GENETIC BASIS OF SEED YIELD AND SEED QUALITY IN SESAME (*Sesamum indicum* L.)

By

V.R. SHAJAN

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2002

DECLARATION

I hereby declare that this thesis entitled "**Genetic basis of seed yield and seed quality in sesame (*Sesamum indicum* L.)**" is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award of any degree, diploma, associateship, fellowship or other similar title, of any other university or society.

Vellayani,

15-11-2002

V.R. Shajan
(96-21-09)

CERTIFICATE

Certified that this thesis entitled "**Genetic basis of seed yield and seed quality in sesame (*Sesamum indicum* L.)**" is a record of research work done independently by Sri. V.R. Shajan (96-21-09) under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to him.

C Chandramony

Vellayani,
15-11-2002

Dr. D. Chandramony
(Chairman, Advisory Committee)
Professor and Head
Department of Plant Breeding and Genetics
College of Agriculture, Vellayani
Thiruvananthapuram-695 522

APPROVED BY:

CHAIRMAN

Dr. D. CHANDRAMONY,
Professor and Head,
Department of Plant Breeding and Genetics,
College of Agriculture, Vellayani,
Thiruvananthapuram – 695522.

Chandramony D
15.11.2002

MEMBERS

Dr. S.G. SREEKUMAR,
Associate Professor,
Department of Plant Breeding and Genetics,
College of Agriculture, Vellayani,
Thiruvananthapuram – 695522.

15/XI/02

Dr. D.I. SUMABAI,
Associate Professor,
Department of Plant Breeding and Genetics,
College of Agriculture, Vellayani,
Thiruvananthapuram – 695522.

Suma Bai D.I
15-11-2002

Dr. P. SARASWATHY,
Professor and Head,
Department of Agricultural Statistics,
College of Agriculture, Vellayani,
Thiruvananthapuram – 695522.

Saraswathy P
15/11/02

Dr. P. RAJENDRAN,
Associate Professor,
Department of Soil Science and Agricultural Chemistry,
College of Agriculture, Vellayani,
Thiruvananthapuram – 695522.

15/11/02

EXTERNAL EXAMINER

DR JABARAJ
PROFESSOR
CENTRE FOR PLANT BREEDING
AND GENETICS
TNAU
COIMBATORE

15/11/02

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Introduction

1. INTRODUCTION

Sesame, considered as the Queen of oil seeds, is one of the important oil seed crops in India having varied utility. Its seeds, besides being used for oil extraction, is also directly consumed roasted or added to flavour bread, biscuits, snacks and sweets. In addition it is also considered to have medicinal properties. Sesame seed is highly nutritive with an oil content of upto 60 per cent. It contains 25 per cent protein exceptionally rich in methionine. It is also rich in calcium, phosphorus and vitamin E. Sesame oil is highly stable because of the presence of antioxidants which prevents rancidity.

Oil seeds form the second largest agricultural commodity after cereals in India, accounting for nearly five per cent of the gross national product and 10 per cent of the value of all agricultural products. However, there is a drastic reduction in the area, production and productivity of oil seeds during the last decade despite a steady increase in demand. With decline in production in one hand and increasing consumption on the other, only 54 per cent of the national requirement is now being met from indigenous sources.

Sesame is the fourth important oil seed crop after groundnut, rape seed and mustard and sunflower. Though a native of Africa, it was brought to India well before the vedic period and finds mention in Rigveda and Yajurveda. There are evidences of sesame being used in the rituals from ancient times.

Though India is the largest producer of sesame, its productivity in India (332 kg ha^{-1}) is one of the lowest in the world. But it is more than three fold in Egypt (1175 kg ha^{-1}) where the productivity is maximum. It is cultivated in most of the states in India with the maximum production in Uttar Pradesh. In Kerala, the area under sesame has declined from 185,600 ha in 1952-53 to 27,700 ha in 1998-99 resulting in a decline in production from 5920 metric tonnes to 790 metric tonnes. Socio-economic factors and lack of increase in productivity have contributed to this great slide in acrage of the crop in the state. Sesame is a crop of the small and marginal farmers and there is hardly any scope for bringing additional area under its cultivation. Hence, newer approaches to increase productivity and expand its cultivation under different farming situations have become imperative. Sesame breeding programmes should aim at improvement in quality besides focusing on yield increase.

Information on the genetic architecture of sesame, the nature of its gene action and genetic basis of quality are essential for the success of any breeding programme. In the current work emphasis was given to seed quality attributes. information on which is scanty. The present study is envisaged with the following objectives:

1. to assess genetic variability, heritability and genetic advance of sesame genotypes
2. to find out interrelationship among various yield attributing characters
3. to study the direct and indirect effects of component characters on yield

4. to study the genetic divergence to select parents for hybridization
5. to estimate combining ability of genotypes with respect to various characters
6. to find out gene action mechanism in character expression of various quantitative characters and
7. to estimate heterosis.

Review of Literature

2. REVIEW OF LITERATURE

Variability

Information on the variability in the available germplasm is the preliminary step in any crop improvement programme. Study of the magnitude of variability present in a crop species is essential for the success of any breeding programme. Variability is produced by genotype, environment and genotype-environment interaction. It can be assessed by estimating phenotypic, genotypic and environmental variability, genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV). A brief review of work done in sesame is reviewed here under:

Dhindsa and Gupta (1973) estimated the variability for seed quality characters in 28 strains of sesame and reported that oil content of these varieties ranged from 46.50 to 55.32 per cent, protein 18.05 to 26.25 per cent, methionine 2.85 to 3.85 g/ 16 g of nitrogen and iodine value 109 to 113.

Rangaswamy (1980) reported high genotypic coefficient of variation for plant height and number of capsules per plant. Thakur and Borulkar (1980) reported variability for oil and protein percent. Yadava *et al.* (1980) studied 22 genotypes of sesame and reported high phenotypic variability for capsules on main shoot, total number of capsules, plant height, 1000-seed weight, days to first flowering and maturity.

Janardhanam *et al.* (1981) reported high variability for plant height, number of capsules on main stem, total number of capsules, length of capsule and yield per plant and low variability for number of seeds per capsule and

1000 grain weight. High phenotypic and genotypic coefficient of variation was observed for number of capsules on main stem and total number of capsules per plant.

Paramasivam and Prasad (1981) from their study reported high variability for capsule number, capsule length and seed yield. Rai *et al.* (1981) reported high genotypic coefficient of variation for number of branches. Solanki and Pallival (1981) reported high phenotypic and genotypic variances for capsules per plant and seeds per capsule and high phenotypic variance for plant height. They have also reported high phenotypic and genotypic coefficient of variation for seeds per capsule, high phenotypic and medium genotypic coefficients of variation for capsule per plant and medium phenotypic and genotypic coefficient of variation for yield per plant and low genotypic and phenotypic coefficients of variation for days to flowering and maturity, plant height, branches per plant, capsule length and 1000 seed weight.

Chavan and Chopde (1982) reported high variability for number of capsules per plant, seed yield per plant and number of capsules on main shoot. Devi *et al.* (1984) studied fatty acid composition of seed oil and reported that sesame seed oil contains C_{16} (9.90 %), C_{18} (5.10 %), $C_{18:1}$ (41.0 %) and $C_{18:2}$ (44.0 %) and iodine value (119), saponification value (192.6) and acid value (4.79).

Geetha (1984) reported high phenotypic and genotypic variation for number of seeds per capsule and height of plant, medium genotypic and phenotypic coefficients of variation for number of seeds per capsule and low genotypic and medium phenotypic coefficient of variation for number of pods

per plant and seed yield per plant, low genotypic and phenotypic coefficients of variation for number of days to flowering and maturity, height of plant, length of pod, weight of 1000 seeds and oil content.

Genotypic and phenotypic coefficients of variation were studied by Seenaiah and Reddy (1984) and reported medium values for total number of capsules per plant, number of capsules on the main stem and oil yield per plant and low values for plant height and number of branches per plant. Shadakshari (1984) reported high phenotypic and genotypic coefficients of variation for total number of capsules, number of branches, seed yield per plant and low phenotypic and genotypic coefficients of variation for capsule length, oil content and days to maturity.

Chandramony and Nayar (1985) reported high genotypic and phenotypic variability for height at maturity and pods per plant. Genotypic coefficient of variation was maximum for pods per plant followed by seed yield per plant and pods on main axis. Genotypic coefficient of variation was low for height at maturity, seeds per pod, 1000 seed weight, oil content and days to flowering.

Kandaswamy (1985) reported high phenotypic and genotypic variances for yield, number of capsules per plant and seeds per capsule. The genotypic coefficients of variation were high for number of capsules per plant, number of seeds per capsule and number of capsules on main stem. Pathak and Dixit (1986) reported maximum genotypic and phenotypic coefficients of variation for seed yield followed by capsules per plant, height upto first capsule, 1000 seed weight, plant height, days to flowering, days to maturity, seeds per capsule and the minimum for capsule length.

Yen *et al.* (1986) reported that fatty acid composition had small variability with maximum variability for linoleic acid for the genotypes studied. They also reported that seed was rich in methionine but deficient in lysine and isoleucine.

From a study of 34 genotypes, Bhele *et al.* (1987) estimated medium genotypic coefficient of variation for seed yield per plant and low genotypic coefficient of variation for plant height, number of branches per plant, number of capsules per plant, number of seeds per capsule, days to maturity, 1000 seed weight and oil content. High phenotypic and genotypic coefficients of variation for height upto first capsule and branches per plant were reported by Bakheit and Mahdy (1988).

Li (1988) reported high genotypic variability for capsules per plant and yield per plant and low genotypic variability for plant height, branch number and 1000 seed weight. Govindarasu *et al.* (1990) reported high phenotypic and genotypic variances for plant height and capsule on primaries. Phenotypic and genotypic coefficients of variation were medium for capsule on primaries and seed yield.

Kandaswamy *et al.* (1990) estimated high phenotypic coefficient of variation with medium genotypic coefficient of variation for height of plant, high phenotypic coefficient of variation with low genotypic coefficient variation for number of capsules per plant and medium phenotypic coefficient of variation with low genotypic coefficient of variation for yield per plant, number of branches per plant, number of capsules on main stem and number of capsules per plant.

Reddy and Dorairaj (1990) reported medium genotypic and phenotypic coefficients of variation for seed number per capsule and seed yield and low genotypic and phenotypic coefficients of variation for plant height, number of capsules on main stem, capsule length, 1000 seed weight, days to maturity and oil content.

Kumar (1991) reported high genotypic coefficient of variation for number of capsules and seed yield. Kuriakose (1991) reported high phenotypic and low genotypic variability for plant height, seeds per capsule and seed yield. Phenotypic and genotypic variability were low for number of capsules, capsule length, days to flowering and oil content.

High genotypic and phenotypic coefficients of variation were recorded for number of capsules per plant, seed yield per plant and number of branches per plant by Babu (1992). But low genotypic and phenotypic coefficients of variation were recorded for 1000 seed weight and plant height.

Channabasavanna and Setty (1992) reported high variability for seed yield per plant, capsules per plant, branches per plant and plant height.

High genotypic and phenotypic coefficients of variation were observed by Pathak and Dixit (1992) for plant height, number of branches, seed yield and capsule number whereas moderate for days to flower and protein content

High phenotypic and genotypic variances for total number of capsules and moderate phenotypic and genotypic variance for plant height, total number of branches, days to maturity and seed yield per plant were reported by Shadakshari *et al.* (1992). They have also reported high phenotypic and

genotypic coefficients of variation for number of capsules, number of branches and seed yield per plant.

Baruah and Goud (1993) reported high genotypic and phenotypic coefficients of variation for plant height, length of capsule, number of seeds per capsule, 1000 seed weight and oil content.

Chandrasekhara and Reddy (1993c) estimated high genotypic and phenotypic variances for plant height, height up to first capsule and capsules per plant. They reported moderate genotypic and phenotypic coefficients of variation for height up to first capsule, capsule on main stem, capsules per plant and seed yield per plant.

John and Nair (1993) reported that, in general, the phenotypic coefficient of variability was higher than the respective genotypic coefficient of variability. High genotypic coefficient of variation was observed for seed yield per plant followed by capsules on main stem, number of capsules per plant and number of branches. Low genotypic coefficient of variation was recorded for number of days to flowering, number of days to maturity, height of the plant, height upto first capsule, length of capsule, number of seeds per capsule, weight of 1000 seeds, seed oil content and protein percentage.

Mishra *et al.* (1993) reported high genotypic variances for days to maturity, plant height, number of branches per plant, number of capsules per plant, number of seeds per capsule, capsule length and seed yield per plant. They also recorded high genotypic and phenotypic coefficient of variation for number of branches per plant, number of capsules per plant and seed yield per plant.

Bhombe *et al.* (1994) reported maximum genotypic coefficient of variation for capsules per plant and followed by yield per plant, branches per plant, seeds per capsule, plant height and capsule length.

Eldin and Appelquist (1994) reported that sesamum oil fatty acid contains palmatic acid (8.2 – 12.7 per cent), steric acid (5.6 – 9.1 per cent), oleic acid (33.4 – 46.9 per cent) and linoleic acid (32.2 – 48.4 per cent).

Ranganatha *et al.* (1994) reported high phenotypic variance for days to maturity. Biswas and Akbar (1995) reported that genotypic coefficient of variation was the highest for seed yield per plant followed by number of branches per plant .

Govindarasu (1995) observed high genotypic variability for plant height, capsule number, 1000 seed weight and seed number per capsule.

Lee (1995) reported variation for palmitic acid, oleic acid and linolic acid content for sesame oil in different varieties.

Mishra *et al.* (1995a) reported high genotypic and phenotypic variance for plant height, capsule number per plant and number of seeds per capsule. Maximum genotypic coefficient of variation was recorded for branch number per plant; followed by seed yield per plant, number of seeds per capsule, days to maturity, plant height and capsule length.

The two hundred and twentyfive indigenous and exotic germplasm of sesamum were evaluated by Shadakshari *et al.* (1995) and reported that the phenotypic and genotypic variances were high for number of capsules, moderate for plant height, number of branches, days to maturity and seed yield per plant and low for oil content.

Kaya and Savran (1996) reported that in sesame oil main fatty acids were oleic acid and linolic acid. They also identified methionine as the major amino acid.

Patil and Sheriff (1996) reported high phenotypic and genotypic variability for plant height, number of capsules and number of seeds per capsule. The phenotypic and genotypic coefficients of variation were high for number of capsules, oil yield per plant, seed yield per plant and number of branches.

Amaresha (1997) reported high genotypic and phenotypic coefficients of variation for yield, moderate genotypic and phenotypic coefficients of variation were recorded for plant height, number of capsules per plant and 1000 seed weight. Low genotypic and phenotypic coefficient of variation were recorded for days to flowering and maturity, number of seeds per capsule and oil percentage.

High values for phenotypic and genotypic coefficients of variation for seed yield and number of capsules per plant were reported by Joel and Thangavelu (1997).

Singh *et al.* (1997a) reported medium genotypic and phenotypic coefficient of variation for number of capsules per plant and seed yield per plant. Das and Samanta (1998) reported high genotypic variability for oil content. Jayalakshmi *et al.* (1998) reported high phenotypic and low genotypic variance for capsules per plant and medium for days to maturity. She also reported medium phenotypic coefficient of variation for capsules on main stem, capsules, capsules per plant and seed yield per plant.

Shanmugavalli and Vanniarajan (1998) reported high phenotypic and genotypic coefficient of variation for number of capsules per plant and yield.

Baydar *et al.* (1999) reported high variability for seed yield, oil content and protein content.

Arriel *et al.* (2000) reported high genotypic and phenotypic variability for grain yield. High genotypic coefficient of variation for seed yield, branch number and capsule number were reported by Govindarasu (2000). Moderate phenotypic and genotypic coefficients of variation was reported by Saravanan *et al.* (2000) for the number of capsules per plant and seed yield per plant. Singh *et al.* (2000a) reported moderate phenotypic and genotypic coefficient of variation for seed yield per plant and number of capsules per plant.

Heritability and Genetic advance

Estimation of heritability indicate the proportion of genetic control of that character and genetic advance quantify the possible genetic gain by selection. So estimation of these factors help in crop improvement programme.

High heritability and genetic advance for number of capsules on main stem, number of capsules per plant and yield per plant were reported by Janardhanam *et al.* (1981). They have also reported high heritability and medium genetic advance for 1000 grain weight and high heritability and low genetic advance for length of capsule.

Paramasivam and Prasad (1981) observed high heritability with high genetic advance for capsule number and seed yield and high heritability and

medium genetic advance for capsule length and high heritability and low genetic advance for plant height and days to maturity.

Chavan and Chopde (1982) estimated moderate heritability and genetic advance for number of capsules per plant and moderate heritability and low genetic advance for plant height, height up to first capsule, number of capsules on main shoot and low heritability and low genetic advance for number of seeds per capsule, length of capsule, days to first flowering and 1000 seed weight.

High heritability was reported by Thangavelu and Rajasekaran (1982) for plant height, branch number, capsule number per plant, capsule number on main stem, seeds per capsule, 1000 seed weight, days to maturity, oil content and seed yield per plant. High heritability coupled with high genetic advance was observed for branch number, seed yield and capsule number.

Chandramony (1984) reported high heritability and low genetic advance for oil content, number of seeds per pod, 1000 seed weight and duration to first flowering showed medium heritability and low genetic advance. Seenaiah and Reddy (1984) reported moderate heritability and genetic advance for pant height, number of capsules on main stem and number of capsules per plant and medium heritability and low genetic advance for number of branches per plant.

Shadakshari (1984) reported high heritability and genetic advance for seed yield per plant, number of capsules and number of branches. Capsule length and oil content showed high heritability with low genetic advance.

Venkatesh (1984) estimated high heritability and genetic advance for days to maturity, height upto first capsule, capsule on main shoot, number of capsules per plant and oil content. Chandramony and Nayar (1985) reported high heritability and low genetic advance for oil content. Moderate heritability and medium genetic advance was reported for capsules per plant.

Kandaswamy (1985) reported high heritability and genetic advance for number of branches, number of seeds per capsule and yield. Pathak and Dixit (1986) reported high heritability and genetic advance for plant height, height upto first capsule, capsules per plant, 1000 seed weight and seed yield per plant and high heritability and low genetic advance for days to flowering and maturity and seeds per capsules.

Bhele *et al.* (1987) estimated high heritability and genetic advance for plant height, number of branches per plant, days to maturity, 1000 seed weight and seed yield per plant. High heritability and low genetic advance for oil content and medium heritability and genetic advance for number of capsules per plant and medium heritability and low genetic advance for number of seeds per capsule.

Li (1988) reported high heritability for 1000 seed weight and seeds per capsule and low for plant height. Genetic advance were high for capsule per plant and yield per plant and low for plant height, branch number and 1000 seed weight.

Govindarasu *et al.* (1990) reported high heritability and medium genetic advance for plant height and high heritability and low genetic advance for first pod bearing node, capsule length, 1000 seed weight, days to

flowering and maturity and seed yield. Kandaswamy *et al.* (1990) estimated high heritability with high genetic advance for yield per plant and medium heritability and low genetic advance for height of plant and number of branches and low heritability and genetic advance for number of capsules on main stem and number of capsules per plant.

Reddy and Dorairaj (1990) reported high heritability for seed number per capsule, days to maturity, plant height and first capsule bearing node and moderate heritability for number of branches, seed yield, capsule length and 1000 seed weight. Capsules on main stem recorded low heritability. A moderate genetic advance was recorded for first capsule bearing node and seed number per capsule while low genetic advance was recorded for oil content.

Kumar (1991) observed high heritability and genetic advance for number of capsules and seed yield. Malarvizhi (1991) estimated high heritability and genetic advance for number of branches, number of capsules and seed yield. Pathak and Dixit (1992) reported high heritability and genetic advance for protein and oil content, days to flowering and maturity. Plant height, capsule number and number of branches showed moderate heritability with high genetic advance. Capsule length and seeds per capsule recorded low heritability and low genetic advance.

Shadakshari *et al.* (1992) estimated high heritability and genetic advance for total number of branches and high heritability and moderate genetic advance for total number of capsules, seeds per capsule, seed yield per plant and high heritability and low genetic advance for capsule length, 1000 seed yield, oil content and days to maturity.

High heritability and genetic advance for seed yield per plant, plant height and number of capsules per plant were reported by Baruah and Goud (1993). Chandrasekhara and Reddy (1993c) estimated high heritability and medium genetic advance for plant height, height up to first capsule, capsules per plant and high heritability and low genetic advance for capsule on main stem, length of capsule, seeds per capsule, 1000 seed weight, days to maturity, oil percentage and seed yield per plant.

High heritability and genetic advance, number of capsules on main stem, number of branches and seed yield per plant was reported by John and Nair (1993). Seed oil content, seed protein content and weight of 1000 seeds had high heritability and low genetic advance.

High heritability and genetic advance for capsules per plant and plant height were reported by Mishra *et al.* (1993). They have also reported high heritability and low genetic advance for days to maturity, number of branches per plant, number of seeds per capsule, capsule length and seed yield per plant. Biswas and Akabar (1995) estimated high heritability for days to flowering, days to maturity and 1000 seed weight.

Govindarasu (1995) estimated high heritability and genetic advance for seed yield, capsule number, branch number, plant height, capsule length and seed number per capsule. Mishra *et al.* (1995a) reported high heritability and genetic advance for branch number per plant, capsule number per plant and seed yield. Reddy and Dorairaj (1995) reported high heritability and genetic advance for capsule weight and seed weight.

High heritability and genetic advance was reported by Shadakshari *et al.* (1995) number of branches, number of capsules and seed yield per plant. High heritability and low genetic advance were reported for capsule length, seeds per capsule, 1000 seed weight, oil content and days to maturity.

Patil and Sheriff (1996) estimated high heritability and genetic advance for number of capsules, seed yield per plant, heritability and medium genetic advance for 1000 seed weight and high heritability and low genetic advance for days to maturity, capsule length and oil content. Amaresha (1997) estimated high heritability and genetic advance for seed yield per plant, plant height, number of seeds per capsule, 1000 seed weight and number of capsules per plant. Backiyarani *et al.* (1997b) reported high heritability for capsule number, seeds per capsule, oil per cent and yield.

Joel and Thangavelu (1997) reported high heritability and genetic advance for height up to first capsule, number of capsules on main stem, number of capsules per plant and seed yield. High heritability and medium genetic advance for plant height, seeds per capsule, 1000 seed weight and high heritability and low genetic advance for capsule length, days to first flowering and maturity and oil content.

High heritability and low genetic advance were reported for days to maturity and seed yield per plant by Singh *et al.* (1997a).

Jayalakshmi *et al.* (1998) reported high heritability and low genetic advance for days to maturity. High heritability and medium genetic advance for number of capsules per plant and yield were reported by Shanmugavalli

and Vanniarajan (1998). They also reported medium heritability and low genetic advance for plant height.

High heritability for days to maturity, plant height and seed yield and low heritability for capsule number was reported by Arriel *et al.* (1999).

Govindarasu (2000) reported medium heritability and genetic advance for branch number and seed yield and medium heritability and low genetic advance for plant height, capsule number, seed number and 1000 seed weight.

Saravanan *et al.* (2000) estimated high heritability and moderate genetic advance for plant height, number of branches per plant, number of capsules per plant and seed yield per plant. Singh *et al.* (2000a) reported high heritability and medium genetic advance for number of capsules per plant, number of seeds per capsule and seed yield per plant and high heritability and low genetic advance for plant height, 1000 seed weight and oil content. High heritability and medium genetic advance for seed yield was reported by Singh *et al.* (2000b).

Correlation

Correlation coefficient analysis measures the mutual relationship between various plant characters. Positive correlation indicates the change of two variables in same direction and negative correlation indicates the movement in opposite direction. So in a selection programme correlation is important.

Paramasivam and Prasad (1980) reported that seed yield was positively and significantly associated with plant height and capsule number and these

characters also found to be associated among one another. Rangaswamy (1980) reported positive association of number of capsules with yield.

Rathnaswamy (1980) reported that seed yield was positively and significantly correlated with capsules per plant, plant height and branches per plant. Positive and significant correlation of seed yield with total number of capsules and weight of 1000 seeds were reported by Yadava *et al.* (1980).

Chavan and Chopde (1981) observed higher genotypic correlations than phenotypic correlations. Seed yield per plant had high positive correlation with the number of branches and capsules per plant. The number of seeds per capsules was negatively correlated with seed yield per plant. Plant height and length of capsule were correlated positively with number of capsules but negatively with number of seeds per capsule. The number of seeds per capsule had a positive association with the length of the capsule and plant height.

Significant positive correlation of yield per plant with plant height, number of capsules on main stem, number of capsules per plant, length of capsule and number of seeds per capsule were reported by Janardhanam *et al.* (1982). Vaidya *et al.* (1982) reported positive association of yield with capsule number per plant and seeds per capsule.

Significant positive correlation of grain yield with days to flower, number of branches, capsules per plant and plant height were reported by Gupta and Labana (1983). Plant height had significant positive correlation with days to flowering, number of branches and capsules per plant. Capsules

per plant had significant positive correlation with days to flowering and number of branches.

Ibrahim *et al.* (1983) reported that seed yield per plant was positively correlated with numbers of days to flowering, number of capsules on main stem and number of capsules per plant. Oil content was correlated positively with 1000 seed weight and negatively correlated with number of days to flowering in sesamum.

Thangavelu and Rajasekaran (1983a) have observed significant positive correlation of seed yield with plant height, branch number, capsule number, capsules on main stem, 1000 seed weight, days to maturity and oil content. The inter correlations among the characters also have high association.

Geetha (1984) reported significant positive genotypic correlation of seed yield per plant with number of days to flowering, number of days to maturity, height of plant, number of pods per plant, length of pod, weight of 1000 seed and oil content.

Reddy (1984) reported that plant height, number of branches, number of capsules and 1000 seed weight were positively correlated with yield both at phenotypic and genotypic levels. Plant height was positively correlated with number of branches and number of capsules. Number of branches exhibited high positive correlation with number of capsules and negative association with number of seeds per capsule both at phenotypic and genotypic levels.

Positive correlation of seed yield with plant height, number of branches and capsules per plant were reported by Reddy *et al.* (1984b).

Seenaiah and Reddy (1984) estimated positive and significant genotypic correlation among plant height, number of branches per plant, number of capsules on the main stem and total number of capsules per plant. Positive and significant association of yield with total number of capsules, plant height, 1000 seed weight, oil content and days to maturity were reported by Shadakshari (1984).

Sharma and Chauhan (1984a) reported positive association of seed yield with number of capsules per plant, 1000 seed weight and oil content. Hu (1985) reported significant positive correlation of number of seeds per capsule and number of capsule per plant with seed yield per plant.

Uzo *et al.* (1985) reported significant positive correlation of yield with plant height and number of capsules per plant.

Krishnadoss and Kadamavanasundaram (1986) observed positive and significant correlation of yield with plant height, branches per plant and capsules per plant. These characters had significant positive inter-correlation among themselves also. Ranganatha (1986) reported significant positive correlation of number of capsules with seed yield.

Bhele *et al.* (1987) reported that genotypic correlations were higher than the phenotypic correlations. Yield per plant was positively and significantly associated with number of capsules per plant, 1000 seed weight and plant height at phenotypic and genotypic level whereas oil content and number of seeds per capsule were positively and significantly associated with yield per plant at genotypic level only. Oil content had significant positive genotypic correlation with plant height, number of capsules per plant and

1000 seed weight. 1000 seed weight had significant positive genotypic and phenotypic correlation with number of capsules per plant. Number of capsules had significant positive correlation at genotypic and phenotypic levels with plant height and number of branches per plant.

Khorgade (1987) estimated significant positive genotypic correlation of seed yield with days to maturity, plant height, number of branches per plant, capsule length, number of capsules per plant and number of seeds per capsule.

Majumdar *et al.* (1987) reported that seed yield was positively and significantly correlated with number of capsules per plant, number of seeds per capsule, 1000 seed weight and height of the plant. They have positive significant correlation among themselves also.

Bakheit and Mahdy (1988) reported high positive correlation of seed yield with plant height, height upto first capsule, 1000 seed weight and capsules per plant. Capsule length showed low correlation with height and height upto first capsule and showed negative correlation with branches per plant. Li (1988) estimated significant correlation of seed yield with capsules per plant, seeds per capsule and 1000 seed weight.

Chandramony (1990) observed that number of pods per plant, plant height and pods on main axis were inter related and showed a high degree of positive association with seed yield per plant. Seeds per pod and duration for first flowering showed negative relation with seed yield.

Significant positive genotypic correlation between yield and number of capsules on main stem, height of plant, days to flowering, number of branches per plant and number of capsules on main stem and number of capsules per plant were reported by Kandaswamy *et al.* (1990). Negative and significant correlation was observed between height of plant and number of branches per plant and number of capsules per plant.

Kumar (1991) observed significant positive association of seed yield with plant height, number of branches, number of capsules and weight of 1000 seeds. Malarvizhi (1991) reported that seed yield was associated with number of capsules, number of seeds per capsule and 1000 seed weight. Manivannan (1991) reported positive association of seed yield with total number of capsules and number of branches. Rao *et al.* (1991) reported significant positive correlation of seed yield with plant height, number of branches, capsule number, capsule length and number of seeds.

Reddy and Haripriya (1991) reported significant positive genotypic correlation of plant height, number of branches per plant, number of capsules per plant with seed yield per plant.

Significant positive association of seed yield with number of capsules per plant, plant height and number of seeds per capsule were reported by Babu (1992). Geetha and Subramanian (1992a) reported positive and significant association of seed yield with 1000 seed weight and capsule number.

Pathak and Dixit (1992) reported strong positive correlation of seed yield with branches and capsules per plant at phenotypic level and capsule number, capsule length and seeds per capsule at genotypic level. However, seed yield showed significant negative correlation with days to flower and maturity and oil content.

Reddy and Haripriya (1992) reported significant positive correlation of number of capsules per plant and seed yield per plant. Reddy *et al.* (1992b) reported significant positive correlation of number of capsules, 1000 seed weight and plant height with seed yield. Shadakshari *et al.* (1992) reported that the association of seed yield with total number of capsules per plant, plant height, 1000 seed weight, oil content and days to maturity was positive and significant.

Chandrasekhara and Reddy (1993a) reported oil percentage had significant positive phenotypic and close genotypic association with 1000 seed weight. Seed yield per plant had also similar association with seeds per capsule and 1000 seed weight.

Significant positive correlation of seed yield with branches per plant and capsules per plant and among themselves were reported by Mishra *et al.* (1993). They have also reported positive association of plant height with number of branches per plant, number of capsules per plant, number of seeds per capsule. Balan (1994) reported negative correlation of seed yield with 1000 seed weight and oil content. Ranganatha *et al.* (1994) reported high positive association of seed yield with number of capsules and number of capsules and days to maturity. Subramanian and Subramanian (1994) reported significant positive correlation of seed yield with capsule number.

Biswas and Akbar (1995) estimated significant positive genotypic correlation of seed yield with days to maturity, plant height, number of branches per plant, number of capsules per plant and 1000 seed weight.

Significant positive correlations of seed yield with plant height, number of capsules on main axis, number of capsules per plant, capsule length and seeds per capsule were reported by Chaudhary (1995). Govindarasu (1995) estimated positive genotypic correlation of capsule number and branch number with seed yield. Mishra *et al.* (1995a) estimated significant positive association of seed yield with capsule number per plant. Plant height; branches per plant and capsules per plant gave positive and significant correlations among themselves also.

Mishra *et al.* (1995b) reported significant positive phenotypic and close genotypic correlation of capsule length with days to maturity and seeds per capsule. Reddy and Dorairaj (1995) estimated significant positive genotypic and phenotypic correlation of seed weight with capsule weight. Balan *et al.* (1996) estimated significant positive genotypic correlation of seed yield with capsule weight.

Kumar and Sivasamy (1996b) reported significant positive correlation of seed yield per plant with number of capsules on main stem and plant height with first productive node and number of capsules on main stem and negative significant correlation between oil content and 1000 seed weight. Padmavathi and Thangavelu (1996) reported significant positive phenotypic correlation of plant height, height upto first capsule and days to maturity with seed yield.

Ravindran (1996) reported significant positive correlation of days to flowering, plant height, capsule number and capsule length with seed yield. Significant positive correlation of seed yield with plant height, first capsule bearing node, number of branches, number of capsules on main stem, number of capsules per plant and capsule length was reported by Thiyagarajan and Ramanathan (1996). They have also reported strong positive correlation of these characters among themselves. Amaresha (1997) reported high positive correlation of seed yield per plant with plant height, number of capsules per plant, capsule length and seeds per capsule.

Karuppaiyan (1997) reported positive correlation of seed yield with number of capsules, plant height, number of branches and days to maturity. Rai *et al.* (1997) reported that in general, genotypic correlation were higher than phenotypic correlation. Seed yield was significantly and positively associated both at phenotypic and genotypic level with number of capsules per plant, number of capsules on main shoot and number of seeds per capsule.

Singh *et al.* (1997a) recorded significant positive genotypic correlation of seed yield per plant with number of capsules per plant. Singh *et al.* (1997b) reported that oil content had significant positive correlation with plant height, number of capsules per plant and seed yield per plant. Plant height had significant positive correlation with days to maturity and number of capsules per plant.

Significant positive correlation of seed yield with number of capsules on main shoot, number of capsules per plant and seeds per capsule were reported by Tak (1997). Plant height showed negative correlation with 1000 seed weight.

Backiyarani *et al.* (1998b) reported high positive association of seed yield with number of capsules per plant and days to flowering both at phenotypic and genotypic level. The traits like days to first flowering, plant height and number of capsules were interrelated. Jarwar *et al.* (1998) reported significant positive correlation of seed yield with days to maturity and plant height.

High correlation of seed yield with number of branches and capsules on main stem were reported by Manivannan (1998). Vijayakumar (1998) reported significant positive correlation of seed yield with plant height, branch number, 1000 seed weight and oil content. Jayalakshmi and Reddy (1999) reported that seed yield was positively and significantly correlated with capsules per plant and capsules on main stem and they are inter-correlated among themselves. Kavitha and Ramalingam (1999) estimated negative significant correlation between days to first flowering and seed yield. Nimbalkar *et al.* (1999) reported significant positive correlation of seed yield with number of capsules per plant, plant height, 1000 seed weight, days to first flowering and number of branches per plant.

Sankar (2000) reported high positive genotypic correlation of plant height, capsule length, number of capsules per plant and 1000 seed weight with seed yield.

Karuppaiyan and Ramasamy (2000) estimated significant positive genotypic correlation for seed yield with number of capsules, plant height, number of branches, days to maturity and oil content. Days to maturity, plant height, number of branches and number of capsules had significant correlation among themselves. Singh *et al.* (2000a) observed significant positive association of seed yield with plant height, number of branches per plant and number of seeds per capsule.

Singh *et al.* (2000b) reported that seed yield was positively and significantly associated with plant height, number of branches per plant and number of seeds per capsule. Plant height had significant positive correlation with number of seeds per capsule, which showed high positive correlation with oil percentage.

Path coefficient analysis

Path coefficient analysis measures the direct and indirect contribution of independent variables on dependent variable. Path coefficient analysis reveals whether the association of independent variable on dependant variable is due to their direct effect or is a consequence of their indirect effect via other component characters.

Rathnaswamy (1980) reported that capsules per plant had high positive direct effect on seed yield. Yadava *et al.* (1980) reported that number of capsules and 1000 seed weight had high direct effect on seed yield. Plant height, 1000 seed weight and days to flowering had high indirect effect through number of capsules on seed yield.

Chavan and Chopde (1981) reported that number of capsules per plant had high direct effect on seed yield. Janardhanam *et al.* (1982) revealed that plant height had negative direct effect, whereas number of capsules per plant and 1000 seed weight showed positive direct effect. Vaidya *et al.* (1982) reported high positive direct effect of seed number and number of capsules on yield.

Ibrahim *et al.* (1983) reported that number of capsules had the highest direct effect on seed yield and days to flowering had the greatest indirect

effect on seed yield. Shukla (1983) showed that number of capsules per plant had direct positive effect on yield. Thangavelu and Rajasekaran (1983a) reported maximum positive direct effect of capsule number on seed yield followed by 1000 seed weight and seed number.

Chandramony (1984) reported high positive direct effect of pods per plant and moderate positive direct effect of plant height on seed yield.

Reddy *et al.* (1984b) reported high positive direct effect of plant height and capsules per plant on seed yield. They also reported that number of branches had negative direct effect on seed yield.

Shadakashari (1984) revealed high positive direct effect of total number of capsules on yield. Plant height and number of branches showed positive indirect effect on yield. 1000 seed weight, plant height and total number of branches had moderate positive direct effect while seeds per capsule had negligible positive direct effect on yield.

Sharma and Chauhan (1984b) estimated high positive direct effect of number of capsules per plant on seed yield. Godawat and Gupta (1986) reported that number of capsules per plant had positive direct and indirect effect on seed yield. Pathak and Dixit (1986) reported high positive direct effect of plant height, capsules per plant and moderate positive direct effect of seeds per capsule on seed yield.

High positive direct effects of 1000 seed weight, number of capsules per plant, number of seeds per capsule and plant height on yield were reported by Bhele *et al.* (1987). Khorgade (1987) reported high positive, direct effect of number of capsule per plant on seed yield. Majumdar *et al.* (1987) reported

high positive direct effect of number of capsules per plant, number of seeds per capsule, weight of 1000 seeds and plant height on seed yield.

Rao *et al.* (1990) estimated moderate positive direct effect of capsules per plant on seed yield. Babu (1992) reported high positive direct effect of number of capsules per plant and number of seeds per capsule on seed yield. Number of capsules per plant contributed positive indirect effect through number of branches per plant and number of seeds per capsule.

Pathak and Dixit (1992) reported that branches per plant had high positive direct effect on seed yield. Reddy *et al.* (1992b) reported high positive direct effect of capsules per plant on seed yield. Chandrasekhara and Reddy (1993b) reported moderate positive direct effect of plant height on seed yield per plant.

Mishra *et al.* (1993) reported high positive direct effect of number of capsules on seed yield. Chaudhary (1995) reported high positive direct effect of capsule number and seeds per capsule on seed yield and moderate direct effect of 1000 seed weight.

High positive direct effect of capsule number and branch number on seed yield was reported by Govindarasu (1995). Mishra *et al.* (1995b) reported high positive direct effect of capsule number per plant and number of seeds per capsule on seed yield per plant. Balan *et al.* (1996) reported high positive direct effect of capsule weight on seed yield.

Kumar and Sivasamy (1996a) reported low positive direct effect of 1000 seed weight on seed yield per plant. Ravindran (1996) revealed that capsule number had high positive direct effect on seed yield.

Thiyagarajan and Ramanathan (1996) estimated high positive direct effect of plant height and 1000 seed weight on seed yield per plant.

Amaresha (1997) estimated high direct effect of number of seeds per capsule on seed yield. Karuppaiyan (1997) reported high direct effect of number of capsules and plant height on seed yield. Rai *et al.* (1997) reported low positive direct effect of plant height on seed yield. Singh *et al.* (1997a) estimated high positive direct effect of number of capsules per plant and plant height on seed yield.

High positive direct effect of plant height, capsules per plant and 1000 seed weight and low positive direct effect of seeds per plant on seed yield were reported by Tak (1997). Manivannan (1998) reported low positive direct effect of branches and 1000 seed weight on seed yield. Jayalakshmi and Reddy (1999) estimated high positive direct effect of capsules per plant on seed yield. High positive direct effect of plant height and number of capsules per plant on seed yield was reported by Kavitha and Ramalingam (1999).

Sankar (2000) reported high positive direct effect of capsules per plant on seed yield per plant. Karuppaiyan and Ramasamy (2000) reported that the direct contribution of number of capsules was maximum on seed yield followed by number of seeds per capsule, oil content, plant height and days to maturity.

Genetic divergence

The success of any heterosis-breeding programme depends on the hybridization of genetically divergent parent. Hence the study of genetic

divergent parent is important. This can be done by D^2 analysis developed by Mahalanobis (1936). Studies on sesamum are briefly reviewed here.

Rathnaswamy (1980) clustered 45 genotypes of sesame into 15 clusters. Thangavelu and Rajasekaran (1983b) studied the genetic diversity of 40 genotypes and grouped them into six different clusters. The number of types included in cluster I, II, III, IV, V and VI were 6, 4, 14, 6, 9 and 1, respectively.

Kulkarani (1985) examined the nature of genetic divergence in 169 genotypes and grouped them into 36 clusters. Eighty-eight and 25 genotypes were accounted by the first two clusters and 23 genotypes formed solitary clusters. Ayyasamy *et al.* (1987) applied D^2 analysis for grouping 35 genotypes and they grouped the genotypes into eight clusters. The genotypes in each cluster are I (12), II (13), III (3), IV (2), V (2), VI (1), VII (1) and VIII (1).

Based on D^2 analysis Anitha and Dorairaj (1990) grouped eight parents and 56 hybrids sesamum into 15 clusters with maximum genotypes in cluster I (27) followed by clusters II (2), III (9), IV (8), V (2), VI (3), VII (1), VIII (2), IX (2), X (2), XI (2), XII (1), XIII (1), XIV (1) and XV (1).

Kumar (1991) clustered 60 genotypes into six clusters. Based on D^2 analysis, Alamelu (1992) grouped 65 genotypes into eight clusters. Babu (1992) grouped 27 genotypes into seven clusters. Based on D^2 values Mahapatra *et al.* (1993) grouped 29 varieties into nine clusters with cluster I with five genotypes, cluster II (5), III (4), IV (5), V (2), VI (4), VII (2), VIII (1) and IX (1). Balan (1994) grouped 68 genotypes into eight different

clusters. Based on genetic distance, Patil and Sherieff (1994) grouped 100 genotypes into 14 clusters.

Ganesh and Thangavelu (1995) employed D^2 analysis for 50 genotypes and grouped into four clusters with 40 genotypes in cluster I and four in II, five in III and one in IV. Verma and Mahto (1995) employed D^2 analysis for grouping 16 genotypes and obtained four clusters with nine genotypes in cluster I and 4, 2, and 1 genotypes in clusters II, III and IV, respectively.

Manivannan and Nadarajan (1996) based on D^2 analysis grouped 52 genotypes into six clusters with 40, 5, 3, 2, 1 and 1 genotypes in clusters I, II, III, IV, V and VI respectively. Based on D^2 analysis, Swain and Dikshit (1997) obtained 14 clusters by grouping 40 genotypes with seven genotypes in group I, ten in cluster II, three each in III and IV, four each in V and VI, two in VII and one each in clusters VIII, IX, X, XI, XII, XIII and XIV.

Anitha (1998) based on D^2 analysis grouped eight parents and 56 hybrids into 15 clusters. Dikshit and Swain (2000) grouped eleven parental lines into five clusters based on D^2 values. Manivannan and Ganesan (2000b) subjected 67 sesame genotypes to D^2 analysis and grouped them into 10 clusters. Among the clusters cluster I had 46 genotypes and cluster III, IV, II and V had 6, 5, 3 and 2 genotypes respectively. Cluster VI, VII, VIII, IX and X were highly divergent from cluster II and cluster I from cluster X.

Reddy *et al.* (2000) grouped 9 parental lines into four divergent classes DC1, DC2, DC3 and DC4 based on D^2 analysis. Gupta *et al.* (2001) studied genetic divergence in 50 genotypes and grouped them into sixteen clusters with 12, 9, 5, 3, 4, 2, 2, 3, 1, 2, 2, 1, 1, 1 and 1 genotypes in cluster I to XVI,

respectively. Navale *et al.* (2001) evaluated genetic diversity of 50 germplasm lines and grouped into six clusters with cluster I with 19 genotypes followed by cluster II (17), cluster III ((8), cluster IV (3), cluster V (2) and cluster VI (1).

Combining ability and gene action

Information on combining ability is essential for deciding breeding procedure to be followed and success of the programme depends on the gene action governing the character. Pertinent literature on this subject is reviewed here.

Rathnaswamy (1980) reported predominance of additive gene action for plant height, number of branches per plant, number of capsules per plant and length of capsule.

Gupta (1981) reported higher magnitude of GCA than SCA. Non-additive gene action occurred for plant height, number of branches, capsules per plant and grain yield.

Shrivas and Singh (1981) studied diallel cross involving ten varieties and reported that, 'N66-173' and 'TC66' were the best general combiners and the hybrids 'TC66 x M3-1' and 'N66-173 x SF155' were having high sca effects for yield. Tyagi and Singh (1981) reported non-additive gene action for yield.

Fatteh *et al.* (1982) studied six strains and reported significant GCA and SCA for all the characters studied. Additive gene action was more important for days to flower, height of plant, number of capsules per plant,

days to maturity, yield per plant and weight of 1000 seeds whereas non additive gene action was important for oil percentage.

Investigation by Reddy *et al.* (1982) revealed that cultivar SI-851 was a good general combiner for days to flower, plant height, and capsules per plant, seed and oil yield per plant. For plant height and oil content additive gene action was predominate. For days to flower, number of branches, capsules on main stem, capsules per pant and seed yield per plant influence of non-additive gene action was high.

Shivaprakash (1982) reported additive gene effects for plant height, height to first capsule, capsule length, number of seeds per capsule and number of capsules per plant.

Chandraprakash (1983) reported higher GCA variances than SCA variances for 1000 seed weight, capsule length, number of capsules on main stem, seed yield, height of first capsule and oil percentage. Dominant gene action was predominant for the above characters except for seed yield.

Chavan *et al.* (1983) reported that seed yield per plant was governed by additive as well as dominant gene effects. Djigma (1983) reported that the varieties 'Yendev 55' and 'Jaalgon 128' were good general combiners for 1000 seed weight. Singh *et al.* (1983) observed significant GCA variances for days to flowering, plant height, yield per plant, 1000 seed weight, number of capsules per plant, number of seeds per capsule and oil content. SCA variances were significant for days to flowering and maturity and oil content. From a diallel cross involving eight parents of sesamum, Chaudhari *et al.* (1984b) identified 'GT-1' Mrug-1 and 'HT-1' as good general combiners for

yield the crosses 'Mrug 1 x HT-1', 'K71-12 x TL25', 'Mrug 1 x T_{13}', 'GT_1 x Mrug 1' and 'GT_1 x K71-12' had high sca effects for yield and yield attributes viz., days to flowering, plant height, branches per plant, capsules per plant and seeds per capsule, days to maturity, 1000 seed weight and oil percentage. Additive and non-additive gene effects predominate all the characters except days to flower and maturity.

Five varieties were crossed by Djigma (1984) and reported that additive effects predominates for capsule length and 1000 seed weight. Krishnasami and Appadurai (1984) reported that the varieties Co-1 and N 62-34/3 had significant GCA effect for plant height, number of branches, number of capsules and seed yield. From diallel crosses involving ten varieties Reddy *et al.* (1984a) revealed that SI, 1854 and T 85 were good general combiners for seed yield and oil yield per plant.

