

**GENETIC STUDIES IN EARLY GENERATIONS
OF
THREE CROSSES IN SESAME
(*Sesamum indicum* L.)**

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**DEPARTMENT OF GENETICS AND PLANT BREEDING
UNIVERSITY OF AGRICULTURAL SCIENCES
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OF
THREE CROSSES IN SESAME
(*Sesamum indicum* L.)**

AMARESHA M.

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*AFFECTIONATELY DEDICATED TO
MY BELOVED PARENTS,
(Mr. RAMAKRISHNA. RAO. M. & Mrs. SEETHAMMA)
BROTHERS, SISTERS and Miss. TRIVENI T.R.*

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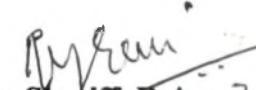
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CERTIFICATE

This is to certify that the thesis entitled **“GENETIC STUDIES IN EARLY GENERATIONS OF THREE CROSSES IN SESAME (*Sesamum indicum* L.)”** submitted by **Mr.AMARESHA. M., B.Sc., (Agri.)**, in partial fulfillment of the requirements for the **DEGREE OF MASTER OF SCIENCE (Agriculture)** in **GENETICS and PLANT BREEDING** to the University of Agricultural Sciences, Bangalore, is a record of research work carried out by him under guidance and supervision and that no part of this thesis has been submitted for the award of any other degree, diploma, associateship, fellowship or other similar titles.

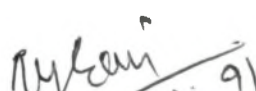
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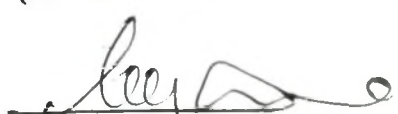
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INTRODUCTION

I. INTRODUCTION

Sesame (*Sesamum indicum* L.) is one of the most ancient oilseed crops known and used by man. In the world it is cultivated on an area of about 2.5 million hectares with a production of 0.81 million tonnes of seeds. India ranks first both in area and production, with an area of 1.42 million hectares and production of 0.25 million tonnes annually, accounting for 35 percent and 25 percent of world's area and production respectively. Predominantly it is grown in Uttar Pradesh, Orissa, Gujarat, Tamil Nadu, Karnataka, West Bengal, Bihar and Assam. In Karnataka, it is grown on an area of 1.3 lakh hectares with a production of 40 thousand tonnes of seeds.

Sesame belongs to the family Pedaliaceae and polytopic in origin comprising of China, Africa and India (Nayar and Mishra 1970). It is variously termed as gingelly, til, simsin, gerglin and beniseed in different regions. It contains about 50 percent of high quality edible oil and is a good source of Protein, Vitamins and Minerals. When compared to world's productivity, India's productivity is very low with an average yield of about 300 kilograms per hectare, due to the limited yield potential of the cultivars and poor response to production technologies, however, considerable scope is open for improvement.

The genetic improvement should endeavour to enhance productivity by disentangling the complex nature of yield and its attributes. The composite effect of environment along with associated characters on other hand, make direct selection scheme an imperative.

Various statistical techniques have been utilised to formulate indirect selection strategies. Confirmation of genetic variability, estimation of correlation, direct and indirect effects of yield components and indirect selection based on selection indices are some of the criteria that help in the genetic improvement of a crop.

Analysis of variance and estimation of genetic parameters indicate the quantum of improvement possible. Determination of character association points out characters on which selection should be based. These associations are partitioned in to direct and indirect effects by path coefficient analysis. A comparison of relative efficiencies of discriminant functions involving different combinations of characters determines what should be the phenotype of a desirable line, more so in a self pollinated crop.

However, information on the genetic improvement in sesame based on selection indices, intergeneration correlations and other indirect selection strategies in segregating populations are meagre. Hence the present investigation was carried out in second and third filial generations of three crosses in sesame with the following objectives.

1. To estimate the Heritability, genetic advance and other genetic parameters in the segregating populations.
2. To estimate the association between yield and its attributes.
3. Apportioning of relative contribution of yield attributes
4. Formulating selection indices in F_3 generation for seed yield.
5. Determining the intergeneration correlations and narrow sense heritabilities between second and third filial generations.

REVIEW OF LITERATURE

II REVIEW OF LITERATURE

The review of literature in respect of sesame and other crops relevant to present investigation is presented below under the aspect of study, under the following headings.

2.1 Variability, Heritability and Genetic Advance.

2.2 & 2.3 Correlation and Path Coefficient analysis.

2.4 Selection indices.

2.5 Intergeneration correlation and narrowsense heritability.

2.1 Variability, Heritability and Genetic Advance

Variability in crop plants is due to the continuous human and Natural selections, Variability in segregating population was ascribed to both heritable and nonheritable factors while the variation in a pure line solely due to environmental factors (Johnsen 1909), which was later refined by Nilsson-Ehle (1909) while East (1916) confirmed the continues variation with Mendalian genetics. Estimates of heritability indicates the proportion of genetic control for character expression. Genetic advance under selection quantified the possible genetic gain by selection. Thus these factors help in crop improvement programme.

The total variance was separated in to genetic and environmental components by Charles and Smith (1939), Powers (1942) and Powers *et al.* (1957). The genotypic variance

was partitioned by Fisher *et al.* (1932), Smith (1936), Panse (1940), Lush (1945) and Mather (1949) into additive and nonadditive components.

Lush (1949) proposed that the heritability in narrow sense, as the ratio of additive variance to the total variance. Later, Hanson *et al.* (1956) proposed heritability in broad sense as the ratio of genotypic variance to total variance. Expected genetic advance was suggested as the product of heritability, phenotypic standard deviation and selection differential by Burton and Devane (1953).

Sesame :

Mazzani (1959) observed the high level of influence of environmental factors on seed oil content than by inherent difference between cultivars.

High genetic advance and high heritability for number of branches and seed weight was observed by Bhargava and Saxena (1964).

Mohanthly and Sinha (1965) found high heritability for number of branches and number of capsules and low heritability for number of flowers, duration of flowering and percentage fruit set. Significant difference in coefficient of variation was also observed for heritable and non heritable character.

High heritability values for number of branches and plant height was reported by Darbal (1967).

Kranthikumar *et al.* (1967) observed more variation in number of capsules on main shoot and less variation with respect to days to maturity.

Range of variability and high heritability for number of capsules per plant, capsule length, number of seed per capsule, yield per capsule, yield per plant and 1000 seed weight was reported by Dabral and Holenker (1971).

Sawant (1971) observed high coefficient of variation for both genotype and phenotype for number of branches per plant. High heritability accompanied by high genetic advance was also observed for 1000 seed weight, number of days to first capsule formation, number of days to flower initiation and plant height.

High heritability accompanied by high genetic advance for number of branches was found by Naphade and Kolte (1972).

Gupta (1975) observed high genotypic coefficient of variation for branches per plant, capsules per plant and yield per plant.

Desai *et al.* (1976) observed wide range of phenotypic variability for most of the metric traits. High genotypic coefficient of variation was noticed for capsules per leaf axil, branches per plant and seed yield per plant.

Very low genotypic variability and high heritability for number of days to 50 per cent flowering, number of primary branches and number of capsules per main branch was reported by Chaudhary *et al.* (1977).

In an investigation Gupta and Gupta (1977) observed high heritability estimates along with high genetic coefficient of variation and high expected genetic advance for capsules per plant and seed yield.

Reddy and Reddy (1977) reported high degree of genetic advance with respect to number of axils per plant, number of branches, number of capsules and yield. Stem girth, plant height, length of capsules and number of seeds per capsules recorded moderate values for genetic variability.

Low genotypic and phenotypic coefficient of variation for capsule length and high genetic advance for height at which capsule formed and number of branches was noticed by Murgesan *et al.* (1979a).

High phenotypic variability with respect to number of primary branches, number of capsules on mainshoot, total number of capsules per plant, 1000 seed weight, number of days of first flowering, 50 per cent flowering and days to maturity was reported by Yadav *et al.* (1980).

Janardhan *et al.* (1981) noticed high degree of genotypic and phenotypic coefficient of variation, high heritability and genetic advance for yield per plant.

High variability for capsule number per plant, number of primary branches per plant, capsule length and seed yield and further high heritability and high genetic advance for capsule number, number of primary, secondary branches and seed yield was observed in segregating population by Paramashivam and Prasad (1981).

Rai *et al.* (1981) reported high genotypic coefficient of variability, heritability and genetic advance for number of branches.

Solanki and Paliwal (1981) found high genotypic and phenotypic variance for number of capsules per plant and number of seeds per capsule. High heritability was observed for 1000 seeds weight, capsule length, number of seeds per capsules, number of days to maturity and capsule girth. Moderate heritability for seed yield per plant and number of capsules per plant and high heritability coupled with high genetic advance for number of seeds per capsule and number of days to maturity, was reported by them.

Chavan and Chopde (1982) reported high variability for number of capsules per plant, number of primary branches height up to first branch and number of capsules on the main shoot. High heritability along with high expected genetic advance was observed for number of

capsules per plant, number of primary branches, height up to first capsule and number of capsules on main shoot, while number of days to 50 percent flowering had highest heritability with moderate genetic advance.

High estimates of heritability for plant height and height to first capsule, highest expected genetic gain for height to first capsule, seed yield and plant height was observed by Shivaprakash (1982).

Chandraprakash (1983) reported low heritability values for 1000 seed weight, capsule length, number of capsules on main stem, seed yield and height to first capsule and higher values for harvest index and number of capsules on primary branches.

More than 90 percent heritability for eight out of nine yield components was observed by Zahn (1983).

Gupta and Chopra (1984) reported high heritability along with high genetic advance for cluster of branches and capsules on branches.

Shadakshari (1984) reported high genotypic and phenotypic coefficient of variability for number of capsules, number of branches and seed yield per plant. High heritability coupled with high genetic advance was observed for seed yield per plant, number of capsules and number of branches.

High heritability and expected genetic advance for branch number, capsule number per branch, seed number per capsule and yield was noticed by Kandaswamy (1985).

Pathak and Dixit (1986) observed greatest genetic advance for seed yield per plant. Wide variability and high heritability were observed for all characters except capsule length, capsule girth and number of seeds per capsule.

Bakheit and Mahdy (1988) reported high phenotypic and genotypic coefficient of variability for height to first capsule and number of branches per plant.

High heritability for 1000 seed weight and seeds per capsule and low heritability for plant height, high genotypic variation and expected genetic advance for number of capsule per plant and yield per plant and low for plant height, number of branches and 1000 seed weight was found by Li (1988).

Govindarasu *et al.* (1990) found that seed yield, capsule on primaries, capsule on secondaries and number of secondaries had high genotypic coefficient of variation value, heritability estimate and genetic advance.

Kandaswamy *et al.* (1990) observed high heritability with high genetic advance for yield per plant, high heritability with low genetic advance for days to 50 per cent flowering and low heritability with low genetic advance for number of capsules on main stem, number of capsules on branches and total number of capsules per plant.

Reddy and Dorairaj (1990) observed that the number of capsules per branch had high heritability combined with high genetic advance, while seed number per capsule, dry matter production and first capsule bearing node had high heritability with medium genetic advance.

John *et al.* (1993) by analysis of variance observed significant variation for 14 character out of 16 characters they studied. They also obtained highest phenotypic, and genotypic coefficient of variation for number of capsules on branch followed by seed yield per plant and number of capsules on main stem. Further they obtained highest heritability value for seed protein content and seed oil content. Seed yield per plant followed by number of capsules on main stem recorded highest genetic advance.

Fendel and Penso (1994) obtained moderate to high estimate of heritability for number of capsules per plant, capsule length, number of seeds per capsule, seed weight per capsule, 1000 seed weight and five-plant yield.

Ranganatha *et al.* (1994b) revealed significant differences in mean and variance for maturity duration, number of primary branches, number of productive capsules and seed yield for different crosses in F₃ and F₄ generations.

Biswas and Akbar (1995) in their study observed the highest genotypic coefficient of variation for seed yield per plant followed by number of branches per plant. They also showed that Broad sense heritability was highest for days to flowering followed by days to maturity and 1000 seed weight.

Reddy and Dorairaj (1995a) obtained highest genotypic coefficient of variability, heritability and genetic advance for stem weight and lowest for root weight and seed yield.

Sunflower :

Pathak (1975) reported high heritability for stem diameter and moderate for seed yield and head diameter.

High phenotypic and genotypic variability for seed yield, 100 seed weight, plant height and seed filling in open pollinated sunflower varieties were observed by Singh *et al.* (1977).

Lakshmanaiah (1980) in a genetic variability study observed a high heritability estimates for oil content, number of days to flower, plant height and head number.

Significant variation for seed yield, number of achenes and head diameter and highest genetic advance for seed yield per plant was observed by Alam *et al.* (1984).

Chaudhary and Anand (1985) found greatest variability along with high degree of genetic advance for seed yield.

Sheriff *et al.* (1986) in their study involving 23 genotypes, reported highly significant differences among genotypes for all the characters indicating adequate variability.

Significant variation for seed yield, number of achenes and head diameter was observed by Alam *et al.* (1987).

High heritability for 100 seeds weight, seed yield, number of filled seed per plant, oil yield and oil content was observed by Mogali (1992).

Niger :

Nayakar (1976) reported low genetic variability for seed yield per plant. Days to flowering and plant height recorded highest heritability estimates and high expected genetic advance.

Highest heritability for days to flowering and greatest expected genetic advance for number of secondary branches and number of capitula per plant was recorded by Sahu and Patnaik (1981).

Channarayappa (1987) observed high genotypic and phenotypic coefficient of variation for seed yield per plant, number of capitula and plant height. Plant height recorded high heritability and genetic advance.

High heritability and high genetic gain for grain yield and harvest index was found by Mather and Gupta (1988).

Patel *et al.* (1993a) while studying variability and correlation observed highest genotypic coefficient of variation, heritability and genetic advance for number of branches per plant and 1000 achene weight.

Goyal and Sudhir Kumar (1993) in their varietal study found highly significant differences among varieties for all the characters studied.

Mishra (1995) while studying the variability obtained significant differences among the genotypes for days to 50 per cent flowering, days to 50 per cent maturity, plant height, number of branches per plant and number of seeds per plant.

2.2 & 2.3 Correlation and path coefficient analysis

Metric characters of economic importance often associated with one another and yield in particular is dependent on several other component characters. The correlation study indicates the degree of interdependence of plant characters, which is an important tool in selection of particular genotype. The indirect selection schemes concentrate on these associations to improve a highly complex trait like yield. The efficiency of selection depends on the direction and magnitude of association between yield and its component character. In this direction, the correlation, as given by Al-Jibouri *et al.* (1958) is used to identify such relationships.

A knowledge of inter-relationships between yield and its components as well as among the components themselves is of great importance if the selection for simultaneous improvement in these components is to be effective. To unveil these direct and indirect effects of different characters on the yield, path coefficient analysis was devised by Wright (1921). This provides a critical examination of specific forces acting to produce a given correlation and measure the relative importance of each casual factor. The review of work of correlation and path coefficient analysis in sesame and other oil seed crops is presented below.

Sesame :

Sikka and Gupta (1949) in their study revealed that greatest contribution towards yield was made by number of capsules per plant followed by number of branches and plant height.

Angarita (1962) found significant positive correlation of total yield with height to first fruit and plant height.

Dabral (1967) observed correlation of seed yield with number of capsules, number of branches and plant height, where in capsules number was found depends on number of branches and plant height.

High correlation between number of capsules per plant, capsule length and breadth with yield was observed by Phadnis *et al.* (1970).

Khidir and Osman (1970) found that yield was positively correlated with all characters except with the days to first flower and days to first maturity. They further concluded that stem height, number of pods per plant and seed size was the best criterion for selection.

Dixit (1975) observed positive genotypic correlation of yield with number of capsule per plant, length of main fruiting branch, number of branches and negative correlation with days to flowering. He also noticed the positive direct effect on yield by number of capsules on main fruiting branch and negative direct effect by plant height and days to flowering.

Desai *et al.* (1976) found that yield was significantly positively correlated with number of capsules per plant, 1000 seed weight and days to 50 per cent flowering. But oil content was highly significantly negatively correlated with seed yield. Path analysis revealed that number of capsules per plant had highest direct effect, while days to maturity had very low indirect effects towards yield and generally negative.

Significant contribution of number of secondary branches, number of capsules per main branch and number of capsules per plant towards seed yield was reported by Shukla and Verma (1976).

Gupta (1976) indicated that capsule number, number of branches per plant and plant height were major factors which directly contribute to seed yield. Similar results were also reported by Ekbote and Tayyab (1974), Kaushal *et al.* (1974) and Sanjeevaiah and Joshi (1974).

Gupta and Gupta (1977) observed positive association of seed yield with capsules per plant, capsule length, seeds per capsule and 1000 seed weight capsules were found to have direct effect on yield, while capsule length had direct negative effect.

Murugesan *et al.* (1979b) in path analysis study observed the characters with greatest direct effect on yield varied with season.

Close association of seed yield with yield components like capsule number per plant, number of seeds per capsule and 1000 seed weight was reported by Rao and Venkatachari (1970).

Paramashivam and Prasad (1980) in their study in segregating population found positive significant association of seed yield with height, number of primary branches and number of capsules per plant.

Yadav *et al.* (1980) observed positive association of seed yield with number of primary branches, number of capsules and 1000 seed weight. Number of capsules, 1000 seed weight, number of days to 50 per cent flowering and number of primary branches were found have direct effect on yield, while number of capsules and primary branches had positive indirect effect.

Chavan and Chopde (1981) observed positive significant correlation of seed yield with number of primary branches, number of capsules per plant and plant height. Further they noticed capsule length and number of capsules per plant had positive direct effect on yield.

Rai *et al.* (1981) reported positive association of number of branches per plant with capsule number, which in term was positively correlated with seed yield.

Ibrahim *et al.* (1983) observed that seed yield per plant was positively correlated with number of days to flowering, number of capsules on main stem and number of capsules per plant and was negatively correlated with 1000 seed weight and seed yield per capsule. Further

oil content was positively correlated with number of fruiting branches per plant, seed yield per capsule per unit length of stem. By path analysis they found that number of capsules per plant had the highest direct effect on seed yield and days to flowering had greatest indirect effect on seed yield.

Strongest positive direct effect of capsule number and 1000 seed weight on yield was reported by Thangavelu and Rajashekaran (1983a).

Gupta and Chopra (1984) found positive direct effect of capsule per branch on seed yield and negative direct effect of plant height on yield.

Reddy *et al.* (1984) observed positive direct effect of plant height and capsule per plant and negative effect of branches per plant on seed yield.

Positive correlation of yield with plant height, girth of stem, number of branches and number of capsules was reported by Reddy (1984).

Shadakshari *et al.* (1984) found positive and significant associated of seed yield with number of capsules, days to 50 per cent flowering, plant height, height to first branch, productive area, 1000 seed weight, oil content and days to maturity. Number of capsules had the highest positive direct effect on seed yield.

Positive associated of yield with number of capsules per plant, 1000 seed weight and oil content was observed by Sharma and Chauhan (1984).

Godawath and Gupta (1986) found positive significant correlation of seed yield with number of branches per plant, capsule length and number of seeds per capsule. Number of capsules per plant showed highest direct and indirect effect on seed yield.

Pathak and Dixit (1986) recorded highest direct effect of days to flowering, plant height, capsule length, seeds per capsule and 1000 seed weight on seed yield.

Bhele *et al.* (1987) reported positive direct effect of 1000 seed weight, number of capsules per plant and number of seeds per capsule on seed yield.

Majumdar *et al.* (1987) observed positive significant correlation of seed yield with capsule number per plant, number of seeds per capsule, 1000 seed weight and plant height. Number of seed per capsule had showed highest direct effect on yield.

Bakheit and Mahdy (1988) found high positive correlation of seed yield with plant height, height to first capsule, 1000 seed weight and capsule per plant.

Li (1988) reported significant correlation of seed yield with capsule number per plant, seeds per capsule and 1000 seed weight.

Rong and Wu (1989) observed greater genetic correlation than phenotypic correlation. Genotypically seed yield showed highly significant positive correlation with capsules per plant and significant negative correlation with seeds per capsule and 1000 seed weight. Capsule per plant had the greatest direct effect on seed yield, followed by 1000 seed yield.

Positive significant correlation of seed yield with number of capsules per plant, total dry matter, capsule dry weight and number of grains per plant and negative correlation between grain yield and plant height and number of leaves per plant was recorded by Deshmuk and Chavan (1990).

Positive significant phenotypic, genotypic and environmental correlations were observed between number of capsules on main stem and total number of capsules per plant by Kandaswamy *et al.* (1990).

Ramakrishnan and Sundarapandian (1990) observed that yield was highly significantly positively correlated with plant height, photosynthetic efficiency and number of capsules per plant.

Li and Zhang (1991) found that the most important contributor to single plant yield was 1000 seed weight followed by effective pods per plant and number of seeds per pod.

Narkhede *et al* (1991) found that number of primary branches per plant, capsules per plant, length of the capsule, seeds per capsule and yield per plant were generally controlled by dominant gene action while length of reproductive main stem was under additive gene control and test weight had both additive and dominant gene action.

Reddy and Haripriya (1991) reported significant positive correlation between number of branches and capsules per plant with oil yield per plant.

Significant positive correlation of seed yield with plant height was noticed by Babu and Shivasubramanian (1992).

Positive significant association of seed yield with number of capsules on primaries, number of capsules per plant, seed yield on primaries, and secondaries was noticed by Reddy and Haripriya (1992). Further by path analysis they revealed that seed yield on primaries and number of capsules per plant had the greatest direct contribution to seed yield.

Chandrashekar and Reddy (1993) obtained positive phenotypic correlation of oil yield per plant with seed yield, 1000 seed weight and number of seeds per capsule. Further by path analysis they revealed that seed yield per plant had greatest direct effect on oil yield.

Vadhani *et al*. (1992) during their investigation observed significant negative correlation between yield and oil content. They also noticed that capsule number had greatest direct effect on yield.

Ranganatha *et al*. (1994a) observed highly significant positive correlation of number of capsules with seed yield in both F_3 and F_4 generation. They further reported that seed yield was positively correlated with number of primary branches and days to maturity over

generation for all the crosses, while oil content was non significantly correlated with seed yield.

Subramanian and Subramanian (1994) in their investigation in F₄ and F₅ generation of 2 crosses revealed that the magnitude and direction of correlation between eight pairs of traits varied with generation in both the crosses. They also showed that plant height and capsule number was significantly positively correlated with each other. Path coefficient analysis revealed that primary branches, secondary branches, capsule number per plant, seed number per capsule and 1000 seed weight should be considered for improving the seed yield and selection of parents.

Vanishri *et al.* (1994) reported that seed yield per plant was positively correlated with number of secondary branches, capsules on primaries, number of productive capsules per plant, capsule length, 1000 seed weight, harvest index and oil yield per plant. Path analysis indicated that number of productive capsules, capsules weight and number of seeds per capsule had the greatest positive direct effect on seed yield.

Significant positive correlation of seed yield with number of capsules per plant was noticed by Fendel and Penso (1994).

Biswas and Akbar (1995) in their study found that seed yield was significantly positively correlated with days to maturity, plant height, number of branches per plant, number of capsules per plant and 1000 seed weight at genotypic level.

Reddy and Dorairaj (1995b) obtained highest genotypic correlation for stem weight followed by capsule weight, root height and leaf weight with seed yield. Further they reported dry matter production and harvest index had the greatest positive direct effects on seed yield. They concluded that these traits also had a positive indirect effect on seed yield through a number of other characters.

Mishra *et al.* (1995) in his correlation study found that yield was most affected by number of branches per plant, number of flowers and number of seeds per plant.

Patil and Sheriff (1996) observed significant positive association of seed yield with number of capsules per plant, plant height, capsule girth, productive area, number of branches, height to first capsule, days to maturity, 1000 seed weight and capsule length. Path coefficient revealed highest direct effect of number of capsules on seed yield per plant, followed by days to maturity productive area and 1000 seed weight, while number of branches per plant had negative direct effect on seed yield per plant.

Niger :

Kandaswamy (1973) observed positive correlation of yield with number of branches and capitula per plant.

Sahu and Patnaik (1981) noticed the height and number of capitula per plant were positively correlated with yield. Path coefficient analysis indicated positive direct effect of these traits on yield.

Channarayappa (1983) observed positive correlation of seed yield with capitula per plant, branches per plant, seeds per capitulum, 1000 seed weight and oil per cent.

High positive correlation of yield with plant height, number of capitula per plant and 1000 seed weight was observed by Joshi and Thambre (1984).

Goyal and Kumar (1985) reported significant positive association of yield with days to maturity, plant height, number of capitula and number of seeds per capitulum.

Singh and Patra (1989) observed correlation of seed yield with 1000 seed weight, capitula per plant, branches per plant and seeds per capitulum. 1000 seed weight had highest direct and indirect effect on seed yield per plant.

Goyal and Sudhirkumar (1993) observed significant positive association of seed yield with number of capitula per plant, days to maturity, seeds per capitulum and plant height.

Significant positive correlation of yield per plant with number of branches per plant and 1000 achene weight was observed by Patel *et al.* (1993a).

Patel *et al.* (1993b) while studying the path analysis observed that days to 50 per cent flowering followed by capitula per plant had the highest direct effect on seed yield.

Ravanappa and Sheriff (1996) observed highly significant positive correlation of seed yield per plant with days to 50 per cent flowering, number of primary branches number of secondary branches, number capitula and significant positive correlation with days to maturity.

Sunflower :

Burns (1970) found a high correlation between head diameter and yield per plant indicating that yield estimates based on head size would be more accurate than actual seed weight.

Significant negative correlation between the percentage of seed set and capitulum and stem diameter observed by Khanna (1972).

Baldzi (1976) found a positive correlation between percentage of filled seeds and seed weight per head.

A close association between the head diameter and stem girth was reported by Ayyaswamy *et al.* (1977).

Lakshmanaiah (1980) observed positive association of seed yield and oil content with capitulum diameter, 100 seed weight, seed filling, plant height and seed weight.

Highest positive direct of achenes per plant and 100 achene weight on yield was noticed by Pathak *et al.* (1983).

Sheriff *et al.* (1986) reported a positive correlation of seed yield with stem girth, head diameter and number of seeds per capitulum.

Positive association of seed yield with number of filled seeds per plant, seed filling percentage and head diameter was reported by Mogali (1992).

Giriraj *et al.* (1987) observed achene yield had highly significantly positively correlated with harvest index, leaf area and total dry matter.

Vanishree *et al.* (1988) found that head diameter, stem diameter, 100 seed weight, leaves per plant and plant height were highly and significantly positively correlated with yield.

2.4 Selection Indices

The discriminant function technique was developed by Fisher (1936). Its use for plant selection programmes was proposed by Smith (1936). He suggested that better way of exploiting genetic correlation with several traits having high heritability is to construct an index called "Selection Index", which combines information on all the independent variable.

Hazel (1943) proposed that the selection of a metric character based on a combination of different metric character would be more effective Panse and Kargonkar (1957) ascertained discrimination of environmental component in total genotype as a better indicator of true genetic worth. Importance of multiple selection criteria was stressed by Brim *et al.* (1959).

Limited work in sesame has been done in this direction, hence the available reviews in sesame and other crops are presented below.

Lee and Chang (1986) in sesame obtained the maximum efficiency for selection index when all the character are considered and use of selection index combining days to flowering, length of stem, length capsule and capsule number per plant was recommended.

Nie *et al.* (1991) in sunflower by selection indices observed that selection for higher seed oil content based on branching position, 100 seed weight, duration of initial flowering

ge and seed to hull ratio may give best results.

Asad *et al.* (1993) in sunflower observed significant discriminant weights for character combination kernel per spike, kernel weight and tiller number.

Singh and Dalal (1980) in soyabean opined that selection based on selection index was as good as selection based on yield itself items of efficiency.

Milaland and Verma (1991) in their study in pea observed that there was progressive increase in the relative efficiency based on two, three, four and five character combination over straight selection. They further concluded that the maximum efficiency was noticed with selection indices based on five character viz., days to flower, productive pod, length productive number of seeds per pod, productive pod weight and Test weight of 1000 green grains.

Nandan and Pandya (1980) in lentil reported that efficiency of selection was increased by 22 per cent over straight selection for grain yield when component characters were considered.

Mathur and Gupta (1992) in finger millet observed selection indices based on single character over straight selection for yield alone was less efficient. But when grain yield, capitula per plant and harvest index combinations was considered the selection index gave higher relative efficiency and genetic advance.

Selection indices formulated in F_3 population of finger millet consideration the characters plant height and number of productive tillers in cross HR-911 x Indaf-9, ear weight, straw weight and harvest index in the cross Indaf-8 x HR-41-2 was found to be best indices for indirect selection for grain yield by Basavaraja and Sheriff (1992).

Thirthamallappa and Sheriff (1992) observed that the combination of characters plant height, basal diameter, top diameter, days to flowering, node number and seed weight had high genetic advance and are useful for simultaneous improvement of fibre yield in canaf.

Venkatesh Bhat and Sheriff (1994) in finger millet found that simultaneous selection for number of fingers, era weight and 1000 grain weight in Cross HR 6-271 x Indaf-9 and for ear weight, straw weight and 1000 grain weight in the Cross HR 911 x HR 7-30-2 were efficient in enhancing grain yield.

Sundaram and Palaniswamy (1994) using discriminant function in rice indicated that the selection based on discriminant function was more useful than straight selection based on yield alone.

2.5 Intergeneration correlation and Narrowsense heritability

Intergeneration correlation studies by using parent off-spring regression help in estimating the extent of transferring genetic potentials of the character from one generation to other.

Lush (1940) proposed parent - offspring regression method which involves regressing the mean value of a character in the progeny upon the value of same character in the parent. This technique is useful in determine the influence of environment on different characters. Influence of environment on different characters in progenies obtained from individual selection from early generations and to study the real genetic potential of the progenies inherited from their parents. Since studies in this direction is very limited in sesame the available review in sesame and other crops are presented below.

In soyabean Mahamud and Kramer (1957) obtained highly significant correlation between yield of F_3 and F_4 lines grown in same season.

