 | 801 | 558 | — | — | — |
| 3. Sunflower (45/105×24 cm) | 399 | 842 | 621 | — | — | — |
| 4. Pigeonpea (60×30 cm) | — | — | — | 798 | 289 | 544 |
| *Inter cropping Pigeonpea (PP) with sunflower (SF)* | | | | | | |
| 5. As Tr. 3+PP in inter paired space | 303 | 833 | 568 | 275 | 56 | 166 |
| 6. As Tr. 5+Additional fertilizer for PP | 267 | 903 | 585 | 328 | 321 | 325 |
| 7. As Tr. 2+PP in between SF rows | 309 | 723 | 516 | 296 | 142 | 219 |
| 8. As Tr. 7+Additional fertilizer for PP | 313 | 909 | 611 | 329 | 107 | 218 |
| C.D. (P = 0.05) | 64 | NS | NS | 116 | 169 | 236 |
| Note. Tr = Treatment | | | | | | |
| C.V. (%) | 11 | 13 | 18 | 15 | 49 | 38 |

**TABLE 3 Economics of inter cropping system of Pigeonpea as an inter crop in the altered stand geometry of sunflower**

| | Treatments | Cost of cultivation (Rs/ha) | Net returns (Rs/ha) | | Cost benefit ratio | | |
|---|---|---|---|---|---|---|---|
| | | | 1987 | 1988 | 1987 | 1988 | Pooled mean |
| | *Sole cropping* | | | | | | |
| 1. | Sunflower (60×30 cm) | 2716 | 92 | 5314 | 1.03 | 2.96 | 2.00 |
| 2. | Sunflower (75×24 cm) | 2716 | -346 | 3292 | 0.87 | 2.21 | 1.54 |
| 3. | Sunflower (45/105×24 cm) | 2716 | 279 | 3597 | 1.10 | 2.32 | 1.71 |
| 4. | Pigeonpea (60×30 cm) | 3150 | 1636 | -1416 | 1.52 | 0.55 | 1.04 |
| | *Inter cropping piegeonpea (PP) with Sunflower (SF)* | | | | | | |
| 5. | As Tr.3+PP in inter paired space | 2894 | 1024 | 3692 | 1.35 | 2.28 | 1.82 |
| 6. | As Tr.5+Additional fertilizer for PP | 3376 | 597 | 5322 | 1.18 | 2.58 | 1.88 |
| 7. | As Tr.2+PP in between SF rows | 3145 | 948 | 3125 | 1.30 | 1.99 | 1.65 |
| 8. | As Tr.7+Additional fertilizer Ior PP | 3627 | 692 | 3833 | 1.19 | 2.06 | 1.63 |
| | C.D. (P = 0.05) | — | — | — | 0.21 | 0.56 | 0.28 |
| | C.V. (%) | — | — | — | 9.97 | 15.22 | 14.20 |

Note. Tr. = Treatment

*Economics based on selling rates of sunflower seed @ Rs.750/Qtl and Piegonpea @ Rs.600/Qtl.*

were obtained with sole croppng of sunflower at 60×30 cm planting geomentry and lowest with sole pigeonpea and intercropping treatments ranged between these two sole croppings. Non-receipt ot late rains (Nob. 5 to Dec. 9) after the harvest of sunflower crop when flowering commenced in pigeonpea reulted the failure of pigeonpea. The beenfit-cost ratio of 2.96 obtained with sole sunflower was on par with that ot paired row inter-cropping treatment receiving additional fertilizer dose for pigeonpea (2.58). The pooled analysis showed non-significant differences in seed yields of Sunflower among treatments but sole sunflower at 60×30 cm stand geometry recorded the highest benefit cost ratio of 2.00 which was on par with that ot the intercropping treatments under paired row system of planting (1.82 and 1.88 without and with additional fertilizer dose for pigeonpea respectively). The studies at Hyderabad by CRIDA showed higher returns and LER values with one row of sunflower in 90 cm pigeonpea rows and two rows of sunflower in 120 cm pigeonpea rows (Anno., 1987). Intercropping of short duration pulses with sunflower conducted at other places in India (Singh and Singh, 1977), Umapathy *et al.*, 1980 and Narwal and Malik (1986) also revealed higher production and more returns over sole crops.

The results of present investigation clearly indicated that intercropping pigeonpea in paired rows of sunflower (45/105 × 24 cm) will serve as some sort of insurance

aganst total failure under umpredictable monsoon situations to sustain interest in the new promising oilseed crop of sunflower.

## ACKNOWLEDGEMENT

The authors are thankful to Dr. A. Seetharam, In-Charge Project Co-ordinator (Sunflower), University of Agricultural Sciences, GKVK, Bangalore, for his valuable comments and suggestions during the preparation ot this research article.

## LITERATURE CITED

ANONYMOUS, 1987, Annual Report, CRIDA, Hyderabad, PP. 16-17.

ANONYMOUS, 1989, Annual Peogress Report, 1988, DOR, Hyderabad.

NARWAL, S.S. and MALIK, D.S., 1986, Effect of intercropping on the growth and yield of rainfed legumes, *Intern, J. Trop.Agril.*,4: sunflower and companion 55-62.

NARWAL, S S and MALIK, D S , 1986, Effect of intercropping on thergrowth and yield of rainfed sunflower and companon legumes, *Intern. J. Trop. Agril.* 4: 55-62

SINGH, K.C. and SINGH, R.P , 1977, Intercropping of annual grain legumes with sunflower. *Indian J. agric. Sc.*, 47:563-7.

UMAPATHY P.N., KRISHNE GOWDA, K.T and VENKATARAMU, M N , 1980, Inter-cropping. in sunflower with groundnut, blackgram and greengram, *Curr. Res.* 9:78-80.

J. Oilseeds Res. 7 (1990):47-55
*ISSN* 0970-2776

# BIOCHEMICAL QUALITY OF OILSEEDS

G. NAGARAJ
Directorate of Oilseeds Reserach, Rajendranagar, Hyderabad-500 030,

ABSTRACT

Oilseeds are important sources of energy and nutrition. Groundnut, rapeseed-mustard, safflower, sesame, sunflower, niger, castor and linseed are the major oilseed crops of India. The composition and quality of the oilseeds vary with respect tp genotype, season, location and other growth factors. Oil quality mainly depends on its fatty acid make up. Oleic and linoleic acids are the most important fatty acids of the vegetable oils. Rapesseed-mustard contains erucic acid while ricinoloie and linoleinc acids are the main components of castor and nseed oils. Similarly amin acid composition and the levels of antinutritional factors determine the quality of oil-cakes. Aflatoxins are associated with groundnut and its cake. The paper reviews research work carried out in India over the past decade on the quality of oilseeds and their products.

**Key words** Oil, Protein, Fathyacids

## INTRODUCTION

Oilseeds are the major sources of commercially useful oils. Groundnut Rapeseed-Mustard, Sunflower, Sesame and Niger are the most important edible oilseed crops of India. Castor and Linseed are the major sources of industrial oil. Oil seeds also contain valuable proteins. Hence, they play an important role in releiving the malnutrition and calorie nutrition of the country. In addition, they serve as good sources of vitamins and minerals. In view of all these factors a good amount of research work has been carried out in India on the production of quality oilseeds. The following is an account of the research work carried out during the last decade. The present review is restricted to the following crops namely, groundnut, rapeseed-mustard, sunflower, safflower, sesame, niger, castor and linseed.

### Groundnut:

Groundnuts as they are produced have an outer, thick woody shell. Inside it are embedded 2 or 3 seeds (kernel). The seed consists of two cotyledons and a germ with an outer, thin skin called testa. Groundnut kernel can be eaten raw or roasted. It satisfies the palate of many people due to its good taste and flavour properties.

There are four botanical types of groundnut under cultivation. They are virginia runner, virginia bunch, valencia and spanish bunch. They differ with respect to their chemical composition and oil quality (Table1.) Virginia bunch group was rich in oil and energy content followed by spanish bunch (Nagaraj, 1988a). Protein content was higher among valencias, while soluble sugars higher in virginia runner. Oleic acid was highest in valencias. With respect to oil keeping quality (Oleic/linoleic ratio) runner type was better while valencias possessed a higher nutritional quality index (linoleic/saturated fatty acids). Hence virginia runners have been considered to be better wth respect to their oil quality.

Oil content was higher (48%) in seeds of size 7 to 9mm diameter (Misra and Gaur, 1982). Seed size has also been reported to have correlation with lipids and oleic acid (Raheja *et al.*, 1986). The seed characteristics, composition and quality of some

Received on Nov. 10, 1989.

varieties of groundnut have also been studied and reported (Badami *et al*, 1979, Gupta *et al.*, 1982b). Some varieties with higher oil contents of 52-56% have been identified and reported (Nagaraj *et al.*, 1986).

**TABLE 1**
**Composition and oil quality of groundnut genotypes**

| *Character* | Virginia runner | Virginia bunch | Valencia | Spanish bunch |
|---|---|---|---|---|
| *Whole Seed* | | | | |
| Oil % | 47.2 | 51.4 | 47.2 | 48.7 |
| Protein % | 23.6 | 23.0 | 23.7 | 22.9 |
| *Soluble Sugars* % | 11.6 | 9.8 | 7.9 | 9.8 |
| Energy Value (J/100g) | 2646 | 2708 | 2645 | 2676 |
| *Oil Quality* | | | | |
| Palmitic (16:0) % | 12.6 | 13.1 | 13.3 | 14.3 |
| Stearic (18:0) % | 2.7 | 2.9 | 2.2 | 4.3 |
| Arachidic (20:0) % | 1.6 | 1.4 | 1.5 | 1.6 |
| Behenic (22:0) % | 0.9 | 0.8 | 0.9 | 0.9 |
| Oleic (18:1) % | 49.7 | 47.6 | 46.1 | 44.7 |
| Linoleic (18:2) % | 31.6 | 34.0 | 35.9 | 34.7 |
| Iodine Value (I.V.) | 96.2 | 95.4 | 98.4 | 96.3 |
| Oil stability index (18:1/18:2) | 1.6 | 1.5 | 1.1 | 1.3 |
| Nutritional quality index (18:2/Sat. fatty acids) | 2.1 | 2.2 | 2.4 | 1.8 |

Fatty acid composition of groundnut varieties has been studied in detail by many workers. (Badami *et al.*, 1978, Badami *et al*, 1979, Nagaraj, 1986, Skhon *et al*, 1980). In general, Virginia runner had 10% more oleic acd than spanish bunch varieties. However, the spanish bunch varieties contained 8-10% more linoleic acid. Oleic acid concentration was negatively correlated with that of linoleic acid suggesting that selection of genotypes in each group with improved industrial or nutritional qualities would be feasible (Raheja *et al.*, 1987).

The effect of irrigation on the yield, seed composition and fatty acid composition has also been studied under the AICORPO at Ludhiana (Table 2). Two irrigations, one each at pegging and pod development increased the oil content and also improved the nutritional quality of oil. However, the quality was better when the irrigations were given at flowering and pod developmental stages.

TABLE 2

**Effect of irrigation on pod yield and oil quality in groundnut**

| Irrigation (Stage) | Pod Yield (kg/ha) | Shelling % | Oil % | Oil Stability | Nutritional quality |
|---|---|---|---|---|---|
| *No irrigation* | *1009* | *73.9* | *51.3* | *1.98* | *1.63* |
| One irrigation (Pegging) | 1037 | 66.4 | 51.8 | 2.27 | 1.54 |
| Two irrigation (Pegging and Pod development) | 1000 | 64.6 | 52.0 | 2.16 | 1.63 |
| Two irrigations (Flowering and pegging) | 963 | 65.2 | 51.3 | 2.32 | 1.54 |
| Two irrigations (Flowering and pod development) | 920 | 63.9 | 51.5 | 2.38 | 1.42 |
| *Three irrigations (Flowering, pegging and pod development)* | *981* | *64.1* | *51.3* | *2.19* | *1.57* |

*Source:* AICRPO 1985a.

Some simpler methods for estimation of oil content in groundnut have been developed and reported. These include a butyrometric method (Shukla *et al.*, 1980) and NMR methods (Jambunathan *et al.*, 1985, Sagare and Naphade 1983). Summer groundnut was good for higher oil yield and also better oil quality. However the summer groundnut contained lower level of sugars and proteins (Nagaraj and Sheela Chauhan, 1987). Harvesting of bunch varieties at 122 days after sowing in summer gave higher oil yields (Nagaraj *et al*, 1987).

There was no deterioration in the quality of raw oil when stored at ambient temperatures for 660 days (Yousuf Ali Khan *et al*, 1979). In a similar study, oil stored in amber coloured bottles for 18 months did not show marked changes in the physico-chemical characteristics (Nasirullah *et al*, 1983). The quality also did not deteriorate after deep fat frying for 10 hrs (Nataraja murthy and Lakshminarayana, 1979).

### Aflatoxins in groundnut

Aflaxotin contamination is a serious quality problem in groundnut as it is a good substrate for the growth of *Asperuillus flavus*, the casual organism. Exports of hand picked seed (HPS) and the groundnut cake/meal have suffered a serious blow due to the problem of aflatoxins. Hence, research on aflatoxins has received a tremendous importance. This topic has been reviewed extensively (Ghewande *et al*, 1987, Basappa, 1983, Mehan, 1985, Mehan and Mc Donald, 1984). Aflatoxin estimation by dialysis has been developed and reported (Basappa *et al*, 1977). Among the different methods examined, the Pon's method has been considered to be more convenient for handling large number of samples (Mehan *et al*, 1985).

The effect of genotype and location on the aflatoxin contamination has been studied in detail (Nagaraj and Kailash Kumar, 1986). Certain locations like Jalgaon

and Khargoan and varieties like Karad-4-11 and Kadiri-1 were observed to have lower levels of natural aflaxotin contamination. Further, varieties which had more than 3% testa phenols generally contained lesser natural contamination of aflaxotins. Nearly 66.7% of oil and oil cake samples in Hapur market of Uttar Pradesh contained 1135-2250 ppb of aflatoxins. However, refined oil and vanaspati were free from contamination (Pal *et al*, 1979). Growth of *A. flavus* and the production of aflatoxins were found to be less in J-11 variety when treated with asafoetida followed by black rock salt and propionic acid (Ghewande and Nagaraj, 1987). Varieties favouring lesser aflatoxin production under artificial inoculation have been reported. These are RSB-87,TMV12, TMV-7, S-230 and KRG-1 (Ghewande *et al*, 1986). Work on detoxification and control of aflatoxins have also been carried out. Exposure to sunlight (14 hr) and Urea spray (20% Urea with 2% soyaflour) reduced 50-70% of the aflatoxins B-1 (Shanta *et al* 1986). Exposure to burning cowdung fumes also have been reported to reduce the toxins on the seeds by 15-25% (Nagaraj and Kailash Kumar, 1985). Groundnut oil could easily be decontaminated to a level of 25 ppb through a process of adsorption cum filtration (Basappa and Sreenivasa Murthy, 1979). Sunlight detoxified oil could easily be stored up to 3 months without any deterioration in quality (Shanta and Sreenivasa Murthy, 1980).

**Rapeseed-Mustard**

Five different rapeseed-mustard species/varieties are grown in India. These are mustard (*Brassica juncea*), toria (*B. campestris*, var *toria*), taramira (*Eruca sativa*), yellow sarson (*B. campestris* var yellow sarson) and brown sarson (*B. campestris* var. brown sarson). Among these *B. juncea* is the most important, covering more than 75% of total area followed by *B. campestris* and *Eruca sativa*. All of them differ in their chemical composition and quality. The range of oil content in some of the varieties is presented in Table3.

TABLE 3

**Oil content of Rapeseed-Mustard**

| Rapeseed-Mustard | Range of Oil |
|---|---|
| Raya | 32.6 – 44.5 |
| Toria | 38.4 – 44.9 |
| Gobhi Sarson | 37.7 – 47.2 |

*Source:* AICORPO, 1984b.

Analysis of breeding material belonging to the three species namely B. *juncea*, *B. napus* and *B. campestris* revealed that strains of *B. juncea*, SM-2, RH-786, RH-8402, RS-92 and DIR-226; *B. napus*, GS-119 GS-124, and GS-203 and *B.campestris*, T-138, T-101 and T-110 had higher oil content of 45-46.1% (AICORPO, 1984b).

TABLE 4

**Composition and characteristics of Rapeseed-Mustatd**

| | Oil | Protein % cake | Ahh % Cake | I.V. | Refractive Index at 40-C |
|---|---|---|---|---|---|
| Toria | 31.2 to 44.4 | 37.3 to 44.2 | 5.4 to 9.0 | 74.1 to 98.4 | 1.4612 to 1.4662 |
| Yellow Sarson | 40.1 to 47.5 | 37.0 to 42.2 | 6.3 to 8.1 | 100.2 to 101.5 | 1.4769 to 1.48.00 |
| Mustard | 32.3 to 40.3 | 38.5 to 42.2 | 6.0 to 7.8 | 100.2 to 101.5 | 1.4604 to 1.4627 |

*Source:* Sarkar and Bhattacharya, 1987.

TABLE 5

**Fatty acid composition of seed oils from some species and selections of cruciferae**

| Species and selections | 16:0 | 18:1 | 18:2 | 18:3 | 20:1 | 22:1 |
|---|---|---|---|---|---|---|
| *B. napus* | | | | | | |
| Cultivars | 3–4 | 8–23 | 11–16 | 6–11 | 6–14 | 41–54 |
| Low 22:1 sel. | 4–5 | 23–40 | 24–31 | 10–15 | 0–19 | 0–11 |
| *B. campestris* | | | | | | |
| Cultivars | 2–3 | 9–34 | 11–18 | 6–12 | 8–12 | 24–61 |
| Low 22:1 sel. | 4–7 | 48–55 | 21–31 | 10–14 | 0–18 | 0 |
| *B. juncea* | 2–4 | 7–22 | 12–24 | 10–15 | 6–14 | 18–49 |

*Source:* Ahuja, 1986.

The composition and characteristics of some of the Indian varieties of rapeseed-mustard have been analysed and reported (Sarkar and Bhattacharya, 1987).

Biochemical aspects like disease and insect resistance, quality and composition of oil, cakes and fatty acid composition of the three species of mustard have also been reported (Ahuja, 1985, Ahuja 1986).

The normal range of erucic acid (22:1) in mustard cultivars has been found to vary from 13.1 to 45.5%. Some lines with low erucic acid (13.1 to 13.9%) have been

identified. They are 24-154, 43-55, 44-56 and 51-64 (AICORPO, 1985b). All these belonged to *B. juncea*. Application of 2:4 D and maleic hydrazide (M.H.) and Incresel decreased the 22:1 levels at Ludhiana. A line containing 35% linoleic acid and only 15% euric acid has also been developed and reported from Ludhiana (Brar, 1980). *B. campestris* varieties had a higher protein content of 19 to 25.4%. *B. juncea* contained lower levels of proteins. In view of this *B. campestris* has been considered to be more nutritional (Gupta *et al*, 1982). Some of the mutants of *B. juncea* had the following composition (Ahuja *t al*, 1984); oil content 37.6 to 43.9%; fatty acids, 16:0, 1.8 to 4.6: 18:1, 8.6 to 17.2; 18:2, 11.8 to 23:1; 18.3, 3:3 to 10.0; 20:1 5.8 to 12.6 and 22:1, 42.8 to 55.6. Negative correlation of other fatty acids with 22:1 has been considered to be useful in breeding varieties for industrial (high 22:1) as well as nutritional purposes (low 22:1). Gambhir *et al*, (1983) and Ahuja *et al*, (1981) have considered that harvesting at yellowish brown and pale yellow stages were good for obtaining higher oil yield and better oil quality.

Protein content of Indian mustard seeds varied from 22-34%. The amino acid composition of mustard varieties have also been analysed and reported (Gupta *et al*, 1982a). *B. campestris* in general and higher levels of protein, crude fibre, lysine and methionine and lower levels of allyl iso-thio cyanates than *B. junea*. Mustard meal contains about 35% carbohydrates with higher levels of frutose and raffinose (Sindhukanya and Kantharaj Urs, 1983).

Mustard contains glucosinolates (1 to 3%) whose hydrolytic products, isothiocyanates, oxalidine thions and nitriles are goitrogenic. The variety RSL41 has been ident fied to contain the lowest level (1.5%) of glucosinolates (Gupta *et al*, 1988). Kantharaj *et al*, (1979) have developed a simple detoxification method. The seeds were subjected to heat treatment followed by water leaching to remove glucosinolates. The seeds were dried and used for oil extraction.

TABLE 6

**Farty acid composition of safflower oil**

| | | | |
|---|---|---|---|
| Oil content | 27–35 | | |
| Unsaponifiable matter | 1.2–1.8% | 18:1% | 6.1 to 7.6 |
| I.V. | 140–147 | 18:2% | 74.9 to 78.4 |
| Saponification equivalent | 270–278 | | |
| 16:0% | 5.0–7.6 | | |
| 18:0% | 1.4–4.8 | | |
| 20:0% | 1.2–3.6 | | |

*Source:* Doulatabad, 1982.

**Safflower:**

Safflower has gained much importance recently due to the highly nutritious oil it contains. The seed of the traditionally grown cultivars contained 48-51% kernel and 52% hull or pericarp. Thin hulled varieties which have been identified recently contained 55 to 70% kernel, with an oil content of 34-35% and 13-17% protein (Kulkarni *et al*, 1985). The physicochemical characteristics of safflower oil has been reported by Vibhakar *et al*' (1981). I.V. = 136 to 146; S.V. 186-196; f.f.a. 0.15 to 1.09; Butyrometric refractive index 62.5 to 64.5 at 40°C. Safflower seed has been reported to contain 14.9% protein, 27.5% oil, 2.0% ash, 3.2% total sugar and 40.6% crude fibre (Latha and Prakash, 1984). The fatty acid composition of some new varieties of safflower has been reported by Doulatabad *et al.*, 1982.

Oil content is governed by additive gene action. It has been suggested that there is scope to isolate high oil lines in the segregating population of safflower in view of high heritability estimates coupled with a fewer number of genes controlling oil content (Vijaya Kumar and Giriraj, 1985). High oil per cent of seed depended on three factors namely, thin hull, high seed content and high oil content of kernel (Sangale *et al*, 1982). Thus to elevate the oil content of Indian varieties, thin, reduced and stripped hull types were utilized in breeding programmes (Ramachandram, 1985). Biparental mating followed by recurrent selection has also been suggested for the simultaneous improvement of seed yield and oil content (Ramachandraam and Goud, 1981).

Normally whole safflower seeds are crushed for expressing oil and the cakes contain large amounts of fibre (2.9 to 4.0%). Such cakes are unfit for human consumption. Kulkarni *et al.*, (1981) have developed some methods to debitter the safflower meal and also protein isolates fit for human consumption. Bitter principle (1 matairesine mono-FD-glucoside) was removed through washing the meal with 70% ethnaol. Safflower meal which was evaluated as poultry feed was also analysed for its P(0.29 to 0.39%). Ca (0.29 to 0.47%), tannin (0.52 to 0.74%) and energy contents (1470 to 3804 K Cal/kg) by Raj *et al.*, (1983).

**Sunflower**

Sunflower which was an ornamental plant earlier has become an important oilseed plant because it contains high quality and digestible oil. The seed generally cotains about 30% hull. The average oil content of the seed is 29-33%. The decorticated seed contains 45 to 55% oil. A thorough screeing of the germplasm revealed the range of oil content to be 41.2 to 55.1% (AICORPO, 1986). APSH-12 and APSH-4 were found to contain a higher oil content of 45.8% (AICORPO, 1984a). The oil content of Peredovik was higher than Sunvik variety in both *Rabi* and spring seasons (Verma *et al.*, 1977). However, in general *Rabi* season was associated with higher oil and spring season with higher iodine value of oil. Sowing from third week of April to third week of May yielded oleic rich oil. Sowing in first week of June yielded lowest oil content (Bhattacharya *et al.*, 1982). The sunflower seed oil grown in India had the characteristics (Kamath *et al.*, 1979) shown in Table 7.

TABLE 7

Some characteristics of sunflower oil

| | |
|---|---|
| Specific gravity | 0.9109 – 0.9187 |
| Refractive index 40°C | 1.4636 — 1.4681 |
| Colour (Y + R5) | 1.0 to 12.7 |
| Acid value | 0.7 to 2.5 |
| Iodine value | 101.4 to 135.0 |
| Saponification value | 1.93 to 2.00 |
| Unsaponifiables | 0.20 to 1.93 |

*Source:* Kamath *et al.*, (1979)

The oil had an oleic acid content of 42-57% and a linoleic acid content of 33–48% (Chakraborty *et al.*, 1979). The influence of irrigation and temperature during seed maturation on oil quality has been examined by Afzalpurkar and Lakshminarayana (1980a). Variation in oil content and quality depending upon the shape and size of sunflower heads has also been reported by Afzalpurkar and Lakshminarayana (1980b) Oil extracted from rainfed crop had a better keeping quality than that of irrigated one (Balasaraswathi and Raj, 1983). Thr oil quality did not deteriorate up to 700 days of storage at ambient temperature (Yousuf Ali Khan *et al.*, 1979). The oil from the dehulled seeds could be stored for longer periods (Thayumanavan, 1981).

The defatted seed contained 48.5 to 49.3% proteins (Rahma and Narsing Rao 1981).

**Antinutritional constituents:**

Haemagglutinin activity ranged from 50.6 to 132.8 units/mg of protein. The highest activity 132.8 units was noticed in CMS 234. The phenol content ranged from 2.6 to 3.8%. There was no significant variation in oil content between varieties and hybrids. However, hybrids contained lower levels of phenols (AICORPO, 1986). Phenols are undesirable since they effect discolouration of proteins. Changes in the chlorogenic, caffeic and quinic acids during maturation has been reported by Afzalpurkar and Lakshminarayana (1981). Rahma and Narsing Rao (1981) have also developed some methods to remove phenols.

**Sesame**

Sesame is the oldest oil seed crop with good quality oil and oil cake. Sesame seed and oil have been analysed for their composition. The seed contained 38–41% oil. The oil had an I.V. of 96 to 112, refractive index 1.4598 to 1.4667 (Sarkar and Bhattacharya, 1987). 35 Varieties have been analysed for oil (32–68%) and protein

TABLE 8

**Oil quality characteristics of sesamum**

| | | | |
|---|---|---|---|
| Oil % | 48.8 | to | 49.1 |
| Refractive index 25oC | 1.4760 | to | 1.4770 |
| Acid value | 1.1 | to | 2.2 |
| I.V. | 103.6 | to | 112.8 |
| S.V. | 188.6 | to | 191.2 |
| Unsaponifiables % | 1.4 | to | 2.5 |
| Palmitic acid % | 8.4 | to | 11.9 |
| Stearic acid % | 3.5 | to | 7.9 |
| Arachidic acide % | Traces | to | 1.4 |
| Oleic acid % | 34.6 | to | 47.3 |
| Linoleic acid % | 27.9 | to | 47.2 |
| Linoleic acid % | Traces | to | 1.8 |

*Source:* Tyagi and Vasistha (1983)

(18–26%) by Chavoramony and Padmaja (1982). Tyagi and Vasistha (1983) who analysed 15 genotypes of sesamum reported the following variation in oil and oil quality characteristics (Table 8).

They also analysed the component glycerides of the oil and reported that the mono unsaturated-diunsaturated glycerides varied between 33.3 to 40.6%, while triunsaturated glycerides varied from 50.2 to 61.5%. SP 1162 was considered to be a good source of nutritional and stable oil. T 4, NT 7, Pb No.1 and T 12 were linoleic acid rich and hence were nutritionally better varieties.

Brar (1982) who screened 27 diverse sesame accessions reported that I.V. and 18:1 were negatively correlated while I.V. and 18:2 were positively correlated. Low fat, high protein sesame seed was prepared which had 26-33% oil and 31-36% protein (Surendranath *et al.*, 1984). Oil yield, I.V. and S.V. decreased due to leaf curl disease (Prasad *et al.*, 1985). Sesame seed has also been found to be associated with mycotoxin producing fungi (Reddy and Reddy, 1983).

**Niger:**

Niger is a minor oilseed which has received limited research efforts, particularly from the quality angle. Nine niger seed samples collected from Maharashtra and Gujarat were analysed for their physico-chemical characteristics and fatty acid composition (Nasirulla *et al.*, 1982). The following composition has been reported by them (Table 9).

TABLE 9

**Composition of niger seed and oil**

| | | | |
|---|---|---|---|
| Oil | 30.0 | to | 32.4 |
| Crude Protein % | 26.0 | to | 30.6 |
| I.V. | 112.8 | to | 129.0 |
| S.V. | 1.4655 | to | 1.4673 |
| Refractice index at 40°C | 0.5 | to | 1.0 |
| Unsaponifiable matter | 0.2 | to | 1.7% |
| Palmitic acid % | 6.0 | to | 9.4 |
| Stearic acid % | 5.0 | to | 7.5 |
| Oleic acid % | 13.4 | to | 39.3 |
| Linoleic acid % | 45.4 | to | 65.8 |
| Arachidic acid % | 0.2 | to | 1.0 |

*Source:* Nasirullah *et al.*, 1982

**Castor:**

Castor is a unique oilseed in that its oil contains 85% ricinoleic acid, a 12-hyroxy oleic acid. Some information on the castor composition and utility has been

TABLE 10

**Composition of castor seed and oil**

| | | | |
|---|---|---|---|
| Oil % | 45 | to | 52 |
| Protein % | 12 | to | 16 |
| Soluble sugars % | 3 | to | 7 |
| Fibre % | 23 | to | 27 |
| Minerals % | 2.0 | to | |
| Specific gravity of oil | 0.950 | to | 0.974 |
| S.V. | 81 | to | 91 |
| I.V. | 86 | to | 94% |
| Oleic acid | 0 | to | 8% |
| Linoleic acid | 0 | to | 4% |

*Source:* Nagaraj, 1988b.

reviewed by Kulkarni and Ramana Murthy (1977). Extensive research work has been carried out on castor oil and its derivatives at RRL, Hyderabad (Laskhminarayana, 1983). Castor contains about 40% oil and the castor oil production of the country stands at around 1.2 lakh tonnes. The oil has an enormous export demand. The major indigenous outlet for castor oil is in soap making and to a small extent in paints and industrial chemicals (Bringi *et al.*, 1985). Lakshminarayana *et al.*, (1984) have reported the composition of 17 new varieties of castor. The composition and characteristics of castor are presented below (Nagaraj, 1988)

Polysacharides of castor have been analysed and reported (Anjaneyulu *et al.*, 1983). Castor cake contains some toxic factors like ricin (protein) and ricinine (alkaloid). Hence it is mostly used as an organic manure. However a ration containing 10% castor bean meal was found to be harmless for the sheep (Purushotham *et al.*, 1986) Castor cake contains 20–25% protein, 40–45% crude fibre and 15% carbohydrate. Some work on the utilization of castor cake has been discussed by Mulky (1985).

**Linseed**

Linseed is a raw material for the industry and its oil is used in the manufacture of paints and varnishes. Rai (1986) has reviviewed the work carried out under the AICORPO. The compositional characteristics of the seed and oil are as follows, (Table 11).

**TABLE 11**

**Composition and quality of linseed and its oil**

| | | | |
|---|---|---|---|
| Oil content % | 29.7 | to | 55.3 |
| Protein % | 11.1 | to | 31.9 |
| Specific gravity of oil | 0.914 | to | 0.930 |
| Refractive index | 1.4756 | to | 1.4802 |
| Acid value % | 0.7 | to | 2.9 |
| I.V. | 153.1 | to | 194.3 |
| S.V. | 192.4 | to | 198.3 |
| Palmitic acid % | 4.2 | to | 15.9 |
| Stearic acid % | 0.3 | to | 10.3 |
| Oleic acid % | 13.0 | to | 35.4 |
| Linoleic acid | 8.1 | to | 65.8 |
| Linolenic acid % | 35.8 | to | 65.8 |

*Source:* Rai, 1986.

Eighty six genotypes were analysed by Batta *et al*, (1985) and reported the following ranges; oil 37.8-47.7%. Oleic, 15.7-33.5%, Linoleic 7.6-15.3% and linolenic acid 40.6–62.6%. Important varieties with specific advantageous characteristics have been identified as part of the AICORPO programme (AICORPO, 1985b). Bajpai *et. al* (1985) have reported the variation in oil quality and glyceride composition of 10 varieties. They concluded that 74-685 with high saturated fatty acids was suitable for crossing with LS2 with 33.7% linoleic acid for obtaining varieties suitable for edible use. Other varieties namely T 397, LS 4, MP 485 with higher unsaturation were more suitable for industrial use. Rai *et al.*, (1985) have considered that over 25% improvement in moisture, protein and fibre content of seed and 16:0, 18:0 of oil could be brought about by utilizing effective breeding methodologies. The possibility of genetic advance in 18:3 was only 6.6% whereas for oil content it was 15%. Development of biparental progenies at successive hybridisations has been suggested for improving oil content in linseed (Jeswani, 1985).

**Future thrusts:**

1. The available germplasm in the oilseeds need to be screened for the different quality characteristics. Later, development of oilseed varieties with balanced oil keeping quality and nutritional characteristics should be given priority.
2. Identification of proper time of harvest for realisation of higher oil and protein yield with better nutritional and keeping qualities.
3. Studies on pre-and post-harvest technologies for prevention of mycotoxins and their detoxification.
4. Utilisation of oilseed meals/cakes for human beings as well as livestock.
5. Identification of varieties with lower levels of anti-nutritional factors like glucosinolates, phenolic compounds, protease inhibitors, organic acids, ricin etc.
6. Develop technologies for utilization of sheel/hull, stalk etc.

## LITERATURE CITED

AFZALPURKAR, A.B. and LAKHMINARAYANAYA, G. 1980a. Influence of water availability and tempearute on composition of zunflower seed and oil. J. Oil Technol. Assoc. India **12**:1-3.

AFZALPURKAR, A.B. and LAKSMINARAYANA, G. 1980b. Variaitons in oil content and fatty acid composition with sunflower head size and shape. J. Am. Oil Chem. Soc. **57**:105-107.

AFZALPURKAR, A.B. and LAKSHMINARAYANA, G. 1981. Changes in chlorogenic, caffeic and quinic acid contents during sunflower seed maturation. J. Agric. Fd. Chem. **29**:203-204.

AHUJA, K.L., 1985. Chemistry and Biochemistry Research in India. Proc. joint Review meetings of Indo-Swedish collaborative Research Programme on Rapeseed-Mustard Improvement and Oil and Proteins, Utilization. Feb. 28th - March 3rd, New Delhi.

AHUJA, K.L., 1986. Quality of oil and cake of Rapeseed-Mustard. Paper presented in the subject matter work-shop-cum-seminar on Rabi Oilseeds, D.O.R., Hyderabad, August 28th - Sept. 4th, 1986.

AHUJA, K.L., BADWAL, S.S. and LABANA, K.S. 1981. Qualitative and quantitative changes in the seed and oil contents of *Brassica juncea* mutants at different times of harvesting. Qual. Plant Pl. Foods Human Nutr. **31**:61-66.

AHUJA, K.L., LABANA, K.S., RAHEJA, R.K. and BADWAL, S.S. 1984. Oil content and fatty acid variation in mutants of *Brassica juncea* L. Czern-cross, J. Oilseeds Res. **1**:71-75.

AICORPO. 1984a. Annual Progress Report of Kharif Oilseeds Workshop, D.O.R, Hyderabad.