Venkatesh (1984) estimated significant additive and non-additive components for days to maturity, plant height, height to first capsule, number of capsules on main shoot and number of seeds per capsule and additive effects for total number of branches, total number of capsules per plant, yield per plant and oil content. Non-additive effects were predominant for capsule length and 1000 seed weight.

Sharma and Chauhan (1985) reported that SH50, T12, B local and SH 62 were best general combiners when four to six characters were considered at a time. They have studied days to flowering, plant height, number of capsules per plant, days to maturity, 1000 seed weight, seed yield and oil percentage. Higher magnitude of GCA than SCA variances indicate the

predominance of additive and additive x additive epistatic component of genetic variance.

Dora and Kamala (1986) reported additive as well as non-additive gene effect for plant height, capsules per plant, seeds per capsule, seed yield, oil content, days to maturity, 1000 seed weight and days to first flowering. Narkhede (1986) reported non-additive gene action for protein content, oil content and iodine value. The nature of combining ability in a diallel set of four varieties was studied by Dora and Kamala (1987) and recorded highly significant GCA and absence of significant SCA indicating the predominance of additive as well as non-additive gene action for all the characters they have studied. They identified 'Gouri' and 'Madhavi' as best general combiners with significant gca.

Line x tester analysis by Krishnadoss *et al.* (1987) reported significant SCA variance for days to maturity, plant height, branches per plant, capsules per plant and yield per plant indicating additive gene action. The SCA variances were also significant for all the characters indicating dominant gene action. The parent Si 244/2 was good general combiner for plant height and capsules per plant and 68/20 for plant height and yield per plant. Kumar and Rangasamy (1987) reported higher GCA variance than SCA variance indicating predominance of non-additive gene action for yield.

Chandramony and Nayar (1988) reported high GCA and SCA variance for number of days to first flowering, plant height, number of pods on main axis, total number of pods per plant, 1000 seed weight and seed yield per plant. Higher GCA variance indicated the presence of additive gene action in

the expression of these characters. The oil content was found to be controlled by non-additive gene action.

Khorgade *et al.* (1988) estimated higher SCA variance than GCA variance for days to maturity, capsule length, number of branches per plant, number of capsules per plant and 1000 seed weight. Additive as well as non-additive gene action was observed for these characters. IC 252 was the best general combiner for plant height, number of branches per plant, seed yield per plant and IC 252 x N128 was the best specific combiner.

Pathak and Dixit (1988) reported that days to maturity, plant height, height at first bearing node, capsules per plant, capsule length and seeds per capsule were controlled by additive as well as non additive gene effects. For days to flowering additive gene action was found to be most important.

Khorgade *et al.* (1989) revealed significant GCA and SCA variances for days to maturity, plant height, number of branches per plant, capsule length, number of capsules per plant, number of seeds per capsule, 1000 seed weight, oil content and seed yield. The parent SP125/283 was the best general combiner for plant height, capsule length, number of branches per plant and number of seeds per capsule. Non-additive gene action for seed yield per plant was reported by Reddy and Haripriya (1990). Ramakrishnan and Soundrapandian (1990a) reported predominance of SCA variance over GCA variance for the characters like plant height, number of capsules per plant, number of days to maturity, 1000 seed weight and seed yield per plant. They indicated that these traits might be controlled by non-additive gene action.

Goyal and Sudhirkumar (1991) from a 8 x 8 diallel analysis reported that the variance due to GCA and SCA were highly significant indicating the presence of additive and non-additive gene action for seed yield, oil content, seeds per capsule, capsules per plant, number of branches, plant height, days to flower and days to maturity. The parent 'Vinayak' and 'SP-1162' were good general combiners for most of the characters except oil content.

Significant GCA and SCA variances for number of capsules per plant, length of capsules, yield per plant, oil content, protein content and iodine number were reported by Narkhede and Kumar (1991a). Both additive and non-additive gene action were significant for all the characters. Narkhede and Kumar (1991b) reported predominance of dominant gene action for capsules per plant, length of capsule, seeds/capsule and yield. From a line × tester analysis Shinde *et al.* (1991) reported significant GCA for plant height indicating the predominance of additive gene action and larger amount of SCA variances for number of capsules per plant and seed yield per plant indicating the presence of dominance variance. TC-328 and RT 25 were good general combiners for yield.

Alamelu (1992) reported predominance of additive gene action for plant height, number of capsules on main stem, number of capsules and oil content and non-additive gene action for number of seeds per capsule. Both additive and non-additive gene action were important for number of seeds per capsule and seed yield. Brindha (1992) estimated preponderance of additive gene action for days to first flowering, branches per plant, capsules per plant, seeds per capsule and seed yield and non-additive gene action for pant height.

Delgado and Layrisse (1992) recorded high SCA for yield. From a set of 9 x 9 diallel, Reddy *et al.* (1992a) estimated higher GCA than SCA variance for oil content which indicated predominance of additive gene action for oil content. Non-additive gene action was predominant for seed yield.

In a 6 x 6 diallel cross conducted by Geetha and Subramanian (1992b) found both additive and non-additive gene effects for plant height, branch number, capsule number, seed number, 1000 seed weight and oil per cent. The crosses Co-1 x TSS 6 and TNAU 10 x TSS 6 were best combiners for seed yield, capsule number, 1000 seed weight, plant height and oil per cent. Jayaprakash (1992) reported predominance of dominant gene action for plant height, days to first flowering, number of branches, height upto first capsule, number of capsules, days to maturity and seed yield per plant.

Kadu *et al.* (1992) observed higher GCA variance than SCA variance for days to maturity, plant height, and number of branches per plant, capsule length, and number of seeds per capsule and seed yield per plant. Additive as well as non-additive gene action was important for all these characters. JLT7 was the best general combiner for yield and the cross TC 25 x N 128 was identified as best specific combiner for seed yield, oil content and number of capsules per plant.

Dharmalingam and Ramanathan (1993) reported that the sesamum varieties TMV 6 and 'SO-549' were good general combiners and the hybrids 'SO-569 x ACV1' and 'SO-549 x AT 11' were the best specific combiners for seed yield per plant. Haripriya and Reddy (1993) reported both additive and dominance gene action for seed yield per plant. Reddy *et al.* (1993) estimated

significant GCA and SCA for oil content revealed both additive and non-additive gene action for oil content.

Thiyagarajan (1993) reported that SCA variances were higher than GCA variances for days to maturity, plant height, height upto first capsule, number of branches, number of capsules on main stem, number of capsules per plant, capsule length, number of seeds per capsule, 1000 seed weight, seed yield and oil content indicating predominance of non-additive gene action. Balan (1994) reported additive and non-additive gene action for seed yield and oil content. Chandramony and Nayar (1994) reported additive as well as non-additive gene action for plant height, number of pods on main axis, number of pods per pant, 1000 seed weight and seed yield per plant.

Durga *et al.* (1994) reported non-additive gene action for days to flowering, height upto first capsule, capsule on main stem, plant height, days to maturity, oil per cent and seed yield per plant. Sajjanar (1994) reported that GCA variances were greater than SCA variances indicating preponderance of additive gene action for plant height, number of capsules per plant, 1000 seed weight, days to maturity, seed yield and oil content.

Significant GCA and SCA obtained by Fatteh *et al.* (1995) revealed the importance of additive and non-additive gene action for days to flowering, plant height, number of capsules per plant, length of capsule, number of seeds per capsule, days to maturity, yield per plant, 1000 grain weight and oil content. The parents PT 64 and HT 1 were good general combiners.

Combining ability analysis conducted by Ram (1995) indicated predominance for non-additive gene action, plant height, number of capsules

per plant and seed yield per plant. TMV 3 and Co-1 were good general combiners for all the characters. The best specific combiners were B-67 x Co-1 and C-7 x C0-1.

Line x tester analysis conducted by Kumar and Sivasamy (1995) indicated higher sca effects than gca effects showing predominance of non-additive gene action for plant height, capsules on main stem, oil content and yield per plant. TNAU 12 and TMV 6 were identified as good general combiners and TNAU 12 x TMV 3 and TSS 6 x TMV 3 as good specific combiners.

Mcharo *et al.* (1995) reported non-additive gene action for seeds per capsule, capsule length and capsules per plant but additive gene action for height upto first capsule and 1000 seed weight. Sundaram (1995) estimated predominance of additive gene action for height of the plant, days to first flower, and number of capsules on main stem, number of capsules per plant and seed yield.

Thiyagarajan and Ramanathan (1995a) reported importance of non-additive gene action for number of branches per plant, number of capsules per plant, 1000 seed weight, seed yield and oil content. Combining ability study by Thiyagarajan and Ramanathan (1995b) revealed that the parents G 51-266, Si 1669 and Si 1703 were good general combiners and crosses Si 953 x Co-1and G51-266 x Co-1 were good specific combiners for yield.

Higher SCA variances for plant height, length of capsule, number of seeds per capsule, days to maturity, 1000 seed weight, seed yield per plant and oil content indicating predominance of non additive gene action were

reported by Devaraj (1996). Kumar and Sivasamy (1996a) reported predominance of additive gene action for seed yield per plant.

Line x tester analysis by Mishra and Yadav (1996) revealed non-additive gene action for days to maturity, number of capsules per plant, number of seeds per capsule, 1000 seed weight and seed yield per plant. TC-289 x Phule-1 and JT 7 x T225 were good specific combiners. Raja (1996) reported additive gene action for plant height and number of capsules on main stem and non additive gene action for height of the first capsule bearing node, number of capsules per plant, weight of 1000 seeds and seed yield per plant.

Predominance of non-additive gene action for days to flower, plant height, capsule number, capsule length, seed yield and oil content were reported by Ravindran (1996).

Ravindran and Amrithadevarathinam (1996) reported predominance of additive gene action for plant height, number of capsules per plant, 1000 seed weight and number of seeds per capsule.

Diallel analysis involving six parents conducted by Backiyarani *et al.* (1997a) showed predominance of additive genetic variances for days to first flowering, plant height, number of capsules, oil per cent and yield.

Manivannan (1997) reported additive gene action for seed yield. Baviskar *et al.* (1998) reported that JLSC-84, Tapi and TRG were good general combiners for grain yield. In a nine parental diallel cross, Chakraborti and Basu (1998) observed significant GCA and SCA variances for days to flowering, plant height, seed yield per plant and oil content indicating both additive and non-additive gene action.

John (1998) reported both additive and non-additive gene action influencing days to first flowering, plant height, number of branches per plant, number of capsules per plant, capsule length, 1000 seed weight, oil per cent and seed yield per plant.

Ramesh *et al.* (1998) identified two lines *viz.* DO RS 102 and E8 as good general combiners, number or branches per plant, total number of capsules per plant, capsule yield per plant and seed yield per plant. E8 x Madhavi was found as the best specific combiner for plant height, number of branches per plant, total number of capsules per plant, capsule yield per plant, days to maturity and seed yield per plant. Reddy (1998) reported major role of additive gene action for number of branches per plant, oil percentage and capsule yield per plant.

Das and Chaudhury (1999) reported that both additive and non-additive gene action for oil content.

Das and Gupta (1999) reported that additive genetic variance was of greater importance for number of capsules per plant and seed yield per plant. While non-additive genetic variance were equally important for days to flowering, 1000 seed weight and oil content. The variety B9 was the best general combiner for seed yield and other major components of yield. The cross 'B14 x B9' emerged as best specific combination for seed yield and its components.

In a 6 x 6 diallel experiment Kamala (1999) found days to maturity had additive action whereas non-additive gene action was predominant for plant height, number of branches, capsules per plant, seeds per capsule, 1000 seed weight and seed yield per plant. Krishnavel (1999) reported predominance of additive gene action for number of capsules per plant, number of seeds per

capsule and seed yield. Predominance of non-additive gene action for seed yield per plant and additive gene action for plant height was reported by Pathirana (1999).

Thakare *et al.* (1999) reported that TC 25, JLT 7 among lines and NT9-91 and Padma among testers were good general combiners for plant height, days to maturity, number of capsules per plant, number of seeds per capsule, 1000 seed weight, oil content and yield per plant. These characters showed both additive and non-additive gene effects. Cross TC 25 x NT 8-91 showed significant SCA for seed yield and oil content. Chakraborti and Basu (2000) reported preponderance of additive and non-additive gene effect for oil content.

Combining ability study by Jayalakshmi *et al.* (2000) revealed predominance of non-additive gene action, days to maturity, capsules per plant and seed yield per plant. The parent RT 54, VS 16 and RB4-4-2 were good general combiners and RT54 x X198 and VS 16 x AT 3 were best specific combiners. Karuppaiyan *et al.* (2000) reported that variance due to SCA was higher than GCA for plant height, number of capsules, seed yield and oil content indicating predominance of non-additive gene action. However additive gene action was reported for days to maturity.

Higher magnitude of SCA variances observed by Manivannan and Ganesan (2000a) for plant height, number of branches per plant, number of capsules per plant and seed yield per plant indicated predominance of non-additive gene action. Mudagal (2000) reported higher GCA - SCA ratio for seed yield per plant indicating predominance of non-additive gene action. Ragiba and Reddy (2000a) reported higher SCA variances for plant height,

height to first capsule, number of capsules per plant, 1000 seed weight and seed yield per plant indicating non-additive gene action.

Remesh *et al.* (2000) reported predominance of additive gene action for days to maturity, number of capsules per plant, 1000 seed weight, seed yield per plant and oil content.

Sumathi and Kalamani (2000) in a line x tester cross involving seven lines, they observed high magnitude of sca effects indicating predominance of non additive gene action for days to flowering, plant height, number of branches per plant, height of first capsule, number of capsules per plant, days to maturity, number of seeds per plant, 1000 seed weight and seed yield per plant.

Dikshit and Swain (2001) reported preponderance of additive genetic variances for days to flowering, plant height, 1000 seed weight and oil content. Both additive and non-additive gene actions were observed for days to maturity, height upto first capsule, branches per plant, capsules on main stem, capsules per plant, capsule length, seeds per capsule and seed yield per plant. They found that TNAU-11, Kanak and Kayamkulam-1 were good general combiners. From the line x tester analysis test conducted by Manivannan and Ganesan (2001a) revealed that the magnitude of SCA variances were more than GCA variances for all the characters they studied. Preponderance of non-additive gene action was recorded for plant height, number of branches per plant, number of capsules per plant and seed yield per plant. Manivannan and Ganesan (2001b) reported Si 861, IS 207 and BS 6-1 - 1 were good general combiners for seed yield with additive gene action.

Heterosis

In self-pollinated crop also significant heterosis were reported. Heterosis in sesame also reported by various workers and relevant literature is reviewed here.

Gupta (1980) from 30 crosses involving six parents reported significant positive heterosis for yield in 13 crosses over mid parent and six crosses over better parent. The crosses TS 15-72 x Til black recorded significant positive heterosis over both mid parent and better parent for grain yield, capsules per plant, branches per plant and plant height. Rathnaswamy (1980) reported that the range of heterosis over mid parent was between 0.06 to 24.91, -17.65 to 63.64, -0.64 to 45.57, -15.00 to 10.72 and –2.04 to 67.95 per cent for plant height, number of branches, capsules per plant, capsule length and seed yield per plant respectively.

Fifteen lines including four testers were evaluated by Tyagi and Singh (1981) for heterotic effects. Hybrid vigour was pronounced for the number of branches, plant height, number of capsules and yield. Chavan *et al.* (1982) observed significant positive heterosis over better parent in the cross D 7-11 x visubdar for capsules per plant. Significant positive heterosis for yield was observed for the cross PT1 x visubdar. For plant height negatively significant heterobeltiosis was observed in the cross PBN local x K_3 130 and PT 1 x No.17N. Sivaprakash (1982) reported significant positive heterobeltiosis for height upto first capsule and negative significant heterosis for seed yield and plant height.

Chandraprakash (1983) estimated significant positive relative heterosis and heterobeltiosis for plant height, height upto first capsule, number of capsules, capsule length, seeds per capsule, capsule on main stem, 1000 seed weight and seed yield for different crosses. Djigma (1983) reported low positive relative heterosis for height of main stem, number of capsules and 1000 seed weight.

The performance of F_1hybrids involving 10 varieties was studied by Sharma and Chauhan (1983) and reported negative heterosis over mid parent for days to flower in the cross W 128 x SH 62 (-19.63 per cent). Heterobeltiosis for number of capsules per plant was maximum in hybrid JT 66 – 173 x T12 (32 per cent) for 1000 seed weight and heterobeltiosis was maximum in hybrid T 21 x SH 50 (25.51 per cent). For seed yield highest heterotic effect of 60.27 and 105.70 per cent over the superior and mid parent was recorded for the hybrid T 12 x SH 62 and JT 66 – 173 x SH 50 respectively.

Desai *et al.* (1984) reported maximum heterosis for number of branches per plant followed by seed yield. The hybrid IPS 20 x MT 67-52 was the tallest hybrid with 28.44 per cent heterosis over mid parent. Relative heterosis was negative for length of capsule. The hybrid U2 x MT 76-52 showed 40.22 per cent relative heterosis for 1000 seed weight with 5.51 per cent average heterosis for oil content. Djigma (1984) reported high relative heterosis for seed yield per plant.

Chaudhari *et al.* (1984a), from a diallel cross involving eight parents, reported high positive heterosis for grain yield and capsules per plant. Thirty six hybrids were studied by Krishnaswamy and Appadurai (1984) for standard

heterosis and reported positive heterosis for plant height in fifteen crosses, number of branches in one cross and number of capsules in twelve crosses and for seed yield in nine crosses.

Godawat and Gupta (1985) reported significant relative heterosis for plant height, number of capsules per plant and grain yield. Dora and Kamala (1986) reported high positive relative heterosis for branches per plant, capsules per plant, seeds per capsule and seed yield per plant. Singh *et al.* (1986) reported significant positive heterobeltiosis and standard heterosis for seed yield plant. Ding *et al.* (1987) observed high positive relative heterosis for number of capsules per plant 1000 seed weight and number of seeds per capsule.

Krishnadoss and Kadambavanasundaram (1987) reported significant positive relative heterosis for seed yield. Goyal and Kumar (1988) in a 8 x 8 diallel crosses of sesamum reported high heterosis for yield, plant height, days to flower, number of branches, height of first fruiting node, number of capsules and seeds per capsule.

Jadon and Mehrotra (1988) reported significant positive heterobeltiosis for seed yield, capsules per plant, branches per plant, seeds per capsule, 1000 seed weight, plant height and days to flowering. Pathak and Dixit (1988) reported significant positive heterobeltiosis for plant height and capsules per plant.

Manoharan *et al.* (1989) reported positive heterobeltiosis for number of branches and seed yield. Ramakrishnan and Soundarapandian (1990b) studied 60 hybrids of sesamum and reported positive heterosis for plant height.

number of capsules per plant seed yield per plant, 1000 seed weight and days to maturity for different crosses. High significant positive heterosis for yield, days to first flowering, days to maturity, number of capsules per plant and number of seeds per capsules were reported by Sasikumar and Sardana (1990).

Sodani and Bhatnagar (1990) got positive significant heterosis for 21 hybrids for seed yield. Relative heterosis was high for number of capsules and branches per plant and low for plant height and capsule length. Anitha and Dorairaj (1991) reported significant positive heterosis over better parent for seed yield per plant and capsules on main stem. Frequency of heterotic crosses was also high for seeds per capsule and days to flowering.

Ding *et al.* (1991) reported high heterosis for yield per plant. Kumar (1991) estimated significant positive standard heterosis for plant height, number of branches, number of capsules, 1000 seed weight and and seed yield for different crosses. Tu *et al.* (1991) reported significant heterobeltiosis for plant height, number of branches, capsules per plant, seeds per capsules, 1000 seed weight and yield per plant.

Yadav and Mishra (1991) reported significant positive heterobeltiosis for number of branches per plant, capsules per plant and seed yield per plant. Significant positive heterobeltiosis and standard heterosis for seed yield was reported by Alamelu (1992). Brindha (1992) identified significant positive heterosis for seed yield per plant, number of capsules per plant, number of branches per plant and number of seeds per capsule for the crosses RS 6-1-1 x TSS11, TSS11 x Si 1730 and Madhavi x Si 1730.

High positive heterosis for yield was recorded by Delgado and Layrisse (1992). Jayaprakash (1992) found significant positive heterosis for number of capsules and seed yield for the hybrids.

Ray and Sen (1992) reported that heterosis over better parent and mid parent were significant for plant height, number of days to flowering, 1000 seed weight and seed yield for most of the crosses. Heterosis was also significant and positive for number of capsules per plant and number of capsules on main stem in few crosses.

Reddy *et al.* (1992a) estimated low or negative heterosis for oil content and moderate to high heterosis for seed yield per plant. Sridharan (1992) estimated significant positive relative heterosis, heterobeltiosis and standard heterosis for seed yield per plant, plant height, number of branches and oil content and significant negative heterobeltiosis and standard heterosis for days to maturity.

Reddy and Haripriya (1993) reported significant positive heterobeltiosis for seed yield for 1000 seed weight and oil content. Reddy *et al.* (1993) estimated either low or negative mid parental or better parental heterosis for seed yield per plant. Thiyagarajan (1993) reported significant positive heterobeltiosis for seed yield.

Balan (1994) reported that the range of standard heterosis for seed yield per plant was from –34.3 to 184.8 per cent, for oil content -24.9 to –6.3 per cent and for days to maturity –3.9 to 7.8 per cent. Significant positive relative heterosis and heterobeltiosis for number of seeds per capsule, oil content and 1000 seed weight and yield per plant was reported by Balsane *et al.*

(1994). All the crosses exhibited negative heterosis over mid parent and better parent for days to maturity.

Kumar (1994) reported significant poisitive standard heterosis for seed yield. Sajjanar (1994) reported significant positive heterosis over mid parent and better parent for seed yield, number of capsules per plant and 1000 seed weight.

Chandramony and Nayar (1995) studied fifteen hybrids of sesamum and observed significant positive heterosis over mid parent and better parent for plant height, number of pods on main axis, total number of capsules per plant, 1000 seed weight, seed yield per plant and oil content.

High magnitude of heterosis over better parent for grain yield per plant followed by number of branches per plant and number of capsules per plant were reported by Fatteh *et al.* (1995). Govindarasu (1995) reported significant positive heterosis over mid parent, better parent and standard variety for seed yield and branch number.

Kumar (1995) estimated mid parental heterosis and reported significant positive heterosis for plant height, capsule number, oil content and seed yield.

From a set of 10 x 10 diallel cross, Navadiya *et al.* (1995) reported significant heterobeltiosis and standard heterosis for yield per plant, plant height and number of capsules per plant. Days to flowering and maturity, 1000 seed weight and oil content showed low heterosis.

Quijada and Layrisse (1995) reported significant positive standard heterosis for seed yield per plant. Sundaram (1995) reported that the range of heterosis over the mid parent varied between –30.95 to 39.14 for plant height,

-8.07 to 12.80 for days to first flowering, -56.71 to 72.18 for capsules on main stem, -38.28 to 72.18 for capsules per plant and –45.98 to 91.83 for seed yield. Chandramony and Nayar (1996) reported significant positive heterosis for plant height, capsules on main axis and seed yield per plant.

Devaraj (1996) reported significant positive heterosis over mid parent for plant height, number of capsules per plant, length of the capsule, number of seeds per capsule, 1000 seed weight, seed yield and oil content.

Kumar (1996) reported significant relative and standard heterosis for plant height, capsules on main stem, oil content and seed yield per plant. Raja (1996) reported significant positive heterosis for plant height, height upto first capsule, number of capsules on main stem, number of capsules per plant, 1000 seed weight and seed yield. Ravindran (1996) observed that significant positive relative heterosis and heterobeltiosis for seed yield.

Remesh (1996) reported significant positive heterosis for over better parent and standard variety for number of branches per plant, total number of capsules per plant and seed yield. Karuppaiyan (1997) reported high heterosis for seed yield and oil content. Keneni and Woyessa (1997) rported significant positive heterobeltiosis for seed yield for most the hybrids under study.

Manoharan *et al.* (1997) studied a set of diallel cross of six varieties of sesamum and reported heterosis over midparent for seed yield in five hybrids. In respect of 1000 seed weight, only four hybrids registered positive heterosis over better parent while 10 hybrids exhibited positive heterosis over standard parent. Acevedo and Penso (1998) reported significant positive relative heterosis for capsules per plant, weight of 1000 seeds and seed yield. Anitha

(1998) reported significant positive heterobeltiosis and standard heterosis for seed yield. Backiyarani (1998a) from her study reported maximum relative heterosis for yield.

Baviskar *et al.* (1998) estimated high magnitude of heterosis over better parent for number of capsules per plant, grain yield and number of branches per plant. Kumar *et al.* (1998) reported significant positive standard heterosis for 1000 seed weight. Significant positive heterobeltiosis for seed yield per plant from a 6 x 5 line x tester analysis was reported by Padmavathi (1998).Penzo and Fedel (1998) reported significant positive heterobeltiosis for number of capsules per plant, number of seeds per capsule, 1000 seed weight and seed yield per plant.

Sakhare *et al.* (1998) reported highest magnitude of relative heterosis, heterobeltiosis and standard heterosis for seed yield per plant and capsules per plant. Twenty one F_1's obtained by crossing seven varieties were studied by Alam *et al.* (1999) and reported significant positive heterobeltiosis for seed yield per plant, oil content per plant and capsule number per plant.

Govindarasu *et al.* (1999a) observed significant positive heterosis for seed yield, branch number and capsule number.

Dikshit and Swain (2000) reported significant relative heterosis and heterobeltiosis for seed yield.

Govindarasu and Ramamoorthi (2000) observed significant relative heterosis, heterobeltiosis and standard heterosis for seed yield per plant and capsule number. Jayaprakash and Sivasubramanian (2000) reported significant mid parental, better parental and standard parental heterosis for plant height,

days to first flowering, number of branches, number of capsules, seed yield and days to maturity.

Kavitha *et al.* (2000) reported significant standard heterosis and heterobeltiosis for plant height, number of capsules per plant, 1000 seed weight, seed yield per plant and oil content and negative significant relative heterosis for days to first flowering.

Significant standard heterosis and heterobeltiosis for seed yield were reported by Mudagal (2000). Ragiba and Reddy (2000b) reported, seven out of ten crosses showed positive heterosis and the rest showed negative heterosis for seed yield per plant. Sankar (2000) reported high heterosis for plant height, number of capsules per plant, capsule length and single plant yield.

Solanki and Gupta (2000) reported significant positive heterobeltiosis and standard heterosis for seed yield, capsules per plant, branches per plant, 1000 seed weight and plant height.

Dikshit and Swain (2001) reported significant relative heterosis for seed yield per plant, capsules per plant, branches per plant and seeds per capsule. Durga and Raghunadham (2001) estimated significant heterobeltiosis for capsules on main stem, seed yield and oil yield. Negative heterosis was recorded for days to first flowering and height of first capsule. Significant standard heterosis for days to maturity, plant height, number of capsules, seed yield and soil content was recorded by Karuppaiyan and Ramasamy (2001).

Mannivannan and Ganesan (2001c) reported significant standard heterosis for plant height, number of branches per plant, number of capsules per plant, seed yield per plant and oil content. Mishra and Sikarwar (2001) reported positive heterobeltiosis for plant height. Reddy *et al.* (2001) reported significant standard heterosis and heterobeltiosis, plant height, number of branches per plant, number of capsules per plant, capsule length, days to maturity, number of seeds per capsule, capsule yield per plant, seed yield per plant and oil content.

Materials and Methods

3. MATERIALS AND METHODS

The present study was undertaken at the Department of Plant Breeding and Genetics, College of Agriculture, Kerala Agricultural University, Vellayani, Thiruvananthapuram during the period 1998-2000 as an irrigated crop adopting management practices as per the package of practices recommendations-Crops 96' of the Kerala Agricultural University (KAU, 1996).

3.1 Experiment No. 1

Evaluation of varieties for selection of parents for crossing.

3.1.1 Materials

Fifty sesame (*Sesamum indicum* L.) varieties from germplasm maintained at Regional Agricultural Research Station for Onattukara region were used for the study. The description of the varieties is given in the Table

3.1.2 Methodology

The fifty genotypes were planted during December-March, 1997 in randomised block design (RBD) replicated twice. The seeds were sown in single row for each variety. The spacing was 30 x 15 cm and each row was having 15 plants Ten plants at random were selected from each variety and the average value of the following observations recorded and average of the observations were utilized for statistical analysis. The objective of the experiment was screening the varieties for selection of the parents for hybridization based on the variability and genetic distance.

Table 3.1.1 Description of varieties

Treatment	Genotypes	Seed colour	Treatment	Genotypes	Seed colour
T_1	IVTS-1	White	T_{26}	Si-266	Brown
T_2	IVTS-2	Brown	T_{27}	Si-722	Black
T_3	IVTS-3	Black	T_{28}	Si-833	White
T_4	IVTS-5	Brown	T_{29}	Si-902	Brown
T_5	IVTS-7	Brown	T_{30}	Si-926	White
T_6	IVTS-8	Brown	T_{31}	Si-931	White
T_7	IVTS-9	White	T_{32}	Si-1007	White
T_8	IVTS-11	White	T_{33}	Si-1041	White
T_9	IVTS-12	White	T_{34}	Si-1052	White
T_{10}	IVTS-13	Black	T_{35}	Si-1061	White
T_{11}	IVTS-14	White	T_{36}	Si-1066	Brown
T_{12}	IVTS-16	White	T_{37}	Si-1150	Black
T_{13}	Kayamkulam-1	Black	T_{38}	Si-1210	White
T_{14}	Thilak	Brown	T_{39}	Si-1484	Black
T_{15}	IVTS-17	White	T_{40}	Si-1720	Brown
T_{16}	IVTS-18	White	T_{41}	Si-1542	Brown
T_{17}	IVTS-19	Brown	T_{42}	Si-16672	White
T_{18}	AVTS-8	Brown	T_{43}	Si-1669	Brown
T_{19}	AVTS-9	Brown	T_{44}	Si-2247	White
T_{20}	AVTS-14	White	T_{45}	Si-44	White
T_{21}	AVTS-16	Brown	T_{46}	Si-778	Brown
T_{22}	Si-59	Brown	T_{47}	Si-1107	Brown
T_{23}	Si-175	Brown	T_{48}	Si-3214	Black
T_{24}	Si-59	Brown	T_{49}	TMV-3	Brown
T_{25}	Si-255-2	Brown	T_{50}	TMV-4	Brown

3.1.2.1 Plant height (cm)

Height of the plant from the ground level to the tip of the main stem was measured in centimeters at the time of harvest.

3.1.2.2 Height upto first capsule (cm)

Height of the plant from ground level to the lowest capsule was measured and recorded in centimeters.

3.1.2.3 Number of branches

Total number of branches per plant was counted at the time of harvest.

3.1.2.4 Capsules on main axis

Total number of capsules produced on main axis was counted at the time of harvest.

3.1.2.5 Number of capsules per plant

Total number of capsules produced by the plant including those produced on the main axis and branches was counted at the time of harvest.

3.1.2.6 Length of capsule (cm)

Five pods per plant were selected at random and their length was measured in centimeters and taken as the average length of pod.

3.1.2.7 Number of seeds per capsule

Seeds were extracted from five pods per plant selected at random and counted. The average seed number per capsule was recorded.

3.1.2.8 Seed yield per plant (g):

Seeds were extracted from the capsules from single plant weighed and expressed in grams.

3.1.2.9 Weight of capsules per plant (g):

Total capsules produced by the plant was weighed and expressed in grams.

3.1.2.10 1000 seed weight (g):

Random samples of 1000 seeds were taken and their weight was recorded in grams. Five samples were taken from each variety under each replication.

3.1.2.11 Number of days taken for first flowering

The number of days taken from the date of sowing to the opening of the first flower was recorded

3.1.2.12 Number of days taken for harvest

The number of days taken from the sowing of seeds to harvest of crop was recorded.

3.1.2.13 Seed oil (%)

Seed oil percentage was determined by extracting oil from 3 g powdered seeds using petroleum ether in a soxhlet extraction apparatus and oil percentage was calculated using the method described by Sadasivam and Manickam (1992).

3.1.2.14 Seed protein (%)

Seed sample of 100 mg was digested using concentrated H_2SO_4 using potassium sulphate and mercuric oxide as catalyst. Digested material was distilled and distillate was collected in boric acid added with mixed indicator. Titration was done with the solution against standard acid. The values were multiplied by 5.30, the conversion factor. Method described by Sadasivam and Manickam (1992) was followed.

3.1.3 Statistical analysis

The data recorded were subjected to the following statistical analysis.

3.1.3.1 Evaluation of genotypes for mean performance

Analysis of variance and covariance

The data were subjected to variance and co-variance analysis. The varieties were tested for their genotypic differences, for each of the characters under study. Estimation of the components of variance and co-variance was done as follows. With 'v' treatments replicated 'r' times in RBD, the following ANOVA / ANACOVA was done.

Table 3.1.3 ANOVA and ANACOVA

Sources of variation	DF	MS		MSP	E (MS)		E (MSP)
		X_i	X_j	$X_i X_j$	X_i	X_j	$X_i X_j$
Blocks	r-1	M_{bi}	M_{bj}	M_{bij}			
Genotypes	v-1	M_{gi}	M_{gj}	M_{gij}	$r\sigma^2_{gi} + \sigma^2_{ei}$	$r\sigma^2_{gj} + \sigma^2_{ej}$	$r\sigma_{gij} + \sigma_{eij}$
Error	(r-1) (v-1)	M_{ei}	M_{ej}	M_{eij}	σ^2_{ei}	σ^2_{ej}	σ_{eij}
Total	rv-1						

3.1.3.2 Estimation of variability components

Estimates of variance-covariance components for characters X_i and X_j are as follows

X_i	X_j	$X_i X_j$
$\hat{\sigma}^2 g_i = \frac{Mg_i - Me_i}{r}$	$\hat{\sigma}^2 g_j = \frac{Mg_j - Me_j}{r}$	$\hat{\sigma} g_{ij} = \frac{Mg_{ij} - Me_{ij}}{r}$
$\hat{\sigma}^2 e_i = Me_i$	$\hat{\sigma}^2 e_j = Me_j$	$\hat{\sigma} e_{ij} = Me_{ij}$
$\hat{\sigma}^2 p_i = \sigma^2 g_i + \sigma^2 e_i$	$\hat{\sigma}^2 p_j = \sigma^2 g_j + \sigma^2 e_j$	$\hat{\sigma} p_{ij} = \sigma g_{ij} + \sigma e_{ij}$

$$PCV = \frac{\sigma p_i}{\overline{X}_i} \times 100 \qquad GCV = \frac{\sigma g_i}{\overline{X}_i} \times 100$$

3.1.3.3 Estimation of heritability (broad sense) and genetic advance (as percentage of mean)

$$H^2 = \frac{\sigma^2 g_i}{\sigma^2 p_i}$$

GA =k H^2 σp_j , k being the selection differential = 2.06 at 5 per cent selection
= 1.76 at 1 per cent selection

Classification

Heritability

>60 %	-	high
30-60 %	-	moderate
<30 %	-	low

Genetic advance

>20 %	-	high
10-20 %	-	moderate
<10 %	-	low

3.1.3.4 Correlation among different characters

The correlation coefficients viz., Phenotypic, genotypic and environmental were worked out.

$$\text{Genotypic correlation } (r_{gij}) = \frac{\sigma g_{ij}}{\sigma g_i \times \sigma g_j}$$

$$\text{Environmental correlation } (r_{eij}) = \frac{\sigma e_{ij}}{\sigma e_i \times \sigma e_j}$$

Phenotypic correlation (r_{pij})= $\frac{\sigma p_{ij}}{\sigma p_i \times \sigma p_j}$

3.1.3.5 Path coefficient analysis

Path analysis was developed by Wright (1921) to study the cause and effect relationship among a closed system of variables. The direct and indirect effects were estimated for each of the characters X on Y.

$$R_{xx}{}_{K \times K} \quad \underset{K \times 1}{P} = \underline{R}_{xy}$$

Where R_{xx} is the genotypic correlation matrix of dependent variables. $\underline{P}$ is the vector of path coefficients and $\underline{R}_{XY}$ is the vector of genotypic correlation of Y with X.

The direct effect of X_i on Y is the path of X_i on Y is estimated as the standard regression coefficient and the indirect effect of X_i on Y via X_j as

$r_{ij}\, p_j$. The residue factor (R) is estimated as

$$R^2 = 1 - \sum_{L=1}^{k} r_{xy}\, P_i$$

Classification of direct and indirect effect

>1	–	very high
0.30	–	0.99 – high
0.20	–	0.29 – moderate
0.12	–	0.19 – low
<0.09	–	negligible

(Singh and Narayanan, 1997).

3.1.3.6 Genetic divergence analysis

Genetic divergence was measured using D^2 - statistic proposed by Mahalanobis (1936). Applying this method 50 genotypes of sesame were clustered.

D^2 value for i^{th} and j^{th} genotypes is computed as

$$D^2 = \sum_{l=1}^{k} (x_{il} - x_{je})^2$$

Where k is the number of characters. Based on these D^2 values, the genotypes were grouped into several clusters following the Tocher's method of clustering (Rao, 1952).

3.2 Experiment No. II

Six parents selected from experiment I based on genetic divergence on high yield from Cluster I, II, III, IV, V and VII were raised in pots and crossed in half diallel fashion during October – December, 1999 .

3.2.1 Technique of crossing

The flowers are bisexual and self-pollinated. So emasculation was done in the previous evening. Since the flowers are epipetalous, emasculation was easy. The mature flower buds, which will open on the next day were selected and the corolla tube was carefully pulled out without damaging the pistil. The androecium was completely removed along with the corolla tube. The emasculated flower bud was then protected with a straw, which is cut to convenient length and folded at the tip. Flower bud of the pollen parent was also protected using a paper cover. On the next day about 7am i.e., at the

time of anthesis, flowers protected in the male parent were taken and anthers were rubbed on the pistil of the emasculated flower. After pollination straw was replaced and the flower was properly labelled.

The straw was retained for two days. Matured capsules were collected in labelled bags.

3.2.1.1 Materials

Parents

1) IVTS – 5
2) AVTS – 8
3) AVTS – 16
4) Si – 255-2
5) Si – 266
6) Si – 722

Hybrids

1) IVTS – 5 x AVTS – 8
2) IVTS – 5 x AVTS – 16
3) IVTS – 5 x Si – 255-2
4) IVTS – 5 x Si – 266
5) IVTS – 5 x Si – 722
6) AVTS – 8 x AVTS – 16
7) AVTS – 8 x Si – 255-2
8) AVTS – 8 x Si – 266
9) AVTS – 8 x Si – 722
10) AVTS – 16 x Si – 255-2
11) AVTS – 16 x Si – 266
12) AVTS – 16 x Si – 722
13) Si – 255-2 x Si – 266
14) Si – 255-2 x Si – 722
15) Si – 266 x Si – 722

A standard variety, Kayamkulam – 2 was also planted along with the above material to study standard heterosis.

3.2.1.2 Planting and layout of F_1s

Seeds from 15 cross combinations; six parents and one standard check variety were sown in the field during January – March, 2000 with a spacing of 30 x 15 cm in single row with 15 plants in one row RBD with three replications. Ten plants were selected from each row representing a treatment in each replication and observations were taken as in experiment No. 1. In addition to these, observations on the following seed quality characters were also studied.

a) Acid value

Ten gram of oil was dissolved in neutral solvent and titrated against standard alkali using phenolphthalein as indicator. Procedure given by Sadasivam and Manickam (1992) was followed.

b) Saponification value

Two grams of oil was refluxed using 50 ml alcoholic potash. After complete saponification the excess potash was determined by titrating with standard hydrochloric acid using phenolphthalein indicator. Methods described by Sadasivam and Manickam (1992) was followed.

c) Iodine value

The iodine value was determined by treating 0.5 g of sample with non-excess of iodine monochloride (Wijs solution). The iodine monochloride left unabsorbed was treated with excess potassium iodide. Chlorine in iodine monochloride releases an equivalent quantity of iodine. The total amount of

excess iodine was determined by titration with standard sodium thiosulphate. The method given by Paquot and Hautfenne (1987) was followed.

d) Peroxide value

One gram oil was dissolved in 20 ml of solvent mixture along with 1 g potassium iodide. Boiled and transferred to a known quantity of standard potassium iodide solution. Titration was done against standard sodium thiosulphate solution. When the yellow colour just disappears starch indicator was added and titration was done against standard sodium thiosulphate. Method given by Sadasivam and Manickam (1992) was followed.

e) Total nitrogen

Seed sample of 100 mg was digested using concentrated H_2SO_4 using potassium sulphate and mercuric oxide as catalyst. Digested material was distilled and distillate was collected on boric acid added with mixed indicator. Titration was done the solution against standard acid. Method given by Sadasivam and Manickam (1992) was followed.

f) Amino acid profile

For studying the amino acid the method suggested by Thimmaiah (1999) was followed. Two grams of sample of seeds were hydrolyzed using standard HCl by refluxing for 20 hours in an oil bath. Filtered through suction and diluted to one litre with water. Fifty millilitre of the sample was evaporated in a rotary evaporator. The residue was used for separating amino acid by paper chromatography. The residue was spotted in filter paper and standards were also spotted. The chromatogram was developed in a chamber using n-Butanol-acetic acid-water (4 : 1 : 5 v/v) as solvent. Paper was air

dried and ninhydrin was sprayed on the paper. Based on the R_f value amino acids were identified.

The data were subjected to statistical analysis.

3.2.2 Statistical analysis

The data collected from the parents, hybrids and the standard were subjected to analysis of variance to detect the presence of genotypic differences, with respect to each character. This was further subjected to combining ability analysis and heterosis.

3.2.2.1 Combining ability analysis

Griffing's model II and method II (1956) of combining ability analysis was applied to study the contribution of the parents i.e., the general combining ability effects (*gca*) of parents and the excess over and above the sum of two *gca* effects. i.e., the specific combining ability (*sca*) of crosses. The variation among the genotypes was split into components as follows:

With 'n' parents and nc_2 F_1s raised in RBD with 'r' replications (Dabbolkar, 1992), combining ability analysis was done as follows:

Analysis of variance – combining ability

Source	Degrees of freedom	Mean square	Expected mean squares E (MS)
Genotypes	$n + nc_2 - 1$	M_c	$\sigma^2_e + r\,\sigma^2_g$
GCA	n-1	M_g	$\sigma^2_e + \sigma^2_{sca} + (n + 2)\,\sigma^2_{gca}$
SCA	nc_2	M_s	$\sigma^2_e + \sigma^2_{sca}$
Error	$(n + nc_2)\,(r-1)-1$	M_e	σ^2_e

Mg, Ms and Me are the estimates of mean squares for GCA, SCA and experimental error. The estimates of variance components are given below :

Error variances $= \sigma^2_e = M_e$

GCA variance $= \hat{\sigma}^2_{gca} = \frac{Mg - Ms}{(n + 2)}$

SCA variance $= \sigma^2_{sca} = (M_s - M_e)$

The additive (σ^2_a) and dominant (σ^2_d) components of variance were estimated as :

$$\sigma^2_a = 2\sigma^2_{gca}$$

$$\sigma^2_d = \sigma^2_{sca}$$

If significant differences among GCA and SCA were obtained, their effects were estimated as follows :

General combining ability effect (gi) $= \frac{1}{(n + 2)} \left[\Sigma (Y_{i.} + Y_{ii}) - \frac{2Y..}{n} \right]$

Specific combining ability effect of i x j^{th} cross

$$(S_{ij}) = Y_{ij} - \frac{(Y_{i.} + Y_{ii} + Y_{j.} + Y_{jj})}{(n + 2)} + \frac{2Y..}{(n + 1)(n + 2)}$$

where, Y_{ij} = Mean value for the cross P_i x P_j

Y_{ii} = Mean value for selfing P_i i.e., for P_i x P_i

$Y_{i.}$ = Total for i^{th} parental array

$Y..$ = Grand total of all the observations

The standard error (SE) of g_i and s_{ij} and also for their differences are given below :

Effect	Standard error
g_i	$\sqrt{\frac{(n-1)}{n(n+2)}\sigma^2_e}$
$g_i - g_j$	$\sqrt{\frac{2}{(n+2)}\sigma^2_e}$
S_{ij}	$\sqrt{\frac{(n^2+n+2)}{(n+1)(n+2)}\sigma^2_e}$
$S_{ij} - S_{ik}$ (one parent in common)	$\sqrt{\frac{2(n+1)}{(n+2)}\sigma^2_e}$
$S_{ij} - S_{kl}$ (different parents)	$\sqrt{\frac{2n}{(n+2)}\sigma^2_e}$

The significance of g_i and S_{ij} were tested by applying student's t-test.

g_i : $t = \frac{|g_i|}{SE(g_i)}$

s_{ij} : $t = \frac{|S_{ij}|}{SE(S_{ij})}$

The *gca* effects of parents and the *sca* effects of crosses were compared with the critical difference (CD) value, where

$CD = t_\alpha \times SE_d$, SE_d = SE of the difference of effects.

3.2.2.3 Heterosis

Three estimates of heterosis *viz.*, relative heterosis, heterobeltiosis and standard heterosis were estimated using the methods suggested by Hayes *et al.* (1955) and Briggle (1963). Standard heterosis was worked out against the standard check variety Kayamkulam-2.

$$\text{Relative heterosis} = \frac{\overline{F_1} - \overline{MP}}{\overline{MP}} \times 100$$

$$\text{Heterobeltiosis} = \frac{\overline{F_1} - \overline{BP}}{\overline{BP}} \times 100$$

$$\text{Standard heterosis} = \frac{\overline{F_1} - \overline{SP}}{\overline{SP}} \times 100$$

Where, $\overline{F_1}$ Mean performance of F_1's

$\overline{MP}$ – Mean performance of the average of two parents

$\overline{BP}$ – Mean performance of better parent

$\overline{SP}$ – Mean performance of standard variety Kayamkulam-2

The significant differences for heterosis were compared using the critical difference (CD) as computed below.

To test significance over mid parent, F_1 and mid parent were compared by critical difference (CD) where:

$$CD = t_{\alpha} \sqrt{\frac{3\ MSE}{2r}}$$

The significance of the difference between F_1's and better parent and standard parent were compared by the CD, where,

$$CD = t_{\alpha} \sqrt{\frac{2\ MSE}{r}}$$

Where t_{α} – 5 per cent value of t at error d.f.

Results

4. RESULTS

The results of the present study on 'Genetic basis of seed yield and seed quality in sesame (*Sesamum indicum* L.)' are presented under two major topics.

4.1 Experiment No. I : Evaluation of varieties for selection of parents for crossing

4.2 Experiment No. II : Estimation of combining ability, gene action and heterosis

4.1 Experiment No. I : Evaluation of varieties for selection of parents for crossing

The performance of 50 sesamum genotypes were evaluated for various morphological and yield traits. The data on these observations were statistically analysed and the results are presented below in the following sub heads.