Anand and Torry (1963) obtained very low correlation and heritability in Soybean between F_3 and F_4 generation when they were grown in different season for yield. Similar results were obtained by Briggs and Shebeshi (1971) and Knott and Kramer (1975).

Ratnaswamy and Ponnaiya (1963) reported that the number of productive tillers might serve as an index in selection for yield in Italian millet.

Sandhu *et al.* (1974) observed that a selection index based on primary tillers per plant and plant height would account for 19 per cent of variation for grain yield.

Forty eight varieties of foxtail millet were studied by Chinnaswamaiah (1975) and found that most of the selection indices with a combination of two or more characters were far superior than straight selection. He concluded that straw weight and number of productive tillers could serve as an index in selection for grain yield.

Dhagat *et al.* (1977) reported that the combination of three yield components viz., 1000 seed weight, grain weight of the main ear and length of main ear along with the yield had the highest relative efficiency.

Virupakshappa (1982) estimated Intergeneration correlation coefficient in F_2 - F_3 , F_3 - F_5 and F_5 - F_6 generations of cowpea for seed yield. He observed non significant correlation and low heritability in all the generation.

Reddy (1984b) in little millet indicated that the selection index comprising grain yield, plant height and panicle weight were found to be the best in increasing the efficiency.

Abraham and Borthakur (1987) in there study in foxtail millet involving 52 genotypes obtained highest genetic advance for number of ears per plant and days to maturity.

Gupta *et al.* (1988) in peal millet observed non significant correlation and low heritability between F_2 and F_3 generations.

Basavaraja (1990) in his study in F_2 and F_3 generation of finger millet cross found that the Intergeneration correlation was non significant for grain yield. However significant positive association were observed for length of the ear and number of finger per ear in both the crosses, for plant height in Cross-HR 911 x Indaf-9 and for number of productive tillers in the Cross Indaf-8 x HR-41-2. He also noticed low narrow sense heritability values for grain yield and ear weight, however it was high for length of the ear in both the crosses, for plant height, number of productive tillers and number of fingers per ear in cross HR-911 x Indaf-9, moderate for plant height and number of finger per ear in Cross Indaf-8 x HR-41-2.

Venkatesh Bhatt (1994), in his study in involving F_2 and F_3 generation of finger millet cross observed significant Intergeneration correlation for yield and 1000 grain weight. Further high narrow sense heritability was noticed for grain yield and total ear weight in the Cross HR-6-27-1 x Indaf-9 and for number of fingers on main ear and 1000 grain weight in HR-911 x HR-7-30-2.

Ranganatha *et al.* (1994b) in the study from F_2 to F_6 generation of sesame crosses observed moderate Intergeneration correlation for yield per plot and was significant for one cross and non significant for other two crosses. Between F_2 and F_3 , and F_3 and F_4 generation the Intergeneration correlation was noticed for days to maturity. They also worked out narrow sense heritability and was found high for days to maturity. It was low for seed yield per plant yield per plot, primary branches, effective capsules per plant and oil percentage. They further concluded that early generation testing for seed yield per plant was not a reliable indicator of performance of progeny in subsequent generations.

MATERIAL AND METHODS

III MATERIAL AND METHODS

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The material used and methods followed in conducting present experiment have been discussed in this chapter.

3.1 Material

The experimental material for the present study comprised of F_2 generations of three crosses involving four sesame cultivars viz. R843602, C30P8, DORS 102 and Madhavi obtained from senior plant scientist (oil seeds), University of Agricultural Sciences, G.K.V.K., Bangalore-560 065. The study was conducted at the G.K.V.K. which is located at the latitude of $12^{\circ}15'N$, longitude of $77^{\circ}35'E$ and an altitude of 930 meter above MSL.

The material consisted of the F_2 and F_3 generations of following three crosses, involving above mentioned parents.

1. R843602 x Madhavi
2. DORS 102 x Madhavi
3. C30P8 x Madhavi

3.2 METHODS

The progenies of F_2 and F_3 generations were grown during Kharif 1995 and Summer 1996, respectively. The recommended package of practices for cultivation was adopted to rise the crop.

3.2.1 F_2 generation

The F_2 population of three crosses along with their parents were grown separately and 110 plants from each population were randomly selected and observation on these selected plants parents were recorded on ten metric traits.

3.2.2 F₃ generation

For study of F₃ generation the F₂ plants were chosen in such a way that selections covering the range of mean yield in F₂ $\pm$ 1 standard deviation were advanced. This accounts to 84 plants which were grown along with their parents. The 84 entries were sown in single row of 2.5 metres in length in three replications in a randomized complete block design. Ten plants in each entry were randomly selected and observations were recorded on 11 metric traits.

The following observations except oil content were recorded on 110 plants in F₂ and on 10 randomly selected plants for all the 11 characters in F₃ generations in each progeny and replication.

1. Days to Flowering :

In F₂ generation it was recorded on single plant for the number of days taken from the date of sowing to the day on which the flowers opened. In F₃ generation days to 50 percent flowering was considered as the number of days taken from date of sowing to the day on which flowers opened in 50 per cent of the plants.

2. Plant height

Height of plants were measured and recorded in centimetres from the ground level to the tip of plants.

3. Number of Primary Branches per plant

Total number of branches that are present on main stem at the time of harvesting was recorded.

4. Number of secondary branches :

Total number of branches that are borne on primary branch at the time of harvest was recorded.

5. Number of capsules per plant :

Total seed bearing capsules on each plant were counted and recorded,

6. Days to maturity :

Recorded as number of days taken from the date of sowing to the day on which the capsules and leaves turn yellowish in colour.

7. Capsule Length :

Length of five matured capsules selected at random from each plant was measured and the mean was expressed in centimetres.

8. Number of seeds per capsule :

Seeds from five capsules from each sample were counted and mean seeds per capsule was recorded.

9. 1000 seed weight :

Well dried 1000 seeds on each plant was weighed and expressed in grams.

10. Yield per plant :

Seeds from each selected plant were weighed and the mean was expressed in grams as seed yield per plant.

11. Oil content :

Nuclear Magnetic Resonance Spectrometer (NMR) available at RRS, U.A.S., Raichur was used to estimate oil content in F₃ generation.

3.3 Statistical methods :

Data recorded were statistically analysed on individual plant basis for F_2 generation and mean value basis of ten plants for F_3 generation separately in each cross. Analysis was done using F_2 GENO, CPATH, SELL and INGEN FORTRAN programmes written by the author at the Computer Centre, University of Agricultural Sciences, Bangalore, in the main frame computer VAX/VMS VERSION V4.5.

Analysis of Variance

a) F_2 generation

Genetic variance was separated from the total variance as per relative variance F_2 method illustrated by Weber and Moorthy (1952). Accordingly to environmental variance was estimated from the non-segregating parental population as -

$$V_e = \frac{V_{p1} + V_{p2}}{2}$$

Where V_e is the environmental variance. V_{p1} and V_{p2} are the variance of two parents p_1 and p_2 respectively.

The genetic variance was estimated as the difference between the total phenotypic variance (mean sum of squares) and environmental variance.

$$V_g = V_p - V_e$$

Where, V_g is the genotypic Variance

V_p is the phenotypic Variance

V_e is the environmental Variance.

b) F_3 generation

Differences between F_3 families and parents for different characters were tested for

gnificance using analysis of variance technique on the basis of following model (Panse and Sukhatme 1967).

$$Y_{ij} = M + g_i + r_j + e_{ij}$$

Where Y_{ij} = phenotypic observation of i^{th} genotype and j^{th} replication

M = general mean

g_i = effect of i^{th} genotype

r_j = effect of j^{th} replication

e_{ij} = Experimental error associated with i^{th} genotype and j^{th} replication.

3.1 Estimation of genetic parameters

a) Phenotypic and genotypic variance :

These were estimated as per Lush (1940)

$$\text{genotypic variance } \sigma_g^2 = \frac{\text{MSS}_t - \text{MSSE}}{r}$$

$$\text{Phenotypic variance } (\sigma_p^2) = \sigma_g^2 + \sigma_e^2$$

Where MS_t = Mean sum of squares due to treatments

MS_e = Mean sum of squares due to error

σ_e^2 = Variance due to error

r = Number of replications.

and GCV) :

These were computed according to Burton (1952).

$$\text{PCV (\%)} = \frac{\text{Phenotypic standard deviation}}{\text{General Mean}} \times 100$$

$$\text{GCV (\%)} = \frac{\text{Genotypic standard deviation}}{\text{General Mean}} \times 100$$

c) Heritability (Broad sense) :

Heritability in broad sense was estimated using following formula of Hanson *et al.* (1956).

$$h^2 (\text{broad sense}) = \frac{\sigma_g^2}{\sigma_p^2} \times 100$$

Where, σ_g^2 = genotypic variance

σ_p^2 = phenotypic variance

d) Genetic Advance :

This was worked out as per the formula proposed by Johnson *et al.* (1955).

$$\text{GA} = h^2 \times K \times P$$

Where h^2 = heritability coefficient.

K = Selection differential at 5% selection intensity (2.06)

P = Phenotypic standard deviation

Genetic advance as percent of mean, was computed as

$$\frac{\text{GA}}{\text{General mean}} \times 100$$

3.2 Correlation coefficients

The phenotypic and genotypic correlation coefficients were determined in all possible combinations of characters by taking appropriate variances and covariances.

Computations were as per AI - Jibouri *et al.* (1958).

$$r_{12} = \frac{Cov_{12}}{\sqrt{V_1 \times V_2}}$$

Where, r_{12} = Correlation coefficient between Character 1 and 2.

Cov_{12} = Covariance between character 1 and 2

V_1 , = Variance of Character 1

V_2 = Variance of Character 2

The significance of correlation coefficients was tested against 't' value of Fisher and Yates (1963).

3.3 Path Coefficient Analysis

Path coefficient analysis was carried out as suggested by Wright (1921) and illustrated by Dewey and Lu (1959).

The path coefficients were obtained by solving the 'P' normal equation following the matrix method given by Singh and Chaudhary (1985).

3.4 Selection Indices

The discriminant function analysis technique used was developed by Fisher (1936) and adopted by Smith (1936) to propose a selection model for selecting several characters

simultaneously. The function aims at discriminating the desirable genotypes from undesirable ones based on its phenotypic performance. The genetic worth of an individual as described by Smith (1936) is -

$$H = a_1 G_{11} + a_2 G_{12} + a_3 G_{13} + \dots + a_n G_{nn}$$

Where, G_{11} , G_{12} , G_{13} , ... G_{nn} are the genotypic values of individual characters and a_1 , a_2 , a_3 , ... signify their relative importance.

Phenotypic performance of various characters (H) is used in defining another function (I) as -

$$I = b_1 p_1 + b_2 p_2 + \dots + b_n p_n$$

Where b_1 , b_2 , ... b_n are to be estimated such that correlation between H and I i.e. r_{HI} becomes maximum. When one such function is obtained, discriminant of good genotypic from undesirable ones will be possible on the basis of phenotypic performance, i.e. P_1 , P_2 , P_3 , ... P_n directly.

a) Genetic Advance based on single character

The expected gain through selection was calculated as per Johnson *et al.* (1955).

$$GA = \frac{g_{1.2}}{P_1} \times K$$

Where, $g_{1.2}$ = genotypic covariance between selected and unselected character.

P_1 = Phenotypic standard deviation of the selected character.

K = Selection differential at 5% (2.06).

b) Genetic advance based on a combination of characters

Genetic advance based on a combination of characters was predicted by the formula given by Robinson *et al.* (1951).

$$GA(SI) = K P_i G_{kij}$$

Where K = Selection differential at 5% (2.06)

P_i = Coefficient at a selection index

$G_{iy} = G_{1y}, G_{2y}, \dots, G_{ny}$, i.e. genotypic covariance between selected (1,2,3.....n) and unselected (y) character.

GY (SI) = Genetic advance of the selection index.

c) Relative efficiency (RE)

Considering the efficiency of yield alone as 100 percent, the relative efficiency of a particular selection index was computed by using the formula given by Brim *et al.* (1959).

$$RE = \frac{\text{GA of Selection index}}{\text{GA by strait selection}} \times 100$$

3.5 Intergeneration correlation and narrowsense heritability

Between F_2 and F_3 generations, Intergeneration correlation coefficients were calculated for all the characters under study except oil percentage. For every character the progeny means (Y) of F_3 generation were regressed on the individual plants of F_2 generation.

$$\text{Intergeneration correlation (r)} = byx \frac{x}{y}$$

$$\text{Where, } byx = \frac{\text{Covariance of xy}}{\text{Variance of x}}$$

x = Standard deviation of x

y = Standard deviation of y

The heritability values in narrow sense were calculated according to Mahmud and Kramer (1951).

$$h^2 = \frac{b_{yx} \times X \times 100}{Y}$$

Where X = Mean of F₂ generation and Y = mean of F₃ generation.

EXPERIMENTAL RESULTS

IV EXPERIMENTAL RESULTS

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The experimental results of the present investigation in F₂ and F₃ generations of sesame as per objectives are presented under following headings:

4.1. Variability, heritability and Genetic advance.

4.2. Character association.

4.3. Path coefficient analysis.

4.4. Selection indices.

4.5. Intergeneration correlation and Narrowsense heritability

4.1 Variability, Heritability and Genetic advance.

4.1.1 Variability

(a) F₂ Generation

The mean and standard errors for different characters for three crosses and four parents are presented in Table 1.

(a) Cross-I (R843602 X Madhavi)

Mean, Range, estimates of genotypic, phenotypic and environmental variances, phenotypic and genotypic coefficient of variation (PCV and GCV), heritability in broadsense, genetic advance at 5 percent selection intensity and as percent mean are presented character wise in table.2. heritability is depicted in figure 1.

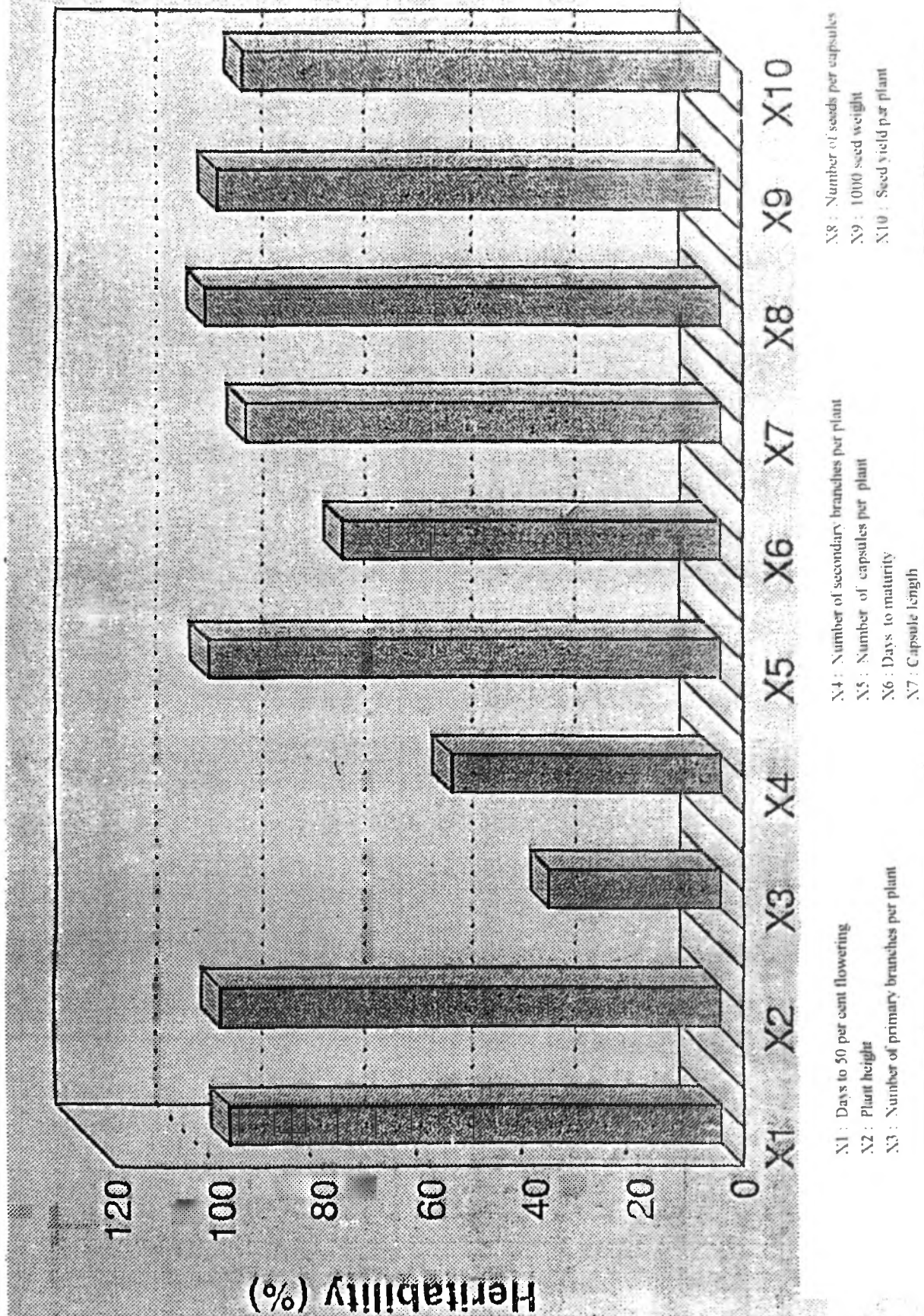
Table 1 : Mean and standard errors (SE) for different characters of four parents and three F₂ population of sesame

Characters	Madhavi	R843602	C30P8	DORS102	R843602 X Madhavi	C30P8 X Madhavi	DORS102 X Madhavi
	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE
1. Days to flowering	42.57 0.94	46.53 0.54	40.56 0.68	44.51 0.74	36.94 0.41	41.50 0.42	40.54 0.41
2. Plant height	55.62 1.76	92.52 2.24	112.24 3.26	90.58 2.56	63.14 1.58	71.00 1.58	72.67 1.41
3. No. of primary branches	3.04 0.34	3.45 0.52	5.46 0.44	3.42 0.42	3.37 0.09	3.74 0.15	2.79 0.09
4. No. of secondary branches	1.26 0.06	1.08 0.08	4.24 0.12	2.38 0.04	1.36 0.10	1.74 0.10	1.90 0.09
5. No. of capsules per plant	31.58 1.24	54.20 1.44	68.66 2.24	60.46 1.96	47.64 1.15	48.45 1.58	42.09 1.29
6. Days to maturity	86.22 0.68	90.64 0.72	93.48 0.94	90.52 0.86	92.87 0.58	91.02 1.20	88.85 0.64
7. Capsule length	2.52 0.01	3.28 0.03	3.42 0.06	3.36 0.04	2.74 0.05	3.13 0.04	2.36 0.05
8. No. of seeds per capsule	43.54 0.68	58.34 1.14	68.52 1.58	61.74 1.52	50.94 0.88	51.60 0.81	53.30 1.16
9. 1000 seed weight (g)	2.64 0.01	3.14 0.02	3.21 0.04	3.28 0.02	2.79 0.04	2.94 0.06	2.80 0.05
10. Seed yield per plant (g)	5.96 0.24	7.54 0.36	12.62 0.19	14.94 0.22	5.39 0.15	6.80 0.22	5.97 0.23

Table 2 : Range, Mean, Heritability, Genetic advance for 10 quantitative characters in sesame in F₂ generation of Cross-I (R843602 X Madhavi)

Charaters	Range	Mean	Variances			Coefficient of variation		Heritability	Genetic Adavance	Genetic Advance as percent mean
			-----			-----				
			Phenotypic	Genotypic	Environ	Phenotypic	Genotypic			
					ment					
1. Days to flowering	30-45	36.94	18.89	17.79	1.10	11.77	11.42	94.18	8.4	22.83
2. Plant Height(cm)	29-103	63.14	276.30	265.20	11.10	26.33	25.79	95.98	32.87	52.07
3. No. of Primary Branches	1-5	3.37	1.04	0.34	0.70	30.28	17.37	32.90	69.23	20.53
4. No. of Secondary Branches	0-5	1.36	1.17	0.60	0.57	79.79	56.92	51.54	1.14	84.19
5. No. of Capsules (cm)	16-72	47.64	147.20	144.44	2.77	25.47	25.23	98.12	24.52	51.47
6. Days to maturity	80-104	92.87	37.29	26.89	10.40	6.57	5.58	72.11	9.07	9.76
7. Capsule length (cm)	1.96-3.34	2.74	0.23	0.21	0.02	17.61	16.81	91.08	90.86	33.04
8. No. of Seeds per Capsule	32 28-66.26	50.94	85.48	84.38	1.10	18.15	18.03	98.72	18.80	36.91
9. 1000 seed weight(g)	1.9-3.6	2.79	0.26	0.25	0.01	18.29	17.97	96.47	1.01	36.36
10. Seed yield per plant(g)	1.8-8.3	5.39	2.46	2.26	0.21	29.12	27.87	91.64	2.96	54.96

Fig. 1. Heritability (%) for 10 quantitative characters in F_2 generation of Cross-I (R843602 X Madhavi)



1. Days of flowering

The overall mean for days taken to flowering by individual plants was 36.94 days with a range of 30 to 45 days. The phenotypic and genotypic variances were low (18.89 and 17.79 respectively). Low phenotypic and genotypic (11.77 and 11.42 respectively) coefficient of variation was observed. A high heritability value of 94.18 percent was observed with an expected genetic advance as percent mean (GAM) of 22.83 percent.

2. Plant height

Wide range of variation from 29 cm to 103 cm with mean of 63.14 cm was noticed. A high phenotypic (276.30) and genotypic (265.20) variance was observed. The phenotypic and genotypic coefficient of variation were 26.33 and 25.79 percent respectively. A high heritability estimate of 95.98 percent with an expected GAM of 52.07 percent was observed for this character.

3. Number of Primary branches

The number of primary branches ranged from 1 to 5 with a mean of 3.37. Low phenotypic (1.04) and genotypic (0.34) variance were noticed. A high genotypic (30.28) and low phenotypic (17.37) coefficient of variations were observed. Heritability estimate was low (32.90) with an expected GAM of 20.53 was observed for this character.

4. Number of Secondary branches

The over all mean for this trait was 1.36 with a range of 0 to 5. Low genotypic and phenotypic variance (1.17 and 0.60 respectively) was observed. The coefficient of variation was high for both phenotypic (79.79) and genotypic (56.92). This character exhibited heritability estimate of 51.54 percent with an expected GAM of 84.19 percent.

5. Number of Capsules

Mean number of 47.64 capsules were recorded with a range of 16 to 72 capsules per plant. A high phenotypic and genotypic variation of 147.20 and 144.44 respectively were recorded for this trait. The genotypic and phenotypic coefficient of variation were 25.47 percent and 25.23 percent respectively. This character showed a heritability estimate of 98.12 percent with an expected GAM of 51.47 percent.

6. Days to maturity

This character ranged from 80 to 104 days with a mean of 92.87 days. This character recorded the phenotypic variance of 37.29 and genotypic variance of 26.89. Low coefficient of variation for both phenotypic (6.57) and genotypic (5.58) was recorded. A high heritability estimate of 72.11 percent with low expected GAM of 9.76 percent was observed.

7. Capsule length

The range for this character was found to be 1.96 to 3.34 cm with a mean of 2.74 cms. Phenotypic (0.23) and genotypic (0.21) variances were low for this character. Further a low phenotypic and genotypic coefficients of variation (17.61 and 16.81 respectively) were recorded. High heritability (91.08) with high expected GAM (33.04%) were recorded for this character.

8. Number of seeds per capsule

The range of variation observed was between 32.28 to 66.26 with a mean of 50.94. The phenotypic and genotypic variances were 85.48 and 84.38, respectively. A moderate phenotypic and genotypic coefficient of variation (18.5 and 18.03 respectively) was noticed. High heritability estimate (98.72%) with high expected GAM (36.91%) were also recorded for this trait.

9. 1000 seed weight

It ranged from 1.92g to 3.6g with a mean of 2.7g. It recorded low phenotypic (0.26) and genotypic (0.25) variance. A moderate phenotypic (18.29) and genotypic (17.97) coefficient of variation was recorded. A high heritability estimate of (96.47%) with high expected GAM of 36.36 percent was observed.

10. Seed yield per plant

The seed yield ranged from 1.88g to 8.3g with a mean of 5.3g. Low variance for phenotypic (2.46) and genotypic (2.6) was recorded for this trait. The coefficient of variations of phenotypic and genotypic were 29.12 and 27.87 respectively. High heritability estimate (91.64%) was high expected GAM (55.96%) was recorded for this trait.

b) Cross-II (DORS102 X MADHAVI)

Mean, Range, estimates of genotypic phenotypic and environmental variances, phenotypic and genotypic coefficient of variations, (PCV and GCV), heritability in broadsense, genetic advance at 5 percent selection intensity and as percent mean are presented character wise in table 3. Heritability is depicted in figure 2.

1. Days to flowering

Days to flowering ranged from 32 days to 47 days with mean of 40.54 days was observed. A low phenotypic (18.69) and genotypic (13.92) variance was noticed for this character. The phenotypic and genotypic coefficient of variations were 10.66 and 9.21 respectively. A heritability estimate of 74.50 percent with low genetic advance of 16.37 percent was recorded.

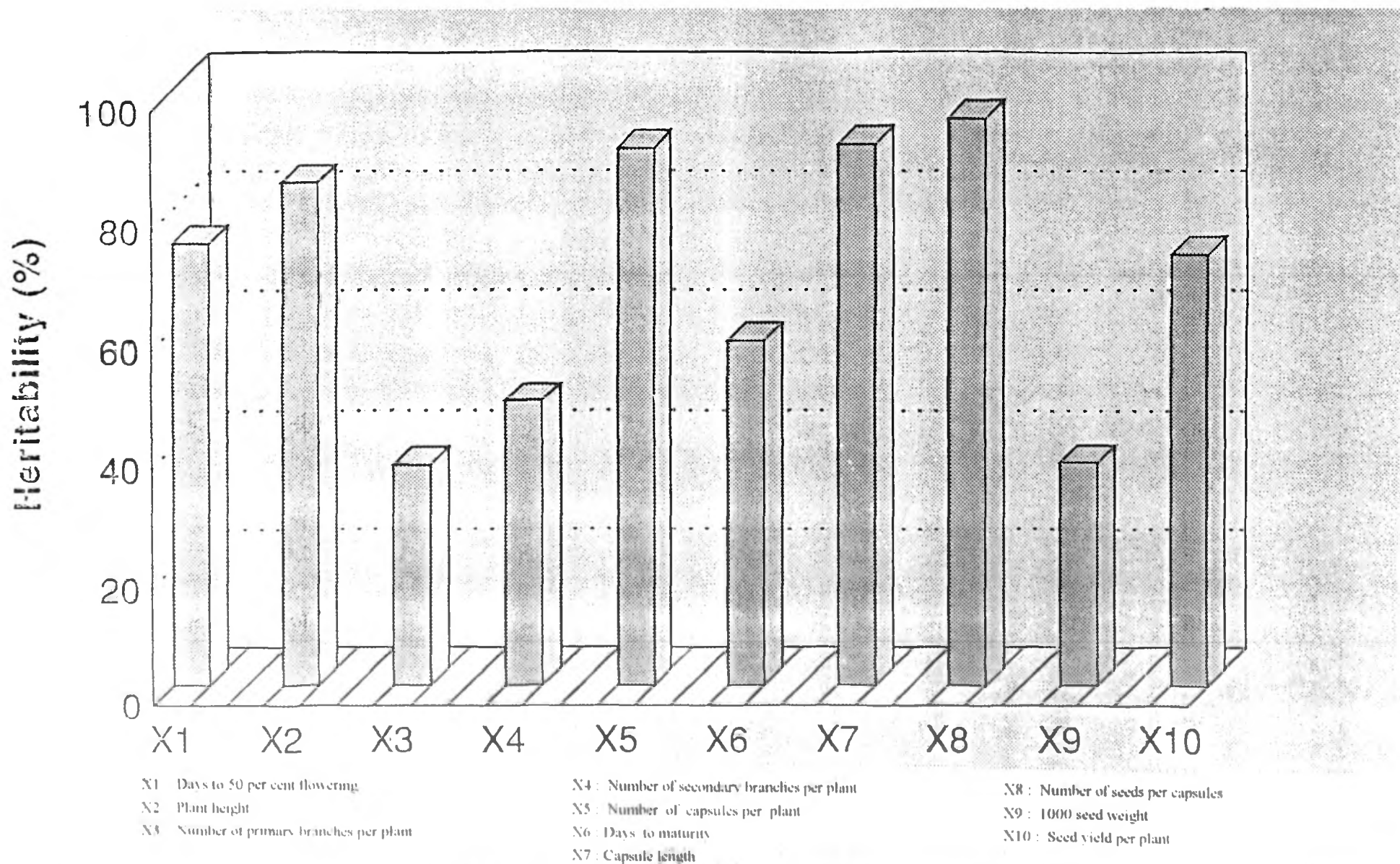
2. Plant height

It ranged from 32 cm to 110 cm with overall mean of 72.67 cm. High phenotypic (218.22)

Table 3 : Range, Mean, Heritability, Genetic advance for 10 quantitative characters in sesame in F_2 generation of Cross-II (DORS102 X Madhavi)

Charaters	Range	Mean	Variances			Coefficient of variation		Broad Sense Heritability	Genetic Advance	Genetic Advance as percent mean
			Phenotypic	Genotypic	Environ ment	Phenotypic	Genotypic			
1. Days to flowering	32-47	40.54	18.69	13.92	4.77	10.66	9.21	74.50	6.64	16.37
2. Plant Height(cm)	32-110	72.67	218.22	184.76	15.43	20.33	19.60	84.66	28.27	38.91
3. No. of Primary Branches	2-8	2.79	0.90	0.43	0.57	34.00	20.77	37.10	0.72	25.98
4. No. of Secondary Branches	0-4	1.90	0.90	0.43	0.47	105.30	72.99	48.04	0.93	48.94
5. No. of Capsules	23-78	42.09	183.68	165.88	17.80	32.20	30.60	90.31	25.21	59.90
6. Days to maturity	83-114	88.85	44.38	25.82	18.57	7.49	5.71	58.17	7.98	8.89
7. Capsule length	21-3.24	2.36	0.36	0.33	0.03	25.53	24.37	91.09	1.13	47.90
8. No. of Seeds per Capsule	36.24-72	53.37	148.17	141.14	7.03	22.81	22.26	95.26	23.87	44.75
9. 1000 seed weight	2.4-3.8	2.80	0.16	0.06	18.56	1.28	45.71			
10. Seed yield per plant (g)	2.0-9.4	5.97	5.57	4.05	1.53	39.58	33.73	72.63	3.53	59.21
										0.23

Fig. 2. Heritability (%) for 10 quantitative characters in F_2 generation of Cross-II (DORS102 X Madhavi)



and genotypic (184.76) variances were observed for the trait. Coefficient of variation of phenotypic and genotypic were 20.33 and 19.60 respectively. This recorded heritability estimate of 84.66 percent with expected GAM of 38.91 percent.