AICORPO. 1984b. Annual Progress Report of Rabi Oilseeds Workshop, D.O.R., Hyderabad.

AICORPO. 1985a. Annual Progress Report of Kharif Oilseeds Workshop, D.O.R, Hyderabad.

AICORPO. 1985b. Annual Progress Report of Rabi Oilseeds Workshop, D.O.R, Hyderabad.

AICORPO. 1986. Annual Progress Report of Kharif Oilseeds Workshop, D.O.R, Hyderabad.

ANJANEYULU, Y.V., KULKARNI, K. and GOUDA, D.C. 1983. Polysaccharides of *Ricinus communis* seed endosperm. Curr. Sci. **52** (18): 874-875.

BAJPAI, M. SHARMA, A. and VASISTHA, A.K. 1985. Component acid and glycerides in the oil of different genetic varieties of Linseed. J. Oil Technol. Assoc. India **17**(1): 15-16.

BADAMI, R.C., SHIVAMURTHY, S.C. and JOSHI, M.S. 1987. Fatty Acid composition of ten varieties of Peanuts by G.L.C. J. Oil Technol. Assoc. India, **10**:14-15.

BADAMI, R.C., SHIVAMURTHY, S.C, JOSHI, M.S., PATIL, K.B. SUBBARAO, Y.V., SASTRI G.S.R., and VISWANATHA RAO, G.K. 1979. Characterization of 15 varieties of genotype Peanuts for yield, oil content and fatty acid composition. J. Oil Technol. Assoc. India. **11** 85–87.

BALASARASWATHI, R. and RAJ, W. 1983. Studies on Sunflower oil with reference to its keeping qualities. J. Food Sci. Technol. India **20**(2):21-24.

BASAPPA, S.C. 1983. Physical methods of detoxification rof aflatoxin contaminated food materials. Proc. Symp. Mycotoxins in food and feed. Bhagalpur:257-273.

BASAPPA, S.C. and SREENIVASAMURTHY, V. 1979. Decontamination of groundnut oil from aflatoxin by adsorption-cum-filtration Ind. J. Technology **17**(1):440-551.

BASAPPA, S.C., SRINIVASA MURTHY, V. and RAJA LAKSHMI, D. 1977. Analysis of aflatoxin in groundnut and its products. Ind. J. Technol. **15**:311-313.

BATTA, S.K. AHUJA, K.L., RAHEJA, R.K. and LABANA, K.S. 1985. Variability in oil content and fatty acid composition in linseed (*Linum usitassimum* L.). Annals of Biology **1**:80-85.

BHATTACHARYA, P., SAMUI, R.C., DASGUPTA, S.K. CHANDRASEKHAR RAO, T. and LAKSHMINARAYANA, G. 1982. Effect of date of sowing and harvesting on characteristics and fatty acid compositon of sunflower seeds. J. Food Sci. Technol (India) 9(6)-246-248.

BRAR, G.S. 1980. Breeding for improved fatty acid composition of seed oil of Indian Mustard (*Brassica juncea* L. Czern & coss). Abstract J. Oil Technol. Assoc. India. **12**(14):pp.170.

BRAR, G.S. 1982. Variation and correlation in oil content and fatty acid composition of sesame. Ind. J. Agric. Sci. **52**(7): 434-439.

BRINGI, N.V, MANI, V.V.S. and KASBEKAR, M.G. 1985. Utilization of non-traditional oils in oilseed production-constraints and opportunities Oxford & IBH publishing Co pp. 589-597.

CHAKRABORTY, M.M., SAHA, S. and DATTA, R. 1979. Cultivation of sunflower (*Heilanthus annus* L.) in West Bangal. Studies on changes in lipid composition according to date of sowing in *rabi* season. J. Oil Technol. Assoc. India. **11**(3):80-82.

DOULATABAD, C.D., ANKALGI, R.F., VIJAYAKUMAR S. and HABIB, A.F. 1982. Fatty acid composition of important safflower varieties of Karnataka. Oilseeds J. **12**:29-32,

GAMBHIR, R.N., CHANORA, S. and TIWARI, P.N. 1983. Stage of harvesting for optimum oil yield in Indian varieties of rapeseed-mustard. Ind. J. Agric. Sci. **53**(2): 115-117.

GHEWANDE, M.P. and NAGARAJ, G., 1987. Prevention of aflatoxin contamination through some commercial chemical products and plant extracts in groundnut, Mycotoxin Research. **3**: 19–24.

GHEWANDE, M.P., NAGARAJ, G. and REDDY, P.S. 1987. Aflatoxins in groundnut: Technologies for better crops. ICAR Bulletin 53.

GHEWANDE, M.P., NAGARAJ, G., RAJ JHALA, BASU, M.S. and REDDY, P.S. 1986. Dry seed resistance to *Aspergillus flavus* colonization and aflatoxin production. Ind. J. Plant Ptotection. **14**(2):59-64.

GUPTA, M.L., AHUJA, K.L., RAHEJA, R.K. and LABANA, K.S. 1988. Variation for biochemical quality traits in promising genotypes of Indian Mustard. J. Res. Punjab. Agric. Univ. **25**(1): 1–5.

GUPTA, S.K , SEKHON, K.S. and AHUJA, K.L. 1982a. Chemical composition of Brassica seeds. J.Food.Sci. Technol. (India). **19**(2):84-86.

GUPTA, S.K., KAMAL DHAWAN, PRAKASH KUMAR and YADAVA, T.P. 1982. Note on chemical composition of some groundnut strains. Ind. J. Agric. Sci. **52**:343-344.

JAMBUNATHAN. R., RAJU, S.M. and BARDE, S.P. 1985. Analysis of oil content of groundnut by nuclear magnetic resonance spectrometry. J. Science of Food and Agriculture. **36**:162-166

JESWANI, L.M. 1985. Linseed (*Linum usitatissimum.* L.) In Oilseed Production - constraints and opportunities. Oxford & IBH publishing Co. - PP 233-249.

KAMATH, K.S., GOVINDAM, P.E., PAUL, T.M., CHATTERJEE, K.L. and MATHEW, J.V. 1979 Sunflower seed oil - Physico chemical charactrristics and industrial use. Research & Industry **24**(3):168-170.

KANTHARAJ URS, M. and KOUSALYA, S. MURTHY, 1979. Integrated processing of mustard seed for food and feed purposes. Proc. Symp. Rapeseed-Mustard, Mysore. pp. 162-766.

KULKARNI, L.G. and RAMANA MURTHY, V. 1977. Castor. ICAR, New Delhi, pp. 74-88.

KULKARNI, D.N., JOGLEKAR, N.V. and INGLE, Y.M. 1985. Processing of safflower and production of edible grade safflower meal. In Oilseed production, constraints and opportunities. Oxford & IBH Publishing Co. pp. 652-656.

LAKSHMINARAYANA, G. 1983. Castor seed products S.S. Ramaswamy Memorial Lecture (1983) at the 38th Annual convention of O.T.A.I. 19th-20th February, 1983. Calcutta. pp.1-34.

LAKSHMINARAYANA, G., PAULOSE, M.M., KUMARI, B.N. 1984. Charcteristics and composition of Indian Castor seed and oil. J. Amer. oil. Chemists Soc. **61**(1):1871-72.

LATHA, T.S. and PRAKASH, V. 1984. Studies on the proteins from safflower seed (*Carthamus Tinctorus* L.). J. Agric. & Food Chem. **32**(6):1412-1416.

MEHAN, V.K. 1985. Aflatoxin problem in groundnut. Approaches to prevention and control. Paper presented in XXVI Annual AICORPO Workshop, Nagpur, India 15-19th April, mimographed paper p. 1-23.

MEHAN, V.K., BHAVANISANKAR, T.N. and BEDI, J.S. 1985. Comparison of different methods for extraction and estimation of aflatoxin $B_1$ in groundnut, J Food Science and Technol. (India) **22**(2):123-125.

MEHAN, V.K., McDONALD, D. 1984. Research on the aflatoxin problem in groundnut at ICRISAT Plant and Soil 79(2):255-260.

MISRA, S.D., GAUR, B.K. 1982. Effect of seed size on oil content in groundnut Var. TG-1. Ind. J. Plant Physiol 25(1):106-109.

MULKY, M.J. 1985. Utilization of oilseed meals for animal and human nutrition. In Oilseed production, constraints and opportunities. Oxford and IBH Publishing Co. pp. 611-624.

NAGARAJ, G. 1986. Fatty acid composition of some released Indian Groundnut varieties. Sympo. Newer Technologies for augmentation and utilization of oilseeds and derived products, Hyderabad Feb. 8th-9th, 1986.

NAGARAJ, G. 1988) Kharif Oilseeds, their nutritional quality and utilization. Paper presented in the subject matter specialists workshop cum seminar on kharif oilseeds held at D.O.R., Hyderabad May 10-24th, 1988.

NAGARAJ, G. and KAILASH KUMAR. 1985. Detoxification of aflatoxins in groundnut. J. Oil Technol. Assoc. India, 17(2):40.

NAGARAJ G., KAILASH KUMAR, SHEELA CHOUHAN, TASLIM AHMED and BHAGAT, N.R. 1986. High oil groundnut varieties. Indian J. Agric. Sci. 56:64-65.

NAGARAJ, G. and SHEELA CHOUHAN. 1987 Seasonal variation in oil quality of groundnut. Ind. J. Agric. Sci. 57(6): 522-524.

NAGARAJ, G., SHEELA CHOUHAN and RAVINDRA, V. 1987. Influence of maturity on oil, protein content and yield in three Spanish groundnut varieties. Seeds and Farms 13(8):53-54.

NASIRULLAH, K., ANKIAH, N., KRISHNA MURTHY, M.V., NAGARAJA RAO, K.V. and KAPUR, O.P. 1982. Storage study on groundnut oil. J. Oil. Technol. Assoc. India 14:55.

NASIRULLA, K., MALLIKA, T., RAJALAKSHMI, S., PASUPATHI, K.S., ANKIAH, N., VIBHAKAR, S., KRISHNA MURTHY, M.V, NAGARAJA, K.V. and KAPUR O P. 1982. Studies on niger (*Guizotica abyssinica*) seed oil. J. Food Sci. Technol. (India). 19(4): 147-149.

NATARAJA MURTHY, T. and LAKSHMINARAYANA, G. 1979. Studies on stability of groundnut oil during continuous deep frying in a Plant. Abstracts on Int. Congress on Oilseeds and Oil. pp.37.

PAL, R., VERMA, B.K. and SRIVASTAVA, D.D. 1979. Aflatoxin in groundnut oil, groundnut cake and hydrogenated oil in Hapur market. J. Food Science and Technology (India). 16(4): 169-170.

PRASAD, B., VERMA, O.P. and DAFTRI, L.N. 1985. Effect of leaf curl disease on seed and oil qualities of sesame. Curr. Sci. 54(8):388-389.

PURUSHOTTAM, N.P., RAO, M.S. and RAGHAVAN, G.V. 1986. Utilization of castor bean meal in the concentrate mixture of sheep. Ind. J. Animal Sciences. 56(10):1090-93.

RAHEJA, R.K., BATTA, S.K., AHUJA, K.L., LABANA, K.S. and SINGH, M. 1987. Comparison of oil content and Fatty acid composition of Peanut genotypes differing in growth habit. Plant foods for human nutrition. 37:103-108.

RAHEJA, R.K., KANCHAN GANDHI, AHUJA, K.L. and LABANA, K.S. 1986. Correlation among kernel size, lipid constituents and fatty acid composition in groundnut *Arachis hypogaea*. Annals of Biology 2:45-50.

RAHMA, E.H. and NARASINGA RAO, M.S. 1981. Removal of polyphenols from sunflower meal by various solvents. Effect of functional properties. J.Food Sci. 46(5):1521-1522.

RAI, M. 1986. Quality aspects of linseed oil and cake and their uses. Paper presented in the subject matter workshop cum seminar held at D.O.R., Hyderabad, August 28th-Sept. 4th, 1986.

RAI, M., VASASITHA and NAQUI, P.A. 1985. Estimates for variability, heritability and genetic advances in seed and oil components of linseed. J. Oilseed Res. 2:240-245.

RAJ, A.G., KOTHANDARAM, P., KADIVREL, R., 1983. Proximate composition and nutritive value of safflower seed meal. Cheiron. **12**(6): 290-293.

RAMACHANDRA, M. and GOUD, J.V. 1981 Genetic analysis of seed yield, oil content and their components in safflower. Theor. Appl. Gen. **60**:191-195.

REDDY, A.S. and REDDY, S.M. 1983. Elaboration of mycotoxins from fungi associated with til. (*Sesamum-indicum* L.). Curr. Sci. **52**(:12)613-614.

SAGARE, B.N., NAPHADE, K.T. 1983. Comparison of pulsed NMR method of seed oil determination with soxhlet method. J. Mahrarashtra Agric. Universities **8**:240-241.

SANGALE, P.B., PAGAR, S.D., DAFTARDAR, S.Y. 1982. Note on the association of seed oil content with hull and kernel and seed sizes of safflower Ind. J. Agric. Sci. **52**(9):613-614.

SARKAR, S. and BHATTACHARYA, D.K. 1987. Seed composition of some new varieties of sesamum, toria, yellow sarson, mustard and groundnut. J. Oil Technol. Assoc. India **19**(1):13-15.

SEKHON, K.S., GUPTA, S.K., AHUJA, K.L., JAISWAL., S.V., 1980. Variability in fatty acid composition in semi-spreading peanut types. Oleagineaux. **35**:409-412.

SHANTA, T. and SREENIVASA MURTHY, V. 1980. Storage of groundnut oil detoxified by exposure to sunlight. Ind. J. Technol. **19**(8):346-347.

SHANTA, T., SREENIVASA MURTHY, V., RAVI, E.R., PREMA, V. 1966. Detoxification of groundnut seeds by urea and sunlight. J. Food Safety. 7(4):225-231.

SHUKLA, G.B., BRAHMACHARI, A.N., SHARMA, G.K. and NATARAJA MURTHY, T. 1980. Butyrometric method for rapid deterimnation oil content of groundnut seeds. J. Food Sci. Technol. (India). **17**:242-244.

SINDHUKANYA, T.C. and KANTHARAJ URS, M. 1983. Carbohydrate composition of mustard seed *B. juncea* seed meal. J. Food Sci. and Technol. (India). **20**(3): 124-126.

SURENDRANATH, M.R., GANGI REDDY, N.C AZEEMODDIN, G., ACHUTA RAMAYYA D., THIRUMALA RAO, S.D. 1984. Preparation of low fat high protein sesame seed. J. Food. Sci. Technol. (India). **21**(6): 425-426.

THAYUMANAVAN, B. 1981. Keeping quality of oils from dehulled and whole seeds. Oilseeds J. **12**:54-56.

TYAGI, P. and VASISTHA, A.K. 1983. Component fatty acids and glycerides of oils from different genetic varieties of sesamum indicum. J. Oil Technol. Assoc. India. **15**(2): 28-32.

VERMA, N.S. DUMKA, P.K. TYAGI, S.M. 1977. Biochemical studies in Research on Sunflower. Expt. Stn. Tech. Bull. G.B.P. University of Agril. & Tech. Pantnagar, pp.44-46.

VIBHAKAR, S., RAJALAKSHMI, S., NAGARAJA, K.V., KAPUR, O.P. 1981. Physico-chemical characteristics of safflower oil. Ind. Food Packer. **35**(1): 11-12.

VIJAYA KUMAR, S. and GIRIRAJ, K. 1985. Heritability of oil content in five safflower croses. J. Oilseeds Res. **2**:285-287.

YOUSUF ALIKHAN, R., LAKSHMINARAYANA, J., AZEMODDING, G., ACHUT RAMAYYA, D. and THIRUMALA RAO, S.D. 1979. Shelf life of groundnut and sunflower oils. Abstract of Indian Congree on Oilseeds and Oil pp 33-34.

J. Oilseeds Res. 7(1990) 63-71
*ISSN 0970—2776*

# GENETIC DIVERGENCE AND HYBRID PERFORMANCE IN SESAME

N. ANITHA and M. STEPHEN DORAIRAJ
School of Genetics, Tamil Nadu Agricultural University, Coimbatore-641 003.

ABSTRACT

Based on $D^2$ analysis, eight parents and 56 hybrids were grouped into 15 clusters. The position of the hybrids in relation to their parents in clusters was determined to know the overall dominance and maternal effects of the parents. Out of 28 combinations 15 were closer to one of the parents, 6 were between the parents and 7 were out of the range of parents. Cluster V recorded maximum values for seed yield and oil content besides number of primary branches and harvest index. The hybrid *Si 1125 × TSS 4* in this cluster recorded the highest yield and high oil content among the hybrids. The parents that constitute the heterotic hybrids belong to $DC_2$ group in five combinations and $DC_4$ group in one combination. Among the plant attributes, number of seeds per capsule, leaf area index, fruiting nodes, total capsules per plant, days to flowering and dry matter production were found to be important in the present study of genetic divergence.

**Key words** Genetic divergence - Heterosis - Divergent class.

## INTRODUCTION

The suceess of hybridization programme is mainly dependent on the genetic diversity of the parents involved. So far, analysis of genetic divergence has been used to quantify the genetic distance between the genotypes, to identify promising types to initiate crossing programme and to relate clustering pattern to geographic origin. In the present investigation, the divergence between parents and hybrids and the position of the hybrids in relation to their parents and the position of $F_1$s in relation to their reciprocals in clusters have been studied to know the overall dominance and the maternal effects of the parents.

## MATERIALS AND METHODS

Eight sesame genotypes viz., CO1, TSS 5, TSS 4, Si 1502, Si 1484, Si 1003, Si 1248 and Si 1125 were selected out of the fifty genotypes that were studied in detail for variability, character association and genetic divergence by Reddy (1986). They were crossed in a diallel fashion to obtain 56 hybrids. The parents and hybrids were raised in a radomised block design with three replications. Observations were recorded on five randomly selected plants of each genotype in each replication for twenty metric characters. Mahalanobis' (1936) generalised distance was used for assessing the genetic divergence as described by Rao (1952). Based on genetic distances between the clusters, they were classified into four divergent classes viz. $DC_1$, $DC_2$, $DC_3$, $DC_4$ and as suggested by Arunachalam and Bandyopadyay (1984). In the present study these four classes were discussed as very highly divergent ($DC_1$), highly divergent ($DC_2$), moderately divergent ($DC_3$) and closely related ($DC_4$).

Received on January 28, 1989.

## RESULTS AND DISCUSSION

Analysis of variance showed significant differences among the parents and hybrids for all the characters except for plant height and 1000-seed weight. Wilk's lambda criterion confirmed significant diversity among parents and hybrids ($X^2$ d.f. 1260=3750.904). The $D^2$ values were computed for all possible 2016 pairs of the variants. The highest $D^2$ value of 230.352 was observed between TSS 4 and Si 1502 × Si 1484 and the lowest $D^2$ value of 8.423 between TSS 4×Si 1125 and Si 1125×TSS 5.

The eight parents and 56 hybrids (direct and reciprocal) were grouped into fifteen clusters by applying the clustering technique.

The intra and inter cluster average of $D^2$ and D values among the fifteen clusters are presented in Table 1. The intra cluster distance was found to be nil in clusters VII, XII, XIII, XIV and XV, while the maximum intra cluster distance of 38.366 was found in cluster V. The inter cluster distance ranged from 43.904 between clusters I and IV to 154.903 between clusters XII and XIII.

Accordingly, cluster IX was found to be very highly divergent from clusters V, XI and XII. Similarly clusters XI and XII were very highly divergent from clusters XIII, XIV and XV. Among themselves, cluster XIII was very highly divergent from clusters XIV and XV. High divergence was found in cluster II with III besides IX to XV; cluster IV with V; cluster V with VI to XV except cluster IX; cluster VII with XIV and XV; cluster VIII with X to XV; cluster IX with X, XIII, XIV and XV; Cluster X with XIII, XIV and XV and Cluster XIV with XV. Cluster I was closely related to all the other 14 clusters. Other closely related clusters were III with IV and clusters X with XI. The remaining clusters were moderately divergent from each other.

The constituents of different clusters are presented in Table 2. In many cases, number of hybrids falling in the parental cluster when the parent was used as female differed from those when it was used as male. Only in the case of CO 1 in cluster I, 3 hybrids fell into the cluster irrespective of parental sex. Some other cases where equal number of $F_1$s and reciprocals of a particular parent occurred in non-parental cluster were CO 1 in cluster X, TSS 5 in cluster IV, TSS 4 in cluster III, Si 1502 in cluster IV, Si 1003 in cluster I and Si 1248 in cluster III and VI.

In the case of CO 1×TSS 5, CO 1×Si 1484 and Si 1248×Si 1125, the parents were in different clusters which were closely related and the F1s were in one of the parental clusters indicating the greater influence or overall dominance of one parent over the other in contributing its traits to the hybrids. The contribution of CO 1 over TSS 5 and Si 1484 and Si 1248 over Si 1125 was observed in the hybrids. In many other cases viz., CO 1 × TSS 4, CO 1 × Si 1003, CO 1 × Si 1125, TSS 5 × Si 1502, TSS 5 × Si 1248, TSS 4 × Si 1502, TSS 4 × Si 1248, Si 1502 × Si 1484, Si 1502 × Si 1003, Si 1502 × Si 1125, Si 1484 × Si 1248 and Si 1003 × Si 1248, the parents and hybrids (direct and reciprocal) belong to different clusters but hybrids were close to one of the parental cluster revealing the greater influence of that parent.

**TABLE 1**

**Intra (Diagonal) and inter cluster average of $D^2$ and D (Value within paranthesis) and the extent of diversity among the fifteen clusters**

| | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | XII | XIII | XIV | XV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I | 30.107 (5.487) — | 46.840 (6.844) $DC_4$ | 48.860 (6.990) $DC_4$ | 43.904 (6.626) $DC_4$ | 44.836 (6.696) $DC_4$ | 44.823 (6.695) $DC_4$ | 44.810 (6.694) $DC_4$ | 45.038 (6.711) $DC_4$ | 46.512 (6.820) $DC_4$ | 47.087 (6.862) $DC_4$ | 47.403 (6.887) $DC_4$ | 47.403 (6.885) $DC_4$ | 48.665 (6.976) $DC_4$ | 49.126 (7.009) $DC_4$ | 49.393 (7.028) $DC_4$ |
| II | | 26.564 (5.154) — | 84.493 (9.192) $DC_2$ | 68.409 (8.271) $DC_3$ | 67.832 (8.236) $DC_3$ | 66.961 (8.183) $DC_3$ | 67.667 (8.226) $DC_3$ | 67.060 (8.189) $DC_3$ | 70.880 (8.419) $DC_2$ | 72.012 (8.486) $DC_2$ | 71.217 (8.439) $DC_2$ | 70.308 (8.385) $DC_2$ | 70.403 (8.509) $DC_2$ | 72.880 (8.537) $DC_2$ | 73.239 (8.558) $DC_2$ |
| III | | — | 30.727 (5.507) — | 45.590 (6.752) $DC_4$ | 53.744 (7.331) $DC_3$ | 54.243 (7.365) $DC_3$ | 53.202 (7.294) $DC_3$ | 53.568 (7.319) $DC_3$ | 52.955 (7.277) $DC_3$ | 53.217 (7.295) $DC_3$ | 54.052 (7.532) $DC_3$ | 56.025 (7.485) $DC_3$ | 56.550 (7.520) $DC_3$ | 57.244 (7.566) $DC_3$ | 57.684 (7.595) $DC_3$ |
| IV | | | — | 31.405 (5.604) — | 73.068 (8.548) $DC_2$ | 60.887 (7.803) $DC_3$ | 56.355 (7.507) $DC_3$ | 54.864 (7.407) $DC_3$ | 57.775 (7.601) $DC_3$ | 59.044 (7.684) $DC_3$ | 58.722 (7.663) $DC_3$ | 58.400 (7.642) $DC_3$ | 60.622 (7.786) $DC_3$ | 61.090 (7.816) $DC_3$ | 61.340 (7.832) $DC_3$ |
| V | | | | — | 38.366 (6.194) — | 86.974 (9.326) $DC_2$ | 85.581 (9.251) $DC_2$ | 80.138 (8.952) $DC_2$ | 91.585 (9.570) $DC_1$ | 85.600 (9.252) $DC_2$ | 80.371 (8.965) $DC_2$ | 78.040 (8.834) $DC_2$ | 85.027 (9.221) $DC_2$ | 86.564 (9.304) $DC_2$ | 86.676 (9.310) $DC_2$ |
| VI | | | | | — | 37.100 (6.091) — | 52.258 (7.229) $DC_3$ | 54.790 (7.402) $DC_3$ | 52.780 (7.265) $DC_3$ | 62.489 (7.905) $DC_3$ | 68.658 (8.286) $DC_3$ | 68.956 (8.304) $DC_3$ | 67.733 (8.230) $DC_3$ | 68.376 (8.269) $DC_3$ | 69.472 (8.335) $DC_3$ |
| VII | | | | | | — | 00.000 (0.000) — | 59.275 (7.699) $DC_3$ | 56.671 (7.528) $DC_3$ | 61.497 (7.842) $DC_3$ | 68.261 (8.262) $DC_3$ | 68.343 (8.267) $DC_3$ | 68.990 (8.306) $DC_3$ | 70.241 (8.381) $DC_2$ | 70.325 (8.386) $DC_2$ |
| VIII | | | | | | | — | 35.736 (5.978) — | 67.931 (8.242) $DC_3$ | 79.977 (8.943) $DC_2$ | 75.394 (8.683) $DC_2$ | 73.103 (8.550) $DC_2$ | 76.248 (8.732) $DC_2$ | 75.342 (8.680) $DC_2$ | 74.892 (8.654) $DC_2$ |
| IX | | | | | | | | — | 21.912 (4.681) — | 83.357 (9.130) $DC_2$ | 91.355 (9.558) $DC_1$ | 96.334 (9.815) $DC_1$ | 87.385 (9.348) $DC_2$ | 82.519 (9.084) $DC_2$ | 84.474 (9.191) $DC_2$ |
| X | | | | | | | | | — | 38.143 (6.176) — | 49.928 (7.066) $DC_4$ | 68.211 (8.259) $DC_3$ | 83.339 (9.129) $DC_2$ | 85.027 (9.221) $DC_2$ | 87.068 (9.331) $DC_2$ |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| XI | — | 36.566 (6.047) — | 64.867 (8.054) $DC_3$ | 105.576 (10.275) $DC_1$ | 98.050 (9.902) $DC_1$ | 92.621 (9.624) $DC_1$ |
| XII | | — | 00.000 (0.000) — | 154.903 (12.446) $DC_1$ | 124.858 (11.174) $DC_1$ | 112.296 (10.597) $DC_1$ |
| XIII | | | — | 00.000 (0.000) — | 113.167 (10.683) $DC_1$ | 112.827 (10.622) $DC_1$ |
| XIV | | | | — | 00.000 (0.000) — | 87.741 (9.367) $DC_2$ |
| XV | | | | | — | 00.000 (0.000) — |

$DC_1$ : Very highly divergent = 88.73 and above

$DC_2$ : Highly divergent = 69.66 to 88.72

$DC_3$ : Moderately divergent = 50.59 to 69.65

$DC_4$ : Closely related = Less than 50.59

**TABLE 1** (Contd....)

| Cluster No. | Parents | Hybrids involving | | | | | | | | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Co 1 | | TSS 5 | | TSS 4 | | Si 1502 | | Si 1484 | | Si 1003 | | Si 1248 | | Si 1125 | | |
| | | F | M | F | M | F | M | F | M | F | M | F | M | F | M | F | M | |
| I | CO 1 Si 1248 Si 1502 | 3 | 3 | 5 | 4 | 4 | 2 | – | 2 | 3 | 4 | 2 | 2 | 2 | 3 | 5 | 4 | 24 |
| II | — | – | 1 | – | – | – | – | – | – | – | 1 | – | – | 2 | – | – | – | 2 |
| III | — | – | 2 | – | 2 | 1 | 1 | 4 | 1 | 2 | – | 1 | 2 | 1 | 1 | – | – | 9 |
| IV | — | 3 | – | 1 | 1 | – | 3 | 1 | 1 | – | 1 | 3 | – | – | 1 | – | 1 | 8 |
| V | TSS 4 | – | – | – | – | – | 1 | – | – | – | – | – | – | – | – | 1 | – | 1 |
| VI | — | – | – | – | – | – | – | – | – | 2 | – | – | 1 | 1 | 1 | – | 1 | 3 |
| VII | — | – | – | – | – | – | – | 1 | – | – | – | – | – | 1 | – | – | – | 1 |
| VIII | Si 1125 | – | – | – | – | – | – | 1 | – | – | – | – | – | – | – | – | 1 | 1 |
| IX | Si 1484 | – | – | – | – | – | – | – | 1 | – | – | 1 | – | – | – | – | – | 1 |
| X | — | 1 | 1 | – | – | 1 | – | – | – | – | – | – | 1 | – | – | – | – | 2 |
| XI | — | – | – | – | – | 1 | – | – | 1 | – | – | – | – | – | 1 | 1 | – | 2 |
| XII | TSS 5 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 0 |
| XIII | — | – | – | – | – | – | – | 1 | – | – | 1 | – | – | – | – | – | – | 1 |
| XIV | Si 1003 | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | – | 0 |
| XV | — | – | – | 1 | – | – | – | – | – | – | – | – | 1 | – | – | – | – | 1 |

Note : F — Female
M — Male

When Si 1502 and Si 1125 were considered, $F_1$s were close to one of the parental clusters in which their respective pollen parent occurred indicating the importance of pollen parent.

In the case of TSS 5 × Si 1484, TSS 4 × TSS 5, TSS 5 × Si 1125, Si 1003 × Si 1125 Si 1484 × Si 1003 and Si 1484 × Si 1125, parents and hybris belonged to four different clusters and both the hybrid clusters were close to both the parental clusters indicating the equal contribution of the parents to the hybrid.

In the hybrids CO 1 × Si 1502, CO 1 × Si 1248 and Si 1502 × Si 1248, both the parents belonged to the same cluster but the $F_1$s (direct and reciprocal) though close to parents belonged to two different clusters. In the case of TSS 4 × Si 1125, TSS 4 × Si 1484, TSS 4 × Si 1003 and TSS 5 × Si 1003, parents were in different clusters and among $F_1$s, one was close or moderately divergent from both the parents and the other was highty divergent. In all these cases hybrids were away from the range of parents.

For each genotype number of crosses falling in the same DC group as that of parents are listed here.

| Genotype | *No.of crosses when the genotype is used as* F | M |
|---|---|---|
| CO 1 | 4 | 2 |
| TSS 5 | 2 | 1 |
| TSS 4 | - | 2 |
| Si 1502 | 5 | 3 |
| Si 1484 | 3 | 1 |
| Si 1003 | 2 | - |
| Si 1248 | 3 | 4 |
| Si 1125 | 3 | 2 |

In these cases if a genotype was crossed to other which was close to this, the $F_1$s also was close to it and *vice versa*. That means no change in genetic divergence was seen in these cases.

All these genotypes peoduced a closely related $F_1$s when crossed to a nearer parent. This indicated absence of change in divergence when closely related parents were crossed.

In only seven combinations viz. CO 1 × TSS 5, CO 1 × Si 1484, TSS 5 × TSS 4, TSS 5 × Si 1484, TSS 5 × Si 1125, Si 1003 × Si 1125 and Si 1248 × Si 1125 both direct and reciprocal cross belonged to the same cluster indicating no maternal effects. All other combinations showed different degrees of maternal effects.

**TABLE 3**
**Cluster means for twenty characters and contribution of each of the characters to diversity**

| Cluster | No. of days to 50 per cent flowering | No. of days to maturity | leaf area Index | Plant height (cm) | No. of primaries | No. of secondaries | First capsule bearing node | No. of capsules on | | | No. of capsule bearing nodes to total No. of nodes | | | Volume of the capsule ($cm^3$) | No. of seeds per capsule | 1000-seed weight (g) | Seed yield per plant (g) | Total DMP (g) | Harvest Index (per cent) | Oil content (per cent) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Main stem | Primaries | Secondaries | Main stem (per cent) | Primaries (Per cent) | Secondaries (per cent) | | | | | | | |
| I | 40.82 | 85.52 | 1.44 | 104.56 | 5.17 | 5.14 | 8.14 | 26.13 | 65.86 | 25.95 | 59.46 | 75.27 | 67.77 | 1.32 | 67.86 | 3.08 | 11.29 | 67.93 | 16.74 | 41.62 |
| II | 39.67 | 85.33 | 1.02 | 88.44 | 4.90 | 4.80 | 5.37 | 25.10 | 71.97 | 26.40 | 53.86 | 86.01 | 68.46 | 1.09 | 59.51 | 2.71 | 9.51 | 57.18 | 16.67 | 41.77 |
| III | 38.70 | 85.22 | 1.11 | 101.07 | 4.84 | 4.89 | 5.94 | 25.89 | 55.78 | 24.23 | 61.50 | 66.11 | 81.36 | 1.43 | 73.20 | 3.11 | 9.98 | 68.43 | 14.73 | 40.88 |
| IV | 40.25 | 85.71 | 0.82 | 100.88 | 4.77 | 4.70 | 5.83 | 25.82 | 64.32 | 22.48 | 64.17 | 74.54 | 62.15 | 1.40 | 66.14 | 3.10 | 9.84 | 63.20 | 15.78 | 40.79 |
| V | 42.34 | 88.17 | 1.67 | 95.87 | 5.77 | 5.67 | 6.90 | 24.63 | 70.20 | 29.40 | 53.61 | 68.88 | 83.49 | 1.19 | 62.69 | 3.16 | 15.25 | 75.91 | 20.26 | 42.59 |
| VI | 37.33 | 85.67 | 1.71 | 94.09 | 4.60 | 3.69 | 5.49 | 27.18 | 60.60 | 18.73 | 61.15 | 71.02 | 59.41 | 1.21 | 69.74 | 2.93 | 8.54 | 61.79 | 13.79 | 41.36 |
| VII | 39.33 | 85.67 | 1.04 | 101.00 | 4.40 | 4.07 | 6.67 | 24.47 | 49.27 | 9.07 | 54.82 | 66.84 | 49.80 | 1.60 | 68.56 | 3.17 | 11.62 | 66.25 | 17.40 | 39.83 |
| VIII | 39.83 | 85.67 | 1.37 | 110.14 | 5.20 | 5.07 | 6.27 | 19.77 | 47.74 | 22.84 | 49.67 | 52.80 | 63.74 | 1.09 | 64.88 | 3.08 | 9.47 | 73.80 | 13.02 | 41.34 |
| IX | 39.33 | 85.84 | 1.46 | 100.74 | 4.50 | 4.03 | 6.00 | 22.30 | 48.54 | 17.97 | 55.33 | 65.08 | 61.28 | 1.27 | 81.72 | 3.02 | 7.48 | 67.55 | 11.17 | 40.78 |
| X | 40.50 | 86.00 | 1.15 | 106.00 | 5.07 | 5.17 | 6.93 | 24.30 | 83.57 | 31.64 | 54.99 | 81.83 | 87.81 | 1.40 | 74.07 | 3.26 | 14.29 | 76.19 | 18.88 | 41.67 |
| XI | 42.17 | 88.34 | 0.91 | 107.39 | 5.34 | 5.53 | 6.50 | 27.20 | 69.20 | 40.07 | 69.16 | 80.33 | 91.18 | 1.18 | 68.46 | 2.99 | 12.01 | 67.68 | 16.64 | 42.25 |
| XII | 43.33 | 88.67 | 1.37 | 101.40 | 5.53 | 4.60 | 5.73 | 28.60 | 59.20 | 27.40 | 56.30 | 71.45 | 52.13 | 1.15 | 61.75 | 3.20 | 12.55 | 67.08 | 18.76 | 42.38 |
| XIII | 34.33 | 83.33 | 1.64 | 102.40 | 3.27 | 3.07 | 4.93 | 24.73 | 39.53 | 19.53 | 72.06 | 75.47 | 53.16 | 1.34 | 78.90 | 2.87 | 9.55 | 66.56 | 14.32 | 39.60 |
| XIV | 44.33 | 83.33 | 1.13 | 103.60 | 5.13 | 7.73 | 5.53 | 20.47 | 56.07 | 26.80 | 52.45 | 71.16 | 74.87 | 1.06 | 73.35 | 2.89 | 5.88 | 56.94 | 10.28 | 40.50 |
| XV | 42.67 | 88.00 | 2.15 | 106.07 | 4.60 | .07 | 5.93 | 31.00 | 63.80 | 34.87 | 70.66 | 83.87 | 81.76 | 1.41 | 66.29 | 3.31 | 11.94 | 92.89 | 12.93 | 42.02 |
| Percent contribution to diversity | 11.16 | 4.96 | 12.05 | 0.64 | 0.79 | 3.03 | 2.83 | 1.93 | 7.39 | 2.43 | 1.44 | 4.46 | 6.10 | 5.21 | 15.38 | 1.49 | 2.88 | 10.52 | 2.83 | 2.48 |

Characters most susceptable to maternal effects in the order were number of capsule bearing nodes to total number of nodes on secondaries and primaries, number of seeds per capsule, number of capsules on primaries, leaf area index and harvest index

When all the six hybrids expressing significant and positive heterobeltiosis and/ or standard heterosis for seed yield were considered, the parents involved in them were highly divergent (DC2) in five combinations and closely related (DC4) in one combination. These observations are in agreement with Rathinaswamy (1980), who reported that the cross combinations of intercluster origin had high frequency of heterotic hybrids than those of intraculster origin.