4.1.1 Evaluation of genotypes for mean performance

4.1.2 Estimation of variability components

4.1.3 Estimation of heritability (broad sense) and genetic advance (as percentage of mean)

4.1.4 Correlation among different characters

4.1.5 Path coefficient analysis

4.1.6 Genetic divergence analysis

4.1.1 Evaluation of genotypes for mean performance

Analysis of variance of the data on various characters revealed high significant difference for all the characters under study (Table 4.1.1 (a)). The mean performance of 50 genotypes for 14 characters was presented in Table 4.1.1 (b).

Table 4.1.1 (a) Analysis of variance of 14 characters in 50 genotypes of sesame

Sl. No.	Characters	Mean squares		
		Replication (DF=1)	Genotypes (DF=49)	Error (DF=49)
1	Plant height	63.63	326.07**	24.83
2	Height upto first capsule	0.17	36.35**	10.93
3	Number of branches	0.02	2.30**	0.02
4	Capsule on main axis	9.60	30.98**	4.37
5	Number of capsules per plant	66.59	225.69**	24.58
6	Length of capsules	0.04*	0.05**	0.01
7	Number of seeds per capsules	278.03**	122.51**	11.19
8	Seed yield per plant	20.07**	11.39**	1.22
9	Weight of capsules per plant	24.88**	22.22**	2.46
10	1000 seed weight	0.01	0.14**	0.01
11	Number of days taken for first flowering	1.01*	0.82**	0.32
12	Number of days taken for harvest	1.87**	1.02**	0.24
13	Seed oil	5.39	50.63**	2.04
14	Seed protein	0.00	2.10**	0.01

**Significant at 1 per cent level
DF = Degrees of freedom

Table 4.1.1 (b) Mean performance of genotypes for 14 characters in sesame

Geno-types	Plant height (cm)	Height upto 1st capsule (cm)	No. of branches	Capsules on main axis	No. of capsules per plant	Length of capsules (cm)	No. of seeds per capsule	Seed yield per plant (g)	Weight of capsules per plant (g)	1000 seed weight (g)	No. of days taken for first flowering	No. of days taken for harvest	Seed oil (%)	Seed protein (%)
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
T_1	102.45	40.60	4.70	20.95	54.25	2.26	56.50	5.94	11.58	2.44	33.70	84.95	43.33	20.07
T_2	104.90	46.15	4.60	20.10	47.70	2.04	50.05	6.47	11.50	3.03	33.40	84.80	46.67	20.73
T_3	106.20	45.60	5.65	19.25	49.10	2.28	61.25	7.72	12.91	2.96	34.10	85.20	46.67	20.51
T_4	103.90	47.00	2.75	19.25	37.85	2.29	60.10	5.94	10.13	3.52	33.75	84.90	53.33	19.96
T_5	101.05	43.05	4.75	19.45	41.90	1.99	62.85	8.64	13.08	3.60	34.00	84.75	60.00	19.62
T_6	68.65	41.05	4.75	14.75	42.00	2.15	58.55	5.31	9.79	3.27	34.45	85.15	45.00	21.17
T_7	96.95	35.75	6.30	16.70	51.05	2.15	56.80	7.40	12.67	3.34	33.70	85.10	53.33	21.17
T_8	92.15	41.70	4.75	15.40	37.15	2.18	59.05	4.98	8.87	2.99	34.15	85.90	50.00	20.07
T_9	76.05	38.55	4.75	12.45	29.70	2.01	55.30	9.20	7.20	3.14	34.90	87.35	46.67	18.30
T_{10}	101.10	43.05	2.65	11.50	18.15	2.12	45.50	1.91	4.10	3.20	34.35	85.20	43.33	18.85
T_{11}	113.60	46.45	4.75	22.05	43.15	2.22	74.95	9.68	14.07	3.24	35.45	86.00	48.34	18.74
T_{12}	112.85	48.20	4.45	16.50	37.20	2.06	65.95	6.86	10.10	2.97	35.35	85.55	46.67	19.85
T_{13}	101.25	41.60	3.90	20.85	41.65	2.32	61.15	6.25	10.61	2.96	34.85	85.10	50.00	21.61
T_{14}	109.70	48.50	3.45	19.25	41.90	2.35	63.20	6.53	10.77	3.05	34.65	86.05	46.67	21.61
T_{15}	102.80	45.65	2.75	17.95	27.60	2.05	60.90	4.82	7.77	3.28	34.70	86.55	48.34	20.73
T_{16}	116.75	44.95	2.90	18.45	25.65	2.27	60.45	4.24	6.98	3.26	36.00	86.70	56.67	21.44
T_{17}	118.30	35.60	2.85	21.90	32.90	2.20	64.85	5.11	8.42	3.04	34.95	86.05	53.33	20.67
T_{18}	111.85	40.20	4.70	20.85	49.70	2.61	66.35	7.84	12.83	3.21	34.55	84.80	46.67	21.94
T_{19}	89.05	30.70	4.80	14.20	31.30	2.22	64.25	4.96	8.48	2.89	35.10	85.50	53.33	20.07
T_{20}	107.20	43.05	4.55	18.20	37.55	2.17	66.00	6.77	10.56	3.03	35.10	84.80	51.67	20.95
T_{21}	102.65	38.90	6.65	21.80	52.85	2.10	65.50	9.49	14.81	2.99	34.45	85.15	50.00	20.95
T_{22}	85.05	33.60	4.55	16.65	37.70	2.64	67.50	7.19	11.13	3.18	36.45	87.30	50.00	21.17
T_{23}	112.55	39.90	4.65	21.45	43.00	2.19	53.15	6.24	10.87	3.24	35.25	85.35	41.67	19.44
T_{24}	112.25	51.40	4.80	21.30	42.20	2.47	63.35	8.63	12.89	3.56	34.65	86.40	50.00	20.84
T_{25}	104.60	46.60	4.55	20.80	45.70	2.30	67.15	8.94	13.43	3.22	35.35	85.15	50.00	20.51

Table 4.1.1 (b) Contd...

Geno-types	Plant height (cm)	Height upto 1st capsule (cm)	No. of branches	Capsules on main axis	No. of capsules per plant	Length of capsules (cm)	No. of seeds per capsule	Seed yield per plant (g)	Weight of capsules per plant (g)	1000 seed weight (g)	No. of days taken for first flowering	No. of days taken for harvest	Seed oil (%)	Seed protein (%)
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
T_{26}	108.70	43.05	6.65	21.80	52.30	2.13	63.30	10.35	15.67	3.27	35.10	86.05	46.67	19.40
T_{27}	94.80	42.90	4.75	19.20	38.40	2.05	58.95	7.26	11.12	3.50	34.40	85.50	55.00	22.49
T_{28}	83.60	43.75	4.55	16.15	37.60	2.03	62.15	5.86	9.75	2.86	34.45	84.85	46.67	20.62
T_{29}	112.85	45.30	6.35	19.35	50.90	2.01	56.40	7.17	12.14	2.80	35.90	85.95	53.33	20.51
T_{30}	91.30	40.20	4.75	18.70	40.80	1.93	49.20	5.04	9.29	2.88	34.25	84.90	56.67	19.40
T_{31}	86.45	41.60	2.75	16.55	30.60	1.89	53.10	3.72	6.87	2.71	34.40	84.90	43.33	20.73
T_{32}	105.80	46.35	4.70	22.10	54.35	2.01	49.80	6.65	12.03	3.00	34.95	85.20	38.34	20.40
T_{33}	91.55	43.25	4.35	13.95	29.25	2.26	59.35	4.40	6.90	3.10	34.95	84.90	56.67	19.18
T_{34}	85.60	45.00	4.50	12.95	30.90	2.22	66.00	4.71	7.98	3.79	35.30	84.80	46.67	20.95
T_{35}	72.05	44.25	2.65	12.00	18.40	1.86	42.95	1.40	3.25	2.78	35.80	87.30	45.00	19.85
T_{36}	70.90	46.95	4.35	11.90	32.15	2.19	60.40	5.26	8.32	3.35	34.85	85.30	43.33	19.62
T_{37}	87.70	46.20	4.60	12.60	29.65	2.39	68.80	4.69	7.78	2.81	34.90	84.85	43.33	19.85
T_{38}	105.30	37.05	6.55	21.75	56.85	2.26	67.65	12.43	17.71	3.54	34.55	84.85	43.33	19.62
T_{39}	88.55	38.30	4.75	11.25	33.60	2.25	60.95	5.61	8.90	3.23	34.90	84.95	50.00	22.65
T_{40}	88.10	46.40	4.55	10.20	25.70	2.08	48.65	3.08	5.91	3.26	34.60	85.20	46.67	19.85
T_{41}	86.45	39.60	4.50	13.65	26.75	1.99	54.60	3.89	6.47	3.32	34.95	85.95	51.67	19.40
T_{42}	84.45	40.35	4.35	11.90	25.20	1.99	48.80	2.86	5.38	3.06	35.20	86.55	40.00	18.96
T_{43}	92.90	46.50	4.60	9.80	26.20	2.08	50.80	3.59	6.32	3.55	34.80	85.45	56.67	20.62
T_{44}	106.65	46.25	4.65	19.95	38.10	2.19	62.65	6.12	10.01	2.99	34.25	85.10	46.67	21.83
T_{45}	86.60	45.80	4.70	13.10	29.75	1.86	36.65	2.39	5.65	3.03	35.65	86.30	60.00	19.18
T_{46}	102.60	46.85	6.60	20.50	46.95	2.12	48.75	4.93	9.75	2.80	34.55	84.70	50.00	19.40
T_{47}	101.20	47.20	4.65	14.20	23.05	2.17	49.70	2.69	5.13	3.26	35.30	85.05	48.34	21.39
T_{48}	81.80	38.55	4.70	10.90	23.80	2.14	44.45	1.60	4.02	2.51	36.05	85.40	53.33	22.93
T_{49}	75.60	41.95	2.70	11.30	18.15	2.18	52.20	2.11	3.82	3.22	34.85	85.90	50.00	20.51
T_{50}	96.75	50.55	2.65	12.05	18.60	2.04	55.05	2.10	4.01	3.11	35.40	85.25	48.34	21.83
Mean	96.84	43.02	4.50	16.80	36.74	2.16	58.04	5.65	9.41	3.10	34.83	85.50	49.17	20.42
SE	3.524	2.337	0.110	1.478	3.506	6.756	2.365	0.781	1.110	0.066	0.412	0.347	1.101	0.058
CD (0.05)	10.017	6.644	0.313	4.202	9.966	0.192	6.720	2.220	3.154	0.188	1.142	0.987	2.873	0.165

4.1.1.1 Plant height (cm)

The maximum plant height was recorded for IVTS-19 (118.30 cm) and minimum for IVTS-8 (68.65 cm) with an average of 96.84 cm. IVTS-19 was statistically on par with IVTS-18 (116.75), IVTS-14 (113.60), Si-902 (112.85), IVTS-16 (112.85), Si-175 (112.55), Si-59 (112.25), AVTS-8 (111.85), Thilak (109.70) and Si-266 (108.70). IVTS 19 was significantly superior to other 40 genotypes.

4.1.1.2 Height upto first capsule (cm)

Height upto first capsule ranged from30.70 cm (AVTS-9) to 51.40 cm (Si-59) with an average of 43.02 cm. Si-59 was on par with 21 genotypes *viz.*, TMV-4 (50.55 cm), Thilak (48.50 cm), IVTS-16 (48.20 cm), Si-1107 (47.20), IVTS-5 (47.00 cm), Si-778 (46.85 cm), Si-255-2 (46.60 cm), Si-1669 (46.50 cm), IVTS-14 (46.45 cm), Si-1720 (46.40 cm), Si-1007 (46.35 cm), Si-2247 (46.25 cm), Si-1150 (46.20 cm), IVTS-2 (46.15 cm), Si-1066 (45.95 cm), Si-44 (45.80 cm), IVTS-17 (45.65 cm), IVTS-3 (45.60 cm), Si-902 (45.30 cm), Si-1052 (45.00 cm) and IVTS-18 (44.95 cm) and significantly superior to other 28 genotypes.

4.1.1.3 Number of branches

The maximum number of branches was recorded in AVTS-16 and Si-266 (both 6.65) and minimum in TMV-4 (2.65), AVTS-16 and Si-266 were on par with Si-778 (6.60), Si-1210 (6.55) and Si-902 (6.35) and significantly superior to 45 other genotypes. There were 4.5 branches on an average.

4.1.1.4 Capsules on main axis

Maximum number of capsules on main axis was observed in Si-1007 (22.10) and minimum in Si-1669 (9.80) with 16.80 capsules on an average. Genotype Si-

1007 was on par with 24 genotypes *viz.*, IVTS-14 (22.05), IVTS-19 (21.90), AVTS-16 (21.80), Si-266 (21.80), Si-1210 (21.75), Si-175 (21.45), Si-59 (21.30), IVTS-1 (20.95), Kayamkulam-1 (20.85), AVTS-8 (20.85), Si-255-2 (20.80), Si-778 (20.50), IVTS-2 (20.10), Si-2247 (19.95), IVTS-7 (19.45), Si-902 (19.35), Thilak (19.25), IVTS-5 (19.25), IVTS-3 (19.25), Si-722 (19.20), Si-926 (18.70), IVTS-18 (18.45), AVTS-14 (18.20) and IVTS-17 (17.95) and significantly superior to other 25 genotypes.

4.1.1.5 Number of capsules per plant

Highest number of capsules per plant was recorded in Si-1210 (56.85) and lowest in TMV-3 (18.15), the average number of capsules being 36.74. Si-1007 (54.35), IVTS-1 (54.25), AVTS-16 (52.85), Si-266 (52.30), IVTS-9 (51.05), Si-902 (50.90), IVTS-11 (49.70), IVTS-3 (49.10), IVTS-2 (47.70) and Si-778 (46.95) were on par with Si-1210. Si-1210 was significantly superior to other 38 genotypes.

4.1.1.6 Length of capsule

Longest capsule was noted in Si-59 (2.64 cm) and shortest in Si-44 (1.86 cm) with an average of 2.16 cm. Si-59 was on par with two other genotypes AVTS-8 (2.61 cm) and Si-59 (2.47 cm) and significantly superior to other 47 genotypes.

4.1.1.7 Number of seeds per capsule

Number of seeds per capsule ranged from 36.65 (Si-44) to 74.95 (IVTS-14) and IVTS-14 was on par only with Si-1150 (68.80) and significantly superior to other 48 genotypes. The average number of seeds per capsule was 58.04.

4.1.1.8 Seed yield per plant (g)

Seed yield per plant varied from 1.40g (Si-1061) to 12.43 g (Si-1210), which was on par with Si-266 (10.35 g) with an average seed yield of 5.65 g. Si 1210 was significant superior to other 48 genotypes.

4.1.1.9 Weight of capsules per plant (g)

Average weight of capsules per plant was 9.41g with maximum in Si-1210 (17.71 g) and minimum in Si-1061 (3.25 g). Si-266 (15.67 g) and AVTS-16 (14.81 g) were on par with Si-1210 and this was significantly superior to other 48 genotypes. .

4.1.1.10 1000 seed weight (g)

1000 seed weight had a range of 2.44 g to 3.68 g with an average of 3.10g. Maximum was in IVTS-7 which was on par with Si-59 (3.56 g), Si-1669 (3.55 g), Si-1210 (3.54 g), IVTS-5 (3.52 g) and Si-722 (3.50 g) and minimum for IVTS-1. IVTS-7 was significantly superior to other 45 genotypes.

4.1.1.11 Number of days taken for first flowering

IVTS-2 showed early flowering (33.40 days) and Si-59 showed late flowering (36.45 days). IVTS-2 was on par with IVTS-1 (33.70), IVTS-9 (33.70), IVTS-5 (33.75), IVTS-7 (34.00), IVTS-3 (34.10), IVTS-11 (34.15), Si-2247 (34.25), Si-926 (34.25), IVTS-13 (34.35), Si-722 (34.40), Si-931 (34.40), IVTS-8, AVTS-16 and Si-833 (34.45 in the last three). The average number of days taken for first flowering was 34.83. IVTS-2 is significantly superior to other 35 genotypes.

4.1.1.12 Number of days taken for harvest

IVTS- 2 took 87.35 days for harvest while Si-778 took only 84.70 days for harvest which were on par with IVTS-7 (84.75), AVTS-14 (84.80), Si-1052 (84.80), IVTS-2 (84.80), AVTS-8 (84.80), Si-1210 (84.85), Si-1150 (84.85), Si-833 (84.85), Si-1041 (84.90), IVTS-5 (84.90), Si-931 (84.90), Si-926 (84.90), IVTS-1 (84.95), Si-1484 (84.95), Si-1107 (85.05), Si-2247 (85.10), IVTS-9 (85.10), Kayamkulam-1 (85.10), AVTS-16 (85.15), Si-255-2 (85.15), IVTS-8 (85.15), Si-1720 (85.20), IVTS-3 (85.20), Si-1007 (85.20), IVTS-13 (85.20), TMV-4 (85.25), Si-1066 (85.30), Si-175 (85.35), Si-3214 (85.40), Si-1669 (85.45), Si-722 (85.50), AVTS-9 (85.50) and IVTS-16 (85.55). The average number of days taken for harvest was 85.50. IVTS-12 was Superior to other 16 genotypes.

4.1.1.13 Seed oil (%)

IVTS-5 and Si-44 were on par and significantly superior to other genotpes recorded the maximum seed oil (60 per cent) and Si-1007 minimum seed oil percentage of 38.34% with an average of 49.17%.

4.1.1.14 Seed protein (%)

Average seed protein percentage was 20.42% with maximum in Si-3214 (22.93 per cent) and minimum in IVTS-12 (18.30 per cent). No other genotype was on par with Si-3214 and significant to all other genotypes.

4.1.2 Estimation of variability components

4.1.2.1 Phenotypic, genotypic and environmental variability

The phenotypic, genotypic and environmental variances along with PCV and GCV for 14 characters are presented in Table 4.1.2.

High variability was observed for all characters, the major share of it was attributed to genetic variability. Height upto first capsule and number of days taken for first flowering were the characters influenced more by environment in comparison to others.

The phenotypic variance was very low for length of capsule (0.03) and was maximum (175.45) for plant height. The phenotypic variability exhibited by other characters were as follows: number of capsules per plant (125.14), number of seeds per capsule (66.84), seed oil percentage (26.34), height upto first capsule (23.64), capsule on main axis (17.67), weight of capsules per plant (12.34), seed yield per plant (6.31), number of branches (1.16), seed protein percentage (1.05), number of days taken for harvest (0.63), number of days taken for first flowering (0.57) and 1000 seed weight (0.07).

The genotypic variances observed for various characters were the following: plant height (150.62), number of capsules per plant (100.55), number of seeds per capsule (55.66), seed oil percentage (24.29), capsules on main axis (13.31), height upto first capsule (12.71), weight of capsules per plant (9.88), seed yield per plant (5.09), number of branches (1.14), seed protein percentage (1.05), number of days taken for harvest (0.39), number of days taken for first flowering (0.25), 1000 seed weight (0.06) and length of capsule (0.02).

Environmental variance was negligible for length of capsule, 1000 seed weight and seed protein percentage (0.01). The environmental variance recorded were 25.58, 24.83, 11.19, 10.93, 4.37, 2.46, 2.04, 1.22, 0.32, 0.24 and 0.02 respectively for number of capsules per plant, plant height, number of seeds per capsule, height upto first capsule, capsule on main axis, weight

Table 4.1.2 Components of variance for 14 characters in sesame

Sl. No.	Characters	Variance			Coefficient of variation (%)	
		σp^2	σg^2	σe^2	PCV (%)	GCV (%)
1	Plant height (cm)	175.45	150.62	24.83	13.68	12.68
2	Height upto first capsule (cm)	23.64	12.71	10.93	11.30	8.29
3	No. of branches	1.16	1.14	0.02	23.97	23.72
4	Capsules on main axis	17.67	13.31	4.37	25.03	21.72
5	Number of capsules per plant	125.14	100.55	25.58	30.45	27.30
6	Length of capsule (cm)	0.03	0.02	0.01	8.27	7.00
7	Number of seeds per capsule	66.84	55.66	11.19	14.09	12.85
8	Seed yield per plant (gm)	6.31	5.09	1.22	44.42	39.89
9	Weight of capsules per plant (gm)	12.34	9.88	2.46	37.33	33.40
10	1000 seed weight (gm)	0.07	0.06	0.01	8.65	8.11
11	No. of days taken for first flowering	0.57	0.25	0.32	2.17	1.43
12	No. of days taken for harvest	0.63	0.39	0.24	0.93	0.73
13	Seed oil (%)	26.34	24.29	2.04	10.44	10.03
14	Seed protein (%)	1.05	1.05	0.01	5.03	5.01

σp^2 – Phenotypic variance
σg^2 – Genotypic variance
σe^2 – Environmental variance

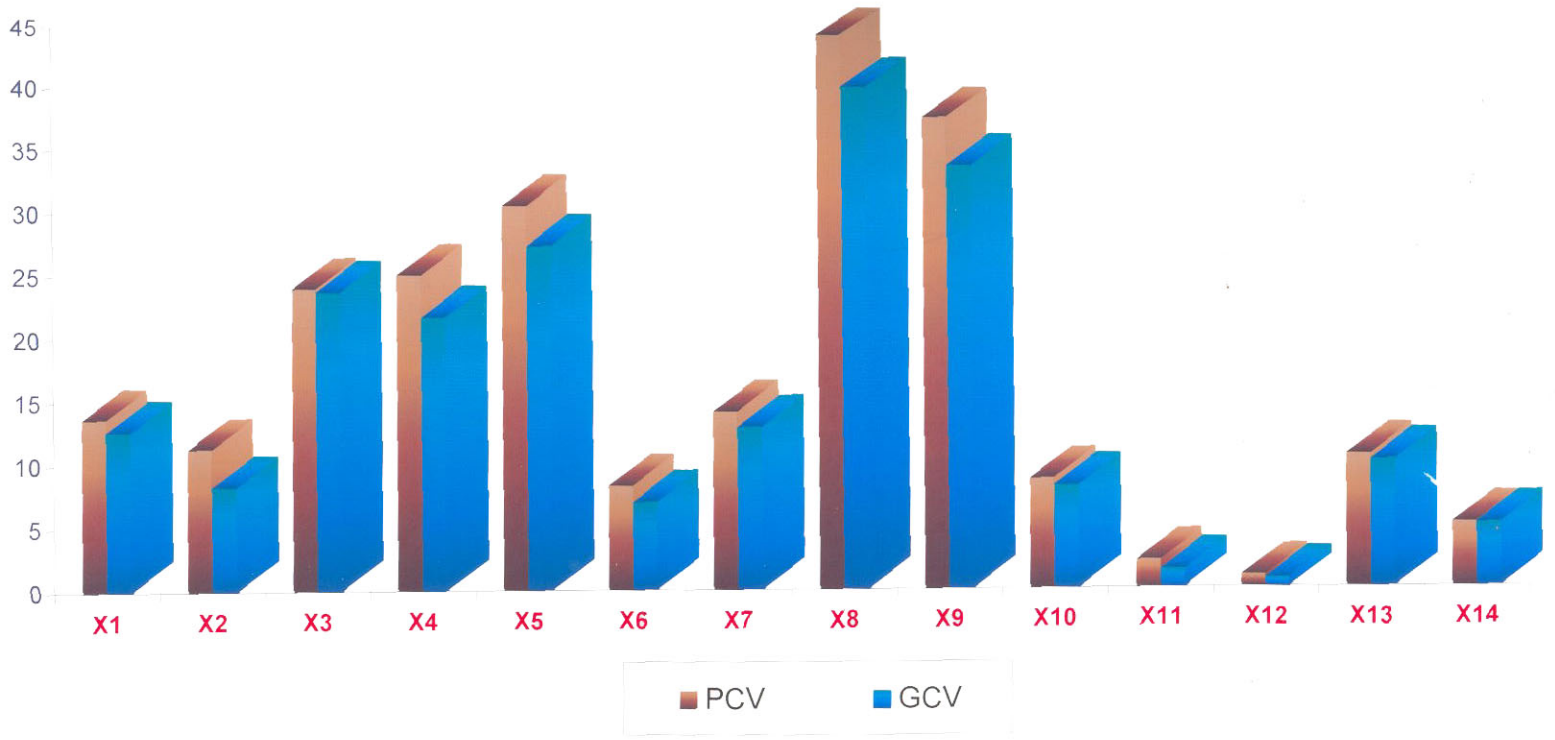
PCV – Phenotypic coefficient of variation
GCV – Genotypic coefficient of variation

of capsules per plant, seed oil percentage, seed yield per plant, number of days taken for first flowering, number of days taken for harvest and number of branches.

4.1.2.2 Coefficient of variation

The estimates of phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) were worked out and presented in the Table 4.1.2 and Fig. 1.

Most of the characters maintained the same trend in the magnitude of variability with respect to the characters studied. Least variability was recorded for number of days taken for harvest followed by number of days taken for the first flowering both at the genotypic and phenotypic level. Maximum PCV and GCV were recorded by seed yield per plant followed by weight of capsules per plant. Length of capsule, 1000 seed weight, number of days taken for first flowering, number of days taken for harvest and seed protein percentage registered a variability of less than 10% both at genotypic and phenotypic levels. GCV was less than 10% for height up to first capsule. 10-20% coefficient of variation was observed in the characters plant height number of seeds per capsule and seed oil percentage at phenotypic and phenotypic levels. The characters viz. number of branches, capsules on main axis, number of capsules per plant, seed yield per plant and weight of capsules per plant registered a variability greater than 20% at phenotypic and genotypic levels.



X1 Plant height (cm)
X2 Height upto 1st Capsule (cm)
X3 No. of branches
X4 Capsule on main axis
X5 Number of capsules per plant
X6 Length of capsules (cm)
X7 Number of seeds per capsules
X8 Seed yield per plant (g)
X9 Capsule yield per plant (g)
X10 1000 seed weight (g)
X11 No. of days taken for 1st flowering
X12 No. of days taken for harvest
X13 Seed oil (%)
X14 Seed protein (%)

Fig. 1 GCV and PCV for 14 characters in sesame

4.1.3 Estimation of heritability (broad sense) and genetic advance (as percentage of mean)

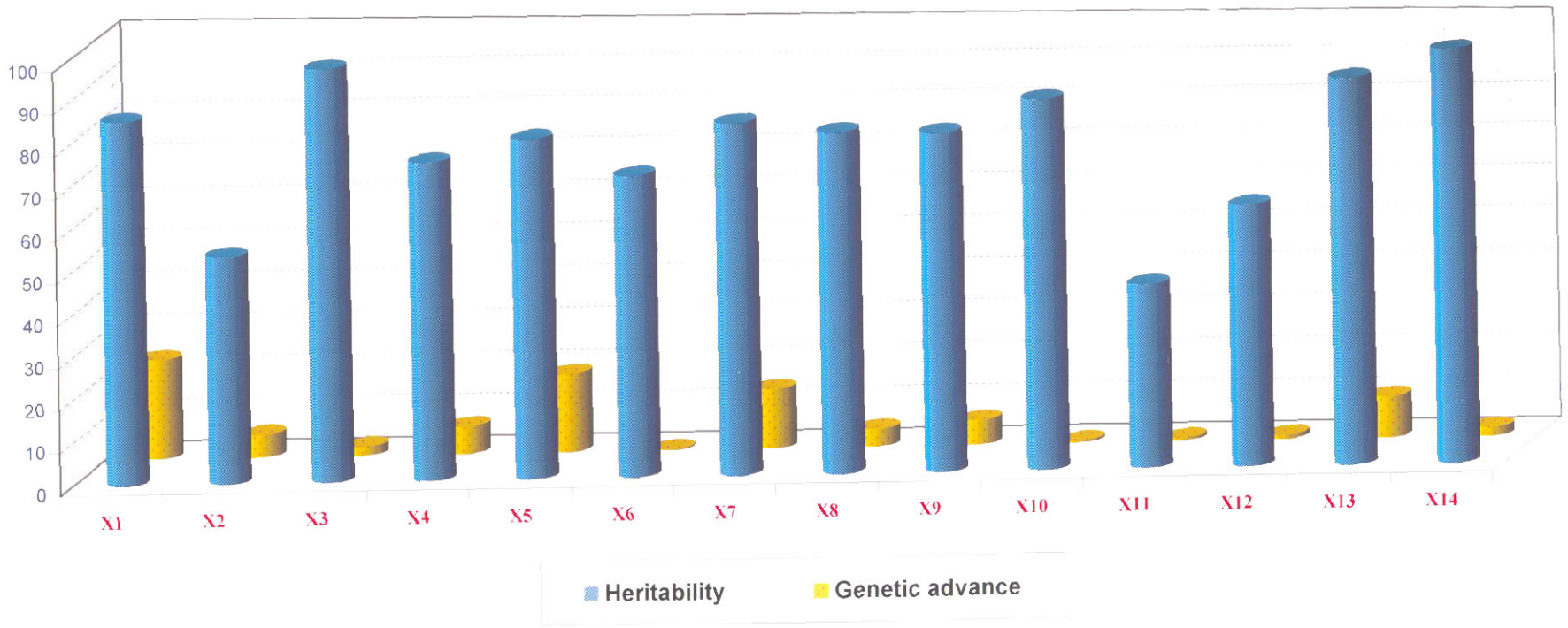
The heritability and genetic advance estimates are presented in Table 4.1.3 and Fig. 2 & 3.

High heritability estimates, above 60 per cent, were recorded for all the characters under study except height upto first capsule (53.78 per cent) and the number of days taken for first flowering (43.45). Maximum heritability estimate was recorded for seed protein percentage (99.37 per cent) followed by number of branches (97.91per cent), seed oil percentage (92.24 per cent), 1000 seed weight (87.82 per cent), plant height (85.85 per cent), number of seeds per capsule (83.27 per cent), seed yield per plant (80.65 per cent), number of capsules per plant (80.36 per cent), weight of capsules per plant (80.05 per cent), capsules on main axis (75.27 per cent), length of capsule (71.28 per cent) and number of days taken for harvest (61.74 per cent).

Genetic advance as percentage of mean was maximum for plant height (23.42) and minimum for length of capsule (0.26). Estimates for other characters are as follows. Number of capsules per plant (18.52), number of seeds per capsule (14.30), seed oil percentage (9.75), capsules on main axis (6.52), weight of capsules per plant (5.79), height upto first capsule (5.39), seed yield per plant (4.17), number of branches (2.17), seed protein percentage (2.10), number of days taken for harvest (1.01), number of days taken for first flowering (0.68) and 1000 seed weight (0.49).

Table 4.1.3 Heritability and genetic advance for 14 characters in sesame

Sl. No.	Characters	Heritability (H^2 as %)	Genetic advance as percentage of mean
1	Plant height (cm)	85.85	23.42
2	Height upto first capsule (cm)	53.78	5.39
3	No. of branches	97.91	2.17
4	Capsules on main axis	75.27	6.52
5	Number of capsules per plant	80.36	18.52
6	Length of capsule (cm)	71.28	0.26
7	Number of seeds per capsule	83.27	14.03
8	Seed yield per plant (gm)	80.65	4.17
9	Weight of capsules per plant (gm)	80.05	5.79
10	1000 seed weight (gm)	87.82	0.49
11	No. of days taken for first flowering	43.45	0.68
12	No. of days taken for harvest	61.74	1.01
13	Seed oil (%)	92.24	9.75
14	Seed protein (%)	99.37	2.10



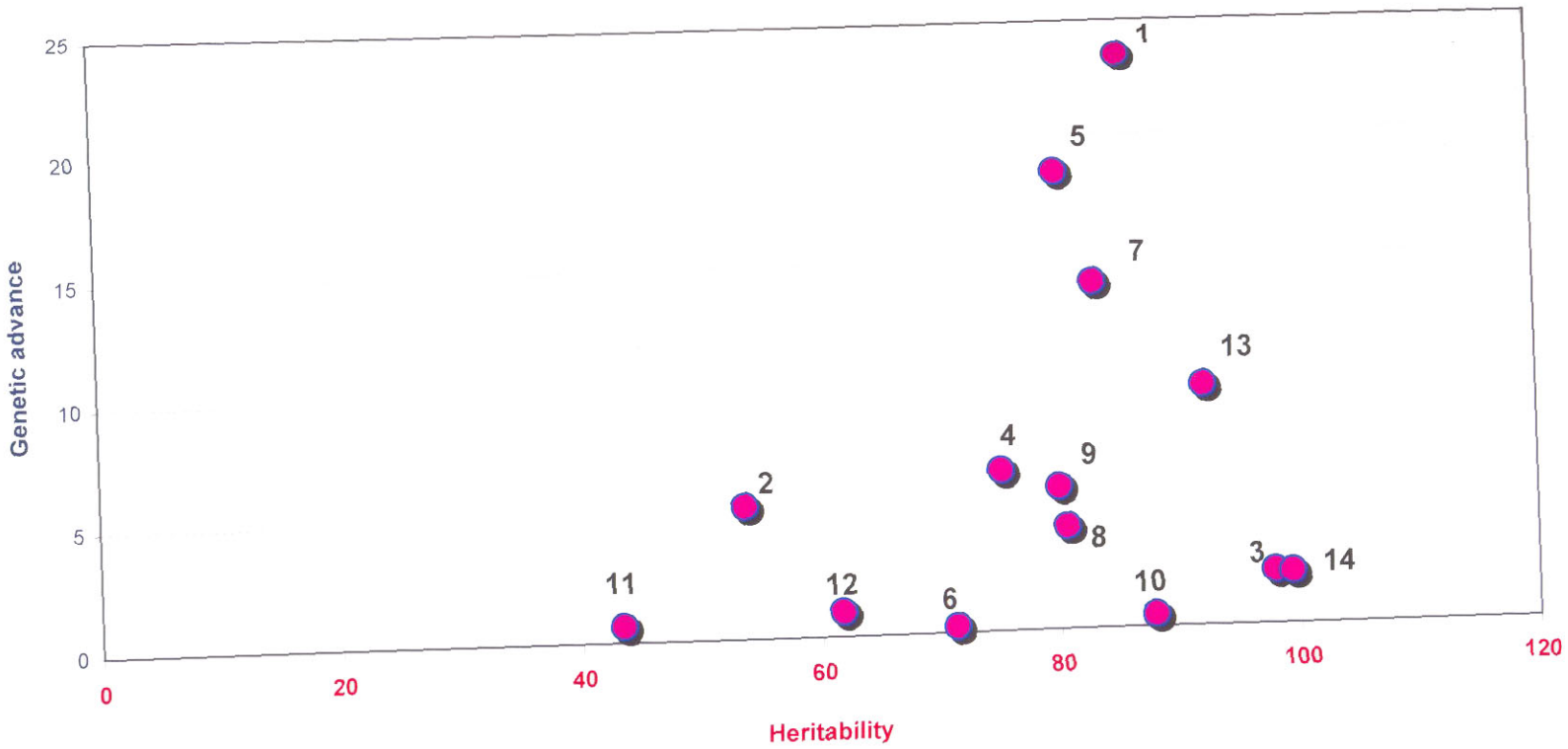
X1 Plant height (cm)
X2 Height upto 1st Capsule (cm)
X3 No. of branches
X4 Capsule on main axis

X5 Number of capsules per plant
X6 Length of capsules (cm)
X7 Number of seeds per capsules
X8 Seed yield per plant (g)

X9 Capsule yield per plant (g)
X10 1000 seed weight (g)
X11 No. of days taken for 1st flowering
X12 No. of days taken for harvest

X13 Seed oil (%)
X14 Seed protein (%)

Fig.2 Heritability and genetic advance for 14 characters in sesame



1 Plant height (cm)
2 Height upto 1st Capsule (cm)
3 No. of branches
4 Capsule on main axis
5 Number of capsules per plant
6 Length of capsules (cm)
7 Number of seeds per capsules
8 Seed yield per plant (g)
9 Capsule yield per plant (g)
10 1000 seed weight (g)
11 No. of days taken for 1st flowering
12 No. of days taken for harvest
13 Seed oil (%)
14 Seed protein (%)

Fig. 3 Character distribution in terms of heritability and genetic advance

4.1.4 Correlation among different characters

The phenotypic, genotypic and environmental correlations were estimated and presented in Table 4.1.4 (a), 4.1.4 (b) and 4.1.4 (c).

4.1.4.1 Phenotypic correlation coefficient

Phenotypic correlation coefficient is presented in Table 4.1.4 (a) and Fig. 4.

Plant height had significant positive correlation with height upto first capsule, capsules on main axis, number of capsules per plant, length of capsule, number of seeds per capsule, seed yield per plant and weight of capsules per plant. It had non-significant negative correlation with number of days taken for first flowering and number of days taken for harvest.

Height upto first capsule had insignificant positive correlation with all characters except plant height.

Significant positive correlation was recorded for number of branches with capsules on main axis, number of capsules per plant, seed yield per plant and weight of capsules per plant and significant negative correlation with number of days taken for harvest.

Capsules on main axis had significant positive correlation with plant height, number of branches, number of capsules per plant, length of capsule, number of seeds per capsule, seed yield per plant and weight of capsules per plant. It had non-significant positive correlation with height upto first capsule, 1000 seed weight and seed protein percentage.

Significant positive correlation was observed for number of capsules per plant with plant height, number of branches, capsules on main axis, length

Table 4.1.4 (a) Phenotypic correlation coefficient among 14 characters in sesame

Characters	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}
X_2	0.2479*												
X_3	0.1367	-0.1584											
X_4	0.7285**	0.0431	0.2845**										
X_5	0.4877**	-0.0791	0.6513**	0.7790**									
X_6	0.2344*	-0.1103	0.0625	0.2168*	0.2405*								
X_7	0.3301**	-0.1057	0.1705	0.4122**	0.3758**	0.6109**							
X_8	0.5206**	-0.0580	0.5659**	0.7431**	0.8464**	0.3674**	0.6717**						
X_9	0.5350**	-0.0681	0.6045**	0.7851**	0.9268**	0.3398**	0.6009**	0.9802**					
X_{10}	0.1185	0.0821	0.0018	0.0499	-0.0081	0.1273	0.1901	0.3054**	0.2086**				
X_{11}	-0.0490	-0.0217	-0.0882	-0.1601	-0.2786**	0.0270	-0.0078	-0.1614	-0.2051	-0.1225			
X_{12}	-0.1348	-0.0632	-0.2228*	-0.0977	-0.2750**	-0.0152	-0.0740	-0.1653	-0.2072*	0.0633	0.4717**		
X_{13}	0.0839	-0.0088	-0.0595	-0.0696	-0.1669	-0.0145	-0.0547	-0.1027	-0.1198	0.2059*	0.0913	0.0217	
X_{14}	0.0763	0.0193	-0.0820	0.0464	0.0265	0.2915**	0.1233	0.0070	0.0142	-0.0595	0.0432	-0.1706	0.1764

X_1 Plant height (cm)
X_2 Height upto first capsule (cm)
X_3 No. of branches
X_4 Capsule on main axis
X_5 Number of capsules per plant
X_6 Length of capsules (cm)
X_7 Number of seeds per capsules
X_8 Seed yield per plant (gm)
X_9 Weight of capsules per plant (gm)
X_{10} 1000 seed weight (gm)
X_{11} No. of days taken for first flowering
X_{12} No. of days taken for harvest
X_{13} Seed oil (%)
X_{14} Seed protein (%)

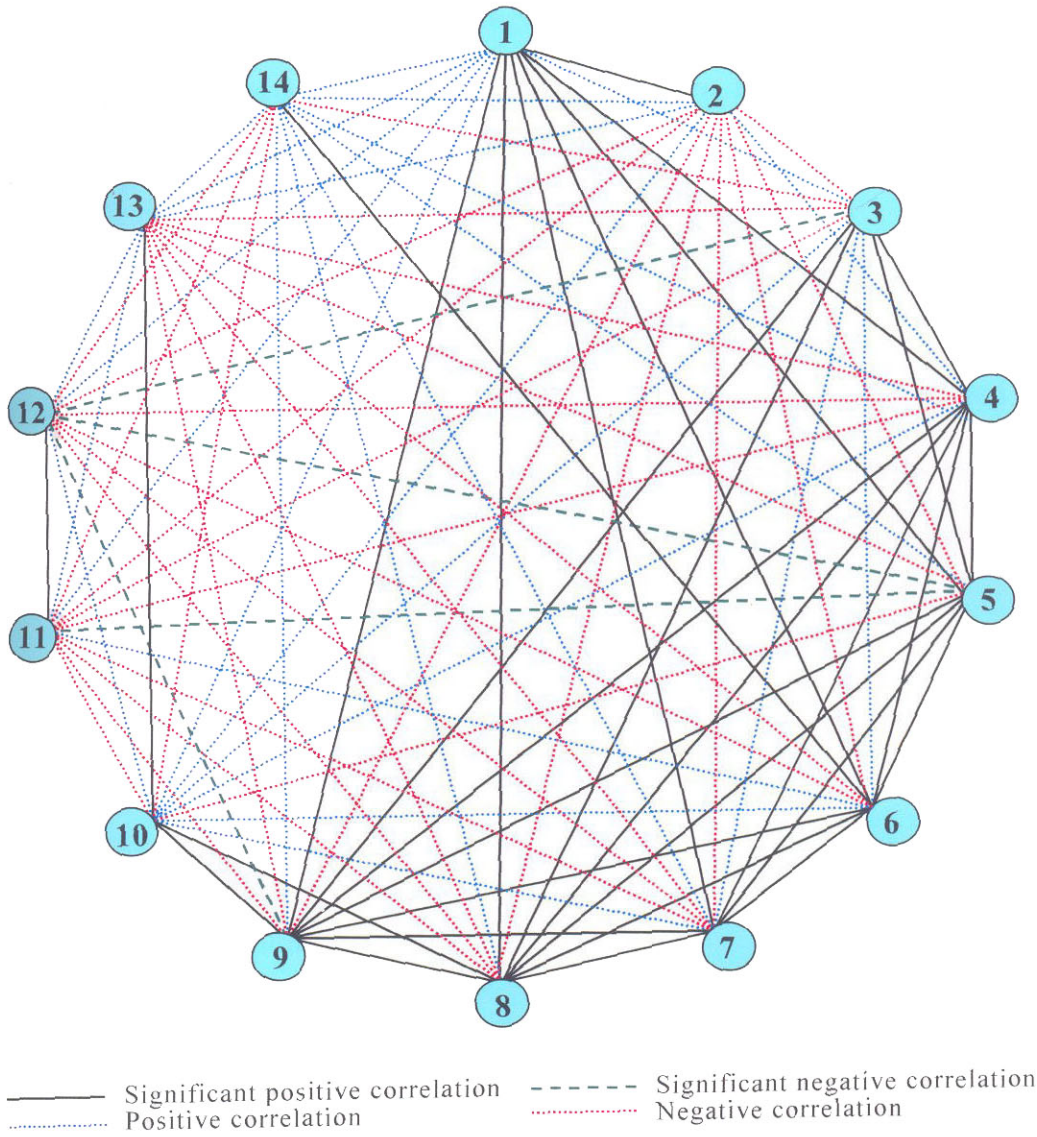


Fig.4 Phenotypic correlation coefficients among the characters

1 Plant height (cm)
2 Height upto 1st Capsule (cm)
3 No. of branches
4 Capsule on main axis
5 Number of capsules per plant
6 Length of capsules (cm)
7 Number of seeds per capsules
8 Seed yield per plant (g)
9 Capsule yield per plant (g)
10 1000 seed weight (g)
11 No. of days taken for 1st flowering
12 No. of days taken for harvest
13 Seed oil (%)
14 Seed protein (%)

of capsule, number of seeds per capsule, seed yield per plant, weight of capsules per plant and significant negative correlation with number of days taken for first flowering and number of days taken for harvest. It had non-significant positive correlation with seed protein percentage.

Length of capsule had significant positive correlation with plant height, capsules on main axis, number of capsules per plant, number of seeds per capsule, seed yield per plant, weight of capsules per plant and seed protein percentage. It had non-significant positive correlation with number of branches, 1000 seed weight and number of days taken for first flowering.

Significant positive correlation was recorded by number of seeds per capsule with plant height, capsules on main axis, number of capsules per plant, length of capsule, seed yield per plant and weight of capsules per plant. It had positive non-significant correlation with number of branches, 1000 seed weight and seed protein percentage.

Seed yield per plant had significant positive correlation with plant height, number of branches, capsules on main axis, number of capsules per plant, length of capsule, number of seeds per capsule, weight of capsules per plant and1000 seed weight. It had non-significant positive correlation with seed protein percentage.

Significant positive correlation was recorded for weight of capsules per plant with plant height, number of branches, capsules on main axis, number of capsules per plant, length of capsule, number of seeds per capsule, seed yield per plant and 1000 seed weight. But it recorded significant negative

correlation with number of days taken for harvest. It had non-significant positive correlation with seed protein percentage.

1000 seed weight had significant positive correlation with seed yield per plant, weight of capsules per plant and seed oil percentage. It had non-significant negative correlation with number of capsules per plant, number of days taken for first flowering and seed protein percentage.

Number of days taken for first flowering had significant positive correlation with number of days taken for harvest and negative significant correlation with number of capsules per plant. It had insignificant positive correlation with length of capsule, seed oil percentage and seed protein percentage.

Number of days taken for harvest had significant positive correlation with number of days taken for first flowering and significant negative correlation with number of branches, number of capsules per plant and weight of capsules per plant. It had positive insignificant correlation with 1000 seed weight and seed oil percentage.

Seed oil percentage had positive significant correlation with 1000 seed weight. It had insignificant positive correlation with plant height, number of days taken for first flowering, number of days taken for harvest and seed protein percentage.

Seed protein percentage had significant positive correlation with length of capsule. It had non-significant negative correlation with number of branches, 1000 seed weight and number of days taken for harvest.

4.1.4.2 Genotypic correlation coefficient

Genotypic correlation among various characters were studied and presented in Table 4.1.4 (b) and Fig. 5.

Plant height had high positive correlation with capsules on main axis, weight of capsules per plant and seed yield per plant. Plant height showed negative correlation with number of days taken for first flowering and number of days taken for harvest.

Height upto first capsule had recorded maximum correlation with plant height.

Number of branches showed high positive correlation with number of capsules per plant, weight of capsules per plant and seed yield per plant. It had negative correlation with height upto first capsule, number of days taken for first flowering, number of days taken for harvest, seed oil percentage and seed protein percentage.

Capsule on main axis had high positive correlation with weight of capsules per plant, number of capsules per plant, seed yield per plant and plant height. It was negatively correlated with number of days taken for first flowering, number of days taken for harvest and seed oil percentage.