3. Number of primary branches

This character exhibited a range of 2 to 8 with mean of 2.79. Phenotypic and genotypic variances were 0.90 and 0.33 respectively. High coefficient of variation for phenotypic (34.00) and medium for genotypic (20.77) were noticed. The heritability estimate for this trait was 48.04 percent with expected GAM of 25.98 percent was recorded.

4. Number of secondary branches

The mean for this character is 1.90 with a range of 0 to 4. Low phenotypic variance of 1.90 and genotypic variance of 0.43 was recorded. Phenotypic and genotypic coefficient of variation was high (105.30 and 72.99 respectively) for this character. A moderate heritability of 48.0 percent with an expected GAM of 48.94 percent was observed.

5. Number of capsules per plant

The number of capsules per plant varied from 23 to 78 with a mean of 42.09. This character recorded high phenotypic (183.68) and genotypic (165.88) variances. The phenotypic coefficient of variation of 32.20 and genotypic coefficient of variation of 30.60 was recorded. A high heritability estimate of 90.31 percent with a high expected GAM of 59.90 percent was observed.

6. Days to maturity

It ranged from 83 days to 114, days with a mean of 88.85 days. The phenotypic and genotypic variance recorded for this character are 44.38 and 25.82 respectively. Low coefficient of variation for

both phenotypic (7.49) and genotypic (5.71) was noticed. The heritability estimate for this character is 58.17 percent with low expected GAM of 8.89 percent.

7. Capsule length

The range for this character was 2.1 cm to 3.24 cm with average mean of 2.36 cm. The phenotypic and genotypic (0.36 and 0.33 respectively) variances were low for this trait. The phenotypic and genotypic coefficient of variation was 25.33 and 24.37 respectively. A high heritability estimated of 91.09 per cent coupled with high expected GAM of 47.90 per cent was recorded for this character.

8. Number of seeds per capsule

The over all mean for this character was 53.37 with a range of 36.24 to 72.00 seed per capsules. High phenotypic variance of 148.17 and genotypic variance of 141.14 was observed for this character. The phenotypic and genotypic coefficient of variation recorded for this character was 22.81 and 22.26 respectively. This character recorded a heritability estimate of 95.26 percent with an expected GAM of 44.75 percent.

9. 1000 seed weight

The range for this character was 2.4g to 3.8g with a mean of 2.80g. The phenotypic and genotypic variances values were 0.16 and 0.06 respectively. This recorded phenotypic coefficient of variation of 14.52 and genotypic coefficient variation of 8.42. The broad sense heritability was 37.50 percent and an expected GAM of 45.71 percent.

10. Seed yield per plant.

The over all mean for this character was 5.97g with a range of 2.0g to 9.4g. This recorded low phenotypic variance (5.57) and genotypic variance (4.05). The coefficient of variation of phenotypic and genotypic were 39.58 and 33.73 respectively. Moderate heritability estimate (72 percent) with high expected GAM (51.81%) was noticed for this character.

c) Cross - III (C30P8 X Madhavi)

Mean, range, estimates of genotypic, phenotypic and environmental variances, phenotypic and genotypic coefficient of variation (PCV and GCV), heritability in broadsense, genetic advance at 5 percent selection intensity and as percent mean are presented character wise in table 4. Heritability is depicted in figure 3.

1. Days to flowering

The overall mean for days taken to flowering was 41.50 days with a range of 30 to 46 days. Low phenotypic (20.09) and genotypic (14.65) variance were recorded for this character. The phenotypic and genotypic coefficient of variations were 10.80 and 9.23 respectively. The heritability estimate was 72.95 percent with an expected GAM of 16.23 percent was observed for this character.

2. Plant height

This has recorded a range of 35 cm to 132 cm with a mean of 71.00 cm. The phenotypic variance and genotypic variance were 275.64 and 252.91 respectively. The phenotypic coefficient of variation was 23.38 and genotypic coefficient of variation was 22.40. This character recorded a high heritability estimate of 91.75 percent and expected GAM as percent mean was 44.20 percent.

3. Number of primary branches

This recorded a range of 4 to 8 with a mean of 3.74. Low phenotypic and genotypic variances were recorded which were being 2.60 and 0.87 respectively. A high coefficient of variation for phenotypic (43.15) and low for genotypic (24.90) was observed. A low heritability estimate of 33.32 percent with a expected GAM of 29.62 percent was recorded for this character.

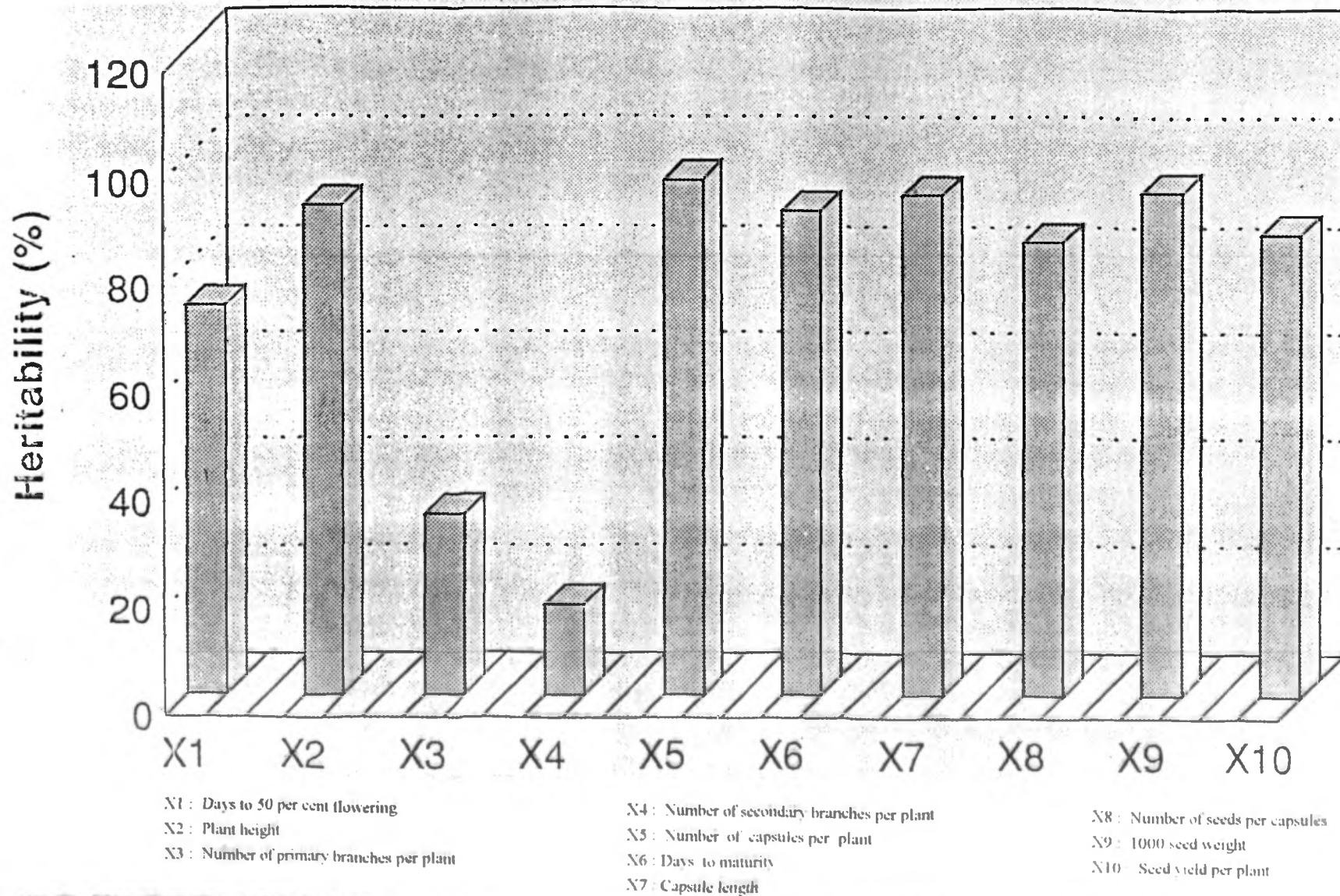
4. Number of Secondary branches

The mean recorded for this was (1.74) with a range of 0 to 5. Very low phenotypic (1.00) and genotypic (0.17) variance was observed. The coefficient of variation of phenotypic and genotypic was 57.68 and 23.74 respectively. The heritability estimate was very low, value being 16.94 percent with an expected GAM of 20.13 percent.

Table 4 : Range, Mean, Heritability, Genetic advance for 10 quantitative characters in sesame in F₂ generation of Cross-III (C30P8 X Madhavi)

Characters	Range	Mean	Variances			Coefficient of variation		Broad Sense Heritability	Genetic Advance	Genetic Advance as percent mean
			-----			-----				
			Phenotypic	Genotypic	Environ ment	Phenotypic	Genotypic			
1. Days to flowering	30-46	41.50	20.09	14.65	5.43	10.80	9.23	72.95	6.73	16.23
2. Plant Height(cm)	35-132	71.00	275.64	252.91	22.73	23.38	22.40	91.75	31.38	44.20
3. No. of Primary Branches	4-8	3.74	2.60	0.87	1.73	43.15	24.90	33.32	1.10	29.62
4. No. of Secondary Branches	3-5	1.74	1.000	0.17	0.83	57.68	23.74	16.94	34.95	20.13
5. No. of Capsules	29-84	48.45	273.55	263.85	9.70	34.14	33.56	96.45	32.86	67.83
6. Days to maturity	84-122	91.02	160.73	145.90	14.83	13.92	13.27	90.77	23.70	26.06
7. Capsule length	2.24-3.84	3.13	0.18	0.17	0.01	12.97	12.55	93.72	0.8298	25.04
8. No. of Seeds per Capsule	31.4-72.60	51.60	71.83	60.98	10.85	16.42	15.13	84.89	14.82	28.72
9. 1000 seed weight	2.1-3.56	2.94	0.39	0.37	0.02	21.33	20.71	94.31	1.21	41.43
10. Seed yield per plant (g)	2.3-8.8	6.80	5.22	4.52	0.70	33.58	31.3	86.52	4.07	59.85

Fig. 3. Heritability (%) for 10 quantitative characters in F_2 generation of Cross-III (C30P8 X Madhavi)



5. Number of capsules per plant.

A mean of 48.45 capsules per plant with a range of 29 to 84 was noticed. The estimates of variances for phenotypic and genotypic were high and value being 273.55 and 263.85 respectively. The coefficient of variations were 34.14 and 33.56 for phenotypic and genotypic respectively. High heritability estimate of 96.45 percent with an expected GAM of 67.83 percent was recorded for this character.

6. Days of maturity

Days to maturity ranged from 84 days to 122 days with a mean of 91.02 days. The phenotypic variance of 160.73 were observed. Low coefficient of variation for phenotypic and genotypic with value being 13.92 and 13.27 was recorded. The estimate of heritability was 90.77 percent with an expected GAM of 26.06 percent.

7. Capsule length

The range for this character was found to be from 2.24cm to 3.84cm with a mean of 3.13 cm. The phenotypic and genotypic variance was 0.18 and 0.17 respectively. The coefficient of variation was 12.97 and 12.55 for genotypic and phenotypic respectively. High heritability estimate of 93.72 percent with an expected GAM 25.04 percent was noticed.

8. Number of seeds per capsule

It ranged from 31.40 to 72.60 with a mean of 51.60 seeds per capsule. This recorded phenotypic variance of 71.83 and genotypic variance of 60.98. The coefficient of variation of phenotypic and genotypic was low with value being 16.42 and 15.13 respectively. Heritability estimate was high (84.89%) with expected GAM of 28.72 percent.

9. 1000 seed weight

The range recorded for this character was 2.1g to 3.56g with an overall mean of 2.94 g. A low phenotypic (0.39) and genotypic (0.37) variance was recorded. The coefficient of variation of

phenotypic and genotypic was 21.33 and 20.71 respectively . This character recorded an heritability estimate of 94.31 percent with high expected GAM of 41.43 percent.

10. Seed yield per plant

The range of variation for this character was from 2.3g to 8.8g per plant, with an overall mean of 6.80g. the phenotypic and genotypic variation was 5.22 and 4.52 respectively was observed. This character showed phenotypic coefficient of variation of 33.58 and genotypic coefficient of variation of 31.23. This character recorded high heritability estimate of 86.52 percent with an expected GAM of 59.85 percent.

II. F₃ generation

(a) Cross - I (R843602 X Madhavi)

Mean, Range, estimates of phenotypic, genotypic and environmental variances, PCV and GCV, heritability in broadsense, genetic advance at 5 percent selection intensity, and as percent mean are character wise in F₃ generation are indicated in table. 5. Heritability is illustrated in figures 4.

1) Days to 50 percent flowering

The mean for this character was 36.21 days with a range of 30 to 44 days. The genotypic and phenotypic were 24.81 and 16.80 respectively. The phenotypic and genotypic coefficient of variation was 22.25 and 20.25 respectively. Moderate heritability estimate of 67.74 percent with an expected GAM of 55.45 percent was observed.

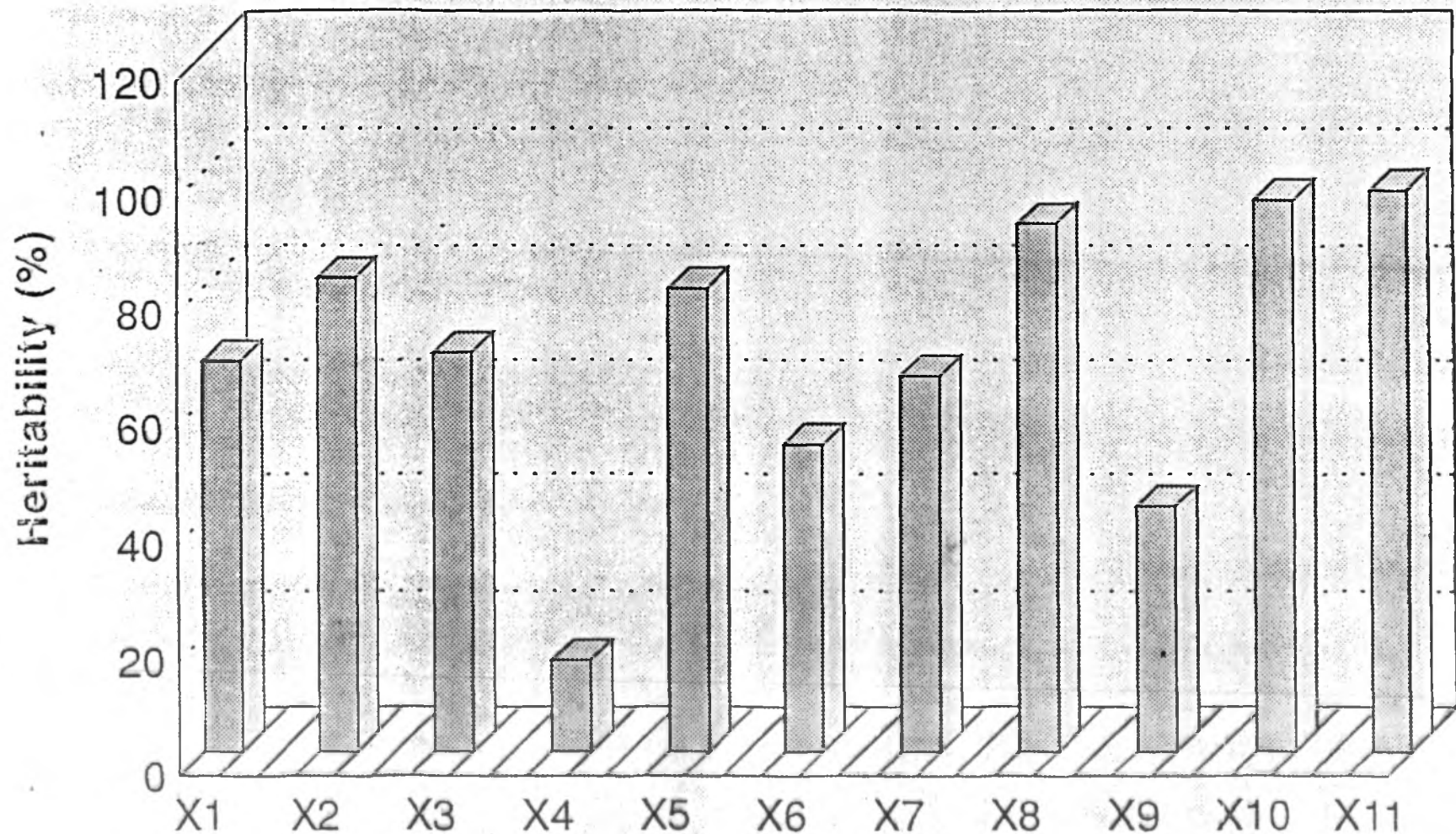
2) Plant height

This character recorded the range of 36cm to 106cm with a mean of 62.14cm. The variance of phenotypic and genotypic were 282.78 and 232.49 respectively. Moderate phenotypic (27.05) and genotypic (24.53) coefficient of variation was observed. The heritability estimate was high (82.21 percent) with an expected GAM of 45.83 percent was recorded for this character.

Table 5 : Range, Mean, Heritability, Genetic advance for 10 quantitative characters in sesame in F₃ generation of Cross-I (R843602 X Madhavi)

Characters	Range	Mean	Variances			Coefficient of variation		Broad sense Heritability	Genetic Advance	Genetic Advance as per cent mean
			Phenotypic	Genotypic	Environment	Phenotypic	Genotypic			
1. Days to flowering	30-44	36.21	24.81	16.80	8.00	22.25	20.25	67.74	20.08	55.45
2. Plant Height(cm)	36-106	62.14	282.78	232.49	50.30	27.05	24.53	82.21	28.48	45.83
3. No. of Primary Branches	2-5	3.33	1.25	0.86	0.38	33.69	28.01	69.16	1.59	47.74
4. No. of Secondary Branches	0-3	1.15	2.69	0.42	2.26	131.74	52.52	15.81	0.54	46.97
5. No. of Capsules	22-56	45.84	188.64	151.65	36.99	29.73	26.65	80.39	22.75	49.63
6. Days to maturity	84-106	91.41	49.88	26.34	23.54	7.74	5.64	52.81	7.68	8.40
7. Capsule length	2.24-3.36	2.70	0.28	0.18	0.10	19.60	15.81	65.08	0.71	26.30
8. No. of Seeds per Capsule	34.64-62.72	49.29	83.33	76.34	6.99	18.52	17.73	91.61	17.23	34.96
9. 1000 seed weight	1.9-3.2	2.82	0.49	0.21	0.28	24.97	16.	42.14	0.61	21.63
10. Seed yield per plant(g)	2.1-7.6	5.23	2.67	2.66	0.01	31.07	31.03	95.69	3.36	64.24
11. Oil Percentage	36-52	46.94	40.45	39.40	1.05	13.54	13.37	97.41	12.76	27.18

Fig. 4. Heritability (%) for 11 quantitative characters in F_3 generation of Cross-I (R843602 X Madhavi)



X1 : Days to 50 per cent flowering

X2 : Plant height

X3 : Number of primary branches per plant

X4 : Number of secondary branches per plant

X5 : Number of capsules per plant

X6 : Days to maturity

X7 : Capsule length

X8 : Number of seeds per capsules

X9 : 1000 seed weight

X10 : Seed yield per plant

X11 : Oil percentage

3. Number of primary branches per plant

The range for this character was 2 to 5, with an overall mean of 3.33. This recorded phenotypic variance of 1.25 and genotypic variances of 0.86. The coefficient of variation of phenotypic and genotypic was 33.69 and 28.01 respectively. A moderate heritability estimate of 69.16 percent with an expected GAM of 47.74 percent was observed.

4. Number of secondary branches per plant

The mean for this character was 1.15 with a range of 0 to 3 secondary branches per plant. The phenotypic and genotypic variance were 2.69 and 0.42 respectively. High phenotypic coefficient of variation (131.74) and low genotypic coefficient of variation (52.52) was observed. Low heritability estimate of 15.8 percent, with an expected GAM of 46.97 percent was noticed for this trait.

5. Number of capsules per plant

This recorded a range of 22 to 56 capsules per plant with a mean of 45.84 capsules per plant. The phenotypic and genotypic variances were 188.64 and 151.65 respectively. The coefficient of variation of phenotypic and genotypic was 29.73 and 26.65. High heritability estimate of 80.39 percent with an expected GAM of 49.63 percent was observed for this character.

6. Days to maturity

The range for this character was 84 days to 106 days with a mean of 91.41 days. The estimate of phenotypic and genotypic variances were 49.88 and 26.34 respectively. This character recorded the phenotypic coefficient of variation of 7.74 and genotypic coefficient of variation of 5.64. A moderate heritability estimate of 52.81 percent with an expected GAM of 8.40 percent was recorded for this character.

7. Capsule length

The range for this character was 2.24 cm to 3.36 cm with an over all mean of 2.70 cms. Low variance for phenotypic (0.28) and genotypic (0.18) was recorded. The coefficient of variation of phenotypic was 19.60 and that of genotypic was 15.81. This character recorded a moderate heritability estimate of 65.08 percent with an expected GAM of 26.30 percent.

8. Number of seeds per capsule

This recorded a mean seeds per capsule of 49.29 with a range of 34.64 seeds to 62.72 seeds per capsule. The phenotypic and genotypic variance was 83.33 and 76.34 respectively. A low coefficient of variation of phenotypic (18.52) and genotypic (17.73) was observed for this character. A high heritability estimate of 91.61 percent coupled with high expected GAM of 34.96 percent was noticed for this trait.

9. 1000 seed weight

The variation for this character was 1.9g to 3.2g with an overall mean of 2.82g. Low phenotypic (0.49) and genotypic (0.21) variance was observed for this trait. The coefficient of variation of phenotypic and genotypic was 24.97 and 16.21 respectively. This recorded a moderate heritability estimate of 42.14 percent coupled with moderate expected GAM of 21.63 percent.

10. Seed yield per plant

The variation for this character was 2.1g to 7.6g with a mean of 5.23g. Low variance for phenotypic (2.67) and genotypic (2.66) was noticed. The coefficient of variation of phenotypic was 31.07 and that for genotypic was 31.03. This recorded a high heritability estimate of 95.69 percent with a high expected GAM of 64.24 percent.

11. Oil percentage

This recorded a range of 36 percent to 52 percent with an overall mean of 46.94 percent. The variances of phenotypic and genotypic was 40.45 percentage and 39.40 percent respectively. The coefficient of variation of phenotypic and genotypic was 13.54 and 13.37 respectively. This recorded high heritability coupled with high expected GAM of 97.41 percent and 27.18 percent respectively.

b) Cross - H (DORS 102 X Madhavi)

Mean, Range, estimates of phenotypic, genotypic and environmental variances, PCV and GCV, heritability estimates in broadsense, genetic advance at 5 percent selection intensity and as percent mean are character wise presented in table.6. Heritability is depicted in figure 5.

1. Days to 50 percent flowering:

This recorded a range of 36 days to 42 days with mean days to flowering of 40.98 days. The phenotypic and genotypic variances were 64.13 and 38.84 respectively. High coefficient of variation of phenotypic (138.56) and genotypic (114.78) was observed for this character. The heritability estimate was 82.82 percent with an expected GAM of 50.76 percent was recorded.

2. Plant height

The mean plant height was 71.96 cm with a range of 36 cm to 124 cm.. High phenotypic (252.70) and genotypic (215.46) variances was recorded for this character. The coefficient of variation of phenotypic was 22.09 and that of genotype was 20.39. This showed a high heritability estimate of 85.22 percent with an expected GAM of 38.79 percent.

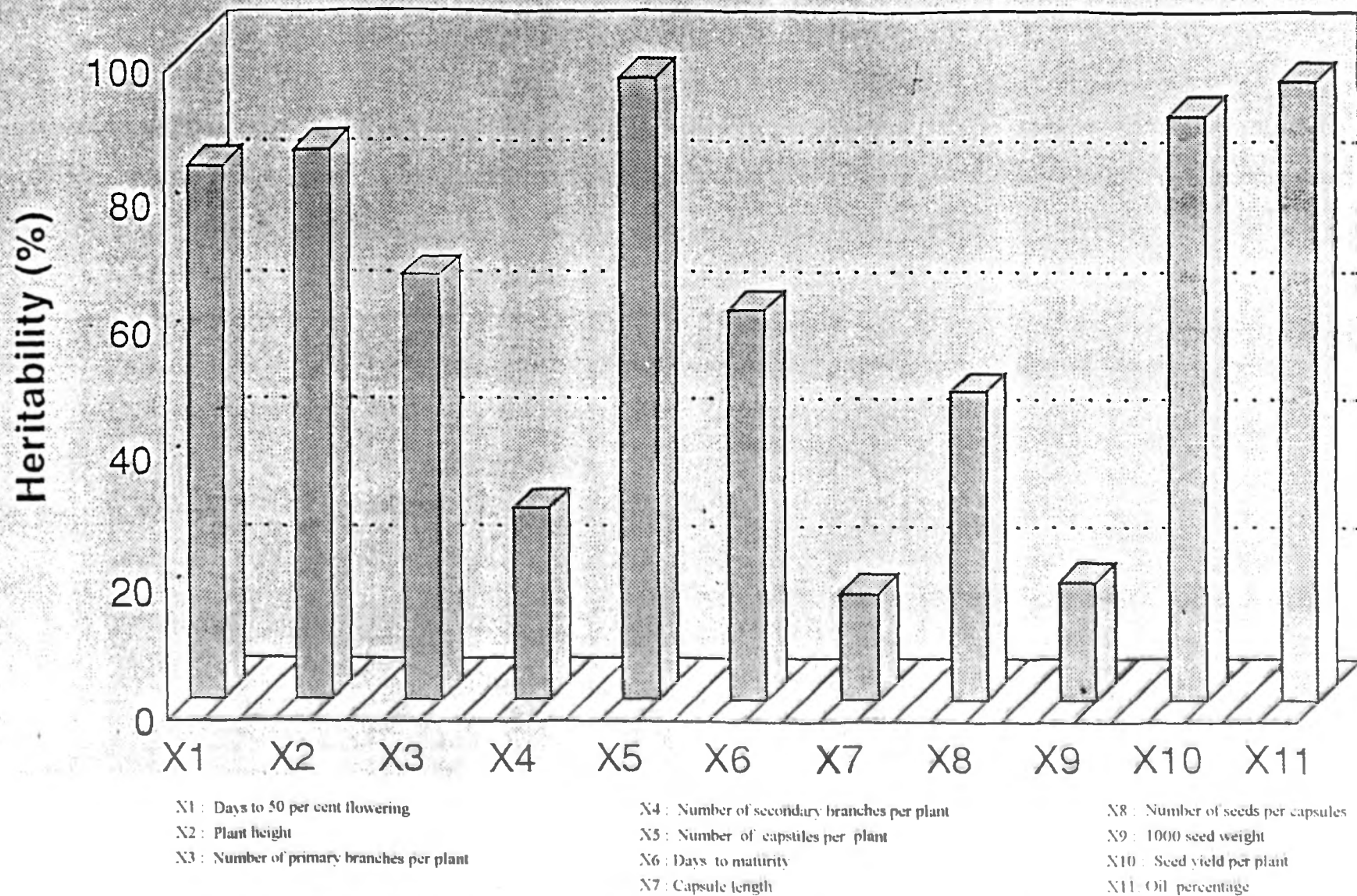
3. Number of primary branches per plant

The variation observed was 0 to 4 primary branches per plant with an overall mean of 2.23. It showed a low phenotypic (1.26) and genotypic (0.83) variance. The coefficient of variation of phenotypic and genotypic was 50.30 and 40.91 respectively. This recorded the expected GAM of 68.16 percent with moderate heritability estimate of 66.14 percent.

4. Number of secondary branches per plant

It ranged from 0 to 2 secondary branches with mean of 1.69. The phenotypic and genotypic variances were 1.13 and 0.32 respectively. High phenotypic (153.04) and genotypic (82.43) coefficient of variation was observed. The heritability estimate was 29.00 percent with expected GAM of 37.86 percent.

Fig. 5. Heritability (%) for 11 quantitative characters in F_2 generation of Cross-II (DORS102 X Madhavi)



5. Number of capsules per plant

This recorded a considerable variation (26 to 48) with mean number of capsules per plant of 41.89. High variance for phenotypic and genotypic (184.44) and 177.98 respectively) were recorded. The phenotypic coefficient of variation was 32.51 and genotypic coefficient variation was 31.85 for this character. A high heritability estimate of 95.98 percent coupled with high expected GAM of 64.26 percent was noticed.

6. Days to maturity

Range for this character was found to be from 80 days to 112 days with mean of 87.89 days. Phenotypic and genotypic variances are 64.14 and 38.84 respectively. Low phenotypic (9.11) and genotypic (7.09) coefficient of variation was observed. Low expected GAM of 11.38 percent with moderate heritability estimate of 60.55 percent was recorded for this character.