The $D^2$ cluster means for all the 20 characters are presented in Table 3. Cluster V recorded maximum values for seed yield and oil content besides number of primary branches and harvest index. The cluster recording maximum values for many characters was cluster XIII followed by cluster XV. With regard to the importance of each of the characters in diversity, the present study revealed the significance of number of seeds per capsule followed by leaf area index, percentage of capsule bearing nodes to total nodes per plant, total number of capsules per palnt besides days to 50 per cent flowering and dry matter production. The importance of number of seeds per capsule (Trehan, 1975) leaf area index (Reddy, 1986) and total number of capsules per plant (Trehan *et al.*, 1975 and Dhamu *et al.*, 1984) were reported by earlier workers also.

## ACKNOWLEDGEMENT

The authors are thanful to Dr. S.R. Sree Rangaswamy, Director, School of Genetics, Tamil Nadu Agricultural University,, Coimbatore, for the facilities provided and encouragement. The present article formed a part of the thesis submitted by the senior author for the award of M.SC. (Ag.) degree of the Tamil Nadu Agricultural University

## LITERATURE CITED

ARUNACHALAM, V., and BANDYOPADHYAYA, A. 1984. Limits to genetic divergence for occurance of heterosis-experimental evidence from crop plants. *Indian J. Genet.*, **44**(3):548-554.

DHAMU, K.P., AYYASWAMY, M.K. and SHANMUGASUBRAMANIAN. 1984. Genetic diversity in *Sesamum indicum* L. *Madras Agric. J.*, **70**(8):495-498.

MAHALANOBIS, P.C. 1936. On the generalised distance in the statistics. *Proc. Nat. Inst. Sci., India* **2**:49-55.

RAO, C.R., 1952. *Advanced Statistical Methods in Biometric Research.* John Wiley and Sons Inc New York, pp.390

REDDY, O.U.K. 1986. Studies on variability, character association and genetic divergence in *Sesamum indicum* L. M.Sc. (Ag.) Thesis, Tamil Nadu Agrl. University, Coimbatore, pp.106.

TREHAN, K.H., RAO, A.V., MEHTA, S.K., CHAND, H., SHARMA, H.N. and BAIJAL, S.K. 1975. Genetic divergence in sesame. *Indian J. Agric. Sci.*, **44**(4): 208-212.

J. Oilseeds Res. 7(1990) 72-77
*ISSN* 0970--2776

# CONSTRAINTS TO CASTOR PRODUCTION ON DRYLANDS

PARSHURAM SAMAL
Directorate of Oilseeds Research, Rajendranagar, Hyderabad-500 030.

ABSTRACT

This study attempts to find out the technological and socio-economic factors limiting rainfed castor production and its remedial measures. The paper is based on information gathered from 120 farmers covering 50 small, 39 medium and 31 large farmers during 1985-86. The prices data of two markets in the study area, collected during 1987-88 were also used. The technological factors limiting castor production identified were absence of quality seed and sub-optimal use of fertilizers. The various socio-economic factors hindering castor production were negative returns in comparison to costs incurred, wide range of fluctuation in prices over years in the absence of support price causing uncertainly, lack of timely availability of seeds and fertilizers, inadequate credit services. The policy measures to boost the castor production and productivity resulted from the study were i) announcing a favourable support price for castor ii) research efforts to evolve suitable varieties for the region and to find out optimum number of intercultural operations iii) seed production programmes to supply quality seed in adequate quantity and in time iv) extension efforts to popularise the advantages of top dressing and v) re-orientation of credit institutions.

**Key words** Castor, Socio-economic constraints.

## INTRODUCTION

Castor is one of the important cash crops in India by virtue of its export trade besides meeting internal demand of various industries such as soaps, paints, varnishes, synthetic detergents and a wide range of chemical products. The export figure for castor has reached Rs. 120.00 crores during the year 1984-85. This crop is largely grown by farmers of Andhra Pradesh and Gujarat state. Though Andhra Pradesh stands first in area coverage under this crop, the productivity level is far less than Gujarat State. In Andhra Pradesh castor is mainly grown as a rainfed crop by the farmers of Nalgonda, Mahboobnagar, Rangareddy, Prakasam and Warangal districts. The district Mahboobnagar was selected for the study from the top five districts mentioned above because it has the lowest per hectare yield (164 kg/ha), when data were considred for the last five years i.e., 1979-80 to 1983-84. This warrants to find out the production constraints causing low yields of castor through survey method. One of the major purposes of the survey aspect of the research is to understand why farmers are not using the inputs needed for high yields, or are not using them at the recommended rates (De Datta, S.K. et al. 1978).

## METHODOLOGY

The talukwise area of Mahboobnagar district under castor crop were collected for the last five years i.e., 1980-81 to 1984-85. It was observed that out of the thirteen taluks, Kalwakurthy taluk alone covers 51.39% of the total castor area in the district. Therefore, Kalwakurthy taluk was selected for the study. The farmers from the taluk were selected by adopting stratified random sampling with proportional allocation technique. Thus, the number of farmers selected from small (0-2 ha), medium (2-4 ha) and large (>4 ha) size groups were 50, 39 and 31 respectively. The required information

Received on February 15, 1989.

from the 120 farmers were obtained by personal interviews with the help of pretested schedules and questionnaires. The data were collected in two phases i.e., before and after harvesting by survey method to increase the accuracy of data collection. The data thus collected and analysed pertains to the cropping year 1985-86 *kharif* season. The prices data collected from two markets i.e., Kalwakurthy and Amangal situated in the study area, pertaining to the years 1983-84 to 1987-88 were also used in this paper.

## RESULTS AND DISCUSSIONS

During the survey a multitude of factors were identified as possible causes of low level of castor production. They were classified as environmental, technological and socio-economic. The environmental factors like rainfall pattern and soils are difficult to change. Therefore, the other two factors were investigated in more details which are relatively easier to manipulate to get better yield from castor crop.

### A. Technological Factors:

The missing and sub-optimal use of inputs are grouped under this head. It is expected that farmers would attain higher yields if they use inputs and cultural practices recommended by the research stations and development departments.

#### *i) Quality Seed:*

Though the farmers of the survey area were using improved varieties of seed like Aruna and GAUCH-1, the seeds were not true to the type. As castor is a cross pollinated crop, Aruna has degenerated over years and lost its yield potential in comparison to original type. The hybrid seeds of castor were not supplied by the Department of Agriculture which is the main supplier of quality seed to farmers.

#### *ii) Fertilizers:*

The fertilizer use level was much below the recommended level causing low yield which is shown in Table 1.

TABLE 1

**Fertilizers and plant protection chemicals used per hectare by different categories of farmers.**

| Size groups | Fertilizers | | Plant protection chemicals | |
|---|---|---|---|---|
| | Quantity in Kg. | Monetary Value | Quantity in Kg. | Monetary Value |
| 0 – 2 ha | 32.60 | 110.87 | 0.24 | 13.60 |
| 2 – 4 ha | 27.84 | 91.81 | 0.12 | 7.38 |
| > 4 ha | 32.93 | 100.17 | 0.11 | 6.82 |
| Overall | 31.35 | 100.00 | 0.14 | 8.45 |

On the average the level of use was 31 kg. per hectare which was 25% of the recommended quantity. The average expenditure on fertilizer input was Rs. 100 per hectare with a little variation among different size groups. Further more, the fertilizers were used mostly as basal application. The reasons of not using recommended doses were lack of capital and uncertainty of yield and price of castor.

B. **Socio-economi factors:**

The socio-economic factors indentified are presented in the following heads.

*i) Costs and returns:*

Though farmers used mostly farm produced inputs in the production process and the net returns were minus in all categories of farmers as is evident from Table 2.

TABLE 2
**Cost C and net returns by different categories of farmers per hectare.**

| Item | Size group in ha | | | Overall |
|---|---|---|---|---|
| | 0 – 2 | 2 – 4 | >4 | |
| Yield in kilograms/ha | 395.67 | 370.03 | 369.58 | 375.34 |
| Average price received per quintal (Rs.) | 274.38 (640.00) | 274.22 (640.00) | 276.04 (640.00) | 275.13 (640.00) |
| Gross Income (Rs.) | 1085.63 (2532.28) | 1014.71 (2368.19) | 1020.21 (2365.31) | 1032.67 (2402.18) |
| Cost C (Rs.) | 1766.87 (2128.53) | 1565.54 (1903.91) | 1430.25 (1766.53) | 1541.52 (1883.90) |
| Net return (Rs.) | -681.24 (403.75) | -550.83 (464.28) | -410 04 (598.78) | -508.85 (518.28) |

(Figures in parentheses indicate the values, when 1987-88 prices of castor are considered for calculating costs and returns).

The main reasons for losses were depressed price of the product in the year under survey (1985-86). When 1987-88 product prices were taken to calculate the gross returns and Cost C, the net returns were positive as is evident from Table 2. The other reasons for negative returns were low yield and increase in cost of production due to excessive use of bullock and human labour in inter-cultural operations.

*ii) Prices of Castor:*

The prices of castor fluctuate over years and over months within the same year as is shown in Table 3.

TABLE 3
**Post harvest prices of castor over years and months in Kalwakurthy and Amangal markets.**
Figures in Rupees

| YEAR | MONTHS | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | October | | November | | December | | January | | February | |
| | K | A | K | A | K | A | K | A | K | A |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 1983–84 | 481 | 469 | 538 | 531 | 579 | 570 | 585 | 568 | 520 | 511 |
| 1084–85 | 490 | 492 | 445 | 454 | 413 | 410 | 368 | 368 | 330 | 319 |
| 1985–86 | 279 | 290 | 279 | 277 | 295 | 273 | 269 | 297 | 280 | 290 |
| 1986–87 | 357 | 353 | 370 | 374 | 390 | 390 | 455 | 457 | 449 | 444 |
| 1987–88 | 619 | 610 | 640 | 653 | 645 | 647 | 652 | 668 | 653 | 661 |
| C.V. | 26.63 | 25.24 | 27.73 | 28.17 | 27.68 | 29.19 | 29.95 | 28.34 | 29.94 | 30.30 |

K — Kalwakurthy, A — Amangal.

The prices varied from Rs. 269/- to Rs. 653/- at Kalwakurthy and Rs. 277/- to Rs. 668/- at Amagal when the five year period fo 1983-84 to 1987-88 were considered. The co-efficient of variation during this period worked out to be 25-30 percent in both the markets which is condidered to be too high. In the absence of a support price, the price variability is more for which farmers face uncertainty in getting economical returns which is a disincentive to castor production. Especially, the prices were so low in the year under survey that all the castor farms incurred losses as shown in Table 2.

*iii) Input availability:*

The problem of getting different inputs like seed, fertilizers and pesticides were asked to farmers and the results were presented in Table 4.

TABLE 4
**Problems of getting inputs and credit by different categories of farmers.**

| Input | 0–2 ha | | 2–4 ha | | >4 ha | | Overall | |
|---|---|---|---|---|---|---|---|---|
| | No. $N_1=50$ | % | No. $N_2=39$ | % | No. $N_3=31$ | % | No. $N=120$ | % |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Seed | 47 | 94.0 | 34 | 87.2 | 22 | 71.0 | 103 | 85.8 |
| Fertilizers | 37 | 74.0 | 25 | 64.1 | 17 | 54.8 | 79 | 65.8 |
| Pesticides | 6 | 12.0 | 3 | 7.7 | — | — | 9 | 7.5 |
| Credit | 50 | 100.0 | 35 | 89.7 | 22 | 71.0 | 107 | 89.2 |

Out of different inputs, availability of quality seed was found to be the major consraint limiting castor peoduction. The seeds which were available in the market or supplied by the Government were not true to the type. Within different size groups of farms, the problems of getting quality seeds increases with decrease in farm size. Besides availability of quality seed, timeliness of getting quality seed and fertilizers was found to be another problem to farmers. The farmers of the survey area hardly used pesticides (Table - 1). So, the farmers are yet to comment on the timeliness of availability of this input.

*iv) Credit services:*

All the small farmers, 90 percent of the medium farmers and 71 percent of the large farmers had expressed their problems regarding availability of credit as revealed from Table 4. This is one of the major reasons for not applying fertilizers in the production process of castor.

**Policy implications:**

*i) Support price:* The Government should anounce a minimum support price with effective market support to assure minimum income to farmers considering Cost C, as the price is fluctuating in a wide range over years.

*ii) Research:* Research has so be intensified to evolve high yielding, drought and disease resistant varieties which can withstand weather fluctuations better than the ruling variety Aruna. The farmers took to intercultural operations six times which is uneconomical because of the excessive use of bullock labour. Therefore, trials have to be conducted to find out the optimum number of inter-cultural operations.

*iii) Seed production:* Pure seed of different recommended varieties is in short supply. There is urgent need to intensify the seed production programme so that farmers could get adequate quantity of quality seed in time.

*iv) Extension service:* Most of the farmers do not take up top dressing in the survey area. To convince the farmers of the benefits of top dressing of fertilizers large scale demonstrations have to be taken up.

*v) Institutional re-orientation:* The existing cooperatives are to be strengthened and reoriented so as to supply the needed credit with all the inputs to castor growers.

Above all, the improvemnt of castor production in the survey area calls for closer coordination among research scientists, policy makers, extension personnel, rural banking agencies and other development agencies.

## ACKNOWLEDGEMENT

The author is grateful to Dr. V. Ranga Rao, Project Director, DOR, Dr. K.P. C. Rao, Economist, NAARM and Dr. P.B. Parthasarathy, Professor (Ag. Economics) APAU, for their valuable guidance and encouragement during the course of the study and preparation of this paper.

## LITERATURE CITED

SBP Board of consultants and Engineers; Castor oil and its derivatives; Small Business Publications New Delhi — 7; PP 25-29.

DE DATTA, S.K. et al; A handbook on the methodology for an integrated experiment survey on rice yield constraints; IRRI, Phillipines; 1978 P.56.

J. Oilseeds Res. 7(1990) 78-97
*ISSN* 0970—2776

# DISEASES OF GROUNDNUT AND THEIR MANAGEMENT

M.P. GHEWANDE
National Research Centre for Groundnut, Junagadh-362 015 (Gujarat) India.

**ABSTRACT**

A large number of fungal diseases are known to be associated with groundnut crop in India. But leaf spots (early and late leaf spots), rust, collar rot, root rot and stem rot are the major diseases of economic importance. The yield losses caused by major diseases are of the high magnitude ranging from 13-59 per cent during both the seasons. Different aspects like losses, disease cycle and disease management strategies have been reviewed in detail. Major research accomplishments in groundnut fungal disease management are summarised. Research gaps and future priorities have been indicated.

**Key words** Groundnut, diseases.

## INTRODUCTION

Groundnut is the major oilseed crop accounting or 45% of the oilseeds area and 55% of the total oilseeds production. Average productivity in 1910 was 12 q/ha, in 1940 it was 10.2 q/ha, and in 1950 it was 9 q/ha and thereafter it has been between 8 to 9s q/ha. In fact, the productivity has decreased, whereas, many of the available varieties at many locations, under normal and disease and insect pests free situations are capable, of yielding 30 to 35 q/ha in India. Besides moisture stress and insect pests problems diseases have been recognised as the major factors limiting groundnut production (Chohan 1978). The All India Coordinated Research Project on Oilseeds (AICORPO), has estimated an annual increase of 5.5. to 6.0% in the production of oilseeds in the country by applying better management practices for disease control (Rajan, 1973). The groundnut crop suffers from a variety of pathogens, and the fungal pathogens being the most destructive. The relative economic importance of the diseases in different states is variable depending upon the local cultivation practices, the environment and the cropping patterns. Some diseases are widely distributed and cause economic crop losses while others are restricted in distribution and are not considered to be economically important at the present time.

A humble beginning on the study of groundnut diseases and their control was made only after the transfer of the research by the Indian Central Oilseeds Committee to the Government of India in 1966 (Chohan, 1978). The AICORPO was established in 1967 and systematic work on the management of groundnut diseases was satrted since then. Research on diseases of groundnut in India has been reviwed by Vasudeva (1962) and Chohan (1974), but disease situation has changed considerably since then.

In this paper the literature on major fungal diseases of both *kharif* (rainy season) and *rabi*/summer (post-rainy season) groundnut in India in respect to losses, disease

Received on Nov. 1, 1989.

cycle and disease management strategies has been reviewed. Major research accomplishments in groundnut fungal disease management are summarized. Research gaps and further priorities have been indicated.

## DISEASE SITUATION

Reports of the AICORPO and other pertinent literature (Subrahmanyam and McDonald, 1986) revealed that the incidence and severity of each disease varies between localities and seasons and there can be fluctuations in disease situation.

*Kharif:*

*Foliar diseases:* Leaf spots (early leaf spot – *Cercospora arachidicola* Hori and late leafspot – *Phaeoisariopsis personata* Berk. Curt. N. Arx) are more prevalent during the *kharif* season in all groundnut growing areas of the country. Late leaf spot is more severe than early leaf spot.

After the initial report of groundnut rust (*Puccina arachidis* Spag.) from Punjab (Chahal and Chohan, 1971), there have been records of its incidence from different parts of the country. Subrahmanyam *et al.*, (1979) reported that rust has been severe particularly in the southern states of India. Surveys conducted by the National Research Centre for Groundnut (NRCG), Junagadh during kharif, 1980-81, 1981-82 and 1982-83 revealed that the rust with moderate to heavy severity was distributed in all groundnut growing districts of Saurashtra region of Gujarat. It is evident from the literature that the rust on groundnut crop now seems to be prevalent throughout India. Of late, Alternaria leaf spot (*A. alternata* (Fr.) Keissler) is becoming increasingly important in Southern States (Subrahmanyam *et al.*, 1981) and Saurashtra region of Gujarat (Ghewande and Reddy, 1986) on *kharif* groundnut crop. The occurrence of *Alternaria* leaf spot was recorded on *kharif* crop from Vriddhachalam (Tamil Nadu)m during 1983-84, from Hissar (Haryana) and Dharwad (Karnataka) during 1985 and recently from Chiplima (Orissa) and Jalgaon (Maharashtra) during 1987.

Other fungal foliar diseases like anthracnose (*Colletotrichum dematium* (Pers. ex. Fr.) Con. Arx., *C. gloeosprioides* (*Glomerella cingulata* (Stomen) Spauld. & V. Schren Pepper spot and leaf scorch (*Leptosphaerulina crassiasca* Sechet ), Phomopsis leaf spot (*Phomopsis* sp.) Phyllosticta leaf spot (*Phyllosticta arachidis-hypogaea* Vasant Rao), Phoma leaf diseases (*Phoma microspora* Balasubramanian and Narayanasawamy *P. sorghina* (Sacc.) Boerema, Dorenbosch & V. kest), Myrothecium leaf blight (*Myrothecium roridum* Tode ex. Fr.), Dreschelera leaf blight (*Drechslera spicifera* (Bain) Von Arx.), Zonate leaf spot (*Cristulariella pyramidelis* waterman and Marshall), Cylindrocladium leaf spot (*Cylindrocladium scoparicum* Morgami), Pestpalotiopsis leaf spot (*estalotiopsis arachidis* Satya,) Powdery midew (*Oidium arachidis* chorin), and leaf blight (*Sclerotium rolfsii* Sacc.) have also been reported on *kharif* crop from different parts of the country. (Subrahmanyam and Ravindranath, 1988, Ghewande, 1988 d). But these diseases are not economically important at present.

*Seed and soil-borne diseases.* Collar rot (*Aspergillus niger* Van Tieghem. *A pulverulentus* (Mc Apine) Thom) is prevalent in almost all groundnut growing areas of the country. Collar rot particularly serious in the sandy loam and medium black soils of Punjab, Tamil Nadu, Uttar Pradesh, Rajasthan and Haryana. It also occurs with low to medium incidence in the states of Andhra Pradesh, Karnataka, Gujarat, Maharashtra, Madhya Pradesh, Orissa and Bihar. This disease is more extensive in the *kharif* than the *rabi*/summer season.

Stem rot caused by *Sclerotium rolfsii* Sacc. is sporadic in occurrence in most of the groundnut growing areas of the country. It is becoming more prevalent in Maharashtra, Madhya Pradesh, Gujarat, Andhra Pradesh, Tamil Nadu and Karnataka.

Root rot (*Macrophomina phaseolina* (Tassi) Goid) is sporadic all over the country in light soils. But it is moderate to serious in Andhra Pradesh, Tamil Nadu, Madhya Pradesh, Maharashtra, Uttar Pradesh, Rajasthan and Gujarat. Other seed and seedling diseases like Rhizoctonia wilt (*Rhizoctonia solani* Kuhn) yellow mould or aflaroot disease (*Aspegillus flavus* (Link) Fries) Fusarium wilt (*Fusarium oxysporum* Schl. emend Syn. and Hans., *F.solani* (Mart) App. and Wr. emend Syn. and Hans), Pythium (*Pythium myriotylum* Drechsler, *P. deberyanum* Hesse) and Rhizopus seed and seedling rot (*Rhizopus arrhizus* Fischer, *R. oryzae* Went and Gerlings, and *R. stolonifer* (Ehrenberg ex. Fr.) Vuillemin), diseases are also reported in some parts of the country. But these diseases are considred to be minor at the present time.

***Rabi*/Summer:**

*Foliar diseases:* The early and late leafspot are present in almost all *Rabi*/summer groundnut growing areas. Late leaf spot is predominant. It is particularly serious in Guntur, Prakasam, Nellore, Chittoor, Krishna, East Godavari, Kurnool, Nalgonda, Cuddapah districts of Andhra Pradesh, North Canara, Bangalore, Dharwad, Mandya and Raichur (Gangawathi area) districts of Karnataka in almost all groundnut growing districts of Tamil Nadu and Orissa (Subrahmanyam and McDonald, 1986).

Rust is present in almost all *Rabi*/summer groundnut cultivation areas. It is serious in Guntur, Prakasam, Nellore, Chittoor, Kurnool, Nalgonda and Cuddapah districts of Andhra Pradesh, in North Canara, Raichur and Dharwad district of Karnataka, in all groundnut growing areas of Tamil Nadu in the Union Territory of Pondicherry (Subrahmanyam and McDonald, 1986). Rust was reported to be serious in Chiplima (Orissa) and Jagtial (Andhra Pradesh) areas during 1983-84 rabi/summer (Anon. 1984). It is sporadic in occurrence and particularly moderate in coastal areas of Saurashtra region of Gujarat.

The Alternaria leaf spot and veinal necrosis disease (*A. alternata*) was first reported on Rabi groundnut (1978) near Madras in Tamil Nadu (Balasubramanian, 1979). Surveys conducted by the ICRISAT (Subrahmanyam *et al.*, 1981) on *Rabi* groundnut during the years 1977 to 1981 and the NRCG during the years 1981 to 1984 on *Rabi*/summer groundnut in the Southern states of Andhra Pradesh, Karnataka, Tamil Nadu

and the Union Territory of Pondicherry and Gujrat (Saurashta) respectively, revealed that the disease was becoming increasingly important in Southern groundnut growing states and Saurashtra region of Gujarat. Recently, stray incidence of this disease has been reported during *rabi*/summer, 1986-87 and 1987-88 from Chiplima (Orissa).

Other minor foliar diseases like Pepper spot and Leaf-scorch, anthracnose, Phyllosticta leaf spot, Dreshelera leaf blight, Exerohilum leaf spot (*E.halodes*). Alternaria leaf blight (*A.tennuissima*), Pestialotiopsis leaf spot and Phoma leaf spot were also recorded on *rabi*/summer groundnut in India. But these are minor diseases at the present time.

*Seed and seedling diseases:* Collar rot, 'aflaroot' and stem rot are the most commonly observed seedling diseases of *rabi*/summer groundnut in India (Anon. 1981-1988). During the ICRISAT survey in the 1979 *rabi*, collar rot and 'aflaroot' were commonly observed in parts of Kurnool, Cuddapah, West Godavari and Visakhapatnam districts of Andhra Pradesh. The incidence of 'aflaroot' was observed to be high in some fields near Kalahasti in Andhra Pradesh. These diseases are commonly present in almost all *rabi*/summer groundnut growing areas of Tamil Nadu and Karnataka. Recently, occurrence of collar rot, stem rot, Fusarium wilt and root rot have been reported from Chiplima (Orissa). Root rot was commonly observed with low incidence in Guntur, Chittoor and Kurnool districts of Andhra Pradesh, in Dharwad and Raichur distrcts of Karnataka, in Junagadh district of Gujarat and in several locations of Tamil Nadu. Pod rots caused by a variety of soil fungi were found to be serious in parts of North Arcot in Tamil Nadu in the 1980-81 *rabi*/summer season, and in North Kanara district of Karnataka in the 1981-82 *rabi*/summer season (Anon. 1981-1982).

From the disease situation in the country it can be concluded that among foliar diseases, only early and late leaf spots, rust and Alternaria leaf spot are wide spread and economically important diseases. Among seed and seedling diseases, collar rot, stem rot a and root rot are major diseases.

## YIELD LOSSES

It appears from the literature and the AICORPO annual progress reports that the yield losses caused by major foliar diseases like leaf spots and rust are of the high magnitude during both the seasons. In general, yield losses due to major seed and seedling diseases have not been worked out systematically and as such only emperical assessments are available.

## DISEASE CYCLE

*Leaf spots:* Early and late leaf spots pathogens are both soil and air borne, disease onset being earliest and attack most severe, when groundnut follows grounut in rotation. The pathogens may survive from season on volunteer groudnut plants and in infected crop debris. No authentic host species are known outside the genus *Arachis.* There is no evidence of either pathogens being internally seed borne. Long distance

**Yield losses due to major foliar and seed and seedling diseases in groundnut**

| Disease | Possible yield loss (%) | Reference |
|---|---|---|
| Leaf spots | 15–59 | Ramakrishna and Appa Rao, 1968; Chohan & Singh 1973; Ghewande *et al.*, 1983 |
| Rust | 13–52 | Siddaramaiah *et al.*, 1977; Ghuge *et al.*, 1981. Subrahmanyam *et al.*, 1980, Ghewande *et al.*, 1983. |
| Collar rot | 40–50 | Chohan, 1974; chahal *et al.*, 1974 |
| Stem rot | 27 & rabove | Mathur, 1953; Singh and Mathur, 1953; Chohan, 1974. |

distribution of the pathogens may be by air-borne conidia, by movment of infected crop debris, or by movement or pods or seeds that are surface-contaminated with conidia or infected crop debris. Temperature in the 25 ro 30°C range and high relative humidity favour infection and disease development (McDonald *et al.*, 1985). The mycelium and conidia of late leaf spot pathogen, can survive in soil for periods upto 22 weeks at 40 per cent moisture (Shanta, 1960). A period of 3 days of high humidity is essential for maximum infection in the case of both the pathogens (Ramakrishnan and Appa Rao, 1965). Conidia are produced directly from mycelium in crop debris in the soil following early rains and, when deposited on the leaves of young groundnut plants by rain splash and wind, they initiate the disease cycle (McDonald *et al.*, 1985). Karunakaran and Raj (1973), have shown that conidia have sufficient longevity to carry-over from one crop to another. Studies on the aerobiology of leaf spots have shown that a diurnal periodicity exists with peak catches of conidia at dew dry-off in the morning (Sreeramulu, 1970; Ghewande and Jhala, 1985).

The perfect stages of the pathogens have not been reported so far from India. However, the role of ascospores, if formed, in initiating the outbreak cannot be ruled out.

*Rust:* Groundnut rust is known to perpetuate, spread and produce severe disesae outbreaks by means of urediniospores. The pathogen is known almost exclusively by its uredinial stage. In India, Chahal anf Chohan (1971) recorded the occurrence of teliospores on groundnut leaves but gave no details of spore morphology. There are no other authenticated reports of the occurrence of teliospores of groundnut rust from India. It is not known if the fungus can produce pycnia and aecia or if any alternate host is involved in the life cycle. It would appear that urediniospers are the main, if not the only, means of dissemination of the groundnut rust disease (Subrahmanyam and Mc Donald, 1982 a, 1983 a, 1987). There is no record of the occurrence of any collateral hosts of groundnut rust outside the genus *Arachis* and in India wild *Arachis* species occur only in research centres and can hardly be involved in perpetuation of the groundnut rust pathogen (Subrahmanyam and Mc Donald, 1987).

Groundnut crop or volunteers are avialble in one or the other parts of the country enabling the survival of uredinial stage round the year. Actual surveys by the author had confirmed the survival of uredinial stage in Saurashtra region of Gujarat on volunteers of groundnut during the off-season (Ghewande and Misra, 1983). Subrahmanyam and Mc Donald (1982) have examined various common crops and weed plants as possible hosts for groundnut rust pathogen, but no case of infection was recorded. It has been reported that urediniospoes are short lived in infected crop debris (Mallaiah and Rao, 1979 b; Lingaraju et al., 1979; Subrahmanyam and McDonald 1982). The practice of continuous cultivation of groundnut appears to be an important factor in the perpetuation of groundnut rust in India (Mayee, 1981; Subrahmanyam and McDonald, 1982; 1983; 1987; Ghewande and Misra, 1983). Urediniospores can remain viable for several months when stored at temperature (-16°C) while at 40°C they lost viability within 5 days (Subrahmanyam and Mc Donald, 1987). Mallaih and Rao (1979 b) found that urediniospores remained viable for upto 4 weeks when stored at temperatures below 30 °C but lost viability within two weeks when stored at temperatures above 35°C. Mayee and Ekbote (1983) also reported that urediniospores remained viable for 20 days on leaf debris and at low temperature (-6°C) beyond 52 days. Thus it appears that temperature is an important factor influencing viability and longevity of groundnut rust urediniospores. There is no reliable evidence of groundnut rust being internally seed-borne (Mayee, 1981, Subrahmanyam and McDonald, 1982 a, 1983 a; Kolte and Awasti, 1979; Verma and McDonald, 1987). It has also been reported by Verma and McDonald (1987) that there should be no risk of rust diesease being spread through exchange of germplasm conducted through proper plant quarantine channels. An optimum temperature of 20°C, availability of liquid water on the leaf surface and high relative humidity favour infection (Mallaiah and Rao, 1979 a). The diurnal periodicity in urediniospore production by the groundnut rust pathogen was observed (Pande, 1982; Ghewande and Jhala, 1985). Intermittent rains with mean relative humidity above 87 per cent and temperatures between 23 and 24°C for several days favour increased initiation of infection (Krishna Prasad et al., 1979; Siddaramaiah *et al.*, 1980.

**Seed and seedling diseases:**

*Collar rot:* The primary source of the inoculum of collar rot pathogen has been shown to be mycelium and spores carried on the seeds and organic debris in the soil (Nema *et al.*, 1955). Seeds become infected during the last days of maturation in the soil and during harvesting, handling andrparticularly during shelling (Subrahmanyam and Rao, 1977).

*Root rot:* The root rot pathogen is seed and soil-borne and persists in the soil for long periods as actively growing mycelia or dormant sclerotia. Subrahmanyam and Rao (1977) reported that the fungus usually invades maturing shell and kernel tissues. The sclerotia retain their viability for a long time (Sunderaraman, 1928). The infected pods and kernels have an important role in the spread of the disease (Sunderaraman, 1928, 1929; Singh, 1948; Kang and Chohan, 1966; Ravindranath, 1975; Mridha and Fakir, 1978). Bell (1967) reported that optimum temperature for seedling infection seems to be bertween 29 and 35°C. High soil temperature and/or low soil moisture

are perhaps conducive for the activity and infection of the pathogen. The dissemination of the fungus is by sclerotia via plant debris and soil, and also infected pods, shell and kernel.

*Stem rot:* The stem rot pathogen of grouhdnut has a wide host range and spreads through infected soil, rain drops, sclerotia transport through infected soil, raindrops, and possibly through seed. Soil moisture plays an important role in germination of sclerotia and in fungal infection. Pathogenicity was found to be very high between 40 and 50 per cent soil mositure levels but there was no infection when the soil moisture level was 100 per cent (Subrahmanian, 1964; Onkarayya and Appa Rao, 1970).

## MANAGEMENT

*Host plant resistance:* Until recently there were no agronomically acceptable groundnut varieties with a high level of resistance to either of the leaf spots or rust. However, a foliar disease resistant variety viz., Girnar 1 (CGC 4018) has been developed in 1988 by the National Resrarch Centre for Groundnut, Junagadh. The variety, ALR 1 from Aliyarnagar (Tamil Nadu) resistant to foliar diseases has also been developed. Some other genotypes like ICGS (FDRS) 4 and ICGS (FDRS)10 developed by the ICRISAT are available. Screening for resistance to leaf spots and rust has been intensively carried out at different AICORPO groundnut centres, NRCG, ICRISAT and elsewhere in the coutry and a number of sources for foliar disease resistance have been reported (Chahal and Sandhu, 1972; Misra and Misra, 1975; Ravindranath and Indira, 1975; Singh *et al.*, 1976; Kolte *et al.*, 1977; Mehta and Mandal, 1978; Prasad *et al.*, 1979., Sharma and Mathur, 1979; Singh *et al.*, 1979; Mayee *et al.*, 1979; Subrahmanyam et al., 1980 a, 1980 b, A982 b, 1983 a. 1983 b, 1983 c, 1987; Ghewande *et al.*, 1983 and Anon. 1981-1989). Sources of multiple resistance especially for late leaf spot and rust are available from ICRISAT. These are: EC 76446 (292), NCAc 17133 RF, PI 259747, PI 350680, PI 215696, PI 381622, PI 390595 and USA 63. Recently, Ghewande et al., (1990 unpublished) have indentified 5 multiple disease resistant germplasm accessions viz., NCAc 17149, NCAc 927, NCAc 17133 RF, PI 393646 and PI 341879 which are resistant to early leaf spot, late leaf spot, rust and Alternaria leaf spot. Some wild Arachis species have been reported to be highly resistant or immune to late leaf spot and rust (Subrahmanyam *et al.*, 1980 b, 1983 d, McDonald *et al.*, 1985). Efforts are being made to involve several resistant lines in diesease resistance breeding programme at AICORPO centres, NRCG and ICRISAT. A lot of disease resitant material has been generated by these centres through this programme and some disease resitant advanced breeding lines with high yield potential are being tested under AICORPO trials.