Number of capsules per plant had high positive correlation with weight of capsules per plant, seed yield per plant, capsules on main axis and number of branches, while it showed negative correlation with height upto first

Table 4.1.4 (b) **Genotypic correlation coefficient among 14 characters in sesame**

Characters	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}
X_2	0.2339												
X_3	0.1512	-0.2297											
X_4	0.7828	0.0054	0.3515										
X_5	0.4975	-0.1110	0.7295	0.8409									
X_6	0.3156	-0.0781	0.0588	0.2836	0.2475								
X_7	0.4071	-0.0699	0.1732	0.4934	0.4242	0.6322							
X_8	0.5542	-0.0843	0.6299	0.7947	0.8550	0.3842	0.7312						
X_9	0.5668	-0.0960	0.6741	0.8495	0.9329	0.3504	0.6565	0.9845					
X_{10}	0.1599	0.1473	0.0020	0.0690	0.0246	0.1976	0.2163	0.3428	0.2440				
X_{11}	-0.1615	-0.0534	-0.1548	-0.4132	-0.5427	0.0772	-0.0545	-0.3602	-0.4533	-0.1799			
X_{12}	-0.1412	-0.1524	-0.2576	-0.2190	-0.3694	-0.1078	-0.1524	-0.2260	-0.2773	0.1240	0.6623		
X_{13}	0.0967	0.0093	-0.0638	-0.0631	-0.1873	-0.0477	-0.0473	-0.1265	-0.1472	0.2043	0.1336	0.0416	
X_{14}	0.0825	0.0238	-0.0812	0.0468	0.0218	0.3479	0.1379	-0.0029	0.0068	-0.0716	0.0873	-0.2143	0.1856

X_1 Plant height (cm)
X_2 Height upto first capsule (cm)
X_3 No. of branches
X_4 Capsule on main axis
X_5 Number of capsules per plant
X_6 Length of capsules (cm)
X_7 Number of seeds per capsules
X_8 Seed yield per plant (gm)
X_9 Weight of capsules per plant (gm)
X_{10} 1000 seed weight (gm)
X_{11} No. of days taken for first flowering
X_{12} No. of days taken for harvest
X_{13} Seed oil (%)
X_{14} Seed protein (%)

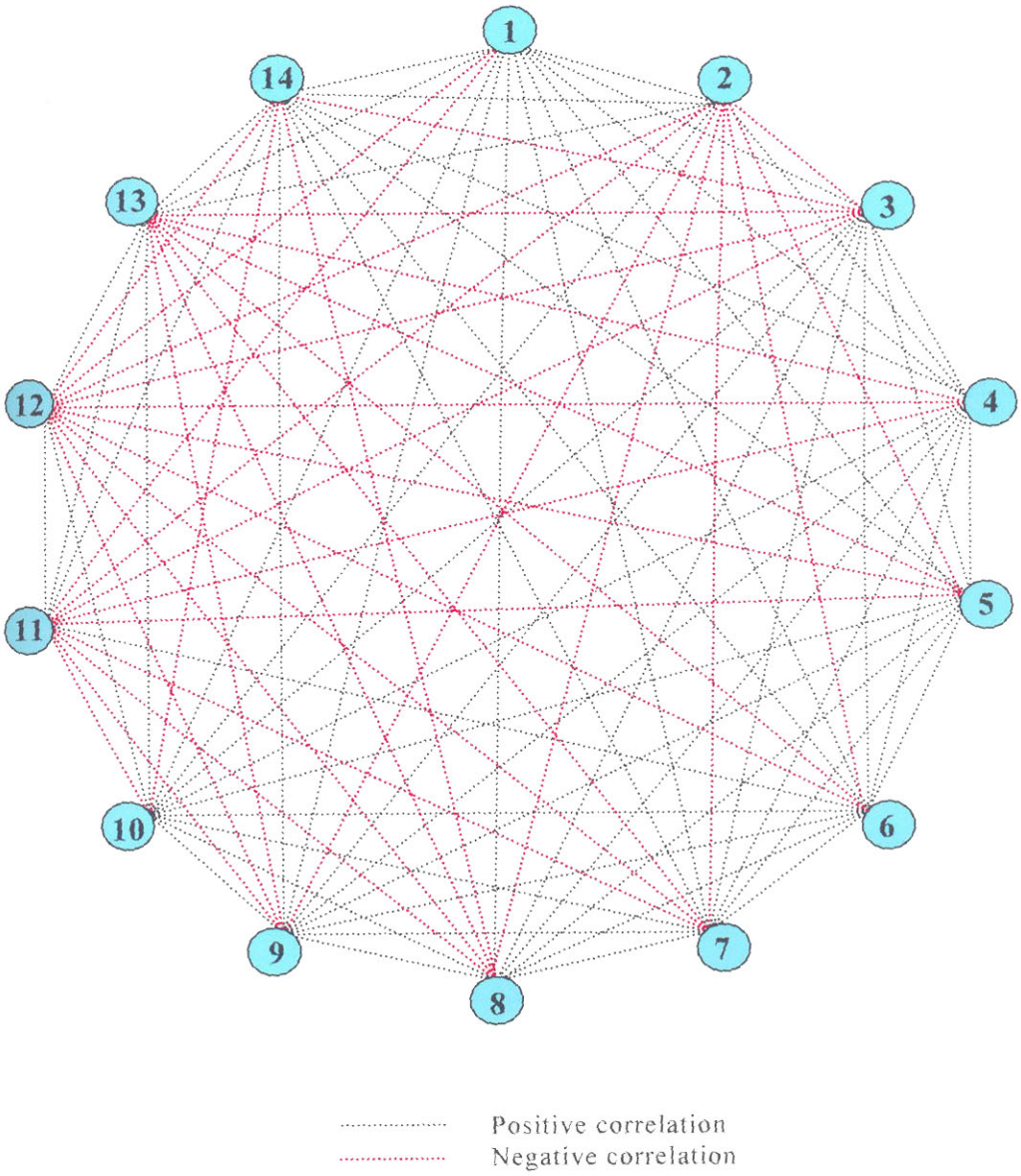


Fig.5 Genotypic correlation coefficients among the characters

1 Plant height (cm)
2 Height upto 1st Capsule (cm)
3 No. of branches
4 Capsule on main axis
5 Number of capsules per plant
6 Length of capsules (cm)
7 Number of seeds per capsules
8 Seed yield per plant (g)
9 Capsule yield per plant (g)
10 1000 seed weight (g)
11 No. of days taken for 1st flowering
12 No. of days taken for harvest
13 Seed oil (%)
14 Seed protein (%)

capsule, number of days taken for harvest and number of days taken for first flowering and seed oil percentage.

Length of capsule showed high correlation with number of seeds per capsule. It had negative correlation with height upto first capsule, number of days taken for harvest and seed oil percentage.

High positive correlation was recorded for number of seeds per capsule with seed yield per plant, weight of capsules per plant and length of capsule. But number of seeds per capsule was negatively correlated with height upto first capsule, number of days taken for first flowering, number of days taken for harvest and oil percentage.

Seed yield per plant had high positive correlation with weight of capsules per plant, number of capsules per plant, capsule on main axis, number of seeds per capsule, number of branches and plant height but it had negative correlation with height upto first capsule, number of days taken for first flowering, number of days taken for harvest, seed oil percentage and seed protein percentage.

High positive correlation was recorded for capsule yield and seed yield per plant, number of capsules per plant, capsule on main axis, number of seeds per capsule, number of branches and plant height. It recorded negative correlation with height upto first capsule, number of days taken for first flowering, number of days taken for harvest and seed oil percentage.

1000 seed weight had low positive correlation with most of the characters except for number of days taken for first flowering and seed protein percentage, which recorded low negative correlation.

Number of days taken for first flowering had high positive correlation with number of days taken for harvest and low positive correlation with length of capsule, seed oil percentage and seed protein percentage. Number of days taken for first flowering was negatively correlated with all other characters.

High positive correlation was recorded for number of days taken for harvest and number of days taken for first flowering. But the correlation was low with 1000 seed weight and seed oil percentage. Number of days taken for harvest showed negative correlation with all other characters.

Seed oil percentage had low positive correlation with plant height, height upto first capsule, 1000 seed weight, number of days taken for first flowering, number of days taken for harvest and seed protein percentage. But it showed negative correlation with all other characters.

Seed protein percentage showed low negative correlation with number of branches, seed yield per plant, 1000 seed weight and number of days taken for harvest. But it recorded low positive correlation with the other characters.

4.1.4.3 Environmental correlation coefficient

Environmental correlation coefficient is presented in Table 4.1.4 (c) and Fig. 6.

Plant height had significant positive correlation with height upto first capsule, capsules on main axis, number of capsules per plant, seed yield per plant and weight of capsules per plant. It had non-significant positive correlation with number of days taken for first flowering and seed protein percentage.

Table 4.1.4 (c) Environmental correlation coefficient among 14 characters in sesame

Characters	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}
X_2	0.3480*												
X_3	-0.0352	0.0843											
X_4	0.5307**	0.1173	-0.2400										
X_5	0.4472**	-0.0203	0.0672	0.5673**									
X_6	-0.0622	-0.1698	0.1725	0.0340	0.2242								
X_7	-0.0918	-0.2119	0.2390	0.1061	0.1590	0.5650**							
X_8	0.3595**	-0.0084	0.0977	0.5663**	0.8113**	0.3226*	0.4031**						
X_9	0.3874**	-0.0168	0.1187	0.5660**	0.9021**	0.3136*	0.3553*	0.9627**					
X_{10}	-0.1546	-0.0806	-0.0012	0.0356	-0.1862	-0.1552	0.0357	0.1103	0.0254				
X_{11}	0.1753	0.0080	0.1173	0.2038	0.1262	-0.0395	0.0811	0.1566	0.1853	-0.0434			
X_{12}	-0.1376	0.0586	-0.2522	0.1678	-0.0540	0.1699	0.1394	-0.0213	-0.0443	-0.1299	0.2767*		
X_{13}	-0.0208	-0.0814	0.0281	-0.1227	-0.0453	0.1618	-0.1159	0.0525	0.0540	0.2271	0.0318	-0.0563	
X_{14}	0.0031	0.0354	-0.1688	0.1491	0.1981	-0.0293	-0.0664	0.2736	0.2275	0.2624	-0.2367	-0.0556	-0.0573

X_1 Plant height (cm)
X_2 Height upto first capsule (cm)
X_3 No. of branches
X_4 Capsule on main axis
X_5 Number of capsules per plant
X_6 Length of capsules (cm)
X_7 Number of seeds per capsules
X_8 Seed yield per plant (gm)
X_9 Weight of capsules per plant (gm)
X_{10} 1000 seed weight (gm)
X_{11} No. of days taken for first flowering
X_{12} No. of days taken for harvest
X_{13} Seed oil (%)
X_{14} Seed protein (%)

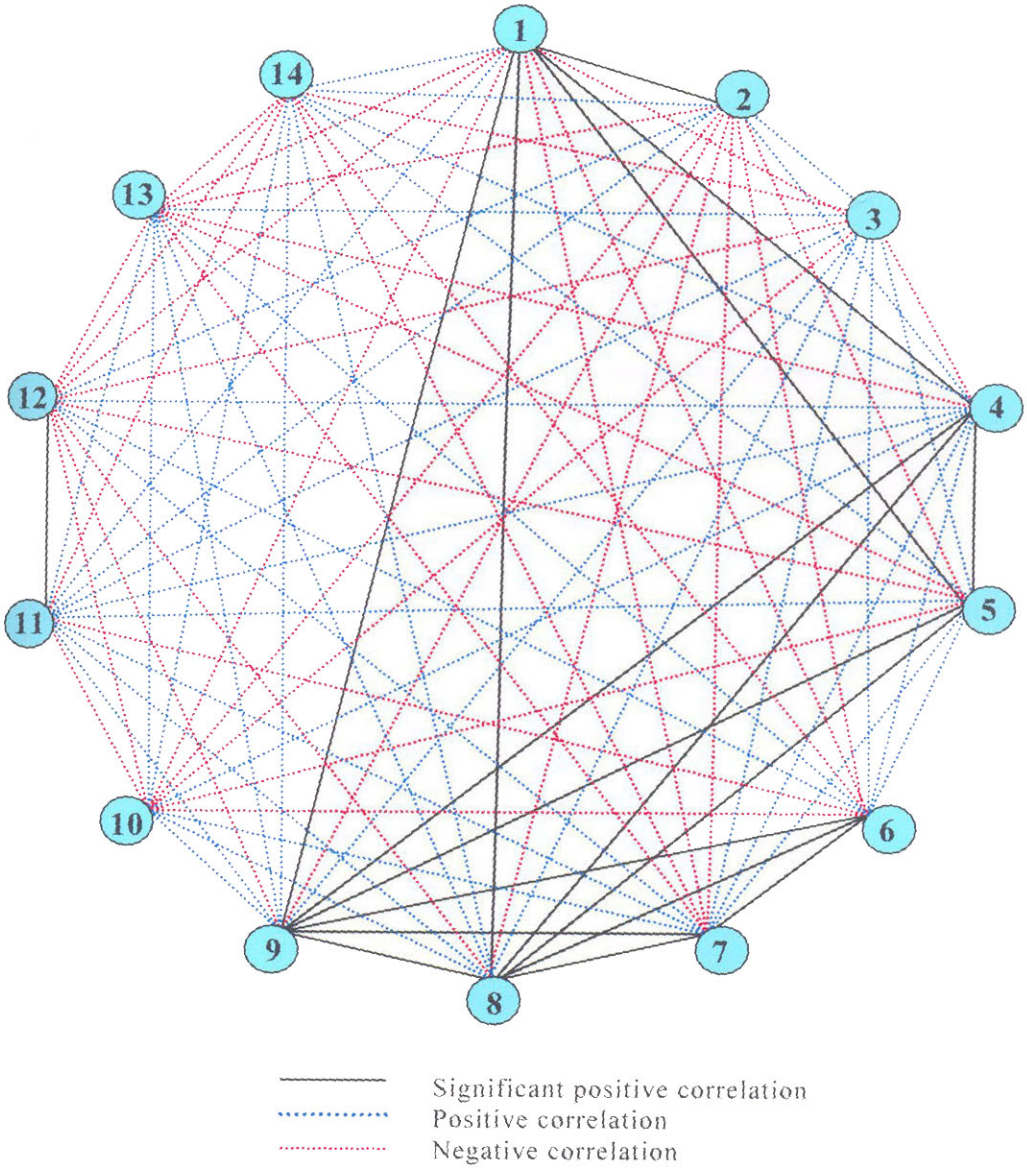


Fig.6 Environmental correlation coefficients among the characters

1 Plant height (cm)
2 Height upto 1st Capsule (cm)
3 No. of branches
4 Capsule on main axis
5 Number of capsules per plant
6 Length of capsules (cm)
7 Number of seeds per capsules
8 Seed yield per plant (g)
9 Capsule yield per plant (g)
10 1000 seed weight (g)
11 No. of days taken for 1st flowering
12 No. of days taken for harvest
13 Seed oil (%)
14 Seed protein (%)

Height up to first capsule had recorded significant positive correlation with pant height and it had non-significant positive correlation with number of branches, capsules on main axis, number of days taken for first flowering, number of days taken for harvest and seed protein percentage

Number of branches had no significant correlation with any of the characters under study. However, it showed negative correlation with plant height, capsules on main axis, 1000 seed weight, number of days taken for harvest and seed protein percentage.

Capsules on main axis had significant positive correlation with plant height, number of capsules per plant, seed yield per plant and weight of capsules per plant. It had non-significant negative correlation with number of branches and seed oil percentage.

Significant positive correlation was recorded for number of capsules per plant with plant height, capsules on main axis, seed yield per plant and weight of capsules per plant. It had non-significant negative correlation with height upto first capsule, 1000 seed weight, number of days taken for harvest and seed oil percentage.

Length of capsule had significant positive correlation with number of seeds per capsule, seed yield per plant and weight of capsules per plant. It had non-significant positive correlation with number of branches, capsules on main axis, number of capsules per plant, number of days taken for harvest and seed oil percentage.

Number of seeds per capsule had significant positive correlation with length of capsule, seed yield per plant and weight of capsules per plant. It had

non-significant negative correlation with plant height, height upto first capsule, seed oil percentage and seed protein percentage.

Seed yield per plant had significant positive correlation with plant height, capsules on main axis, number of capsules per plant, length of capsule, number of seeds per capsule and weight of capsules per plant. It had non-significant negative correlation with height upto first capsule and number of days taken for harvest

Weight of capsules per plant had significant positive correlation with Plant height, capsules on main axis, number of capsules per plant, length of capsule, number of seeds per capsule and seed yield per plant. It had non-significant negative correlation with height upto first capsule and number of days taken for harvest.

1000 seed weight had no significant correlation with any of the character. However, it had non-significant positive correlation with capsules on main axis, number of seeds per capsule, seed yield per plant, weight of capsules per plant and seed oil percentage.

Number of days taken for first flowering had significant correlation with number of days taken for harvest. It had non-significant negative correlation with length of capsule, 1000 seed weight and seed protein percentage.

Number of days taken for harvest had significant positive correlation with number of days taken for first flowering. It had positive non-significant correlation with height upto first capsule, capsules on main axis, length of capsule and number of seeds per capsule.

Seed oil percentage had no significant correlation with other characters under study. However, non-significant positive correlation was observed with number of branches, length of capsule, seed yield per plant, weight of capsules per plant, 1000 seed weight and number of days taken for first flowering.

Seed protein percentage had no significant correlation with other characters. But it recorded non-significant negative correlation with number of branches, length of capsule, number of seeds per capsule, number of days taken for first flowering, number of days taken for harvest and seed oil percentage.

4.1.5 Path coefficient analysis

Path coefficient analysis was done to estimate the direct and indirect effect of plant height, number of branches, number of capsules per plant, number of seeds per capsule and 1000 seed weight on seed yield per plant. The direct and indirect effects are presented in the Table 4.1.5 and Fig. 7.

4.1.5.1 Direct effect

All the characters showed positive direct effect on seed yield per plant. The direct effect of each character was as follows: Plant height (negligible), number of branches (low), 1000 seed weight (moderate), number of capsules per plant (high) and number of seeds per capsule (high).

4.1.5.2 Indirect effect

Plant height had moderate indirect effect on seed yield per plant through number of capsules per plant. Plant height exerted negligible indirect effect through all the other characters.

Table 4.1.5 Direct and indirect effects of component characters on seed yield per plant

Character	X_1	X_2	X_3	X_4	X_5	Total
Plant height (X_1)	**0.0684**	0.0256	0.2590	0.1641	0.0370	0.5541
Number of branches (X_2)	0.0103	**0.1695**	0.3798	0.0698	0.0005	0.6299
Number of capsules per plant (X_3)	0.0341	0.1236	**0.5207**	0.1710	0.0057	0.8551
Number of seeds per capsule (X_4)	0.0279	0.0294	0.2209	**0.4030**	0.0501	0.7313
1000 seed weight (X_5)	0.0109	0.0003	0.0128	0.0872	**0.2315**	0.3427

Residue effect : 0.036
Direct effects : Diagonal elements
Indirect effects : Off diagonal elements

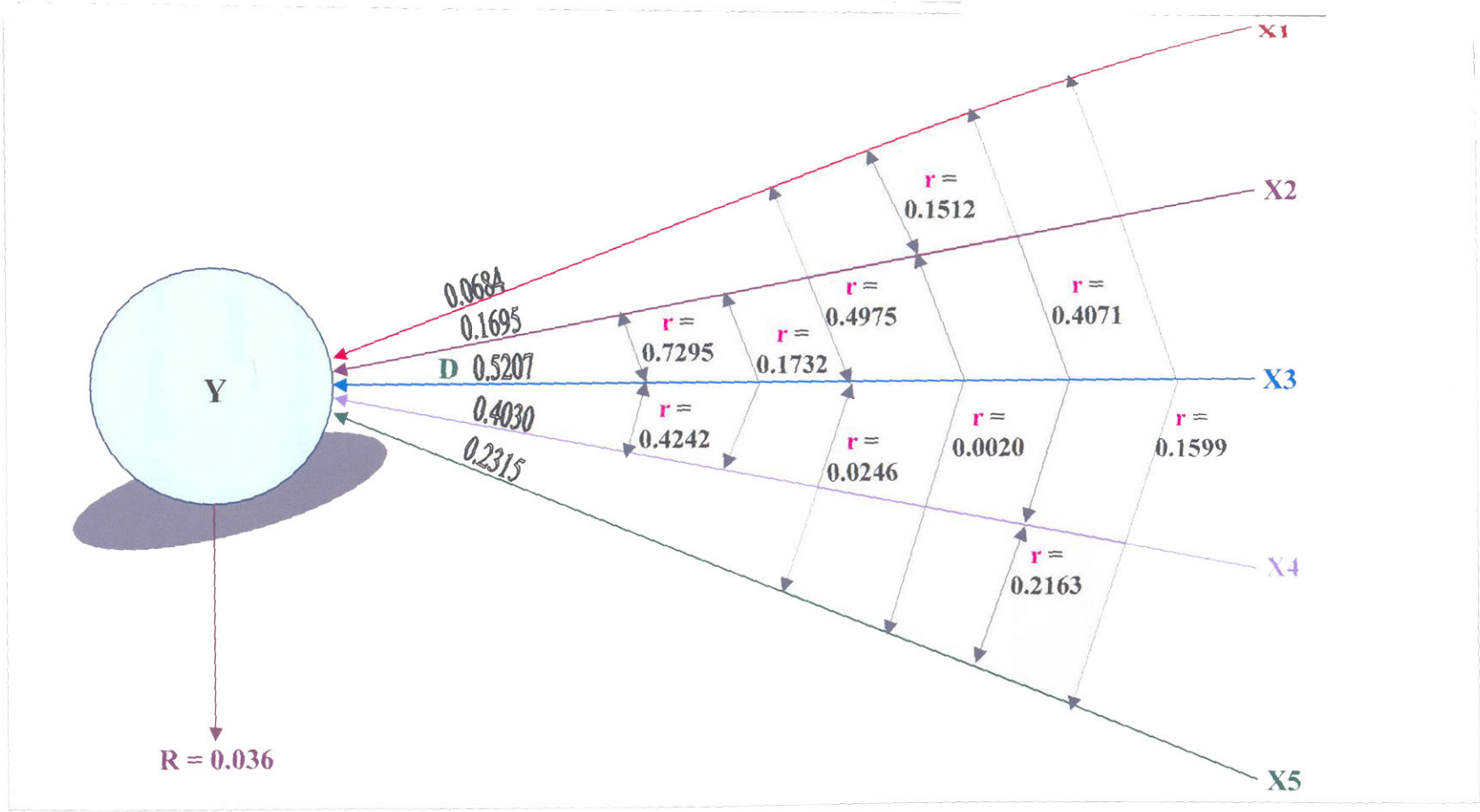


Fig.7 Path diagram showing direct effects of the components on yield

R = Residual effect
D = Direct effect
r = Genotypic correlation coefficient

X1 = Plant height
X2 = Number of branches
X3 = Number of capsules per plant

X4 = Number of seeds per capsule
X5 = 1000 seed weight
Y = Seed yield per plant

Number of branches had high indirect effect on seed yield per plant through number capsules per plant. While the indirect effects of number of branches through all other characters were negligible.

Number of capsules per plant had low indirect effect through number of branches per plant and number of seeds per capsule. It had negligible indirect effect on seed yield per plant through the remaining characters.

Number of seeds per capsule had moderate indirect effect on seed yield per plant through number of capsule per plant. It had negligible indirect effect on seed yield per plant through the remaining characters.

1000 seed weight had only negligible indirect effect on seed yield per plant through all the characters.

About 96 per cent of variation in seed yield per plant was attributed to the influence of the above five component characters.

4.1.6 Genetic divergence analysis

The 50 genotypes were subjected to D^2 analysis based on plant height, height upto first capsule, number of branches, capsules on main axis, number of seeds per capsule, seed yield per plant, weight of capsules per plant, 1000 seed weight, number of days taken for first flowering, number of days taken for harvest, seed oil percentage and seed protein percentage.

Using Tocher's method of clustering these genotypes were grouped into nine clusters and the clustering pattern is presented in Table 4.1.6 (a).

The cluster I had the highest number of genotypes (19) which include genotypes IVTS-1, IVTS-2, IVTS-3, IVTS-7, IVTS-11, IVTS-16, AVTS-9, AVTS-14, Si-175, Si-59, Si-255-2, Si-833, Si-926, Si-1007, Si-1066, Si-1150,

Table 4.1.6 (a) Clustering pattern of 50 genotypes in sesame

Sl. No.	Cluster number	No. of genotypes	Genotypes
1	I	19	T_1, T_2, T_3, T_5, T_8, T_{12}, T_{19}, T_{20}, T_{23}, T_{24}, T_{25}, T_{28}, T_{30}, T_{32}, T_{36}, T_{37}, T_{40}, T_{41}, T_{43}
2	II	3	T_{26}, T_{38}, T_{46}
3	III	10	T_6, T_{13}, T_{14}, T_{16}, T_{18}, T_{22}, T_{34}, T_{39}, T_{44}, T_{47}
4	IV	3	T_7, T_{21}, T_{29}
5	V	6	T_4, T_{15}, T_{17}, T_{31}, T_{35}, T_{49}
6	VI	5	T_9, T_{11}, T_{33}, T_{42}, T_{45}
7	VII	2	T_{27}, T_{48}
8	VIII	1	T_{10}
9	IX	1	T_{50}

Si-1720, Si-1542 and Si-1669 followed by cluster III with 10 genotypes viz., IVTS-8, Kayamkulam-1, Thilak, IVTS-18, AVTS-8, Si-59, Si-1052, Si-1484, Si-2247 and Si-1107 and cluster V with six genotypes (IVTS-5, IVTS-17, IVTS-19, Si-931, Si-1061 and TMV-3), cluster VI with five (IVTS-12, IVTS-14, Si-1041, Si-16672 and Si-44). Cluster II with three (Si-266, Si-1210 and Si-778) and cluster IV with three (IVTS-9, AVTS-16 and Si-902) genotypes and cluster VII with two genotypes (Si-722 and Si-833). The genotypes IVTS-13 and TMV-4 remained as divergent genotypes and cannot be accommodated in any of the clusters and each remained as separate individuals.

The average inter and intra-cluster distances were estimated and presented in Table 4.1.6 (b), 4.1.6 (c) and Fig. 8. The average intra-cluster distance varied from 6.24 (cluster IV) to 45.27 (Cluster I). The inter-cluster distance varied from 18.46 (between Clusters III and IX) to 63.54 (between clusters VII and VIII).

The maximum and minimum divergence between clusters is presented in Table 4.1.6 (d). The cluster I had the greatest distance from cluster VII followed by clusters IX, VII, III, IV, VI, II and V respectively.

The cluster II had the maximum distance from cluster VI followed by clusters IX, III, VIII, V, IV, VI and I.

The cluster III had the greatest distance from cluster VIII followed by clusters VI, II, III, V, I, VII, IV and IX respectively.

The cluster IV had maximum distance from cluster III followed by clusters VI, V, IX, II, I, III and VIII respectively.

Table 4.1.6 (b) Average intra and inter cluster distance (D^2)

Clusters	I	II	III	IV	V	VI	VII	VIII	IX
I	**2049.76**	473.18	608.52	527.18	418.95	525.51	1698.15	847.24	1080.47
II		**117.80**	1340.18	582.93	1116.99	483.06	2675.71	1171.53	2333.39
III			**779.77**	508.56	642.66	1647.02	606.01	1971.40	340.90
IV				**38.94**	1058.69	1289.18	370.95	2174.68	1176.81
V					**540.11**	766.09	1889.39	687.01	708.99
VI						**486.03**	3388.16	433.60	2250.46
VII							**160.82**	4037.30	612.39
VIII								**0**	2334.85
IX									**0**

Diagonals – intracluster distance
Off diagonals – intercluster distances

Table 4.1.6 (c) **Average intercluster and intracluster distances ($\sqrt{D^2}$)**

Clusters	I	II	III	IV	V	VI	VII	VIII	IX
I	**45.27**	21.75	24.67	22.96	20.47	22.92	41.21	29.11	32.87
II		**10.86**	36.61	24.14	33.42	21.98	51.73	34.23	48.31
III			**27.92**	22.55	25.35	40.58	24.62	44.40	18.46
IV				**6.24**	32.54	35.91	19.26	46.63	24.31
V					**23.24**	27.68	43.47	26.21	26.63
VI						**22.05**	58.21	20.82	47.44
VII							**12.68**	63.54	24.75
VIII								**0**	48.32
IX									**0**

Diagonals - Intracluster distance
Off diagonals - Intercluster distance

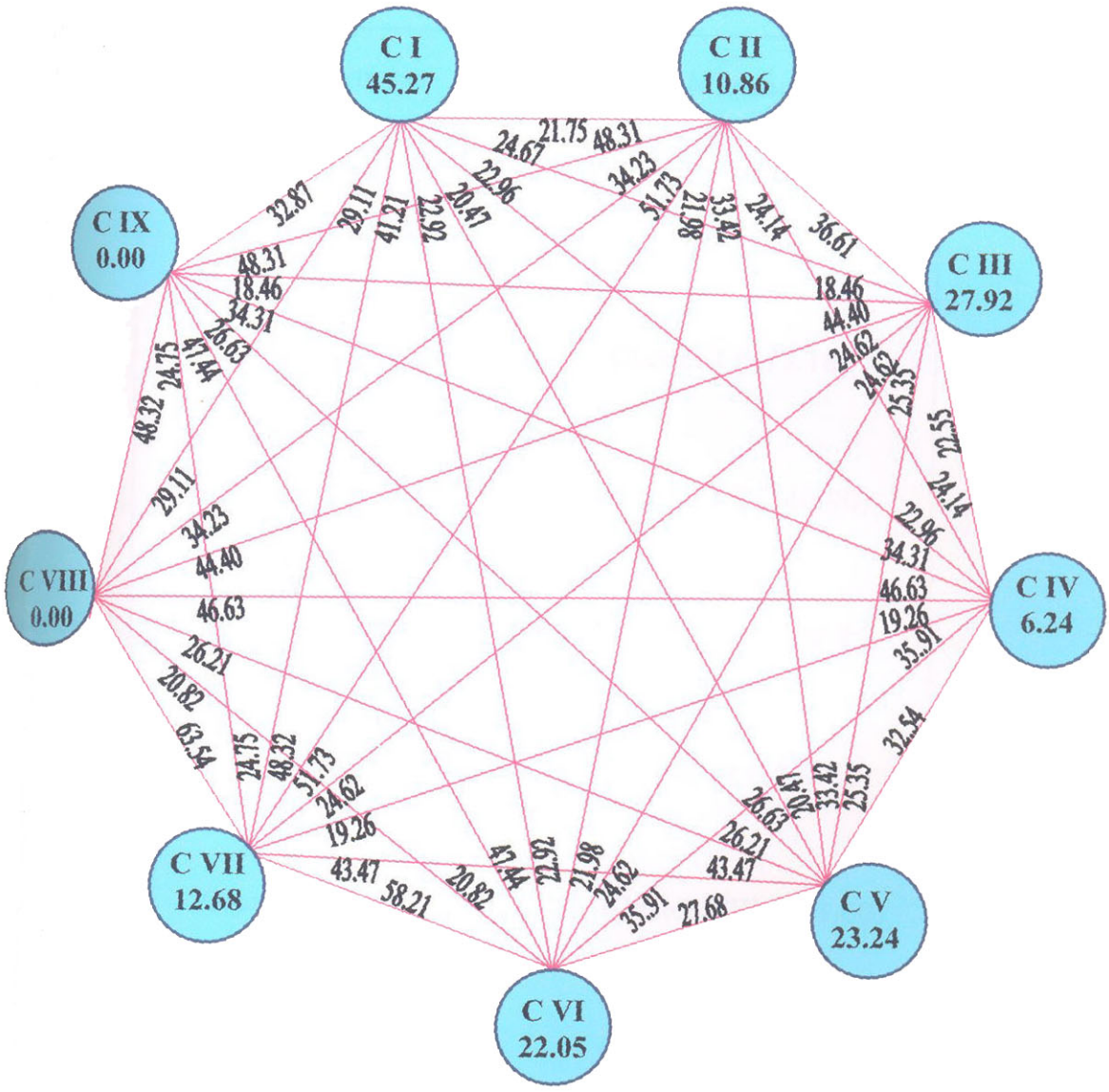


Fig.8 Average intra and inter cluster distance(D)

Table 4.1.6 (d) Maximum and minimum divergence between clusters

Clusters	Maximum	Minimum
Cluster I	Cluster VII (1698.15)	Cluster V (418.95)
Cluster II	Cluster VII (2675.71)	Cluster I (473.18)
Cluster III	Cluster VIII (1971.40)	Cluster IX (340.90)
Cluster IV	Cluster VIII (2174.68)	Cluster VII (370.95)
Cluster V	Cluster VII (1889.39)	Cluster I (418.95)
Cluster VI	Cluster VII (3388.16)	Cluster VIII (433.60)
Cluster VII	Cluster VIII (4037.30)	Cluster IV (370.95)
Cluster VIII	Cluster VII (4037.30)	Cluster VI (433.60)
Cluster IX	Cluster VIII (2334.85)	Cluster III (340.90)

Table 4.1.6 (e) Cluster means of 14 characters in sesame

Clusters	Plant height (cm)	Height upto I capsule (cm)	No. of branches	Capsules on main axis	No. of capsules per plant	Length of capsules (cm)	No. of seeds per capsule	Seed yield per plant (g)	Weight of capsules per plant (g)	1000 seed weight (g)	No. of days taken for first flowering	No. of days taken for harvest	Seed oil (%)	Seed protein (%)
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
I	97.47	43.84	4.68	16.98	38.96	2.15	58.63	6.01	10.01	3.10	34.63	85.27	48.25	20.13
II	105.53	42.32	6.60	21.35	52.03	2.17	59.90	9.24	14.38	3.20	34.73	85.20	46.67	19.47
III	97.53	42.67	4.28	16.92	36.43	2.32	61.65	5.65	9.41	3.22	35.07	85.50	48.67	21.58
IV	104.15	39.98	6.43	19.28	51.60	2.09	59.57	8.02	13.21	3.04	34.68	85.40	52.22	20.88
V	93.18	42.68	2.74	16.49	27.58	2.08	55.68	3.85	6.71	3.09	34.74	85.93	50.00	20.41
VI	90.45	42.88	4.58	14.69	31.41	2.07	55.01	5.71	7.84	3.11	35.23	86.22	50.34	18.87
VII	88.30	40.73	4.73	15.05	31.10	2.10	51.70	4.43	7.57	3.01	35.23	85.45	51.17	22.71
VIII	101.10	40.05	2.65	11.50	18.15	2.12	45.50	1.91	4.10	3.20	34.35	85.20	43.33	18.85
IX	96.75	50.55	2.65	12.05	18.60	2.04	55.05	2.10	4.01	3.11	35.40	85.25	48.34	21.83
Mean	97.16	43.19	4.37	16.04	34.01	2.13	55.85	5.21	8.58	3.12	34.90	85.49	48.78	20.53
CV (%)	6.03	6.96	34.38	19.71	36.27	3.89	8.89	47.10	41.98	2.34	1.00	0.42	5.43	6.57

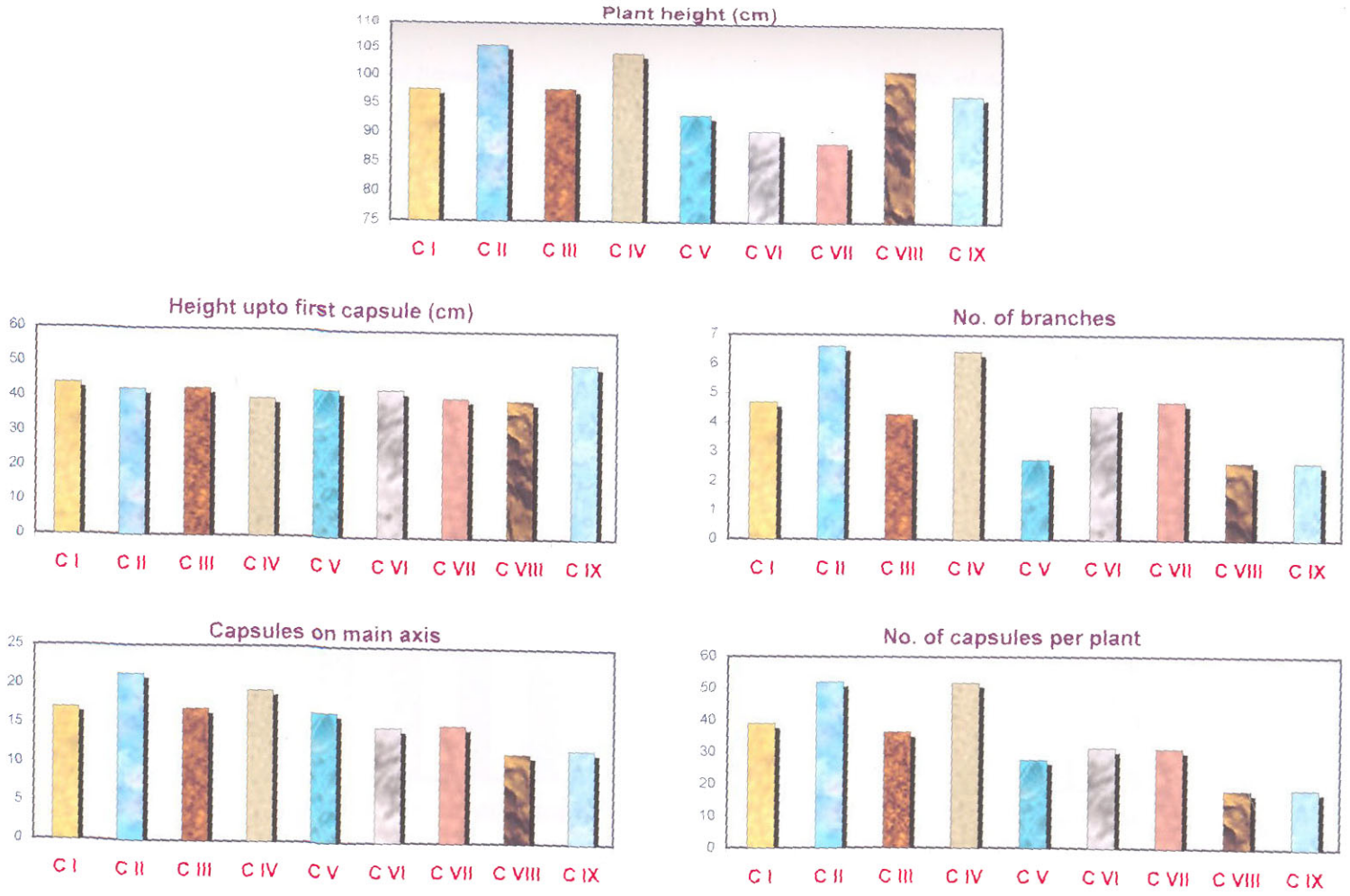


Fig. 9 Character wise performance of genotypes within clusters

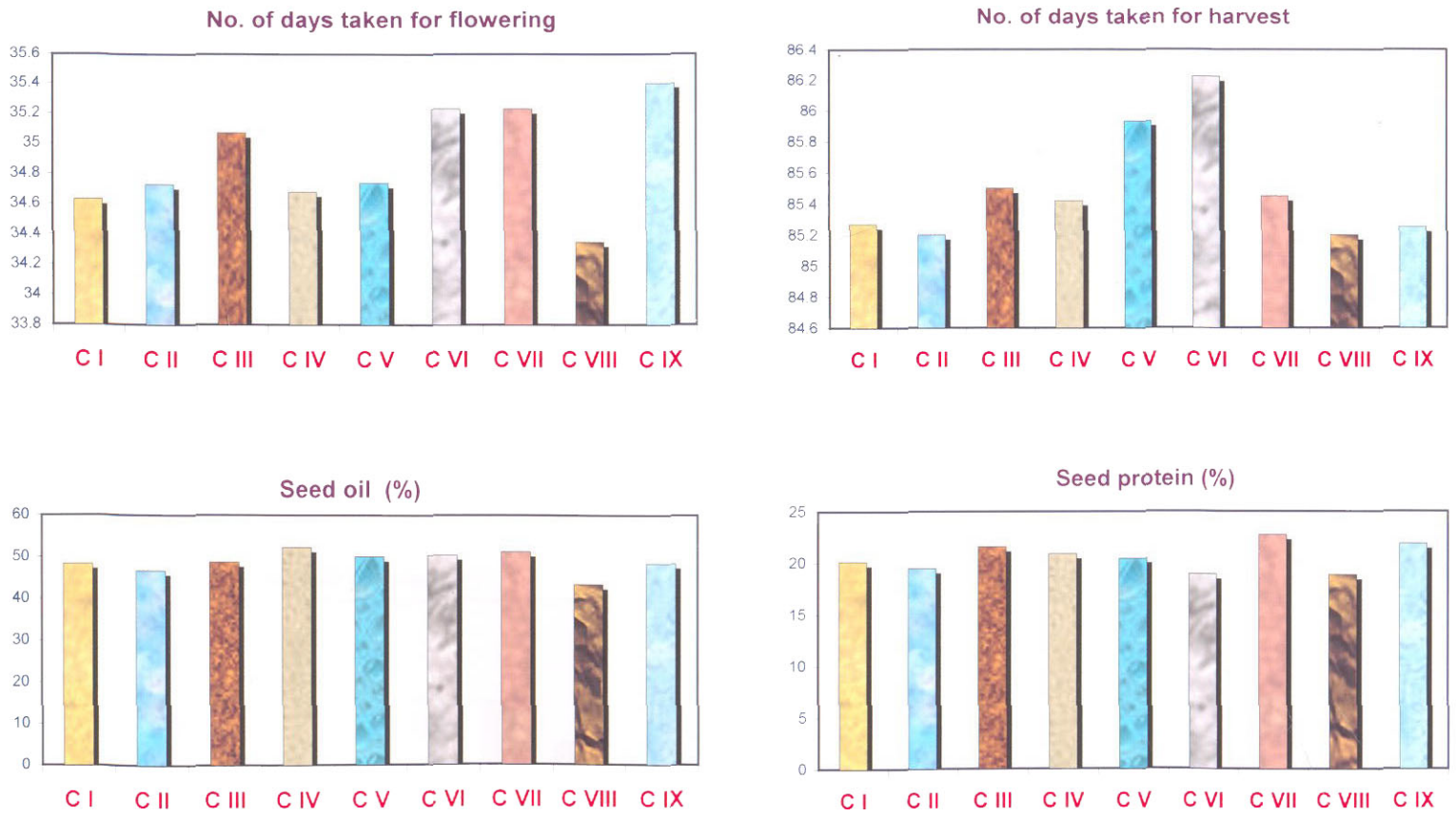


Fig. 9 Character wise performance of genotypes within clusters (continued)

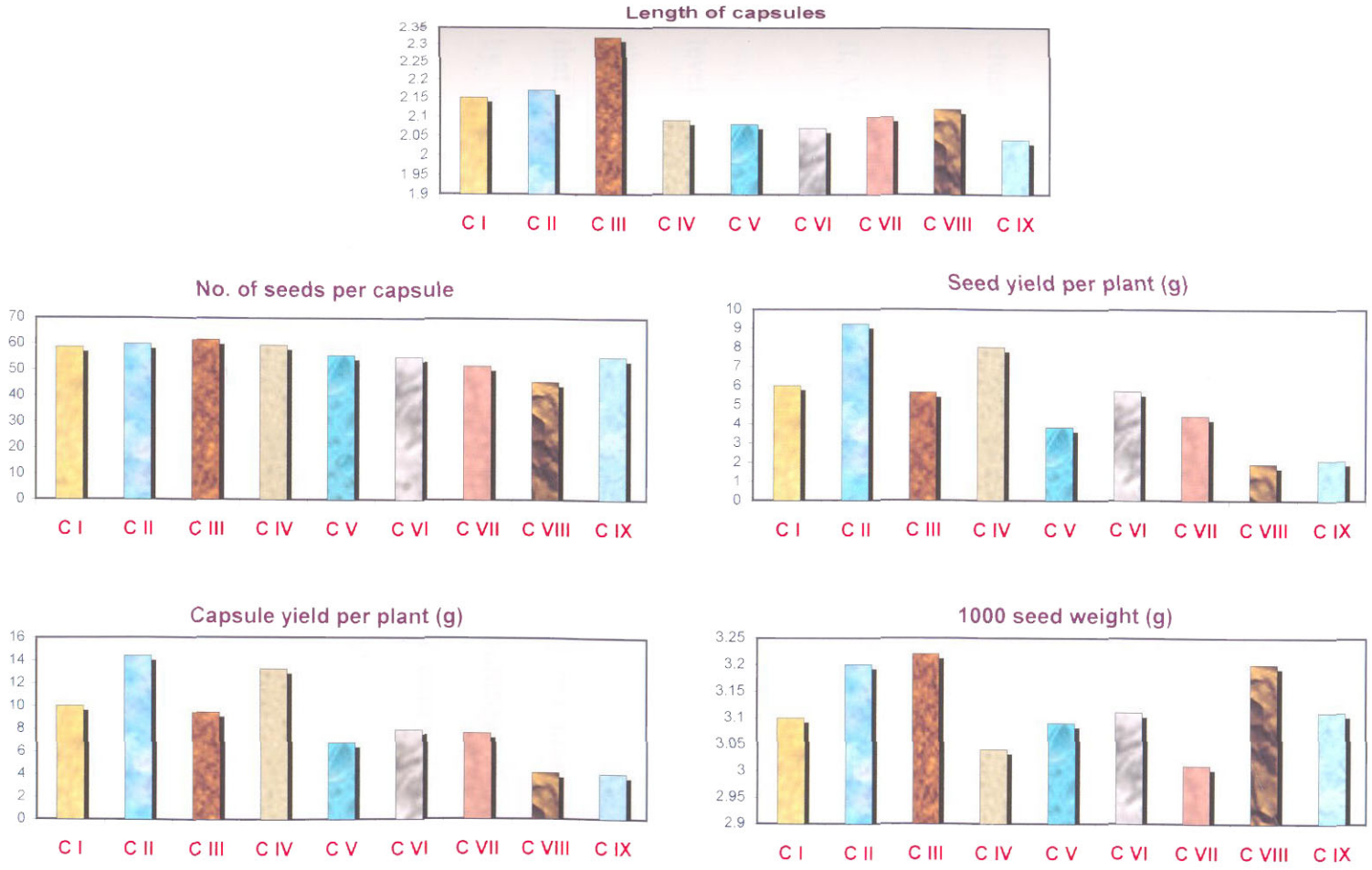


Fig. 9 Character wise performance of genotypes within clusters (continued)

The cluster V had maximum distance from cluster VII followed by clusters II, IV, VI, IX, VIII, III and I respectively.

Cluster VI had the greatest distance from cluster VII followed by cluster IX, II, IV, V, VIII, I and II respectively.

Cluster VII had maximum distance from VIII followed by VII, II, V, I, IX, III and IV respectively.

Cluster VIII had maximum distance from cluster VII followed by cluster IX, IV, III, II, I, V and VI respectively.