7. Capsule length

The variability for this character ranged from 2.14 cm. to 3.26 cm. with an overall mean of 2.43 cms. Low phenotypic (0.98) and genotypic (0.16) variance was noticed. This showed a phenotypic coefficient of variation of 40.63 and genotypic coefficient of variation of (16.38). The heritability estimate was low 16.26 percent with a low expected GAM of 13.58 percent.

8. Number of seeds per capsule

It ranged from 42.28 seeds to 66.63 seeds per capsule with mean of 52.89 seeds per capsule. The phenotypic and genotypic variance were 28.73 and 13.62 respectively. This recorded a phenotypic coefficient of variation of 13.08 and genotypic coefficient of variation of 9.06. Moderate heritability estimate of 47.43 percent with low expected GAM of 9.91 percent was recorded for this character.

9. 1000 seed weight

Range of variation recorded for this character was 2.3g to 3.1g with a mean 1000 seed weight of 2.56g. This showed low phenotypic (0.29) and genotypic (0.05) variance. The coefficient of

variation of phenotypic and genotypic was 21.08 and 8.96 respectively. A low heritability estimate of 18.07 percent coupled with low expected GAM of 7.81 percent was recorded.

10. Seed yield per plant

Seed yield per plant ranged from 2.8g to 7.4g with overall mean of 5.76g. The phenotypic and genotypic coefficient of variation was 5.84 and 5.28 respectively. This showed high coefficient of variation for both phenotype and genotype that is 41.93 and 39.88 respectively. A high heritability estimate of 90.45 percent with high expected GAM of 78.13 percent was recorded.

11. Oil percentage

The range of variation was from 38 percent to 47 percent with an over all mean of 43.28 percent. This recorded high phenotypic (125.28) and genotypic (119.78) variances. The coefficient of variation of phenotype and genotypic was 26.76 and 26.16 respectively. This recorded high heritability (95.61%) and high expected GAM of (50.92%).

c) Cross - III (C30P8 X Madhavi)

Mean, Range estimates of phenotypic, genotypic and environmental variances, PCV and GCV, heritability in broadsense, genetic advance at 5 percent selection intensity and as percent mean are character wise presented in table.7. Heritability estimates is illustrated in figure 6.

1. Days to 50 percent flowering

The over all mean for days taken to 50 percent flowering was 41.44 days with a range of 36 days to 46 days. A low phenotypic (11.82) and genotypic (9.25) variances were observed. The coefficient of variation was 8.30 and 7.34 for phenotypic and genotypic respectively. This recorded an heritability estimate of 78.22 percent with low expected GAM of 13.37 percent.

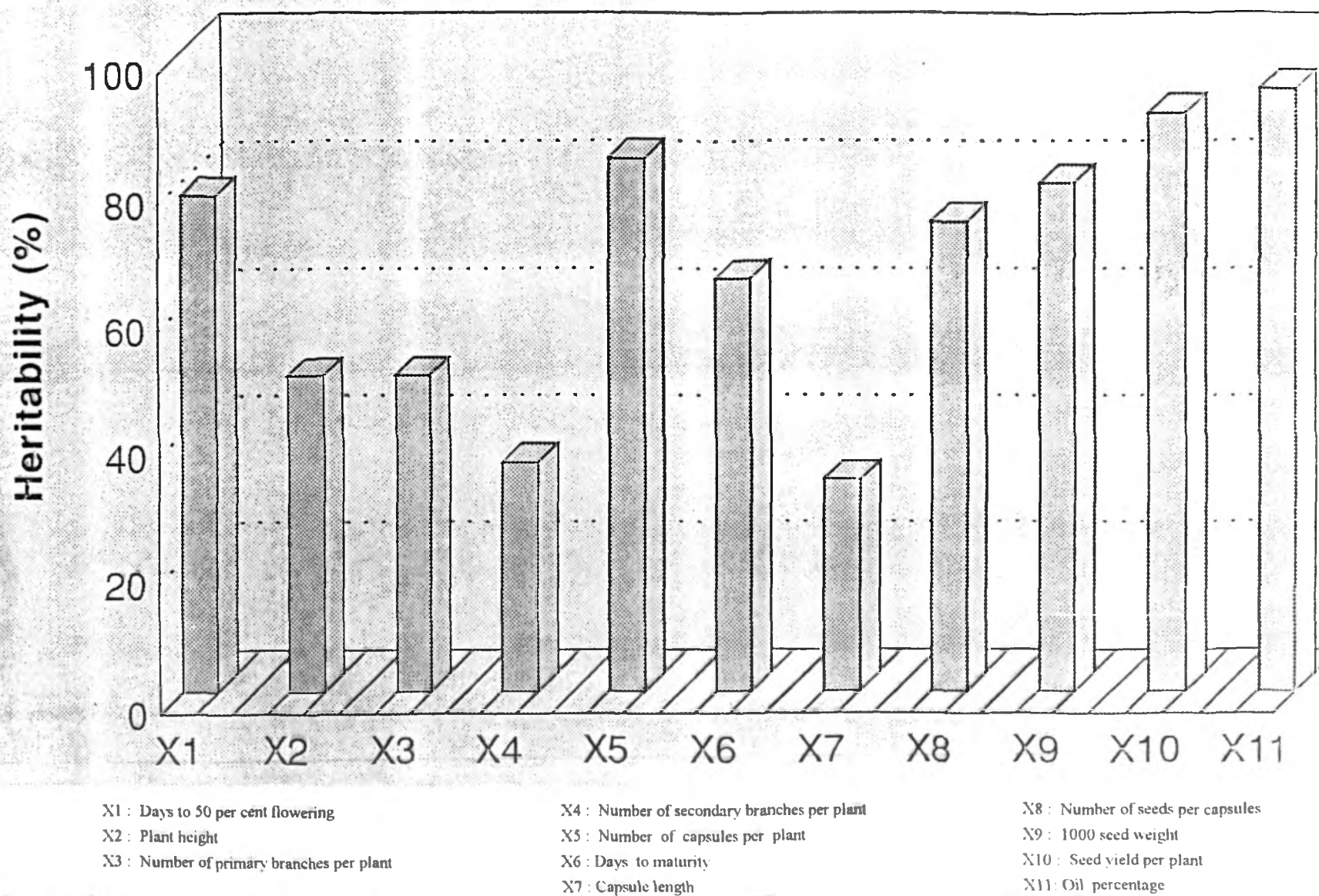
2. Plant height

The range for this character was considerable (41 to 134cm) with mean plant height of 67.94 cm. High phenotypic variance (143.38) and genotypic variance (70.94) were recorded. This showed a coefficient of variation of phenotypic of 17.63 and genotypic of 12.40. The heritability estimate was 49.47 percent with an expected GAM of 17.96 percent was observed.

Table 7 : Range, Mean, Heritability, Genetic advance for 10 quantitative characters in sesame in F₃ generation of Cross-III (C30P8 X Madhavi)

Characters	Range	Mean	Variances			Coefficient of variation		Broad-Sense Heritability	Genetic Advance	Genetic Advance as per cent mean
			Phenotypic	Genotypic	Environ-ment	Phenotypic	Genotypic			
1. Days to flowering	36-46	41.44	11.82	9.25	2.58	8.30	7.34	78.22	5.54	13.37
2. Plant Height(cm)	41-134	67.94	143.38	70.94	72.45	17.63	12.40	49.47	12.20	17.96
3. No. of Primary Branches	2-8	4.24	2.99	1.39	1.59	40.60	27.71	49.59	1.66	39.15
4. No. of Secondary Branches	0-6	2.75	2.10	0.79	1.33	51.62	30.80	35.60	1.06	38.55
5. No. of Capsules	28-58	45.95	146.00	122.60	23.40	26.29	24.10	83.97	20.90	45.48
6. Days to maturity	86-116	90.36	145.44	94.54	50.90	13.35	10.76	65.00	16.15	17.87
7. Capsule length	2.26-3.48	3.23	0.12	0.04	0.08	10.82	6.22	33.02	0.24	7.4
8. No. of Seeds per Capsule	40.64-72.64	49.65	35.88	26.58	9.31	12.06	10.38	74.06	5.54	11.16
9. 1000 seed weight	2.3-3.4	2.93	0.12	0.09	0.02	11.58	10.36	80.04	0.56	19.11
10. Seed yield per plant	2.5-8.6	6.07	2.04	1.93	0.10	23.57	22.94	94.78	2.79	45.96
11. Oil Percentage	49-59	54.87	42.94	39.69	3.25	14.61	14.56	94.56	13.42	29.91

Fig. 6. Heritability (%) for 10 quantitative characters in F_3 generation of Cross-III (C30P8 X Madhavi)



3. Number of primary branches per plant.

The variability for this character ranged from 2 to 8 primary branches per plant with a mean of 4.24. Low phenotypic variance of 2.99 and genotypic variance of 1.39 was recorded. The coefficient of variation of phenotypic and genotypic were 40.60 and 27.71 respectively. This recorded a moderate heritability estimate of 49.59 percent with an expected GAM of 39.15 percent.

4. Number of secondary branches per plant

This ranged from 0 to 6 with a mean of 2.75 secondary branches per plant. Low phenotypic (2.10) and genotypic (0.79) variances were observed. This recorded a phenotypic and genotypic coefficient of variation of 51.62 and 30.80 respectively. The heritability estimate was 35.60 percent with an expected GAM of 38.55 percent was observed.

5. Number of capsules per plant

The variation ranged from 28 to 58 capsules with a mean of 45.95 capsules per plant. The variance of phenotypic and genotypic was 146.00 and 122.60 respectively. This recorded a phenotypic coefficient of variation of 26.29 and genotypic coefficient of variation of 24.10. The heritability estimate for this character was 83.97 percent with high expected GAM of 45.48 percent.

6. Days to maturity

This recorded a mean of 90.36 day with a range of 86 to 116 days. A high variance of phenotypic (145.44) and genotypic (94.54) was noticed. This recorded low phenotypic (13.35) and genotypic (10.76) coefficient of variation. A moderate heritability estimate of 65.00 percent with an expected GAM of 17.84 percent was recorded.

7. Capsule length

The range of variation of this character was 2.26 cm. to 3.48 cm., with a mean capsule length of 3.23 cms. Low phenotypic (0.12) and genotypic (0.04) variance was recorded for this character. The coefficient of variation was low for both genotypic and phenotypic (10.82 and 6.22 respectively). This recorded a low heritability estimate of 33.02 percent with low expected GAM of 7.4 percent.

8. Number of seeds per capsule

The over all mean for this character was 49.65 with a range of 40.64 to 72.64 seeds per capsule. The phenotypic and genotypic variance were 35.88 and 26.58 respectively. This recorded a low phenotypic (12.06) and genotypic (10.38) coefficient of variation. The heritability estimate was 74.06 percent with an expected GAM of 11.16 percent.

9. 1000 seed weight

This recorded a range of 2.3g to 3.4g with a mean 1000 seed weight of 2.93 grams. It showed low phenotypic (0.12) and genotypic (0.09) variance. A low coefficient of variation for genotypic and phenotypic (11.58 and 10.36 respectively) was observed. The heritability estimate was 80.04 percent with expected GAM of 19.11 percent.

10. Seed yield per plant

The range of variation for this character was 2.5g to 8.6 g with overall mean of 6.07g. The variance of phenotypic and genotypic was 2.04 and 1.93 respectively. Phenotypic and genotypic coefficient of variation was 23.57 and 22.94 respectively. This recorded a high heritability estimate of 94.78 percent with high expected GAM of 45.96 percent.

11. Oil percentage

Oil percentage ranged from 49 to 59 percent with a mean of 54.87 percent. The variance for phenotypic and genotypic was 42.94 and 39.69 respectively. The coefficient of variation of phenotypic (14.61) and genotypic (14.56) was low. High heritability estimate (94.56%) with moderate expected GAM (29.91%) was recorded for this trait.

4.2 CHARACTER ASSOCIATION

The phenotypic correlation was worked out among 10 characters in F₂ generation and among 11 characters in F₃ generation for 3 crosses. The results are presented in table.8,9,10,11,12 and 13 and illustrated in figure 7,8,9,10,11 and 12.

4.2.1 F₂ generation

(a) Cross-I (R843602 X Madhavi)

Association of seed yield with its related characters

Seed yield was highly significantly and positively correlated with plant height (0.6133), number of primary branches (0.3355), number of capsules per plant (0.7192), days to maturity (0.3190), capsule length (0.6989) and number of seeds per capsule (0.7584) and it was highly significantly and negatively correlated with days to flowering (-0.5339). (Table 8 and Figure 7)

Association among yield related characters

1) Days to flowering

This exhibited highly significant negative correlation with plant height, number of capsules per plant, capsule length and number of seeds per capsules besides seed yield per plant.

2) Plant height

This showed highly significant positive correlation with number of capsules per plant, capsule length and number of seeds per capsule. A highly significant negative association was observed with days to flowering.

3) Number of primary branches per plant.

This was highly significantly positively correlated with seed yield and further significantly positively correlated with number of capsules per plant.

4) Number of secondary branches

None of the characters showed any significant correlation with this character.

Table 8 : Phenotypic correlation coefficients for 10 yield and yield components in F₂ generation of Cross-I (R843602 X Madhavi)

Characters	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10
X1	1.000	-0.5306**	-0.0731	-0.024	-0.5419**	-0.41931**	-0.5882**	-0.6215**	0.1138	-0.5339**
X2		1.000	0.1014	0.0901	0.6542**	0.6459**	0.569**	0.5609**	-0.0159	0.6133**
X3			1.000	0.0755	0.2262*	-0.0982	0.1137	0.1514	0.1458	0.3355**
X4				1.000	0.0421	0.0515	0.0075	0.0512	0.1835	0.03415
X5					1.000	0.3865**	0.5114**	0.5884*	0.0359	0.7192**
X6						1.000	0.4382**	0.4202**	0.0698	0.3190**
X7							1.000	0.8736**	0.0102	0.6989**
X8								1.000	0.0701	0.7584**
X9									1.000	0.0243
X10										1.000

X1 : Days to 50 per cent flowering

X2 : Plant height

X3 : Number of primary branches per plant

X4 : Number of secondary branches per plant

X5 : Number capsules per plant

X6 : Days to maturity

X7 : Capsule length

X8 : Number of seeds per capsules

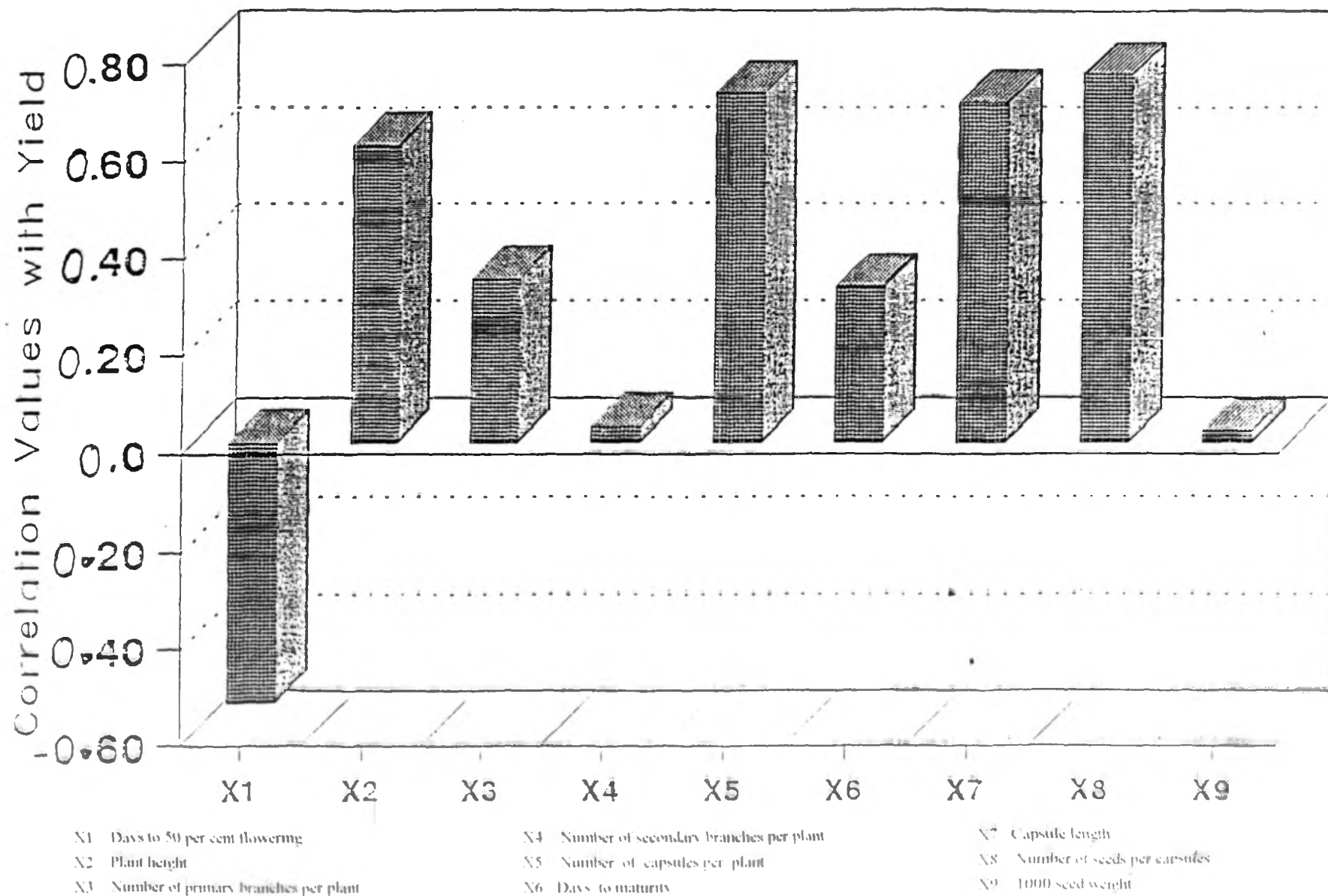
X9 : 1000 seed weight

X10 : Seed yield per plant

* Significant at 1 percent

** Significant at 5 percent

Fig. 7. Correlation coefficient for 9 quantitative characters in F_2 generation of Cross-I (R843602 X Madhavi)



5) Number of capsules per plant.

This character showed highly significant positive association with plant height, days to maturity, capsule length, number of seeds per capsule besides seed yield per plant. This was significantly positively associated with number of primary branches per plant.

6) Days to maturity

This recorded highly significant positive correlation with capsule length, Number of seeds per capsule, plant height, days to flowering, and seed yield per plant.

7) Capsule length

Highly significant positive correlation was observed with number of seeds, days to maturity plant height, number of capsules per plant and with seed yield per plant. Highly significant negative correlation was observed with days to flowering.

8) Number of seeds per capsule

This character recorded high positive correlation with plant height, number of capsules per plant, capsule length and seed yield per plant. A high significant negative correlation was observed with days to flowering.

9) 1000 seed weight

This character did not show any significant association with any other character.

b) Cross - II (DORS 102 X Madhavi)

Association of seed yield with its related characters.

Highly significant and positive correlations with seed yield was observed with plant height ($r=0.5482$), number of capsules per plant ($r=0.5260$), days to maturity ($r=0.3477$) number of seeds capsule ($r=0.4272$) and also capsule length ($r=0.5103$). Highly significant negative correlation ($r=0.3409$) was showed with days to flowering. It had significant positive correlation with number of primary branches ($r=0.2226$). 1000 seed weight ($r=0.0487$), number secondary branches per plant showed low non significant negative correlation with yield ($r=0.0341$). (Table 9 and Figure 8)

Association among yield related characters

1. Days to flowering

This showed highly significant negative association with plant height with number of capsules, capsule length, and number of seeds per capsule besides yield. It also exhibited significant negative association with days to maturity.

2. Plant height

This recorded high positive significant correlation with number of capsules per plant, days to maturity, number of seeds per capsule besides seed yield per plant.

3. Number of primary branches per plant

Highly positively significant correlation was observed with number of capsules per plant. Significant positive correlation was observed with capsule length apart from seed yield per plant.

Table 9 : Phenotypic correlation coefficients for 10 yield and yield components in F₂ generation of Cross-II (DORS102 X Madhav)

Characters	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10
X1	1.000	-0.3443**	-0.0962	0.0386	-0.3729**	-0.3095**	-0.2951**	-0.4578**	0.0202	-0.3409**
X2		1.000	0.1776	0.1368	0.8203**	0.5356**	0.9187**	-0.3405**	-0.0408	0.5485**
X3			1.000	0.0672	0.2803**	-0.0218	0.1947*	0.0547	0.0563	0.226*
X4				1.000	0.1770	0.0540	0.1299	-0.2060	-0.1100	0.1323
X5					1.000	0.4994**	0.7776**	0.3013**	-0.0236	0.5260**
X6						1.000	0.4976**	0.1289**	0.0832	0.3477**
X7							1.000	0.2078*	-0.0165	0.5103**
X8								1.000	0.0048	0.4272**
X9									1.000	-0.0487
X10										1.000

X1 : Days to 50 per cent flowering

X2 : Plant height

X3 : Number of primary branches per plant

X4 : Number of secondary branches per plant

X5 : Number capsules per plant

X6 : Days to maturity

X7 : Capsule length

X8 : Number of seeds per capsules

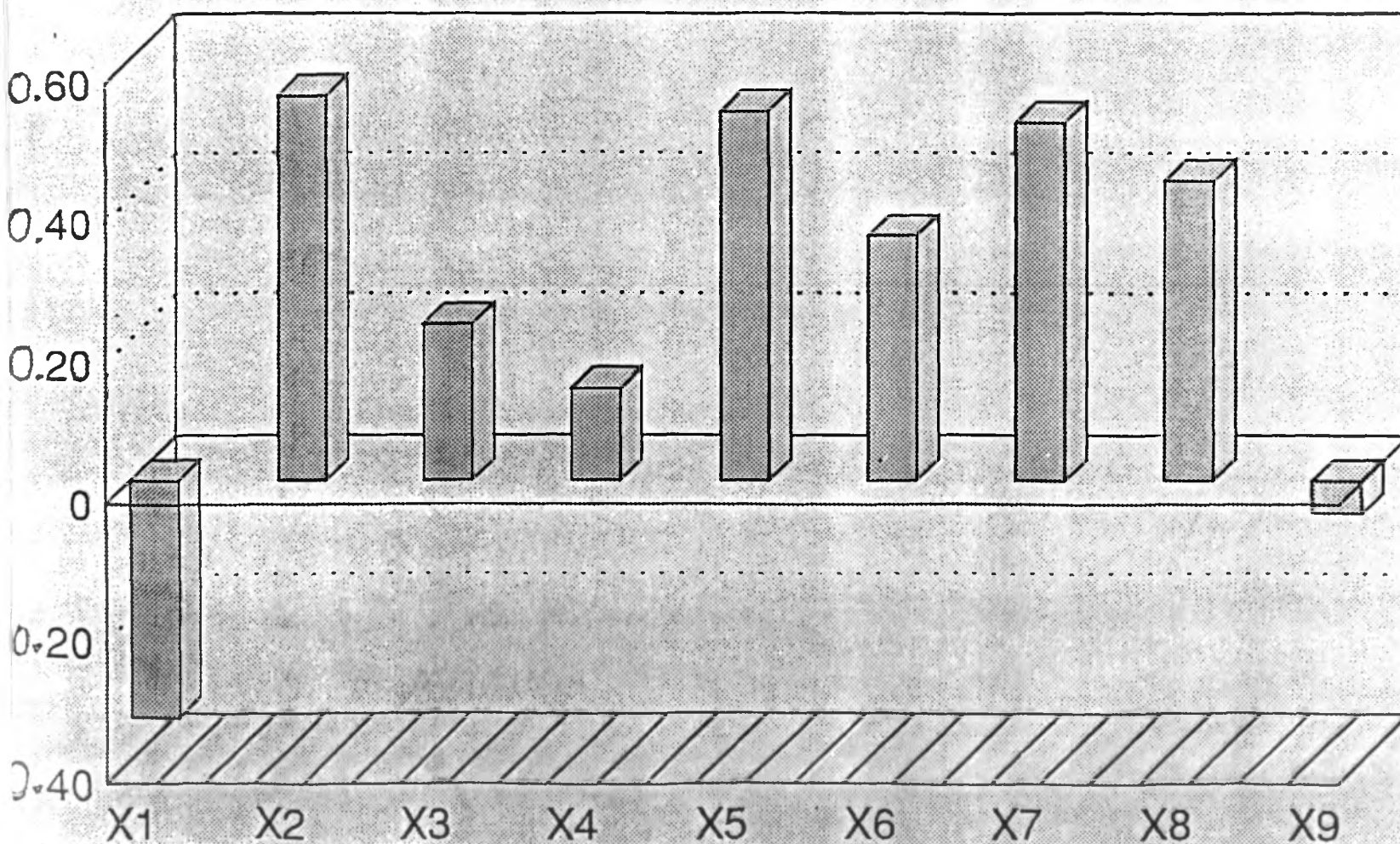
X9 : 1000 seed weight

X10 : Seed yield per plant

* Significant at 1 percent

** Significant at 5 percent

Fig. 8. Correlation coefficient for 9 quantitative characters in F_2 generation of Cross-II (DORS102 X Madhavi)



X1 : Days to 50 per cent flowering
 X2 : Plant height
 X3 : Number of primary branches per plant

X4 : Number of secondary branches per plant
 X5 : Number of capsules per plant
 X6 : Days to maturity

X7 : Capsule length
 X8 : Number of seeds per capsules
 X9 : 1000 seed weight

4. Number of secondary branches

None of the characters showed significant correlation with this character.

5. Number of capsules per plant

This character showed high significant positive correlation with plant height, capsule length, days to maturity, number of seeds per capsule, number of primary branches, along with seed yield per plant. Highly significant negative association was observed with days to flowering.

6. Days to maturity

This showed highly significant positive association with plant height, number of capsule per plant, capsule length, and seed yield per plant. Highly significant negative correlation was observed with days to flowering.

7. Capsule length

This exhibited highly significant positive association with plant height, number of capsules per plant and seed yield per plant. Further significant positive correlation was observed with number of seeds per capsule and number of primary branches per plant. Significant negative correlation was noticed with days to flowering.

8. Number of seeds per capsule

This showed highly significant positive correlation with plant height, number of capsules per plant and seed yield per plant. This also showed significant positive correlation with capsule length.

9. 1000 seed weight

This character did not show significant correlation with any other characters.

c) Cross - III (C30p8 X Madhavi)

Association of seed yield with its other related character

Seed yield showed highly significant positive correlation with plant height (0.3546), number of capsules per plant, (0.5498) days to maturity (0.5782) and capsule length (0.9145). Highly significant negative association was observed with days to flowering (-0.9047). (Table 10 and Figure 9)

Association among yield related characters

1. Days to flowering

This recorded highly significant negative association with plant height, number of capsules per plant, days to maturity, capsule length and seed yield per plant. This also showed significant negative association with 1000 seed weight.

2. Plant height

This showed highly significant positive correlation with number of capsules per plant, days to maturity, capsule length and with seed yield per plant. Significant positive association was noticed with number of primary branches and number of secondary branches was observed. This character was highly significantly negatively correlated with days to flowering.

3. Number of primary branches

This showed highly significant positive correlation with number of capsule per plant only.

4. Number of secondary branches

Significant positive correlation with number of capsules per plant and days to maturity was showed by this character

Table 10 : Phenotypic correlation coefficients for 10 yield and yield components in F₂ generation of Cross-III (C3OP8 X Madhavi)

Characters	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10
X1	1.000	-0.3313**	-0.0746	-0.1855	-0.5430**	-0.6634**	-0.9267**	0.1424	0.1947*	-0.9047**
X2		1.000	0.2420**	0.2044*	0.2992**	0.4693**	0.3434**	0.1662	-0.1073	0.3546**
X3			1.000	0.3826**	0.0608	0.0316	0.0869	0.0279	-0.0513	0.0779
X4				1.000	0.0657	0.1982*	0.1736	0.0006	0.1002	0.1202
X5					1.000	0.2340**	0.2430*	0.0432	0.0280	0.5498**
X6						1.000	0.6585**	0.0458	0.1064	0.5782**
X7							1.000	-0.0702	0.1855	0.9145**
X8								1.000	-0.043	-0.1215
X9									1.000	0.1502
X10										1.000

X1 : Days to 50 per cent flowering

X2 : Plant height

X3 : Number of primary branches per plant

X4 : Number of secondary branches per plant

X5 : Number capsules per plant

X6 : Days to maturity

X7 : Capsule length

X8 : Number of seeds per capsules

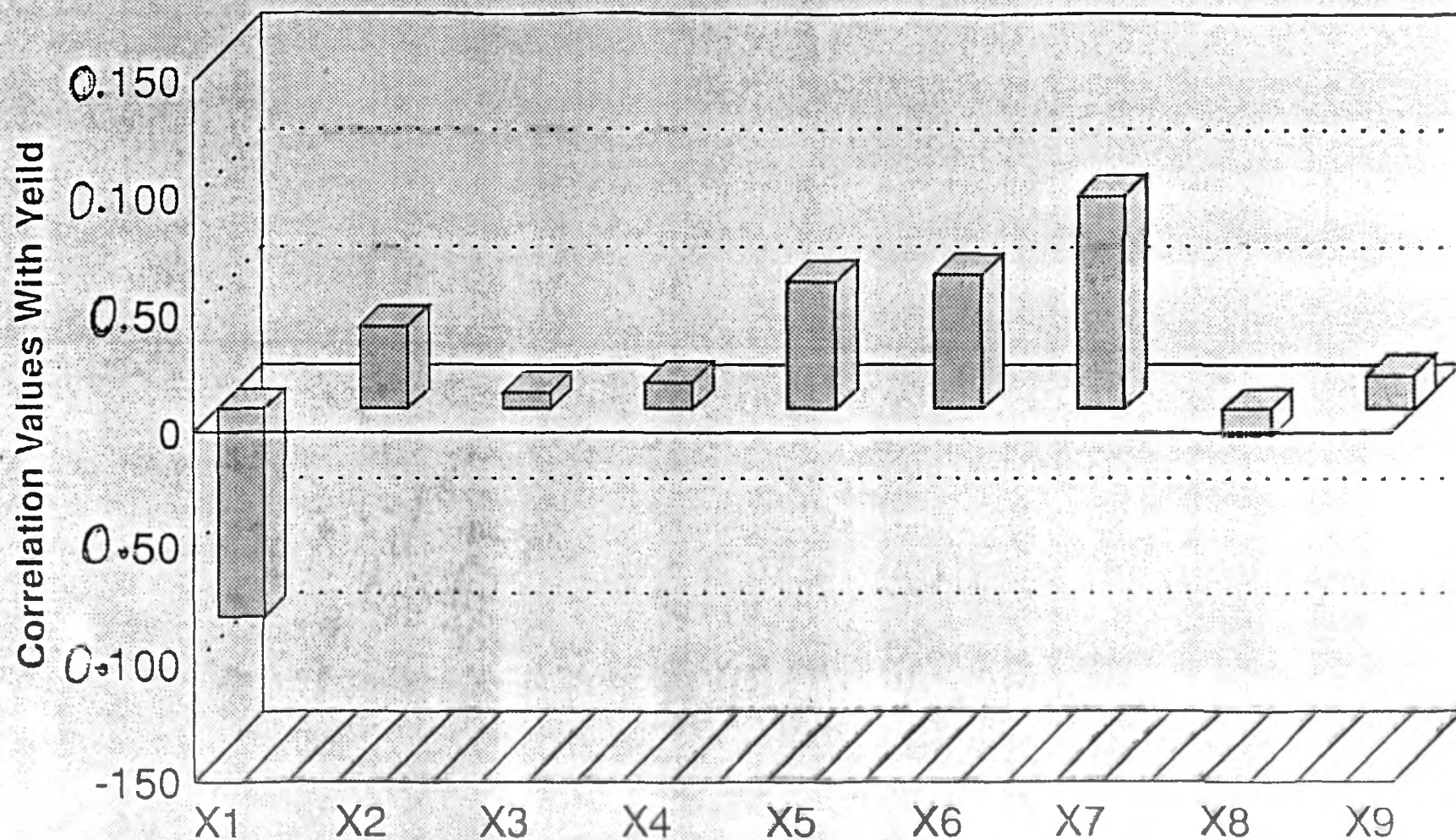
X9 : 1000 seed weight

X10 : Seed yield per plant

* Significant at 1 percent

** Significant at 5 percent

Fig. 9. Correlation coefficient for 9 quantitative characters in F_2 generation of Cross-III (C30P8 X Madhavi)



X1 : Days to 50 per cent flowering

X2 : Plant height

X3 : Number of primary branches per plant

X4 : Number of secondary branches per plant

X5 : Number of capsules per plant

X6 : Days to maturity

X7 : Capsule length

X8 : Number of seeds per capsules

X9 : 1000 seed weight

5. Number of capsules per plant

This recorded highly significant positive correlation with plant height and seed yield per plant. Further significant positive association was noticed with number of secondary branches per plant, days to maturity and capsule length. Highly significant negative correlation was noticed with days to flowering.