Resistance to leaf spot pathogene has been attributed to various anatomical and morphological characteristics of host plant and to different cehmical constituents of host leaves and seed (Ravindranath *et al.*, 1965). There is some evidence of variation in pathogenicity in leaf spot fungi, but races have not been clearly characterised (McDonald et al., 1985).

The rust resistance at present available in the cultivated groundnut is of the "slow rusting type, i.e. resistant genotypes have increased incubation period, decreased infection frequency, and reduced pustule size and spore production and reduced spore viability (Sokhi and Jhooty, 1987). There is no authenticated report of the occurrence of races in groundnut rust.

Studies carried out at the NRCG showed that the resistance to both late leaf spot and rust diseases was recessive and under bigenetic control. The two genes governing rust resitance acted in a polymeric fashion. The bigenic control of resistance to late leaf spot was similar to that of duplicate genes (Tiwari *et al.*, 1984). Singh *et al.*, (1984) reported that rust resistance in some diploid wild Aachis species appears to be partially dominant in nature.

Chohan *et al.*, (1970) tested 734 groundnut genotypes for resistance to collar rot and found one genotype, EC 21115 (U4-47-7), highly resistant. J11, a spanish bunch released variety and other genotypes like C.No.-45-23, PI 350680, NCAc 17157, B-201 and RAU 31-3 have been reported to be resistant to collar rot in Ludhiana (Chahal *et al.*, 1974; Anon. 1984).

Resistant sources like TMV 1 (Shanmugam and Govindaswamy, 1973), TMV 8, (Lewin *et al.*, 1971). B 30 and B 31 (Raj and Prasad, 1975) and several others (Mathur *et al.*, 1967) for root rot (*M. phaselina*) have been reported.

Screening of groundnut germplasm for resistance to stem rot (*S. rolfsii*) has been carried out in India but a very few genotypes resistant/tolerant have been reported (Ma thur and Kureel, 1965). Mehan *et al.*, (1981) reported that the genotypes, J 11, NCAc 841, Exotic 6, Var. 27, Ah 7223 and Ah 7299, were found to be resistant to pod rot caused by *F.solani* and *F. oxysporum* in India.

It appears that a very limited sources of resistance to major seed and seedling diseases are available and requires large scale evaluation of available germplasm gainst these diseases in the country. Diseases resistance breeding programme especially in the case of collar rot at PAU, Ludhiana has been initiated.

*Cultural:* This aspect of plant disease management was neglected and/or over looked all these years. Spraying machines, chemicals and even water, often become limitations to marginal and small scale farmers. In such context, adoption of cultural practices would resolve the crop losses to some extent. Some of the cultural practices which can be adopted easily by farmers are: adjusting the date of sowing wherever possible so that the susceptible stage of the crop growth does not coincide with the environment highly congenial for pathogens to attack; close or wider planting. Much less is the scientific understanding with regard to the role of disease in the situations of sole groundnut crop vis a vis combination of other crops with groundnut in the same season. Leafspots and rust being mainly air borne diseases, spread quickly where there is continuity of host plants over large areas. It would be worthwhile knowing the various economically problem combinations which may check the spread of the diseases to some

extent. Optimum fertilizer schedules from disease situation point of view have not been so far established in groundnut. Crop rotation particularly in Saurashtra region of Gujarat state, is very rarely followed by the farmers which would certainly help in minimising the incidence of some soil-borne diseases.

Attempts have been made at the NRCG to control leaf spots and rust through agronomic practices. The early planting (15 days early than normal), plant spacing of 45× 10 cm and intercropping with redgram (*Cajanus cajan* L.) and castor (*Ricinis communis* L.)in 2:4 ratio reduced the leaf spots and rust by 7 to 21 percent (Ghewande *et al.*, 1986). Siddharamaiah *et al.*, (1980) have recommended sowing in the first fortnight of June to avoid the incidence of groundnut rust. Leafspot incidence could be reduced by early planting or groundnut (Ravindranath and Kulkarni, 1967). Kodmelwar and Ingle (1989) reported that early planting (June, 28) and wider spacing (30-40 cm) were found to reduce tikka and rust. Removal of volunteer groundnut plants, removal or burial of infected crop debris, crop rotation etc. are important in reducing the leaf spots and rust diseases (McDonald *et al.*, 1985; Subrahmanyam and McDonald, 1983). Rust progressed more slowly in treatments where 60 and 75 kg $P_2O_5$/ha were applied than in those where low levels of phosphorus or no phosphorus were given (Mayee, 1983). Strict plant quarantine regulations should be enforced to avoid the spread of rust on pods or seeds to disease free areas (Subrahmanyam and McDonald, 1983).

Deep planting of seed should be avoided as etiolated hypocotyls are prone to infection by collar rot pathogen. Deep ploughing of fields and rotation of groundnut with gram and wheat are useful in reducing the collar rot disease incidence (Chohan and Capoor, 1967; Ghewande, 1985). Chohan (1972) reported control of collar rot by resorting to early sowing in June. Rotation of crops in the case of *M. phaseolina* is not much helpful since the fungus has a wide host range and a saprophytic nature. Groundnut planted wih a spacing of 30 cm between the rows had lowest root rot incidence than when planted with a row spacing of 45 cm or 60 cm (Sharma 1982). The lower incidence of collar rot and stem rot in early sown (June) crop and close plant spacing has been reported (Ghewande, 1983). Cultural practices such as deep covering or burial of organic matter before planting, non durting cultivation by avoiding movement of soil up around the base of plants, prevention of development of organic debris are useful for reducing the incidence of stem rot.

*Biological:* Mycoparasites, *Dicyma pulvnata* (Berk. & Curt.) v. Arx (=*Hansforda pulvinata* (Berk. ; Curt.) Hughes) (Ashok Krishna and Singh, 1979; Siddharamaiah *et al.*, 1981) and *Verticillium lecanii* (Zimmerm) viegas McDonald *et al.*, 1985) have been observed to parasatize the early and late leaf spot pathogens of groundnut. Similarly, mycoporasites, *V.lecanii Penicillium islandicum* Sopp., *Eudarluca caricis* (Fr) O. Ericks, *Acremonium persicinum* (Nicot.) W. Gams, *Darulca filum* (Biv.) and *Tuberculina costaricana* Syd. have been observed to parasitize *P. arachidis* (Bhama, 1972; Sharma *et al.*, 1977, 1980; Subrahmanyam *et al.*, 1984, 1987). Mycophagus insects feeding on urediniospores of *P. arachidis* have also been reported (Shanmugam et al., 1975; Vaishnav and Kapadia, 1982). However, no serious attenpts were made to use mycoparasites in the control of leaf spots and rust diseases in the country. Attempts were made to

control leaf spot and rust both under laboratory and field conditions using several mycoparasites and their culture filtrates at the NRCG. Studies carried out at the NRCG showed that the *D. pulvinate* and *V. lecanii* and their feltrates inhabitated the in vitro spore germination of lalely culture spot pathogen by varying degrees (33-75%). Mycoparasites and their culture filtrates reduced *in-vive* development of late leaf spot significantly. The spray application of culture filtrate of both the mycoparasites reduced the leaf lesions by 37.5 to 50% and lesion size by 16.8 to 37.4% of late leaf spot and gave higher pod yield/ plant (17 g/plant) when compared with the control (13 g/plant) (Ghewande, 1989 a) Mycoparasites, *A.parasicimun E.caricis, P.islandicum, T. costaricana* and *V. lecanii* and their culture filtrates inhibited urediniospores germination and reduced rust development by varying degrees. Maximum inhibition of *in-vitro* germination of urediniospores and significant reduction in *in-vivo* development of rust was shown by *V.lecanii* and *P.islandicum* and their culture filtrates. The inoculation of mycoparasites and rust on the same day gave best control of rust. Spray of culture filtrates of *V.lecanii* and *P. islandicum* significantly controlled rust disease under field condition (Ghewande, 1989 b.)

Some soil fungi, actinomycetes and bacteria antagonastic to collar rot pathogen have been reported (Chohan, 1974). Both *Trichoderma viride* and *T.harzianum* were found to be capable of reducing the sclerotial population of *M.phaseolina* (Sharma 1982). It has been reported that the seed treatment with spores and mycelium of *T. polysporum* protects the seeds from invasion by *M.phaseolina* (Chohan, 1974).

*Chemical:* Several fungicides have been evaluated in different parts of the country for the control of leaf spots (Vijayan and Natarajan, 1964; Vidhyasekaren and Kondandaraman, 1968; Tandon and Singh, 1968; Lewin and Natarajan, 1971; Chahal and Aulakh, 1972; Sindhu and Chohan, 1972; Aulakh and Chahal 1973; Aulakh and Sunran 1973; Kolte and Sinha, 1976; Parni and Bandyopadhyaya, 1976; Singh and Naik, 1977; Siddaramaiah *et al.*, 1977; Kolta *et al.*, 1978; Rao, 1980; Vidhyasekaran, 1981; Singh and Kana, 1981; Sekhon and Dhillon, 1981; Narian *et al.*, 1981; Jani and Patel, 1981). Recently, Lalithakumari *et al.*, (1984) reported that among the fungicides tested against leaf spot, baycor gave an excellent control. Rattan and Kang (1984) also reported that carbendezim and benomyl were found to be effective in controlling leaf spots. Five sprays of carbendazim (0.05%) + mancozeb (0.2%) at 15 days interval were the best for the control of leaf spots in the late sown crops in Manipur (Gupta, 1985).

Research on fungicide control of groundnut rust have been carried out in different parts of the country (Patil and Kalekar, 1974; Seshadri, 1976; Mayee *et al.*, 1977, 1979; Padmanabhan *et al.*, 1977; Siddaramaiah *et al.*, 1977; Dorairaj and Mohan, 1978; Patil *et al.*, 1979; Kanjale *et al.*, 1981; Vidhyasekaran, 1981; Ghuge *et al*, 1981. Patil et al., (1983) reported that mancozeb was found to be very effective and economical for the control of rust giving a net profit of Rs. 543/ha followed by chlorothalonil. Similarly, Kalekar *et al.*, (1983) also reported that chlorothalonil 0.3% was found most effective in controlling rust intensity and increasing yield (73 to 1 0%) followed by mancozeb (32 to 58%). Natarajan *et al.*, (1983) have recommended that for the control of ground-

nut rust, triadimeform at 100 g/acre can be sparyed and two sprays are necessary on 35 and 50 days after sowing (cost benefit ratio for 100 g/acre was 1:3.2).

Several fungicides and their combinations have been tested for the control of leaf spots and rust since rust and leaf spots often appear together (Ponnaiah *et al.*, 1982; Rewal *et al.*, 1982; Natarajan, 1984). Shekhwat *et al.*, (1985) reported that the spray schedule consisting two sprays of mancozeb (0 .2%) at 35 and 70 days after germination and one spray of carbendezim (0.25%) at 60 days after germination was most economical with a ICBR of 1:2:85 and thus found suitable for its recommendation to the farmers of northern Saurashtra. Vyas *et al.*, (1986) recommended that Carbendazim (0.075%) +Mancozab (0:15%) mixture should be sprayed around August 15 which is most suceptible stage of the crop for both leaf spots and rust diseases and second and third spray should be repeated depending on the intensity of these diseases. The rust and leaf spots were substantially reduced due to the application of carbendazim (0:0 25%) + tridemorph (0 .40) five times at fortnightly intervals commencing 35 days after sowing during summer season (Jayasekhar and Rajasekharan, 1986). The leaf spots and rust are controlled effectively by the spray application of carbandazim (0.05%) + mancozeb (0.2%) at 2-3 weeks interval, 2 or 3 times starting from 4-5 weeks after planting and gave the highest CBR ranging from 1:14.8 to 1.24.4 under AICORPO (Anon. 1981-82). It has been reported by Ghewande (1989 c) that leaf extracts of *Azadrirachta indica* (Neem) and *Lawsonia alba* (Mehandi) at 2% were found to be useful in controlling late leaf spot and rust diseases.

Seed dressings with fungicides have given very good and effective control of collar rot disease. The commonly used seed protectant fungicides used against collar rot and other externally seed carried fungi is tetramethyl thiuram disulphide (thiram, TMTD). The beneficial affects of seed dressing with fungicides against collarrot have been reported by various workers (Chohan, et al., 1966; Gupta and Chohan, 1970 a, 1970 b; Kumar and Khare, 1970; Chohan 1971; Mathur and Sharma, 1970; Sindu and Chohan, 1971; Sharma *et al.*, 1973; Lal and Jayamma, 1978; Siddaramaiah *et al.*, 1979).

Root rot is both seed and soil-borne and the chemical control measures include both seed and soil treatment. Application of lime @ 1000 kg/ha is useful in reducing the root rot (Sundararaman, 1929). Pentachloro nitrobenzene (PCNB) 0 .5% can be applied @ 1 litre/square meter or in the form of soil dust @ 25 kg/ha in two split appli cations, 12.5 kg before sowing and the other 12.5 kg15 days later (Shanmugam and Govindaswamy, 1973).

A mixture of fungicides viz., terrachlor × terrazole @ 20 kg/ha + 40 kg/ha at pegging is effective in controlling stem rot (Chohan, 1978). Soil drenching with carboxin has been reported to be effective against *S.rolfsii* (Amma and Shanmugam, 1974). Dhamnikar and Peshney (1982) reported that dry seed dressing. with PCNB (0 .3%), mancozeb (0.3%) and carboxin 0 .1% gave good control of Sclerotium wilt of groundnut. Fungicides have also been evaluated for the control of stem rot (Siddaramiah *et al.*, 1979; Patil and Rane, 1982).

The development of resistance by fungi to more and more specialized fungicides appears to be an obvious corollary. For example, continuous seed treatment with seed dressing fungicides in groundnut yielded tolerant strains of *S. rolfsii* (Saler and Gangawane, 1981a).

It appears from the literature that a considerable work on the evaluation of fungi cides for the control of foliar and seed and seedling diseaseshas been done in the country. However, further research work involving a large number of fungicides available and some new ones for feasibility of application by the marginal and small farmers with reference to economics will continue as on going programme for AICORPO centres. For an effective chemical management programme, particularly in the case of leaf spots and rust, an efficient disease forecasting service on a regional basis becomes a pre-reqsits for economic preventive measures.

## MAJOR RESEARCH ACCOMPLISHMENTS

Inspite of many limitations, the AICORPO groundnut research centres, NRCG, ICRISAT and Agricultural Universities in India have made significant contribution in the field of disease management in groundnut and generated some useful results which are summarized below:

1. Many new diseases have been recorded on groundnut which otherwise would have gone unnoticed and established.

2. The losses from major fungal foliar diseases like leaf spots and rust have been worked out and based on this information economic importance of these diseases has been determined.

3. A large number of germplasm lines resistant to one or more diseases have been identified and wre further evaluated in the multilocation uniform disease nurseries.

4. Foliar disease resistant sources have been incorporated into the disease resistant breeding programmes and advanced foliar disease resistant breeding lines/varieties have been developed (e.g., Girnar 1, ALR 1, ICGS (FDRS)4 and ICGS (FDRS)10.

5. Many seed dressing fungicides have been evaluated for their efficacy in controlling seed and seedling diseases and chemicals like thiram, mancozeb and carbendazim have been recommended.

6. Control measures for all the major fungal diseases i.e., leaf spots, rust, collar, rot root rot and stem rot have been determined. The most significant achievement in this area is the control of leaf spots and rust by the spray application of carb dazim (0.05%) + mancozeb (0.2%) at 2-3 weeks interval, 2 or 3 times starting from 4-5 weeks after planting with the highest CBR ranging from 1:14.8 to 1:24.4. Thees chemicals and spray schedule have been recommended at a national level.

## RESEARCH GAPS AND FUTURE PRIORITIES AND THRUSTS

1. The survey and survillance system for groundnut diseases have not been established in the country. It would provide reliable information on the changesof disease complex in dynamic agricultural system, thus in turn helping to prevent epidemics through such measures as replacement or readjustment of crop varieties and agricultural practices.

2. Disease resistance : is a much desired component of disease management in groundnut and is in its infancy in the country. Durable and dependable sources of resistance to fungal diseases in groundnut are very limited in number. There is a need to concentrate on "germplasm enhancement" to obtain higher levels of resistance to economically important diseases. Disease management practices like cultural and chemical effective and economical in one situation may not be suitable in another. Therefore, there is a need to develop multiple disease resistant varieties. In doing so, it is necessary to take into consideration the stability of resistance in relation to host pathogen × environment interaction, and the possible occurrence of races of pathogens.

3. Whether it is a case of deriving horizontal resistance or may it be varietal resistance, the knowledge of pathogen variability is prerequisite for rational hybridization programme. It is necessary to make an indepth study on race flora of major foliar diseases.

4. Additional information on cultural and biological management of economically important diseases needs to be generated for formulating integrated disease management programme in groundnut.

5. Although a large number of diseases occurring on groundnut have been reported, biology, epidemiology and suitable control measures are known only for a few. Research work on these aspects need to be carried out in the case of diseases which are on increase (e.g. Alternaria leaf spot).

6. A disease forecasting system needs to be developed in the country to forewarn groundnut farmers of epidemics of both rust and leaf spots.

7. Efforts are required to be made in utilizing all available and compatible disease control measures in an integrated way wherever possible in increasing groundnut production.

## ACKNOWLEDGEMENT

Author is thankful to Dr. P.S. Reddy, Director, NRCG, Junagadh for encouragement.

## LITERATURE CITED

AMMA, P.A. and SHANMUGAM, N. 1974. Studies on the root rot of groundnut caused by *Sclerotium rolfsii* Sccc. Madras Agric. J. **61**:973-978.

ANON. 1981-89. Annual Progress Reports, Kharif and Rabi/summer groundnut, All India- Co-ordinated Research Project on Oilseeds, Directorate of Oilsseeds Research, Rajendranagar, Hyderabad.

ASHOK KRISHNA and SINGH, R.A. 1979. *Hansfordia pulvinata* mycoparasitic on Cercospora species causing "Tikka disease" of groundnut. Indian Phytopath. **32**:318-320.

AULAKH, K.S. and CHAHAL, A.S. 1973. Chemical control of leaf spot of groundnut. Indian Phytopath. **26**:68-71.

AULAKH, K.S. and SUNAR, M.S. 1973. Chemical control of leaf spot of groundnut. Indian Phy topath. **26**:68-71.

BALASUBRAMANIAN, R. 1979. A new type of alternariosis in *Arachis hypogaea* L. Cur. Sci. **48**(2): 76-77.

BELL, D.K. 1967. Pathogenecity of fungi to peanut seedlings in known fungi culture at four temperatures. Oleagineux **22**:373-375.

BHAMA, K.S. 1972. A rust on groundnut leaves near Madras. Curr. Sci. **41**:188-189.

CHAHAL, A.S. and AULAKH, K.S. 1972. Control of leaf spot of *Cercospora arachidicola* and *Cercospora personata* of groundnut with benomyl. Plant Dis. Reptr. **56**:1099-1100.

CHAHAL, A.S. and CHOHAN, J.S. 1971. *Puccinia* rust on groundnut, FAO Plant Prot. Bull. **19**:90.

CHAHAL, A.S. and SANDHU, R.S. 1972. Reaction of groundnut varieties against *Cercospora personata* and *C. arachidicola*. Plant Dis. Reptr. **56**:601-603.

CHAHAL, A.S., DUTT.S. and CHOHAN, J.S. 1974. Varietal resistance in groundnut (*Arachis hypogaea* L.) to collar rot (*Aspergillus niger*) in the Punjab State. J. Res. Punjab Agric. Univ **11**(2): 200-203.

CHOHAN, J.S. 1971. Seed and soil-borne fungi, seed rot, and seedling diseases of groundnut and their control. Labsev. J. Sci. Tech. **9B**: 10-16.

CHOHAN, J.S. 1972. Final Progress Report, I.C.A.R. Scheme for research on important diseases of groundnut in the Punjab for the period 1957-67. Deptt. Plant Pathology, Punjab Agri. Univ. Ludhiana, India 117 pp.

CHOHAN, J.S. 1974. Recent Advances in diseases of groundnut in India. In: Current trends in Plant Pathology. pp. 171-184., Lucknow Univ. Press, Lucknow, India.

CHOHAN, J.S. 1978. Diseases of Oilseeds Crops, future plans and strategy for control under small holders farm conditions. India Phytopath. **31**:1-15.

CHOHAN, J.S. and CAPOOR, S.P. 1967. Cultural factors in relation to collar rot of groundnut. J. Res. Punjab Agric. Univ. **4**:536-542.

CHOHAN, J.S. and SINGH, T. 1973. Control of seed-borne pathogens in groundnut. Indian J. Mycol. Pl. Pathol. **3**(2): 1993-94.

CHOHAN, J.S., RAI, I.S. and CAPOOR, S.P. 1966. Comparison of non-mercurial and mercurial fungicides for control of collar rot of groundnut. J Res. Punjab Agric. Univ., **3**:406-409.

CHOHAN, J.S., SANDHU, R.S. and DALAL, J.L. 1970. Screening of world collection of groundnut (*Arechis hypogaea* L.) germplasm for resistance to collar rot disrases caused by *Aspergillus niger* van Tiegham in Punjab. Indian J. Agric. Sci. **40**:546-551.

DHAMNIKAR, S.V. and PESHNEY, N.L. 1982. Chemical control of Sclerotium wilt of groundnut Pesticides **16**:19-21.

DORAIRAJ, P. and MOHAN, R. 1978. Evaluation of fungicides for the control of groundnut rust. Madras Agric. J. **65**:692.

GHEWANDE, M.P. 1983. Effect of cultural practices on the disease (bud necrosis, collar rot, stem rot) incidence and yield of groundnut. Indian Bot. Reptr. **2**:176-177.

GHEWANDE, M.P. 1985. Seed and seedling diseases of groundnut deserve attention for better productivity. Seeds & Farms. **11**(3):9-19.

GHEWANDE, M.P. 1989 a. Biological control of late spot (*Phaeoisariopsis personata*) of groundnut. *Arachis hypogaea* Indian J. of Agri. Sci. **53**(3): 189-90.

GHEWANDE, MP. 1989 b. Biological control of groundnut (*Arachis hypogaea* L.) rust (*Puccinia arachidias* Speg.) in India. Tropical Pest Management (Accepted).

GHEWANDE, M.P. 1989 c. Management of foliar diseases of groundnut (*Arachis hypogaea*) using plant extracts. Indian J. of Agri. Sci. **59**(2):133-4.

GHEWANDE, M.P. 1989 d. Fungal diseases of groundnut and their management. In Ground Production Technology, NDDB, Sept. 25-30, 1989.

GHEWANDE, M.P. and JHALA, R. 1985. Epidemiology of foliar diseases of groundnut. Absrt. Vol. Proc. of 3rd International Conference on Aerobiology, August 6-9, 1986, Basel Switzerland.

GHEWANDE, M.P. qnd MISRA, D.P. 1983. Groundnut Rust: A challenge to meet. Seeds & Farms **9**(6):12-15.

GHEWANDE, M.P. and REDDY, P.S. 1986. Strategy for the management of major diseases of groundnut. Pesticides. **20**(5):57-61.

GHEWANDE, M.P., SHUKLA, A.K., PANDEY, R.N. and MISRA, D.P. 1983. Losses in groundnut yields due to leaf spots and rust at different intensity levels. Indian J. Mycol Pl. Pathol. **13** (1):125-127.

GHEWANDE, M.P., SHUKLA, A.K. and PANDEY, R.N. 1986. Management of foliar diseases of groundnut through agronomic practices. Indian Bot. Reptr. **5**:(2):122.

GHEWANDE, M.P., DESAI, S., PREM NARAYAN and KAMBLE, S.D. 1990. Some sources of resistance to early leaf spot of groundnut (*Arachis hypogaea* L.) in India. Tropical Agriculture (Communicated).

GHUGE, S.S., MAYEE, C.D. and GODBOLE, G.M. 1981. Assessment of losses in groundnut due to rust and tikka leaf spots. Indian Phytopath. **34**:179-182.

GUPTA, V.K. and CHOHAN, J.S. 1970 a. Losses and nature of damage caused by seed rot fungi in a stored groundnut in Punjab. Indian Phytopath **23**:606-609.

GUPTA, V.K. and CHOHAN, J.S. 1970 b. Seed-borne and seed health testing in relation to seedling diseases of groundnut. Indian Phytopath. **23**:622-625.

GUPTA, D.K. 1985. Fungicidal control of Tikka disease of groundnut in Manipur Indian J. Mycol Pl. Pathol. **15**(11:99-101.

JANI, S M and PATEL, P K 1981. Evaluation of different fungicides for the control of Cercospora leaf sopt of groundnut. Gujarat Agric. Univ. Res. J. 6:72-74.

JAYASEKHAR, M. and RAJASEKARAN, R. 1986. Appraisal of yield loss in groundnut due to rust and late leaf spot. Madras Agric. J. **73**(9): 525-527.

KALEKAR, A.R., PATIL, B.C. and MORE, B.B. 1983. Evaluation of fungicides against groundnut rust (*Puccibia arachidis* Speg.) Pesticides **19**(8):61-64.

KANG, M.S. and CHOHAN, M.S. 1966. Some pathogenic fungi from groundnut seeds in Punjab. J. Res. Punjab Agric. Univ. **3**:158-161.

KARUNAKARAN, P. and RAJ, J.S. 1973. The survival of *Cercospora personata* (Berk. & Curt.) E 11. & Ev., *Cercospnra libisci* Tracy and Earle, and *Cercospora henningsii* Allesch in the soil. Agric. Res. J. Kerala **11**:162-163.

KENJALE, L.D. SHINDE, P.A. and UTIKAR, P.G. 1981. Loss in groundnut yield due to rust. Indian Phytopath. **34**:374-376.

KODMELWAR, R.V. and INGLE, A.Y. 1989. Effect of sowing dates, spacing and meterological factors on the development of tikka and rust of groundnut. Indian Phytopath. **42**(2):274.

KOLTE, S.J. and SINHA, A.P. 1976. The influence of soil and seed application of certain systemic fungicides on the severity of *Cercospora* leaf spot of groundnut. Pesticides **10**:31-32.

KOLTE, S.J., TEWARI, A.N. and AWASTI, R.P. 1978. Chemical control of *Cercospora* leaf spot of groundnut. Pesticides **12**:21-25.

KOLTE, S.J. and AWASTHI, R.P. 1979. *Some observations on occurrence of groundnut rust in the* Nainital Tarai region of Uttar Pradesh. Indian Phytopath. **32**:155-156.

KOLTE, S.J., TEWARI, A.N. and AWASTHI, R.P. 1977. Source of resistance to *Cercospora* leaf spot of groundnut. Indian Phytopath. **30**:421-422.

KRISHNA PRASAD, K.S., SIDDARAMAIAH, A.L. and HEGDE, R.K. 1979. Development of peanut (groundnut) rust disease in Karnataka State India. Plant Dis. Reptr. **63**:692-695.

KUMAR, S.M. and KHARE, M.N. 1970. Efficacy of seed dressing fungicides in controlling *Aspergillus* blight of groundnut. Mysore Agril. J. **4**:349-351.

LAL, T.B. and JAYAMMA, K.K. 1978. Evaluation of seed dressing fungicide mixtures against *Aspergillus niger* the incitant of collar rot of groundnut. Indian J. Plant Prot. **6**:15-18.

LALITHAKUMARI, D., GANESAN, T. and NAGESWARA, RAO, M. 1984. Effect of systemic fungicides on the physiological response of groundnut plant against tikka leaf spot. Indian Phytopath. **37**(1):111-114.

LEWIN, H.D. and NATARAHAN, S. 1971. Fungicidal control of Tikka leaf spot of groundnut in Tamil Nadu. Madras Agric. J. **58**:480-487.

LEWIN, H.D., LEELA DAVID, A., SAROJA, R., NATARAJAN, S. and JANARATHNAM, R 1971. A comparative study on the pests and diseases of different strains of groundnut. Madras Agric J. **58**:1-20

LINGARAJU, S., SIDDARAMAIAH, A.L. and HEGDE, R.K. 1979. *Viability and survival of ure*dospores of *Puccinia arachidis* Speg. in Dharwad. Curr. Res. **8**:68-69.

MALLAIAH, K.V. and RAO, A.S. 1979 a. Groundnut rust: Factors influencing diseases development, sporulation and germination of uredospores. Indian Phytopath. **32**:382-388.

MALLAIAH, K.V. and RAO, A.S. 1979 b. Survival of groundnut rust in India. Indian J. Microbiol. **19**:209-213.

MATHUR, S.C. 1953. Diseases of groundnut in Uttar Pradesh. J. Agri. Ani. Hush (Spl. number. **10**: 12:49-53

MATHUR, R S and KUREEL, D C 1965 Search of resistance in groundnut varieties to sclerotial root rot in Uttar Pradesh Indian Oilseeds J 9:152-153

MATHUR, S.B., SINGH, A. and JOSHI, L.M. 1967. Varietal response in groundnut to *Sclerotium bataticola*. Plant dis. Reptr. **51**:649-651.

MATHUR, R.L. and SHARMA, L.C. 1970. Observations on performance of groundnut varieties with respect to crown rot disease (*Aspergillus niger*) in Rajasthan. Indian Phytopath. **23**:143-144

MCDONALD, D., SUBRAHMANYAM, P., GIBBONS, R.W. and SMITH, D.H. 1985. Early and late leaf spots of groundnut. Information Bulletin No.21. Patancheru, A.P. 502 324. India International Crops Resaerch Institute for the Semi-Arid Tropics.

MAYEE, C.D. and KEBOTE, A.V. 1983. Life cycle and micro-epidemiology of *Puccinia arachidis* Speg., rust of groundnut in Maharashtra. Indian Plant Path. **1**:62-67.

MAYEE, C.D. 1981. Epidemiology of groundnut rust from Marathwada. Third International Symposium on Plant Patholgy, New Delhi. December 14-18, 1981 (Abstract)

MAYEE, C.D. 1983. Epidemiology and forecasting of groundnut rust in Marathwada region: final report India: Marathwada Agricultural University, Parbhani, Maharashtra 76 pp

MAYEE, C.D., PATIL, F.S., PEDGADNKER, S.M. and GODBOLE, G.M. 1977. Some aspects of control of *Puccinia arachidis* Speg. MAU, Res. Bull. **1**:72-74.

MAYEE, C.D., PATIL, M.A., GODBOLE., KIDE, D.S. and P ATIL, F.S. 1979. Fungicidal control of groundnut rust. Pesticides. **13**:13-14.

MEHTA, P.P. and MANDAL, K.K. 1978. Field screening of groundnut cultures against rust and tikka Indian Phytopath. **31**:259-260.

MEHAN, V.K., MCDONALD, D. and RAO, V.R. 1981. Pod rot disease of peanut at ICRISAT, India. Proc. Amer. Peanut Res. Educ. Soc. 13-91.

MISRA, A.K. and MISRA, A.P. 1975. Groundnut rust in Bihar-Varietal reaction. Indian Phytopath. **28**:557-55 9

MRIDHA, A.U. and FAKIR, G.A. 1978. Seed transmission of *Macrophomina phaseolina* and *Sclerotium rolfsii* in groundnut (*Arachis hypogaea* L.) in Bangladesh, Bangladesh J. Bot. 7:31-34.

NARAIN, A., SAHU, K.C. and SWAIN, N.C. 1981. Comparative efficacy of selected fungicides and a plant extract on tikka disaeses of groundnut. Pesticides **15**:27-28.

NATARAJAN, S., SACHIDANAMTHAM, K., RAJAMANICKAM, B. and MADHAVA RAO, S. 1983. Chemical control of groundnut rust with triadimefon. Pesticides **17**(1): 17-18.

NATARAJAN, S. 1984. Fungicidal control of rust and tikka leaf spot of groundnut. Pesticides **18** (11): 40-41

NEMA, K.G., JAIN, A.C. and ASTHANA, R.P. 1985. Further studies on *Aspergillus blight* of groundnut seedlings and its control. Indian (Phytopath. **8**: 13-21.

ONKARAYYA, M. and APPA RAO, A. 1970. Factors influencing the stem rot of groundnut. Indian J. Agric. Sci. **40**:1077-1081.

PANDE, B.N. 1982. Atmospheric concentration of uredospores over groundnut field. Indian Bot. Reptr. **1**:168.

PADMANABHAN, D., VISVANATHAN, A. and RAJU, P.D. 1977. Study of the incidence and control of groundnut rust in Tamil Nadu. Pesticides **11**:42-44.

PARNI, NR. and BANDYOPADHYAYA, D.C. 1976. Control of tikka disease of groundnut by fungicides. Sci. and Cult. **42**:521-523.

PATIL, B.P. and KALEKAR, A.R. 1974. Effect of seven fungicides and antibiotics on the intensity of leaf rust of groundnut (*Puccinia arachidis* Speg.) Pesticides **8**: 23-25.

PATIL, M.B., WANI, P.V. and PATIL, G.D. 1979. Evaluation of fungicides for the control of groundnut leaf rust (*Puccinia arachidis* Speg.) Pesticides. **13**:24-25.

PATIL, M.B. and RANA, M.S. 1982. Incidence and control of *Sclerotium rolfsii* wilt of groundnut. Pesticides. **16**:23-24.

PATIL, M.B., JADHAV, B.R. and RANA, M.S. 1983. Fungicidal control of groundnut rust. Indian J. Mycol. and Pl. Pathol. **13**(2): 225-226.

PRASAD, K.S.K., HEGDE, R.K., SIDDARAMAIAH, A.L. and JAYARAMAIAH, H. 1979. Screening of groundnut varieties for tikka disease resistance. Curr. Res. **8**: 104-105.

PONNIAH, S., SACHITHANANTHAM, K. and MADHAVA RAO, S. 1982. Evaluation of fungicides against tikka and rust disease of groundnut. Pesticides **16**(11): 27-28.

RAJAN, S.S. (Ed.) 1973. National Commission on Agriculture; Report on Oilseed study Team No.8, 221 pp.

RAJ, S.A. and PRASAD, N.N. 1975. Reaction of groundnut to *Rhizoctonia bataticola* (*Macrophomina phaseoline*). Indian Phytopath. **28**: 440-441.

RAO, A.N.S. 1980. Control of tikka leaf spot of groundnut by Carbendazim. Pesticides. **14**:23.

RAMAKRISHNAN, V. and APPA RAO, A. 1968. Studies on Tikka disease of groundnut. Indian Phytopath. **21**: 31-36.