Cluster IX had greatest distance from cluster VIII followed by cluster II, VI, I, V, IV and III respectively.

A comparison of clusters which were divergent at maximum and minimum level with each cluster was seen from Table 4.1.6 (d). The cluster means for each character is presented in Table 4.1.6 (e) and Fig. 9. From the table it is clear that the maximum variation was for seed yield per plant (47.10%), followed by weight of capsules per plant (41.98), number of capsules per plant (36.27%) and number of branches (34.38 per cent). These characters were mainly responsible for divergent at cluster level. Days to harvest contributed minimum towards the divergence (0.42 per cent).

4.2 Experiment No. II

Based on the results of D^2 analysis of experiment No. I, six divergent parents from six divergent clusters *viz.*, Cluster I, II, III, IV, V and VII were selected to study gene action through combining ability in a half diallel cross. These six parents and their direct F_1's and standard check variety were raised in a R.B.D. with three replications. The data generated on nineteen traits were subjected

to statistical analysis and the results are presented below in the following sub heads.

4.2.1 Mean performance of parents and hybrids

4.2.2 Combining ability and gene action

4.2.3 Estimation of heterosis

4.2.1 Mean performance of parents and hybrids

Analysis of variance on the performance of the parents and hybrids showed significant difference for all the characters excluding days to flower and maturity and saponification value (Table 4.2.1(a)). Mean performance of parents and hybrids are presented in Table 4.2.1(b). The six parents and two promising hybrids are presented in Plate 1 to 4. The mean plant height of parents ranged from 84.34 cm (Si-255-2) to 130.20 cm (Si-722) and that of hybrids ranged from 76.98cm (Si-255-2 x Si-266) to 142.64 cm (AVTS-16 x Si-255-2). The mean height upto first capsule ranged from 34.28 cm (AVTS-16) to 45.82 cm (IVTS-5) and in hybrids it ranged from 33.62 cm (Si-255-2 x Si-722) to 49.09 cm (IVTS-5 x Si-722). The average number of branches in parents ranged from 4.65 in IVTS.5 to 6.50 in Si-266 and in hybrids it ranged from 4.12 in Si-255-2 x Si-266 to 6.79 in IVTS-5 x AVTS-16. The minimum number of capsules on main axis in parents was recorded by Si-255–2 (18.54) and maximum was recorded by AVTS-16 (32.21). Among the hybrids the minimum 17.26 was recorded by Si-255-2 x Si-266 and maximum 33.14 was recorded by AVTS-16 x Si-722. Number of capsules per plant ranged from 52.24 (Si-255-2) to 72.65 (AVTS-16) in parents and it ranged from 53.18 (Si-255-2 x Si-266) to 82.74 (IVTS–5 x AVTS–16) in hybrids.

Table 4.2.1(a) Analysis of variance of nineteen characters in six parents, 15 hybrids and standard check variety

Sl. No.	Character	Mean squares		
		Replication DF -2	Genotypes DF -21	Error DF-42
1	Plant height	38.06	1175.81**	32.98
2	Height upto first capsule	26.47	60.09**	13.67
3	Number of branches	0.13	1.43**	0.16
4	Capsules on main axis	36.60*	67.27*	9.08
5	Number of capsules per plant	63.14	215.77**	20.01
6	Length of capsule	0.35	0.49**	0.11
7	Number of seeds per capsule	21.11	75.91**	17.26
8	Seed yield per plant	1.23	7.91**	0.39
9	Weight of capsules per plant	4.76	31.68**	3.28
10	1000 seed weight	0.41	2.28*	0.14
11	Number of days taken for first flowering	1.59	5.26	6.96
12	Number of days taken for harvest	38.72	5.72	9.26
13	Seed oil	0.52	29.61**	0.25
14	Seed protein	0.05	5.55**	0.02
15	Acid value	0.01	0.92**	0.01
16	Saponification value	7.25	11.45	2.24
17	Iodine value	11.06	486.48**	4.11
18	Peroxide value	1.15	0.84**	0.22
19	Total nitrogen	0.01	0.21**	0.01

** Significant at 1 per cent level
* Significant at five per cent level
DF- Degrees of freedom

Table 4.2.1(b) Mean performance of six parents, fifteen hybrids and standard check variety

Sl. No.	Genotypes	Plant height (cm)	Height upto first capsule (cm)	Number of branches	Capsules on main axis	Number of capsules per plant	Length of capsule (cm)	Number of seeds per capsule	Seed yield per plant (g)	Capsule yield per plant (g)	1000 seed weight (g)	No. of days taken for first flowering	No. of days taken for harvest
1	IVTS -5	114.68	45.82	4.65	24.61	64.32	2.36	60.48	9.28	17.04	2.93	37.40	88.42
2	AVTS-8	92.43	44.34	4.94	23.16	56.22	2.41	57.14	6.77	11.28	2.57	38.20	89.92
3	AVTS-16	126.16	34.28	6.13	32.21	72.65	2.14	58.86	10.11	15.81	2.68	36.12	89.30
4	Si-255-2	84.34	35.13	5.88	18.54	52.24	3.21	62.18	5.24	8.78	3.12	35.18	88.44
5	Si-266	96.84	40.14	6.50	24.43	62.16	3.11	68.15	8.19	14.45	3.11	38.12	86.22
6	Si-722	130.20	41.24	5.14	28.18	66.26	2.12	58.32	8.12	12.37	2.32	38.29	88.79
7	IVTS – 5 x AVTS – 8	115.72	45.13	5.46	27.37	76.24	2.33	68.88	10.20	19.62	2.96	38.81	87.55
8	IVTS – 5 x AVTS – 16	132.15	38.84	6.79	28.34	82.74	2.86	66.63	10.99	17.75	3.06	37.64	90.4
9	IVTS – 5 x Si – 255-2	116.78	47.84	6.11	23.85	65.47	3.27	68.35	8.33	13.35	3.33	36.17	85.62
10	IVTS – 5 x Si – 266	120.13	49.09	5.71	32.21	69.33	3.06	72.05	9.56	15.19	2.98	38.50	87.82
11	IVTS – 5 x Si – 722	128.49	37.06	6.15	26.47	65.40	2.41	60.50	8.95	15.88	2.46	39.15	89.01
12	AVTS – 5 x AVTS – 16	121.58	39.31	5.21	21.18	74.87	2.86	56.12	7.81	12.29	2.77	35.72	88.61
13	AVTS – 8 x Si – 255-2	112.21	45. 87	5.38	17.68	58.22	3.16	69.73	8.13	13.34	2.77	37.89	90.26
14	AVTS – 8 x Si – 266	116.61	46.03	5.96	26.13	72.29	2.89	59.16	9.23	14.11	3.16	37.63	89.20
15	AVTS – 8 x Si – 722	136.86	38.69	5.13	30.12	66.31	2.63	64.21	7.24	10.32	2.39	38.93	85.50
16	AVTS – 16 x Si – 255-2	142.64	36.82	6.12	28.46	68.74	2.11	59.22	5.11	7.72	2.16	35.02	89.80
17	AVTS – 16 x Si – 266	89.12	39.09	5.03	27.24	58.69	2.98	65.16	8.36	13.26	2.88	36.01	89.40
18	AVTS – 16 x Si – 722	105.18	42.98	6.11	33.14	71.63	2.88	54.62	7.63	10.18	2.91	38.42	87.61
19	Si – 255-2 x Si – 266	76.98	38.18	4.12	17.26	53.18	3.22	69.92	5.04	8.06	3.14	35.22	87.43
20	Si – 255-2 x Si – 722	82.87	33.62	4.86	19.13	48.32	2.89	64.26	6.77	8.81	2.63	38.64	87.25
21	Si – 722 x Si – 266	79.72	37.56	4.92	22.53	63.13	2.14	62.87	8.32	12.52	2.81	37.32	88.91
22	Kayamkulam-2	126.12	41.62	5.84	27.18	68.26	2.72	65.18	9.13	15.76	3.02	37.78	87.93
	SE	3.316	2.135	0.231	1.740	2.583	0.187	2.399	0.359	1.045	0.215	1.523	1.757
	CD	4.79	3.08	0.33	2.51	3.73	0.27	3.46	0.52	1.51	0.31	NS	NS

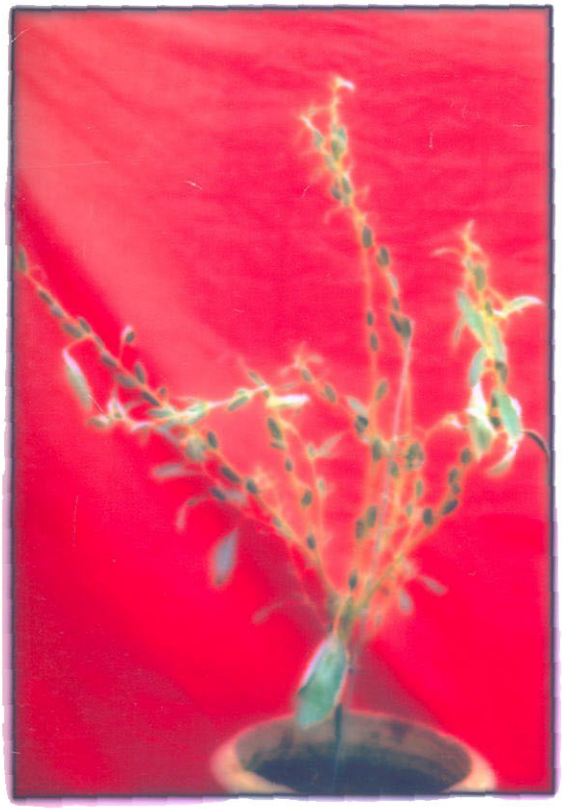
Table 4.2.1(b) Contd...

Sl. No.	Genotypes	Seed oil (%)	Seed protein (%)	Acid value	Saponification value	Iodine value	Peroxide value	Total nitrogen
1	IVTS -5	52.89	19.70	2.36	190.47	116.59	3.00	3.71
2	AVTS-8	47.11	21.90	2.97	188.55	87.25	4.00	4.13
3	AVTS-16	50.11	20.95	4.21	188.40	97.97	4.67	3.95
4	Si-255-2	50.33	20.80	3.46	192.11	103.09	4.33	3.92
5	Si-266	47.11	19.33	2.56	193.55	79.78	4.00	3.65
6	Si-722	55.67	22.20	3.09	188.17	115.99	4.67	4.34
7	IVTS – 5 x AVTS – 8	51.89	22.12	2.85	192.14	114.72	3.33	4.17
8	IVTS – 5 x AVTS – 16	54.44	21.39	3.50	190.74	113.21	5.00	3.84
9	IVTS – 5 x Si – 255-2	52.56	22.27	3.62	190.74	114.97	4.67	4.20
10	IVTS – 5 x Si – 266	44.38	18.45	2.81	193.55	108.12	4.33	3.48
11	IVTS – 5 x Si – 722	49.44	22.34	2.99	189.34	109.39	4.33	4.21
12	AVTS – 5 x AVTS – 16	49.56	21.98	4.40	190.74	107.10	4.67	4.15
13	AVTS – 8 x Si – 255-2	51.11	18.37	3.40	190.74	89.34	4.00	3.46
14	AVTS – 8 x Si – 266	48.00	19.85	2.86	193.55	76.65	4.33	3.75
15	AVTS – 8 x Si – 722	51.78	21.10	2.57	188.87	105.50	4.67	3.98
16	AVTS – 16 x Si – 255-2	52.22	21.48	3.21	190.74	113.96	4.33	4.05
17	AVTS – 16 x Si – 266	48.00	20.14	4.22	194.95	100.42	3.00	3.80
18	AVTS – 16 x Si – 722	56.44	21.90	2.92	189.34	91.87	4.33	4.13
19	Si – 255-2 x Si – 266	51.22	18.15	3.55	193.55	90.87	4.00	3.42
20	Si – 255-2 x Si – 722	52.67	22.05	3.24	190.74	118.44	4.33	4.16
21	Si – 722 x Si – 266	46.44	20.95	2.58	188.87	118.79	4.67	3.95
22	Kayamkulam-2	54.78	21.90	3.21	190.74	105.50	4.00	4.13
	SE	0.291	0.090	0.051	0.864	1.171	0.268	0.059
	CD	0.42	0.14	0.08	NS	1.69	0.39	0.09

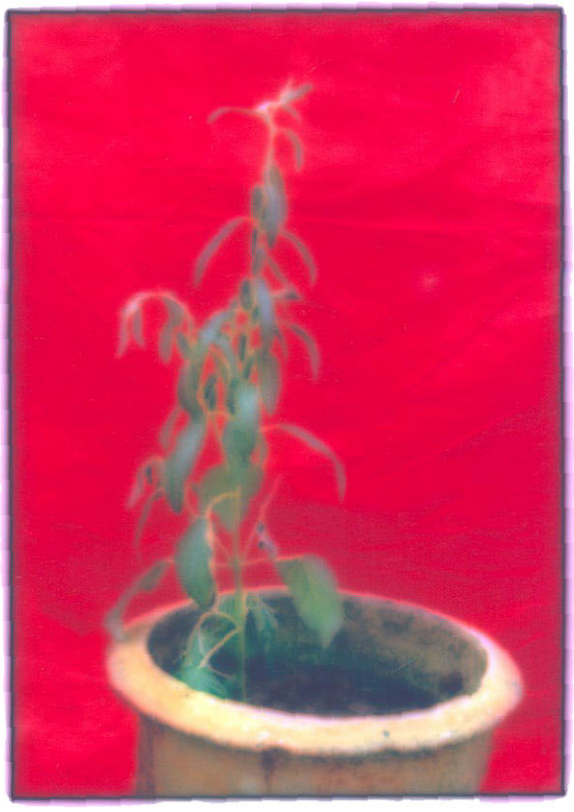
IVTS - 5

AVTS - 8

Plate 1 - Varieties used as parents



AVTS - 16



Si - 255 - 2

Plate 2 - Varieties used as parents

Si - 266

Si - 722

Plate 3 - Varieties used as parents

IVTS - 5 x AVTS - 8

IVTS - 5 x AVTS - 16

Plate 4 - Promising Hybrids

The minimum length of capsule was recorded by Si-722 (2.12 cm) and the maximum was recorded by Si-255–2 (3.21cm) among parents. The length of capsule in hybrid was minimum in AVTS-16 x Si-255-2 (2.11cm) and maximum in AVTS-5 x Si-255-2 (3.27 cm).

Number of seeds per capsule in parents ranged from 57.14 (AVTS-8) to 68.15 (Si-266) and in hybrids, it ranged from 54.62 (AVTS-16 x Si–722) to 72.05 (IVTS-5 x Si-266). Maximum seed yield per plant was observed for AVTS-16 (10.11g) and minimum for Si–255-2 (5.24g) among parents. Among hybrids maximum seed yield per plant was recorded in IVTS–5 x AVTS-16 (10.99 g) and minimum was recorded for Si-255-2 x Si-266 (5.04 g). Weight of capsules per plant was maximum for IVTS-5 (17.04g) and minimum for Si-255–2 (8.78 g) among the parents. In the hybrids the maximum was recorded in IVTS–5 x AVTS–8 (19.62 g) and the minimum in AVTS-16 x Si-255–2 (7.72 g). 1000 seed weight in parents ranged from 2.32g (Si-722) to 3.12g (Si-255-2). In the hybrids it ranged from 2.16g (AVTS –16 x Si-255 –2) to 3.33g (IVTS–5 x Si-255–2). Among parents Si-255-2 was early flowering (36.12 days) and Si-722 was late flowering (38.29 days). Among hybrids AVTS–16 x Si-255-2 was early flowering (35.02 days) and IVTS–5 x Si-722 was late flowering (39.15 days).

Among parents Si-266 (86.22 days) and AVTS-8 (89.92 days) were early and late maturing respectively. In the hybrids AVTS-8 x Si –722 (85.50 days) and IVTS-5 x AVTS-16 (90.4 days) were early and late maturing hybrids respectively. Seed oil percentage was maximum for Si-722 (55.67%) and minimum for AVTS-8 and Si-266 (both 47.11 %) among parents. Among hybrids the maximum seed oil percentage was for AVTS–16 x Si-722

(56.44%) and minimum for IVTS–5 x Si-266 (44.38%). Seed protein percentage was minimum for Si-266 (19.33) and maximum for Si-722 (22.20) among parents. Among hybrids the minimum was recorded for Si-255-2 x Si-266 (18.15) and the maximum was recorded for IVTS-4 x Si-722 (22.34).

Lowest acid value was recorded for IVTS-5 (2.36) and highest value was recorded for AVTS-16 (4.21) among parents. Among hybrids the lowest value was recorded by AVTS- 8 x Si–722 (2.57) and highest value was recorded by AVTS–8 x AVTS.16 (4.40). Lowest saponification value was 188.17 (Si-722) and highest was 193.55 (Si-266) among parents. Among hybrids AVTS–8 x Si -722 recorded the lowest value (188.87) and Si-722 x Si-266 recorded the highest value (193.55) by IVTS-5 x Si-266 and AVTS–8 x Si-266. Iodine value was lowest for Si-266 (79.78) and highest for IVTS-5 (116.59) among parents. Among hybrids the lowest value was recorded by AVTS –8 x Si-266 (76.65) and the highest value was recorded by Si-722 x Si–266 (118. 79). Peroxide value ranged from 3.00 (IVTS-5) to 4.67 (AVTS-16 and Si–722) among parents and among hybrids it ranged from 3.00 (AVTS-16 x Si-266) to 5.00 (IVTS–5 x AVTS-16). Total nitrogen ranged from 3.65 (Si-266) to 4.34 (Si-722) among parents and from 3.42 (Si–255-2 x Si-266) to 4.21 (IVTS–5 x Si-722) among hybrids.

Types of essential amino acids present in sesame parents and hybrid seeds were histidine, arginine, thrconine, methionine, valine, tryptophan. isoleucine, phenyalinine and lucine (Fig. 10 and Plate 5).

Sesame oil contains saturated fatty acids, viz., palmitic acid (16 : 0), stearic acid (18 : 0) and arachidic acid (20 : 0) and unsaturated fatty acids *viz.*, oleic acid (18 : 1), linoleic acid (18 : 2) and linolenic acid (18 : 3) (Fig. 11).

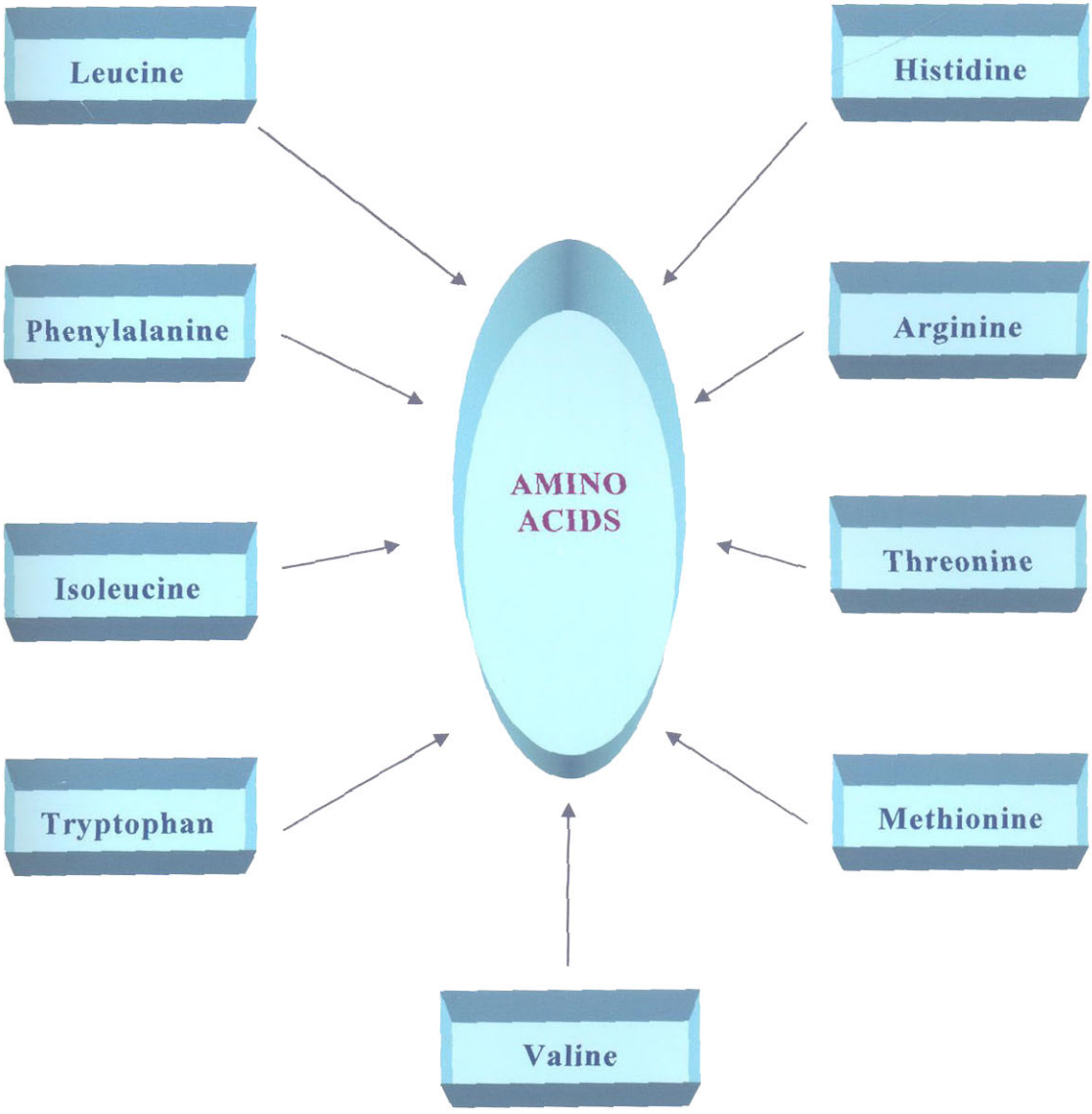


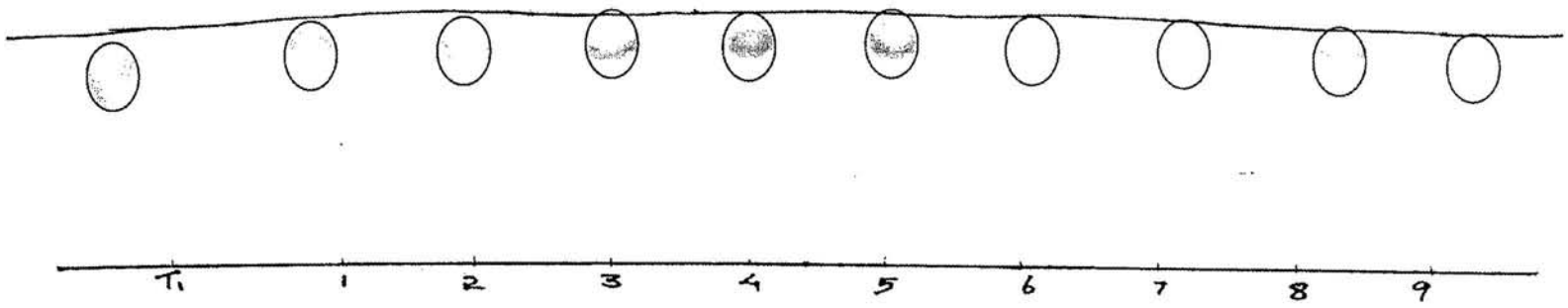
Fig.10 Amino acid profile of sesame protein

Amino acids (standard) used in paper chromatograph

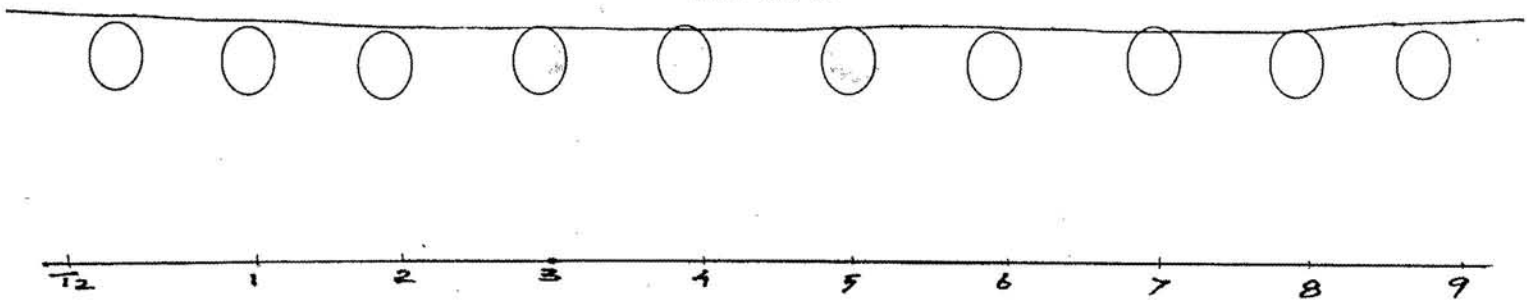
1) Histidine
2) Arginine
3) Threconine
4) Methionine
5) Valine
6) Tryptophan
7) Isolecucine
8) Phenylalanine
9) Leucine

Plate 5 Amino acid profile of oil of parents and hybrids (paper chromatograph)

IVTS-5



AVTS-8



AVTS-16

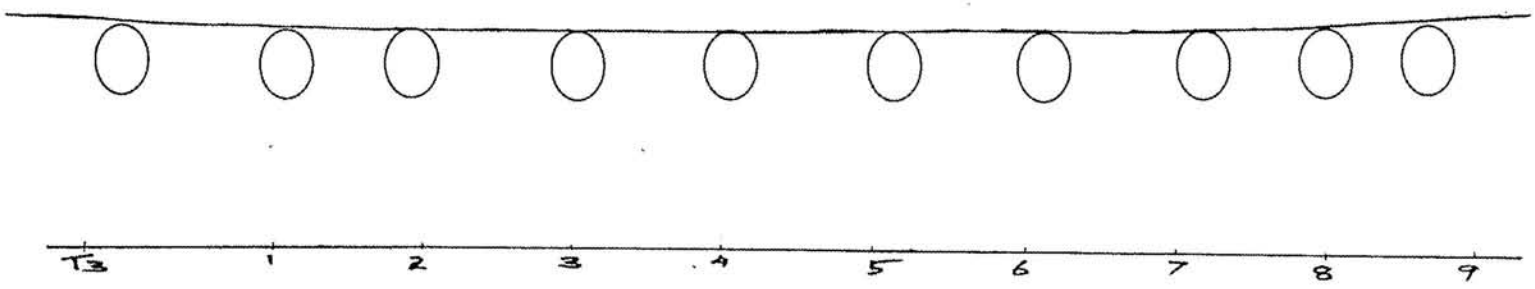
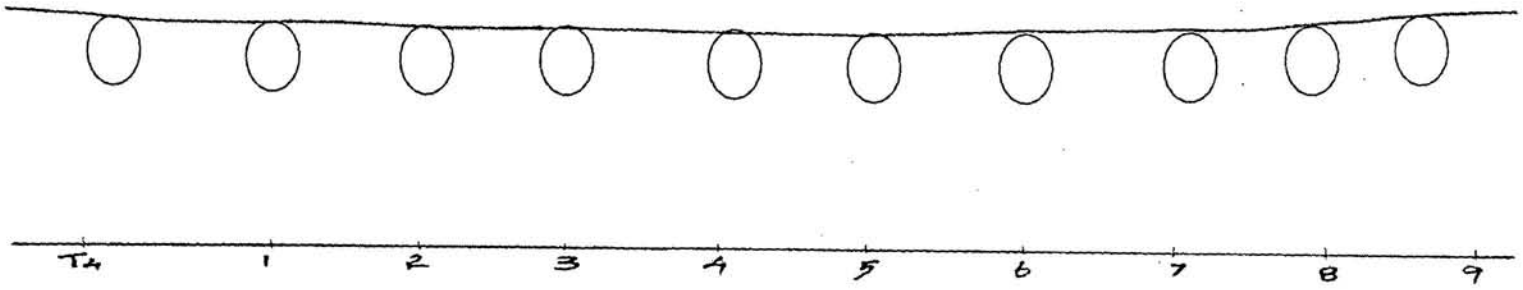
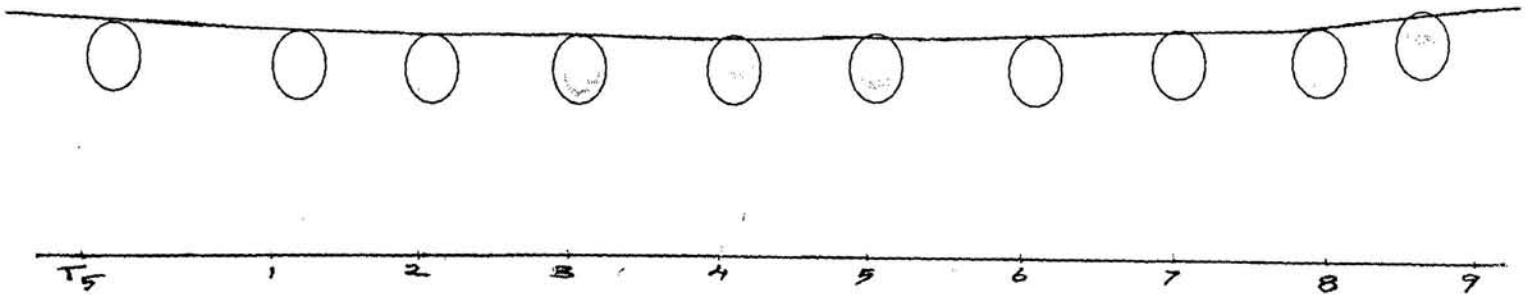


Plate 5 Contd...

Si – 255-2



Si – 266



Si – 722

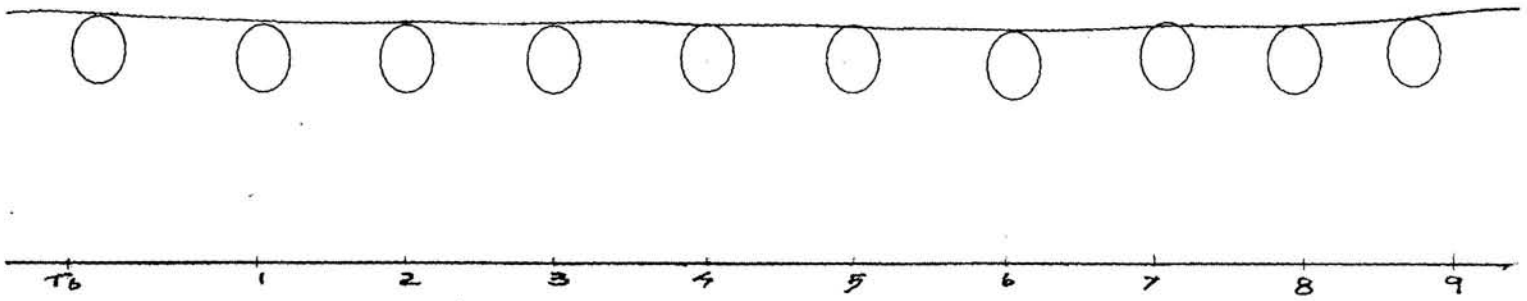
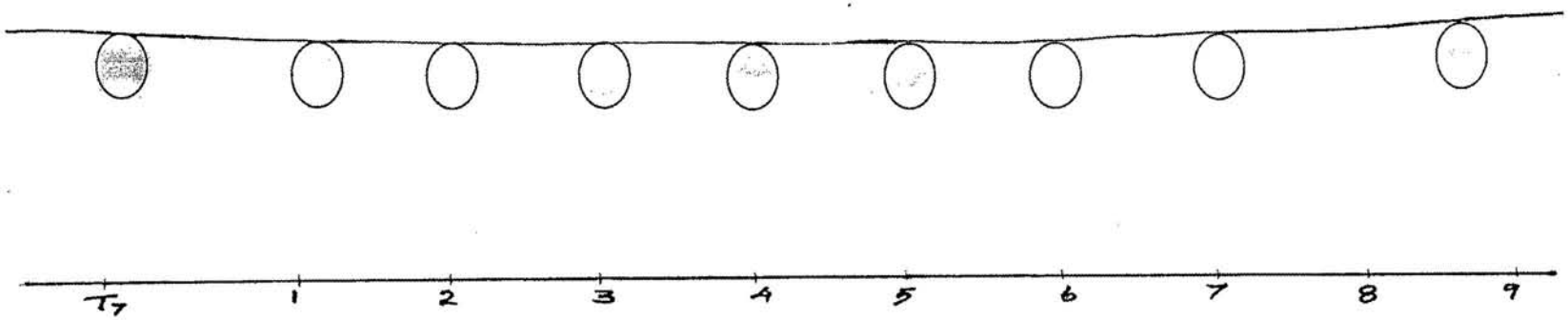
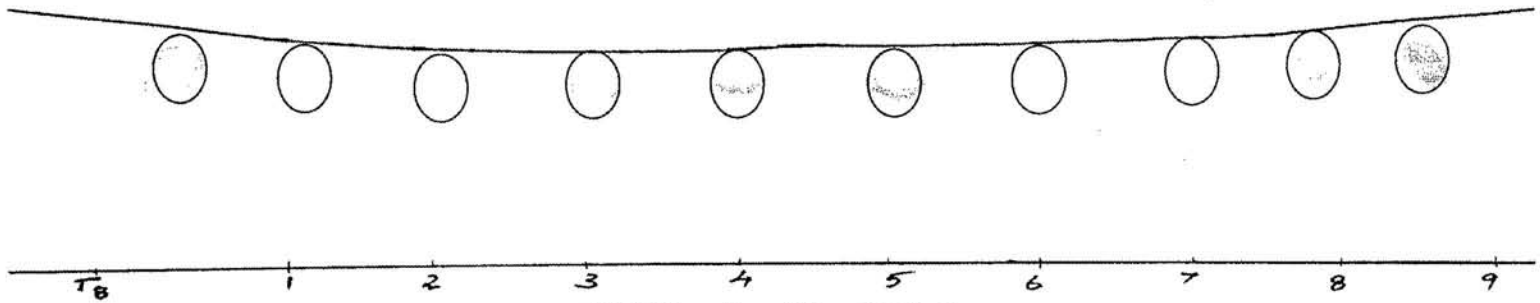


Plate 5 Contd...

IVTS – 5 x AVTS – 8



IVTS – 5 x AVTS – 16



IVTS – 5 x Si – 255-2

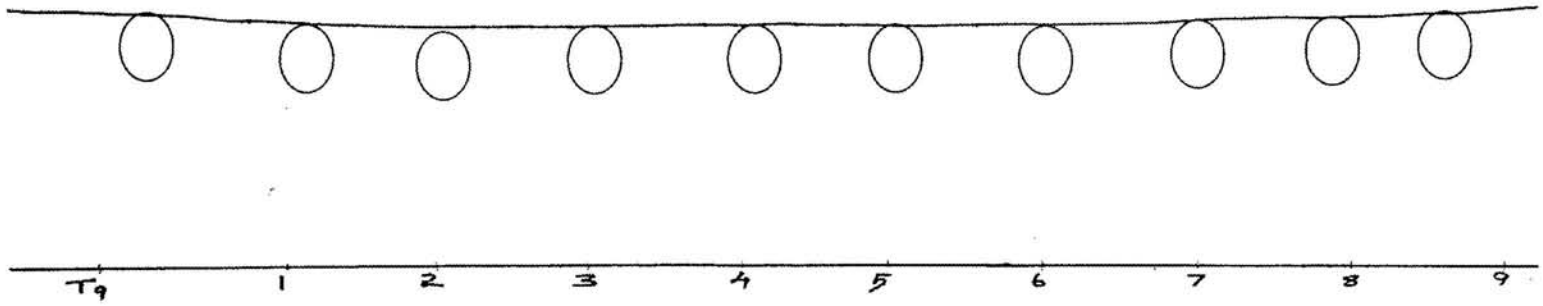
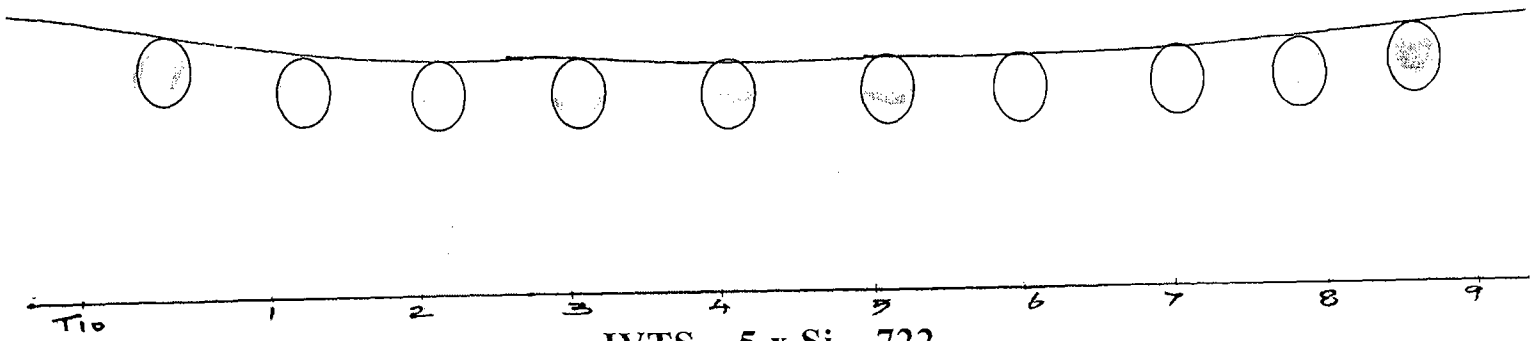
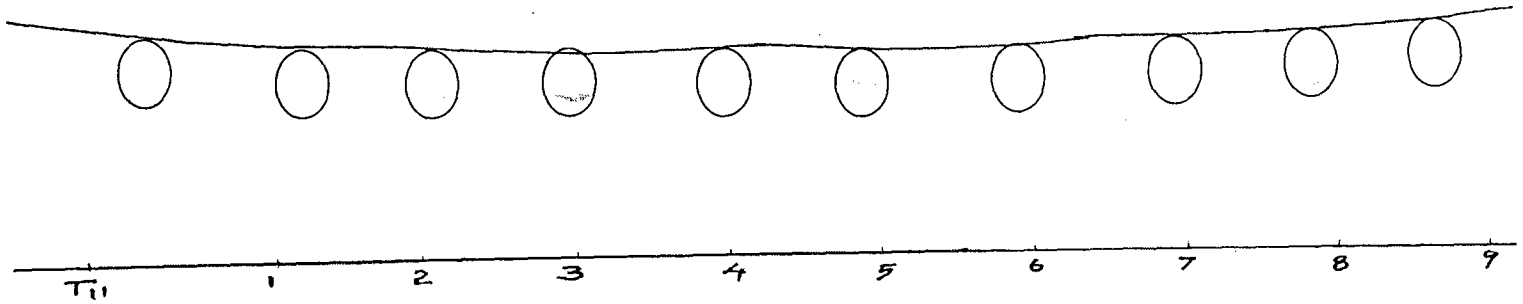


Plate 5 Contd...

IVTS – 5 x Si – 266



IVTS – 5 x Si – 722



AVTS – 8 x AVTS – 16

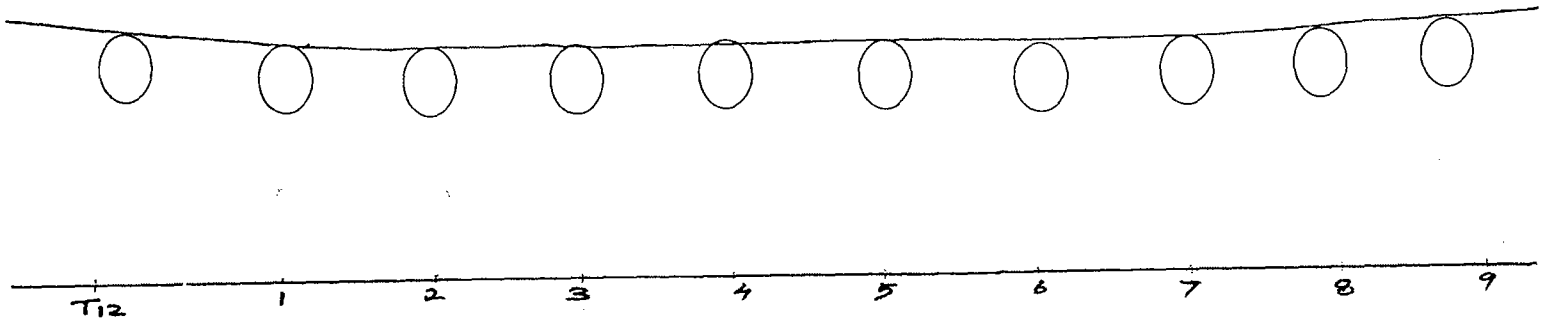
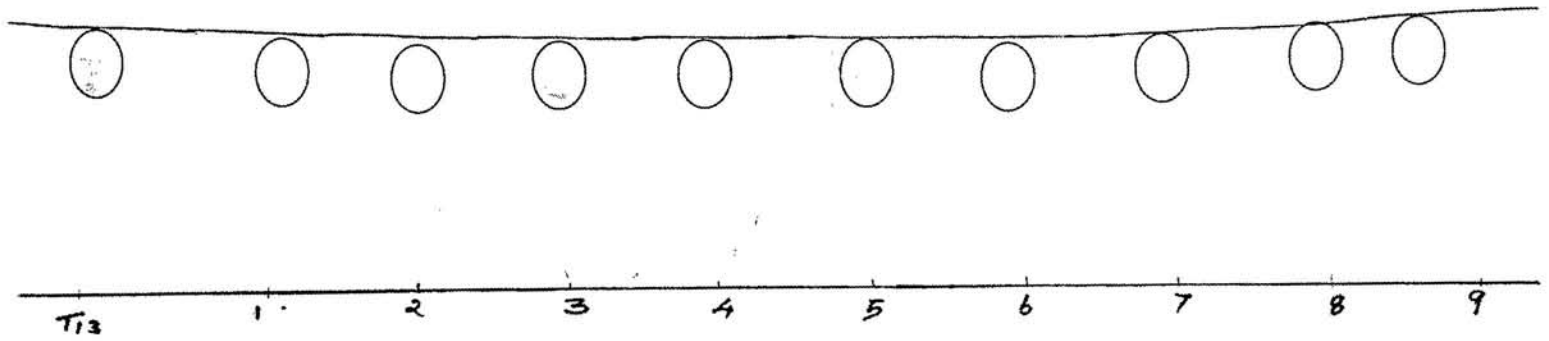
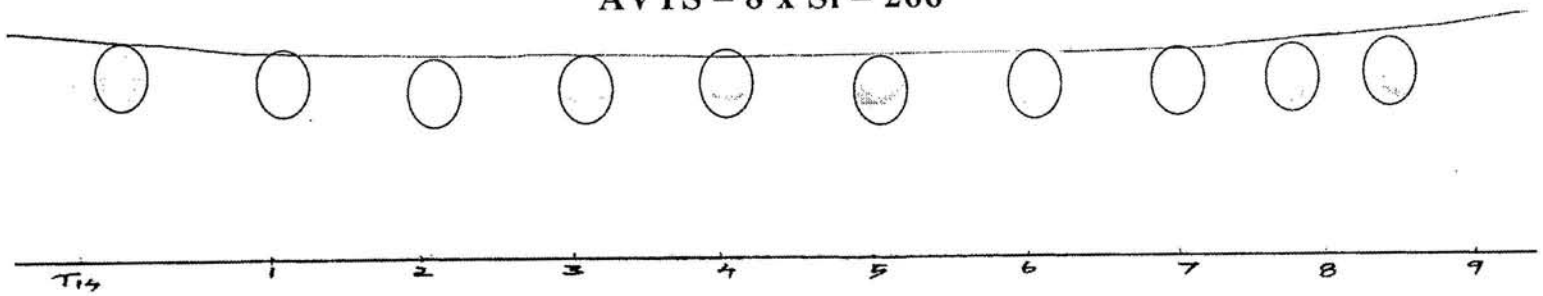


Plate 5 Contd...

AVTS – 8 x Si – 255-2



AVTS – 8 x Si – 266



AVTS – 8 x Si – 722

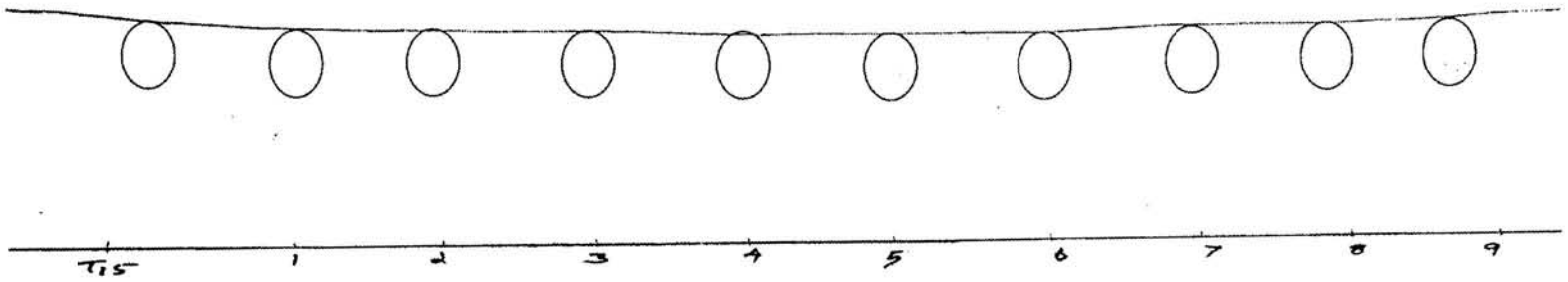
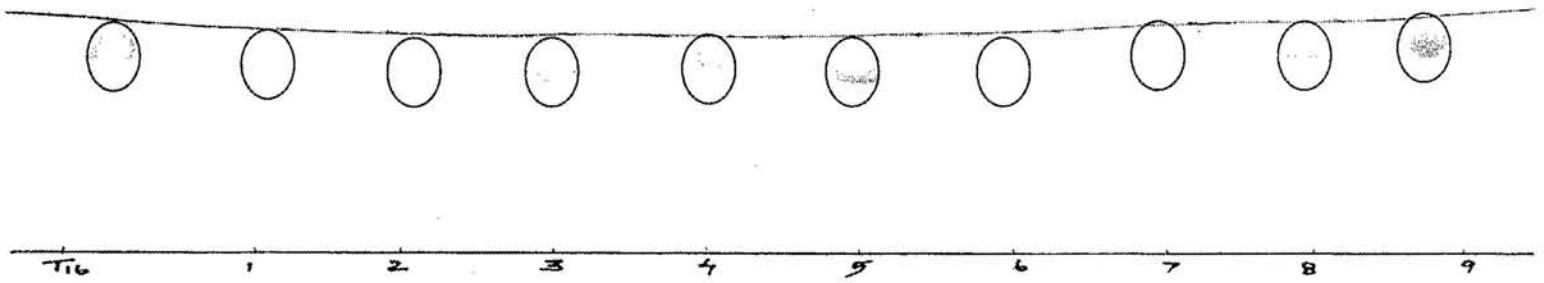
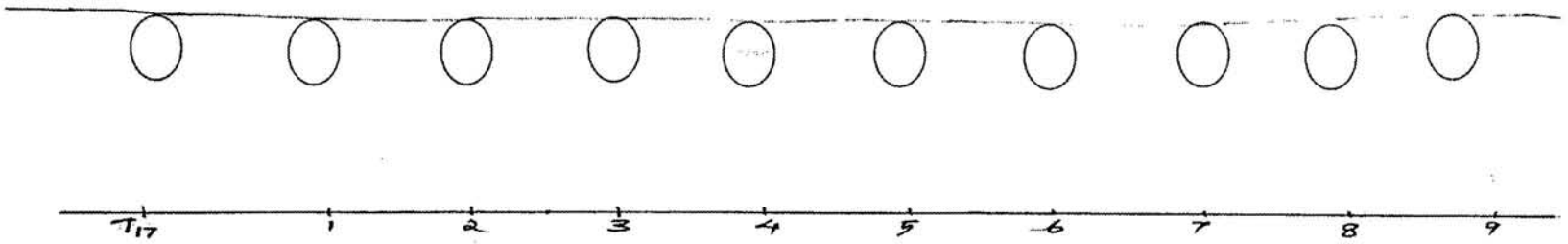


Plate 5 Contd...