6. Days to maturity

This character was found to be highly significant and positively correlated with plant height, capsule length and seed yield per plant. Further significant positive correlation was observed with number secondary branches and number of capsules per plant. Highly significant negative association was noticed with days to flowering.

7. Capsule Length

Capsule length was highly significant and positively correlated with plant height, days to maturity and seed yield per plant. This also showed significant positive correlation with number of capsules per plant. Highly significant negative correlation was noticed with days to flowering.

8. Number of seeds per capsule

This showed no significant correlation with any other characters.

9. 1000 seed weight

This showed significant negative correlation with days to flowering.

4.2.2 F₃ Generation

a) Cross-I (R843602 X Madhavi)

Association of seed yield per plant with its related characters.

Seed yield was highly significantly positively correlated with plant height (0.5594), primary branches (0.4537), number of capsules per plant (0.3672), capsule length (0.3602),

number of seeds per capsule (0.7257) and 1000 seed weight (0.4784). It also showed significant positive correlation with number of secondary branches per plant (0.2251) and with days to maturity (0.2428). It was highly significantly negatively correlated with days to flowering (-0.5890) and oil percentage (-0.2869). (Table 11 and Figure 10)

Association among yield related characters

1 Days to 50 percent flowering

This was highly significantly negatively correlated with plant height, number of capsules per plant, days to maturity, capsule length, number of seeds per capsule and with seed yield per plant.

2. Plant height

This character exhibited highly significant positive correlation with days to maturity, capsule length, number of seeds per capsule and with seed yield per plant. Further significant positive correlation was observed with number of primary branches, number of secondary branches and number of capsules per plant. Highly significant negative correlation was found with days to flowering.

3. Number of primary branches

This exhibited highly significant positive correlation with seed yield per plant. It also showed significant positive correlation with plant height, and number of seeds per capsule.

4. Number of secondary branches per plant

It was found that this character was significantly positively correlated with plant height and seed yield per plant.

5. Number of capsules per plant

It was observed that this character exhibited highly significant positive association with seed

Table 11 : Phenotypic correlation coefficients for 10 yield and yield components
in F₃ generation of Cross - I (R843602 X Madhavi)

Characters	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11
X1	1.000	-0.5485**	-0.1984	-0.2041	-0.2946**	-0.5367**	-0.5743**	-0.4236**	0.0356	-0.5890**	-0.0375
X2		1.000	0.2381*	0.2213*	0.6067**	0.4435**	0.5194**	0.4178**	0.5594	0.5594**	0.0686
X3			1.000	0.1790	0.1420	0.0141	0.1975	0.2567*	-0.1248	0.4537	-0.2896**
X4				1.000	0.1914	0.1813	0.1490	0.1962	-0.0506	0.2251*	-0.1105
X5					1.000	0.0031	0.0473	0.1864	-0.1582	0.3672**	-0.0594
X6						1.000	0.4061**	0.3968**	0.1367	0.2428**	0.0797
X7							1.000	0.8633**	-0.1601	0.3602**	-0.0021
X8								1.000	0.3331	0.7257**	-0.0834
X9									1.000	0.4784**	-0.0834
X10										1.000	-0.2869
X11											1.000

X1 : Days to 50 percent flowering

X2 : Plant height

X3 : Number of primary branches per plant

X4 : Number of secondary branches per plant

X5 : Number capsules per plant

X6 : Days to maturity

X7 : Capsule length

X8 : Number of Seeds per capsule

X9 : 1000 seed weight

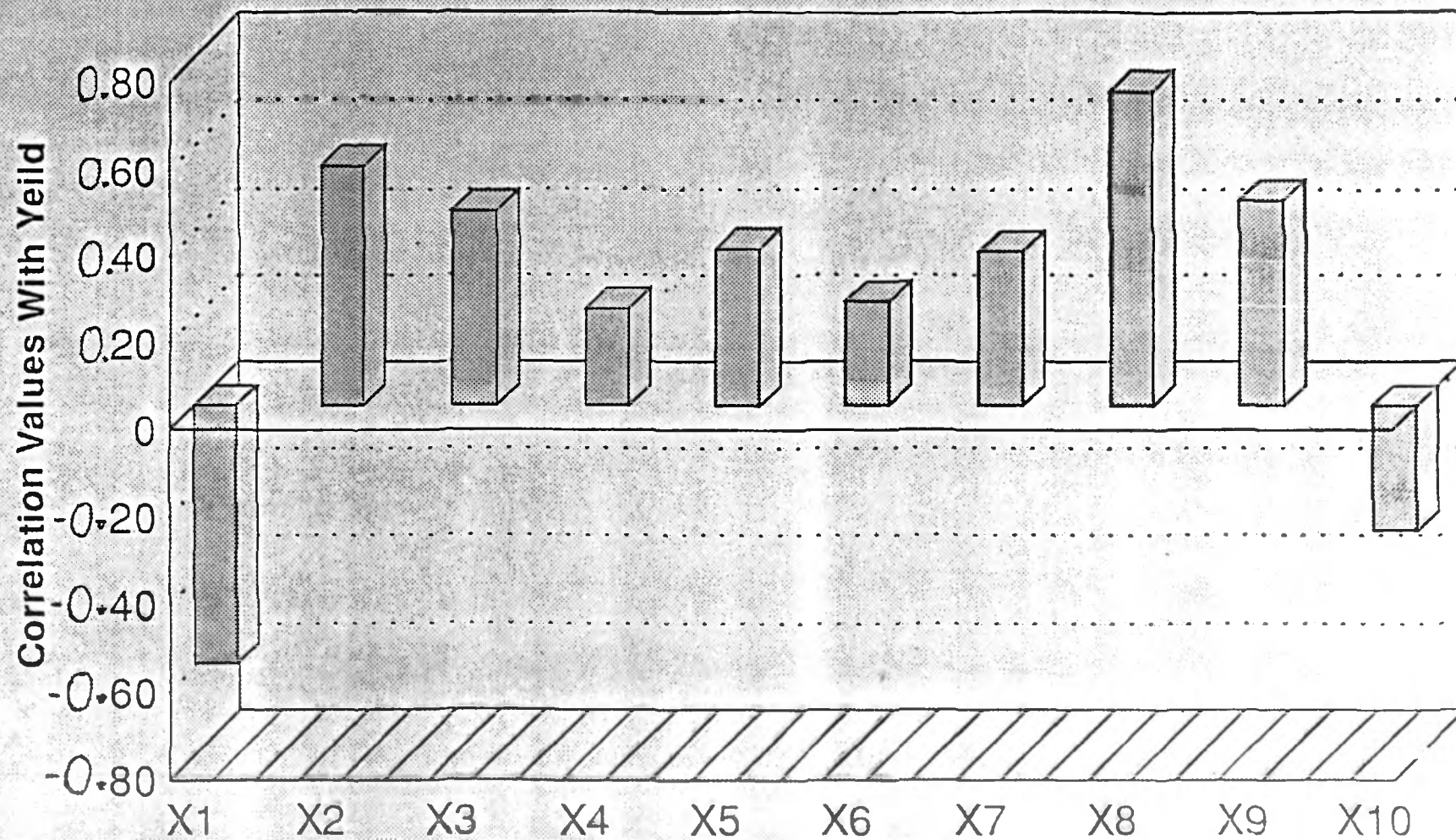
X10 : Seed yield per plant

X11 : Oil percentage

** Significant at 1 per cent

* Significant at 5 per cent

Fig. 10. Correlation coefficient for 10 quantitative characters in F_3 generation of Cross-I (R843602 X Madhavi)



X1 : Days to 50 per cent flowering
 X2 : Plant height
 X3 : Number of primary branches per plant

X4 : Number of secondary branches per plant
 X5 : Number of capsules per plant
 X6 : Days to maturity
 X7 : Capsule length

X8 : Number of seeds per capsules
 X9 : 1000 seed weight
 X10 : Oil percentage ...

yield only. Further it showed significant positive association with plant height. Highly significant negative correlation was noticed with days to flowering.

6. Days to maturity

This character showed highly significant positive correlation with plant height, capsule length and number of seeds per capsule. It also showed positive significant association with seed yield per plant. This was highly significantly negatively correlated with days to flowering.

7. Capsule length

It was observed that this character was highly significantly positively correlated with plant height, days to maturity, number of seeds per capsule and seed yield per plant. Days to flowering exhibited highly significant negative correlation with this character.

8. Number of seeds per capsule

This character revealed a highly significant positive correlation with plant height, days to maturity, capsule length, 1000 seed weight and seed yield per plant. It was significantly positively correlated with number of primary branches per plant.

9. 1000 seed weight

Highly significant positive correlation was noticed with number of seeds per capsule and seed yield per plant.

10. Oil percentage

This recorded highly significant negative correlation with seed yield per plant. The correlation with rest of the character was non significant.

II. Cross - II (DORS 102 X Madhavi)

Association of seed yield per plant with its related character

Highly significant positive correlation of seed yield with plant height (0.4823), number of primary branches per plant (0.2973), number of capsules per plant (0.4825), capsule length (0.7301), days to maturity (0.7301) and with 1000 seed weight (0.3455). It also showed significant positive association with number of seeds per capsule (0.2393). Oil percentage recorded highly significant negative correlation (-0.7900) with seed yield per plant. (Table 12 and Figure 11)

Association among other yield related characters

1) Days to 50 percent flowering

Highly significant negative correlation was noticed with plant height and number of capsules per plant. This character also showed negative significant correlation with number of seeds per capsule and 1000 seed weight.

2) Plant height

This was found to be highly positively correlated with number of capsules per plant, number of primary branches per plant, days to maturity, capsule length, number of seeds per capsule and seed yield per plant. Further it exhibited positive significant association with 1000 seed weight. This was highly significantly negatively correlated with days to 50 percent flowering.

3) Number of primary branches per plant

Seed yield per plant had highly significant positive correlation with this character. It also showed positive significant correlation with number of capsules per plant, number of seeds per capsule and 1000 seed weight.

Table 12 : Phenotypic correlation coefficients for 11 yield and yield components in F₃ generation of Cross-II (DORS102 X Madhavi)

Characters	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11
X1	1.000	-0.3715**	-0.1944	-0.1483	-0.3399**	-0.3111**	-0.0356**	-0.2385*	-0.2277	-0.0538	-0.2757
X2		1.000	0.4768**	0.0315	0.4052**	0.3738**	0.2856**	0.8019**	-0.2485*	0.4823**	-0.3676**
X3			1.000	-0.0511	0.2747*	-0.2094	0.0952	0.2582*	0.2484*	0.2973*	-0.0845
X4				1.000	-0.0175	0.0545	0.1923	0.0306	-0.1483	0.1963*	-0.1106
X5					1.000	0.2385*	0.3444**	0.1534	0.2253	0.4825**	-0.3705
X6						1.000	0.2686*	0.2359*	0.2163*	0.4249**	-0.3517**
X7							1.000	0.3293**	0.2587	0.7301**	-0.5804**
X8								1.000	0.2277*	0.2393*	-0.3288**
X9									1.000	0.3455**	-0.0834
X10										1.000	-0.7900**
X11											1.000

X1 : Days to 50 per cent flowering

X2 : Plant height

X3 : Number of primary branches per plant

X4 : Number of secondary branches per plant

X5 : Number capsules per plant

X6 : Days to maturity

X7 : Capsule length

X8 : Number of seeds per capsules

X9 : 1000 seed weight

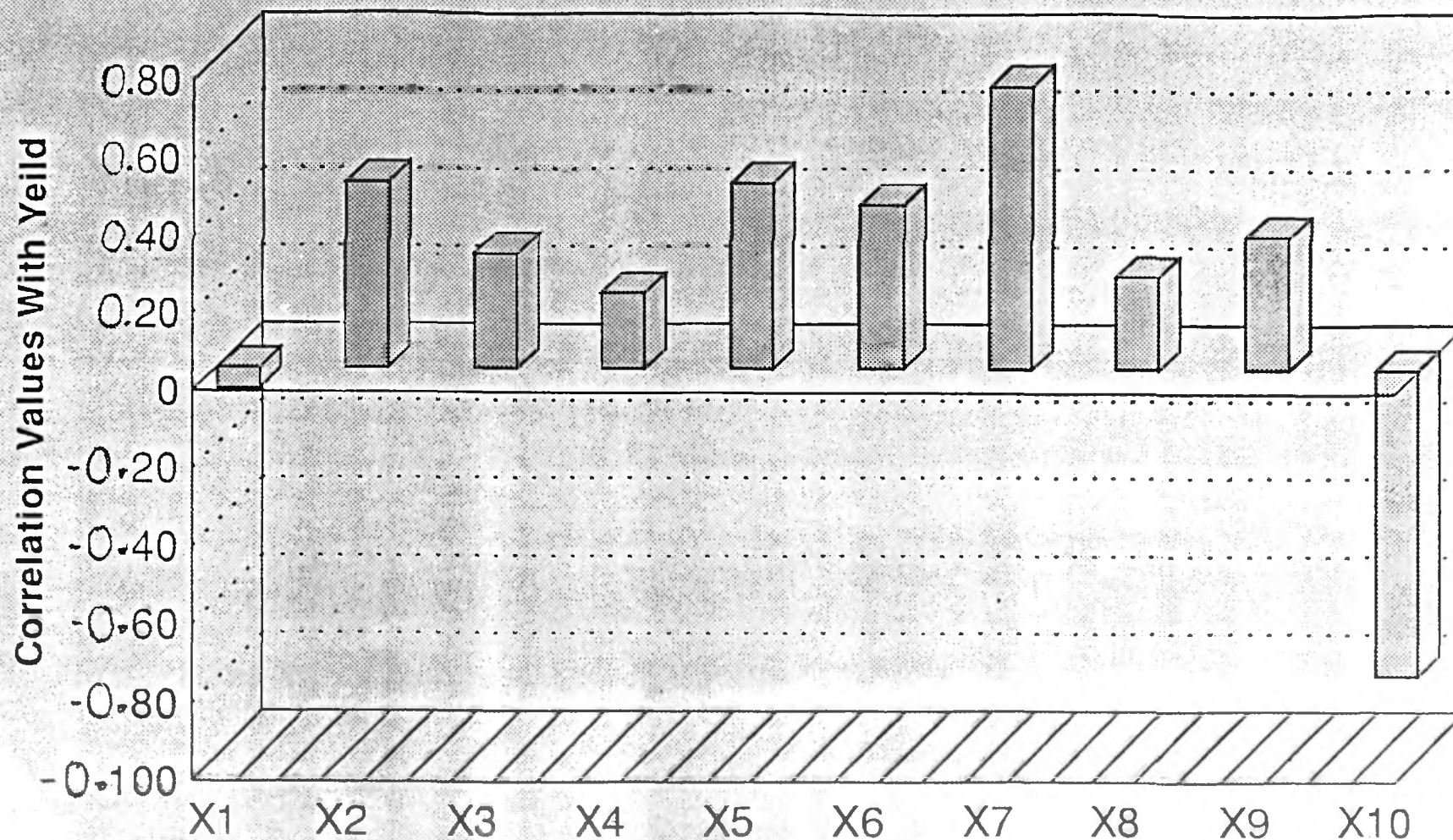
X10 : Seed yield per plant

X11 : Oil percentage

* Significant at 1 percent

** Significant at 5 percent

Fig. 11. Correlation coefficient for 10 quantitative characters in F_3 generation of Cross-II (DORS102 X Madhavi)



X1 : Days to 50 per cent flowering

X2 : Plant height

X3 : Number of primary branches per plant

X4 : Number of secondary branches per plant

X5 : Number of capsules per plant

X6 : Days to maturity

X7 : Capsule length

X8 : Number of seeds per capsules

X9 : 1000 seed weight

X10 : Oil percentage

4) Number of secondary branches per plant

It was observed that none of the characters had any significant correlation with this character.

5) Number of capsules per plant

Highly significant positive correlation was found with plant height, capsule length and seed yield per plant. Further this exhibited significant positive correlation with number of primary branches, days to maturity, and 1000 seed weight. Days to 50 percent flowering showed highly significant negative correlation with this trait.

6) Days to maturity

Days to maturity showed highly significant positive correlation with plant height, 1000 seed weight and seed yield per plant. Significant positive association was also noticed with number of capsules per plant, capsule length and number of seeds per capsule.

7) Capsule length

This character showed a highly significant positive correlation with plant height, number of capsules per plant, Number of seeds per capsule and with seed yield per plant. This also exhibited significant positive correlation with days to maturity and 1000 seed weight.

8) Number of seeds per capsule

Highly significant positive correlation was observed with plant height and capsule length. Further significant positive correlation was also observed with number of primary branches per plant, days to maturity, 1000 seed weight and with seed yield per plant. This was significantly negatively correlated with days to 50 percent flowering.

9) 1000 seed weight

This character was highly significantly positively correlated with days to maturity and seed yield per Plant. It was also observed that significant positive association of this character with number primary

branches, number of secondary branches, number of capsules per plant, capsule length and number of seeds per capsule. It was significantly negatively correlated with days to 50 percent flowering.

10) Oil percentage

This recorded highly significant negative correlation with plant height, number of capsules per plant, day to maturity, capsule length, number of seeds per capsule and seed yield per plant.

c) Cross - III (C30 P8 X Madhavi)

Association of seed yield per plant with its related character

A high positive significant correlation was observed with plant height (0.3504), with number of capsules per plant (0.4490), capsule length (0.6554) and with days to maturity (0.3870). It also exhibited significant positive correlation with 1000 seed weight (0.2657). highly significant negative correlation (-0.7200) with oil percentage was also noticed. (Table 13 and Figure 12)

Association among yield related characters

1) Days to 50 percent flowering

This exhibited highly significant negative correlation with number of primary branches. It also showed significant negative correlation with number of capsules per plant, and capsule length.

2) Plant height

Plant height showed significant positive association with number of primary branches, number of capsules per plant, days to maturity, capsule length, 1000 seed weight and seed yield per plant. Significant positive correlation with number of seeds per capsule was noticed.

3) Number of primary branches per plant

This character revealed a highly significant positive correlation with plant height, number of capsules per plant and capsule length. Days to maturity showed significant positive correlation with this character. Highly significant negative correlation was noticed with days to 50 percent flowering.

Table 13 : Phenotypic correlation coefficients for 11 yield and yield components in F₃ generation of Cross-III (C30P8 X Madhavi)

Characters	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11
X1	1.000	-0.0359	-0.2815	-0.0731	-0.2533**	-0.1395	-0.2357*	-0.1049	-0.0209	-0.1500	-0.0718
X2		1.000	0.4451**	0.1046	0.6294**	0.5307**	0.3849**	0.2482*	-0.2845*	0.3504**	-0.3047**
X3			1.000	0.1339	0.4406**	0.2763*	0.4484**	0.2352*	0.1985	0.1974	0.0271
X4				1.000	-0.0333	0.1302	0.2456*	0.1227	0.0825	0.1225*	-0.0066
X5					1.000	0.1302	0.1960	0.2925	0.2333	0.4490**	-0.3580**
X6						1.000	0.4735**	-0.0009	0.1064	0.3870**	-0.1104
X7							1.000	0.2113	0.0903	0.6554**	-0.2865*
X8								1.000	0.1554*	0.2065*	0.3534**
X9									1.000	0.2657*	-0.2882*
X10										1.000	-0.7205**
X11											1.000

X1 : Days to 50 per cent flowering

X2 : Plant height

X3 : Number of primary branches per plant

X4 : Number of secondary branches per plant

X5 : Number capsules per plant

X6 : Days to maturity

X7 : Capsule length

X8 : Number of seeds per capsules

X9 : 1000 seed weight

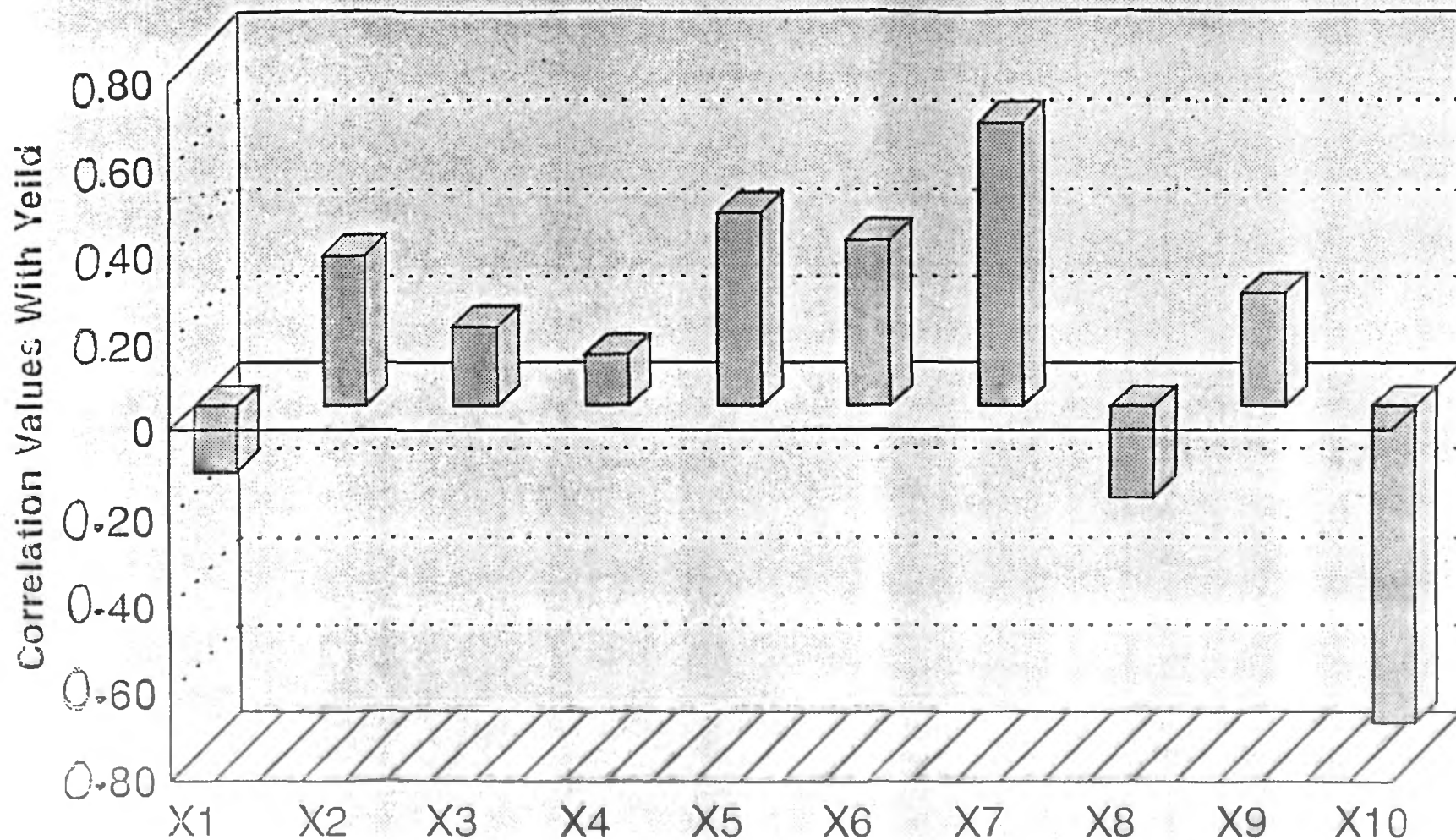
X10 : Seed yield per plant

X11 : Oil percentage

* Significant at 1 percent

** Significant at 5 percent

Fig. 12. Correlation coefficient for 10 quantitative characters in F_3 generation of Cross-III (C30P8 X Madhavi)



X1 : Days to 50 per cent flowering
 X2 : Plant height
 X3 : Number of primary branches per plant

X4 : Number of secondary branches per plant
 X5 : Number of capsules per plant
 X6 : Days to maturity
 X7 : Capsule length

X8 : Number of seeds per capsules
 X9 : 1000 seed weight
 X10 : Oil percentage

4) Number of secondary branches per plant

Positive significant correlation was observed with capsule length and number of seeds per capsule with this character.

5) Number of capsules per plant

It was found that this character was highly significantly positively correlated with plant height, number of primary branches, with number of seeds per capsule and with seed yield. It also showed significant positive correlation with 1000 seed weight. Significant negative correlation was observed with days to 50 percent flowering.

6) Days to maturity

This character exhibited highly significant positive correlation with plant height, with capsule length and with seed yield per plant. Number of primary branches per plant showed significant positive correlation with this trait.

7) Capsule length

It was found that the capsule length had high positive significant correlation with plant height, number of primary branches, days to maturity and with seed yield per plant. Further significant positive correlation was observed with number of secondary branches per plant. Significant negative correlation was noticed with days to 50 percent flowering.

8) Number of seeds per capsule

This exhibited highly significant positive correlation with number of capsules per plant. There was significant positive correlation with plant height and with number of primary branches per plant.

9) **1000 seed weight**

This character showed highly significant positive correlation with plant height. It also had positive significant association with number of capsules per plant.

10) **Oil percentage**

This recorded highly significant negative correlation with plant height, number of capsules per plant, capsule length, number of seeds per capsule, 1000 seed weight and with seed yield per plant.

4.3 PATH COEFFICIENT ANALYSIS

By correlation study we will know only the nature and extent of association existing between the pairs of characters. A dependent characters like seed yield is influenced by several other components characters which were mutually associated. Each component has two path action, viz, direct effect on yield and indirect effects through components which were not revealed by correlation studies.

The phenotypic correlation was partitioned in to direct and indirect effects on the seed yield per plant in both the generations for all the three crosses and the results are presented in table 14,15,16,17,18 and 19. Path diagram (figure 13,14,15,16,17 and 18) was drawn separately for seed yield per plant considering five characters which were showed significant correlation with seed yield per plant in all the generation consistently in all the crosses, Viz., days to flowering, plant height, number of capsules per plant, capsule length and number of seeds per capsule.