RATTAN, G.S. and KANG, M.S. 1984. Efficacy of different systemic and non-systemic fungicides against tikka disease of groundnut and their effects on host physiology. Pesticides **18**(14): 30-32.

RAVINDRANATH, V. 1975. Studies on some seed and soil-borne diseases of groundnut. Ph.D thesis, Banaras Hindu University, Varanasi, India.

RAVINDRANATH, V. and INDIRA, S. 1975. Screening of groundnut (*Arachis hypogaea* L.) against rust (*Puccinia arachidis* Speg.) Indian Phytopath. **28**:121-123.

RAVINDRANATH, V., APPAJI RAO, B. and KULKARNI, L.G. 1965. Preliminary biochemical observation on leaf spot disease of groundnut. Indian Phytopath. **18**: 206-207.

RAVINDRANATH, V. and KULKARNI, L.G. 1967. Effect of different dates of sowing groundnut on the development and intensity of leaf spot disease by *Cercospora* Spp. Indian Journal of Agril. Sci. **37**: 362-368.

RAWAL, P.P., JAIN, S.M. and KHANDAR, R.R. 1982. Foliar diseases of groundnut in Gujarat. Indian Farming. **32**(41:17-20.

SALER, R.S. and GANGAWANE L.V. 1980. Tolerance of target and non-target spermosphere microfungi of groundnut to fungicides. Pesticides. **14**: 22-24.

SEKHON, I.S. and DHILLON, A.S. 1981. Studies on chemical control of 'tikka' disease of groundnut. Pesticides. **15**: 19-21.

SESHADRI, K. 1976. Effect of fungicides in the control of groundnut rust. Madras Agric. J. **63**: 416-417.

SHANTA, P. 1960. Studies on Cercospora leaf spot of groundnuts (*Arachis hypogaea*) J. Madras Univ. **30**: 167-177.

SHANMUGAM, N. and GOVINDASWAMY, C.V. 1973. Varietal susceptibility of groundnut (*Arachis hypopgea* Linn) to Macrophomina root rot. Madras Agric. J. **60**: 591.

SHANMUGAM, N., THANGAVELU, P. and VASANTHARAJ DAVID. 1975. Occurrence of a mycophagus thrips on the recently recorded groundnut rust. Sci. & Cult. **41**: 80.

SHARMA, R.C. 1982. Studies on groundnut root rot caused by *Macrophomina phaseolina* (Tessi) Goid (=*Rhizyctonia bataticola* (Taub) Butler. Ph.D. thesis, I.A.R.I., New Delhi.

SHARMA, L.C. and MATHUR, A.K. 1979. Reaction of groundnut cultivars to Carcospora leaf spots Madras Agric. J. **66**:626.

SHARMA, L.C., MATHUR, R.L. and DALELA, G.C. 1973. Check crown rot in groundnut. Indian Farming **23**: 24-25.

SHARMA, N.D., VYAS, S.C. and JAIN, A.C. 1977. *Tuberculina costaricana* Syd: A new hyperparasite on groundnut rust (*Puccinia arachidis*) Speg. Curr. Scil **46**:311-312.

SHARMA, N.D., VYAS, S.C. and JAIN, A.C. 1980. *Euderluca caricis* (Fr.) O. Erikss, a new hyper parasite on *Puccinia arachidis* Speg., the incitant of groundnut rust. Sci. & Cult. **46**: 50.

SHEKRAWAT, P.S., PATEL, V.N. and PATEL, J.G. 1985. Economic fungicidal spray schduel for control of Tikka and Rust diseases of rainfed groundnut. Indian J. Mycol. & Pl. Pathol. **17** (1(): 11-16.

SIDDARAMAIAH, A.L., PRASAD, K.S.K. and HEGDE, R.K. 1977. Chemical control of groundnut rust. Pesticides **11**: 38-39.

SIDDARAMAIAH, A.L., PRASAD, K.S.K. and HEGDE, R.K. 1979. Effectivenes of seed dressing chemicals against crown rot of groundnut. Pesticides **13**: 28-29.

SIDDARAMAIAH, A.L., DESAI, S.A., HEGDE, R.K. and JAYARAMAIAH, H. 1980. Effect of different dates of sowing of groundnut on rust development in Karnataka. Proc. Indian Nat. Sci. Acad. (B) **46**: 389-392.

SIDDRAMAIAH, A.L., DESAI, S.A. and JAYARAMAIAH, R. 1981. Occurrence and severity of a mycoperasite on 'tikka' leaf spots of groundnut. Curr. Res. **10**: 14-15.

SINGH, V.B. 1948. Phytopathological examination of seeds by Ulster method. Curr. Sci. **17**: 266-297

SINGH, B. and MATHUR, S.C. 1953. Sclerotial root rot disease of groundnut in Uttar Pradesh. Curr Sci. **22**: 214-215.

SINGH, B.P., SHUKLA, B.N., JOSHI, L.K. and NEMA, K.G. 1976. Screening of groundnut varieties against rust (*Puccinia archidis*) JNKVV. Res. J. **10**: 91-92.

SINGH, B.P., SINGH, S.P., MOHAMMAD, A., SINGH, D.K., AHMAD, Q. and ASTHANA, K.S. 1979. Sources of resistance in groundnut against tikka disease in Bihar. Indian Phytopath. **32**: 648-649

SINGH, P.P. and KANG, M.S. 1981. Effectiveness of Bavistin in controlling *Cercospora* leaf spot of groundnut and its effect on growth, yield and oil content of the crep. Pesticides **15**:16-19.

SINGH, S.D. and NAIK, S.M.P. 1977. Field evaluation of some modern fungicides for the control of tikka disease of groundnut, Pesticides **11**: 49-50.

SINGH, A.K., SUBRAHMANYAM, P. and MOSS, J.P. 1984. The dominent nature of resistance to *Puccinia arachidis* in certain wild Arachis species. Oleagineux **39**(11): 535-537.

SINDHU, G.S. and CHOHAN, J.S. 1971. The field scale testing of different fungicides for controlling collar rot of groundnut in the Punjab J. Res. Punjab Agric. Univ. **8**: 211-214.

SINDHU, G.S. and CHOHAN, J.S. 1972. Field scale testing of fungicides for the control of leaf spot (tikka) disease of groundnut in the Punjab, J. Res. Punjab Agric. Univ., **9**:451-454.

SOKHI, S.S. and JHOOTY, J.S. 1982. Factors associated with resistance to *Puccinia arachidis*. Peanut Sci. **9**: 96-97.

SREERAMULU, T. 1970. Condial dispersal in two species of *Cercospora* causing tikka leaf spot of groundnut (*Arachis hypogaea* L.) Indian J. Agric. Sci. **40**: 173-178.

SUBRAHMANIAN, K.S. 1964. Studies on sclerotial root rot disease of groundnut (*Arachis hypogaea* L.) caused by *Sclerotium rolsii* Sacc. Madras Agric. J. **51**: 367-378.

SUBRAHMANYAM, P., GIBBONS, R.W., NIGAM, S.N. and RAO, V.R. 1980 a. Screening methods and further sources of resistance to peanut rust. Peanut Sci. **7**:10-12.

SUBRAHMANYAM, P., MEHAN, V.K., NEVILL, D.J. and MCDONALD, D. 1980 b. Research on fiungal diseases of groundnut at ICRISAT. In: *ICRISAT (International crops Research Institute for the Semi-Arid Tropics)*, 1980. Proc. Int. Workshop on Groundnuts, 13-17 October, 1980, Patancheru, A.P., India, PP. 193-198.

SUBRAHMANYAM, P. and MCDONALD, D. 1982 a. Groundnut rust its survival and carry-over in India. Proc. Indian Acad. of Sci. (Plant Sci.) 91:93-100.

SUBRAHMANYAM, P., MCDONALD, D., GIBBONS, R.W., NIGAM, S.N. and NEVILL, D.J 1982 b. Resistance to rust and late leaf spot disease in some genotypes of *Arachis hypogaea* Peanut Sci. **9**:6-10.

SUBRAHMANYAM, P., MCDONALD, D., SIDDARAMAIAH, A.L. and HEGDE, R.K. 1981. Leafspot and veinal necrosis disease of groundnut in India caused by *Alternaria alternata*, F.A.O.Pl. Prot. Bull. **29**:74-76.

SUBRAHMANYAM, P., MCDONALD, D., GIBBONS, R.W. and SUBBA RAO, P.V. 1983 b. Components of resistance to *Puccnia arachidis* in Peanuts. Phytopathology. **73**:253-256.

SUBRAHMANYAM, P. MCDONALD, D. 1983 a. Rust disease of groundnut. Information Bulletin No.13. Patancheru, A.P., India: International crops Research Institute for the Smi-Arid Tropics.

SUBRAHMANYAM, P., MCDONALD, D. and SUBBA RAO, P.V. 1983 c. Influence of host genotype on uredospore production and germinability in *Puccinia arachidis*. Phytopathology. **73** : 726-729.

SUBRAHMANYAM, P., REDDY, D.V.R., GIBBONS, R.W., RAO, V.R. and GARREN, K.H. 1979. Current distribution of groundnut rust in India. PANS: **25**: 25-29.

UBRAHMANYAM, P. and RAVINDRANATH, V. 1988. Fungal and Nematode Diseases, In groundnut (Tech. Ed. P.S. Reddy), Krizhi Bhavan, Pusa, New Delhi, pp. 583.

SUBRAHMANYAM, P. and MCDONALD, D. 1986. Diseases of Rabi groundnut in India. "Workshop-cum-seminar on high yielding technology for Rabi/summer oulseeds, Directorate of Oilseeds Research, Rajendranagar Hyderabad-30, November 25, 1986.

SUBRAHMANYAM, P. and MCDONALD, D. 1987. Groundnut Rust Disease: Epidemiology and *Control*. ICRISAT (International Crops Research Institute for the Semi-Arid Tropics), 1987. Groundnut rust disease, Proceedings of Discussion Group Meeting. 24-28 September, 1984, ICRISAT Centre, India. Patancheru, A.P. 502 324: India. ICRISAT.

SUBRAHMANYAM, P. and RAO, A.S. 1977. Fungal infection of groundnut pods and aflatoxin accumulation before harvest. Proc. Indian Acad. Sci. **85**: 432-443.

SUNDARARAMAN, S. 1928. Adm. Rep. Govt. Mycol. 1927-1928. Rep. Dept. Agric. Madras pp. 335-372.

SUNDARARAMAN, S. 1929. Adm. Rep. Govt. Mycol 1928-1929. Rep. Dept. Agric. Madras p.27.

TANDON, I.M. and SINGH, B.K. 1968. Chemical control of leaf spot of groundnut. Indian Phytopath. **21**: 281-288.

TIWARI, S.P., GHEWANDE, M.P. and MISRA, D.P. 1984. Inheritance of resistance to rust and late leaf spot in groundnut (*Arachis hypogaea* L.) J. Cytol & Genet. **19**: 97-101.

VAISHNAV, M.V. and KAPADIA, M.N. 1982. Occurrence of mycophegous midge, *Mycodiplosis* sp. on groundnut rust in Gujarat. Pesticides. **16**: 21.

VASUDEVA, R.S. 1962. In: "Groundnut" ed. C.R. Seshadri. Indian Central Oilseeds Committee Hyderabad, India, pp. 229-240.

VERMA, B.K., MCDONALD, D. 1987. Groundnut Rust Disease and Plant Quarantine, ICRISAT (International Crops Rdsearch Institute for the Semi-Arid Tropics). 1987 Groundnut rust disease: Proceedings of a Discussion Group Meeting, 24-28 Sep. 1984, ICRISAT Centre, India, Patencheru, A.P. 502 324, India: ICRISAT (CP 408).

VIDHYASEKARAN, P. and KODANDARAMAN, P. 1968. Fungicidal control of Tikka leaf spot of groundnut. Indian J. Agric. Sci. **38**:373-377.

VIDHYASEKARAN, P. 1981. Control of rust and tikka diseases of groundnut. Indian Phytopath. **34**: 20-23.

VIJAYAN, K.M. and NATARAJAN, S. 1964. A preliminary note on the fungicidal control of tikka leaf spot of groundnut. Madras Agri. J. **51**: 218-220.

VYAS, S.C., PRASAD, K.V.V., SHASTRY, P.P. and SHUKLA, B.N. 1986. Field control of leaf spots and rust of groundnut by fungicides. Indian Phytopath. 39(3): 447-448.

J. Oilseeds Res. 7(1990) 98-105
*ISSN* 0970—2776

# INTERACTION OF CONSERVATION TILLAGE AND NITROGEN FERTILIZATION ON GROWTH AND YIELD OF RAINFED CASTOR *

M. UMA DEVI, V. SANTAIAH, S. RAMA RAO, A. PRASADA RAO AND M. SINGA RAO
Department of Soil Science and Agricultural Chemistry College of Agriculture, A.P. Agricultural University, Rajendranagar, Hyderabad-500 030.

**ABSTRACT**

A field experiment was conducted at Agricultural Research Institute, Rajendranagar, Hyderabad on red sandy loam soil (Alfisol), during kharif 1988-89 to study the effect of different conservation tillage practices viz., deep tillage, broad bed and furrows, dead furrows, ridges and furrows and flat bed (control) with varying levels of nitrogen fertilization viz., 0, 20, 40, 60 and 80 kg N ha$^{-1}$ on castor (Var Aruna) under rainfed conditions. Deep tillage with increase in successive levels of nitrogen upto 80 kg N ha$^{-1}$ resulted in higher dry matter production. While the mean seed yield was significantly increased by all tillage treatments compared to control (flat bed), the differences among the tillage treatments were not significant. Castor responded significantly with increase in successive levels of N upto 80 kg ha$^{-1}$. Dead furrows coupled w th 80 kg N/ha resulted in the highest yield of 750 kg ha$^{-1}$. The net cost benefit ratio for all tillage treatments compared to flat beds was favourable. ranging from 4.7 to 14.5 Based on the results and ease of adoption, formation of dead furrows at an interval of 1.5 m in combination with 80 kg N ha$^{-1}$ was found to be best in red chalka soil, for increasing the productivity of rainfed castor.

**Key words** Conservation tillage, nitrogen levels, rainfed conditions and contour cultivation.

## INTRODUCTION

Andhra Pradesh accounts for over 53 percent of the 5.79 lakh hectares in terms of area and over 30 percent of the 2.37 lakh tonnes in terms of production of castor (*Ricinus communis* L.) in the country. Castor is a rainfed crop in the state. In Telangana region castor is largely confined to sandy loam soils (or red chalkas), which are shallow, low in moisture retention, poor in fertility, prone to surface crusting and soil erosion. The annual rainfall in the castor growing region of the state is around 700 mm, which is highly unpredictable and often interspersed with long dryspells leading to uncertain and low productivity (176 to 233 kg ha-$^{1}$). Consequently, the small farmers growing castor have not been investing much on fertilizers to enhance crop productivity. Since water is the most limiting factor for productivity in these soils, improving its productivity should involve reduction of runoff and increasing the water intake rate and storage through *in situ* moisture conservation practices. Fertilizer application, particularly, nitrogen also increases the productivity of castor in these soils. Tillage practices improved the fertilizer use efficiency in case of many rainfed crops like jowar, *bajra* maize, pigeonpea, castor etc., through *in situ* mositure conservation (AICRPDA 1980 and 1983; CRIDA 1984; AICRP on SPCIP Ludhiana Centre, 1989). However, not much work is reported on interaction effect of these factors on productivity of castor.

---

*Part of M.Sc. (Ag) Thesis submitted by the senior author to A.P. Agricultural University.

Received on January 29, 1990.

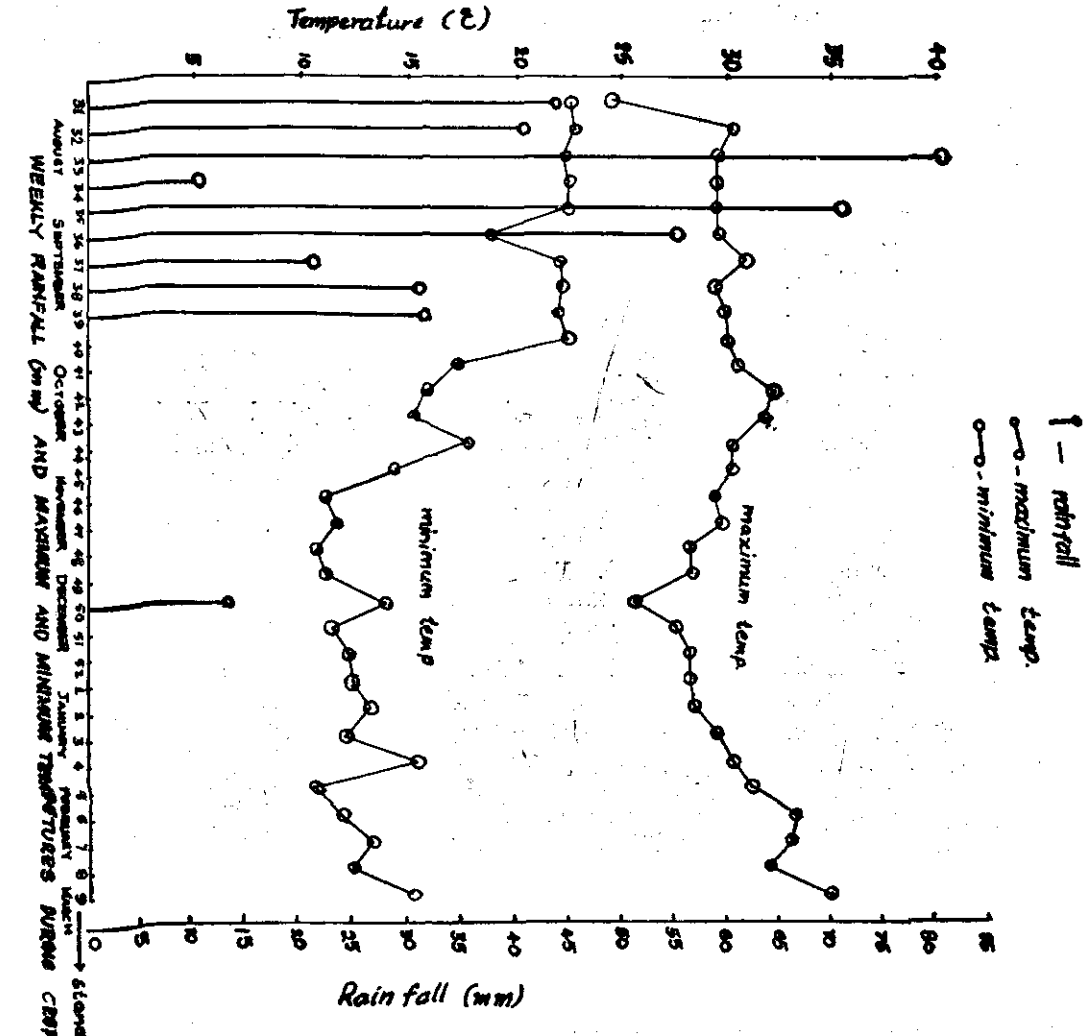
Therefore, studies on interaction of tillage practices and nitrogen application on chalka soils for castor have been carried out and reported here under.

## MATERIALS AND METHODS

A field experiment was conducted under rainfed conditions on the Farm of the Agricultural Research Institute, Rajendranagar, during kharif 1988-89 to study the interaction of conservation tillage practices and N fertilization on growth and yield of castor (cultivar Aruna). The experimental area is located on a slopy land (2 percent slope). The soil was gravelly sandy loam in texture, neutral in reaction, nonsaline, low in organic carbon, available N and K and high in available P. The treatments include five conservation tillage practices viz., deep tillage, broad bed and furrows, dead furrows, ridges and furrows and flat bed (control) taken as main treatments, and five N levels viz. 20,40,60, and 80 kg ha$^{-1}$ taken as sub treatments in s strip plot design and replicated four times.

The cultivation was done along the contours with the aid of earlier established vegetative contour key lines (*Khus* grass). Experimental area was over ploughed after summer showers with tractor drawn cultivator and before sowing it was disc harrowed across the slope. Deep tillage (25-30cm) was done using a sub soiler before sowing and the land was levelled. In case of broad bed and furrows, a bed of 75 cm width with a furrow of 45 cm width and 5 cm depth was formed 30 days after sowing (DAS) with the help of spade. Dead furrows of 15 cm deep were opened 30 DAS with the help of ridge plough at 1.5 m intervals (in alternate inter-rows) along the contours. Ridges and furrows were formed with ridge plough along the contours 30 DAS in between the plant rows. No tillage was given in case of flat bed (control).—Nitrogen was applied (dose as per treatments) in bands along the rows in two equal splits, at 30 DAS, and 50 DAS. Phosphorus (60 kg $P^2O^5$ ha-1) and potassium (30 kg $K^2O$ ha$^{-1}$) were applied as basal dose in all the treatmental plots. Castor (cv. Aruna) was sown on 5.8.1988, along contours by hand dibbling behind the plough with a spacing of 75×30 cm. Data on rainfall and mean maximum and minimum temperature are illustrated in Fig.1. It could be noted from the data that 417 mm of rainfall was received in 27 days during the crop growth periods, during the months of August, Sepetmber and October. Dry spell prevailed from 1st week of October till harvest of the crop, except for a single shower of 17 mm during the 2nd week of December. Weekly mean maximum and minimum temperatures varied from 24.5°C to 35.2°C and 10.8°C to 22.8°C respectively with an average of 30°C and 16.3°C.

Interaction effects of tillage practices and N fertilization on castor growth was studied in terms of dry matter production and seed yield. Net cost benefit ratio was computed taking into consideration the additional costs and returns as per the treatments. Flat bed tillage with no N application was taken as control for the purpose of working out the net cost benefit ratio. The cost of N fertilizer was Rs. 4.75 per kg and cost of N appiication in the field was estimated to be Rs. 15/- per hectare. The additional cost of deep tillage, ridges and furrows, broad bed and furrows and dead furrows


Temperature (C)
Rain fall (mm)
1 — rainfall
- maximum temp.
- minimum temp.
maximum temp
minimum temp
Standard weeks
WEEKLY RAINFALL (mm) AND MAXIMUM AND MINIMUM TEMPERATURES DURING CROP GROWTH PERIOD

was estimated to be Rs. 200, 125, 100 and 100, respectively over flat bed. The sale price of castor seed was Rs. 6.50 per kg and marketing charges were estimated to be Rs. 16.50 per quintal.

## RESULTS AND DISCUSSIONS

Data presented (Table 1) on drymatter accumulation at 60, 90 and 140 DAS revealed the significant effect of different tillage treatments at 90 and 140 DAS. The mean drymatter accumulated ranged from 214 to 426 kg ha$^{-1}$ at 60 DAS, 383 to 154 kg ha$^{-1}$ at 90 DAS and from 694 to 2548 kg ha$^{-1}$ at 140 DAS.

**TABLE 1**

***Drymatter accumulation (Kg ha$^{-1}$) of castor as affected by different tillage practices and nitrogen levels at various stages of growth***

| Main treatments (T) | Dry matter production, kg ha$^{-1}$ Subtreatments (N) | | | | | Mean |
|---|---|---|---|---|---|---|
| | No | $N_{20}$ | $N_{40}$ | $N_{60}$ | $N_{80}$ | |
| | | | 60 DAS | | | |
| $T_1$ Deep tillage (T) | 268 | 328 | 382 | 440 | 421 | 368.0 |
| $T_2$ Broad bed and furrows | 271 | 266 | 365 | 401 | 384 | 377.4 |
| $T_3$ Dead furrows | 271 | 313 | 337 | 335 | 384 | 328.0 |
| $T_4$ Ridges and furrows | 238 | 327 | 370 | 366 | 426 | 345.4 |
| $T_5$ *Flat bed* | 214 | 312 | 331 | 319 | 369 | 309.0 |
| Mean | 252.4 | 309.2 | 357.0 | 372.2 | 396.8 | |
| CD at 5% T | | | NS | | | |
| N | | | 40.31 | | | |
| T at same N | | | NS | | | |
| N at same T | | | NS | | | |
| | | | 90 DAS | | | |
| $T_1$ Deep tillage | 632 | 750 | 1159 | 1401 | 1514 | 1091.2 |
| $T_2$ Beoad bed and furrows | 742 | 906 | 1002 | 1005 | 1045 | 940.0 |
| $T_3$ Dead Furrows | 647 | 781 | 905 | 975 | 979 | 857.4 |
| $T_4$ Ridges and furrows | 543 | 859 | 888 | 1218 | 1304 | 962.4 |
| $T_5$ Flat bed | 383 | 604 | 747 | 815 | 1022 | 714.2 |
| *Mean* | 589.4 | 780.0 | 940.2 | 1022.8 | 1172.8 | |

| | | |
|---|---|---|
| CD at 5% | T | 179.65 |
| | N | 64.64 |
| T at same | N | 248.33 |
| N at same | T | 182.99 |

| | | 140 DAS | | | | | |
|---|---|---|---|---|---|---|---|
| $T_1$ | Deep tillage | 1250 | 1523 | 1978 | 2327 | 2548 | 1925.2 |
| $T_2$ | Broad bed and furrows | 1471 | 1753 | 1880 | 1982 | 2001 | 1817.4 |
| $T_3$ | Dead furrows | 1369 | 1573 | 1740 | 1928 | 2023 | 1726.6 |
| $T_4$ | Ridges and furrows | 1080 | 1580 | 1685 | 2136 | 2316 | 1759.4 |
| $T_5$ | Flat bed | 694 | 1146 | 1359 | 1552 | 1835 | 1317.2 |
| | Mean | 1172.8 | 1515.0 | 1728.4 | 1985.0 | 2144.6 | |

| | | |
|---|---|---|
| CD at 5% | T | 297.59 |
| | N | 69.64 |
| T at same | N | 340.16 |
| N at same | T | 179.18 |

At 90 DAS, highest mean dry matter (1091 kg ha-$^1$) was recorded with deep tillage, followed by ridges and furrows (962 kg ha-$^1$) and lowest was recorded in flat bed (714 kg ha-$^1$). At 140 DAS, all the tillage treatments ($T_1$, $T_2$, $T_4$ and $T_3$) recorded significantly higher dry matter over flat bed (control), which were on par among themselves, although deep tillage resulted in relatively higher dry matter production.

Similarly, successive increase in levels of nitrogen from 20 to 80 kg ha-$^1$ significantly increased the dry matter accumulation at all stages of sampling.

The interaction effects between tillage practices and N levels were significant at 90 and 140 DAS.

At 90 DAS, with no or low levels of nitrogen ($N_{20}$) application, broad bed and furrow method recorded higher dry matter, which was significantly higher over that of flatbed (control) and was on par with deep tillage, dead furrows and ridges and furrows at the same N levels. Contrary to this, at higher level of N application ie., at $N_{40}$, $N_{60}$ and $N_{80}$, deep tillage recorded higher dry matter over other tillage sreatments. Similar trends of interaction effects were observed at 140 DAS also. At higher level of N application, that is at N80, deep tillage has an advantage over other tillage treatments, probably because of the accessibility of roots to larger volume of soil and plant nutrients

With ridges and furrows also, the drymatter production is high compared to broad bed nad dead furrows, probably because of the method of nitrogen application in the furrows. It is possible that since the soil is a gravelly sandy loam, the N applied has obviously leached down to deeper layers, which was effectively utilized by the deep root system in deep tillage treatment. In case of broad bed and furrows, and dead furrows, though the N applied might have leached down, the plant was unable to utilize the same due to relatively shallow root system. This is also evidenced by higher residual nitrogen in the sub soil (15-30 cm) in broad bed and furrows (230.4 kg ha$^{-1}$) and dead furrows (193.4 kg ha$^{-1}$) compared to deep tillage (182.8 kg ha$^{-1}$).

At all the stages of growth, tillage practices by themselves, even in the absence of any nitrogen application, significantly increased the drymatter accumulation which has significance in the management of castor crop. The importance of different tillage practices in promoting better crop growth was reported by (AICRPDA, Hyderabad Centre 1983 and AICRP on SPCIP, Hyderabad Centre, 1984).

Data on seed yield (Table 2) showed significant influence of tillage practices, N levels and their interactions. The highest mean seed yield was recorded with broad bed and furrows and dead furrows tillage practices. (629.8 and 629.2 kg ha$^{-11}$, respectively). The seed yield increased significantly with successive increase in levels of N upto 80 kg ha$^{-1}$. Under Rajendranagar (Hyderabad) conditions, response of castor upto 60 kg ha$^{-1}$ was reported by AICOPRO (1978) and Madhusudhana Rao and Venkateswarlu (1988). The results obtained in the present study are in agrreement with the earlier resutls.

**TABLE 2 Seed yield (kg ha$^{-1}$) of castor as affected by different tillage practices and nitrogen levels.**

| Main treatments | Sub Treatments $N_0$ | $N_{20}$ | $N_{40}$ | $N_{60}$ | $N_{80}$ | Mean |
|---|---|---|---|---|---|---|
| $T_1$ Deep tillage | 395 | 532 | 591 | 624 | 682 | 564.8 |
| $T_2$ Broad bed and furrows | 546 | 611 | 636 | 658 | 698 | 629.8 |
| $T_3$ Dead furrows | 515 | 578 | 624 | 679 | 750 | 629.2 |
| $T_4$ Ridges and furrows | 410 | 535 | 581 | 650 | 720 | 579.2 |
| $T_5$ Flat bed | 191 | 399 | 458 | 556 | 604 | 441.6 |
| Mean | 411.4 | 531.0 | 578.0 | 633.4 | 690.8 | |
| CD at 5% T | | | 108.63 | | | |
| N | | | 32.30 | | | |
| T at same N | | | 119.40 | | | |
| N at same T | | | 59.24 | | | |

The interaction effects of tillage practices and N levels on seed yield was significant. The seed yield in dead furrow at $N_{80}$ resulted in the highest yield of 750 kg ha$^{-1}$ which was on par with that of ridges and furrows, board bed and furrows and deep tillage at $N_{80}$. The mean seed yield with broad bed and furrows (546 kg ha$^{-1}$) and dead furrows (515 kg ha$^{-1}$) with no nitrogen application was on par with the flat bed (control) with 60 kg N ha$^{-1}$- (556 kg ha$^{-1}$). This indicates the overwhelming importance of tillage practices even in the absence of N fertilization.

The net cost benefit ratio (table 3) showed that broad bed and furows resulted in the highest cost benefit ratio (8·82) followed by dead furrows (8.64). Among the N levels the cost benefit ratio decreased from 8.42 at N20 to 5.62 at N80. Data on interactions between tillage practices and nitrogen levels showed that with every tillage practice, the cost benefit ratio decreased with nitrogen application. It ranged from 4.7 with deep tillage coupled with 80 kg N ha $^{-1}$ to a maximum of 14.54 with broad bed and furrows with no N application. The mean cost benefit ratio for the four tillage practices viz., broad bed and furrows (14.54), dead furrows (13.72), ridges and furrows (8.84) and deep tillage (5.67) were high even with no N application, thereby indicating the overwhelming importance of conservation tillage practices under rainfed farming.

**TABLE 3 Effect of tillage practices and nitrogen levels on net cost benefit ratio**

| | | $N_0$ | $N_{20}$ | $N_{40}$ | $N_{60}$ | $N_{80}$ | |
|---|---|---|---|---|---|---|---|
| $T_1$ | Deep tillage | 5.67 | 6.04 | 6.50 | 4.90 | 4.70 | 5.56 |
| $T_2$ | Broad bed and furrows | 14.54 | 9.78 | 7.65 | 6.37 | 5.69 | 8.82 |
| $T_3$ | Dead furrows | 13.72 | 9.19 | 7.47 | 6.61 | 6.19 | 8.64 |
| $T_4$ | Ridges and furrows | 8.84 | 7.66 | 6.43 | 5.96 | 5.66 | 6.91 |
| $T_5$ | Flat bed | (Control) | 9.37 | 6.96 | 6.59 | 5.80 | 7.18 |
| | Mean | 10.67 | 8.42 | 7.01 | 6.09 | 5.62 | |

Taking together the data obtained on dry matter accumulation (Table 1), seed yield (Table 2) and net cost benefit ratio (Table 3) interesting observations could be made. While the deep tillage and ridges and furrows resulted in higher dry matter production, broad bed and furrows and dead furrows appeared to be better based on seed yield and the cost benefit ratio (Table 3). It is possible that with deep tillage and ridges and furrows, the early crop growth was better owing to high infiltration of rain water leading to more vegetative growth followed by rapid depletion of stored soil moisture. Consequently, crop with better vegetative growth under deep tillage and ridges and furrows has obviously undergone more stress during the resproductive phase, compared to that under broad bed and dead furrows, which had relatively higher stored moisture during reproductive stage. The mean per cent soil moisture stored, based on eleven observations during crop growth period (59 to 124 DAS) upto 30 cm depth was 7.8, 6.3, and

4.6, in broad bed and furrows, dead furrows and deep tillage respectively and 4.0 per cent in bo h ridges and furrows and flat beds. This has obviously resulted in relatively higher seed yield with broad bed and dead furrows.

From the above discussion it may be concluded that deep tillage and formation of ridges and furrows, though resulted in better growth of plant, as indicated by the dry-matter production, broad bed and furrows, and dead furrows (imposed 30 DAS) resulted in relatively higher seed yield, due to favourable balance between vegetative and reproductive growth. The yield of castor in the shallow red chalka soils under Rajendranagar conditions was significantly increased upto 80 kg N ha-1. It is significant that the tillage practices by themselves results in higher production, and maximum returns from rupee invested, even in the absence of N fertilization. It implies that the small marginal farmers, who have to operate more often under the constraints of no or low capital to purchase fertilizers, can realise higher productivity from castor through using their own cattle pairs and plough. Among the tillage pratices, formation of dead furrows at 1.5 m interval is easy to adopt. Formation of broad bed and furrows, though slightly better than the former, requires a bed former, which may not be readily available with the small and marginal farmers. Considering the ease of adoption, formation of dead furrows at an interval of 1.5 m can be safely recommended, and deep tillage, though comparatively yields on par with other tillage practices, needs heavy plough with more draft requirement and the cost benefit ratio was also relatively low. Similarly, for the formation of ridges and furrows, the coverage per plough will be less with relatively low cost benefit benefit ratio. Therefore, adoption of dead furrows is practically more feasibe. In addition, N application upto 80 kg ha-1 may be recommended for increasing the productivity of castor.

## LITERATURE CITED

All India Co-ordinated Research Project for Dryland Agriculture, Annual Report for 1983: Hyderabad, P.95.

All India Co-ordinated Research Project on Improvement of Soil Physical Conditions to increase agricultural production in problematic areas. Annual progress report for 1984. Hyderabad centre, 28-30.

All India Co-ordinated Research Project on Improvement of Soil Physical Conditions to increase agri cultural production in problematic areas. Annual progress report for 1987. Punjab Agricultural University, Ludhiana pp 1-11 and 23-29.

All India Co-ordinated Research Project on oil seeds. *Annual progress report for* 1978. Sunflower niger and castor. Indian council of Agricultural Research, Directorate of Oilseeds Research Hyderabad P.468.

Central Research Institute for Dryland Agriculture. *Annual report for* 1984, Santoshnagar, Hyderabad p 94.

MADHUSUDHAN RAO CH., and VENKATESWARLU, J. 1988. Effect of Plant densities, irrigation and graded dose of N on oil content and nutrient uptake in castor, *Journal of Research, Andhra Pradesh Agricultural University* XVI/1:43-46.