AVTS – 16 x Si – 255-2



AVTS – 16 x Si – 266



AVTS – 16 x Si – 722

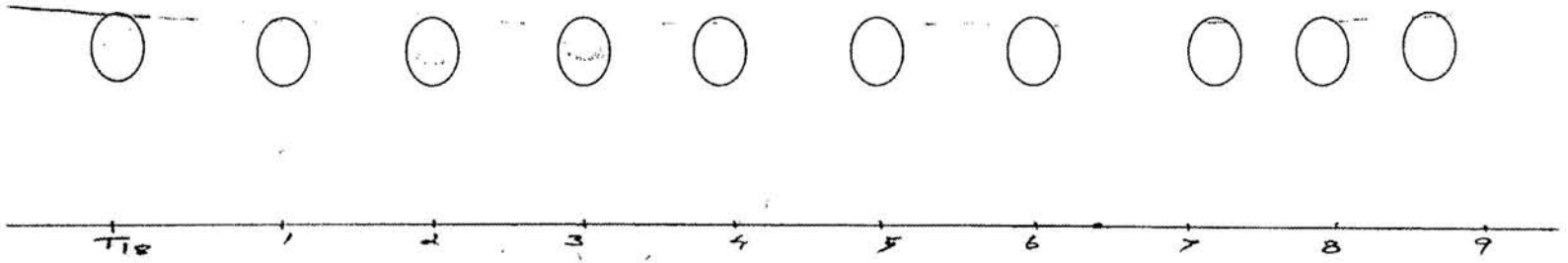
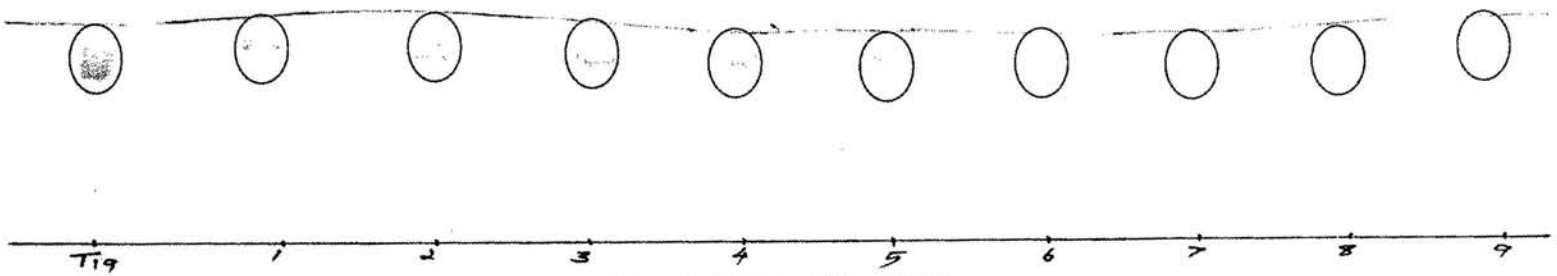
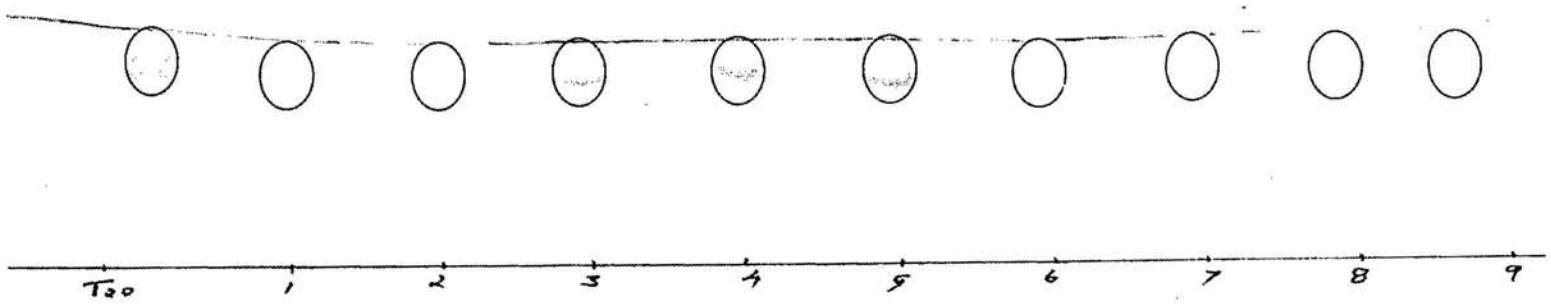


Plate 5 Contd...

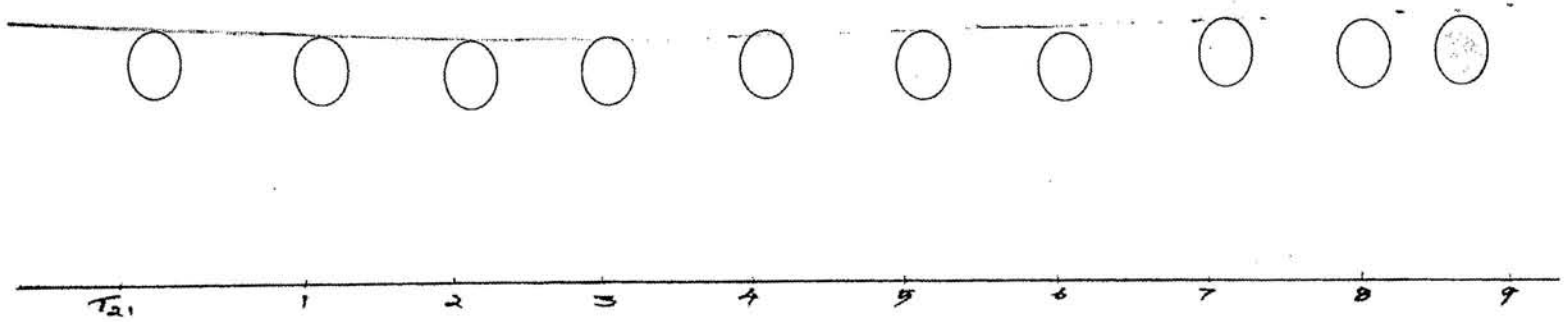
Si – 255-2 x Si – 266



Si – 255-2 x Si – 722



Si – 266 x Si – 722



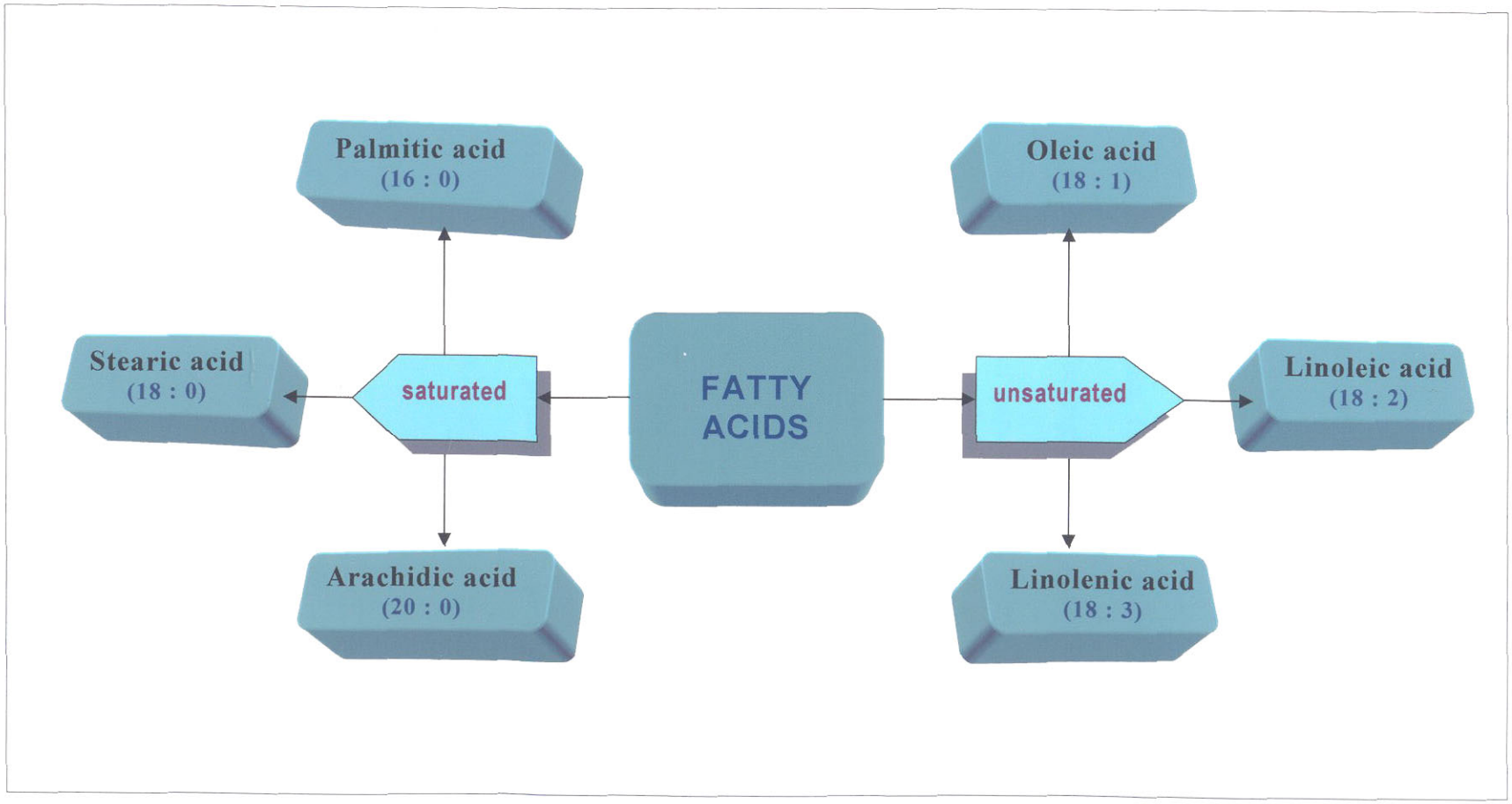


Fig.11 Fatty acid profile of sesame oil

4.2.2 Combining ability and gene action

The general combining ability effects and its variances of parents involved in hybridization and the specific combining ability effects and its variances of the hybrids were evaluated and the results are presented in Table 4.2.2 (a) to 4.2.2 (e).

The analysis of variance for combining ability revealed that the GCA and SCA were significant for eight of the characters while insignificant for number of branches, length of capsule, 1000 seed weight, acid value, peroxide value and total nitrogen.

Further the GCA was not significant for number of days taken for harvest, while its SCA was significant. Seed yield per plant, number of days taken for first flowering, seed protein percentage and saponification value. The GCA was significant while SCA was insignificant. The general combining ability variances of the parents and the specific combining ability variances of the hybrids are presented in Tables 4.2.2(b) and *gca* effects in Table 4.2.2(c), Fig. 10 and SCA effects in Table 4.2.2(d).

4.2.2.1 Plant height

The GCA and SCA were significant for plant height. All the parents except AVTS–8 (1.70) showed significant *gca* effect. Three parents *viz.* IVTS–5 (8.55), AVTS-16 (8.72) and Si–722 (2.54) showed significant positive *gca* effect while two parents *viz.* Si-255-2 (-9.26) and Si–266 (-12.25) showed significant negative *gca* effect. AVTS-16 and IVTS-5 were on par for *gca* effect and AVTS-16 was the best general combiner for this character. Significant difference in the *sca* effect of hybrids was observed.

Table 4.2.2(a) Analysis of variance of nineteen characters in six parents and 15 hybrids

Sl. No.	Character	Mean squares		
		Replication DF -2	Genotypes DF -20	Error DF-40
1	Plant height	47.59	1200.13**	33.26
2	Height upto first capsule	21.64	63.00**	18.84
3	Number of branches	0.07	1.41**	0.16
4	Capsules on main axis	27.67	68.53**	9.07
5	Number of capsules per plant	62.98	222.84**	20.02
6	Length of capsule	0.33	0.50**	0.11
7	Number of seeds per capsule	19.32	77.75**	16.75
8	Seed yield per plant	1.02	8.04**	0.40
9	Weight of capsules per plant	3.79	32.14**	3.40
10	1000 seed weight	0.38	0.29*	0.15
11	Number of days taken for first flowering	0.33	5.50	6.78
12	Number of days taken for harvest	34.09*	5.96	9.62
13	Seed oil	0.48	28.63**	0.27
14	Seed protein	0.05	5.65**	0.03
15	Acid value	0.01	0.97**	0.01
16	Saponification value	7.62*	12.01**	2.33
17	Iodine value	11.97	510.25**	4.23
18	Peroxide value	1.21**	0.88**	0.22
19	Total nitrogen	0.01	0.22**	0.01

** Significant at 1 per cent level
* Significant at five per cent level
DF- Degrees of freedom

Table 4.2.2(b) Analysis of variance for combining ability

Sl. No.	Character	Mean sum of square		
		GCA DF (5)	SCA DF (15)	Error DF (40)
1	Plant height (cm)	630.74**	323.14**	11.09
2	Height upto first capsule (cm)	41.72**	14.10**	4.61
3	Number of branches	0.33	0.52	0.05
4	Capsules on main axis	52.22**	13.05**	3.02
5	Number of capsules per plant	169.10**	42.68**	6.67
6	Length of capsule (cm)	0.28	0.13	0.04
7	Number of seeds per capsule	48.40**	18.42**	5.59
8	Seed yield per plant (gm)	6.92**	1.26	0.14
9	Weight of capsules per plant (gm)	29.71**	4.38**	1.13
10	1000 seed weight (gm)	0.19	0.07	0.05
11	Seed oil (%)	20.88**	5.77**	0.09
12	Seed protein (%)	3.87**	1.22	0.01
13	Acid value	0.74	0.18	0.01
14	Saponification value	10.88**	1.72	0.78
15	Iodine value	391.01**	96.44*	1.41
16	Peroxide value	0.28	0.30	0.07
17	Total nitrogen	0.16	0.04	0.01

*Significant at 5 per cent level
**Significant at 1 per cent level
DF – degrees of freedom

Table 4.2.2(c) Components of GCA and SCA variances and additive and dominant variances

Sl. No.	Character	σ^2gca	σ^2sca	σ^2e	Additive variance σ^2a	Dominance variance σ^2d	σ^2a / σ^2d
1	Plant height (cm)	38.45	312.05	11.08	76.90	312.05	0.25
2	Height upto first capsule (cm)	3.45	9.48	4.61	6.90	9.48	0.73
3	Capsules on main axis	4.90	10.03	3.02	9.79	10.03	0.98
4	Number of capsules per plant	15.80	36.00	6.67	31.61	36.00	0.88
5	Number of seeds per capsule	3.75	12.84	5.59	7.49	12.84	0.58
6	Seed yield per plant (gm)	0.71	1.13	0.13	1.42	1.12	1.27
7	Weight of capsules per plant (gm)	3.17	3.24	1.13	6.33	3.24	1.95
8	Seed oil (%)	1.89	5.68	0.09	3.78	5.68	0.67
9	Seed protein (%)	0.33	1.21	0.01	0.66	1.21	0.55
10	Saponification value	1.15	0.94	0.78	2.29	0.94	2.44
11	Iodine value	36.82	95.03	1.41	73.64	95.03	0.39

Table 4.2.2(d) The general combining ability (*gca*) effect of the six parents

Sl. No.	Parent	Plant height (cm)	Height upto first capsule (cm)	Number of Capsules on main axis	Number of capsules per plant	Number of seeds per capsule	Seed yield per plant (g)	Weight of capsules per plant (g)	Seed oil (%)	Seed protein (%)	Saponification value	Iodine value
1	IVTS -5	8.55**	2.99**	1.26*	3.96**	1.89*	1.27**	3.15**	0.50**	0.02	0.11	8.62**
2	AVTS-8	1.70	2.25**	-1.08	0.53	-1.24	-0.04	0.19	-0.99**	0.18**	-0.44	-7.11**
3	AVTS-16	8.72**	-2.51**	3.17**	5.73**	-2.85**	0.46**	0.26	0.80**	0.37**	-0.41	-0.27
4	Si-255-2	-9.26**	-1.64*	-4.25**	-7.22**	1.70*	-1.58**	-2.73**	0.75**	-0.24**	0.51	1.14**
5	Si-266	-12.25**	0.57	-0.40	-1.90*	2.90**	0.05	0.17	-2.77**	-1.20**	1.87**	-8.78**
6	Si-722	2.54*	-1.66*	1.29*	-1.10	-2.40**	-0.16	-1.03**	1.71**	0.87**	-1.64**	6.41**
SE (gi)		1.075	0.693	0.561	0.834	0.763	0.118	0.344	0.096	0.032	0.285	0.383
CD(gi-gj)		5.601	2.330	1.527	3.372	2.822	0.068	0.573	0.045	0.005	0.393	0.712

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

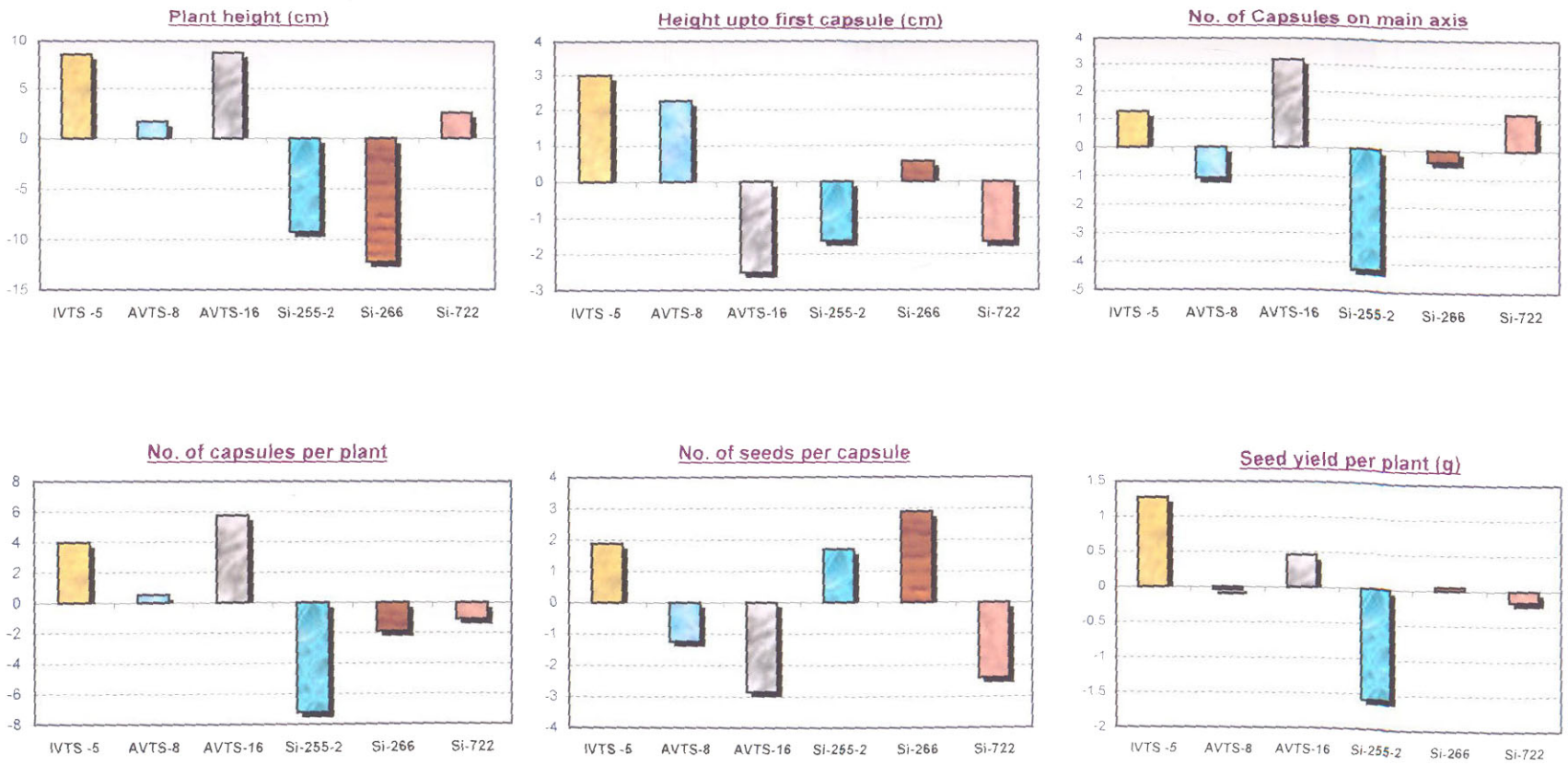


Fig. 12 General combining ability of six parents

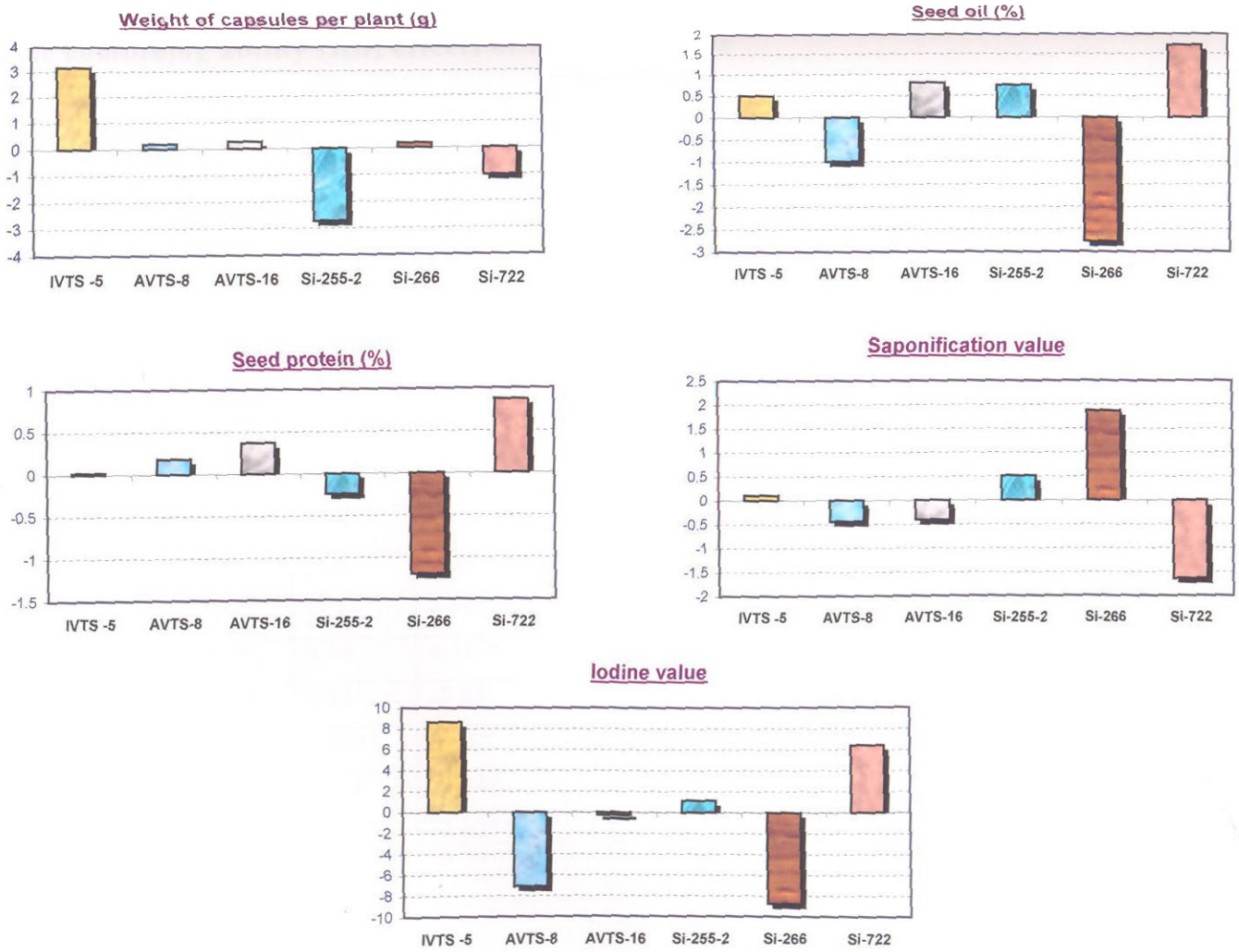


Fig. 12 General combining ability of six parents (continued)

Table 4.2.2(e) Specific combining ability (*sca*) effects of fifteen hybrids

Sl. No.	Parent	Plant height (cm)	Height upto first capsule (cm)	Number of Capsules on main axis	Number of capsules per plant	Number of seeds per capsule	Weight of capsules per plant (g)	Seed oil (%)	Iodine value
1	IVTS – 5 x AVTS – 8	-5.14*	-0.93	1.85	6.59**	5.05**	3.33**	1.74**	9.69**
2	IVTS – 5 x AVTS – 16	4.28	-2.45	-1.44	7.89**	4.41*	1.39	2.40**	1.34
3	IVTS – 5 x Si – 255-2	6.88**	5.70**	1.49	3.56	1.59	-0.02	0.67**	1.69
4	IVTS – 5 x Si – 266	13.23**	4.72**	6.01**	2.10	4.09*	-1.08	-3.99**	4.77**
5	IVTS – 5 x Si – 722	6.80**	-5.08**	-1.42	-2.62	-2.18	0.81	-3.41**	-9.16**
6	AVTS – 8 x AVTS – 16	0.55	-1.24	-6.26**	3.45	-2.98	-1.12	-0.90**	10.96**
7	AVTS – 8 x Si – 255-2	9.16**	4.44**	-2.35	-0.26	6.09**	2.93**	0.71**	-8.21**
8	AVTS – 8 x Si – 266	16.55**	2.40	2.26	8.50**	-5.69**	0.79	1.13**	-10.99**
9	AVTS – 8 x Si – 722	22.02**	-2.71	4.56**	1.72	4.66*	-1.80*	0.42	-2.67**
10	AVTS – 16 x Si – 255-2	32.58**	0.16	4.10**	5.07*	-2.81	-2.77**	0.04	9.57**
11	AVTS – 16 x Si – 266	-17.96**	0.22	-0.88	-10.30**	1.93	-0.13	-0.67**	5.95**
12	AVTS – 16 x Si – 722	-15.68**	6.34**	3.33*	1.84	-3.31	-2.01*	3.30**	-17.79**
13	Si – 255-2 x Si – 266	-12.11**	-1.56	-3.44*	-2.87	2.14	-2.33**	2.61**	-5.01**
14	Si – 255-2 x Si – 722	-21.01**	-3.89*	-3.62**	-8.52**	1.78	-0.38	-0.42	7.37**
15	Si – 266 x Si – 722	-21.17**	-2.16	-3.71**	0.97	-0.81	0.43	-3.13**	17.64**
	SE (r_{ij})	2.437	1.571	1.273	1.891	1.730	0.779	0.218	0.869
	CD (one parent in common)	8.902	5.741	4.649	6.906	6.318	2.846	0.797	3.173
	CD (different parents)	8.241	5.315	4.304	6.394	5.849	2.635	0.738	2.937

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

Among this IVTS-5 x Si-255-2 (6.88), IVTS-5 x Si-266 (13.23), IVTS-5 x Si-722 (6.80), AVTS-8 x Si-255-2 (9.16), AVTS-8 x Si-266 (16.55), AVTS-8 x Si-722 (22.02) and AVTS-16 x Si-255-2 (32.58) showed significant positive *sca* effect while IVTS-5 x AVTS-8 (-5.14), AVTS-16 x Si- 266 (-17.96), AVTS-16 x Si–722 (-15.68), Si-255 –2 x Si –266 (-12.11), Si-255-2 x Si-722 (-21.01) and Si-722 x Si –266 (-21.17) showed significant negative *sca* effects. AVTS-16 x Si-255-2 was significantly different from other hybrids and was the best specific combiner showing maximum mean plant height 142.64 cm. AVTS-8 x Si-722 and AVTS-8 x Si-266 were on par for *sca* effect. Mean height of hybrids AVTS-16 x Si-255-2 (142.64 cm) and AVTS-8 x Si-722 (136.86 cm) were on par and significantly different from other hybrids for mean value. Significant GCA and SCA variances indicate that both additive and non-additive gene action were involved in the expression of this character. The high magnitude of SCA variance indicates preponderance of non-additive gene action. The relative proportion of additive and dominance variance showed the predominance of dominance variance.

4.2.2.2 Height upto first capsule

Analysis of variance for combining ability showed that SCA and GCA were significant. A negative performance is desirable for height upto first capsule. There was significant difference among parents for height upto first capsule. Five parents showed significant *gca* effect. The parents AVTS–16 (-2.51), Si-255-2 (-1.64) and Si-722 (-1.66) showed significant negative *gca* effects and parents IVTS-5 (2.99) and AVTS-8 (2.25) showed significant positive *gca* effect. AVTS-16, Si-255-2 and Si-722 were on par for *gca* effect. The parent AVTS-16 was the best general combiner for this character.

Six hybrids showed significant *sca* effect, among this IVTS–5 x Si –722 (-5.08) and Si-255 –2 x Si –722 (-3.89) showed significant negative *sca* effect and they were on par. IVTS-5 x Si-255-2 (5.70), IVTS-5 x Si-266 (4.72), AVTS-8 x Si-255-2 (4.44) and AVTS-16 x Si-722 (6.34) showed significant positive *sca* effect. Mean value for IVTS-5 x Si-722 (37.06 cm) and Si-255-2 x Si-722 (33.62) were on par. Seven other hybrids with non-significant *sca* effect were also on par for mean height upto first capsule with the hybrid IVTS-5 x Si-722 with significant negative *sca* effect. Significant GCA and SCA variances showed that height upto first capsule is under the influence of additive as well as non-additive gene action. The high magnitude of SCA variance indicates the preponderance of non-additive gene action. The relative proportion of additive and dominance variance showed the predominance of dominance variance.

4.2.2.3 Number of branches

The GCA and SCA were not significant for this character, i.e., neither the parents did not differ in their combining ability nor their crosses.

4.2.2.4 Number of capsules on main axis

The GCA and SCA were significant for number of capsules on main axis indicating the involvement of additive and non-additive gene action. Four parents showed significant *gca* effect for number of capsules on main axis and out of this three *viz.* IVTS–5 (1.26), AVTS–16 (3.17) and Si-722 (1.29) showed significant positive *gca* effect and AVTS-16 was significantly different from other two which are on par. Only Si-255-2(-4.25) showed significant negative *gca* effect. Among the parents AVTS-16 with its

maximum *gca* effect was the best general combiner. Hybrids IVTS-5 x Si-266 (6.01), AVTS–8 x Si-722 (4.56), AVTS-16 x Si–255-2 (4.10) and AVTS–16 x Si–722 (3.33) showed significant positive *sca* effect. The mean values of these hybrids were statistically on par. AVTS-8 x AVTS-16 (-6.26), Si-255-2 x Si-266 (-3.44), Si-255-2 x Si-722 (-3.62) and Si-266 x Si-722 (-3.71) showed significant negative *sca* effect. The best specific combination was IVTS-5 x Si-266-2 with its maximum *sca* effect. The higher SCA variance indicates the preponderance of non-additive gene action over additive gene action. The components of variance indicate the predominance of dominance variance.

4.2.2.5 Number of capsules per plant

Analysis of variance for combining ability showed that GCA and SCA were significant for this character indicating the involvement of additive and non additive gene action. Two parents IVTS-5 (3.96) and AVTS-16 (5.73) showed significant positive *gca* effect and they are statistically on par while Si-255-2 (-7.22) and Si-266 (-1.90) showed significant negative *gca* effect. The best general combiner was AVTS-16 with its high *gca* effect. Hybrids IVTS-5 x AVTS-8 (6.59), IVTS–5 x AVTS-16 (7.89) and AVTS–8 x Si-266 (8.50) and AVTS-16 x Si-255–2 (5.07) showed significant positive *sca* effect. The mean values 76.24, 82.74, 72.29 and 68.74 respectively for these crosses were on par. Hybrids IVTS-5 x AVTS-16 and IVTS-5 x AVTS-8 are on par for mean value AVTS-11 x Si-266 (-10.30) and Si-255-2 x Si-722 (-8.52) showed significant negative *sca* effects. The best hybrid was AVTS-16 x Si-255-2 with maximum *sca* effect. Predominance of SCA variance indicates the predominance of non-additive gene action. Study of components of variance shows the predominance of dominance variance.

4.2.2.6 Length of capsule

The GCA and SCA were not significant for this character. Hence this character was not expected to contribute for inheritance.

4.2.2.7 Number of seeds per capsule

Mean sum of square for GCA and SCA were significant for number of seeds per capsule indicating the involvement of additive and non-additive gene action. The *gca* effects were significant for five parents and among these IVTS–5 (1.89), Si–255-2 (1.70), Si-266 (2.90) showed significant positive *gca* effect and they were statistically on par. AVTS-16 (-2.85) and Si–722 (-2.40) showed significant negative *gca* effect. Among the parents the best general combiner was Si-266 with its maximum *gca* effect. Significant positive *sca* effect were observed for IVTS –5 x AVTS–8 (5.05), IVTS-5 x AVTS-16 (4.41), IVTS-5 x Si-266 (4.09) AVTS–8 x Si-255-2 (6.09) and AVTS–8 x Si-722 (4.66) and they are statistically on par and their mean values 68.88, 66.63, 72.05, 69.77 and 64.21 respectively were on par. Significant negative *sca* effect was observed for AVTS-8 x Si-266 (-5.69). The cross AVTS-8 x Si-255-2 was the best specific combination with its high *sca* effects. High SCA variance observed for number of seeds per capsule indicates importance of non-additive gene action. Study of components of variance showed predominance of dominance variance.

4.2.2.8 Seed yield per plant

Analysis of variance showed that only GCA was significant indicating the predominant role of additive gene action. Only two parents viz., IVTS–5 (1.27) and AVTS-16 (0.46) showed significant positive *gca* effect for this

character. Si–255-2 (-1.58) showed significant negative gca effect. The parent IVTS-5 was the best general combiner with maximum gca effect. Analysis of component of variance showed the predominance of additive variance.

4.2.2.9 Weight of capsules per plant

Mean sum of square for GCA and SCA were significant for weight of capsules per plant indicating the involvement of additive and non additive gene action. Among parents, only IVTS–5 (3.15) showed significant positive gca effect where as Si–255-2 (-2.73) and Si–722 (-1.03) showed significant negative gca effect. The parent IVTS-5 was the best general combiner. Hybrids IVTS-5 x AVTS-8 (3.33) and AVTS-8 x Si-255-2 (2.93) showed significant positive *sca* effect and they are statistically on par. The mean values were 9.62 and 13.34 respectively recorded for the two hybrids had significant difference. Hybrids AVTS–8 x Si-722 (-1.80), AVTS–16 x Si-255-2 (-2.77), AVTS–16 x Si-722 (-2.01) and Si-255-2 x Si-266 (-2.33) showed significant negative *sca* effect. The best specific combiner was IVTS–5 x AVTS–8. Since GCA and SCA variances are almost equal, both additive and non-additive gene action are important in governing weight of capsules per plant. Study of components of variance in the indicated the predominance of additive variance.

4.2.2.10 1000 seed weight

The GCA of parents and the SCA of hybrids was not significant revealing the insignificance of parents involved in the hybridization for the improvement of this character.

4.2.2.11 Seed oil (%)

Analysis of variance for combining ability showed that mean sum of square for GCA and SCA were significant for seed oil content indicating the involvement of additive and non-additive gene action. All the parents showed significant *gca* effect. IVTS-5 (0.50), AVTS-16 (0.80), Si-255-2 (0.75) and Si-722 (1.71) had significant positive *gca* effect and they are not on par. Negative significant *gca* effect was observed for AVTS-8 (-0.99) and Si-266 (-2.77). The parent Si-722 was the best general combiner with maximum positive *gca* effect. Twelve out of fifteen hybrids showed significant positive *sca* effect. The hybrids IVTS-5 x AVTS-8 (1.74), IVTS–5 x AVTS-16 (2.40), IVTS-5 x Si–255-2 (0.67), AVTS-8 x Si-255–2 (0.71), AVTS-8 x Si-266 (1.13), AVTS-16 x Si-722 (3.30) and Si–255-2 x Si-266 (2.61) showed significant positive *sca* effect and there mean values were 51.89, 54.44, 52.56, 51.11, 48.00, 56.44 and 51.22 respectively. For *sca* effect AVTS-16 x Si-722 (3.30) and Si-255-2 x Si-266 (2.61) were on par and AVTS-16 x Si-722 (56.44) was significantly superior with its highest mean value. Significant negative *sca* effect was recorded for IVTS-5 x Si-266 (-3.99), IVTS-5 x Si-722 (-3.41), AVTS-8 x AVTS-16 (-0.90), AVTS-16 x Si-266 (-0.67) and Si-266 x Si-722 (-3.13). The best combination was AVTS-16 x Si-722, which recorded the maximum *sca* effect and mean value. Higher estimates of *SCA* variance indicated the preponderance of non-additive gene action. Components of variance also showed the predominance of dominance variance for seed oil percentage.

4.2.2.12 Seed protein (%)

Analysis of variance for combining ability showed significant GCA indicating the involvement of additive gene action. Except IVTS-5, all the parents showed significant *gca* effect. Parents AVTS-8 (0.18), AVTS-16 (0.37) and Si-722 (0.87) with positive *gca* effect. Parents Si-255-2 (-0.24) and Si-266 (-1.20) had negative *gca* effect. The parent Si-722 was the best general combiner. The *sca* effect was not significant. Components of variance showed the predominance of dominance variance.

4.2.2.13 Acid value

Analysis of variance for combining ability showed non-significance for GCA and SCA for acid value.

4.2.2.14 Saponification value

Analysis of variance for combining ability indicated the significance of GCA and involvement of additive gene action. Only two parents showed significant *gca* effect. They were Si-266 (1.87) and Si-722 (-1.64). The parent Si-722 was the best general combiner with its significant negative *gca* effect. The *sca* effect was not significant. Additive variance also showed much higher value compared to dominance variance. Higher estimates of *gca* showed preponderance of additive gene action for saponification value. Additive variance also showed much higher value compared to dominance variance.

4.2.2.15 Iodine value

Analysis of variance showed significant mean sum of square for GCA and SCA indicating the involvement of additive and non-additive gene action.

Significant positive gca effect was observed for IVTS–5 (8.62), Si –255-2 (1.14) and Si-722 (6.41) and they are significantly different for gca effect. Significant negative gca effect was observed for AVTS-8 (-7.11) and Si-266 (-8.78). The parent IVTS-5 was the best general combiner. Hybrids IVTS-5 x AVTS-8 (9.69), IVTS-5 x Si–266 (4.77), AVTS-8 x AVTS-16 (10.96), AVTS-16 x Si-255-2 (9.57), AVTS-16 x Si-266 (5.95), Si-255-2 x Si-722 (7.37) and Si-266 x Si-722 (17.64) showed significant positive sca effect and their mean values were 144.72, 108.12, 107.10, 113.96, 100.42, 118.74 and 118.79 respectively. Si-266 x Si-722 was significantly superior to other hybrids for sca effect and for mean value. Hybrids IVTS-5 x Si-722 (-9.16), AVTS-8 x Si-255-2 (-8.21), AVTS-8 x Si-266 (-2.67), AVTS-16 x Si-722 (-17.79) and Si-255-2 x Si-266 (-10.99), AVTS-8 x Si-722 (-2.67) showed significant negative sca effect. The best specific combination with maximum positive sca effect was Si-266 x Si-722. Higher estimate of sca efect indicate preponderance of non-additive gene action. The dominance variance was also higher than additive variance.

4.2.2.16 Peroxide value

The GCA and SCA were not significant for this character.

4.2.2.17 Total nitrogen

The GCA and SCA were not significant for this character.

4.2.3 Estimation of heterosis

All the three estimates of heterosis *viz.*, relative heterosis, heterobeltiosis and standard heterosis were estimated. Popular sesame variety

Table 4.2.3 Estimate of relative heterosis, heterobeltiosis and standard heterosis

Sl. No.	Genotypes	Plant height							Height upto first capsule						
		Mean	$\bar{F}_1 - \overline{MP}$	Relative heterosis (%)	$\bar{F}_1 - \overline{BP}$	Heterobeltiosis (%)	$\bar{F}_1 - \overline{SP}$	Standard heterosis (%)	Mean	$\bar{F}_1 - \overline{MP}$	Relative heterosis (%)	$\bar{F}_1 - \overline{BP}$	Heterobeltiosis (%)	$\bar{F}_1 - \overline{SP}$	Standard heterosis (%)
1	IVTS -5	114.68							45.82						
2	AVTS-8	92.43							44.34						
3	AVTS-16	126.16							34.28						
4	Si-255-2	84.34							34.13						
5	Si-266	96.84							40.14						
6	Si-722	130.2							41.24						
7	IVTS – 5 x AVTS – 8	115.72	12.17	11.75*	1.04	0.91	-10.40	-8.25	45.13	0.05	0.10	0.79	1.77	3.51	8.43
8	IVTS – 5 x AVTS – 16	132.15	11.73	9.74*	5.99	4.75	6.03	4.78	38.84	-1.21	-3.03	4.56	13.29	-2.78	-6.69
9	IVTS – 5 x Si – 255-2	116.78	17.27	17.35*	2.10	1.83	-9.34	-7.41	47.84	7.37	18.21*	12.71	36.19*	6.22	14.95*
10	IVTS – 5 x Si – 266	120.13	14.37	13.59*	5.45	4.75	-5.99	-4.75*	49.09	6.11	14.21*	8.95	22.29*	7.47	17.94*
11	IVTS – 5 x Si – 722	128.49	6.05	4.94	-1.71	-1.31	2.37	1.88	37.06	-6.47	-14.86*	-4.18	-10.14	-4.56	-10.96
12	AVTS – 8x AVTS – 16	121.58	12.29	11.24*	-4.58	-3.63	-4.54	-3.60	39.31	00	00	5.03	14.67	-2.31	-5.55
13	AVTS – 8 x Si – 255-2	112.21	23.83	26.96*	19.78	21.40*	-13.91	-11.03*	45. 87	6.14	15.44*	10.74	30.57*	4.25	10.21
14	AVTS – 8 x Si – 266	116.61	21.98	23.22*	19.77	20.42*	-9.51	-7.54	46.03	3.79	8.97	5.89	14.67	4.41	10.60
15	AVTS – 8 x Si – 722	136.86	25.55	22.95*	6.66	5.12	10.74	8.52*	38.69	-4.10	-9.58	-2.55	-6.18	-2.93	-7.04
16	AVTS – 16 x Si –255-2	142.64	37.39	35.53*	16.48	13.06*	16.52	13.10*	36.82	2.12	6.09	2.54	7.41	-4.8	-11.53
17	AVTS – 16 x Si – 266	89.12	-22.38	-20.07*	-37.04	-29.36*	-37.00	-29.34*	39.09	1.88	5.04	4.81	14.02	-2.53	-6.09
18	AVTS – 16 x Si – 722	106.18	-22.00	-17.16*	-24.02	-18.45*	-19.94	-15.81*	42.98	5.22	13.82	8.70	25.37*	1.36	3.27
19	Si – 255-2 x Si – 266	76.98	-13.61	-15.02*	-19.86	-20.51*	-49.14	-38.96*	38.18	0.55	1.45	3.05	8.68	-3.44	-8.27
20	Si – 255-2 x Si – 722	82.87	-24.40	-22.75*	-47.33	-36.35*	-43.25	-34.29	33.62	-4.57	-11.96	-1.51	-4.3	-8.00	-19.22*
21	Si – 266 x Si – 722	79.72	-33.80	-29.77*	-50.48	-38.77*	-46.40	-36.79	37.56	-3.13	-7.69	-2.58	-6.43	-4.06	-9.76
22	Kayamkulam –2	126.12							41.62						
CD				8.241		9.516		9.516			5.315		6.137		6.138

*Significant at five per cent level

Table 4.2.3 Contd...