4.3.1 F_2 generation

(a) **Cross - I (R843602 X Madhavi)**

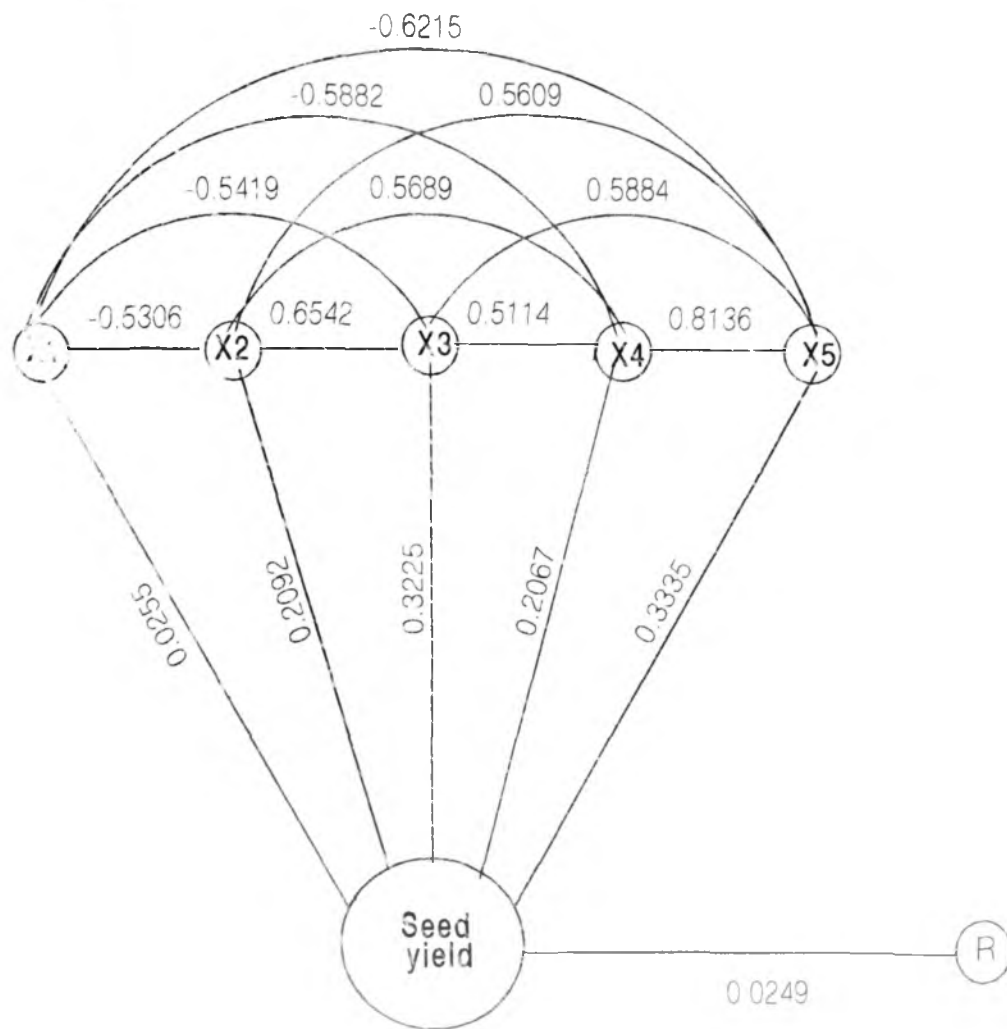
Direct effect of different yield attributing charactes on seed yield.

The direct effect of number of seeds per capsule was highest (0.3555) towards yield followed by number of capsules (0.3223), plant height (0.2092), capsule length (0.2067) and days to flowring (0.0380). (Table 14 and Figure 13)

TABLE 14. The Direct and Indirect effects of five quantitative traits in F_2 generations of Cross - I (R843602 X Madhavi)

Characters	X1	X2	X3	X4	X5	Correlation with seed yield
X1	<u>0.0255</u>	-0.1110	-0.1720	-0.1267	-0.1488	-0.5339**
X2	-0.0205	<u>0.2092</u>	0.2108	0.1004	0.1882	0.6133**
X3	0.0106	0.1368	<u>0.3223</u>	0.1418	0.1960	0.7192**
X4	-0.0228	0.1016	0.1831	<u>0.2067</u>	0.2303	0.6989**
X5	-0.2418	0.1417	0.1284	0.1774	<u>0.3355</u>	0.7584**
X1 :	Days to 50 percent flowering			Residual effect = 0.0249		
X2 :	Plant height					
X3 :	Number of capsules per plant					
X4 :	Capsule length					
X5 :	Number of Seeds per capsule					
** Significant at 1 per cent						

Fig. 13 : Path diagram showing direct and indirect effect of five yield attributing characters on seed yield in F_2 generation of Cross-I (R843602 X Madhavi)



X1 = Days to flowering

X2 = Plant height

X3 = Number of capsules per plant

X4 = Capsule length

X5 = Number of seeds per capsule

R = Residual Effect

(1) Days to flowering

Days to flowering showed low direct effect. But it had negative indirect effect through plant height, number of capsules, capsule length and through number of seeds per capsule.

2) Plant Height

Highest indirect effect of plant height was through number of capsules per plant followed by number of seeds per capsules and capsule length and its direct effect towards yield was positive.

3) Number of capsules per plant

Number of capsules per plant showed positive direct effect towards yield and its indirect effect through capsule length and number of seeds per capsule was positive.

4) Capsule length

Capsule length had positive direct effect on yield besides its indirect effect on yield through plant height number of capsules per plant. Highest indirect effect was through number seeds per capsule.

5) Number of seeds per capsule

This exhibited highest positive direct effect towards yield. It had its positive indirect effect on yield through plant height number of capsules per plant and capsule length.

b) Cross II (DORS102 X Madhavi)

Direct effect of different yield attributing characters on seed yield.

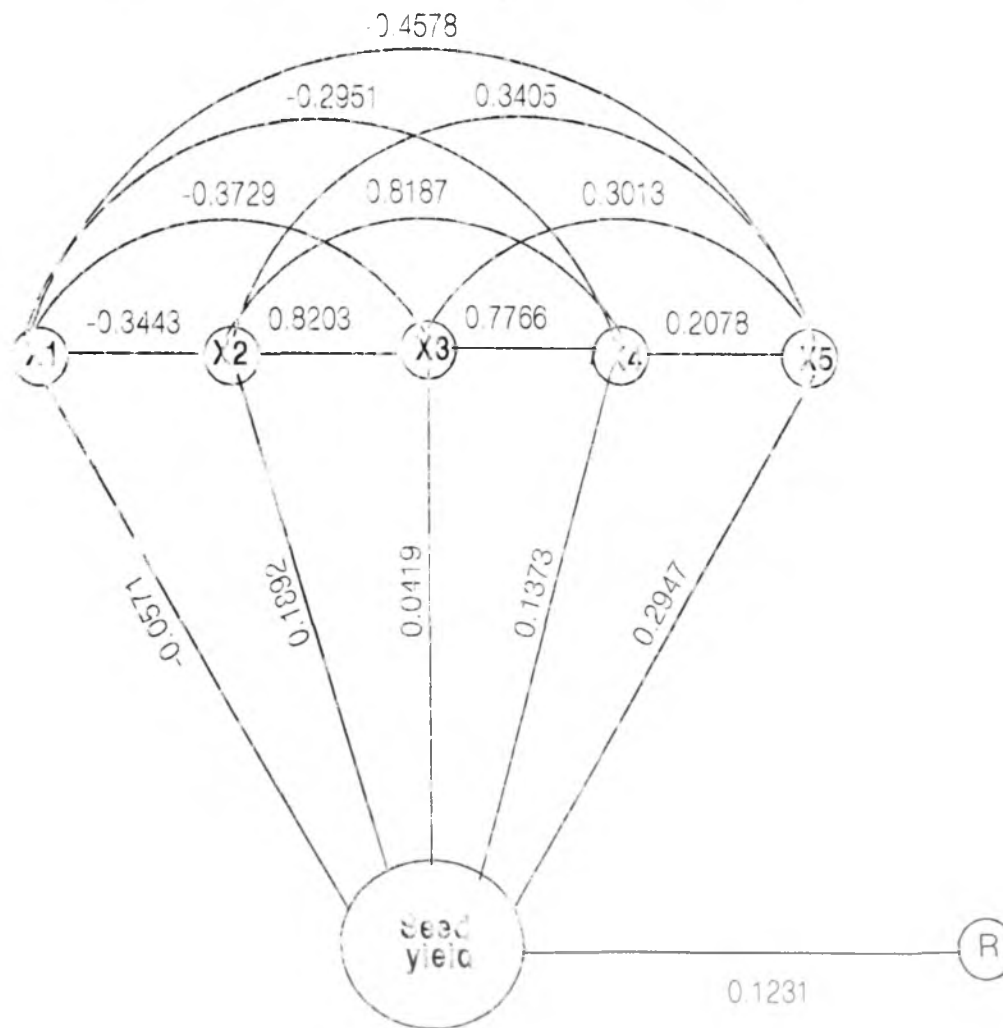
The highest direct effect on seed yield was revealed by number of seeds per capsule (0.2947) followed by plant height (0.1892), capsule length (0.1375), number of primary branches (0.1276) number of secondary branches and days to maturity (0.1094). The contribution of other characters towards yield was negligible. (Table 15 and Figure 14)

TABLE 15. The Direct and Indirect effects of five quantitative traits in F_2 generations of Cross - II (DORS102 X Madhavi)

Characters	X1	X2	X3	X4	X5	Correlation with seed yield
X1	<u>-0.0571</u>	-0.0725	-0.0126	-0.0405	-0.1587	-0.3409**
X2	0.0598	<u>0.1892</u>	0.0263	0.1124	0.1605	0.5482**
X3	0.0438	0.1910	<u>0.0419</u>	0.0164	0.0888	0.5260**
X4	0.0333	0.1797	0.0794	<u>0.1373</u>	0.0805	0.5103**
X5	0.0261	0.08335	0.0237	0.0374	<u>0.2947</u>	0.4272**
X1 :	Days to 50 percent flowering			Residual effect = 0.1231		
X2 :	Plant height					
X3 :	Number of capsules per plant					
X4 :	Capsule length					
X5 :	Number of Seeds per capsule					

** Significant at 1 per cent

Fig. 14 : Path diagram showing direct and indirect effect of five yield attributing characters on seed yield in F_2 generation of Cross-II (DORS102 X Madhavi)



X1 = Days to flowering

X2 = Plant height

X3 = Number of siliques per plant

X4 = Capsule length

X5 = Number of seeds per capsule

R = Residual Effect

1) Days to flowering

This had low negative direct effect on seed yield. However it showed negative indirect effect towards yield through number of seeds per capsule. Others had low indirect effect on seed yield.

2) Plant height

Plant height expressed positive direct effect towards yield. Its indirect effect through capsule length was positive. Other characters did not show any considerable indirect effect towards yield through this trait.

3) Number of capsules per plant

The contribution of number of capsules per plant towards yield was low but indirect effects through plant height and capsule length was positive.

4) Capsule length

The capsule length had positive direct effect on seed yield per plant. Plant height had a positive indirect effect towards yield. Rest of the characters recorded low indirect effect towards seed yield per plant.

5) Number of seeds per capsule.

This exhibited highest positive direct effect on seed yield per plant. The contribution through other characters was negligible.

c) Cross - III (C30P8 X Madhavi).

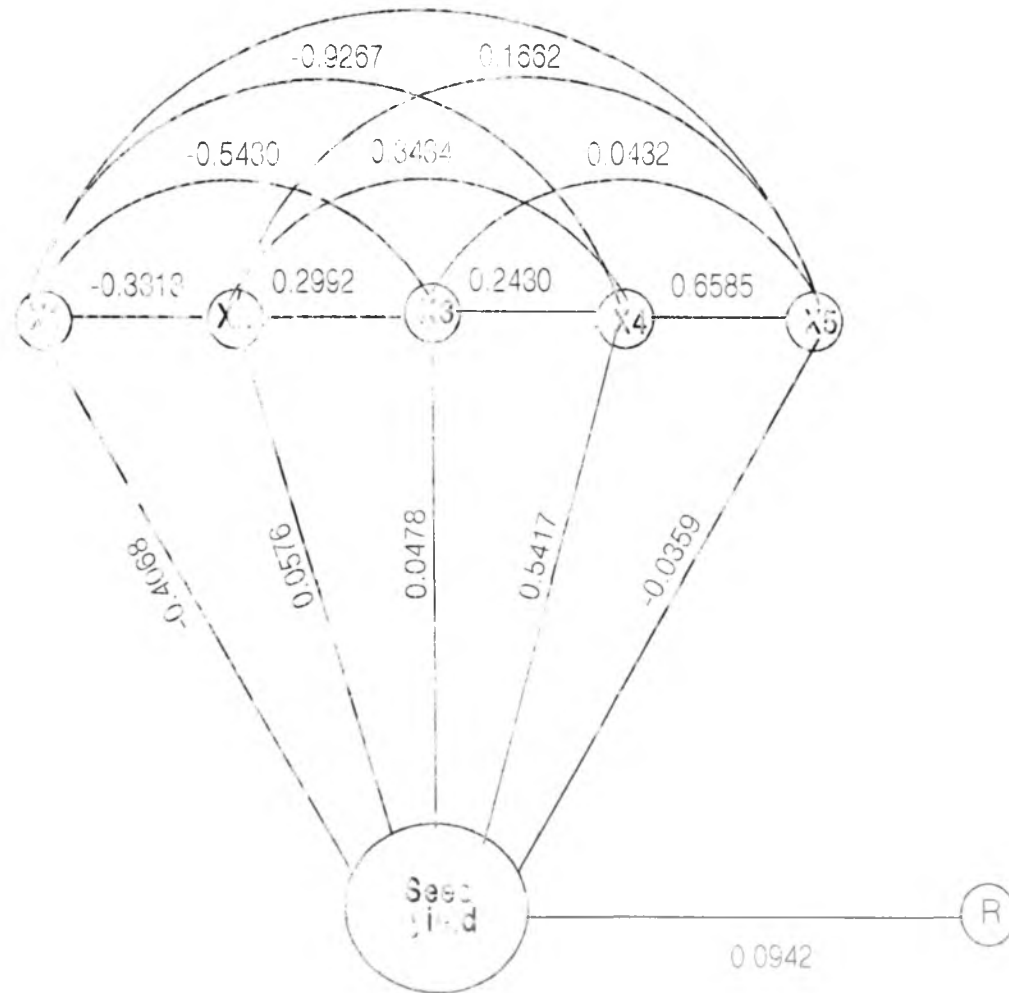
Direct effect of different yield attributing characters on seed yield.

The highest positive direct effect (0.5417) towards seed yield was from capsule length, whereas days to flowering recorded negative direct (-0.4068) effect. None of the characters showed considerable direct effect on seed yield per plant. (Table 16 and Figure 15)

TABLE 16. The Direct and Indirect effects of five quantitative traits in F_2 generations of Cross - III (C30P8 X Madhavi)

Characters	X1	X2	X3	X4	X5	Correlation with seed yield
X1	<u>-0.4068</u>	0.0137	-0.0259	-0.5020	0.0412	-0.9047**
X2	0.1347	<u>0.0565</u>	-0.0170	0.1860	-0.0059	0.3546**
X3	0.2209	0.0169	<u>0.0478</u>	0.2823	-0.0181	0.5498**
X4	0.3770	0.0140	-0.0234	<u>0.5417</u>	0.0052	0.9145**
X5	-0.0579	0.0109	0.0021	0.0407	<u>-0.0359</u>	-0.1215**
Residual effect = 0.0942						
X1 :	Days to 50 percent flowering					
X2 :	Plant height					
X3 :	Number of capsules per plant					
X4 :	Capsule length					
X5 :	Number of Seeds per capsule					

** Significant at 1 per cent



1 = Days to flowering
2 = Plant height
3 = Number of capsules per plant

R4 = Capsule length
R5 = Number of seeds per capsule
R = Residual effect

1) Days to flowering

This exhibited negative direct effect on seed per plant. But highest negative indirect effect towards seed yield per plant was from capsule length was noticed. Indirect effect of rest of the characters was low.

2) Plant height.

The direct effect of this character towards seed yield per plant was negligible. Plant height exerted positive indirect effect through capsule length. Contribution from this character through other characters was low and negligible towards seed yield per plant.

3) Number of capsules per plant.

Though the direct effect of this character on seed yield was low, the indirect effect of this through capsule length and days to 50 percent flowering was positive. Number of capsules per plant did not show any indirect effect towards seed yield per plant through other characters.

4) Capsule length.

Capsule length exhibited highest direct effect on seed yield per plant. High positive indirect effect of this character through days to 50 percent flowering was also observed. Capsule length recorded low indirect effects through other character towards seed yield per plant.

5) Number of seeds per capsule :

The direct and indirect effects of number of seeds per capsule on seed yield were of negligible magnitude.

a) Cross - I(R843602 X Madhavi).

Direct effect of different yield attributing characters on seed yield.

The highest positive direct effect on seed yield per plant was found to be by number of seeds per capsule (0.3338) followed by plant height (0.3043), capsule length (0.1663), by number of capsules per plant (0.1652) and days to flowering (0.0476). (Table 17 and Figure 16).

1. Days to flowering

Days to flowering exhibited low negative direct effect on seed yield per plant. It had negative indirect effect through plant height, capsule length and number of seeds per capsule on seed yield per plant. Other characters showed low indirect effects.

2. Plant height

High positive direct effect of plant height was noticed on seed yield. Plant height exhibited positive indirect effect through number of seeds per capsule. It also exhibited positive indirect effect through other character while negative indirect effect was noticed through oil percentage on seed yield.

3. Number of capsules per plant.

The positive direct effect was observed by the number of capsules per plant on seed yield per plant. Except days to maturity all other characters showed low positive indirect effects on seed yield plant. Because of this total effect the number of capsules showed highly positive correlation with yield.

4. Capsules length

The direct effect of capsule length on seed yield per plant was positive. But it showed higher indirect effect through number of seeds per capsule and positive direct effect through plant height on seed yield per plant. Because of this capsule length

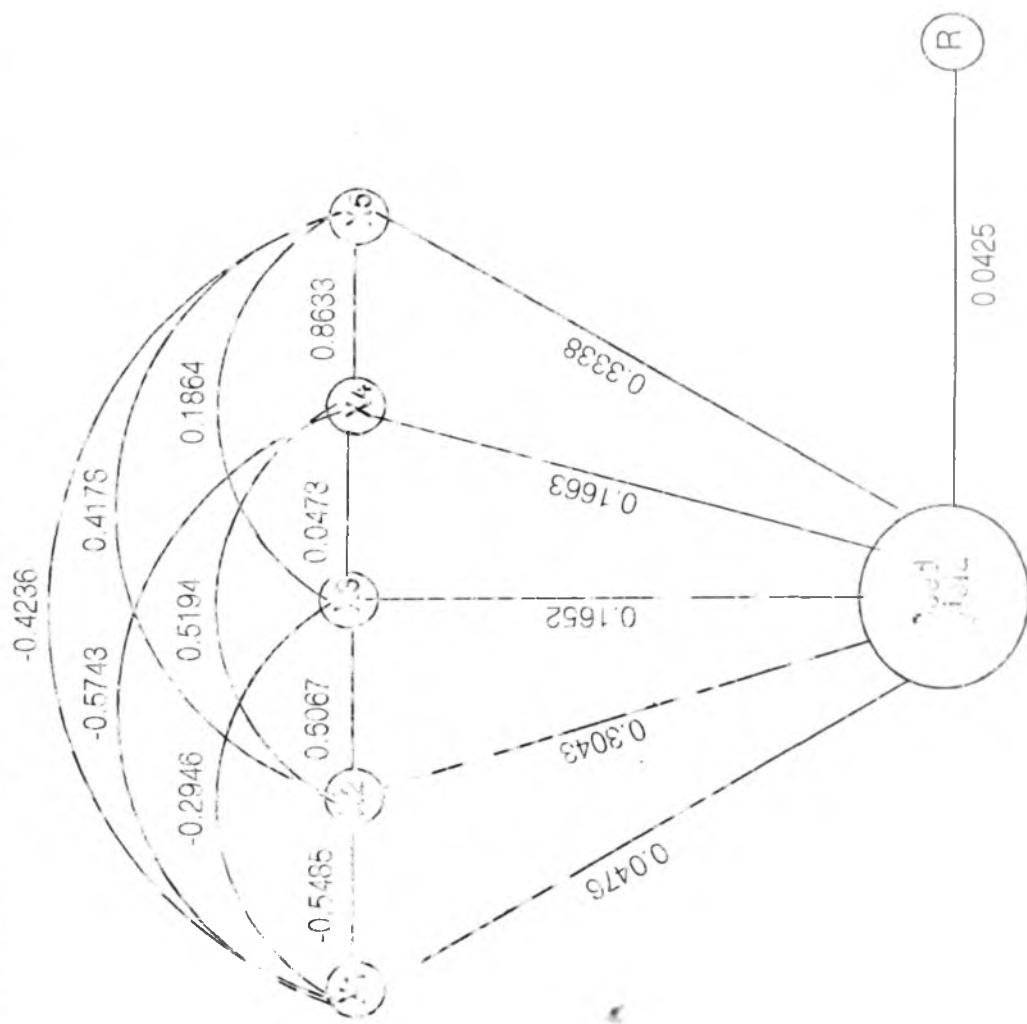
BLE 17. The Direct and Indirect effects of five quantitative traits in F_3 generations of Cross - I (R843602 X Madhavi)

Characters	X1	X2	X3	X4	X5	Correlation with seed yield
X1	<u>0.0476</u>	-0.1669	-0.0729	-0.1717	-0.1928	-0.5890**
X2	0.0397	<u>0.3043</u>	0.0422	-0.0575	0.1732	0.5594**
X3	0.0144	0.1177	<u>0.1652</u>	0.0078	0.0621	0.3672**
X4	0.0321	0.1363	0.0076	<u>0.1663</u>	0.2879	0.6302**
X5	0.0344	0.1580	0.1330	0.1435	<u>0.3338</u>	0.7257**

X1	: Days to 50 percent flowering	Residual effect 0.0425
X2	: Plant height	
X3	: Number of capsules per plant	
X4	: Capsule length	
X5	: Number of Seeds per capsule	

** Significant at 1 per cent

Fig. 1.1: Path diagram showing direct and indirect effects of the field attributes variables on seed yield in a population of *C. sativum*



X_4 = Capsule length
 X_5 = Number of capsules per capsule
 R = Residual Effect

X_1 = Days to maturity
 X_2 = Plant height
 X_3 = Number of capsules per plant

showed positive and highly significant correlation with seed yield per plant. The remaining characters showed low indirect effects on seed yield per plant.

5. Number of seeds per capsule

The highest direct effect on seed yield per plant was noticed by number of seeds per capsule which had a high positive correlation with seed yield per plant. The plant height exerted positive indirect effect through number of seeds per capsule.

b) Cross - II (DORS 102 X Madhavi)

Direct effect of yield attributing characters on seed yield.

The positive direct effect of capsule length was highest (0.3036) followed by number of capsules per plant (0.2026) and plant height (0.1657) on seed yield per plant. While the other characters did not show noticeable direct effect on seed per plant. (Table 18 and Figure 17)

1) Days to 50 percent flowering

Days to 50 percent flowering recorded low and positive direct effect towards seed yield per plant. This also showed low indirect effect through other characters which in turn expressed non significant correlation with seed yield per plant.

2. Plant height

Plant height exhibited positive direct effect on seed yield per plant. Its indirect effect through number of capsules was also positive. Other characters did not show considerable indirect effect through this character.

3. Number of capsules per plant

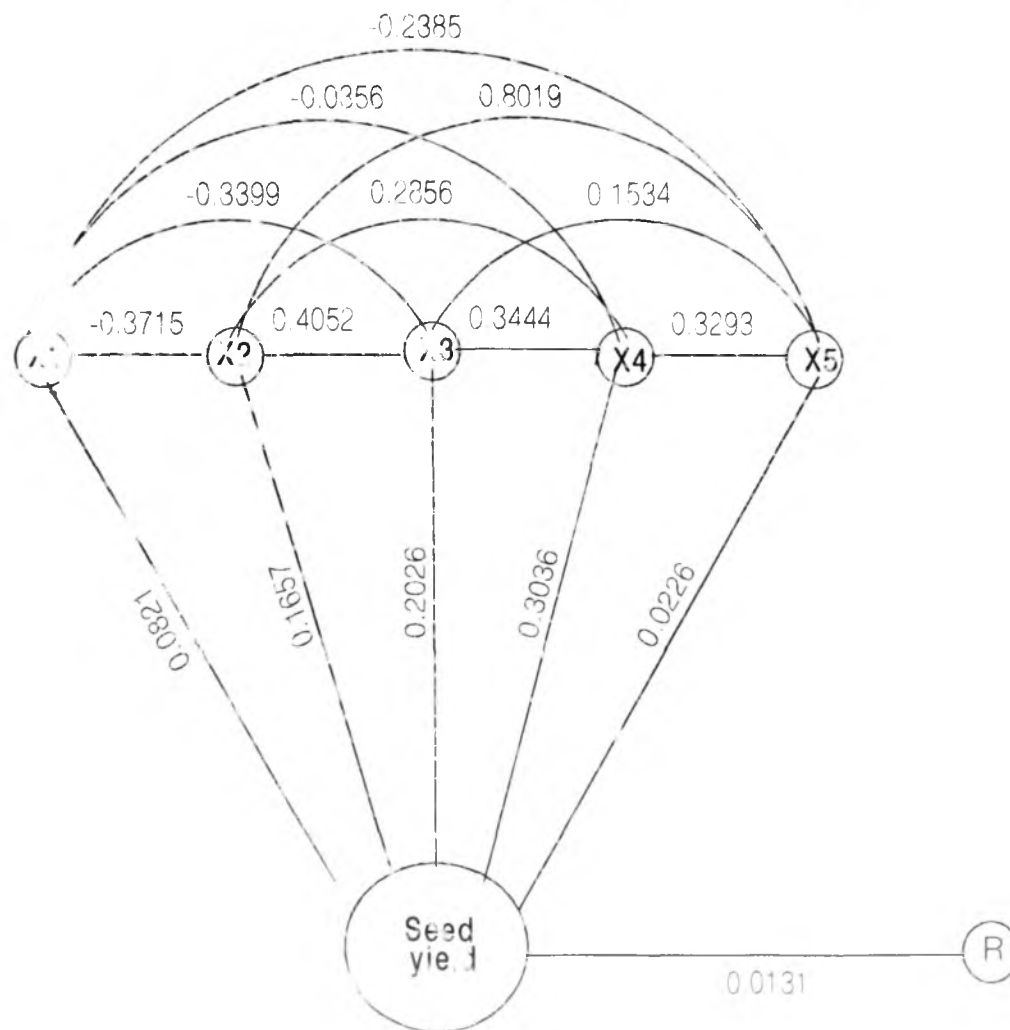
Number of capsules per plant recorded positive direct effect on seed yield per plant. It also showed positive indirect effect through plant height and capsule length.

TABLE 18. The Direct and Indirect effects of five quantitative traits in F_3 generations of Cross - II (DORS102 X Madhavi)

Characters	X1	X2	X3	X4	X5	Correlation with seed yield
X1	<u>0.0821</u>	-0.0615	-0.0688	-0.0109	0.0053	-0.0538**
X2	-0.0204	<u>0.1657</u>	0.1834	0.0874	0.0664	0.4823**
X3	-0.0189	0.1500	<u>0.2026</u>	0.1055	0.0434	0.4825**
X4	0.1247	0.1373	0.0783	<u>0.3036</u>	0.0825	0.7301**
X5	0.0113	0.2012	-0.1730	0.1008	<u>0.0226</u>	-0.2394**
X1	: Days to 50 percent flowering				Residual effect = 0.01312	
X2	: Plant height					
X3	: Number of capsules per plant					
X4	: Capsule length					
X5	: Number of Seeds per capsule					

** Significant at 1 per cent

Fig. 17 : Path diagram showing direct and indirect effect of five yield attributing characters on seed yield in F_3 generation of Cross-1 (DORS102 X Madhavi)



X1 = Days to flowering

X2 = Branches

X3 = Number of capsules per plant

X4 = Capsule length

X5 = Number of seeds per capsule

R = Residual Effect

4. Capsule length

Capsule length showed highest positive direct effect on seed yield per plant. Indirect effect through other characters was low.

5. Number of seeds per capsules

Though this character showed low direct effect on seed yield per plant, its highly significant negative correlation with seed yield per plant was mainly due to its negative indirect effect through plant height and number of capsules per plant on seed yield per plant. Capsule length had positive indirect effect through this character.

c) Cross - III (C30P8 X Madhavi)

The highest direct effect on seed yield per plant was showed by capsule length and number of capsules per plant. Rest of the characters did not show any noticeable direct effect on seed yield per plant. (Table 19 and figure 18.)

1. Days to flowering

The direct effect on seed yield per plant was negative. As a result it exhibited negative correlation with seed yield per plant. This character did not show significant indirect effect through other characters.

2. Plant height

Positive direct effect was noticed by plant height on seed yield per plant. This also recorded positive indirect effect on seed yield per plant through number of capsules per plant. Indirect effect of plant height through other characters was low.

3. Number of capsules per plant

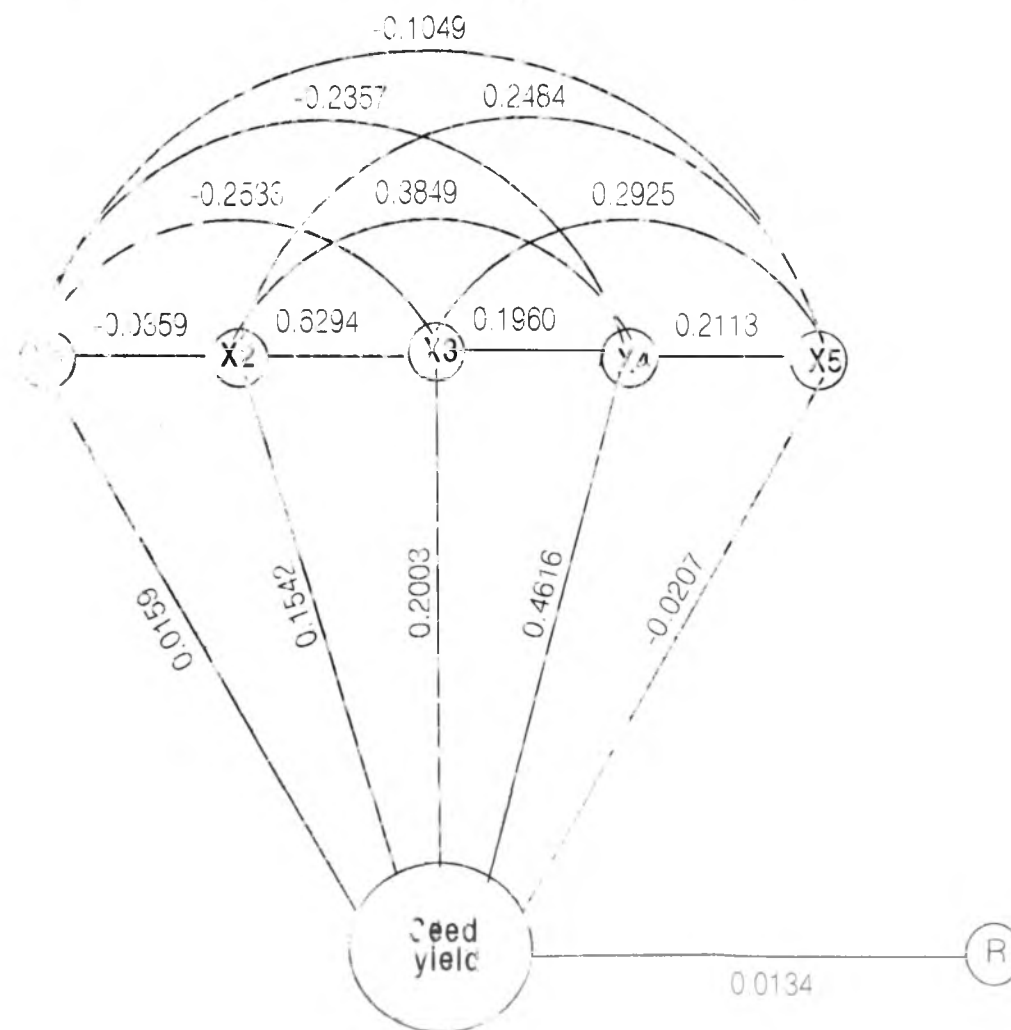
Positive direct effect was noticed on seed yield per plant by this character. Similarly its indirect effect through plant height was also positive. The indirect effect of this through rest of the character was low.