J. Oilseeds Res. 7(1990) 106-110
*ISSN:* 0970--2776

# MECHANICAL EXPRESSION OF OIL FROM LINSEED (*LINUM USITATISSIMUM* L)

JASWANT SINGH AND P.C. BARGALE
Central Institute of Agricultural Engineering (ICAR) Nabi Bagah, Berasia Road, Bhopal-462 018 (M.P.) INDIA

## ABSTRACT

Oil expression studies were conducted with linseed. The samples of linseed were given different treatments viz., water sprinkling, mixing and conditioning; Soaking in water forone hour at room temperature followed by sundrying and direct steaming of raw samples for 5, 10, 15 and 20 minutes prior to expressing through mini-40 scr w press (oil expeller). Prepared samples were allowed to have the m.c. n the neighbourhood of 5, 7, 9 and 11% m.c. (wb) in each case except for direct steaming. It was observed that treatments as well as moisture contents affected the oil yield significantly. One hour soaking in water at room temperature followed by sundrying to about 7% m.c.rapart from helping in reducing the gums in oil,rgave the maximum oil recovery of about 87.96% with energy conzumption of 0.319 kWh/kg of feed.

**Key words**: Linseed, mechanical expression, hydrothermal treatment, Oil recovery.

## INTRODUCTION

Though about 90% of the oilseeds are mechanically, crushed for production or edible oils, requirement is not fully met and about 1.1 million tonnes of edible oils are impoted. In the past various investigators, Prinsloo and Hugo (1981), Thomson and Peterson (1982) and Jacob and Bacjer (1986) conducted studies on sunflower oil expression and reported that chole settings, pre-heat treatment and the moisture content influenced the capacity, percent oil recovery and thickness of the cake. Simlarly Singh and Singh (1985) reported that rapeseed oil expression was greatly affected by the moisture content under its cold static pressing. Singh et al (198) found that hydrothermal treatments as well as seed moisture content had significant influence on press capacity and oil recovery from soybean, a low oil bearing material. Thus no attention appears to be adepuately given on oil expression from linseed which has considerably higher percentage of oil (about 35%). Therefore, in order to reduce the demand and supply gap, linseed crop with annual production of about 0.37 million tonnes must also be exploited more for the edibe oil purposes instead of only industrial uses. It was of this reason that the efforts were made to study the mechanical oil espression from linseed The present article describes about the effect of different pretreatments and the moisture contents on oil recovery from linseed.

## MATERIALS AND METHODS

Linseed (R-397) taken for the study, was cleaned of its impurities like trashes, stones, chaffs and wevilled grains. Cleaned samples of linseed were given different treatment viz i) to get desired moisture contents of about 5,7,9 and 11% wb in the sampes of known weight, predetermined quantity of water was sprinkled, mixed and packed

Received on 1990

in multilayered polythelene bags (250 gauge thick) and stored for 48 h in air-tight dessi sicators for equilibration ii) samples of raw cleaned linseed were soaked in water at room temperature for different lengths of lime (30,60, 120 and 240 min). Due to lot of gum present in the linseed soaking treatment presented some problems in drying the samples uniformly to above mentioned mositure contents due to clods formation. This problem became more pronounced when efforts were made to raise moisture content of linseed beyond 9% (Singh and Bargale, 1988). Therefore, in case of tap water soak ing followed by drying (whether in sun or in mechanical tray dryer) beyond 9% moisture content, studies were not conducted further. Also due to severe gum problems, linseed could not be proceeded with the treatments of soaking in hot water and boiling water followed by drying and iii) samples of lineseed, taken in a perforated container, were given direct steam treatment at 1 atm for 5,10, 15 and 20 minutes and were then mechanically expressed.

The moisture contents were determined by hot air oven method following Indian Standard (IS 3579:1966). The prepared samples each weighing about 3 kg were fed into the mini-40 screw press oil expeller (make-Roedown, reported capacity = 40 kg/h, motor hp=3, and worm rpm=120) for expression study (operators manual). All the experiments were replicated thrice. The oil and cake were collected at their respective outlets in separate containers. The oil was allowed to settle down for their particles in suspension. Expression was done by multipass pressings. Beyond third pass pressing problems like charring and browning of cake and burning smell were pronounced and also negligible oil yields were obtained.

## RESULTS AND DISSCUSSIONS

The observed data have been analysed and presented in Fig 1 through 3. It can be seen that samples when moisture conditioned (through water sprinkilng and mixing) to 5.31, 7.23, 9.10 and 11.14% (wb) and expelled in the expeller gave the avergae oil recovery of 73.69%, 80.10%, 81.35% and 70.26% respectively. It depicts that though oil recovery was low from among these the samples having 9% mositure content yielded maximum of about 81.35 % (Fig 1). This is statistically significant with higher CV of 3,21% compared to that of 3.03% in the case of oil recovery with samples having 7% m.c. This happened probably because the shear and compression were relatively better in this case than the lower moisture content as well as the higher moisture contents. While low moisture casuses brittleness, the higher moisture content causes the plasticizing effect which reduces the level of compression which ultimately contributes to the po recovery. Because of these reasons only as moisture content increased the energy consumption had a decreasing trend.

The variations in the oil recovery percentage with the moisture content in the case of water soaking treatment of linseed followed by sun drying has been shown in Fig 2. The figure depicts that corresponding to 7% moisture content the oil recovery was maximum with minimun of energy consumption. Statistical analysis also revealed that percent oil recovery of 88% in the case of samples with 7% m.c. compared to 78 and 75.6% in case of samples with 5 and 7% m.c. was significant (CV 16%). It is in agrreement of studies of

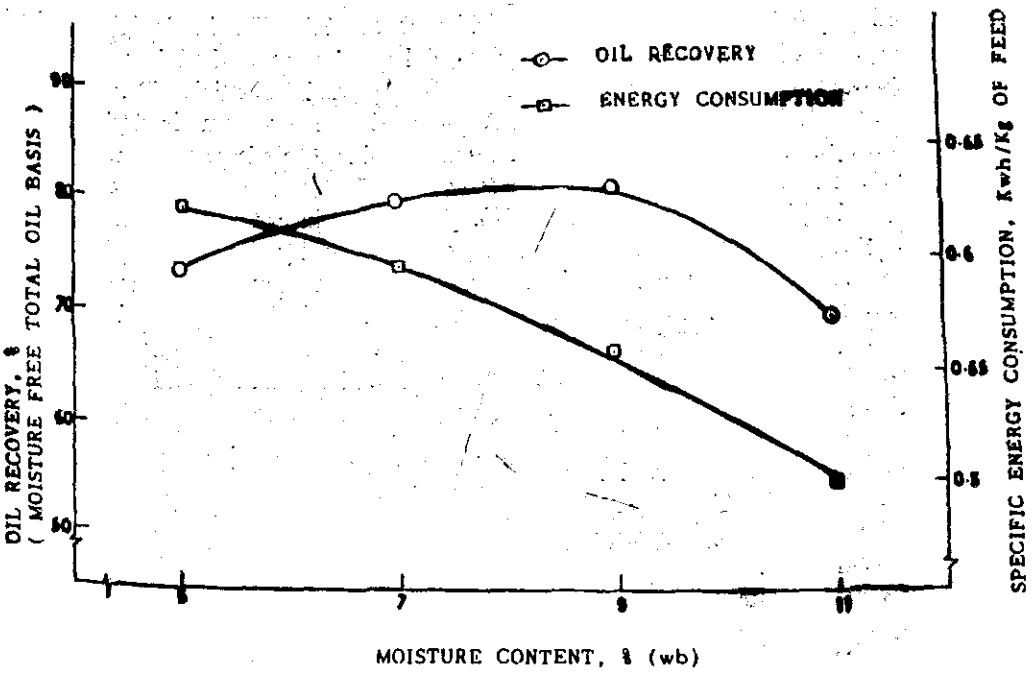



FIG. 1: VARIATION IN OIL RECOVERY AND SPECIFIC ENERGY CONSUMPTION WITH MOISTURE CONTENT CORRESPONDING TO MOISTURE CONDITIONING TREATMENT OF LINSEED.

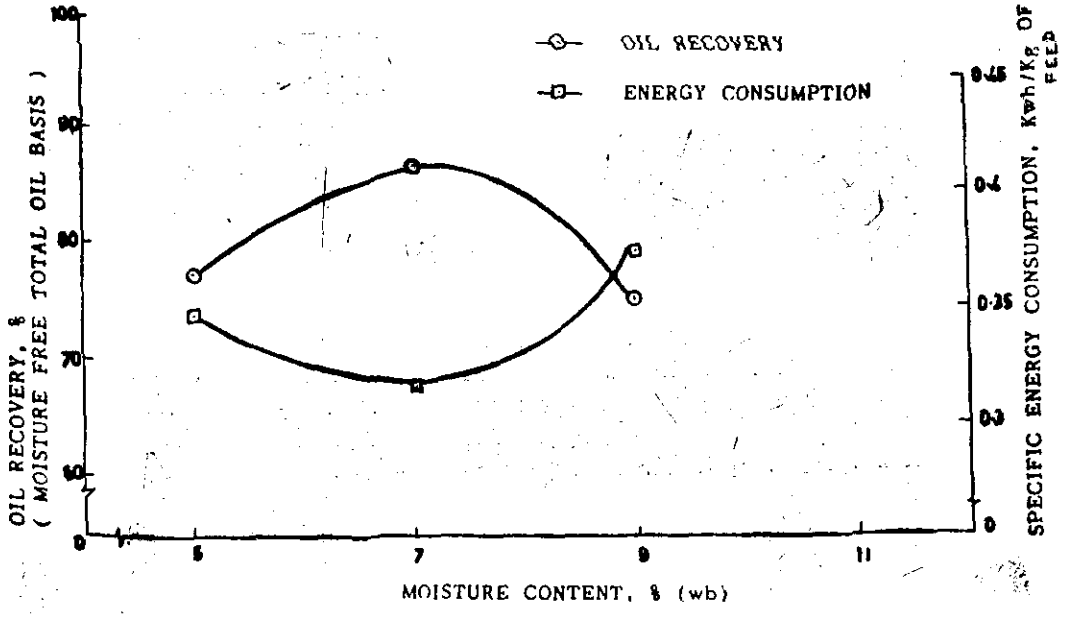



FIG. 2: VARIATION IN OIL RECOVERY AND SPECIFIC ENERGY CONSUMPTION WITH MOISTURE CONTENT CORRESPONDING TO TAP WATER SOAKING TREATMENT OF LINSEED.

Singh and Singh, 1985 on rapeseed. As regards energy consumption the trend was reverse. As a matter of fact in this particular treatment the moisture penetrated slowely inside the structure of the seed which is slighlty different in shape and size than that of other oilseeds. When mositure penetrated gradually length, width and thickness got enlarged but on drying the samples, reverse process took place causing shrinkage resulting in loosening of oil cell walls and change in physical and physico-chemical characteristics. Due to this on application of pressure the oil bodies burst and the oil oozed out towards the outer surface. As moisture content increased the energy consumption also had increasing trend due to the fact that plasticity of material increased and to compress the same material pressure had to be maintained for longer time.

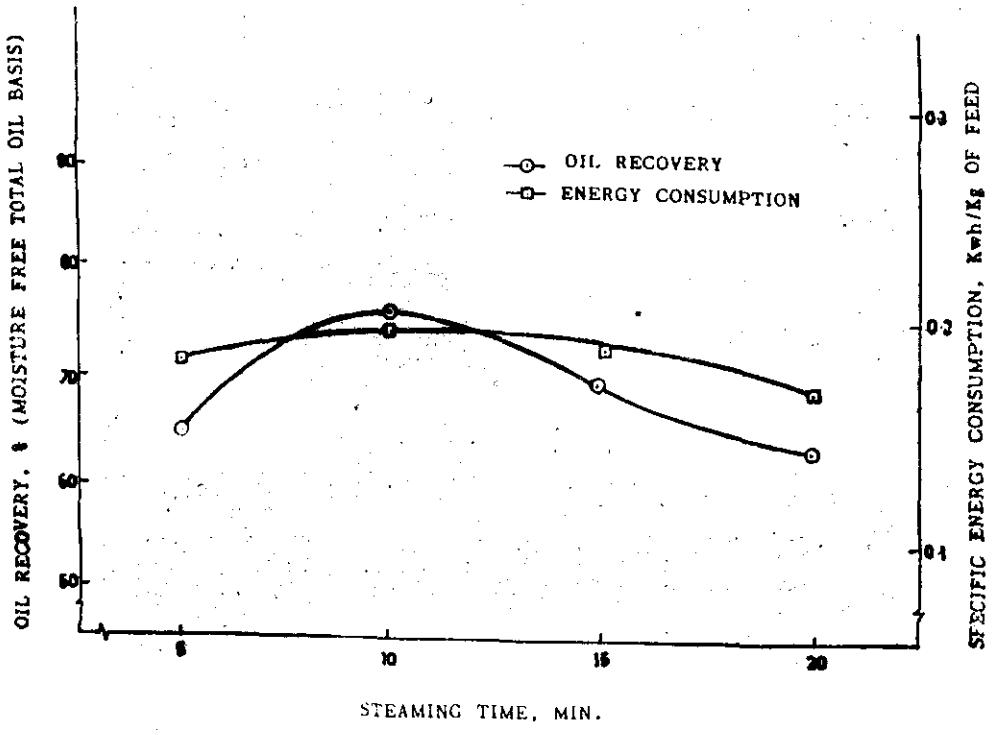



FIG. 3 VARIATION IN OIL RECOVERY AND SPECIFIC ENERGY CONSUMPTION WITH MOISTURE CONTENT CORRESPONDING TO STEAMING TREATMENT OF LINSEED

Results of the oil recovery and energy consumption in respect of samples treated with the steam for different length of time are shown in Fig 3. As can be seen from the figure oil recovery was relatively more in the case of samples treated with steam for 10 minutes. The energy consumption was also not much when compared with other values corresponding to time of steaming. It can be clearly seen that as the time of steaming the samples increased, the percent oil recovery decreased with decreasing trend in energy consumption byeond 10 minutes of steaming. It could happen probably because of the fast penetration of steam which made the oil cell walls more permeable for easy

release of oil. It was also found that oil recovery in the case of 10 min steamed samples was significantly higher (CV = 7.97%) than other durations of steaming) CV = 1.05 to 2.17%).

Thus gradual and uniform moisture addition through water soaking followed by low grade thermal application (i.e. sundrying) on linseed performed much bette regards oil expression.The water soaking treatment for 1 hour followed by sun-drying to about 7% moisture content when expelled in the expeller gave a maximum oil recovery of about 87.96 % compared to other treatments. Statistically it was highly significant compared to any other treatment and the sub treatment. The corresponding energy consumption was about 0.319 kwh/kg of feed.

## LITERATURE CITED

ANONYMOUS 1988. Summary of latest all India crop estimates Agricultural Sieuation in India.

BUREAY OF INDIAN STANDARDS 1966. Methods for test of oilseed IS : 1966-3579.

JACOB, C.A. and BACKER, L.F., 1986. Recovery of sunflower oil with a small screw expeller, J. Energy in Agriculture, 5:199-209.

Operator's Manual on Mini-40 Screw Press, Rosedown, U.K.

PRINSLOO, M. and HUGO, F.J.C. 1981. On-farm sunflower oil extraction for fuel purpose. *In* Third Inteenational conference on Energy Use Management, Berlin:1775-1782.

SINGH, J. and SINGH, B.P.N. 1985. Effect of moisture on oil yield from rapeseed. In: Proc. Silver Jubilee convention of Indian Society of Agricultural Engineering 3:136-140.

SINGH, JASWANT and BARGALE, P.C. 1988. Performance evaluation of Mini-40 screw press (oil expeller) with different oilseeds. Final Project Report on Project No.151, Central Institute of Agricultural Engineering, Bhopal p 34-42.

SINGH, JASWANT; BARGALE, P.C. and SHUKLA, B.D. 1989. Partial deoiling of soyabeanrby by mechanical crushing J. Instt. of Engineering (India), 69 (AG 2): 98-100.

THOMPSON, J.C. and PETERSON, C.L. 1982. An automated small scale oilseed processing plant for production of fuel for diesel engines. In: Proc. Int. Conf. on Plant and Vegetable oils as Fuels, Fargo, N.D. American Society of Agricultueal Engineers, St. Joseph, MI, Aug 2-4: 261-269.

J. Oilseeds Res. 7 (1990): 111-113
*ISSN* 0970—2776

## Short Communication

# EFFECT OF MOISTURE AND APPLIED NUTRIENTS (P, S, B AND Zn,) ON QUALITY OF INDIAN MUSTARD (*BRASSICA JUNCEA* L.)

Moisture is an important determinent of nutrient availability in soil and thus may affect the growth yield, nutrient uptake in plants and the quality of produce. While application of irrigation and fertilizer increases yield of mustard (Tomar *et al.*, 1980), information regarding their effect on the quality of mustard seed is not well documented in the literature. Therefore, the present investigation was undertaken to study the effect of different moisture regimes and applied P, S, B and Zn on the quality of mustard seed.

An experiment was conducted in polyethylene lined empty bitumin drums (55 cm diameter and 80 cm height), buried in soil and filled with 200 kg well mixed air dried sandy (*Typic ustipsamment*) soil having pH 8.6, Electrical conductivity 0.12 $dsm^{-1}$, C.E.C. 2.17 me/100g soil, $CaCO^3$ nil, organic carbon 0.06% and available N, P, K, S, B and Zn 28.0, 3.0, 53.0 7.0, 0.4 and 0.3 ppm, respectively. The soil had 25.0, 10.5 and 2.5% moisture at saturation, field capacity and wilting point, respectively. The treatments consisted of all possible combinations of three moisture levels, irrigation at 70, 85 and 100% ASMD (available soil moisture depletion); three P levels, 0, 25 and 50 ppm P and other nutrients; check, (refers to no application of B, S or Zn), B (2ppm), S (25 ppm), and Zn (5 ppm). Each treatment was replicated two times and received a basal application of 50, 61, 10, 5, 10 and 5 ppm of N, K, Ca, Mg, Fe and Mn, respectively. The nutrients were mixed in the upper 20 cm layer. The soil was saturated with deionised water and sowing was done after 3 days. Drainage was not provided for the bitumin drums. Post sowing irrigations were given as per requirement of moisture treatments, based on gravimetric determination of moisture from 0 to 70 cm depth. Twelve plants of cultivar Raya Prakash were grown in each drum of which half were harvested at 50 days and rest at maturity.

Oil content and Allyl-isothioynate value in seed samples were determined according to A.O.A.C. (1960). Crude protein in seed material was estimated by multiplying the N content of seed by a constant factor of 6.25 in all samples. Nitrogen in seed samples was determined colorimetrically by Nessler's reagent. Proline in fresh leaves was determined by method of Bates *et al* (1973). Methionine, Cysteine and cystine in seed samples were determined by using methods of Horn *et al.* (1946) and Leach (1966).

The oil content in mustard seed ranged from 35.7 to 44.1% (Table 1) which increased with increasing level of moisture. Crude protein content in seed ranged

Received on January 19, 1987.

**TABLE 1.** *Effect of moisture on oil, protein, proline, methionine and allyl-isothiocynate contents in mustard.*

| Moisture levels (%ASMD)* | Plant part | | | | | |
|---|---|---|---|---|---|---|
| | Fresh leaf | | Seed | | | |
| | Proline, umole/g | | Oil % | Protein % | Methionine mg/16g N | *Allylisothiocynate*, % |
| | Before irrigation | After irrigation | | | | |
| 100 | 153.5 | 40.2 | 35.7 | 28.1 | 652 | 0.418 |
| 85 | 43.3 | 3.8 | 39.7 | 24.8 | 899 | 0.413 |
| 70 | 22.1 | 1.4 | 44.1 | 21.2 | 1152 | 0.413 |
| C.D. (P=0.05) | 19.6 | 4.1 | 1.2 | 1.6 | 77 | — |

* ASMD — Available Soil Moisture Depletion.

**TABLE 2.** Effect of moisture x P, and P x other nutrients (B, S and Zn) on cysteine and cystine contents in mustard seeds at maturity

| Treatments | P levels (ppm) | | | P levels (ppm) | | |
|---|---|---|---|---|---|---|
| | 0 | 25 | 50 | 0 | 25 | 50 |
| | Cysteine, mg/16g N | | | Cystine, mg/16g N | | |
| *Moisture levels (%ASMD)* | | | | | | |
| 100 | 936 | 792 | 855 | 2919 | 2939 | 3068 |
| 85 | 1066 | 775 | 957 | 3661 | 2870 | 3188 |
| 70 | 1144 | 1078 | 1060 | 3281 | 3575 | 3234 |
| *Other nutrients* | | | | | | |
| Check | 1031 | 812 | 1043 | 3217 | 2986 | 3407 |
| B (2 ppm) | 1032 | 866 | 922 | 3390 | 3086 | 2685 |
| S (25 ppm) | 1116 | 901 | 952 | 3343 | 3131 | 3197 |
| Zn (5ppm) | 1017 | 927 | 1045 | 3199 | 3309 | 3291 |

C.D. (P. = 0.05) Moisture X P : 79 Moisture X P : 309 Other nutrients M x P : 357
Other nutrients X P : 92

from 21.24% to 28.1% and decreased with increasing moisture level. These results showed that moisture affected conversion of carbohydrates into proteins or fats and oils. The increase in crude protein content due to moisture stress may be attributed to more accumulation of N in seed under such conditions. With the increasing moisture level growth occured at a faster rate than the N accumulation rate, therefore, a decrease in protein content was noted.

The leaf proline content before irrigation varied from 22.1 to 153.1 μmole/g fresh weight (Table 1). It increased considerably with increasing moisture stress but decreased after irrigation, and ranged from 1.37 to 40.21 umole/g fresh weight. The content after irrigation was approximately 1/4th, 1/12th and 1/6th of that before irrigation at 100, 85 and 70% ASMD, respectively. The proline accumulation under water

stress conditions might be the result of conversion of glutamic acid to free proline. (Stewart and Boggess, 1978).

The content of methionine ranged from 652 to 1152 mg/16 g N (Table 1). It increased with increase in moisture supply. Applied nutrients and their interactions with moisture did not affect oil, protein, proline and methionine contents.

Contents of cysteine and cystine in seeds ranged from 775 to 1116 and 2870 to 3661 mg/16 gN, respectively (Table 2). Both amino- acids increased with increasing moisture supply and the magnitude of increase was more with P application. Their contents decreased with the application of B and S in conjunction with P and were not affected with Zn application.

The results of this study are in partial agreement with the findings of Arora and Luthra (1970), who worked on a leguminous crop.

Allyisothiocynate value ranged from 0.405 to 0.423% (Table 1). Results indicated a slight decrease in allylisothiocynate value with the increase in moisture levels and the effect of other treatments was inconsistent. These results indicated that pungency in mustard oil could be affected by irrigation.

M.L. DIXIT AND U.C. SHUKLA

Deaprtment of Soil Science Haryana Agricultural University Hisar-125 004

A.O.A.C. 1960. Official and tentative methods of analysis. Horatz (Ed.) 9th ed. Washington 4, D.C

ARORA, S.K. and LUTHRA, Y.P. 1970 Metabolism of sulphur containing amino acids in *Phaseolus aureus L.Z. Pfl Ernaohr. Dueng. Bodenk*, 126 : 151-158.

BATES, L.S.; WALDRAN, R.P. and TEARE, R.D. 1973. Rapid determination of free proline for water stress studies *Pl. Soil* 39: 205-207.

HORN, M.J.; JONES, D.B. and BLUM, A.E. 1966. Colorimetric determination of methionine in protein and food. *J. Biol. Chem.* 166: 3131-4140.

LEACH, S.J. 1966. The estimation of thiol and disulphide groups. In a Laboratory Manual of Analytical Methods of Protein Chemistry. Pl Alexander and H.P. Lundgren (eds.), Pregamon Press, Oxford 4: 1-75.

STEWART, C.R. and BOGGESS, S.F. 1978. Metabolism of $5^3H$ proline by barley leaves and its use in measuring the effects of water stress on proline oxidation. *Pl. physiol* 61: 654-657.

TOMAR, N.K.,; CHAHAL, R.S. and KHANNA, S.S. 1980. Balanced nutrition. A key to raised yield of mustard under dry land. *Fertil. News*, 25 (10) : 31-33.

J. Oilseeds Res.7 (1990) 114-116
*ISSN 0970—2776*

# OIL CONTENT AND FATTY ACID COMPOSITION OF SOME PROMISING GENOTYPES OF GOBHI SARSON (*BRASSICA NAPUS*)

The oil content and quality of 26 genotypes of *B. napus* identified on the basis of their superiority in yield and other morphological characters is reported in the present communication to select desirable genotypes for future crop improvement programme. The genotypes are as follows: *GS 3, GS 14, GS 17, GS 18, GS 66, GS 80,* GS 86, GS 123, GS 124, GS 134, GS 138, GS 140, GS 144, GS 203, GS 207, GS 217, GS 249, GS 298, GS 825, GS A, GSB, GSC GSD, V 3, V5, V6 and the standard cultivars of Toria (CV TL 15) and Raya (CV RLM 619). These were sown at the oilseeds research farm, Punjab Agricultural University, Ludhiana during *Rabi* 1985. Oil content was estimated by the use of wide-line NMR Newport Analyser Model MK III A. For fatty acid analysis, oil was extracted by the method of Kartha and Sethi (1957). Fatty acid methyl esters were prepared by the method of Luddy *et al.* (1968) and analysed by NUCON 5700 gas liquid chromatograph with flame ionization detector having a 6 mm x 2 m column packed with 15% (w/w) diethylene glycol succinate (DEGS) on 80 to 100 mash chromosorb W. The instrument was operated at 190° C with nitrogen flow of 60 ml/min and hydrogen flow of 40 ml/min. The peaks were identified by comparison of their retention times with those of standard fatty acid methyl esters. The peak area and the relative percentage of each fatty acid was calculated automatically with the help of data processor chromatopack model EIA. Determinations were carried out in triplicate and data were statistically analysed.

The data regarding range and mean of oil content and fatty acid composition of 26 promising *B.napus* genotypes are presented in Table 1. Variation in oil content

**TABLE 1. Range and mean of oil and various fatty acids of Twenty six promising genotypes of *B.napus***

| Constituents | Range (%) | Mean (%) |
|---|---|---|
| Oil content | 41.2 — 45.4 | 43.4 |
| Palmitic | 2.1 — 4.2 | 3.4 |
| Stearic | 0.5 — 3.7 | 1.7 |
| Oleic | 11.5 — 20.4 | 17.2 |
| Linoleic | 11.9 — 16.0 | 13.2 |
| L nolenic+Eicosenoic | 15.0 — 21.4 | 19.4 |
| Erucic acid | 40.3 — 46.0 | 43.3 |

Received on October 21, 1988

and important fatty acids was noticed. Oil content varied from 41.0 to 45.4% with a mean value of 43.4%. Major fatty acids identified were oleic, linoleic, linolenic + eicosenoic and erucic acids. Linolenic and eicosenoic acids could not be separated out on DEGS column, hence their combined concentration is reported in the present study. Variation in the content of various fatty acids was : palmitic from 2.1% (GS 17) to 4.2% (GS 207), oleic acid from 11.5% (GS 17) to 20.4% (GS 18), linoleic from 11.9% (V 5) to 16.0% (GS 17), linolenic + eicosenoic from 15.0% (GS 17) to 21.4% (GS 203) and erucic from 40.3% (GS 18) to 46.0% (GS 17). Genotypes GS 14, GS 18, GS 124 and GS 207 had maximum amount of oleic acid (18 to 20%) and simultaneously lower content of erucic acid (40 to 41%). Thus these lines are relatively better in quality since more oleic acid imparts stability and long shelf life of oil.

The comparison of the oil content and fatty acid components of *Gobhi sarson* GSL 1 with Toria and Raya cultivars in Table 2 revealed that GSL 1 had significantly higher oil content by 2%. GSL 1 also contained 4% and 7% higher level of oleic acid than Toria and Raya cultivars respectively. Moreover, GSL 1 had 7 to 8% lower content of erucic acid than that of Raya and Toria cultivars. In general, *B.napus* lines had 2 to 3% higher oil content and 6 to 7% lower concentration of erucic acid than *B.campestris* L (Toria) and *B.juncea* varieties. Nutritionally *B.napus* lines are better because of lower level of erucic acid and higher concentration of oleic and linoleic acids. Klassen (1976) reported that strains with less erucic acid had 1 to 3% more oil content and this was also true in the present study with *B. napus* genotypes. Koyama *et al* (1978) have also reported that the oil content of *B. napus* seeds is higher than that of *B. campestris* by Ca. 3 percent.

**TABLE 2. Mean performance of Raya, Toria and Gobhi sarson cultivars for oil and fatty acid composition**

| Variety | Oil content | Palmitic | Stearic | Oleic | Linoleic | Linolenic +Eicosenoic | Erucic acid |
|---|---|---|---|---|---|---|---|
| Raya, RLM 619 | 41.8 | 2.3 | 1.1 | 9.0 | 13.8 | 16.7 | 51.1 |
| Toria, TL 15 | 41.7 | 2.0 | 1.9 | 11.8 | 13.4 | 16.5 | 50.3 |
| Gobhi sarson GSL 1 | 44.6 | 3.8 | 1.1 | 17.2 | 13.0 | 18.9 | 42.9 |
| CD at 0.05 | 0.45 | 0.07 | 0.14 | 0.93 | 0.35 | 0.94 | 1.29 |

Correlation coefficients among oil content and fatty acids are presented in Table 3. In *B.napus*, there existed a negative correlation between oil content and stearic and linoleic acid; between stearic, linoleic and linolenic + eicosenoic acid. Similarly, there existed inverse relationship between stearic acid and erucic acid. The negative correlation of oleic with linoleic and erucic acid suggest that fatty acids in *B.napus* lines are formed by stepwise biosynthetic pathway in which oleic acid (18:1) either undergoes desaturation to form linoleic acid or further chain elongated to form eicosenoic acid and erucic acid. In earlier studies on *B.campestris* and *B.juncea*, it was found that oil content had no significant correlation between any of the fatty acids (Ahuja *et al.* 1975 and 1984).

**TABLE 3. Correlation coefficients among oil and fatty acid constituents in Gobhi sarson**

| Constituents | Palmitic | Stearic | Oleic | Linoleic | Linolenic +Eicosenoic | Erucic |
|---|---|---|---|---|---|---|
| Oil | —0.16 | —0.48** | —0.22 | —0.88** | +0.25 | +0.24 |
| Palmitic | | +0.80** | +0.46* | —0.30 | +0.34 | —0.22 |
| Stearic | | | +0.20 | —0.28 | —0.77** | —0.61** |
| Oleic | | | | —0.66** | +0.57** | —0.56** |
| Linoleic | | | | | —0.52** | +0.44* |
| Linolenic + Eicosenoic | | | | | | —0.41 |

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

There existed a positive correlation between palmitic and stearic and oleic acid, between linoleic and erucic acid and between oleic and linolenic + eicosenoic acid. Earlier, a negative correlation has been reported between erucic acid and oleic, linoleic, linolenic and between oleic acid and linolenic, eicosenoic, palmitic, stearic and linoleic acid in rapeseed (Koyama *et al.* 1978, Rahman, 1978, Nagmani *et al.* 1981). A negative correlation between oleic and linoleic with erucic acid in various genotypes of cauliflower turnip and radish has also been reported by Ahuja *et al.* (1987). An inverse relationship of oleic and linoleic with erucic acid will be useful in breeding genotypes with lower levels of erucic acid.

Department of Plant breeding
Punjab Agricultural University
Ludhiana-141 004 (Punjab)

K.L. AHUJA R.K. RAHEJA
K.S. LABANA T.S. GOMBER

AHUJA, K.L.; LABANA, K.S.; RAHEJA, R.K. and BADWAL, S.S. 1984. Oil content and fatty acids variation in mutants of *Brassica juncea* L. Czern and Coss. J. Oilseeds Res. 1 : 71-75.

AHUJA, K.L., SEKHON, K.S. and SINGH, T. 1975. Correlation studies in oil and fatty acids o Toria (*Brassica campestris*). Indian J. Agri. Sci. **9**: 140-142.

AHUJA, K.L. SINGH, H, RAHEJA, R.K. and LABANA, K.S. 1987. The oil content and fatty acid composition of various genotypes of cauliflower, turnip and radish. Plant Foods Hum. Nutr. **37**: 33-40.

KARTHA, A.R.S. and SETHI, A.S. 1957. A cold percolation method for rapid gravimetric estimation of oil in small quantities of oilseeds. Indian J. Agric. sci **27** : 211-217.

KLASSEN, A.J. 1976. Relationship between quality and quantity of oil in Brassica species. Can.J. Plant Sci. **56** : 427-428.

KOYAMA, Y., FUJU, M. and KUDO, H. 1978. Rapeseed and their extracted oils from different varieties. Yukagaku **27** : 375-380. (Chem., Abstr. **89** : 106-119).

LUDDY, F.E., BARFORD, R.A., HERB, S.F. and PAUL, M.J. 1968. A rapid method for the preparation of methyl esters of butter fat and other fats. J.Am. Oil Chem. Soc. **45** : 549-552.

NAGAMANI, B., KAMALA, T. RAO, T., CHANDRASEKHARA and LAKSHMINARAYANA, G. 1981. Effect of irradiation and chemical treatment on yield and quality of *Brassica juncea* L. Seed and oil. Indian Acad. Sci. (Ser) Plant sci. **90**: 281-284.

RAHMAN, L. 1978. Relationships between major fatty acids of oleiferous species of *Brassica*. Indian J. Agric. Sci. **48** : 401-406.

J. Oilseeds Res 7 (1990) 117-120
*ISSN* 0970—2776

# RESPONSE OF SESAMUM (*SESAMUM INDICUM* L.) TO NITROGEN AND PHOSPHORUS UNDER RAINFED CONDITONS

The common belief that fertilizer application to rainfed crops may not result in adequate response to applied nutrients does not hold true (Venkatesan *et al* 1983) Therefore, an effort was made in this study to compare two varieties of seasmum for their response to different levels of nitrogen and phosphorus under rainfed conditions.

Field experiments were conducted during *kharif* seasons of 1982 and 1983 on sandy loam soils at the Regional Agricultural Research Sttation, Anakapalle, Andhra Pradesh.

The treatments consisted of two varieties (Gouri and Madhavi) and three levels each of nitrogen (0, 20, 40 kg/ha) and phosphorus (0, 20 and 40 kg/ha). A split plot design consisting of three replications with varieties in main plots and fertilizer levels in sub-plots was adopted. The crops were sown with the commencement of pre-monsoon rains on May 29 and May 25 in 1982 and 1983 respectively adopting a spacing of 30 x 15 cm. Half the nitrogen as urea and full dose of phosphorus as single superphosphate as per the treatments were band placed at sowing and the remaining half of the nitrogen was top dressed in the respective treatments at 3-4 weeks after sowing depending upon the rains.

The yield level in the second year was higher than that in the first year. This variation was mainly due to the rainfall received during the seedling and post flowering stages. Rainfall distribution was more favourable for growth and capsule formation during 1983 as compared to 1982. The favourable distribution of rainfall over 31 rainy days helped in maintaining adequate soil moisture for the growth and capsule setting in 1983, leading to normal yields. In 1982, the distribution of rainfall (21 rainy days) was erratic as well as scanty during vegetative and capsule development stages and led to considerable reduction in capsule number resulting in lower yield.