Sl. No.	Genotypes	Number of branches							Number of capsules on main axis						
		Mean	$\bar{F}_1 - \overline{MP}$	Relative heterosis (%)	$\bar{F}_1 - \overline{BP}$	Heterobeltiosis (%)	$\bar{F}_1 - \overline{SP}$	Standard heterosis (%)	Mean	$\bar{F}_1 - \overline{MP}$	Relative heterosis (%)	$\bar{F}_1 - \overline{BP}$	Heterobeltiosis (%)	$\bar{F}_1 - \overline{SP}$	Standard heterosis (%)
1	IVTS -5	4.65							24.61						
2	AVTS-8	4.94							23.16						
3	AVTS-16	6.13							32.21						
4	Si-255-2	5.88							18.54						
5	Si-266	6.50							24.43						
6	Si-722	5.14							28.18						
7	IVTS – 5 x AVTS – 8	5.46	0.67	13.94*	0.52	10.59	-0.38	-6.51	27.37	3.49	14.60	2.76	11.21	0.19	0.70
8	IVTS – 5 x AVTS – 16	6.79	1.40	26.04*	0.66	10.82*	0.95	16.27*	28.34	-0.08	-0.26	-3.87	-12.03	1.16	4.27
9	IVTS – 5 x Si – 255-2	6.11	0.84	15.99*	0.23	3.86	0.26	4.62	23.85	2.27	10.52	-0.77	-3.12	-3.33	-12.25
10	IVTS – 5 x Si – 266	5.71	0.11	1.93	-0.85	-12.91*	-0.13	-2.23	32.21	7.69	31.36*	7.60	30.86*	5.03	18.51*
11	IVTS – 5 x Si – 722	6.15	1.25	25.57*	1.01	19.59*	0.31	5.30	26.47	0.07	0.28	-1.71	-6.07	-0.71	-2.61
12	AVTS – 8x AVTS – 16	5.21	-0.33	-5.87	-0.92	-15.01*	-0.63	-10.79	21.18	-6.51	-23.50*	-11.03	-34.24*	-6.00	-22.08*
13	AVTS – 8 x Si – 255-2	5.38	-0.03	-0.56	-0.50	-8.50	-0.46	-7.88	17.68	-3.17	-15.22	-5.48	-23.68*	-9.50	-34.95*
14	AVTS – 8 x Si – 266	5.96	0.21	3.65	-0.60	-9.15	0.12	2.06	26.13	2.34	9.82	1.70	6.97	-1.05	-3.86
15	AVTS – 8 x Si – 722	5.13	0.09	1.79	-0.01	-0.20	-0.37	6.34	30.12	4.45	17.34*	1.94	6.88	2.94	10.82
16	AVTS – 16 x Si –255-2	6.12	0.12	1.92	-0.01	-0.16	0.28	4.80	28.46	3.09	12.16	-3.75	-11.64	1.28	4.71
17	AVTS – 16 x Si – 266	5.03	-1.32	-20.73*	-1.53	-23.32*	-0.81	-13.87*	27.24	-1.08	-3.81	-4.97	-15.43*	0.06	0.22
18	AVTS – 16 x Si – 722	6.11	0.48	8.43	-0.02	-0.33	0.27	4.62	33.14	2.95	9.75	0.93	2.89	5.96	21.93
19	Si – 255-2 x Si – 266	4.12	-2.10	-33.76*	-2.44	-37.20*	-1.72	-29.45	17.26	-4.22	-19.66	-7.17	-29.34*	-9.92	-36.50*
20	Si – 255-2 x Si – 722	4.86	-0.65	-11.80*	-1.02	-17.35*	-0.98	-16.78*	19.13	-4.23	-18.11	-9.05	-32.12*	-8.05	-29.62*
21	Si – 266 x Si – 722	4.92	-0.93	-15.90*	-1.64	-25.00*	-0.92	-15.75*	22.53	-3.77	-14.35	-5.65	-20.05*	-4.65	17.11
22	Kayamkulam –2	5.84							27.18						
CD				0.565		0.653		0.653			4.303		4.969		4.969

*Significant at five per cent level

Table 4.2.3 Contd...

Sl. No.	Genotypes	No. of capsules per plant							Length of capsule						
		Mean	$\bar{F}_1 - \overline{MP}$	Relative heterosis (%)	$\bar{F}_1 - \overline{BP}$	Heterobeltiosis (%)	$\bar{F}_1 - \overline{SP}$	Standard heterosis (%)	Mean	$\bar{F}_1 - \overline{MP}$	Relative heterosis (%)	$\bar{F}_1 - \overline{BP}$	Heterobeltiosis (%)	$\bar{F}_1 - \overline{SP}$	Standard heterosis (%)
1	IVTS -5	64.32							2.36						
2	AVTS-8	56.22							2.41						
3	AVTS-16	72.65							2.14						
4	Si-255-2	52.24							3.21						
5	Si-266	62.16							3.11						
6	Si-722	66.26							2.12						
7	IVTS – 5 x AVTS – 8	76.24	15.97	26.50*	11.92	18.54*	7.98	11.69*	2.33	-0.06	-2.31	-0.08	-3.32	-0.39	-14.34
8	IVTS – 5 x AVTS – 16	82.74	14.26	20.82*	10.09	13.89*	14.48	21.21*	2.86	0.61	26.96*	0.50	21.05	0.14	5.15
9	IVTS – 5 x Si – 255-2	65.47	7.19	12.33*	1.15	1.78	-2.79	-4.09	3.27	0.48	17.30*	0.60	1.77	0.55	20.22*
10	IVTS – 5 x Si – 266	69.33	6.09	9.63	5.01	7.78	10.07	14.75*	3.06	0.33	12.01	-0.05	-1.50	0.34	12.50
11	IVTS – 5 x Si – 722	65.40	0.11	0.17	-0.86	-1.30	-2.86	-4.19	2.41	0.17	7.59	0.05	2.12	-0.31	-11.40
12	AVTS – 8x AVTS – 16	74.87	10.44	16.20*	2.22	3.06	2.61	9.68	2.86	0.59	25.71*	0.45	18.67	0.14	5.15
13	AVTS – 8 x Si – 255-2	58.22	3.99	7.36	2.00	3.56	-10.04	-14.71*	3.16	0.35	12.57	-0.05	-1.45	0.44	16.18
14	AVTS – 8 x Si – 266	72.29	13.10	22.13*	10.13	16.30*	4.03	5.90	2.89	0.13	4.71	-0.22	-7.07	0.17	6.25
15	AVTS – 8 x Si – 722	66.31	5.07	8.28	0.05	0.08	-1.95	-2.86	2.63	0.37	16.12	0.22	9.13	-0.09	-3.31
16	AVTS – 16 x Si –255-2	68.74	6.30	10.08	-3.91	-5.82	0.48	0.70	2.11	-0.57	-21.12*	-1.10	-34.27*	-0.61	-22.43*
17	AVTS – 16 x Si – 266	58.69	-8.72	-12.93*	-13.96	-19.22*	-9.57	-14.02*	2.98	0.36	13.52	-0.13	-4.18	0.26	9.56
18	AVTS – 16 x Si – 722	71.63	2.18	3.13	-1.02	-1.40	3.37	4.94	2.88	0.75	35.21*	0.74	34.58*	0.16	5.88
19	Si – 255-2 x Si – 266	53.18	-4.02	-7.03	-8.98	-14.45*	-15.08	-22.09*	3.22	0.06	1.90	0.01	0.31	0.50	18.38
20	Si – 255-2 x Si – 722	48.32	-10.93	-18.45*	-17.94	-27.08*	-19.94	-29.21*	2.89	0.23	8.44	-0.32	-9.97	0.17	6.25
21	Si – 266 x Si – 722	63.13	-1.08	-1.68	-3.13	-4.72	-5.13	-7.52	2.14	-0.48	-18.16*	-0.97	-31.19	-0.58	-21.32*
22	Kayamkulam –2	68.26							2.72						
CD				6.393		7.383		7.383			0.473		0. 546		0.547

*Significant at five per cent level

Table 4.2.3 Contd...

Sl. No.	Genotypes	No. of seeds per capsule							Seed yield per plant						
		Mean	$\bar{F}_1 - \overline{MP}$	Relative heterosis (%)	$\bar{F}_1 - \overline{BP}$	Heterobeltiosis (%)	$\bar{F}_1 - \overline{SP}$	Standard heterosis (%)	Mean	$\bar{F}_1 - \overline{MP}$	Relative heterosis (%)	$\bar{F}_1 - \overline{BP}$	Heterobeltiosis (%)	$\bar{F}_1 - \overline{SP}$	Standard heterosis (%)
1	IVTS -5	60.48							9.28						
2	AVTS-8	57.14							6.77						
3	AVTS-16	58.86							10.11						
4	Si-255-2	62.18							5.24						
5	Si-266	68.15							8.19						
6	Si-722	58.32							8.12						
7	IVTS – 5 x AVTS – 8	68.88	10.07	17.12*	8.40	13.88*	3.70	5.67	10.20	2.18	27.10*	0.92	9.91	1.07	11.72*
8	IVTS – 5 x AVTS – 16	66.63	6.96	11.66*	6.14	10.16	1.45	2.23	10.99	1.30	13.40*	0.88	8.74	1.86	20.37*
9	IVTS – 5 x Si – 255-2	68.35	7.02	11.45*	6.17	9.93	3.17	4.86	8.33	1.07	14.70*	-0.95	-10.27	-0.80	-8.76
10	IVTS – 5 x Si – 266	72.05	7.74	12.03*	3.90	5.73	6.87	10.54*	9.56	0.83	9.45	0.28	3.02	0.43	4.71
11	IVTS – 5 x Si – 722	60.50	1.10	1.84	0.01	0.02	-4.68	-7.78	8.95	0.25	2.91	-0.33	-3.52	-0.18	-1.97
12	AVTS – 8x AVTS – 16	56.12	-1.88	-3.24	-2.74	-4.66	-9.06	-13.90*	7.81	-0.63	-7.46	-2.30	-22.75*	-1.32	-14.46*
13	AVTS – 8 x Si – 255-2	69.73	10.07	10.88*	7.55	12.14*	4.55	6.98	8.13	2.13	35.39*	1.36	20.09*	-1.00	-10.95
14	AVTS – 8 x Si – 266	59.16	-3.49	-5.56	-8.99	-13.19*	-6.02	-9.24	9.23	1.75	23.40*	1.04	12.70	0.10	1.10
15	AVTS – 8 x Si – 722	64.21	6.48	11.23*	5.89	10.10	-0.97	-1.49	7.24	-0.21	-2.75	-0.88	-10.84	-1.89	-20.70*
16	AVTS – 16 x Si –255-2	59.22	-1.30	-2.15	-2.96	-4.76	-5.96	-9.14	5.11	-2.57	-33.42*	-5.00	-49.46*	-4.02	-44.03*
17	AVTS – 16 x Si – 266	65.16	1.66	2.61	-2.99	-4.39	-0.02	-0.03	8.36	-0.79	-8.63	-1.75	-17.31	-0.77	-8.43
18	AVTS – 16 x Si – 722	54.62	-3.97	-6.78	-4.24	-7.20	-10.56	-16.20*	7.63	-1.49	-16.29*	-2.48	-24.53*	-1.50	-16.43*
19	Si – 255-2 x Si – 266	69.92	4.76	7.30	1.77	2.60	4.74	7.27	5.04	-1.68	-24.94*	-3.15	-38.46*	-4.09	-44.80*
20	Si – 255-2 x Si – 722	64.26	4.01	6.66	2.08	3.35	-0.92	-1.41	6.77	0.09	1.35	-1.35	-16.63	-2.36	-25.84*
21	Si – 266 x Si – 722	62.87	-0.37	-0.58	-5.28	-7.75	-2.31	3.54	8.32	0.17	2.02	0.13	1.59	-0.81	-8.87
22	Kayamkulam –2	65.18							9.13						
CD				5.849		6.754		6.754			0.908		1.048		1.048

*Significant at five per cent level

Table 4.2.3 Contd...

Sl. No.	Genotypes	Weight of capsules per plant							1000 seed weight						
		Mean	$\bar{F}_1 - \bar{MP}$	Relative heterosis (%)	$\bar{F}_1 - \bar{BP}$	Heterobeltiosis (%)	$\bar{F}_1 - \bar{SP}$	Standard heterosis (%)	Mean	$\bar{F}_1 - \bar{MP}$	Relative heterosis (%)	$\bar{F}_1 - \bar{BP}$	Heterobeltiosis (%)	$\bar{F}_1 - \bar{SP}$	Standard heterosis (%)
1	IVTS -5	17.04							2.93						
2	AVTS-8	11.28							2.57						
3	AVTS-16	15.81							2.68						
4	Si-255-2	8.78							3.12						
5	Si-266	14.45							3.11						
6	Si-722	12.37							2.32						
7	IVTS – 5 x AVTS – 8	19.62	5.46	38.56*	2.58	15.14	3.86	24.49*	2.96	0.21	7.64	0.03	1.02	-0.06	-1.99
8	IVTS – 5 x AVTS – 16	17.75	1.33	8.09	0.71	4.19	1.99	12.65	3.06	0.26	9.21	0.13	4.55	0.04	1.44
9	IVTS – 5 x Si – 255-2	13.35	0.44	3.38	-3.69	-21.67*	-2.41	-15.31	3.33	0.31	10.08	0.21	6.73	0.31	10.27
10	IVTS – 5 x Si – 266	15.19	-0.55	-3.50	-1.85	-10.84	-0.57	-3.60	2.98	-0.04	-1.44	-0.13	-4.29	-0.04	-1.44
11	IVTS – 5 x Si – 722	15.88	1.18	8.01	-1.16	-6.79	0.12	0.78	2.46	-0.16	-6.16	-0.47	-15.93	-0.56	-18.43
12	AVTS – 8x AVTS – 16	12.29	-1.26	-9.27	-3.52	-22.26*	-3.47	-22.02*	2.77	0.15	5.52	0.09	3.36	-0.25	-8.28
13	AVTS – 8 x Si – 255-2	13.34	3.31	33.00*	2.06	18.26	-2.42	-15.39	2.77	-0.08	-2.64	-0.35	-11.22	-0.25	-8.28
14	AVTS – 8 x Si – 266	14.11	1.25	9.68	-0.34	-2.35	-1.65	-10.47	3.16	0.32	11.27	0.05	1.61	0.14	4.64
15	AVTS – 8 x Si – 722	10.32	-1.5	-12.73	-2.05	-16.57	-5.44	-34.52*	2.39	-0.06	-2.25	-0.18	-7.00	-0.63	-20.86*
16	AVTS – 16 x Si –255-2	7.72	-4.58	-37.21*	-8.09	-51.17*	-8.04	-51.02*	2.16	-0.74	-25.52*	-0.96	-30.77*	-0.86	-28.48*
17	AVTS – 16 x Si – 266	13.26	-1.87	-12.36	-2.55	-16.13	-2.50	-15.86	2.88	-0.02	-0.52	-0.23	-7.40	-0.14	-4.64
18	AVTS – 16 x Si – 722	10.18	-3.91	-27.75*	-5.63	-35.61*	-5.58	-35.41*	2.91	0.41	16.40	0.23	8.58	-0.11	-3.64
19	Si – 255-2 x Si – 266	8.06	-3.56	-30.61*	-6.39	-44.22*	-7.70	-48.86*	3.14	0.03	0.80	0.03	0.64	0.12	3.97
20	Si – 255-2 x Si – 722	8.81	-1.77	-16.69	-3.56	-28.78*	-6.95	-44.10*	2.63	-0.09	-3.31	-0.49	-15.71	-0.39	-12.91
21	Si – 266 x Si – 722	12.52	-0.89	-6.64	-1.93	-13.36	-3.24	-20.56*	2.81	0.10	3.50	-0.30	-9.65	-0.21	-6.95
22	Kayamkulam –2	15.76							3.02						
CD				2.635		3.042		3.042			0.543		0.627		0.627

*Significant at five per cent level

Table 4.2.3 Contd...

Sl. No.	Genotypes	No. of days taken for first flowering							No. of days taken for harvest						
		Mean	$\overline{F_1} - \overline{MP}$	Relative heterosis (%)	$\overline{F_1} - \overline{BP}$	Heterobeltiosis (%)	$\overline{F_1} - \overline{SP}$	Standard heterosis (%)	Mean	$\overline{F_1} - \overline{MP}$	Relative heterosis (%)	$\overline{F_1} - \overline{BP}$	Heterobeltiosis (%)	$\overline{F_1} - \overline{SP}$	Standard heterosis (%)
1	IVTS -5	37.40							88.42						
2	AVTS-8	38.20							89.92						
3	AVTS-16	36.12							89.30						
4	Si-255-2	35.18							88.44						
5	Si-266	38.12							86.22						
6	Si-722	38.29							88.79						
7	IVTS – 5 x AVTS – 8	38.81	1.01	2.67	1.41	3.77	1.03	2.73	87.55	-1.62	-1.82	1.33	1.54	-0.38	-0.43
8	IVTS – 5 x AVTS – 16	37.64	0.88	2.40	1.52	4.22	-0.14	-0.36	90.4	1.54	1.73	4.18	4.85	2.47	2.81
9	IVTS – 5 x Si – 255-2	36.17	-0.12	-0.32	0.99	2.82	-1.61	-4.25	85.62	-2.81	-3.17	-0.60	-0.69	-2.31	-2.62
10	IVTS – 5 x Si – 266	38.50	0.74	1.95	1.10	2.93	0.72	1.90	87.82	0.50	0.57	1.60	1.86	-0.11	-0.13
11	IVTS – 5 x Si – 722	39.15	1.31	3.45	1.75	4.68	1.37	3.63	89.01	0.40	0.45	2.79	3.23	1.08	1.22
12	AVTS – 8x AVTS – 16	35.72	-1.44	-3.88	-4.00	-1.11	-2.06	-5.45	88.61	-1.00	-1.11	2.39	2.77	0.68	0.77
13	AVTS – 8 x Si – 255-2	37.89	1.20	3.27	2.71	7.70	0.11	0.29	90.26	1.08	1.21	4.04	4.69	2.33	2.65
14	AVTS – 8 x Si – 266	37.63	-0.53	-1.39	-0.49	-1.29	-0.15	-0.40	89.20	1.14	1.29	2.98	3.46	1.27	1.45
15	AVTS – 8 x Si – 722	38.93	0.69	1.79	0.73	1.91	1.15	3.04	85.50	-3.85	-4.31	-0.72	-0.84	-2.43	-2.76
16	AVTS – 16 x Si –255-2	35.02	-0.63	-1.77	-0.16	-0.46	-2.76	-7.31	89.80	0.93	1.05	3.58	4.15	1.87	2.13
17	AVTS – 16 x Si – 266	36.01	-1.11	-2.99	-0.11	-0.31	-1.77	-4.69	89.40	1.64	1.87	3.18	3.69	1.47	1.67
18	AVTS – 16 x Si – 722	38.42	1.22	3.27	2.30	6.37	0.64	1.69	87.61	-1.44	-1.61	1.39	1.61	-0.32	-0.36
19	Si – 255-2 x Si – 266	38.04	-1.43	-3.90	0.04	0.11	-2.56	-6.78	87.43	0.10	0.11	1.21	1.40	-0.50	-0.57
20	Si – 255-2 x Si – 722	35.22	1.91	5.19	3.46	9.84	0.86	2.28	87.25	-1.37	-1.54	1.03	1.20	-0.68	-0.77
21	Si – 266 x Si – 722	37.32	-0.89	-2.32	-0.80	-0.09	-0.46	-1.22	88.91	1.41	1.61	2.69	3.12	0.98	1.12
22	Kayamkulam – 2	37.78							87.93						
CD				3.722		4.297		4.297			4.433		5.118		5.118

*Significant at five per cent level

Table 4.2.3 Contd...

Sl. No.	Genotypes	Seed oil (%)							Seed protein (%)						
		Mean	$\bar{F}_1 - \bar{MP}$	Relative heterosis (%)	$\bar{F}_1 - \bar{BP}$	Heterobeltiosis (%)	$\bar{F}_1 - \bar{SP}$	Standard heterosis (%)	Mean	$\bar{F}_1 - \bar{MP}$	Relative heterosis (%)	$\bar{F}_1 - \bar{BP}$	Heterobeltiosis (%)	$\bar{F}_1 - \bar{SP}$	Standard heterosis (%)
1	IVTS -5	52.89							19.70						
2	AVTS-8	47.11							21.90						
3	AVTS-16	50.11							20.95						
4	Si-255-2	50.33							20.80						
5	Si-266	47.11							19.33						
6	Si-722	55.67							22.20						
7	IVTS – 5 x AVTS – 8	51.89	1.89	3.78*	-1.00	-1.89*	-2.89	-5.28*	22.12	1.32	6.35*	0.22	1.00	0.22	1.00
8	IVTS – 5 x AVTS – 16	54.44	2.93	5.72*	1.55	2.94*	-0.34	-0.62	21.39	1.06	5.23*	0.44	2.10*	-0.51	-2.34*
9	IVTS – 5 x Si – 255-2	52.56	0.95	1.83*	-0.33	-0.63	-2.22	-4.06*	22.27	2.02	9.06*	1.47	7.05*	0.37	1.67*
10	IVTS – 5 x Si – 266	44.38	-5.62	-11.24*	-8.51	-16.09*	-10.40	-18.99*	18.45	-1.07	-5.48*	-1.26	-6.38*	-3.46	-15.78*
11	IVTS – 5 x Si – 722	49.44	-4.84	-8.92*	-6.23	-11.19*	-5.34	-9.74*	22.34	1.39	6.65*	0.15	0.66	0.44	2.01*
12	AVTS – 8x AVTS – 16	49.56	0.95	1.95*	-0.55	-1.10	-5.22	-9.54*	21.98	0.55	2.57*	0.07	0.34	0.07	0.34
13	AVTS – 8 x Si – 255-2	51.11	2.39	4.91*	0.78	1.55	-3.67	-6.70*	18.37	-2.98	-13.96*	-3.53	-16.12*	-3.53	-16.12*
14	AVTS – 8 x Si – 266	48.00	0.89	1.89*	0.89	1.89*	-6.78	-12.38*	19.85	-0.77	-3.72*	-2.05	-9.38*	-2.05	-9.38*
15	AVTS – 8 x Si – 722	51.78	0.39	0.75	-3.89	-6.99*	-3.00	-5.48*	21.10	-0.95	-4.32*	-1.10	-4.96*	-0.81	-3.68*
16	AVTS – 16 x Si -255-2	52.22	2.00	3.99*	1.89	3.76*	-2.56	-4.67*	21.48	0.61	2.91*	0.53	2.55*	-0.42	-1.92*
17	AVTS – 16 x Si – 266	48.00	-0.61	-1.26	-2.11	-4.21*	-6.78	-12.38*	20.14	0.01	0.02	-0.81	-3.85*	-1.76	-8.04*
18	AVTS – 16 x Si – 722	56.44	3.55	6.72*	0.77	1.39	1.66	3.04*	21.90	0.33	1.53*	-0.29	-1.32*	00.00	00.00
19	Si – 255-2 x Si – 266	51.22	2.50	5.13*	0.89	1.77*	-3.56	-6.50*	18.15	-1.91	-9.54*	-2.65	-12.74*	-3.75	-17.12*
20	Si – 255-2 x Si – 722	52.67	-0.33	-0.62	-3.00	-5.39*	-2.11	-3.85*	22.05	0.55	2.56*	-0.15	-0.66	0.15	0.67
21	Si – 266 x Si – 722	46.44	-4.95	-9.63*	-9.23	-16.57*	-8.34	-15.22*	20.95	0.19	0.90	-1.25	-5.62*	-0.95	-4.35*
22	Kayamkulam –2	54.78							21.90						
CD				0.737		0.851		0.582			0.245		0.283		0.283

Table 4.2.3 Contd...

Sl. No.	Genotypes	Acid value							Saponification value						
		Mean	$\overline{F_1} - \overline{MP}$	Relative heterosis (%)	$\overline{F_1} - \overline{BP}$	Heterobeltiosis (%)	$\overline{F_1} - \overline{SP}$	Standard heterosis (%)	Mean	$\overline{F_1} - \overline{MP}$	Relative heterosis (%)	$\overline{F_1} - \overline{BP}$	Heterobeltiosis (%)	$\overline{F_1} - \overline{SP}$	Standard heterosis (%)
1	IVTS -5	2.36							190.47						
2	AVTS-8	2.97							188.55						
3	AVTS-16	4.21							188.40						
4	Si-255-2	3.46							192.11						
5	Si-266	2.56							193.55						
6	Si-722	3.09							188.17						
7	IVTS – 5 x AVTS – 8	2.85	0.18	6.88*	0.49	20.09*	-0.37	-11.41*	192.14	2.63	1.39*	3.60	1.91*	1.40	0.74
8	IVTS – 5 x AVTS – 16	3.50	0.22	6.55*	1.14	48.37*	0.28	8.82*	190.74	1.30	0.69	2.34	1.24	00	00
9	IVTS – 5 x Si – 255-2	3.62	0.72	24.66*	1.27	53.75*	0.41	12.76*	190.74	-0.55	-0.29	0.27	0.14	00	00
10	IVTS – 5 x Si – 266	2.81	0.35	14.09*	0.45	19.10*	-0.41	-12.66*	193.55	1.54	0.80	3.08	1.62*	2.81	1.47*
11	IVTS – 5 x Si – 722	2.99	0.27	9.79*	0.63	26.87*	-0.22	-6.95*	189.34	0.12	0.01	1.17	0.62	-1.40	-0.73
12	AVTS – 8x AVTS – 16	4.40	0.81	22.53*	1.43	48.04*	1.18	36.83*	190.74	2.27	1.20*	2.34	1.24	00	00
13	AVTS – 8 x Si – 255-2	3.40	0.19	5.91*	0.43	14.59*	0.19	5.91*	190.74	0.41	0.22	2.19	1.16	00	00
14	AVTS – 8 x Si – 266	2.86	0.09	3.37	0.30	11.57*	-0.35	-11.0*	193.55	2.50	1.31*	5.00	2.61*	2.81	1.47*
15	AVTS – 8 x Si – 722	2.57	-0.46	-15.29*	-0.40	-13.58*	-0.65	-20.12*	188.87	0.52	0.27	0.70	0.37	-1.87	-0.98
16	AVTS – 16 x Si –255-2	3.22	-0.62	-16.14*	-0.24	-7.04*	0.01	0.31	190.74	0.48	0.25	2.34	1.24	00	00
17	AVTS – 16 x Si – 266	4.22	0.84	24.67*	1.66	64.63*	1.01	31.33*	194.95	3.98	2.08*	6.55	3.47*	4.21	2.21*
18	AVTS – 16 x Si – 722	2.92	-0.73	-20.06*	-0.17	-5.61*	-0.30	-9.23*	189.34	1.05	0.56	1.17	0.62	-1.40	-0.73
19	Si – 255-2 x Si – 266	3.55	0.54	17.94*	1.00	38.49*	0.34	10.48*	193.55	0.72	0.37	1.44	0.75	2.81	1.47*
20	Si – 255-2 x Si – 722	3.24	-0.04	-1.12	0.45	4.75*	0.02	0.73	190.74	0.60	0.32	2.57	1.37*	00	00
21	Si – 266 x Si – 722	2.58	-0.25	-8.73*	0.12	0.65	-0.63	-19.71*	188.87	-1.99	-1.04	0.70	0.37	-1.87	-0.98
22	Kayamkulam –2	3.21							190.74						
CD				0.129		0.149		0.149			2.181		2.519		2.519

*Significant at five per cent level

Table 4.2.3 Contd...

Sl. No.	Genotypes	Iodine value							Peroxide value						
		Mean	$\bar{F}_1 - \bar{MP}$	Relative heterosis (%)	$\bar{F}_1 - \bar{BP}$	Heterobeltiosis (%)	$\bar{F}_1 - \bar{SP}$	Standard heterosis (%)	Mean	$\bar{F}_1 - \bar{MP}$	Relative heterosis (%)	$\bar{F}_1 - \bar{BP}$	Heterobeltiosis (%)	$\bar{F}_1 - \bar{SP}$	Standard heterosis (%)
1	IVTS -5	116.59							3.50						
2	AVTS-8	87.25							4.00						
3	AVTS-16	97.97							4.67						
4	Si-255-2	103.09							4.33						
5	Si-266	79.78							4.00						
6	Si-722	115.99							4.67						
7	IVTS – 5 x AVTS – 8	114.72	12.80	12.56*	-1.87	-1.61	9.22	8.74*	5.33	-0.17	-4.76	0.33	11.11*	-0.67	-16.67*
8	IVTS – 5 x AVTS – 16	113.21	5.93	5.52*	-3.39	-2.91	7.71	7.31*	5.00	1.67	30.44*	2.00	66.67*	1.00	25.00*
9	IVTS – 5 x Si – 255-2	114.97	5.13	4.67*	-1.62	-1.39	9.47	8.98*	4.67	1.00	27.27*	1.67	55.56*	0.67	16.67*
10	IVTS – 5 x Si – 266	108.12	9.94	10.12*	-8.47	-7.27*	2.62	2.49	4.33	0.83	23.81*	1.33	44.44*	0.33	8.33*
11	IVTS – 5 x Si – 722	109.39	-6.90	-5.93*	-7.20	-6.18*	3.89	3.69*	4.33	0.50	13.04	1.33	44.44*	0.33	8.33*
12	AVTS – 8x AVTS – 16	107.10	14.49	15.65*	9.13	9.32*	1.61	1.52	4.67	0.33	7.69	0.67	16.67*	0.67	16.67*
13	AVTS – 8 x Si – 255-2	89.34	-5.83	-6.13*	-15.75	-13.34*	-16.16	-15.32*	4.00	-0.17	-4.00	0.00	0.00	00	00
14	AVTS – 8 x Si – 266	76.65	-6.87	-8.22*	-10.61	-12.16*	-28.85	-27.35*	4.33	0.33	8.33	0.33	8.33*	0.33	8.33*
15	AVTS – 8 x Si – 722	105.50	3.88	3.82*	-10.49	-9.04*	00	00	4.67	0.33	7.69	0.67	16.67*	0.67	16.67*
16	AVTS – 16 x Si –255-2	113.96	13.43	13.35*	10.86	10.54*	8.46	8.02*	4.33	-0.17	-3.70	0.00	0.00	0.33	8.33*
17	AVTS – 16 x Si – 266	100.42	11.55	12.99*	2.45	2.50	-5.08	-4.81*	3.00	-1.33	-30.77	-1.00	-25.00*	-1.00	-25.00*
18	AVTS – 16 x Si – 722	91.87	-15.11	-14.12*	-24.11	-20.79*	-13.62	-12.91*	4.33	-0.33	-7.14	-0.33	-7.14*	0.33	8.33*
19	Si – 255-2 x Si – 266	90.87	-0.57	-0.62	-12.22	-11.86*	-14.63	-13.87*	4.00	-0.17	-4.00	0.00	0.00	00	00
20	Si – 255-2 x Si – 722	118.44	8.90	8.13*	2.46	2.12	12.95	12.27*	4.33	-0.17	-3.7	0.00	0.00	0.33	8.33*
21	Si – 266 x Si – 722	118.79	20.91	21.36*	2.80	2.41	13.29	12.60*	4.67	0.33	7.69	0.67	16.67*	0.67	16.67*
22	Kayamkulam –2	105.50							4.00						
CD				2.937		3.391		3.391			0.674		0.077		0.077

*Significant at five per cent level

Table 4.2.3 Contd...

Sl. No.	Genotypes	Total nitrogen						
		Mean	$\bar{F}_1 - \bar{MP}$	Relative heterosis (%)	$\bar{F}_1 - \bar{BP}$	Heterobeltiosis (%)	$\bar{F}_1 - \bar{SP}$	Standard heterosis (%)
1	IVTS -5	3.71						
2	AVTS-8	4.13						
3	AVTS-16	3.95						
4	Si-255-2	3.92						
5	Si-266	3.65						
6	Si-722	4.34						
7	IVTS – 5 x AVTS – 8	4.17	0.25	6.37*	0.40	0.97*	0.04	0.97
8	IVTS – 5 x AVTS – 16	3.84	0.01	0.13	-0.11	-2.87	-0.30	-7.18*
9	IVTS – 5 x Si – 255-2	4.20	0.38	10.00*	0.28	7.05*	0.07	1.61
10	IVTS – 5 x Si – 266	3.48	-0.20	-5.53*	-0.24	-6.37*	-0.66	-15.89*
11	IVTS – 5 x Si – 722	4.21	0.19	4.68*	-0.12	-2.84	0.08	1.94
12	AVTS – 8x AVTS – 16	4.15	0.11	2.60	0.01	0.32	0.01	0.32
13	AVTS – 8 x Si – 255-2	3.46	-0.57	-14.03*	-0.67	-16.21*	-0.67	-16.21*
14	AVTS – 8 x Si – 266	3.75	-0.14	-3.60	-0.38	-9.27*	-0.38	-9.27*
15	AVTS – 8 x Si – 722	3.98	-0.26	-6.10*	-0.36	-8.30*	-0.16	-3.79
16	AVTS – 16 x Si –255-2	4.05	0.11	2.88	0.10	2.53	-0.08	-2.02
17	AVTS – 16 x Si – 266	3.80	0.01	0.13	-0.15	-3.71	-0.33	-7.98*
18	AVTS – 16 x Si – 722	4.13	-0.01	-0.24	-0.20	-4.69*	00	00
19	Si – 255-2 x Si – 266	3.42	-0.36	-9.56*	-0.50	-12.74*	-0.71	-17.18*
20	Si – 255-2 x Si – 722	4.16	0.03	0.73	-0.18	-4.07*	0.03	0.65
21	Si – 266 x Si – 722	3.95	-0.04	-1.04	-0.39	-8.92*	-0.18	-4.44*
22	Kayamkulam – 2	4.13						
CD				0.148		0.171		0.171

*Significant at five per cent level

of Kerala, Kayamkulam-2 was taken as standard for estimating the standard heterosis. The results obtained are presented in Table 4.2.3.

4.2.3.1 Plant height

For plant height percentage of relative heterosis ranged from –29.77 (Si-266 x Si-722) to 35.53 (AVTS-16 x Si-255-2). Nine hybrids showed significant positive and five hybrids showed significant negative relative heterosis and one was not significant. Heterobeltiosis ranged from –38.77 (Si-266 x Si-722) to 21.40 (AVTS-8 x Si-255-2) with significant positive value for three hybrids viz., AVTS-8 x Si-255-2 (21.40), AVTS-8 x Si-266 (20.42) and AVTS-16 x Si-255-2 (13.60) and significant negative value for five hybrids. Standard heterosis ranged from –38.96 (Si-255-2 x Si-266) to 13.10 (AVTS-16 x Si-255-2) with significant positive standard heterosis for two hybrids *viz.*, AVTS-8 x Si-722 (8.52) and AVTS-16 and Si-255-2 (13.10). Five hybrids showed significant negative standard heterosis.

4.2.3.2 Height upto first capsule

Relative heterosis for height upto first capsule ranged from -14.86 in IVTS-5 x Si-722 to 18.21 in IVTS-5 x Si-255-2. Significant positive relative heterosis was recorded for three hybrids and significant negative relative heterosis was recorded for one hybrid. Heterobeltiosis ranged from –10.14 in IVTS-5 x Si-722 to 36.19 in IVTS-5 x Si-255-2. Four hybrids showed significant positive heterobeltiosis. They were IVTS-5 x Si-255-2 (36.19), IVTS-5 x Si-266 (22.29), AVTS-8 x Si-255-2 (30.57) and AVTS 16 x Si-722. (25.37). No hybrid showed significant negative heterobeltiosis. Standard heterosis ranged from -19.22 in Si-255-2 x Si-722 to 17.94 in IVTS-5 x Si-266.

Two hybrids showed significant positive standard heterosis and one hybrid showed significant negative standard heterosis

4.2.3.3 Number of branches

The hybrid Si-255-2 x Si-266 (-33.76) had maximum negative relative heterosis for number of branches and the hybrid IVTS-5 x AVTS-16 (26.04) had maximum positive relative heterosis. Significant positive relative heterosis and significant negative relative heterosis recorded for four hybrids each. Heterobeltiosis observed for the character ranged from -37.20 in Si-255-2 x Si-266 to 19.59 in IVTS-5 x Si-722 with significant positive heterobeltiosis for two hybrids viz., IVTS-5 x AVTS-16 (10.82) and IVTS-5 x Si-722 (19.59). For six hybrids, significant negative heterobeltiosis were observed. Standard heterosis ranged from -16.78 in Si-255-2 x Si-722 to 16.27 in IVTS-5 x AVTS-16 with significant positive standard heterosis only for single hybrid and significant negative standard heterosis for four hybrids.

4.2.3.4 Number of capsules on main axis

Relative heterosis for number of capsules on main axis ranged from –23.50 (AVTS-8 x AVTS-16) to 31.36 in IVTS-5 x Si-266 with significant positive relative heterosis for two hybrids and significant negative relative heterosis for one hybrid. Heterobeltiosis ranged from –34.24 (AVTS-8 x AVTS-16) to 30.86 (IVTS-5 x Si-266). Significant positive heterobeltiosis was recorded for only one hybrid and significant negative heterobeltiosis was recorded for six hybrids. Standard heterosis ranged from –36.50 (Si-255-2 x Si-266) to 18.51 (IVTS-5 x Si-266) with two hybrids having significant

positive standard heterosis and four hybrids having significant negative standard heterosis.

4.2.3.5 Number of capsules per plant

Relative heterosis for number of capsules per plant varied from –18.45 (Si-255-2 x Si-722) to 26.50 (IVTS-5 x AVTS-8) with significant positive relative heterosis for five hybrids and significant negative relative heterosis for two hybrids. Heterobeltiosis for this character varied from –27.08 (Si-255-2 x Si-722) to 18.54 (IVTS-5 x AVTS-8). Three hybrids had significant positive heterobeltiosis. They were IVTS-5 x AVTS-8 (18.54), IVTS-5 x AVTS-16 (13.89) and AVTS-8 x Si-266 (16.30). Three hybrids had significant negative heterobeltiosis. Standard heterosis for the character ranged from –29.21 (Si-255-2 x Si-722) to 21.21 (IVTS-5 x AVTS-16) with two hybrids having significant positive standard heterosis and three hybrids with significant negative standard heterosis.

4.2.3.6 Length of capsule

For length of capsule, the hybrid AVTS-16 x Si-255-2 (-21.12) showed maximum negative relative heterosis and the hybrid AVTS-16 x Si-722 (35.21) showed maximum positive relative heterosis. Significant positive relative heterosis was recorded for four hybrids and significant negative relative heterosis was recorded for two hybrids. The hybrid AVTS-16 x Si-255-2 (-34.27) showed significant negative heterobeltiosis while AVTS-16 x Si-722 (34.58) showed maximum significant positive heterobeltiosis. No other hybrid showed significant heterobeltiosis for this character. Standard heterosis ranged from -22.43 (AVTS-16 x Si-255-2) to 20.22 (IVTS-5 x Si-

255-2). Only one more hybrid Si-266 x Si-722 (-21.32) showed significant negative standard heterosis.

4.2.3.7 Number of seeds per capsule

Relative heterosis for number of seeds per capsules ranged from –6.78 (AVTS-16 x Si-722) to 17.12 (IVTS-5 x AVTS-8) with significant positive relative heterosis for six hybrids. No hybrid showed significant negative relative heterosis. Heterobeltiosis ranged from –13.19 (AVTS-8 x Si-266) to 13.88 (IVTS-5 x AVTS-8). The two hybrids, which recorded significant positive heterobeltiosis, were IVTS-5 x AVTS-8 (13.88) and AVTS-8 x Si-255-2 (12.14). The hybrid AVTS-8 x Si-255-2 (10.88) recorded significant negative heterobeltiosis. Standard heterosis ranged from –16.20 (AVTS-16 x Si-722) to 10.54 (IVTS-5 x Si-266) one hybrid revealed significant positive standard heterosis and one hybrid recorded significant negative standard heterosis.

4.2.3.8 Seed yield per plant

Seed yield per plant had showed a range of relative heterosis from –33.42 (AVTS-16 x Si-255-2) to 35.39 (AVTS-8 x Si-255-2) with five hybrids having significant positive relative heterosis and three hybrids with significant negative relative heterosis. Heterobeltiosis ranged from –49.46 (AVTS-16 x Si-255-2) to 20.09 (AVTS-8 x Si-255-2). Significant positive heterobeltiosis was expressed by only one hybrid AVTS-5 x Si-255-2 (20.09). Four hybrids showed significant negative heterobeltiosis. Standard heterosis ranged from –44.80 (Si-255-2 x Si-266) to 20.37 (IVTS-5 x AVTS-16). Two

hybrids showed positive significant standard heterosis while six hybrids showed significant negative standard heterosis.

4.2.3.9 Weight of capsules per plant

Relative heterosis for weight of capsules per plant ranged from –37.21 (AVTS-16 x Si-255-2) to 38.56 (IVTS-5 x AVTS-8). Two hybrids recorded significant positive relative heterosis and three hybrids showed significant negative relative heterosis. Heterobeltiosis for this character ranged from –44.22 (Si-255-2 x Si-266) to 18.26 (AVTS-8 x Si-255-2). No hybrid showed significant positive heterobeltiosis for this character but six hybrids showed significant negative heterobeltiosis. Standard heterosis for this character ranged from –51.02 (AVTS-16 x Si-255-2) to 24.49 (IVTS-5 x AVTS-8). Only one hybrid IVTS-5 x AVTS-8 (24.49) is the only hybrid recorded significant positive standard heterosis, while seven hybrids showed significant negative standard heterosis.

4.2.3.10 1000 seed weight

For 1000 seed weight relative heterosis was significant for only one hybrid AVTS-8 x Si-255-2 (-25.20) which was negative. Relative heterosis for this characters ranged from -25.52 for the above hybrid to 16.40 for AVTS-16 x Si-722. Heterobeltiosis was significant for only one hybrid AVTS-16 x Si-255-2 (-30.77) which was negative. Heterobeltiosis for this character ranged from –30.77 in AVTS-16 x Si-255-2 to 8.58 in AVTS-16 x Si-722. Standard heterosis was significant for only two hybrids which was negative AVTS-16 x Si-255-2 (-28.48) and AVTS-8 x Si-722 (-20.86) and maximum for IVTS-5 x Si-225 (10.27).

4.2.3.11 Number of days taken for first flowering

For number of days taken for first flowering, the estimates of the three types of heterosis were not significant. Relative heterosis ranged from –3.88 (AVTS-8 x AVTS-16) to 5.19 (Si-255-2 x Si-722) while heterobeltiosis ranged from –1.29 (AVTS-8 x Si-266) to 9.84 (Si-255-2 x Si-722). Standard heterosis ranged from –7.31 (AVTS-16 x Si-255-2) to 3.63 (IVTS-5 x Si-722).

4.2.3.12 Number of days taken for harvest

For number of days taken for harvest also, the estimates of three types of heterosis were not significant. Relative heterosis of this character ranged from –4.31 (AVTS-8 x Si-722) to 1.73 (IVTS-5 x AVTS-16), heterobeltiosis ranged from –0.69 (IVTS-5 x Si-255-2) to 4.85 (IVTS-5 x AVTS-16) and standard heterosis ranged from –0.2.76 (AVTS-8 x Si-722) to 2.81 (IVTS-5 x AVTS-16).

4.2.3.13 Seed oil (%)

Seed oil percentage had relative heterosis ranging from –11.24 (IVTS-5 x Si-266 to 6.72 (AVTS-16 x Si-722). Relative heterosis was significant and positive for nine hybrids and significant and negative for three hybrids. Heterobeltiosis for this character ranged from –16.57 (Si-266 x Si-722) to 3.76 (AVTS-16 x Si-255-2). Heterobeltiosis was positive and significant for four hybrids viz., IVTS-5 x AVTS-16 (2.94), AVTS-8 x Si-266 (1.89), AVTS-16 x Si-255-2 (3.76) and Si-255-2 x Si-266. Heterobeltiosis was significant and negative for seven hybrids. Standard heterosis for this character ranged from –18.99 (IVTS-5 x Si-266) to 3.04 (AVTS-16 x Si-722). Only one hybrid showed positive significant standard heterosis and thirteen hybrids showed significant negative standard heterosis.

4.2.3.14 Seed protein (%)

Relative heterosis for seed protein percentage ranged from –13.96 (AVTS-8 x Si-255-2) to 9.06 (IVTS-5 x Si-255-2). This character showed significant positive relative heterosis for eight hybrids and significant negative relative heterosis for five hybrids. Heterobeltiosis for this character ranged from –16.12 (AVTS-8 x Si-255-2) to 7.05 (IVTS-5 x Si-255-2). Significant positive heterobeltiosis was recorded in three hybrids viz., IVTS-5 x AVTS-16 (2.10), IVTS-5 x Si-255-2 (7.05) and AVTS-16 x Si-255-2 (2.55). Significant negative heterobeltiosis was recorded for eight hybrids. Standard heterosis for this character ranged from –17.12 (Si-255-2 x Si-266) to 2.01 (IVTS-5 x Si-722). Significant positive standard heterosis was recorded for two hybrids viz., IVTS-5 x Si-255-2 (1.67) and IVTS-5 x Si-722 (2.01). Nine hybrids showed significant negative standard heterosis.

4.2.3.15 Acid value

For, acid value the relative heterosis ranged from –20.06 (AVTS-16 x Si-722) to 24.67 (AVTS-16 x Si-266). Significant positive relative heterosis was recorded for nine hybrids and significant negative relative heterosis was recorded for four hybrids. Heterobeltiosis for this character ranged from –13.58 (AVTS-8 x Si-722) to 64.63 (AVTS-16 x Si-266). Eleven hybrids showed significant positive heterobeltiosis. Heterobeltiosis was very high in the hybrids Si-255-2 x Si-266 (38.49), IVTS-5 x AVTS-16 (48.37), AVTS-8 x AVTS-16 (48.04), IVTS-5 x Si-255-2 (53.75) and AVTS-16 x Si-266 (64.66). Three hybrids showed significant negative heterobeltiosis. Standard heterosis for this character showed a range of –20.12 (AVTS-8 x Si-722) to 36.83

(AVTS-8 x AVTS-16) with significant positive standard heterosis for six hybrids and significant negative standard heterosis for seven hybrids.

4.2.3.16 Saponification value

Relative heterosis for saponification value ranged from –1.04 (Si-266 x Si-722) to 2.08 (AVTS-16 x Si-266). Four hybrids showed significant positive relative heterosis and none showed significant negative relative heterosis. Heterobeltiosis ranged from 3.47 (AVTS-16 x Si-266) to 0.14 (IVTS-5 x Si-255-2). Five hybrids showed significant positive heterobeltiosis. They were IVTS-5 x AVTS-8 (1.91), IVTS-5 x Si-266 (1.62), AVTS-8 x Si-266 (3.47) and Si-255-2 x Si-722 (1.37). No hybrid showed significant negative heterobeltiosis. Standard heterosis ranged from –0.73 (IVTS-5 x Si-722) to 2.21 (AVTS-16 x Si-266). Four hybrids showed significant positive standard heterosis and no hybrid showed significant negative heterosis.

4.2.3.17 Iodine value

Iodine value ranged from –14.12 (AVTS-16 x Si-722) to 21.36 (Si-266 x Si-722) for relative heterosis. Ten hybrids showed significant positive relative heterosis and four hybrids showed significant negative relative heterosis. Heterobeltiosis ranged from –20.79 (AVTS-16 x Si-722) to 10.54 (AVTS-16 x Si-255-2). Two hybrids showed significant positive heterobeltiosis. They were AVTS-8 x AVTS-16 (9.32) and AVTS-16 x Si-255-2 (10.54). Seven hybrids showed significant negative heterobeltiosis. Standard heterosis for iodine value ranged from –27.35 (AVTS-8 x Si-266) to 12.60 (Si-266 x Si-722). Seven hybrids showed significant positive standard heterosis and five hybrids showed significant negative standard heterosis.