TABLE 19. The Direct and Indirect effects of five quantitative traits in F_3 generations of Cross - III (C30P8 X Madhavi)

Characters	X1	X2	X3	X4	X5	Correlation with seed yield
X1	<u>0.0159</u>	-0.0055	-0.0507	-0.1440	+0.0104	-0.1500**
X2	-0.0057	<u>0.1542</u>	0.1707	0.0177	0.0093	0.3507**
X3	-0.0040	0.1478	<u>0.2003</u>	0.0906	0.0143	0.4490**
X4	0.0085	0.0595	0.1303	<u>0.4616</u>	-0.0043	0.6554**
X5	0.0080	-0.0691	-0.2222	0.0975	<u>-0.0207</u>	-0.2065**
X1 : Days to 50 percent flowering	Residual effect = 0.0134					
X2 : Plant height						
X3 : Number of capsules per plant						
X4 : Capsule length						
X5 : Number of seeds per capsule						

** Significant at 1 per cent

Fig. 18 : Path diagram showing direct and indirect effect of five yield attributing characters on seed yield in F_3 generation of Cross-III (G80P3 X Madhavi)



X1 = Days to flowering

X2 = Plant height

X3 = Number of capsules per plant

X4 = Capsule length

X5 = Number of seeds per capsule

R = Residual Effect

4. Capsule length

Highest positive direct effect was observed by capsule length on seed yield per plant. Other characters did not show any significant indirect effect on seed yield per plant.

5. Number of seeds per capsules

This showed low negative direct effect on seed yield per plant. It was highly significantly and positively correlated with seed yield per plant because of its negative and high indirect effect through number of capsules per plant. Indirect effect of other characters was low.

Analysis of variance in F_3 generation.

Analysis of variance was done in F_3 population. It is to know the difference within F_3 population. It revealed that all the eleven character studied, viz., Days to 50 percent flowering, plant height, number of primary branches, number of secondary branches, number of capsules per plant, days to maturity, capsule length, number of seeds per capsules, 1000 seed weight, seed yield per plant and oil percentage were significantly different from each other (Table 20,21 and Table 22).

4.4 SELECTION INDICES

Selection indices for seed yield were formulated in F_3 populations of three crosses by considering the yield components, viz, plant height, number of capsules per plant, capsule length, number of seeds per capsule and 1000 seed weight in cross I. In Cross II and III, days to maturity was considered instead number of seeds per capsule. Seed yield was considered as dependent variable in the analysis.

Expected genetic advances were computed using discriminant functions and their relative efficiency over straight selection at five percent selection intensity, considering the relative efficiency of seed yield alone as 100 percent. The estimated values of genetic advance and relative efficiency for each combination of characters are presented in table 23,24 and 25 and depicted in figure 19 to 24.

TABLE 20 : Analysis Variance for 11 Quantitative characters in Sesame
in F3 generation of Cross - I (R843602 X Madhavi)

Source of	Mean Sum of Squares										
df	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11
Variation											
Entry	83	58.4	747.77	2.96	3.52	491.94	102.56	0.64	236.01	0.91	119.25
Error	166	8.00	50.30	0.38	2.26	36.99	23.54	0.10	6.99	0.28	1.05
F-Test		4.28**	14.86**	7.79**	1.56*	13.30**	4.36**	6.4**	33.76**	3.25**	2.66**
CV (%)		7.81	8.22	15.27	7.50	5.01	1.73	11.58	5.36	18.99	2.17
X1 : Days to 50 percent flowering						X6 : Days to maturity					
X2 : Plant height						X7 : Capsule length					
X3 : Number of primary branches per plant						X8 : Number of Seeds per capsule					
X4 : Number of secondary branches per plant						X9 : 1000 seed weight					
X5 : Number capsules per plant						X10 : Seed yield per plant					
						X11 : Oil percentage.					

** Significant at 1 per cent

* Significant at 5 per cent

TABLE 21: Analysis of variance for 11 Quantitative characters in Sesame
in F3 generation of Cross - II (DORS-102 X Madhavi)

Source of	Mean Sum of Squares											
Df												
Variation	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	
Entry	83	141.82	683.42	2.94	1.76	541.4	141.82	1.29	55.96	0.383	16.4	364.83
Error	166	25.29	37.32	0.45	0.80	7.46	25.30	0.81	15.10	0.23	0.56	5.49
F-Test		5.61**	18.30**	6.53**	2.22**	72.53**	5.61**	1.59*	3.71**	1.66*	29.28**	66.45**
CV (%)	9.48	8.49	29.86	12.89	6.52	5.72	37.17	9.23	19.08	12.94	5.60	
X1 : Days to 50 percent flowering						X6 :	Days to maturity					
X2 : Plant height						X7 :	Capsule length					
X3 : Number of primary branches per plant						X8 :	Number of Seeds per capsule					
X4 : Number of secondary branches per plant						X9 :	1000 seed weight					
X5 : Number capsules per plant						X10 :	Seed yield per plant					
						X11 :	Oil percentage.					
** Significant at 1 per cent												

TABLE 22 : Analysis of variance of 11 Quantitative characters in sesame

F3 generation of cross - III (C30P8 X Madhavi).

Source of		Mean Sum of Squares									
		Df									
Variation		X1	X2	X3	X4	X5	X6	X7	X8	X9	X10 X11
Entry	83	16.99	288.29	6.16	4.84	192.8	247.24	0.28	54.51	0.15	0.19 49.11
Error	166	2.58	72.45	1.59	1.35	23.40	50.90	0.08	9.31	0.02	0.10 3.25
F-Test		6.59**	3.98**	3.87**	3.59**	8.24**	4.86**	3.5**	5.85**	7.5**	1.5* 15.21**
CV (%)		3.87	9.28	20.26	22.73	10.53	7.89	2.16	6.14	5.17	5.38 2.98
X1 :	Days to 50 percent flowering	X6 : Days to maturity									
X2 :	Plant height	X7 : Capsule length									
X3 :	Number of primary branches per plant	X8 : Number of Seeds per capsule									
X4 :	Number of secondary branches per plant	X9 : 1000 seed weight									
X5 :	Number capsules per plant	X10 : Seed yield per plant									
		X11 : Oil percentage.									

** Significant at 1 per cent

* Significant at 5 per cent

4.4.1 Cross - I (R843602 X Madhavi)

When five yield components were considered individually the highest efficiency was observed for 1000 seed weight (70.84%) followed by number of seeds per capsule (55.81%), plant height (54.41%), number of capsules per plant (42.16%) and capsule length (36.46%). But these were less efficient than the direct selection for seed yield alone. (Table 23 and Figure 19 and 20)

When two characters was taken at a time the highest efficiency was found for the combination of number of capsules per plant and number of seeds per capsule (74.68%) followed by $X_3 + X_5$ (74.37%) and $X_1 + X_5$ (73.48%). The least efficiency was found for $X_2 + X_3$ combination (51.94%)

Among three character combinations the highest efficiency was observed for the combination of $X_2+X_4+X_5$ (77.37%) followed by $X_2+X_3+X_5$ (74.43%) and $X_1+X_2+X_5$ (74.36%). The least efficiency was observed for the character combinations $X_2+X_3+X_4$ (64.49%).

When four characters were taken the highest efficiency was observed for the combination $X_1+X_2+X_3+X_5$ (78.36%) followed by $X_2+X_3+X_4+X_5$ (77.40%). The least efficiency of 72.54% for combination $X_1+X_2+X_3+X_4$ was noticed.

Maximum efficiency was obtained for the selection index when all the five characters were included and it recorded an efficiency of 81.50%. But it was less efficient than direct selection for yield alone.

4.4.2 Cross - II (DORS102 X Madhavi)

1000 seed weight recorded maximum efficiency (103.54%) when individual characters were considered followed by number of capsules per plant (102.84%), capsule length (102.84%) and the least efficiency was showed by plant height (86.62%). (Table 24 and Figure 21 and 22)

Table : 23 Discriminant functions, Their genetic advance and relative efficiency over straight selection for seed yield in F3 generation of Cross - I (R843602 X Madhavi) in seasmum

Sl.No.	Combinations	Genetic advance	Relative efficiency
1.	X6	3.356	100.00
2.	X1	1.826	54.41
3.	X2	1.415	42.16
4.	X3	1.224	36.46
5.	X4	1.873	55.81
6.	X5	2.378	70.84
7.	X1 + X2	2.061	61.08
8.	X1 + X3	1.972	58.73
9.	X1 + X4	2.173	64.72
10.	X1 + X5	2.467	73.48
11.	X2 + X3	1.742	51.91
12.	X2 + X4	2.119	61.13
13.	X2 + X5	2.506	74.68
14.	X2 + X4	2.177	64.84
15.	X3 + X5	2.497	74.37
16.	X4 + X5	2.378	70.85
17.	X1 + X2 + X3	2.164	64.49
18.	X1 + X2 + X4	2.314	68.96
19.	X1 + X2 + X5	2.564	76.36
20.	X1 + X3 + X4	2.326	69.30
21.	X1 + X3 + X5	2.548	75.91
22.	X1 + X4 + X5	2.468	73.52
23.	X2 + X3 + X4	2.498	74.43
24.	X2 + X3 + X5	2.332	69.48
25.	X2 + X4 + X5	2.597	77.37
26.	X3 + X4 + X5	2.458	74.43
27.	X1 + X2 + X3 + X4	2.435	72.54
28.	X1 + X2 + X3 + X5	2.630	78.36
29.	X1 + X2 + X4 + X5	2.565	76.43
30.	X1 + X3 + X4 + X5	2.548	75.93
31.	X2 + X3 + X4 + X5	2.597	77.40
32.	X1 + X2 + X3 + X4 + X5	2.784	81.50

X1 = Days to flowering

X2 = Plant height

X3 = Number of capsules plant

X4 = Capsule length

X5 = Number of capsules per plant

X6 = Seed yield per plant.

Fig. 19. Relative efficiencies (%) of discriminant functions over straight selection for seed yield in F_3 generation of Cross-1 (R843602 X Madhav)

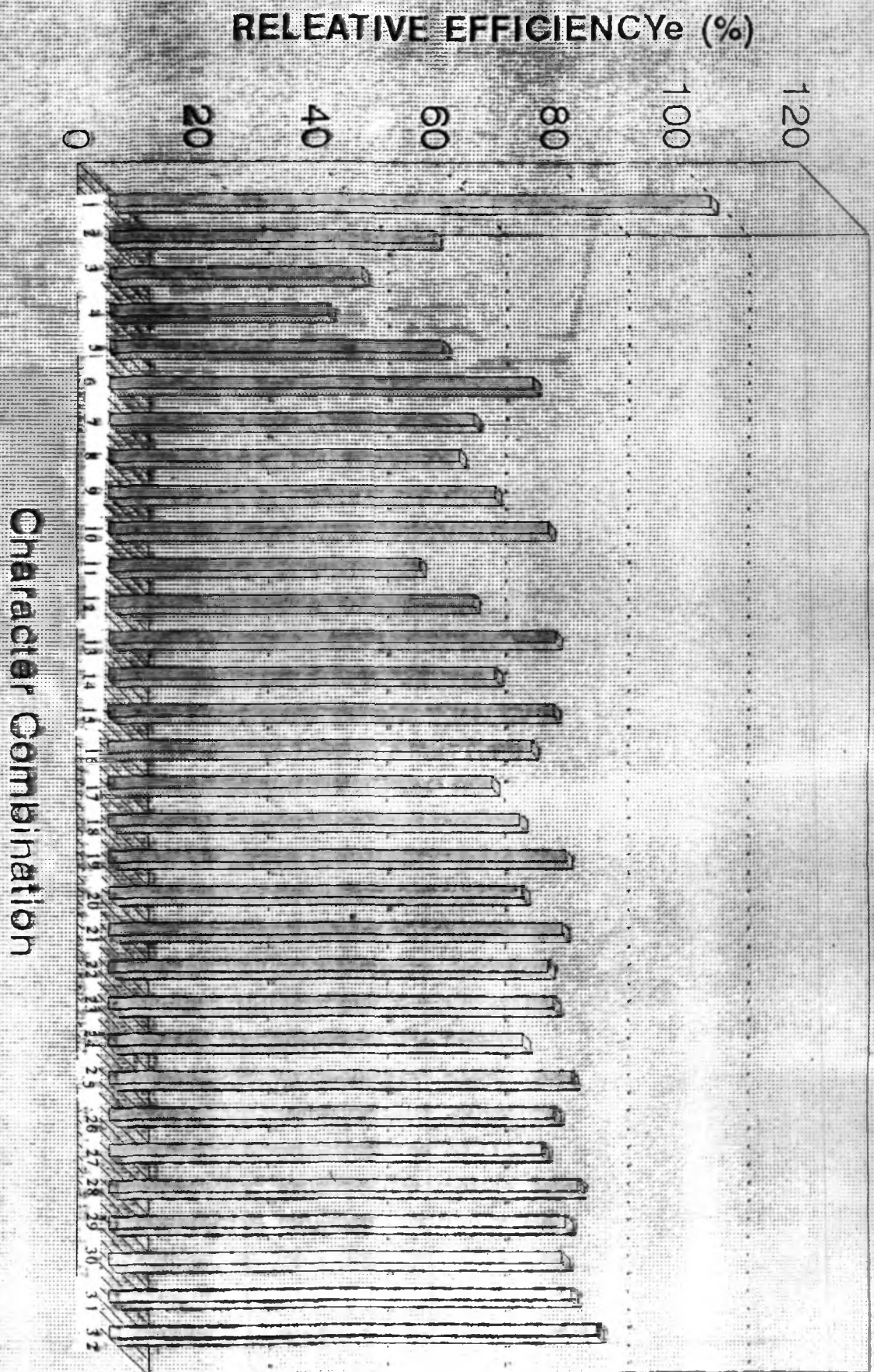


Fig. 20. Genetic advance of discriminant functions over straight selection for seed yield in F_3 generation of Cross-I (R84,3602 X Madhavi)

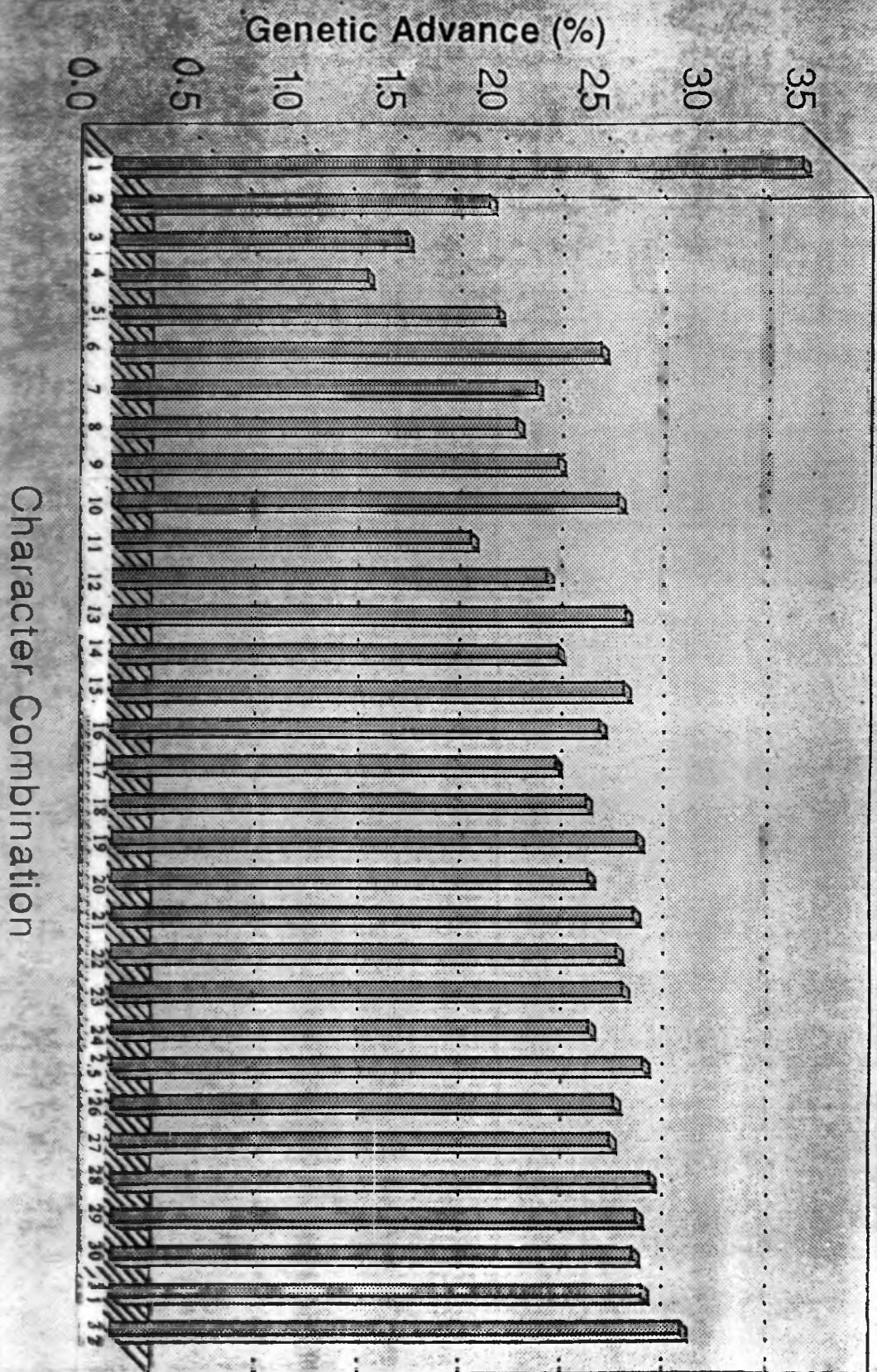


Table : 24 Discriminant functions, Their genetic advance and relative efficiency over straight selection for seed yield in F3 generation of Cross - II (DORS102 X Madhavi) in Sesame

Sl.No.	Combinations	Relative efficiency	Genetic advance
1.	X6	100	4.501
2.	X1	86.62	3.898
3.	X2	103.54	4.660
4.	X3	102.84	4.628
5.	X4	96.76	4.355
6.	X5	101.28	4.558
7.	X1 + X2	115.34	5.19
8.	X1 + X3	104.52	4.681
9.	X1 + X4	102.64	4.619
10.	X1 + X5	126.24	5.682
11.	X2 + X3	138.36	6.227
12.	X2 + X4	128.36	5.777
13.	X2 + X5	132.68	5.972
14.	X2 + X4	98.54	4.435
15.	X3 + X5	134.38	6.048
16.	X4 + X5	131.64	5.925
17.	X1 + X2 + X3	124.28	5.593
18.	X1 + X2 + X4	136.54	6.145
19.	X1 + X2 + X5	130.54	5.875
20.	X1 + X3 + X4	122.60	5.518
21.	X1 + X3 + X5	128.44	5.781
22.	X1 + X4 + X5	121.22	5.456
23.	X2 + X3 + X4	132.48	5.962
24.	X2 + X3 + X5	138.62	6.239
25.	X2 + X4 + X5	131.54	5.920
26.	X3 + X4 + X5	144.64	6.510
27.	X1 + X2 + X3 + X4	139.78	6.291
28.	X1 + X2 + X3 + X5	126.74	5.704
29.	X1 + X2 + X4 + X5	141.54	6.370
30.	X1 + X3 + X4 + X5	134.64	6.060
31.	X2 + X3 + X4 + X5	143.26	6.448
32.	X1 + X2 + X3 + X4 + X5	156.84	7.059

X1 — Days to flowering

X2 — Plant height

X3 — Number of capsules plant

X4 — Capsule length

X5 — Number of capsules per plant

X6 — Seed yield per plant

Fig. 21. Relative efficiencies (%) of discriminant functions over straight selection for seed yield in F_3 generation of Cross-II (DORS102 X Madhav)

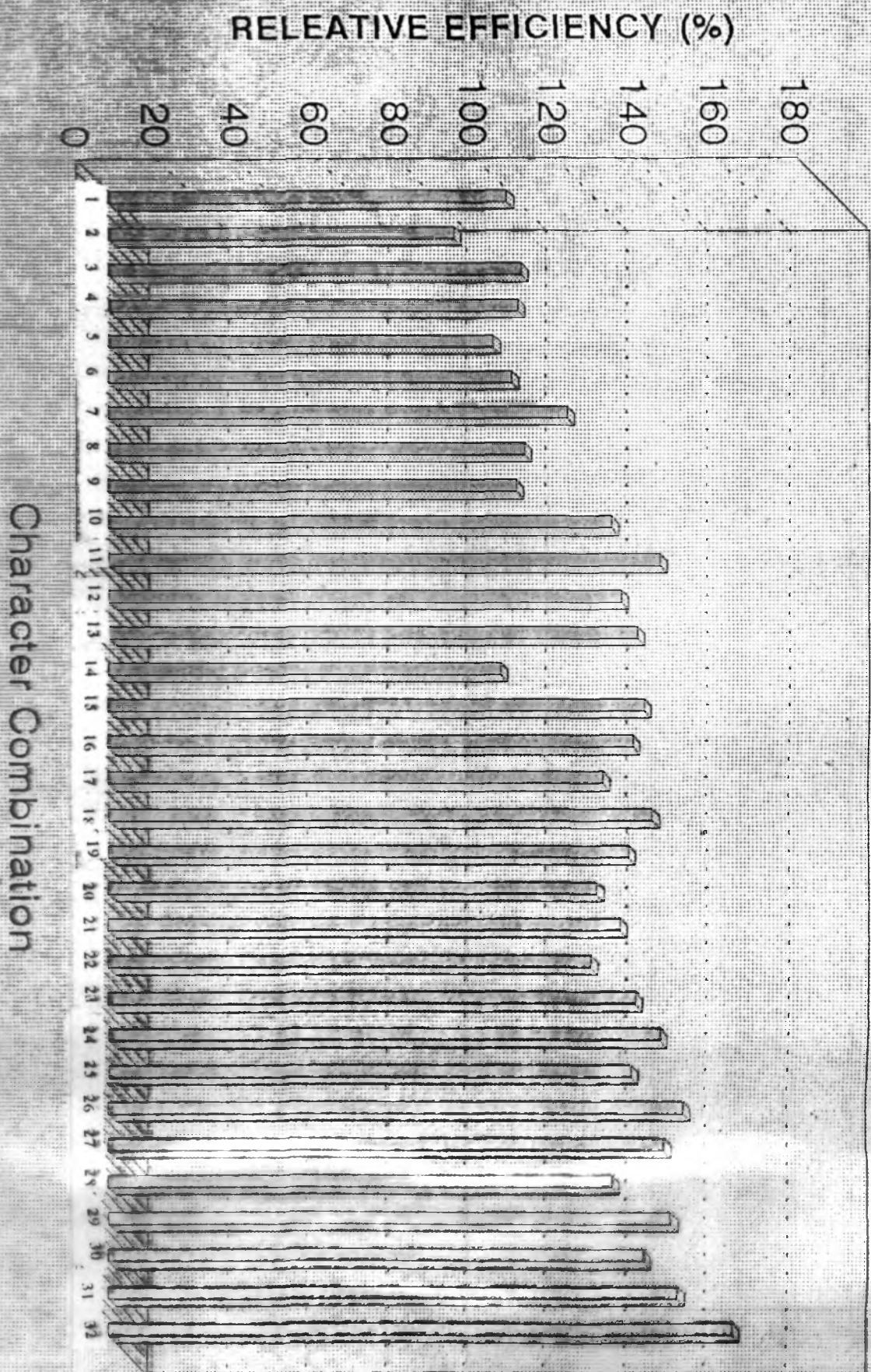
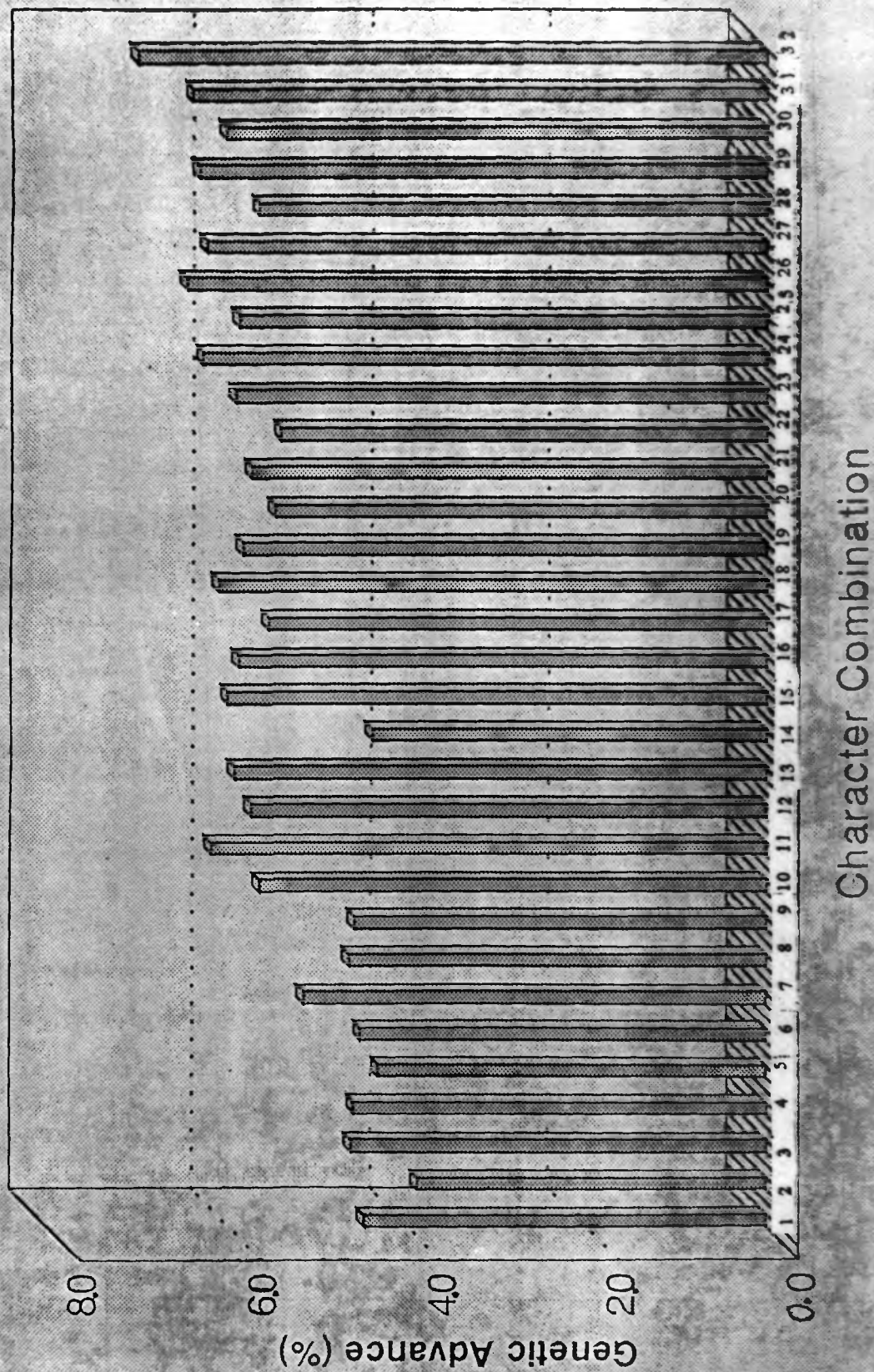


Fig. 22. Genetic advance of discriminant functions over straight selection for seed yield in F_3 generation of Cross-II (DORS102 X Madhavi)



Among two characters combination, the highest efficiency was noticed for combination of X2+X3 (138.36%) followed by X3+X5 (134.38%) and X4+X5(131.64%). The least efficiency was noticed for the combination X1+X4(102.64%).

When three characters are considered, the combination X3+X4+X5 (144.64%) was found to be efficient followed by X2+X3+X5 (138.62%) and the least in combination was X1+X4+X5(121.22%).

Among combination involving four characters, the maximum efficiency was showed by X2+X3+X4+X5 followed by X1+X2+X4+X5 and X1+X2+X3+X4 combinations with an efficiency of 143.26 percent, 141.54 percent and 139.78 percent, respectively.

The combination of all five characters were found to be highly efficient (156.84%) for selection based on discriminant function than direct selection.

4.4.3 Cross - III (C30P8 X Madhavi)

The highest efficiency was observed for capsule length (96.54%) when five yield characters were considered individually. It was followed by 1000 seed weight (91.84%), number of capsules per plant (76.44%), days to maturity (72.54%) and least efficiency was observed for plant height (68.52%). (Table 25 and Figure 23 and 24)

The character combination X3+X4 showed highest efficiency (116.58%) followed by X2+X4 (114.66%) and X4+X5 (110.42%) when two characters was considered. The least efficiency for two characters combination was noticed for X1+X5 (98.55%).