The population of Gouri variety showed taller plants, higher number of branches per plant, higher number of capsules per plant and higher 1,000 seed weight as compared to those under Madhavi during both the years of investigation (Table 1). Gouri with comparatively better yield attributes produced significantly higher seed yield than that of Madhavi in both the years (Table 2).

In 1982, the yield differences between nitrogen levels were not significant (Table 2). But in second year nitrogen application had a remarkable influence on seed yield. The seed yield increased correspondingly with the increasing levels of nitrogen from 20 to 40 kg/ha. However, significant increase in yield was observed only upto 20 kg N/ha. The favourable effects of nitrogen on seed yield of sesamum might be due to the stimulating effect of nitrogen on different yield attributing characters. These results corroborate with the work of Sennaiyan and Arunachalam (1978).

Received on January 19,1987

**TABLE 1. Yield attributing characters of sesamum varieties as affected by nitrogen and phosphorus**

| Treatment | Plant height (cm) | | Branches per plant (number) | | Capsules per plant (number) | | Seeds per capusle (number) | | Weight of 1000 seed (g) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1982 | 1983 | 1982 | 1983 | 1982 | 1983 | 1982 | 1983 | 1982 | 1983 |
| Variety | | | | | | | | | | |
| Madhavi | 138 | 147 | 6.5 | 6.2 | 62 | 88 | 56 | 55 | 3.12 | 3.14 |
| Gouri | 152 | 166 | 7.9 | 8.4 | 77 | 103 | 57 | 56 | 3.16 | 3.18 |
| C.D. (P = 0.05) | 4.76 | 5.02 | 0.45 | 0.64 | 6.8 | 7.1 | N.S. | N.S. | N.S. | N.S. |
| *Nitrogen levels (kg/ha)* | | | | | | | | | | |
| 0 | 133 | 142 | 5.4 | 5.9 | 65 | 96 | 54 | 53 | 2.92 | 2.95 |
| 20 | 146 | 158 | 7.1 | 8.6 | 74 | 115 | 57 | 56 | 3.35 | 3.62 |
| 40 | 154 | 166 | 7.8 | 8.9 | 79 | 127 | 57 | 56 | 3.39 | 3.66 |
| C.D. (P = 0.05) | 10.7 | 11.3 | 1.0 | 1.44 | N.S. | 16.0 | 1.4 | 1.1 | 0.20 | 0.16 |
| *Phosphorus levels* ($P_2O_5$ *kg/ha*) | | | | | | | | | | |
| 0 | 142 | 147 | 5.7 | 5.8 | 58 | 99 | 55 | 54 | 2.96 | 2.74 |
| 20 | 145 | 152 | 5.9 | 6.0 | 63 | 107 | 55 | 55 | 2.99 | 2.79 |
| 40 | 145 | 156 | 5.9 | 6.2 | 66 | 111 | 56 | 55 | 3.01 | 2.80 |
| C.D. (P = 0.05) | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. |

N.S. = Not significant.

**TABLE 2. Seed yield (kg/ha) of sesamum varieties as affected by nitrogen and phosphorus**

| Treatment | Seed yield (kg/ha) | | |
|---|---|---|---|
| | 1982 | 1983 | Mean |
| *Variety :* | | | |
| Madhavi | 211 | 401 | 306 |
| Gouri | 282 | 497 | 390 |
| C.D. (P = 0.05) | 23.2 | 22.3 | |
| *Nitrogen levels (kg/ha)* | | | |
| 0 | 233 | 419 | 326 |
| 20 | 248 | 497 | 373 |
| 40 | 258 | 512 | 385 |
| C.D. ( P = 0.05) | N.S. | 50.1 | |
| *Phosphorus levels($P_2O_5$kg/ha)* | | | |
| 0 | 218 | 450 | 334 |
| 20 | 261 | 480 | 371 |
| 40 | 262 | 497 | 380 |
| C.D. (P= 0.05) | N.S. | N.S. | |

N.S. = Not significant

Application of nitrogen to sesamum resulted in significant increase in the height of the plant, number of branches per plant, number of capsules per plant, number of seeds per capsule and weight of 1,000 seed at 20 kg N/ha over control during both the years (Table 1). The magnitude of increase of these yield attributing characters was, however, more at the lowest level of 20 kg N/ha in comparison to that obtained at 40 kg N/ha. The favourable effect of nitrogen application in increasing the yield contributing characters can be attributed to an improvement in vital functions which nitrogen plays in the plant body and this resulted in higher number of capsules per plant and weight of 1,000 seed. Similar increase in yield attributes with nitrogen fertilization have been reported by Gaur and Tehran (1973), Gopalakrishnan *et al.* (1973) and Krishna Gowda (1974). All these yield contributing characters had additive effect on the seed yield.

**Effect of phosphorus :**

The application of phosphorus did not influence the sesamum yield in any of the years. This is also evident from the yield attibuting characters. The lack of response in the present study may be due to the sufficient supply of phosphorus in the soil. Similar results were also reported by Ananda Rao *et al.* (1984).

Regional Agricultural Research Station Anakapalle (AP) K.L. RAO, D.V.N. RAJU, C.P. RAO

ANANDA RAO, M., GOPALA RAO, P. and ANANDA REDDY, K. (1984). Andhra agric. J. 31: 167-169.

GOPALAKRISHNAN, S. VEERANNA, L. and MOHAMMED, V. (1973). Madras agric. J. 58: 859-861.

GAUR, B.L. and TEHRAN, K.B. (1973). Indian J. Agron. 18 : 94-95.

KRISHNA GOWDA, K.T. (1974). M.Sc. (Ag.) Thesis, Univ. Agril. Sciences, Bangalore.

SENNAIYAN, P. and ARUNACHALAM, L. (1978). Madras agric. J. 65: 347-348.

VENKATESAN, G., ELANGO, R. and ARUNACHALAM L. (1983). Madras agric. J. 70: 468-470

J.Oilseeds *Res.* 7 (1990) 121-123
*ISSN* 0970—2776

# A NEW WILD VARIETY OF SESAMUM—*SESAMUM INDICUM* (L.) VAR. *SENCOTTAI* ADR & NS. COMPARED WITH *S. INDICUM* (L.) VAR. *YANAMALAI* ADR & MS. AND *S. INDICUM* (L.)

A wild variety of *Sesamum* by name *Sesamum indicum* (L.) Var. *Sencottai* ADR & NS. is described and compared with the cultivated *S.indicum* (L.) and the wild variety *S.indicum* (L.) Var. *Yanamalai* ADR & MS.

*Sesamum indicum* (L.) Var. *Sencottai* ADR & NS. An erect annual herb, 60-65 cm high moderately branched. Stem obtusely quadrangular, sulcate, finely pubescent. Leaves opposite below, alternate above, thinly pubescent on the prominent nerves, lower basal leaves short petioled, simple, cordate and dentate, Leaves above simple, oblong, linear, entire, tip acute. Flowers solitary in leaf axils from 4th or 5th node from base; pedicels short 0.1 — 0.2 cm long with two sessile yellow glands, each in the axil of a bract, erectopatent; Calyx persistant, 5 segments, lanceolate, pubescent tips green in colour; corolla 2—2.5 cm long, 1—1.5 cm across, 2 lipped, 5 lobed, broad spreading outward, the lower one longer and forming the lip, pink on the exposed side, lower lip purple, purple marking inside the lower portion of the corolla with foveola and with yellow crescent. Stamens 4, epipetalous, didynamous, filamants 1—1.5 cm long glabrous, white in colour, connective prolonged terminating in a globose gland. Anther 0.3 — 0.4 cm long, cream yellow in colour, light purple streak at the line of dehiscence. Ovary slightly compressed, more or less obtuse at the apex, pilose, 2 locular becoming tetra-locular due to parietal, radial false dissepiment, each compartment having 14-16 one seriate, slantingly superposed ovules. Disc at the base of the ovary annular regular. Style glabrous, white 0.5—1.2 cm long, stigmatic labellae bifid, lanceolate, acute; capsule erect, oblong, quadrangular, 4 grooved, rounded at the base and apex ending in short and cleft beak; 1.8-2.2 cm long, 0.6-0.8 cm broad, pilose finally splitting down to the base; seeds 2.8-3.0 mm long and 1.8 - 2.0 mm broad, brown in colour obovoid with faces transersely rugose.

The pollen fertility was high (99.0%). The pollen is spherical in shape and smooth surfaced. It measured 71.4%. The variety when used as pollen and ovule parent readily sets seeds in crosses involving the cultivated variety and the other wild variety *S.indicum* (L.) Var. *Yanamalai* ARR & MS.

This new variety was collected at Melur near Sencottai at an altitude of 158.19 m from MSL during June 1988. This was found to be moderately tolerant to drought and pests, like leaf roller (*Antigastra catalaunalis*), gall fly (*Asphondylia sesami*) and sesamum sphinx (*Acherantia styx*) under natural conditions.

It has been quoted by Bruce (1953) that Hooker (1885) and Gamble (1925) recorded three species viz., *S.indicum* (L.) the cultivated variety, *S.prostratum* Retz

Received on Mar9h 20. 1989

and *S.laciniatum* Klien, the two wild perennial and prostrate herbs as occuring in India Abraham (1945) has described a wild species and named it as *S.grandiflorum*. John *et al.* (1950) identified a wild sesame in Malabar and considered it to be a variety of cultivated sesame and designated it as *S. orientale* var *malabaricum*. Appala Naidu (1953) described the species by name *S.ekambaramii* from Hyderabad which was however, found to be the same as *S.alatum* by Ramanujam and Joshi (1954). Nair (1963) has recorded a new species from Punjab and described it as *S.mulayanum* Nair Sp. nov. Amirthadevarathinam and Subramaniam (1976) have described a wild variety of sesame found in Madurai, Tamil Nadu and named it as *S.indicum* var. *Yanamalai* ADR & MS.

This new variety is the second wild variety found in Tamil Nadu. It resembles the cultivated type *S.indicum* (L.) in gross morphology. It is very much different from the already described wild variety *S.indicum* var *Yanamalai* ADR & MS in leaf shape, capsule size and seed colour. A comparative description of the three varieties hilighting the similarities and differences is given below.

**Description of varieties**

| Character | *S. indicum* (L) | *S. indicum* var. *Yanamalai* ADR & MS | *S. indicum* var. *Sencottai* ADR & NS |
|---|---|---|---|
| 1 | 2 | 3 | 4 |
| Branching | Branching and non branching, open and bushy types | Open type yet with more number of primaries and secondaries distantly placed | open type, mostly with primary branches and very few secondary branches |
| Leaves | Dimorphic, mostly serrate or dentate margin in basal leaves, entire margin in top leaves | Highly heteromorphic with serrate margin in basal leaves and entire in top leaves | Dimorphic, with dentate margin in basal leaves, entire margin in top leaves |
| First flowering | 25 to 40 days | 55 to 60 days | 35 to 40 days |
| Flowers | Mostly white and occasionally with a purple wash | Purple on the exposeed side with deep purple lower lip | Pink coloured with purple lower lip |
| Filament | White with no streaks | Cream yellow with prominent purple streak at the line of dehiscence | Cream yellow with light purple streak at the line of dehiscence |
| Capsule | 1.5 — 3.2 cm long 0.6 — 0.8 cm broad | 1.8 — 2.0 cm long, 0.3 — 0.4 cm broad | 1.8 — 2.2 cm long, 0.6 — 0.8 cm broad |
| Seeds | Black, brown or white. Smooth Surfaec elongate and orbicular | Jet black reticulately rugose, obvoid | Brown, rugose, orbicular |

Agricultural Research Station, Kovilpatti.

A. AMIRTHA DEVARATHINAM
N. SUNDARESAN

ABRAHAM, A. 1945. Cytogenetical studies on *Sesumum*. *Proc. 32-nd Indian Sci. Congr.* (Abst.) 46 : 20.

AMIRTHADEVARATHINAM, A and M. SUBRAMANIAN, 1976. A new variety of *Sesamum* Linn. from Madurai, South India, *Madras agric. J 7.*, **63**(3) : 169-171.

APPALA NAIDU, B. 1953. A new species of *sesamum* (*Sesamum ekambaramii*), *J. Bombay Nat. Hist. Soc.*, **51** : 697-98

BRUCE, E.A. 1953. Notes on African Pedaliaceas, *Kew bull.* **67** : 417-29.

JOHN, C.M., NARAYANA G.V. and C.R. SESHADRI, 1950. The wild gingelly of Malabar, *Madras agric.* **J.**, **37** : 47-50.

NAIR, N.C. 1963. A new species of *Sesamum* Linn. from Northern India. *Bull. Bot. Surv. India.*, **5** 251-53.

RAMANUJAM, S. and A.B. JOSHI, 1954. Identity and taxonomical status of *Sesammum eekambaramii* Naidu. *J. Bombay Nat. Hist.* Soc , **52** : 667.

Fig 1 *S.indicum* (L) *S.indicum* Var. *Yanamalai* ADR & MS *S.indicum* Var. *Sencottai* ADR & MS

J.Oilseeds Res. 7 (1990) 124-125
*ISSN* 0970—2776

# NEW RECORD OF A MYCOPHAGOUS BEETLE, *THEA CINCTA* FABR. ON POWDERY MILDEW OF NIGER

Powdery mildew caused by *Sphaerotheca* spp. is the most serious disease of niger, *Guzotia abyssinica* Cass. A white powdery coating of fungal growth appears on the leaves, stems, branches and capsules. The affected leaves turn yellow and wither off. This affects plant growth adveresly and ultimately results in poor growth.

In the experimental farm of JNKVV, Regional Agricultural Research Station Chhindwara a coccinellid beetle, *Thea cincta* Fabr. was observed on niger crop during November-December, 1988. Adults were seen on all the parts of the plants while the grubs were more aggregated on the leaves affected with powdery mildew. They were found on the lower surface of the leaves during the period of bright sun. Population of adults ranged from 5-11 per plant while the number of grubs on different stages ranged from 8-20 per plant. Careful examination of the adults and grubs revealed that they feed on the fungus. The fungus was identified as *Sphaerotheca* spp. It was therefore considered appropriate to make some observations on the biology of this fungus feeding beetle under Chhindwara conditions.

The whitish shinning egg masses, each containing 8-10 eggs were mostly seen on the surface of leaves. Incubation period of eggs in the laboratory varied from 5-6 days in December under room temperature. The different instar grubs of *T.cincta* are shown in fig. 1. The first instar grubs were very small measuring about 2.5 mm. long. This instar was very poor feeder. First moulting was observed within 48 hrs. Second instar grubs were elongated, flattened and measured about 3.5 mm. long. They were more active and darker than the first instar grubs. They moulted within 36 hrs. The third instar grubs were still more darker with a prominent head shield and measured 5.5 mm. The fourth instar grub resembled to the previous instar except in length, about 7.0 mm. It moulted within 72 hrs. The fifth instar grub was the longest stage which lasted for 4-5 days. Freshly emerged adults were light in colour which later on changed to bright yellow and developed four black spots on the head.

Different instar grubs were allowed to feed on the powdery mass on the affected leaves in the laboratory. The first instar grubs caused very small specks on the powdery mass showing their poor feeding capacity. Grubs in their advance stages were more active in feeding. Maximum green patches on the leaves due to scrapping of fungus were formed by 4th and 5th instar grubs. The fifth instar grub had, however, stopped feeding before entering into pupal stage.

Received on October 7, 1989

*Thea cincta* has been reported to feed on the fungus, *Oidium lini* of linseed. (Prasad and Rai, 1988) and *Phylloctinia corylea* Pers. on mulbery plants (Lefroy, 1909) This is the first report of feeding of *Thea cincta* on *Sphaerotheca* spp on niger.

JNKVVR
Chirdwara-480 001
(MP)

S.R. DHARPUR
M.K. RAO,
R.B.S. SAGAR

PRASAD, R and M. RAI, 1988. *Farm science Journal* 3(1):89-90.

LEFROY, H. MAXWELL, 1909. *Indian Insect life* Thakkar publication, Calcutta, 307 p.

**Fig.** 1. Different instar grubs of *Thea cincta*

J. Oilseeds Res. 7 (1990) 126-129
*ISSN* 0970-2776

# EFFECT OF IRRIGATION ON GERMINATION AND YIELD OF *SESAME IN SANDY LOAM SOILS*

Sesame (*Sesamum indicum* L.) is generally grown as a catch crop during summer in rice fallows in Kerala utilising the residual soil moisture. The average yield under such a system is low and the main constraints for the low levels of yield include low moisture content of soil at the time of sowing and growth of the crop. Preliminary investigations at the Rice Research Station, Kayamkulam, Kerala revealed that the crop responds to irrigation. It was also noticed that either an excess or a deficiency of soil moitsure in the field affects the germination of sesame seeds adversely resulting in poor stand. The soil moisture for getting maximum germination was found to be 20 per cent under laboratory conditions (Kunju and Salam, 1980). However, Krishnakumar (1981) observed higher germination at a soil moisture of 12 per cent in the field conditions. Sharma and Reddy (1983) reported that the first irrigation should be given immediately after sowing to increase germination and seedling and a second irrigation when the plants are about 15 cm in height. Considering aspects, an investigation was undertaken at the Rice Research Station, Kayamkulam to determine the optimum soil moisture level for obtaining maximum germination under field conditions and to find out the influence of irrigation at the vegetative and reproductive stages on the yield of sesame,. The soil of thr experimental area was sandy loam and the variety used was Kayamkulam 2 (*Thilothhamma*).

The experiment was laid out in split-plot design with three replications. The main-plot treatments consisted of daily sowing after giving a pre-sowing irrigation, starting sowing from the date of the pre-sowing irrigation upto 9 days after irrigation with a control (no pre-sowing irrigation). The sub-plot treatments consisted of giving one irrigation during the vegetative phase ($I_1$) giving two irrigations—one at the vegetative phase and the other at the productive stage ($I_2$) and a control ($I_0$) where there was no irrigation during the growth period. The gross size of the sub-plot was 6 x 5m and a band of half metre was left as border all around. The land was brought to fine tilth and a uniform dose of nitrogen, phosphorus and potassium at the rate of 30:15:30 kg/ha was applied as basal dose. The plots were irrigated to field capacity uniformly except the control plot and sowing was done in different plots daily from the day of the pre-sowing irrigation upto 9 days after it as per the treatment schedule. Usual recommended package of practices were given uniformly except the treatments. Soil samples were taken at the time of sowing for moisture determination. Observations were made on germination and yield. Four sampling units of 50×50cm size were marked in each plot at random and plant counts were taken from these areas 10 days after sowing. Based on the total number of seeds sown per unit area, the germination percentage was worked out. At maturity the crop from the net plot of 5×4 m size

Received on June 27, 1988.

was harvested, cured, threshed, seeds separated, dried in sun for three days, cleaned and weight recorded. The seed yield was expressed in kg/ha.

The data (Table 1) show that germination was significantly influenced by time of sowing. Sowing seeds one day after the pre-sowing irrigation recorded the highest germination followed by sowing seeds on the same day of irrigation. Maximum germination percentage of 58.22 was obtained when the soil moisture content at the time of sowing was 12.72 per cent. It is clear that sesame required certain optimum soil moisture for its maximum germination. When the soil moisture exceeds this optimum level, germination was found to decrease. Similarly, below 12.72 per cent soil moisture, a decreasing trend was observed in germination, thereby resulting in low plant population. Thus, soil moisture above or below this shows deleterious effects on germination of sesame seeds under field conditions. These results are in accordance with the findings of Rao *et al.* (1975) and Krishnakumar (1981). Such an optimum soil moisture content in the field, where the soil is sandy loam, is attained by irrigating the prepared field to field capacity and sowing the seeds one day after it.

**TABLE 1. Soil moisture percentage at the time of sowing and germination percentage at 10 days after sowing**

| Treatments | Soil moisture percentage at sowing | Germination percentage at 10 days after sowing |
|---|---|---|
| $T_0$ No pre-sowing irrigation | 8.50 | 16.95 |
| $T_s$ Sowing on the day of the pre-sowing irrigation | 16.05 | 50.91 |
| $T_1$ Sowing one day after pre-sowing irrigation | 12.72 | 58.22 |
| $T_2$ Sowing two days after pre-sowing irrigation. | 10.90 | 25.85 |
| $T_3$ Sowing three days after pre-sowing irrigation | 10.24 | 21.45 |
| $T_4$ Sowing four days after pre-sowing irrigation | 9.68 | 17.63 |
| $T_5$ Sowing five days after pre-sowing irrigation | 9.89 | 17.42 |
| $T_6$ Sowing six days after pre-sowing irrigation | .34 | 6.39 |
| $T_7$ Sowing seven days after pre-sowoing irrigation | 8.80 | 14.36 |
| $T_8$ Sowing eight days after pre-sowing irrigation | 8.18 | 14.28 |
| $T_9$ Sowing nine days after pre-sowing irrigation | 8.27 | 17.77 |
| CD (0.05) | 0.843 | 0.958 |

**TABLE 2. Seed yield (kg/ha) as influenced by different treatments**

| Tim of sowing | Frequency of irrigation | | | |
|---|---|---|---|---|
| | I0 | I1 | I2 | Mean |
| T0 | 187.00 | 303.33 | 304.66 | 265.00 |
| TS | 633.33 | 777.33 | 778.33 | 729.66 |
| T1 | 646.00 | 850.000 | 859.00 | 785.00 |
| T2 | 352.66 | 424.00 | 420.00 | 398.88 |
| T3 | 331.00 | 414.33 | 414.33 | 386.66 |
| T4 | 243.33 | 296.00 | 291.33 | 276.88 |
| T5 | 248.33 | 290.66 | 286.33 | 275.11 |
| T6 | 205.00 | 250.33 | 253.66 | 236.33 |
| T7 | 127.33 | 184.66 | 180 0 | 164.00 |
| T8 | 128.00 | 158.66 | 158.00 | 148.22 |
| T9 | 126.66 | 160.00 | 158.66 | 148.44 |
| Mean | 293.51 | 373.60 | 373.12 | |

| | |
|---|---|
| CD (0.05—for time of sowong | 12.500 |
| ,, —for frequency of irrigation | 4.736 |
| ,, —for interaction between time of sowing and frequency of irrigation | 15.707 |

The data presented in Table 2 show that the seed yield was significantly influenced by time of sowing, frequency of irrigation and by their interactions. Sowing the seeds one day after the pre-sowing irrigation produced the highest yield and it was significantly superior to other treatments. This was followed by sowing the seeds on the same day of pre-sowing irrigation. It was observed that germination was high in the above two treatments which resulted in higher plant population and consequently higher seed yield.

Irrigation during the growth phases showed significant influence on seed yield when compared to no irrigation during the growth stages. Giving one irrigation during the vegetative phase and two irrigations during the vegetative and reproductive phases were significantly superior to control, however among the two, they were on par. The effect due to interaction between time of sowing and frequency of irrigation was also significant. The highest seed yield of 859.00 kg/ha was obtained by the treatment

combination of sowing the seeds one day after the pre-sowing irrigation and with two subsequent irrigations during the vegetative and reproductive phases of the crop growth.

THOMAS MATHEW and MOHMED KUNJU, U.

College of Agriculture, Vellayani (Kerala).

KRISHNAKUMAR, V. 1981. Evolving suitable agro-techniques for sesamum in Onattukara. M.Sc.(Ag.) thesis, Kerala Agricultural University.

KUNJU, U.M. and Salam, M.A. 1980. Germination of sesamum seeds under different soil moisture regimes. *Agric. Res. J.* Kerala: 18:98-99.

RAO, D.H., RAO, M.S.R.M. and KOSSAINAPPA, V. 1975. Effect of pressing the seeded rows on germination and crop stand in black soils. *Curr. Res.* **4** (1): 14-15.

SHARMA, S.M. and REDDY, B.N. 1983. Research on sesamum makes headway. *Indian Fmg.* **32**(12):3.

J Oilseeds Res 7 (1990) 130-132
*ISSN* 0970—2776

# GENETIC VARIABILITY IN VIRGINIA RUNNER GROUNDNUT (*ARACHIS HYPOGAEA* LINN.)

A critical survey of genetic variability is obligatory for planning and effective execution of both the national and regional breeding researches in groundnut. The genetic resources of cultivated groundnuts and related *Arachis* species assembled from different agro-ecological regions of the world at various groundnut breeding centres including national (NRCG) and international (ICRISAT) centres in India provide a wide array of germplasm accessions that could be utilized for improvement of this crop. The investigation reported here was therefore carried out to assess the variation for pod yield and nine component characters in Virginia runner groundnut germplasm collection.

Fifty accessions of Virginia runner groundnut (*Arachis hypogaea* ssp. *hypogaea* var. *hypogaea*) culled out at random from the germplasm collection available at the Main Oilseeds Research Station, Gujarat Agricultural University and Genetic Resources Section, National Research Centre for Groundnut, Junagadh were sown at the Experimental Farm of Main Oilseeds Research Station, GAU, Junagadh in randomized block design with 4 replications during Kharif, 1986. Thirty four plants spaced at 65 cm x 15 cm constituted a plot. Observations on days to 50 per cent flowering and days to maturity were recorded on plot basis, while number of primary (n+1) branches, total pegs, number of mature pods, harvest index, 100-seed weight (g), shelling percentage and oil content were recorded on five randomly selected plants. The genotypic and phenotypic variances for each of the 10 traits were estimated following Johnson *et al.* (1955). Genotypic and phenotypic co-efficient of variations were estimated following Burton (1952). Heritability and genetic advance were estimated as given in Allard (1960).

Wide phenotypic ranges were observed for all the traits (Table 1). The differences among the varieties for all the characters were further revealed by analysis of variance. Phenotypic and genotypic variance estimates for all the ten characters were also high. These results suggest that the varieties evaluated were of diverse origin and that the utilizable variability in Virginia runner form of groundnut is quite high This view is corroborated by the reasonably high phenotypic and genotypic co-efficients of variation for a majority of the traits (Table 1). The PCV was however, a little higher than G.C.V. for all the traits. The difference between the two was remarkably lower for days to maturity, number of mature pods, harvest index, 100-seed weight, shelling percentage and oil content.

The heritability estimates (Table 1) were high for days to maturity, 100-seed weight, shelling percentage, harvest index, and oil content suggesting the possibility of selection response based on their phenotypic expression. Number of primary bran-

Received on Febeuary 4, 1989

**Table 1.** Genotypic ($\bar{}g$) and phenotypic ($\bar{}p$) variances, genotypic and phenotypic coefficients of variation (GCV and PCV), heritability (broad sense-H) genetic advance (GA) and expected genetic advance expressed as percentage of the mean (GAm) for 10 characters in virginia runner groundnut

| Sr. No. | Character | General mean | Range | $\bar{}g$ | $\bar{}p$ | GCV | PCV | H(%) | GA | GAm |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Pod yield (g) | 16.05 | 11.68 — 19.40 | 3.65 | 5.01 | 11.90 | 13.95 | 72.76 | 3.37 | 20.91 |
| 2. | Days to 50% flowering | 38.51 | 34.25 — 41.00 | 3.03 | 3.99 | 4.52 | 5.19 | 76.08 | 3.13 | 8.13 |
| 3. | Days to maturity | 126.90 | 116.00 —137.75 | 60.77 | 62.10 | 6.14 | 6.21 | 97.86 | 15.89 | 12.52 |
| 4. | Number of primary branches | 6.98 | 5.25 — 8.50 | 0.41 | 1.04 | 9.23 | 14.59 | 39.96 | 0.84 | 12.01 |
| 5. | Total pegs | 106.20 | 90.75 —127.00 | 64.15 | 114.18 | 7.54 | 10.06 | 56.19 | 12.37 | 11.65 |
| 6. | Number of mature pods | 21.31 | 13.25 — 24.75 | 4.57 | 6.53 | 10.03 | 11.99 | 69.87 | 3.68 | 17.27 |
| 7. | Harvest Index | 49.03 | 35.02 — 60.52 | 26.90 | 30.09 | 10.58 | 11.19 | 89.39 | 10.10 | 20.60 |
| 8. | 100 seed weight (g) | 45.00 | 40.40 — 53.23 | 19.50 | 20.16 | 9.81 | 9.98 | 96.72 | 8.95 | 19.88 |
| 9. | Shelling percentage | 67.12 | 60.25 — 71.83 | 6.63 | 6.98 | 3.84 | 3.93 | 94.98 | 5.17 | 7.70 |
| 10. | Oil content (%) | 48.20 | 46.90 — 49.50 | 0.38 | 0.45 | 1.28 | 1.40 | 84.19 | 1.17 | 2.42 |

ches exhibited low heritability, while it was moderate for other characters. Bhagat *et al.* (1986) reported high heritability estimates for days to maturity, 100-seed weight and shelling percentage; Deshmukh et al (1986) for 100-seed weight, shelling percentage and oil content and Singh *et al* (1982) for 100-kernel weight and shelling percentage

Expected genetic advance as percentage of the mean (GAm) (Table 1) was high for pod yield, harvest index, 100-seed weight and number of mature pods; while it was moderate to low for days to Maturity, number of primary branches, total pegs, days to 50 per cent flowering, shelling percentage and oil content. Bhagat *et al* (1986) reported high GAm for pod yield and 100-seed weight and Deshmukh et al (1986) for 100-seed weight.

The characters 100-seed weight, harvest index, pod yield and number of mature pods had high to moderate heritability coupled with high genetic advance. It was interesting to note that the most direct components of pod yield i.e. 100-seed weight, harvest index and number of mature pods had high variability, heritability and GAm. In other words, there appears to be good opportunity to improve the yield components in Virginia runner form of groundnut. Moreover, GAm for harvest index and pod yield were of the same magnitude. This might indicate that opportunity existed for simultaneously increasing total biomass and pod yield.

M.A. VADDORIA V.J. PATEL

Gujarat Agricultural University Junagadh-362 001 (Gujarat)

ALLARD R.W. (1960). "Principles of Plant Breeding". John Wiley and Sons, Inc. New York, PP 85-95.

BURTON, G.W. (1952). Quantitative inheritance in grass. Proc. 6th Int. Grassld. Cong. **1** : 227-283.

BHAGAT, N.R., TASLIM AHMED, LALWANI H.B. and NAGARAJ G. (1986). Variation, character association and path-analysis in improved groundnut varieties. *Indian J. Agric. Sci.*, **56(4)** 300-302.

DESHMUKH, S.N., BASU, M.S., and REDDY P.S. (1986). Genetic variability, character association and path co-efficient of quantitative traits in Virginia bunch varieties of groundnut. *Indian J. Agric. Sci.* **56(12)** : 816-821.

JCHNSON, H.W. ROBBINSON H.F.,, and COMSTOCK R.F. (1955). Estimates of genetic and environmental variability in soybean. *Agron.J.*, **47** : 314-318.

HARI SINGH, YADAVA, A.K., and CHHABRA, M.L. (1982). Genetic variability and heritability for morpho-physiological attributes in groundnut. *Indian J. Agric. Sci.*, **52** : 432-434.

J. Oilseeds Res. 7(1990) 133-135
*ISSN* 0970—2776

# FERTILIZER REQUIREMENT OF GROUNDNUT (*ARACHIS HYPOGEA* L.) UNDER DRY LAND CONDITIONS ON CULTIVATORS' FIELDS.

Chittorgarh district is an important groundnut growing tract in Rajasthan and occupies 33865 ha of area with an average yield of 9.3 Q/ha. Fertilizer consumption in the district is very low. About 3.17 kg N, 0.91 kg $P_2O_5$ and 0.64 kg $K_2O$ per ha is the nutrient use which may be one of the important reason for poor yield. Dahatonde and Rahate (1974) and Tomar *et al.* (1983) reported response of phosphorus upto 40 kg $P_2O_5$ per ha. Birajdar and Ingle (1979) found that economical fertilizer dose was 27 kg N+54 kg $P_2O_5$ per ha which gave a yield of 17.88 Q/ha. Not much research work pertaining to fertilizer requirement of groundnut under dryland conditions has been conducted in the state and no specific information is available for cultivators' holdings. It was, therefore, considered useful to undertake studies on cultivators' holdings. With this end in view, fifty two trials were conducted on cultivators' fields to study the response of NP and K under rainfed conditions in Chittorgarh district in Rajasthan.

The experiments were conducted on groundnut variety AK-12-24 on randomly selected blocks on cultivators' fields in 52 different villages of Chittorgarh district for four years (1978-79 to 1981-82) under All India Coordinated Agronomic Research Project. Soil samples (0-15cm) were collected before sowing of crops and analysed for different soil parameters. The soil of experimental fields were clay loam in texture, $P^H$ ranging from 7.0 to 8.6, E.C. 0:41 mmohs/cm, O.C. 0.39%, available $P_2O_5$ 33.25 kg and available $K_2O$ 349 kg per ha.

**TABLE 1.**
**Soil analysis data of experimental plots in cultivators' fields.**

| Year | pH | E.C.% (mmhos/cm) | O.C.% | $P_2O_5$ (kg/ha) | $K_2O$ (kg/ha) | Texture |
|---|---|---|---|---|---|---|
| 1978-79 | 7.2-8.3 | 0.16-1.96 (0.49) | 0.05-0.089 (0.52) | 4.24-161.26 (42.52) | 100-537 (269) | Clay Loam ,, ,, |
| 1979-80 | 7.0-8.6 | 0.03-0.13 (0.08) | 0.02-1.07 (0.48) | 10.08-115.04 (31.50) | 67-425 (225) | ,, ,, |
| 1980-81 | 7.9-8.4 | 0.76-0.93 (0.86) | 0.08-0.35 (0.36) | 12.73-72.15 (38.00) | 212-1075 (522) | ,, ,, |
| 1981-82 | 8.0-8.6 | 0.12-0.64 (0.23) | 0.10-0.75 (0.30) | 12.73-42.43 (22.50) | 124-1075 (383) | ,, ,, |
| Average | 7.0-8.6 | 0.03-1.96 (0.41) | 0.02-1.07 (0.39) | 10.08-161.26 (33.25) | 67-1075 (349) | ,, ,, |

Figures in parantheses are the average values.

Received on September 15, 1989.

Three levels of nitrogen viz. 0,10 & 20 kg/ha and three levels of $P_2O_5$ viz. 0,30 and 60 kg $P_2O_5$/ha were evaluated alone and in combination. A combination of 20 kg N + 60 kg $P_2O_5$+40kg $K_2O$/ha was also evaluated in these field experiments. All the N, P&K were drilled in furrows at the sowing time.