4.2.3.18 Peroxide value

Peroxide value showed relative heterosis ranging from –30.77 (AVTS-16 x Si-266) to 30.44 (IVTS-5 x AVTS-16). Three hybrids had significant positive relative heterosis and only one hybrid had significant negative relative heterosis. Heterobeltiosis ranged from –25.00 (AVTS-16 x Si-266) to 66.67 (IVTS-5 x AVTS-16). Nine hybrids showed significant positive heterobeltiosis and one hybrid showed significant negative heterobeltiosis. Hybrids showing high positive heterobeltiosis were IVTS-5 x Si-722 (44.44), IVTS-5 x Si-266 (45.44), IVTS-5 x Si-255-2 (55.56) and IVTS-5 x AVTS-16 (66.67). Standard heterosis for this character ranged from –25.00 (AVTS-16 x Si-266) to 25.00 (IVTS-5 x AVTS-16). Eleven hybrids showed significant positive standard heterosis and two hybrids showed significant negative standard heterosis for this character.

4.2.3.19 Total nitrogen

Relative heterosis for total nitrogen ranged from –14.03 (AVTS-8 x Si-255-2) to 10.00 (IVTS-5 x Si-255-2). Three hybrids showed significant positive relative heterosis and four hybrids showed significant negative relative heterosis. Heterobeltiosis ranged from –16.21 (AVTS-8 x Si-255-2) to 7.05 (IVTS-5 x Si-255-2). Two hybrids viz., IVTS-5 x AVTS-8 (0.97) and IVTS-5 x Si-255-2 (7.05) showed significant positive heterobeltiosis while eight hybrids showed significant negative heterobeltiosis. Standard heterosis for this character ranged from –17.18 (Si-255-2 x Si-266) to 1.94 (IVTS-5 x Si-722). No hybrid showed significant positive standard heterosis but seven hybrids showed significant negative standard heterosis for this character.

Discussion

5. DISCUSSION

For a successful crop improvement programme, a thorough understanding of the genetic basis of yield and yield components is essential. The variability present in the population, heritability and genetic advance are to be essentially estimated. The genetic association between various characters and their effects on yield are also important. Information on heterosis, combining ability and gene action is essential for finalizing the breeding programme. Results of the present study, which is aimed at gathering information in this regard, are discussed below.

Variability

Sesame is an essentially self-pollinated crop and hence the expected natural variability is low. In the present study analysis of variances showed significant differences for all the characters under study. This indicated wide range of differences between the genotypes for all these characters. Mean values also showed wide range of variability for these characters. It is important to know whether this variability is due to genotype or environment. Hence phenotypic, genotypic and environmental variances were estimated. High phenotypic and genotypic variances (>100) were estimated for plant height and number of capsules per plant. This was in conformity with the findings of Chandramony and Nayar (1985), Kandaswamy (1985), Chandrasekhara and Reddy (1993c), Mishra *et al* (1995a) and Patil and Sheriff (1996). Environmental variances were low for all the characters.

Coefficients of variation give more accurate measure of variability since it is independent of scale of measure. From the estimates of phenotypic and genotypic variances, phenotypic and genotypic coefficient of variation can be estimated. In the present study high PCV and GCV were observed for number of branches, capsules on main axis, number of capsules per plant, seed yield per plant and weight of capsules per plant. These findings were in conformity with the findings of Kandaswamy (1985), Babu (1992), Pathak and Dixit (1992), Mishra *et al.* (1993), Patil and Sheriff (1996), Joel and Thangavelu (1997) and Shanmugavalli and Vanniarajan (1998) and Govindarasu (2000).

Medium PCV and GCV were recorded for plant height; number of seeds per capsule and seed oil percentage. Similar results were reported by Chandramony (1984), Geetha (1984), Kandaswamy (1985), Reddy and Dorairaj (1990), Chandrasekhara and Reddy (1993c), John and Nair (1993) and Amaresha (1997). Moderate to high PCV and GCV recorded for plant height, number of branches, capsules on main axis, number of capsules per plant, number of seeds per capsule, seed yield per plant, weight of capsules per plant and seed oil percentage indicate high genetic variability and negligible influence of environment on these characters. The result indicates good scope for improvement through selection. Moderate PCV and low GCV or low PCV and GCV were recorded for length of capsule, 1000 seed weight, number of days taken for first flowering and harvest and seed protein percentage. This shows that the variability is limited and scope for improvement through selection is also limited. These findings are in consonance with the findings of John and Nair (1993), Mishra *et al* (1995a)

Shadakshari *et al.* (1995), Patil and Sheriff (1996), Joel and Thangavelu (1997), Singh *et al.* (1997a) Jayalakshmi *et al.* (1998) and Singh *et al.* (2000a).

Heritability and genetic advance

The success of improvement of the characters under study depends on the heritability of the character and expected genetic advance under selection. Estimates of heritability and genetic advance also give an idea about the gene action governing the characters.

In present study high heritability and genetic advance were recorded for plant height only. This result was in conformity with the reports of Pathak and Dixit (1986), Bhele *et al.* (1987), Baruah and Goud (1993), Mishra *et al.* (1993), Govindarasu (1995) and Amaresha (1997). High heritability along with high genetic advance indicate that this character is governed by additive gene effect and selection may be effective for the improvement of this character.

High heritability and moderate genetic advance were observed for number of capsules per plant and number of seeds per capsule. This was in agreement with the findings of Shadakshari *et al.* (1992), Joel and Thangavelu (1997), Jayalakshmi *et al.* (1998) and Singh *et al.* (2000a). High heritability and moderate genetic advance recorded for the above character indicate the involvement of additive gene action and good scope for selection. High heritability and low genetic advance were estimated for number of branches, capsules on main axis, length of capsule, seed yield per plant, weight of capsules per plant and 1000 seed weight. This was in conformity with the

findings of Govindarasu *et al.* (1990), Chandrasekhara and Reddy (1993 c), John and Nair (1993), Mishra *et al.* (1993), Shadakshari *et al.* (1995), Patil and Sheriff (1996), Joel and Thangavelu (1997), Singh *et al.* (1997a) and Singh *et al* (2000a). High heritability accompanied by low genetic advance indicates that these characters are under the influence of non-additive gene action.

Moderate heritability and low genetic advance were observed for height up to first capsule and number of days taken for first flowering. Similar findings were reported by Chavan and Chopde (1982), Chandramony (1984) and Pathak and Dixit (1986). Moderate heritability along with low genetic advance recorded for these characters indicate the involvement of non-additive gene action. These characters can be improved by heterosis breeding.

Correlation

Correlation coefficient is used to measure the degree and direction of relationship of two or more variables. A positive correlation shows a change of two variables in the same direction. If a strong positive correlation exists then improvement of one character automatically improves the other character also.

Seed yield had high positive genotypic, significant positive phenotypic and significant positive environmental correlation with weight of capsules per plant, number of capsules per plant, capsules on main axis, and number of seeds per capsule. This finding is in tune with the findings of Paramasivam and Prasad (1980), Yadava *et al.* (1980), Janardhanam *et al.* (1982), Gupta

and Labana (1983), Thangavelu and Rajeskharan (1983a), Reddy *et al.* (1984b), Krishnadoss and Kadambavanasundaram (1986), Bhele *et al.* (1987), Majumdar *et al.* (1987), Rao *et al.* (1991), Shadakshari *et al.* (1992), Chandrasekhara and Reddy (1993 a), Mishra *et al.* (1993), Balan *et al.*, 1996, Thiyagarajan and Ramanathan (1996), Jayalakshmi and Reddy (1999), Nimbalkar *et al.* (1999), Karuppaiyan and Ramasamy (2000). However a negative correlation of seed yield per plant with number of seeds per capsule was reported by Chavan and Chopde (1981) and Thangavelu and Rajasekharan (1983 a).

Plant height had high positive genotypic correlation and significant positive phenotypic and environmental correlation with capsules on main axis and weight of capsules per plant. This is in conformity with the findings of Yadava *et al.* (1980), Janardhanam *et al.* (1982), Reddy *et al* (1984b), Seenaiah and Reddy (1984), Reddy and Haripriya (1992), Chandrasekhara and Reddy (1993a) and Kumar and Sivasamy (1996b). Contrary to this finding Rai *et al.* (1997) reported low negative correlation between plant height and weight of capsules per plant.

Number of branches had high genotypic correlation, significant positive phenotypic correlation and positive environmental correlation with number of capsules per plant and weight of capsules per plant. This is in tune with the findings of Gupta and Labana (1983), Thangavelu and Rajasekaran (1983a). Reddy (1984), Reddy *et al0.* (1984b), Krishnadoss and Kadambavanasundaram (1986), Bhele *et al.* (1987), Mishra *et al.* (1995a), Mishra *et al.* (1995b), Nimbalkar *et al* (1999) and Karuppaiyan and Ramasamy (2000).

Number of capsules on main axis had high positive genotypic correlation and significant positive phenotypic and environmental correlation with weight of capsules per plant and number of capsules per plant. Similar results were reported by Janardhanam *et al.* (1982), Thangavelu and Rajasekharan (1983a), Reddy *et al.* (1984b), Seenaiah and Reddy (1984), Reddy and Haripriya (1992), Chandrasekhara and Reddy (1993a) and Rai *et al.* (1997).

Length of capsule had high genotypic correlation and significant positive phenotypic and environmental correlation with number of seeds per capsule. This is in tune with the reports of Chavan and Chopde (1981), Rai *et al.* (1997) and Nimbalkar *et al.* (1999). But contrary to this low genotypic correlation of these characters were reported by Janandhanam *et al.* (1982) and Pathak and Dixit (1986).

Number of days taken for first flowering had high positive genotypic correlation and significant positive phenotypic and environmental correlation with number of days taken for harvest. This is in agreement with the findings of Yadava *et al.* (1980), Vaidya *et al.* (1982) and Pathak and Dixit (1986). However negative correlation was reported by Singh *et al.* (1997a) and Nimbalkar *et al.* (1999).

Higher genotypic correlation observed between plant height and capsules on main axis, plant height and weight and number of capsules per plant, between length of capsule and number of seeds per capsule, between number of seeds per capsule and capsule yield and between number of days taken for first flowering and number of days taken for harvest indicate the strong association of these characters.

Path coefficient analysis

The technique of path analysis was applied in plant selection by Dewey and Lu (1959). It estimates the direct and indirect contribution of the independent variables on dependent variable and the residual effects. Path analysis was done taking plant height, number of branches, number of capsules per plant, number of seeds per capsule and 1000 seed weight as independent variables which had strong genotypic correlation with seed yield per plant. All the characters recorded positive direct and indirect effects.

In the present study maximum direct effect on seed yield per plant was recorded by number of capsules per plant. Similar results were reported by Yadava *et al.* (1980), Pathak and Dixit (1986), Mishra *et al* (1993), Chaudhary (1995) Singh *et al* (1997a), Tak (1997), Jaylakshmi and Reddy (1999), Kavitha and Ramalingam (1999) and Karuppaiyan (2000). But contrary to this Chandrasekhara and Reddy (1993 b) estimated high negative direct effect. Rai *et al.* (1997) reported negligible negative direct effect of number of capsules per plant. The high genotypic correlation showed by number capsules per plant with seed yield per plant was also due to the positive indirect effect through number of branches and number of seeds per capsule. Similar results were reported by Rai *et al.* (1997) and Tak (1997). But Karuppaiyan and Ramasamy (2000) reported that number of branches and number of seeds per capsule had only negligible or low negative indirect effect on seed yield per plant. Mishra *et al.* (1995 b) reported that number of capsules per plant had only negligible indirect effect on seed yield per plant through number of branches.

Next to number of capsules per plant, number of seeds per capsule had high positive direct effect on seed yield per plant. This is in conformity with the findings of Pathak and Dixit (1986), Bhele *et al* (1987), Chaudhari (1995)

and Mishra *et al.* (1995b). But Karuppayian and Ramasamy (2000) reported moderate direct effect and Rai *et al* (1997) reported low negative direct effect for seeds per capsule on seed yield per plant. Number of seeds per capsule exerted moderate positive indirect effect through number of capsules per plant. This finding is in agreement with the findings of Mishra *et al.* (1995 a) and Mishra *et al.* (1995b). But contrary to this Karuppayian and Ramasamy, 2000) reported moderate negative indirect effect. High correlation of number of seeds per capsule with seed yield per plant was due to high direct effect and moderate indirect effect through number of capsules per plant. 1000 seed weight had moderate direct effect on seed yield per plant which is in agreement with the findings of Reddy and Harypriya (1992). But Kumar and Sivasamy (1996b) Thiyagarajan and Ramanathan (1996) and Tak (1997) reported high positive direct effect of 1000 seed weight on seed yield per plant. Rai *et al.* (1997), Singh *et al.* (1997a) and Kavitha and Ramalingam (1999) observed negative direct effect of 1000 seed weight on seed yield per plant. The indirect effect of other characters on seed yield was negligible. So total correlation of this character was minimum in the present study.

In the present study number of branches showed low direct effect on seed yield per plant. Mishra *et al.* (1995 b) reported negligible positive direct effect of number of branches on seed yield per plant and Mishra *et al.* (1995a) observed medium negative and Karuppaiyan and Ramasamy (2000) observed low negative direct effect for number of branches on seed yield per plant. Even though number of branches had low direct effect, its total correlation was high due to high indirect effect through number of capsules per plant. High indirect effect of number of branches through number of capsules per plant observed in the present study is in

conformity with the findings of Mishra *et al.* (1995 a), Mishra *et al.* (1995 b) and Karuappaiyan and Ramasamy (2000).

Plant height had negligible direct effect on seed yield per plant. This finding is in conformity with the findings of Yadava *et al.* (1980), Mishra *et al.* (1995 a), Mishra *et al.* (1995 b) and Rai *et al.* (1997). Contrary to this Thiyagarajan and Ramanathan (1996), Tak (1997) and Kavitha and Ramalingam (1999) reported high positive direct effect of plant height on seed yield per plant. Plant height exerted moderate indirect effect through number of capsules per plant and low indirect effect through number of seeds per capsule. This is in conformity with Yadava *et al.* (1980), Mishra *et al.* (1995b), Singh *et al.* (1997a), Kavitha and Ramalingam (1999) and Karuppaiyan and Ramasamy (2000). Low indirect effect of plant height through number of seeds per capsule was in contrary to the findings of Mishra *et al.* (1995b), Rai *et al.* (1997) and Tak (1997).

Negligible residue effect and high correlation of component characters show the efficiency of selection based on these characters and the little influence of other component characters on seed yield per plant.

Genetic divergence

Hybrids between genetically diverse parents show more heterosis than related parents. Mahalanobis D^2 is used to study the genetic diversity among the genotypes. Greater the distance between two clusters the divergence is more. If the distance is less, then the genotypes are closer. The genotypes within a cluster are closer than between genotypes of different clusters. Fifty genotypes in the present study were clustered into nine clusters with the maximum of 19 genotypes

in cluster I followed by ten genotypes in cluster III. Genotypes in the other clusters were cluster V (six genotypes), cluster VI (five genotypes), cluster II and IV (three each) and cluster VII (two). Two genotypes T_{10} and T_{50} did not come under any of the clusters. The maximum inter cluster distance was between cluster VI and cluster VII (58.21) and the minimum inter cluster distance was between cluster III and cluster IX (18.46). The maximum divergence was exhibited for seed yield per plant followed by weight of capsules per plant, number of capsules per plant and number of branches. So selection of parents for hybridization was done from six divergent clusters-one each from every cluster *viz.,* Cluster I, II, III, IV, V and VII with high yield and black seed.

Performance of parents, hybrids and standard variety

The estimation of amino acid profile of protein present in sesame seeds revealed that the predominant amino acids were histidine, arginine, threonine, methionine, valine, leucine, phenylanine, isoleucine and tryptophan. Sesame protein is rich in essential amino acids like arginine, lucine, phenyalanine, isoleucine and valine. Weiss (1983) who reported essential amino acid composition of sesame protein. This is in conformity with the findings of Dhindsa and Gupta (1973) who reported that sesame protein is rich in methionine. High methionine and tryptophan content in sesame protein makes it very valuable in supplementing diet in human and cattle food.

Sesame oil contains saturated fatty acids viz., palmitic acid (16 : 0), stearic acid (18 : 0), arachidic acid (20 : 0) and unsaturated fatty acid viz., oleic acid (18 : 1), linoleic acid (18 : 2) and linolenic acid (18 : 3). The fatty acid composition of sesame oil is predominantly unsaturated. The extent of unsaturation reaches upto 95 per cent and that of saturated fatty acid is low

(<20 per cent). Among unsaturated fatty acids oleic acid (34-47 per cent) and linoleic acid (18-47 per cent) were predominant. These fatty acids are responsible for many of the properties of sesame oil. Among saturated fatty acids, palmitic acid and stearic acid together constitute upto a maximum of only 20 per cent. Similar observations were reported by Lee and Kaug (1980), Tyagi and Vasistha (1983), Devi *et al.* (1984) and Sarkar and Bhattacharya (1987).

The iodine value of sesame oil ranged from 79.78 to 116.59 which is high indicating the high level of unsaturation due to predominance of unsaturated fatty acid, while that in coconut oil was 7-10 due to less unsaturation. This result was in agreement with the findings of Tyagi and Vasistha (1983). The saponification value of sesame oil was found to be relatively low due to the predominance of long chain fatty acid. A high proportion of oleic acid and linolic acid with less number of COOH groups per unit weight of soil is responsible for the low saponification value of sesame oil, while that of coconut oil was high (254-256) due to the predominance of short chain fatty acids (C_{12} and C_{14}). Analysis of variance showed significant difference for all the characters except number of days taken for flowering and harvest and saponification value.

Combining ability analysis

The six parents selected based on D^2 analysis and their hybrids as a diallel set were subjected to combining ability analysis and the extent of heterosis in the hybrids was estimated. Analysis of variance of parents and hybrids showed significant difference among parents and hybrids for all the characters excluding number of days taken for first flowering and harvest.

The concept of combining ability as a measure of gene action proposed by Sprague and Tatum (1942) was adopted here. The *gca* effects represented the additive and *sca* effect the non-additive nature of gene action. In the present study, analysis of variance for combining ability showed that, for plant height, height upto first capsule, capsules on main axis, number of capsules per plant, number of seeds per capsule, weight of capsules per plant, seed oil percentage and iodine value there were significant involvement of additive and non-additive gene action as indicated by the significant GCA and SCA variances. For seed yield per plant, seed protein and saponification value GCA variance was only significant showing the involvement of additive gene action. For weight of capsules per plant SCA variance was significant showing the significant role of non-additive gene action. A knowledge about the magnitude of heterosis of various characters is essential to identify specific combinations for further breeding programme. The relative heterosis, heterobeltiosis and standard heterosis exhibited by the hybrids for the different characters were estimated are discussed below along with combining ability.

Higher plant height was identified as an important economic attribute in the present study. Analysis of variance for combining ability revealed significant GCA and SCA variances indicating the role of additive and non-additive gene action in the inheritance of plant height. The magnitude of SCA variance was high compared to GCA variance. This showed the predominance of non-additive gene action. The relative proportion of additive and dominance variance also showed the predominance of dominance variance. This is in conformity with the findings of Gupta (1981), Goyal and

(2000a), Dikshit and Swain (2001) and Manivannan and Ganeshan (2001a).

The general combining ability studies showed that the three parents IVTS-5, AVTS-16 and Si-722 were good general combiners for higher plant height with significant positive *gca* effects and the two parents Si-255-2 and Si-266 were good general combiners for dwarfness with significant negative *gca* effects. Seven hybrids showed significant positive *sca* effects. Among these the *sca* effects were significant and positive for the hybrids AVTS-16 x Si-255-2, IVTS-5 x Si-266, IVTS-5 x Si-255-2 and IVTS-5 x Si-722. In the first three crosses the parents were with positive and negative effects. This showed the major role of dominance in the expression of plant height. AVTS-16 x Si-255-2 recorded significant positive relative heterosis, heterobeltiosis and standard heterosis. Significant positive relative heterosis, standard heterosis and heterobeltiosis for plant height was reported by Manoharan *et al.* (1989), Sasikumar and Sardana (1990), Kumar (1996), Sakhare *et al.* (1998), Govindarasu *et al.* (1999), Govindarasu and Ramamoorthi (2000), Jayaprakash and Sivasubramanian (2000) and Reddy *et al.* (2001). The study showed the possibility of exploitation of heterosis for plant height.

In the present study height upto first capsule was found to be an economic attribute. Reduced height upto first capsule was found desirable. Analysis of variance for combining ability showed significant GCA and SCA variances indicating the role of additive and non-additive gene action in the inheritance of this character. The magnitude of SCA variance was high compared to GCA variance. This showed the predominance of non-additive gene action. The relative proportion of additive and dominance variance also

showed the predominance of dominance variance. Similar results were reported by Shrivas and Singh (1981), Durga *et al.* (1994), Ragiba and Reddy (2000a) and Sumathi and Kalamani (2000). But Dikshit and Swain (2001) reported that there was equal importance for additive and non-additive gene action in governing this character.

The study on *gca* effects of the parents showed that the effect was significant and positive for the parents IVTS-5 and AVTS-8 while it was significant and negative in the parents AVTS-16, Si-255-2 and Si-722. Six hybrids recorded significant *sca* effects. The *sca* effect was significant and positive in the hybrids IVTS-5 x Si-255-2, AVTS-8 x Si-255-2 and AVTS-16 x Si-722. In the first two crosses the parents were with positive and negative *gca* effects while in the third cross both the parents were with negative *gca* effects. This indicated that the characters showed dominance and over dominance in the hybrids. The hybrid IVTS-5 x Si-722 recorded significant negative *sca* effect and this recorded significant relative heterosis also. Significant negative relative heterosis, heterobeltiosis and standard heterosis were reported by Kumar (1996) and Jayaprakash and Sivasubramanian (2000). Heterobeltiosis was reported by Ragiba and Reddy (2000b) and Durga and Raghunadham (2001). The results indicated scope for heterosis breeding for height upto to first capsule.

Analysis of variance for combining ability showed that the GCA and SCA were not significant for number of branches per plant. The parents and hybrids did not differ significantly for combining ability. Only one hybrid IVTS-5 x AVTS-16 recorded significant relative heterosis, heterobeltiosis and standard heterosis. Significant positive relative heterosis, heterobeltiosis and

standard heterosis were reported by Manoharan *et al.* (1989), Sasikumar and Sardana (1990), Sakhare *et al.* (1998), Govindarasu *et al.* (1999), Jayaprakash and Sivasubramanian (2000) and Reddy *et al.* (2001).

Analysis of variance for combining ability showed that the GCA and SCA were significant for capsules on main axis which indicated the role of additive and non-additive gene action. However the SCA variance was higher than the GCA variance showing the predominance of non-additive gene action. The relative proportions of additive and dominance variance also showed the predominance of dominance variance. Similar results were reported by Durga *et al.* (1994) and Kumar and Sivasamy (1995).

Analysis on the *gca* effect of the parents showed that three parents *viz.* IVTS-5, AVTS-16 and Si-722 were with significant positive *gca* effects and one parent Si-255-2 was with negative significant *gca* effect. Among hybrids eight recorded significant *sca* effect. Among the hybrids with significant *sca* effect AVTS-16 x Si-255-2 and Si-255-2 x Si-722 were having parents with positive and negative *gca* effects. In the hybrid AVTS-16 x Si-722 both parents were having positive *gca* effects. So there is predominance for the expression of dominance in the hybrids. Significant positive heterobeltiosis for capsules on main axis was reported by Kumar (1996), Ragiba and Reddy (2000b) and Durga and Raghunandham (2001). The study indicated that there is scope for heterosis breeding and combination breeding for this character.

The analysis of variance for GCA and SCA recorded significance for both, showing the importance of additive and non-additive gene action for number of capsules per plant. SCA variance was double than that of GCA variance indicating the major role of non-additive gene action. The relative

proportion of additive and dominance variance also showed high value for dominance variance. Similar results were reported by Shrivas and Singh (1981), Krishnadoss *et al.* (1987), Khorgade *et al.* (1988), Ramakrishnan and Soundarapandian (1990), Goyal and Kumar (1991), Ram (1995), Mishra and Yadav (1996), Jayalakshmi *et al.* (2000) and Manivannan and Ganesan (2001b). Contrary to this additive gene action was reported by Sharma and Chauhan (1985), Shinde *et al.* (1991), Backiyarani *et al.* (1997a), Das and Gupta (1999) and Ramesh *et al.* (2000).

Studies on *gca* effects of parents showed that the *gca* effect was significantly positive in IVTS-5 and AVTS-16. The two parents Si-255-2 and Si-266 recorded significant negative *gca* effects. Among hybrids four showed positive significant *sca* effect and two showed negative significant *sca* effect. The hybrids with significant *sca* effects were IVTS-5 x AVTS-16, AVTS-16 x Si-255-2 and AVTS-16 x Si-266. The first hybrid was having parents with significant positive effects and the other two hybrids were having parents with significant positive and negative effects. This indicated the major role of dominance expression in the hybrids. IVTS-5 x AVTS-16 showed significant positive standard heterosis, heterobeltiosis and standard heterosis were reported by Sasikumar and Sardana (1990), Sakhare *et al.* (1998), Govindarasu *et al.* (1999), Jayaprakash and Sivasubramanian (2000) and Reddy *et al.* (2001). This indicated the possibilities of genetic improvement of number of capsules per plant through heterosis breeding and combination breeding.

The combining ability analysis recorded no significance for GCA and SCA for the character length of capsule. The hybrid IVTS-5 x Si-255-2

showed significant standard heterosis and relative heterosis. Only one hybrid AVTS-16 x Si-722 recorded significant relative heterosis and heterobeltiosis. Significant positive relative heterosis, heterobeltiosis and standard heterosis for length of capsule were reported by Sakhare *et al.* (1998), Govindarasu *et al.* (1999) and Reddy *et al.* (2001).

The analysis of variance for combining ability showed that GCA and SCA were significant for number of seeds per capsule. This indicated the involvement of additive as well as non-additive factors governing the character. The magnitude of SCA variance was three times higher than the GCA variance that showed the predominance of non-additive gene action. The relative proportion of additive variance and dominance variance also projected the high influence of dominance variance for the character. Preponderance of non-additive gene action for this character was reported by Khorgade *et al.* (1988), Goyal and Kumar (1991), Mishra and Yadav (1996) and Sumathi and Kalamani (2000). Contrary to this Shinde *et al.* (1991) and Fatteh *et al.* (1995) reported the predominance of additive gene action for this character.

General combining ability studies showed that the three parents IVTS-5, Si-255-2 and Si-266 were having significant positive *gca* effects and the two parents AVTS-16 and Si-722 were having significant negative *gca* effects. The *sca* effects were significant in six hybrids, two hybrids *viz.*, AVTS-16 x Si-255-2 and IVTS-5 x AVTS-8 recorded significant heterobeltiosis. Three hybrids showed significant standard heterosis. They were AVTS-8 x Si-255-2, IVTS-5 x AVTS-8 and IVTS-5 x AVTS-16.

Significant positive relative heterosis, heterobeltiosis and standard

heterosis were reported for number of seeds per capsule by Sasikumar and Sardana (1990), Sakhare *et al.* (1998), Govindarasu *et al.* (1999) and Reddy *et al.* (2001). The study offered scope for exploiting heterosis for this character.

The analysis of variance for combining ability showed that only GCA was significant for the character seed yield per plant. This indicated the major involvement of additive gene action. The magnitude of SCA variance was slightly higher than GCA variance. The relative proportions of additive variance and dominance variance projected the high influence of additive variance for seed yield per plant. Preponderance of additive gene action was reported by several scientists (Reddy and Haripriya, 1990; Haripriya and Reddy, 1993; Ram, 1995; Manivannan, 1997 and Jayalakshmi *et al.*, 2000). But Manivannan and Ganesan (2001a) reported non-additive gene action for this character.

Studies on general combining ability showed that two parents *viz.* IVTS-5 and AVTS-16 were having positive significant *gca* effects and one parent Si-255-2 was having negative *gca* effect. Significant standard heterosis was recorded for the hybrids IVTS-5 x AVTS-16 followed by the hybrid IVTS-5 x AVTS-8. In the best hybrid IVTS-5 x AVTS-16 both the parents were having significant positive *gca* effects. There is much scope for the genetic improvement of this character through combination breeding.

Significant differences for GCA and SCA were established by analysis of variance for weight of capsules per plant. This indicated additive as well as non-additive factors controlling the character. Equal estimates of GCA and SCA variances project the importance of both additive and non-additive gene

action. Relative proportion of additive and dominance variance revealed influence of additive variance of the character.

The *gca* effect showed parent IVTS-5 had significant positive and Si-255-2 and Si-722 had significant negative effect. Six hybrids *viz.*, IVTS-5 x AVTS-8, AVTS-8 x Si-255-2, AVTS-8 x Si-722, AVTS-16 x Si-255-2, AVTS-16 x Si-722 and Si-255-2 x Si-266 had significant positive *sca* effect. Out of this six hybrids five had one parent with significant negative *gca* effect showing major role of dominance controlling this character. No hybrid showed significant positive heterobeltiosis. Only one hybrid *viz.*, IVTS-5 x AVTS-8 showed significant positive standard heterosis. Significant positive heterobeltiosis for weight of capsules per plant was reported by Reddy *et al.* (2001). The present study showed that this character can be improved through heterosis breeding.

Combining ability analysis indicated that the GCA and SCA were not significant for 1000 seed weight indicating insignificant difference of parents and hybrids. Maximum standard heterosis was expressed in the hybrid IVTS-5 x Si-255-2. Heterobeltiosis and standard heterosis were reported by Navadiya *et al.* (1995), Kumar (1996), Sakhare *et al.* (1998) and Govindarasu *et al.* (1999).

Analysis of variance for number days taken for first flowering and harvest showed nonsignificant difference indicating the lack of variability for this character in parents and hybrids.

Analysis of variance for combining ability for seed oil percentage showed significance for GCA and SCA. This revealed the influence of

additive as well as non-additive factors governing the character. The magnitude of SCA variance was three times higher than GCA variance indicating the predominance of non-additive gene action. The relative proportion of additive variance to dominance variance indicated preponderance of dominance variance. Similar results were recorded by Dora and Kamala (1987), Goyal and Kumar (1991), Kadu *et al.* (1992), Durga *et al.* (1994), Kumar and Sivasamy (1995), Thiyagarajan and Ramanathan (1995a) and Karuppaiyan *et al.* (2000). But contrary to this Sharma and Chauhan (1985), Narkhede and Kumar (1991a), Reddy *et al.* (1992a), Reddy *et al.* (1993), Ramesh *et al.* (2000) and Dikshit and Swain (2001) reported additive gene action for this character.

All the six parents showed significant *gca* effect. Among this IVTS-5, AVTS-16, Si-255-2 and Si-722 showed significant positive *gca* effect and AVTS-8 and Si-266 showed significant negative effect. Seven hybrids showed significant positive *sca* effect *viz.*, IVTS-5 x Si-266, IVTS-5 x AVTS-8, AVTS-8 x AVTS-16, AVTS-8 x Si-255, IVTS-5 x AVTS-16, IVTS-5 x Si-255-2 and IVTS-5 x Si-722. Among these first four had one parent with significant negative *gca* effect and the other with significant positive *gca* effect and for fifth hybrid both the parents had significant negative *sca* effect showing dominance and overdominance in the expression of this character. Hybrids IVTS-5 x AVTS-16, AVTS-8 x Si-266 and AVTS-16 x Si-255-2 showed significant positive heterobeltiosis and only one hybrid *viz.*, AVTS-16 x Si-722 showed significant positive standard heterosis. Relative heterosis, heterobeltiosis and standard heterosis were reported by Manoharan *et al.* (1989), Sasikumar and Sardana (1990), Kumar (1996), Sakhare *et al.* (1998),

Jayaprakash and Sivasubramanian (2000) and Reddy *et al.* (2001). The present study offered much scope for the genetic improvement of this character through heterosis breeding as well as combination breeding.

Analysis of variances for combining ability indicated that the GCA was significant showing the major involvement of additive factors in the expression of seed protein percentage. The relative proportion of additive and dominance variance showed predominance of dominance variance. Preponderance of non-additive gene action was reported by Singh *et al.* (1983) and Narkhade (1986). But Narkhede and Kumar (1991a) reported additive gene action.

Studies on general combining ability indicated that the two parents Si-255-2 and Si-266 were with negative significant *gca* effects and the three parents AVTS-8, AVTS-16 and Si-722 were with positive significant *gca* effects. IVTS-5 x Si-255-2 and IVTS-5 x Si-722 were two hybrids with significant positive standard heterosis.

Analysis of variance for combining ability for acid value showed non-significant GCA and SCA limiting the improvement of this character.

Analysis of variance for combining ability showed that there is significance for GCA only indicating the major role of additive gene action for saponification value. The magnitude of GCA variance was higher than SCA variance. The relative proportion of additive and dominance variance also indicated major role of additive variance.

Analysis on *gca* effect of parents showed that two parents Si-266 and Si-722 were having significant positive and negative *gca* effect respectively.

No hybrid showed significant negative standard heterosis. But IVTS-5 x Si-722, AVTS-8 x Si-722, AVTS-16 x Si-722 and Si-722 x Si-266 showed non-significant negative standard heterosis.

Iodine value had significant GCA and SCA as indicated by analysis of variance. This shows both additive as well as non-additive factors governing this character. Estimation of SCA variance was double than that of GCA variance indicated predominance of non-additive gene action governing the character. Higher proportion of dominance variance than additive variance revealed importance of dominance variance.

Parents IVTS-5, Si-255-2 and Si-722 showed significant positive *gca* effect and AVTS-8 and Si-266 showed significant negative *gca* effect. Hybrids IVTS-5 x Si-266, AVTS-8 x AVTS-16, AVTS-8 x Si-255-2, AVTS-8 x Si-722, AVTS-8 x Si-266, IVTS-5 x AVTS-8 and IVTS-5 x Si-722 had significant *sca* effect with first four hybrids had one of the parents with significant negative *gca* effect and fifth hybrid had both parent with significant negative *sca* effects showing the influence of dominance and overdominance. AVTS-8 x AVTS-16 and AVTS-16 x Si-255-2 were the two hybrids with significant positive heterobeltiosis and IVTS-5 x AVTS-8, IVTS-5 x AVTS-16, IVTS-5 x Si-255-2, IVTS-5 x Si-722, AVTS-16 x Si-255-2, Si-255-2 x Si-722 and Si-266 x Si-722 were the hybrids with significant standard heterosis.

Analysis of variance showed non-significant GCA and SCA variance for peroxide value indicating non-significant differences among parents and hybrids for this character.

IVTS-5 x AVTS-8 and AVTS-16 x Si-266 were two hybrids with significant negative standard heterosis. Hybrids AVTS-16 x Si-266 and AVTS-16 x Si-722 showed significant negative heterobeltiosis.

Analysis of variance for combining ability indicated that there was no significance for either GCA or SCA for total nitrogen content in the seed. For the hybrids IVTS-5 x Si-255-2 and IVTS-5 x AVTS-8 both relative heterosis and heterobeltiosis were significant and positive. In the first cross both the parents were with negative *gca* effects and in the second cross the parents were with negative and positive *gca* effects. This indicated that there is dominance and over dominance for the expression of this trait.

Combining ability, heterosis and gene action vary with the characters and hybrids under study. Two hybrids *viz.*, IVTS-5 x AVTS-8 and IVTS-5 x AVTS-16 showed significant superiority for the most important economic characters *viz.*, seed yield per plant, seed oil percentage and other characters number of capsules per plant, number of seeds per capsule, protein percentage and iodine value. So these hybrids can be considered as good hybrids for further crop improvement programme. The study also showed that there is much scope for improving the characters viz., capsules on main axis, number of capsules per plant, seed yield per plant, seed oil content and seed protein content through combination breeding.

Summary

6. SUMMARY

The present study, "Genetic basis of seed yield and seed quality in sesame (*Sesamum indicum* L.)", was carried out at the Department of Plant Breeding and Genetics, College of Agriculture, Vellayani during 1998-2000. The objective of the study was to assess the genetic basis of seed yield and seed quality characters in sesame. Fifty varieties of sesame were evaluated in a field experiment to assess the extent of variability available in the crop. Genetic parameters, correlation and path coefficients were analysed. The genetic divergence was also estimated to group the 50 varieties into different clusters. The characters studied were plant height at maturity, number of branches per plant, height upto first capsule, number of capsules on main axis, total number of capsules per plant, seed yield per plant, weight of capsules per plant, length of capsule, seeds per capsule, 1000 seed weight, number of days taken for first flowering, number of days taken for harvest, seed oil content and seed protein content.

The second part consists of the analysis on combining ability, heterosis and gene action. Six varieties having maximum expression for the different yield related characters were selected for genetically distinct clusters and crossed in random combination as a diallel set without reciprocals. Apart from the characters taken for the first part of the study, seed quality characters such as acid value, saponification value, iodine value, total nitrogen, amino acid profile and peroxide value were also estimated.

The data collected were analysed using appropriate statistical techniques and the salient points reflected from the results are summarised below:

1. The analysis of variance study conclusively proved that sesamum, in spite of being an essentially self pollinated crop is rich in varietal variability and it was very wide in the case of plant height, number of capsules per plant and number of seeds per capsule.
2. High phenotypic and genotypic variances were estimated for plant height and number of capsules per plant. Environmental variances were very low for the above two characters. Genotypic variance was minimum for length of capsule
3. High genotypic and phenotypic coefficients of variations were observed for number of branches, capsules on main axis, number of capsules per plant, seed yield per plant and weight of capsules per plant. Medium phenotypic and genotypic coefficients of variations were observed for plant height, number of seeds per capsule and seed oil percentage and there is scope for improvement of these characters through selection.
4. High heritability and genetic advance were observed for plant height only.
5. High heritability and moderate genetic advance were observed for number of capsules per plant and number of seeds per capsule.
6. Plant height, number of capsules per plant and number of seeds per capsule can be improved through selection.

7. High heritability and low genetic advance were observed for number of branches, capsules on main axis, length of capsule, seed yield per plant, weight of capsules per plant and 1000 seed weight.

8. Moderate heritability and low genetic advance were observed for the two characters - height upto first capsule and number of days taken for first flowering.

9. Number of branches, capsules on main axis, length of capsule, seed yield per plant, weight of capsules per plant and 1000 seed weight, height upto first capsule and number of days taken for first flowering can be improved through heterosis breeding or combination breeding.

10. Plant height, number of branches, weight of capsules per plant, number of capsules per plant, capsules on main axis and number of seeds per capsule showed high positive genotypic correlation with seed yield.

11. Plant height recorded high positive genotypic correlation with capsules on main axis and weight of capsules per plant.

12. Number of branches showed high positive genotypic correlation with number and weight of capsules per plant.

13. Number of capsules on main axis showed high positive genotypic correlation with weight and number of capsules per plant.

14. Analysis on cause effect relationship showed that total number of capsules per plant is exerting maximum direct effect on seed yield. Number of seeds per capsule and 1000 seed weight also exerted some direct effect on seed yield. Selection for these characters will definitely improve the seed yield.

15. Plant height and number of branches showed low direct effect on seed yield. But recorded maximum indirect effect through number of capsules per plant.

16. Based on the genetic divergence the fifty genotypes were grouped into nine clusters.

17. The highest number of genotypes was in cluster I with 19 genotypes. Two genotypes remained as independent as they cannot be accommodated in any of the clusters.

18. The maximum intercluster distance was between cluster VI and cluster VII. The minimum intercluster distance was between cluster III and cluster IX.

19. The maximum divergence was exhibited for seed yield per plant followed by weight of capsules per plant, number of capsules per plant and number of branches. D^2 analysis showed high genetic distance between clusters and we can expect good heterosis by selecting divergent parents.

20. From D^2 analysis, six genotypes IVTS-5, AVTS-8, AVTS-16, Si-255-2. Si-266 and Si-722 were selected from divergent clusters *viz.*, V, III, IV, I, II and VII respectively.

21. Types of essential amino acids present in sesame parents and hybrid seeds were histidine, arginine, threonine, methionine, valine, tryptophan, isoleucine, phenyalinine and lucine. High methionine and tryptophan content in sesame protein makes it very valuable in supplementing diet in human and cattle field.

22. Sesame oil contains saturated fatty acids, palmitic acid, stearic acid, arachidic acid and unsaturated fatty acids, oleic acid, linoleic acid and

linolenic acid. Predominance of unsaturated fatty acids is responsible for many of the properties of sesame oil.

23. Analysis of variance for combining ability showed that GCA and SCA variances were significant for the characters, plant height, height upto first capsule, capsules on main axis, number of capsules per plant, number of seeds per capsule, weight of capsules per plant, seed oil percentage and iodine value which indicated that additive and non-additive gene actions are important in the expression of these characters. These characters can be improved by recurrent selection

24. For seed yield per plant, number of days taken for first flowering, seed protein and saponification value GCA variance was only significant showing the involvement of additive gene action. These characters can be improved by selection.

25. For weight of capsules per plant and number of days taken for harvest only SCA variance was significant showing the significant role of non-additive gene action. For improvement of this character heterosis breeding or recombination breeding can be recommended.

26. Based on the gca effects of parents the variety IVTS-5 with the best general combiner for plant height, number of branches, height upto first capsule, capsules on main axis, total capsules per plant, seed yield, seed protein, seed oil and iodine value. The next good general combiner was the variety AVTS-16 which is having positive gca effects for plant height. Capsules per plant, seed yield, seeds per capsule, seed oil, acid value and saponification value.

27. Significant positive heterosis was expressed in the hybrids for plant height, height upto first capsule, capsules on main axis, length of capsule, seeds per capsule, seed yield, weight of capsules per plant, 1000 seed weight, seed oil content, total nitrogen content of seed, saponification value and iodine value.

28. The parents IVTS-5 and AVTS-16, the good general combiners can be utilized for further crop improvement programmes.

29. Considering the yielding ability and seed quality characters the two hybrids IVTS-5 x AVTS-8 and IVTS-5 x AVTS-16 are the good specific combination.

In this study for the economic attributes seed yield, weight of capsules per plant and 1000 seed weight, additive gene action was predominant. So there is much scope for yield improvement. The two hybrids identified can be considered for further crop improvement programme.

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*Original not seen

GENETIC BASIS OF SEED YIELD AND SEED QUALITY IN SESAME (*Sesamum indicum* L.)

By

V.R. SHAJAN

ABSTRACT OF THE THESIS
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DEPARTMENT OF PLANT BREEDING AND GENETICS
COLLEGE OF AGRICULTURE
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ABSTRACT

The present study, "Genetic basis of seed yield and seed quality in sesame (*Sesamum indicum* L.)" was carried out at the Department of Plant Breeding and Genetics, College of Agriculture, Vellayani during 1997-2000. The objective of the study were :

To assess the genetic basis of seed yield and seed quality attributes, to study the interrelationship and direct influence of different characters on yield.

To assess the general combining ability of parents and specific combining ability of the hybrids to identified good parental combinations and to estimate the extent of heterosis expressed in the hybrids for the different characters.

Fifty genotypes of sesame (*Sesamum indicum* L.) maintained at RARS for Onattukara region were used for the study. The genotypes were planted in an RBD with two replications. Analysis of variance showed significant difference among genotypes with respect to all the characters studied *viz.*, plant height, height upto first capsule, number of branches, capsules on main axis, number of capsules per plant, length of capsule, number of seeds per capsule, seed yield per plant, weight of capsule per plant, 1000 seed weight, number of days taken for first flowering, number of days taken for harvest, seed oil percentage and seed protein percentage. The characters *viz.*, number of branches, number of capsules per plant, seed yield per plant and weight of capsules per plant registered high coefficient of variation at phenotypic and genotypic level revealing the scope for selection.

High heritability and high genetic advance were observed for plant height only. High heritability and moderate genetic advance were observed for number of capsules per plant and number of seeds per capsule and these characters can be improved through selection. All other characters showed high heritability and low genetic advance and these characters can be improved by heterosis breeding or recombination breeding. .

Seed yield had high positive genotypic correlation with plant height, number of branches, capsules on main axis, number of capsules per plant, number of seeds per capsule and weight of capsules per plant. So selection for these characters will improve the yield. Plant height had high positive genotypic correlation with capsules on main axis and weight of capsules per plant. Number of branches had high positive genotypic correlation with number of capsules per plant and weight of capsules per plant. Capsules on main axis had high genotypic correlation with number of capsules per plant and weight of capsules per plant. Length of capsule had high genotypic correlation with number of seeds per capsule. Number of days taken for first flowering and harvest recorded high genotypic correlation.

Path coefficient analysis showed that number of capsules per plant, number of seeds per capsule had high direct effect on seed yield and 1000 seed weight had moderate direct effect on seed yield. Selection for these characters will automatically improve yield.

Genetic divergence analysis was done based on Mahalanobis' D^2 and the genotypes were clustered using Tocher's method. Fifty genotypes were clustered into nine clusters with maximum in cluster I with 19, cluster II with three, cluster III with 10, cluster IV with three, cluster V with six, cluster VI

with five, cluster VII with two and VIII and IX with 1 each genotypes. Maximum average intracluster distance was observed for cluster I and maximum intercluster distance between cluster VII and cluster VIII. Based on D^2 analysis, six divergent parents with high yield *viz.*, IVTS-5, AVTS-8, AVTS-16, Si-255-2, Si-266 and Si-722 from six divergent clusters *viz.*, V, III, IV, I, II and VII respectively were selected. They were crossed in half diallel fashion. These parents, their direct F_1s and one standard variety were raised in RBD with 3 replications. In addition to the observations taken for the evaluation of the parents, quality aspects *viz.*, acid value, saponification value, iodine value, peroxide value, total nitrogen, amino acid profile and fatty acid profile were estimated. Analysis of variance showed significant difference among genotypes for all the characters, except, number of days taken for first flowering and harvest. The GCA and SCA variances for number of branches, length of capsule, 1000 seed weight, acid value, peroxide value and total nitrogen were non-significant. Hence, gene action could not be worked out for these traits. Seed yield per plant; seed protein and saponification value had non-significant SCA showing significance of only additive gene action. For plant height, height upto first capsule, capsule on main axis, number of capsules per plant, number of seeds per capsule, capsule yield per plant, seed oil percentage and iodine value both gca and sca effects were significant. Both additive and non-additive gene action were significant.

Plant height, height upto first capsule, capsule on main axis, number of capsules per plant, number of seeds per capsule, seed oil percentage and iodine value showed a preponderance of non-additive gene action. Seed yield

per plant, weight of capsules per plant and saponification value showed predominance of additive gene action.

Significant heterobeltiosis and standard heterosis were observed for different characters in different hybrids.

The parents IVTS-5 and AVTS-16, the good general combiners can be utilised for further crop improvement programmes.

The two hybrids *viz.*, IVTS-5 x AVTS-8 and IVTS-5 x AVTS-16 showed significant superiority for the most important economic characters *viz.*, seed yield per plant, seed oil percentage, number of capsules per plant, number of seeds per capsule, protein percentage and iodine value. So these hybrids can be considered for further crop improvement programme.