**TABLE 2.**
**Yield of dry pods of groundnut (q/ha) as affected by various treatments.**

| Year | | | 1978-79 | 1979-80 | 1980-81 | 1981-82 | Pooled Mean |
|---|---|---|---|---|---|---|---|
| No. of trials | | | 14 | 13 | 14 | 11 | 52 |
| N | P | K | | | | | |
| 0 | 0 | 0 | 4.27 | 4.16 | 10.68 | 12.23 | 7.65 |
| 0 | 30 | 0 | 4.70 | 4.90 | 15.16 | 14.43 | 9.62 |
| 0 | 60 | 0 | 5.64 | 5.54 | 18.74 | 16.26 | 11.39 |
| 10 | 0 | 0 | 4.87 | 4.79 | 12.16 | 13.28 | 8.59 |
| 10 | 30 | 0 | 5.52 | 5.69 | 17.21 | 15.88 | 10.90 |
| 10 | 60 | 0 | 6.45 | 6.41 | 20.57 | 18.24 | 12.74 |
| 20 | 0 | 0 | 5.70 | 5.49 | 13.16 | 14.26 | 9.47 |
| 20 | 30 | 0 | 7.05 | 6.59 | 20.12 | 18.04 | 12.78 |
| 20 | 60 | 0 | 7.76 | 7.39 | 23.61 | 20.08 | 14.54 |
| 20 | 60 | 40 | 8.28 | 7.91 | 25.99 | 21.57 | 15.77 |
| G. Mean | | | 6.02 | 5.89 | 17.74 | 16.43 | 11.34 |
| S.Ed.± | | | 0.23 | 0.26 | 0.40 | 0.23 | 0.15 |
| C.D. 5% i | | | 0.46 | 5.51 | 0.79 | 0.45 | 0.29 |

**Response of Nitrogen**

**TABLE 3.**
**Effect of nitrogen levels on dry pods of groundnut.**

| Nitrogen (kg/ha) | Pods yield (kg/ha) | Increase over control (kg/ha) |
|---|---|---|
| 0 | 765 | - |
| 10 | 859 | 94 |
| 20 | 947 | 182 |

Yield data given in table-3 revealed that application of N @ 10 & 20 kg/ha proved highly significant over control and N @ 20 kg/ha also proved significantly superior over N @ 10 kg/ha.

Response equation fitted for nitrogen data was $Y=766 + 9.10 X$. Response to Nitrogen was found to be 9.10 kg dry pods per kg of N applied.

**Response of Phosphorus**

TABLE 4.
**Effect of phosphorus levels on dry pods of groundnut**

| $P_2O_5$ (kg/ha) | Pods yield (kg/ha) | Increase over control (kg/ha) |
|---|---|---|
| 0 | 765 | – |
| 30 | 962 | 187 |
| 60 | 1139 | 374 |

Though the soils were medium in available phosphorus (Table-1), yield data for four years given in Table-3 indicated that application of $P_2O_5$ @ 30 & 60 kg per ha proved to be highly beneficial. Application of $P_2O_5$ @ 60 kg per ha was also singificantly superior over $P_2O_5$ applied @ 30 kg per ha.

Reponse equation fitted for phosphorus data was $Y=768 + 6.23 X$ which revealed that response to per kg of applied $P_2O_5$ was 6.23 kg pods of groundnut.

**Response of Potash**

Though the soils were rich in available $K_2O$ (Table-1), application of 40 kg $K_2O$/ha along with N and $P_2O_5$ @ 20 & 60 kg/ha respectively, proved significantly superior over application of the same without $K_2O$ (Table-2)

The yield data given in Table-2 indicate that balanced use of nitrogen and phosphate in all the combinations proved highly significant over their application alone. Similarly balanced use of NPK proved highly significant over NP combinations alone.

Thus it may be inferred that balanced use of N, $P_2O_5$ & $K_2O$ @ 20,60 & 40 kg per ha respectively, proved highly desirable dose for boosting groundnut production under Chittorgarh conditions which increased the yield from 7.65 to 15.77 kg per ha.

G.L. YADAV.

Agricultural Research Station, Fathepur, Shekhawati - 332 301

BIRAJDAR, J.M. and INGLE, V.N. (1979). Studies on the watering and N and P fertilization requirement of summer groundnut crop. Indian J. Agron 24(1):7-9.

DAHATONDE, B.N. and RAHATE, V.T. (1974). Effect of levels and methods of phosphate fertilization on yield contributing characters of summer groundnut. P.K.V. Res. J. 3:1-4.

TOMAR, S.P.S; CHAUHAN, Y.S., JAIN, V.K. and JAIN, P.C. (1983). Response of Phosphorus on different varieties of groundnut (*Arachis hypogea Linn*). Madras agric J. 70(5): 301-305

J. Oilseeds Res. 7(1990) 136-139
*ISSN* 0970—2776

# EFFECT OF SECONDARY NUTRIENTS AND BORON ON SOME GROWTH CHARACTERS AND YIELD IN SUNFLOWER

The problem of poor seed set and filling has been one of the most commonly encountered problem in sunflower cultivation. Poor seed filling is reflected in terms of higher percentage of hollow seeds and lower test weight of the produce (rarely exceeds 4 g/100 seeds). This problem demands greater attention due to its adverse effect on seed yield and quality of the produce. Hollow seeds are the results of failure of pollination either due to lack of pollinators or self-incompatibility. Nutrients having role in photosynthesis and translocation of metabolites influence the test weight. Besides major fertilizer nutrients (NPK), the trace element boron appears to have special role in influencing seed filling.

Studies conducted in India and elsewhere indicated that even though with no visible boron deficiency symptoms, sunflower responds to boron fertilization as soil application or as foliar spray in terms of improved seed filling and yield (Blamey, 1976; Satyanarayana *et al.*, 1977; Blamey and Chapman, 1982 and Su, 1982). Blamey (1976) opined that boron plays major role during the reproductive phase rather than in vegetative phase. Bobek and Kovacik (1972) reported that boron and calcium help in better pollen germination and result in higher seed set. No studies were conducted regarding response of sunflower to dusting of boron on sunflower heads at the time of flowering (ray floret opening). With this information in back ground a field experiment was conducted under protective irrigation during kharif 1988 at University of Agricultural Sciences, GKVK, Bangalore to study the effect of calcium, magnesium and micronutrient boron on yield and quality parameters in sunflower genotypes, Morden and EC. 68415. The soil was of red sandy loam, medium in organic carbon (0.53%) and medium in available P (21 kg/ha) and low in available K (100 kg/ha). The exchangeable Ca, Mg and B status of these soils were 315, 172 and 1 ppm respectively. The design adopted was factorial RBD with three replications and the plot size followed was 16.2 $m^2$. The borax dusting on sunflower heads was done at seed filling stage (56 and 63 days after sowing in Morden and EC. 68415 varieties respectively). The borax was taken in muslin/kora cloth bag and dusting was done on each sunflower heads by touching the heads with borax filled bag. Each head received 0.027 to 0.036 g of borax. The other nutrient treatments included were soil applications of calcium and sulphur through gypsum @ 20 and 15 kg/ha respectively, magnesium and sulphur through $MgSO_4$ @ 10 and 13 kg/ha respectively and Boron through Borax @ 2 kg/ha besides a control treatment of only N,P,K. The fertilizer doses given were 60-60-40 and 80-90-40 kg of kg N, $P_2O_5$ and $K_2O$ per ha for Morden and EC. 68415 varieties respectively. The nutrient treatments included and their influence on yield and other ancillary characters on these two sunflower varieties are given in Table 1.

The variety EC.68415 gave significantly higher yield by 241 kg per ha over Morden. It was also significantly superior in test weight, head diameter and oil per cent. Dusting 2 kg borax on sunflower heads at seed filling stage was found to be significantly superior

Received on October 7, 1989.

TABLE 1.
**Influence of secondary nutrients and boron on seed yield and ancillary characters in sunflower**

| Treatments | Symbol | Seed yield (kg/ha) | 100 seed weight (g) | Seed filling (%) | Head diameter (cm) | Oil (%) | Germination (%) | Vigour index |
|---|---|---|---|---|---|---|---|---|
| *Varieties* | | | | | | | | |
| Morden | V1 | 763 | 4.82 | 76 | 15.0 | 30.7 | 89.0 | **1522** |
| EC.68415 | V2 | 1004 | 5.70 | 80 | 17.5 | 36.7 | 94.0 | **1800** |
| C.D. (P=0.05) | | 91 | 0.008 | NS | 0.9 | 1.2 | 2.3 | 182 |
| *Nutrients* | | | | | | | | |
| Calcium (Gypsum) @ 20 kg/ha | N1 | 846 | 5.00 | 79 | 17.0 | 34.0 | 93.0 | **1546** |
| Magnesium ($MgSO_4$) @10 kg/ha | N2 | 802 | 5.00 | 71 | 15.2 | 34.4 | 90.0 | **1534** |
| Boron (Borax) @ 2 kg/ha (Soil Application) | N3 | 894 | 5.90 | 81 | 16.5 | 32.8 | 94.0 | **1800** |
| Boron (Borax) = 2 kg/ha (Dusting heads) | N4 | 1220 | 6.40 | 89 | 17.8 | 33.2 | 96.0 | **2162** |
| Control | C | 654 | 4.00 | 71 | 14.7 | 34.2 | 84.0 | **1263** |
| C.D. (P=0.05) | | 143 | 0.013 | 6.3 | 1.5 | NS | 4.0 | **287** |
| *Interaction* ($V \times N$) | | | | | | | | |
| $V_1N_1$ | | 770 | 4.90 | 74 | 16.6 | 32.6 | 93.0 | **1436** |
| $V_1N_2$ | | 637 | 4.10 | 65 | 13.3 | 30.9 | 85.0 | **1419** |
| $V_1N_3$ | | 720 | 5.30 | 79 | 14.7 | 30.5 | 93.0 | **1820** |
| V1N4 | | 1056 | 6.00 | 86 | 16.3 | 28.9 | 95.0 | **1979** |
| $V_1C$ | | 632 | 3.70 | 77 | 14.0 | 30.9 | 77.0 | **958** |
| $V_2N_1$ | | 923 | 5.00 | 84 | 17.3 | 35.4 | 92.0 | **1656** |
| $V_2N_2$ | | 963 | 5.90 | 76 | 17.0 | 37.8 | 96.0 | **1648** |
| $V_2N_3$ | | 1068 | 6.50 | 82 | 18.3 | 35.3 | 95.0 | **1780** |
| $V_2N_4$ | | 1383 | 6.80 | 92 | 19.3 | 37.6 | 97.0 | **2346** |
| $V_2C$ | | 675 | 4.30 | 64 | 15.3 | 37.5 | 91.0 | **1568** |
| C.D. (P=0.05) | | NS | 0.018 | 8.9 | NS | 2.7 | 5.5 | NS |
| C.V.% | | 13.98 | 6.62 | 6.61 | 7.41 | 4.58 | 2.45 | 10.81 |

compared to any other treatments. This gave 1220 kg per ha followed by soil applications of 10kg borax (894 kg/ha) 20 and 15 kg/ha Ca and S respectively as gypsum (846 kg/ha), 10 and 13 kg/ha Mg and S respectively as $MgSO_4$ (894 kg/ha) and control (654 (kg/ha) which was significantly the lowest. The per cent increase in yield over control varied from 86.5 with borax dusting of sunflower heads at seed filling stage to 22.6 per cent with soil application of 10 and 13 kg/ha Mg and S respectively as $MgSO_4$. The borax treatment significantly improved the test weight, seed filling and head diameter compared to control. Though, interaction effects between varieties and nutrients treatments did not influence the seed yield, borax treatments caused significant improvements in test weight and seed filling over their respective controls in both the varieties.

Dusting sunflower heads with borax gave significantly highest germination per cent of 96 and vigour index of 2162 compared to control (84% germination and 1263 vigour index) and other treatments which were on par amongst themselves in germination per cent (90 to 93) and vigour index (1534 to 1800). All nutrient treatments were significantly superior to control. The interaction effects between varieties and nutrients were significant only with respect to germination per cent. Highest germination was observed with dusting treatment of borax on both the varieties.

The newly emerged leaves in B deficient plants appear leathery and malformed. Further B deficiency result in head deformation and poor seed set.

Crotical B concentration levels in soils have not been identified so far, but Blamey *et al.* (1979) established a B concentration of 34 mg/kg in the yougest expanded leaf at flowering stage as critical in field grown sunflower.

The beneficial effect of boron fertilization as dusting of borax on sunflower heads during seed filling stage on seed yield and ancillary characters observed in the present investigation was very much substantial compared to the reports of earlier workers who fertilized boron as soil application for foliar spray (Blamey, 1976; Satyanarayana *et al.*, 1977; Blamey and Chapman, 1982 and Su, 1982). In the present study, dusting of 2kg borax per ha on sunflower heads during seed filling stage significantly improved the seed yield by 87%, test weight 60%, seed filling 25%, head diameter 21%, germination per cent 14 and seedling vigour 71% compared to control treatment (seed yield 654 kg/ha, 100 seed weight 4g, seed filling per cent 71, head diameter 15 cm, germination per cent 84 and seedling vigour 1263).

The authors are thankful to Dr. A. Seetharam In-charge Project Coordinator (Sunflower), UAS, GKVK, Bangalore, for his valuable comments and suggestions during the preparation of the research article.

University of Agri. Sciences
GKVK Campus,
Bangalore-560 065.

TUFAIL AHMEDKHAN
K. VENUGOPAL
CHIKKA DEVAIAH
K. SEENAPPA.

BLAMEY, F.P.O., 1976, Boron nutrition of sunflower (*Helianthus anuus* L.) on an Avalon medium sandy loam. *Agro Chemophysica,* **8**:5-10.

BLAMEY, F.P.O., MOULD, D. and CHAPMAN, J., 1979, Critical boron concentrations in plant tissues of two sunflower cultivars. *Agron. J.*, **71**:243-247.

BLAMEY, F.P.O. and CHAPMAN, J., 1982. Differential response of two sunflower cultivars to boron fertilization. In: Proceedings 10th International. Sunflower Conference held at Australia during May 14 to 18, 1982, 92-94 (Fide: *Fld. Crop Abstr.*, **36**:769, 1983).

BOBEK, J. and KOVACIK, A., 1972. Pollen germination in sunflower (*Helianthus annuus* L.). *Vitro Geneticaa slechteni*, 8(4):243-253 (Fide: Fld. Crop. Abstr., **27**:530, 1973).

SATYANARAYANA, T., VARADAN, K.M. BADANUR, V.P. and HAVANAGI, G.V., 1977, Note on the effects of secondary and trace elements on sunflower yield. *Indian J. agric. Res.* **11**(2): 122-124.

SU, R-Q., 1982. Effect of boron on fertility of sunflower. *Zhongguo Youliao*, **2**:52-53 (Fide:Fld. Crop Abstr., **36**:605, 1983.).

J. Oilseeds Res. 7 (1990) 140-142
*ISSN* 0970-2776

# STUDIES ON ROOT NODULATION IN GROUNDNUT

Groundnut (*Arachis hypogaea* L.) is vulnerable to nodulation by diverse species of *Rhizobia* (Allen and Allen, 1981). Cultivar differences for nodulation have also been reported (Nambiar and Dart, 1980). Nigam *et al.* (1980) reported about the non-nodulating groundnut genotypes. The number of nodules and the mass per nodule determine the nodule mass per plant. The nodules may also influence the root and shoot dry matter production (DMP). The results of an investigation regarding the variablility for nodulation and the traits associated with them are reported in this paper

The experiment was conducted in a red sandy soil which has a native Rhizobial population of $2\times10^4$/g of dry soil. One hundred bunch groundnut genotypes (ssp. *fastigiata*) belonging to both the botanical varieties (var. *fastigiata* and *vulgaris*) were grown in a single row of 4.5 m length spaced at 45 cm between rows and 15 cm between plants within row. The seed material was not inoculated with any Rhizobial culture. A basal dose of 10:10:45 kg N:P:K/ha was applied. Gypsum was aplied @ 200kg/ha on 40 DAS. At the pegging stage (i.e., 45 DAS) five plants were randomly selected, uprooted carefully and washed to remove the adhering soil particles without damaging the nodules. Observations on the number of nodules per plant, mass per nodule (average of 20 nodules), nodule mass per plant, root dry matter production (DMP) and shoot DMP were made. Pod yield was recorded after harvest. The standard deviation, coefficient of variation (CV) and correlation coefficients were worked out.

*The range and CV for the three traits namely, nodule number per plant, mass* per nodule and nodule mass per plant were high indicating that large amount of variability exists among the genotypes studied for nodulation (Table 1). Based on the standard deviation test ($\bar{x} + \bar{2}$) desirable genotypes for nodulation were also identified.

**TABLE 1. Variability for nodulation in groundnut**

| Character | Mean | Range | SD | CV |
|---|---|---|---|---|
| No. of nodules/plant | 30.3 | 11.7 — 81.7 | 13.4 | 44.3 |
| Mass/nodule (mg) | 1.28 | 0.34 — 4.18 | 0.55 | 42 9 |
| Nodule mass/plant (mg) | 37.1 | 6.7 — 113.3 | 18.6 | 50.1 |

The number of nodules per plant ranged from 11.7 to 81.7 with a CV of 44.3. The genotype Gadjah 61 from Indonesia recorded the highest number of nodules per plant (Table 2). VRI 1, the spanish bunch groundnut variety recommended for culti-

Received on October 7, 1989.

**TABLE 2. Genotypes with higher nodule number per plant**

| ICG No. | Identity | Origin | No. of nodules/plant | pod yield/ plant (g) |
|---|---|---|---|---|
| 1458 | V 37 | Senegal | 59.3 | 8.9 |
| 7919 | Gadjah 61 | Indonesia | 81.7 | 9.6 |
| | VRI 1 | India | 70.3 | 12.7 |
| | mean (100 genotypes) | | 30.3 | 8.37 |
| | SE ( ,, ) | | 1.34 | 0.23 |

**TABLE 3. Genotypes possessing higher mass/nodule**

| ICG No. | Identity | Origin | Mass/Nodule (mg) | Pod yield (g/plant) |
|---|---|---|---|---|
| 1158 | Ah.34 | India | 3.15 | 9.0 |
| 1961 | D-46-10 | India | 2.46 | 7.4 |
| 2051 | Ah.7299 | China | 4.18 | 7.8 |
| | mean (100 genotypes) | | 1.28 | 8.37 |
| | SE ( ,, ) | | 0.06 | 0.23 |

**TABLE 4. Genotypes having higher nodule mass per plant**

| ICG No. | Identity | Origin | Nodule/mass plant (mg) | Pod yield/ plant (g) |
|---|---|---|---|---|
| 391 | Toro | Nigeria | 90.0 | 4.9 |
| 1266 | Ah 7205 | USSR | 76.7 | 5.7 |
| 1961 | D 46-10 | India | 100.0 | 7.4 |
| 1458 | V 37 | Senegal | 113.3 | 8.9 |
| | Mean (100 genotypes) | | 37.1 | 8.37 |
| | SE ( ,, ) | | 1.86 | 0.23 |

vation in Tamilnadu also recorded higher nodule number per plant (70.3). The range observed for mass per nodule was from 0.34 to 4.18 mg and the CV was 42.9. The Chinese genotype Ah 7299 registered the highest mass per nodule followed by Ah 34 and D 46-10 (3.15 and 2.46 mg respectively) and both of them have originated in India (Table 3). Nodule mass per plant ranged from 6.7 to 113.3 mg with a CV of 50.1. The genotype V 37 from Senegal recorded the highest nodule mass per plant (113.3 mg). Three other genotypes also possessed higher nodule mass per plant (Table 4). It could be seen from the Tables 2,3 and 4 that the genotype V 37 combined higher nodule number and nodule mass per plant. Similarly D 46-10 combined higher mass per nodule and nodule mass per plant. However, the pod yields of both genotypes were low (8.9 and 7.4g/plant respectively) as compared to 12.7 g of VRI 1. It should be possible to transfer these characters to high yielding varieties by conventional breeding methodologies. For example, a cross between NCAC 2821 (a high n-fixing line) and Robut

33-1 (a high yielding genotpe) had resulted in high yielding progenies (ICRISAT, 1982).

The correlation coefficients (Table 5) bring to light that both number of nodules per plant and mass per nodule were positively and significantly correlated with nodule mass per plant. Shanmugam *et al.* (1984) also observed that number of nodules per plant was positively correlated with nodule mass per plant. Though shoot and root DMP were also positively associated with nodule mass per plant, they were not significant. Nodule number per plant was negatively correlated with mass per nodule which can be attributed to the competition among nodules. Shoot DMP was also negatively associated with mass per nodule. Both nodule number per plant and root DMP were positively correlated with shoot DMP. Nodule number per plant was positively associated with pod yield.

**TABLE 5. Correlation among traits related with nodulation in groundnut**

| | Root DMP | Nodule No/ plant | mass/ Nodule | Nodule mass/ plant | Pod yield/ plant |
|---|---|---|---|---|---|
| Shoot DMP | 0.246* | 0.254** | — 0.231* | 0.023 | 0.148 |
| Root DMP | | 0.089 | 0.086 | 0.124 | — 0.007 |
| Nodule No./plant | | | — 0.315** | 0.518** | 0.211* |
| Mass/Nodule | | | | 0.475** | — 0.073 |
| Nodule mass/plant | | | | | 0.048 |

*, **, Significant at p = 0 05 and 0.01 respectively

As there exists a wide variation for nodulation, the entire germplasm can be screened for nodule mass per plant and related traits. The desirable genotypes should be further screened for nitrogenase activity. Lines possessing high nitrogenase activity could be involved in a hybridisation programme to breed for increased nitrogen fixation.

The authors are thankful to the Genetic Resources Unit, ICRISAT, Hderabad for the supply of seed materials used in the study and also to the ICAR and the Tamilnadu Agricultural University for providing financial and other facilities.

Regional Resecrch Station,
Vriddhachalam-606001 (TN)

V. MANOHARN, R. SRIDHAR
S. THANGAVELU

ALLEN, O.N. and ALLEN, E.K. 1981. Leguminosae, pp xiii-xxiii, and 60-63, The Univ. of Wisconsin Press, Wisconsin, USA.

ICRISAT 1982. International Crop Research Institute for the Semi-Arid Tropics. Annual Report 1981. Patancheru, A.P p. 105.

NAMBIAR, P.T.C. and DART, P.J. 1980. Studies on nitrogen fixation on groundnuts at ICRISAT' *Proceedings of the International Workshop on Groundnut held at* ICRISAT, Patancheru (A.P) pp. 110-124. Gibbons, R.W. (Ed.).

NIGAM, S.N., ARUNACHALAM, V., GIBBONS, R.W., BANDOPADHYAY, A. and NAMBIAR, P.T.C. 1980. Genetics of non-nodulation in groundnut (*Arachis hypogaea* L.). *Oleagineux* **35**: 453-455.

SHANMUGAM, A.S., SREE RANGASAMY, S.R., and RATHNASAMY, R. 1984. Correlation and path analysis for nodule characters in black gram and green gram. *Indian J. agric. Sci.* **54**: 712-718.

J. Oilseeds Res. 7(1990) 143-146
*ISSN* 0970—2776

# INFLUENCE OF INTERCROP ON THE INCIDENCE OF LEAF MINER (*APROAEREMA MODICELLA* DEVENTER) IN GROUNDNUT

The groundnut leaf miner, *Aproaerema modicella* Deventer is one of the major pests in Tamil Nadu causing pod yield losses in groundnut from 40 to 70 per cent (Murali Baskaran and Thangavelu, 1989). Higher incidence of this pest occurs under prolonged drought condition. This pest can easily be controlled by using emulsifiable concentrate formulations rather than dust formulations. However, they are expensive and are of limited use for plant protection under rainfed groundnut. The common practice in Tamil Nadu is to resort to intercropping. One of the reasons for this practice is that it may reduce pest incidence (Kavimani *et al.* 1989). Such crop patterns can also provide diversity of food source for predators and parasites (Risch, 1979). Further some insects avoid feeding on shaded and taller plants which may provide a physical barrier for insect pests of crops in lower strata. Growing sorghum in association with cowpea or lab lab reduced sorghum stem borer infestation (Mahadevan and Chelliah, 1986). Chand and Sharma (1977) also found that growing maize in association with legumes reduced *Chilo partellus* damage on maize. In the present study, different intercropping systems were tried to identify the best intercrop for minimising the pest incidence and also for getting the highest net return.

Five intercropping systems were evaluated against the groundnut leaf miner compared with pure groundnut crop as control. The groundnut variety used in this trial was JL 24 which was intercropped at 4:1 ratio with Redgram (Cv.Co3), Blackgram (Cv.T9), Gingelly (Cv.TMV 3) Cowpea (Cv.Co3) and Bajra (Cv.Co6). The trial was sown on 27th June of 1989 (Kharif season) and each treatment was replicated five times. The plot size was 5 × 4 m and the seeds were dibbled in rows with spacing of 30 × 15 cm, 45 × 30 cm, 30 × 10 cm, 45 × 15 cm, 30 × 30 cm, and 30 × 15 cm for groundnut, redgram, blackgram, cowpea, gingelly and *bajra* respectively. Four rows of ground nut was alternated with one row of intercrop and the average plant densities of 418, 27, 101, 63, 30 and 68 were maintained in groundnut pure crop, redgram, blackgram, cowpea, gingelly and *bajra* respectively. When intercropped with redgram and cowpea the average population in groundnut was 331 whereas, with blackgram, gingelly and *bajra*, it was 359. The trial received no plant protection treatments. The leaf miner incidence was assessed on 35 and 55 DAS by recording number of leaf miner larvae per metre row and per cent leaflet damage (number of affected leaflets to total number of leaflets in 5 randomly selected plants). The per cent parasitism by *Goniozus* sp. on larvae of leafminer was recorded by observing the parasitised larvae of leaf miner. The dry pod yield was recorded and also the economics for each system calculated.

To find out whether the low incidence in intercropping system was because of phytochemicals produced by the *bajra* crop (non host) that deterred the moths or because it produced barrier effect, a laboratory experiment was carried out inside a wire

Received on March 26, 1990.

**TABLE 1.**
**Incidence of leafminer, parasite activity and economics under different intercropping system.**

| Treatment | | No. of leaf miner larvae/m.row | | | % leaflet Damage | | | *Goniozus* sp. parasitism (%) | Yield of Base crop Kg/ha | Yield of *inter* crop Kg/ha | Net return Rs. | % Over base crop |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 35 DAS | 55 DAS | Pooled | 35 DAS | 55 DAS | Pooled | | | | | |
| Groundnut + Redgram | 4:1 | 64.2 | 108.0 | 86.1 | 47.2 (43.40) | 74.8 (59.97) | 61.6 (51.69) | 6.0 (14.63) | 822 | 150 | 2346 | +1.6 |
| Groundnut + Cowpea | 4:1 | 58.2 | 79.6 | 68.9 | 43.6 (41.34) | 71.9 (58.03) | 58.2 (49.69) | 2.4 ( 8.34) | 758 | 41 | 2218 | -4.1 |
| Groundnut + Bajra | 4:1 | 46.0 | 44.0 | 45.0 | 16.6 (14.53) | 26.4 (31.80) | 20.8 (26.01) | 6.4 (15.21) | 684 | 575 | 2423 | +4.7 |
| Groundnut + Blackgram | 4:1 | 64.6 | 99.4 | 82.0 | 45.5 (43.59) | 74.6 (59.74) | 61.5 (51.66) | 5.6 (14.20) | 928 | 55 | 2281 | -1.2 |
| Groundnut + Gingelly | 4:1 | 64.2 | 74.0 | 69.1 | 50.0 (45.08) | 65.8 (54.27) | 58.1 (49.68) | 4.8 (13.36) | 914 | 20 | 2188 | -5.2 |
| Groundnut alone | 4:1 | 69.2 | 96.6 | 82.9 | 50.2 (45.09) | 74.1 (59.58) | 62.7 (52.39) | 4.8 (13.26) | 1154 | — | 2308 | — |
| SE (D) | | 4.1 | 4.3 | 3.3 | 1.6 | 2.1 | 1.4 | 1.2 | 16.3 | — | — | — |
| CD= p(=0.05) | | 12.0 | 12.7 | 9.4 | 4.7 | 6.1 | 3.9 | 3.6 | 34.8 | — | — | — |
| CV% | | 12.8 | 27.6 | 21.2 | 29.7 | 21.0 | 21.9 | 18.8 | 18.8 | | | |

1. Figures in parentheses are arcsine values
2. Mean of two years data.

mesh cage on 30 days old groundnut variety JL 24 in pots. Two plants were grown in each pot and this was replicated seven times for each treatment. All the pots were kept inside a cage. Extract was made from 45 days old *bajra* by macerating 10g of leaves in 100 ml of water (Renwick and Radke, 1981) and compared with water spray. The *bajra* leaf extract was sprayed once on the groundnut plants at 10 ml/plant using an Aspee atomizer. Starting 10 hours after spraying, 25 gravid females of *A.modicella* were released into the cage. This was repeated at 2 day interval for four days, until the cage contained 50 females. The number of eggs present on individual plants was recorded daily. Eggs were removed daily for counting. The number of eggs laid on 14 plants in each treatment was observed.

The Results (Table-1) revealed that incidence of leaf miner was comparatively low on groundnut + *bajra* intercrop. The larval population was 45.0 per metre row with 20.8 per cent leaflet damage in groundnut + *bajra* intercropping system while in the pure crop of groundnut, it was 82.9 larvae per metre row with 62.7 per cent leaflet damage. Other intercrops, groundnut + cowpea or groundnut +gingelly showed marginal decrease in incidence. Kennedy and Raveendran (1989) and Amin (1983) reported that groundnut + bajra intercropping system registered low leaf hopper and thrips population and bud necrosis disease when they tested groundnut with soyabean redgram, greengram, cowpea, sunflower, corn and sorghum as intercrops. Amin (1983) interpreted this to be due to barrier effect which hindered thrips movement. When barriers were arranged across wind direction, this effect was more pronounced.

The mortality due to the bethylid parasite, *Goniozus* sp. was observed to be comparatively high (6.4%) in groundnut + *bajra* combination, which was on par with other intercropping systems except groundnut + cowpea combination (2.4%). The pure groundnut crop yielded 1154 Kg/ha of pods. The yield in the groundnut + *bajra* system was 684 Kg/ha. Though the yield of the base crop in groundnut + *bajra* system was low, because of substantial increase in yield of the companion crop, *bajra*, this system recorded the highest net return of Rs.2423 in contrast to Rs. 2308 in base crop.

**TABLE 2.**
**Effect of *bajra* leaf extract on the ovipositional preference by *A.modicella***

| Treatment | Number of eggs laid by 50 females* | |
|---|---|---|
| | 4 days after spraying | 6 days after spraying |
| Bajra leaf extract in water | 2.02[c] (105) | 2.45[b] (283) |
| Water alone | 2.33[b] (215) | 3.04[a] (1098) |
| Untreated | 2.99[a] (981) | 3.05[a] (1120) |

*Total number of eggs laid on 14 plants (2 Plants/pot × 7 replications)

Figures in parentheses are actual number of eggs
The data followed by same letter are not significantly different at $p = 0.05$ by the Duncan's Multiple test.

Leaf extract of *bajra* when sprayed on groundnut plants prevented oviposition for upto 74 per cent on 6th day after spraying (Table-2). The untreated groundnut plants received 1120 eggs in 6 days which was on par with the treatment of waterspray (1098) and egg laying in both treatments was significantly higher than the treatments which received a spray of bajra leaf extract (283). Tahvanainen and Root (1972) suggested that the biological complexity would affect the olfactory stimuli and alter the insect behaviour in the crop. Here, the phytochemicals produced by *bajra* could have altered the oviposition behaviour of gravid moths of *A.modicella* leading less damage by the leaf miner in the intercropping system. Alternatively, pearl millet extract could have masked the stimulants in groundnut for oviposition or produced deterrent effects. This observation needs further indepth studies.

Authors are greatful to ICAR for financial assistance.

Regional Research Station,
Vridhachalam - 606001, Tamil Nadu.

R. MURALI BASKARAN, S. THANGAVELU

AMIN, P.W. 1983. All India workshop on crop losses due to Insect pests, 7-9 Jan. 1983, A.P.A.U. Hyderabad.

CHAND, P. and SHARMA, N.N., 1977. *Proc. Indian National Science Academy*, **43**(3): 108-114.

KAVIMANI, R., GEETHA LAKSHMI, V. and RAVEENDRAN, T.S., 1989. *Oilseeds Newsletter* 3(3), Directorate of Extension, New Delhi.

KENNEDY, F.J.S. and RAVEENDRAN, T.S. 1989. *Oilseeds Newsletter* 3(4) Directorate of Extension, New Delhi.

MAHADEVAN, N.R. and CHELLIAH, S. 1986. *Tropical Pest Management*, **32**(2): 162-163.

MURALI BASKARAN, R.K. and THANGAVELU, S. 1989. *Technical bulletin*, Regional Research Council Meeting, 15th and 16th July, Regional Research Station, Vridhachalam, Tamil Nadu pp. 15-16.

RENWICK, J. A.A. and RADKE, D.C. 1981. *Entomologia Experimentalis et Applicata*, **30**:201-206.

RISCH, S.J. 1979. Unpub. *Ph.D. Thesis*, Univ. of Michigan, 215 pp.

TAHVANAINEN, J.A. and ROOT, R.A. 1972. *Phylloctreta crucifera Oecologia* (Berlin), **10**:321-345

**INDIAN SOCIETY OF OILSEEDS RESEARCH (ISOR)**

**releases**

**THE PROCEEDINGS OF THE NATIONAL SEMINAR**

**ON**

# "Strategies for making India self-reliant in Vegetable-Oils"

held during Sept. **5-9, 1988** at Hyderabad,

Consisting of 122 papers presented in seven different sessions on:-

— Exploitable production Technologies available for increasing production of various oilseed crops

— Potential new areas/crops and non-conventional sources of oils

— Policy interventions for pricing, procurement and marketing of Oilseeds

— Exploitable post-harvest processing technologies

— Nutritional aspects of oils and oilseed extraction

— Policy issues related production, marketing, export, import etc., of oils and oilseeds by-products and

— Role of public, private and cooperative sectors in oilseeds production.

Price:

Inland : Rs. 400.00 (Rs. 200.00 for member of ISOR)

Foreign : US $ 75.00

*For copies contact*

GENERAL SECRETARY
INDIAN SOCIETY OF OIL SEEDS RESEARCH
DIRECTORATE OF OILSEEDS RESEARCH
RAJENDRANAGAR
HYDERABAD - 500 030
**INDIA**

## INFORMATION FOR CONTRIBUTORS

Contributions from the members on any aspects of Oilseeds Research will be considered for publication in Journal of Oilseeds Research. Papers for publication (in triplicate) should be addressed to The Editor, Journal of Oilseeds Research, Rajendranagar, Hyderabad—500 030. India.

Manuscript should be prepared strictly according to the guidelines for authors printed at the back of volume 2, No. 1 and should not exceed 15 printed pages including tables and figures. Short Communication must not exceed four printed pages including tables and figures. The publication of papers will be seriously delayed if the style and format of the Journal are not followed and figures have to be redrawn.

---

**The Journal of Oilseeds Research is being regularly abstracted in AGRINDEX, abstracting Journals of CAB International, U.K. and Biological Abstract, U.S.A.**

---

*Annual subscription* 1991:

| India | Abroad |
|---|---|
| Individual : Rs. 40.00/ annum +(Admission fee Rs. 10/-) | U.S. $ 50.00/ annum |
| Institution : Rs. 250.00/ annum | U.S. $ 100.00 annum |
| Student: Rs. 30.00/ annum | (Postage extra) |
| Life Membership: Rs. 500.00/ annum | |

For subscription, please contact The Treasurer, Indian Society of Oilseeds Research, Directorate of Oilseeds Research, Rajendranagar, Hyderabad—500 030 India.

---

**Indian Society of Oilseeds Research thankfully acknowledges the financial assistance received from Indian Council of Agricultural Research, New Delhi for the Printing of Journal of Oilseeds Research.**

---

Printed and Published by the Indian Society of Oilseeds Research,
Directorate of Oilseeds Research, Rajendranagar, Hyderabad-500 030.
Printed at Vani Press, Sikh Village, Secunderabad - 500 003.