Table : 25 Discriminant functions, Their genetic advance and relative efficiency over straight selection for seed yield in F3 generation of Cross-III (C30 P8 X Madhavi) in sesame

Sl.No.	Combinations	Relative efficiency	Genetic advance
1.	X6	100	2.7910
2.	X1	68.52	1.592
3.	X2	76.44	2.133
4.	X3	91.84	2.563
5.	X4	96.54	2.694
6.	X5	72.54	2.024
7.	X1 + X2	103.64	2.864
8.	X1 + X3	105.54	2.945
9.	X1 + X4	108.56	3.209
10.	X1 + X5	98.58	2.750
11.	X2 + X3	107.48	2.986
12.	X2 + X4	114.66	3.200
13.	X2 + X5	104.24	2.909
14.	X2 + X4	116.58	3.253
15.	X3 + X5	104.26	2.909
16.	X4 + X5	110.42	3.081
17.	X1 + X2 + X3	117.38	3.276
18.	X1 + X2 + X4	118.54	3.308
19.	X1 + X2 + X5	115.12	3.212
20.	X1 + X3 + X4	125.68	3.507
21.	X1 + X3 + X5	120.58	3.365
22.	X1 + X4 + X5	122.54	3.420
23.	X2 + X3 + X4	131.28	3.664
24.	X2 + X3 + X5	119.78	3.343
25.	X2 + X4 + X5	120.18	3.354
26.	X3 + X4 + X5	128.44	3.584
27.	X1 + X2 + X3 + X4	138.76	3.872
28.	X1 + X2 + X3 + X5	136.26	3.803
29.	X1 + X2 + X4 + X5	137.54	3.838
30.	X1 + X3 + X4 + X5	135.48	3.781
31.	X2 + X3 + X4 + X5	142.56	3.978
32.	X1 + X2 + X3 + X4 + X5	145.46	4.059

X1 = Days to flowering

X2 = Plant height

X3 = Number of capsules plant

X4 = Capsule length

X5 = Number of capsules per plant

X6 = Seed yield per plant.

Fig. 23. Relative efficiencies (%) of discriminant functions over straight selection for seed yield in F_3 generation of Cross-III (C30P8 X Madhavi)

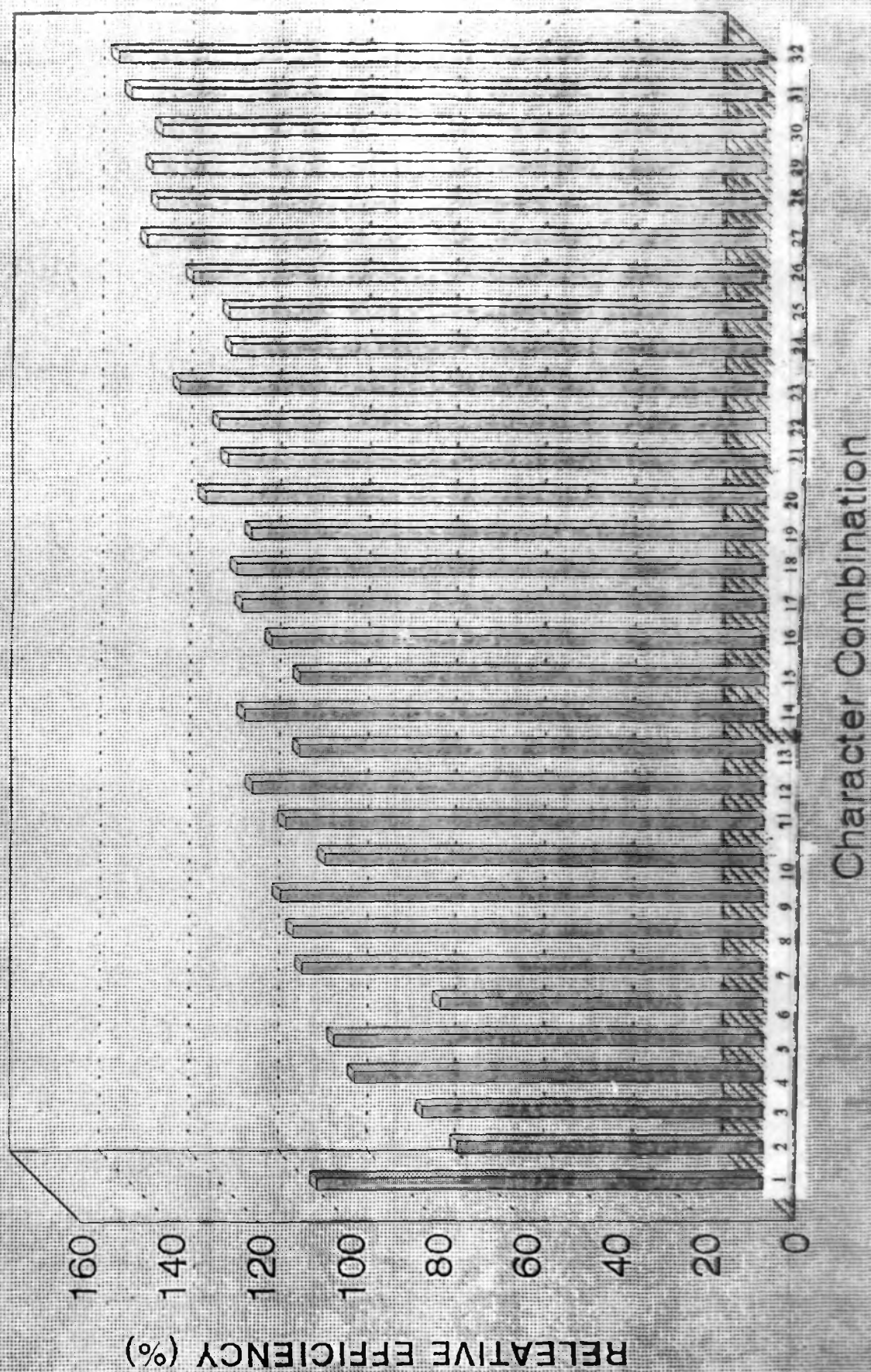
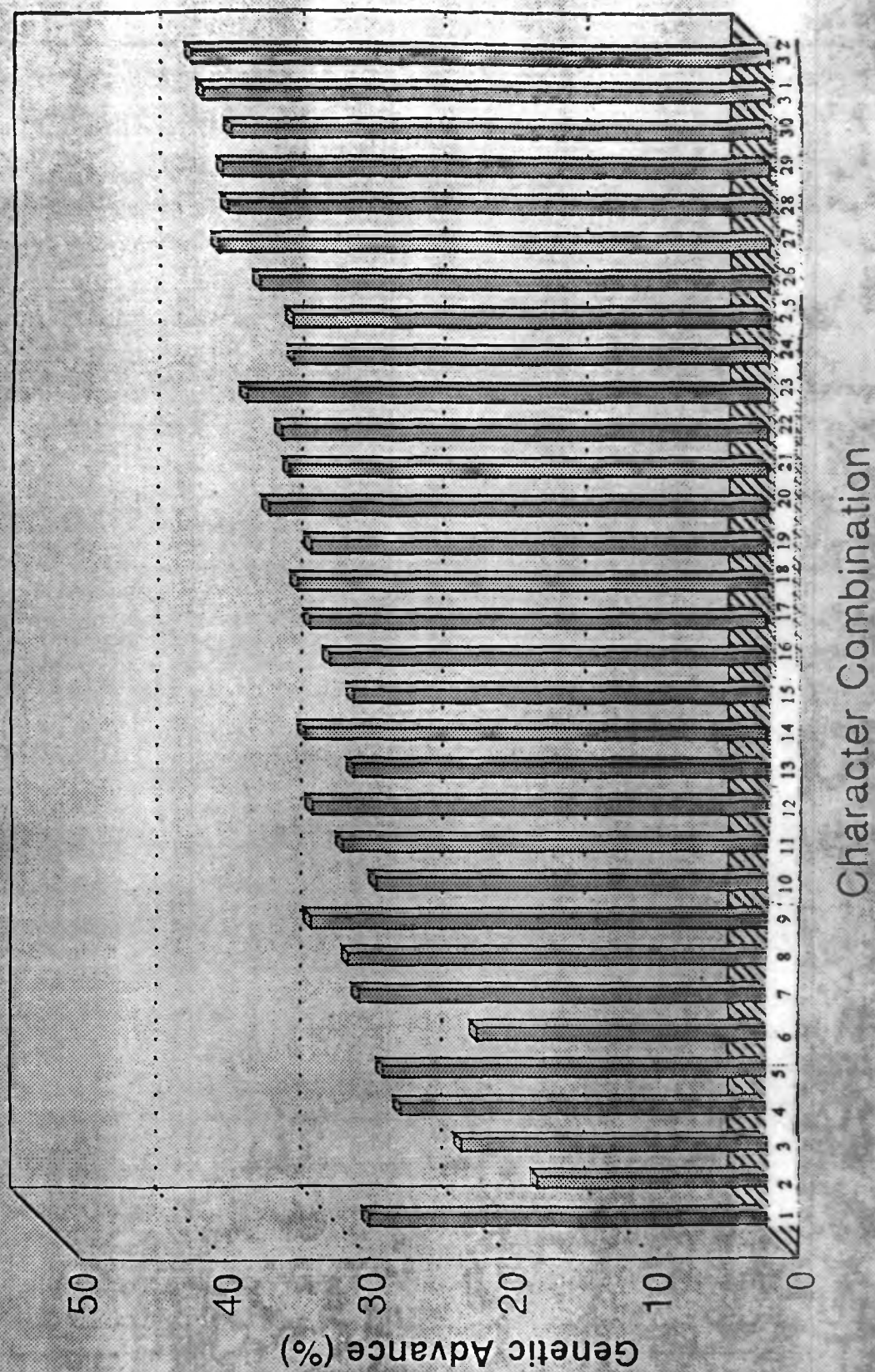


Fig 24. Genetic advance of discriminant functions over straight selection for seed yield in F_3 generation of Cross-III (C30P8 X Madhavi)



Among three characters combination the highest efficiency was noticed for the combination X2+X3+X4 (131.28%). It was followed by X3+X4+X5 (128.44%) and X1+X3+X4 (125.68%). In this combination the least efficiency was observed for the character combination X1+X2+X5 (115.12%).

Among combinations involving four characters the highest efficiency was noticed for X2+X3+X4+X5 (142.56%) followed by X1+X2+X3+X4 (138.76%) and X1+X3+X4+X5 (135.48%). The combination X1+X3+X4+X5 was found to be least efficient.

When all five characters combinations were considered the maximum efficiency was noticed (145.46%) for selection index.

4.5 INTERGENERATION CORRELATIONS AND NARROW SENSE HERITABILITY

Intergeneration correlations and narrow sense heritabilities for each character in all the three crosses are presented in table 26,27 and 28 and illustrated in figure 25 to 30.

4.5.1 Cross - I (R843602 X Madhavi)

All the characters exhibited positive correlation between F_2 and F_3 generations showing the importance of early generation selection. (Table 26 and Figure 25)

The correlation value was highly significant for days to flowering (0.3345), number of capsules per plant (0.5164), days maturity (0.4500) and seed yield per plant (0.5213) and it was significant and positive for number of seeds per capsule (0.2424). For other character it was non significant.

High narrow sense heritability was observed for seed yield per plant (34.33) and rest of the characters it was moderate to low. (Figure 26)

Table 26 : Intergeneration correlation and narrowse heritability for 10 quantitative traits in F₃ generation of Cross-I (R803602 X Madhav)

Characters	Intergeneration correlation	Narrowse Heritability
1. Days to flowering	0.3345**	17.87
2. Plant height	0.1823	7.20
3. No. of primary branches	0.1491	13.33
4. No. of secondary branches	0.0687	6.66
5. No. of capsules per plant	0.5164**	26.67
6. Days to maturity	0.4500**	24.24
7. Capsule length	0.1905	20.00
8. No. of seeds per capsules	0.2424*	13.38
9. 1000 seed weight	0.1791	9.72
10. Seed yield per plant	0.5213**	34.33

** Significant at 1 per cent

* Significant at 5 per cent

Fig. 25. Intergeneration correlations coefficients between F_2 and F_3 generation of Cross-I (R843602 X Madhavi)

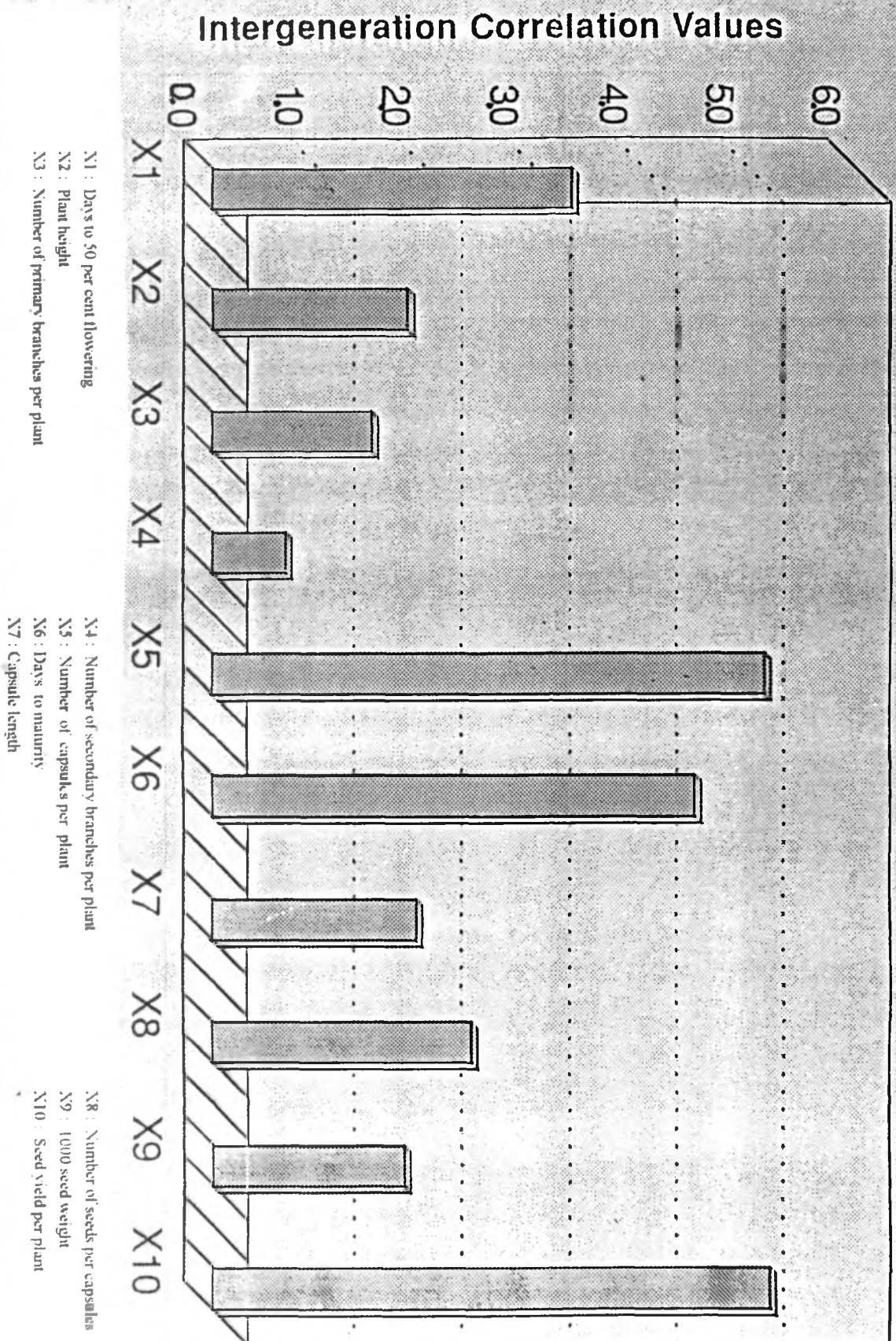


Fig. 26. Narrow-sense heritability for 10 quantitative characters by discriminant function in F₂ generation of Cross-1 (R843602 X Madhavi)

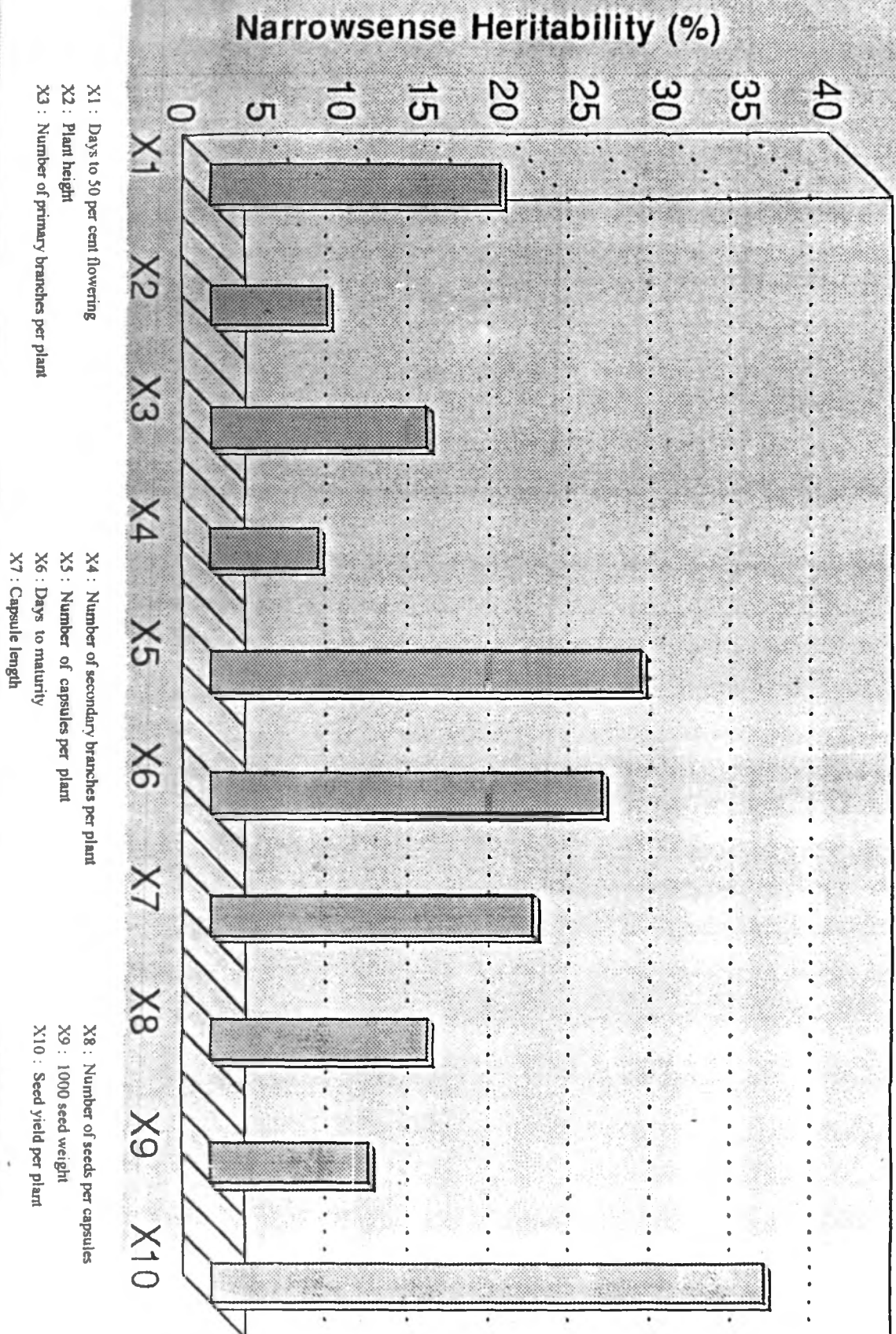


Table 27 : Intergeneration correlation and narrow sense heritability for 10 quantitative traits in Cross-II (DORS102 X Madhavi)

	Characters	Intergeneration correlation	Narrow sense Heritability
1.	Days to flowering	0.3548**	18.19
2.	Plant height	0.4135*	24.23
3.	No. of primary branches	0.2795**	14.25
4.	No. of secondary branches	0.1695	11.58
5.	No. of capsules per plant	0.4536**	47.03
6.	Days to maturity	0.3928*	26.90
7.	Capsule length	0.2248**	19.69
8.	No. of seeds per capsules	0.0792*	6.72
9.	1000 seed weight	0.3241	6.48
10.	Seed yield per plant	0.5246**	20.73

** Significant at 1 per cent

* Significant at 5 per cent

Fig. 27. Intergeneration correlations coefficients between F_2 and F_3 generation of Cross-II (DORS102 X Madhavi)

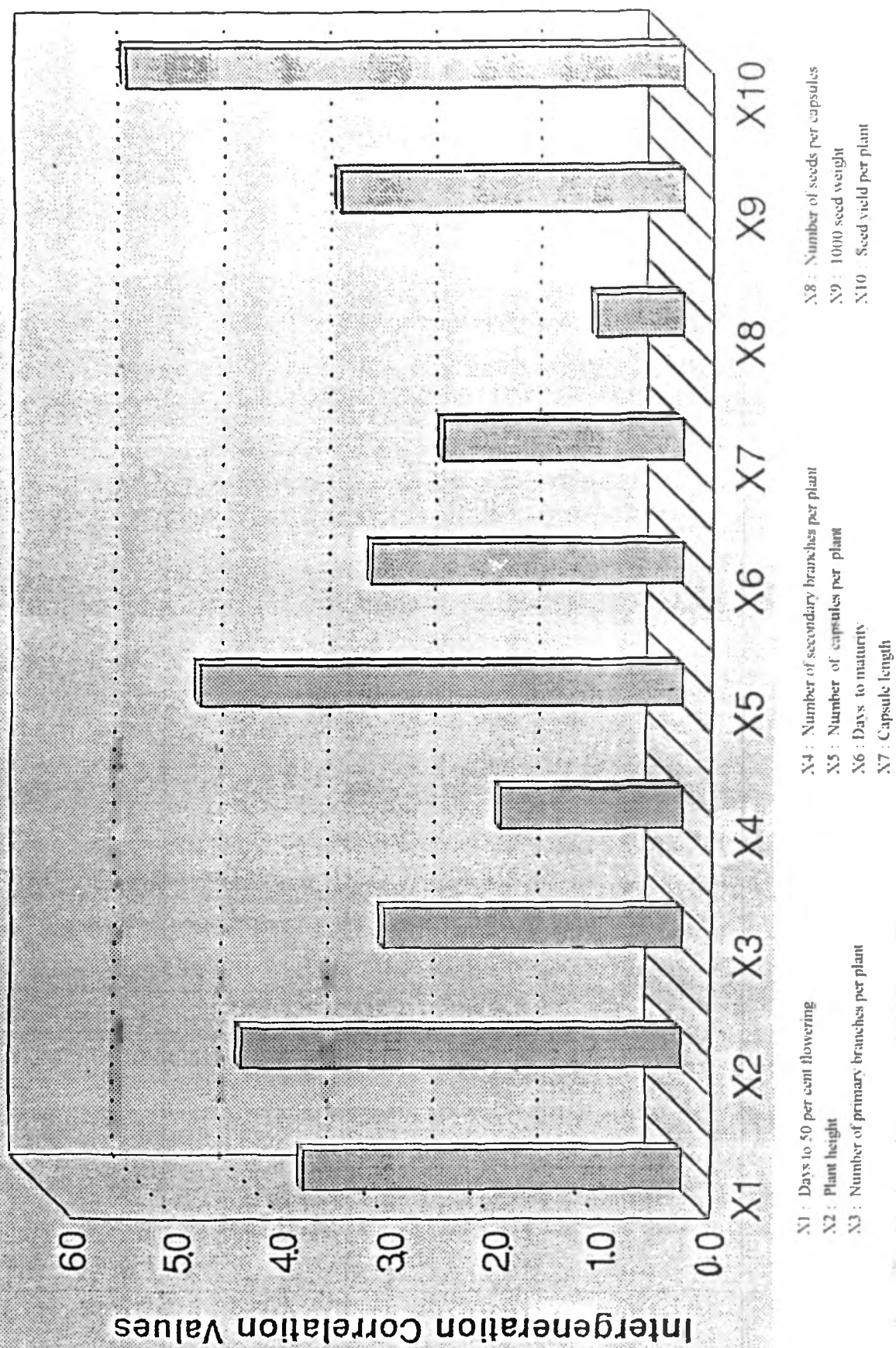
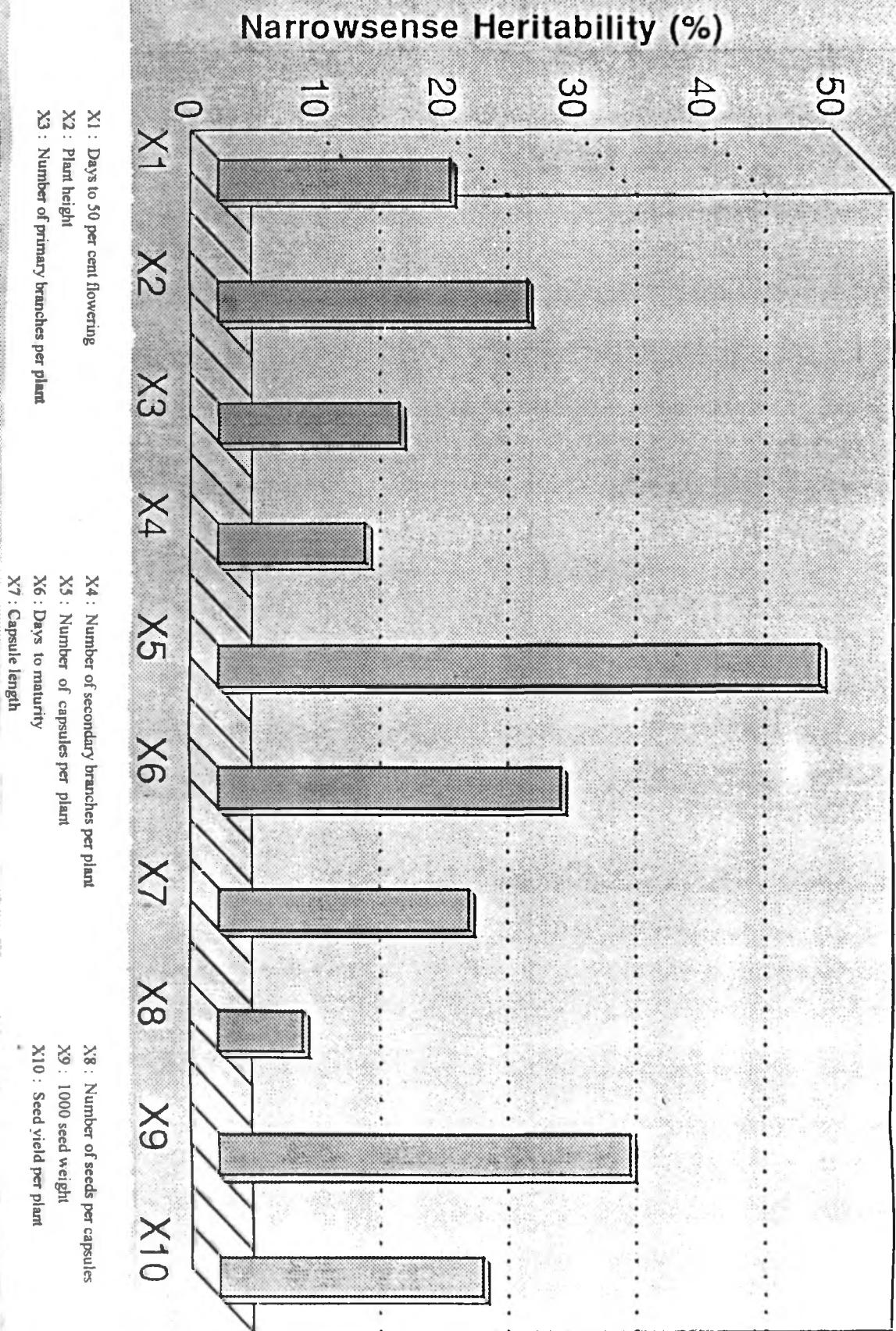


Fig. 28. Narrow sense heritability for 10 quantitative characters by discriminat function in F_3 generation of Cross-II (DORS102 X Madhavi)



4.5.2 Cross - II (DORS102 X Madhavi)

This exhibited positive correlation for all the characters between F_2 and F_3 generations. Highly significant positive correlation was noticed for the characters day to flowering (0.3548), plant height (0.4135), number of capsules per plant (0.4536), 1000 seed weight (0.3241) and for seed yield per plant (0.5246). Further positive significant correlation was also observed for number of primary branches per plant and capsule length. (Table 27 and Figure 27).

High narrow sense heritability was noticed for number of capsules per plant and other characters exhibited moderate to low narrow sense heritability. (Figure 28).

4.5.3 Cross 3 (C30P8 X Madhavi)

In this cross except number of primary branches all other characters showed positive correlation, indicating the good inheritance pattern. Highly significant positive correlation was observed for days to flowering (0.5547), number of capsules per plant (0.4299), capsule length (0.2950) and for yield (0.4671) and significant positive correlation was noticed for days to maturity and number of seeds per capsule. (Table 28 and Figure 29).

High narrow sense heritability was observed for seed yield per plant and moderate for days to flowering, number of capsules per plant and capsule length and rest of the characters exhibited low narrow sense heritability. (Figure 30).

Table 28 : Intergeneration correlation and narrow sense heritability for 10 quantitative traits in F₃ generation of Cross-III (C30P80 X Madhavi)

Characters	Intergeneration correlation	Narrow sense Heritability
1. Days to flowering	0.5547**	26.72
2. Plant height	0.1060	8.58
3. No. of primary branches	-0.0662	--
4. No. of secondary branches	0.1622	13.48
5. No. of capsules per plant	0.4299**	27.02
6. Days to maturity	0.2425*	14.42
7. Capsule length	0.2950**	21.62
8. No. of seeds per capsules	0.2734*	10.80
9. 1000 seed weight	0.0527	6.48
10. Seed yield per plant	0.4671	46.54

** Significant at 1 per cent

* Significant at 5 per cent

Fig. 29. Intergeneration correlations coefficients between F_2 and F_3 generation of Cross-III (C30P8 X Madhavi)

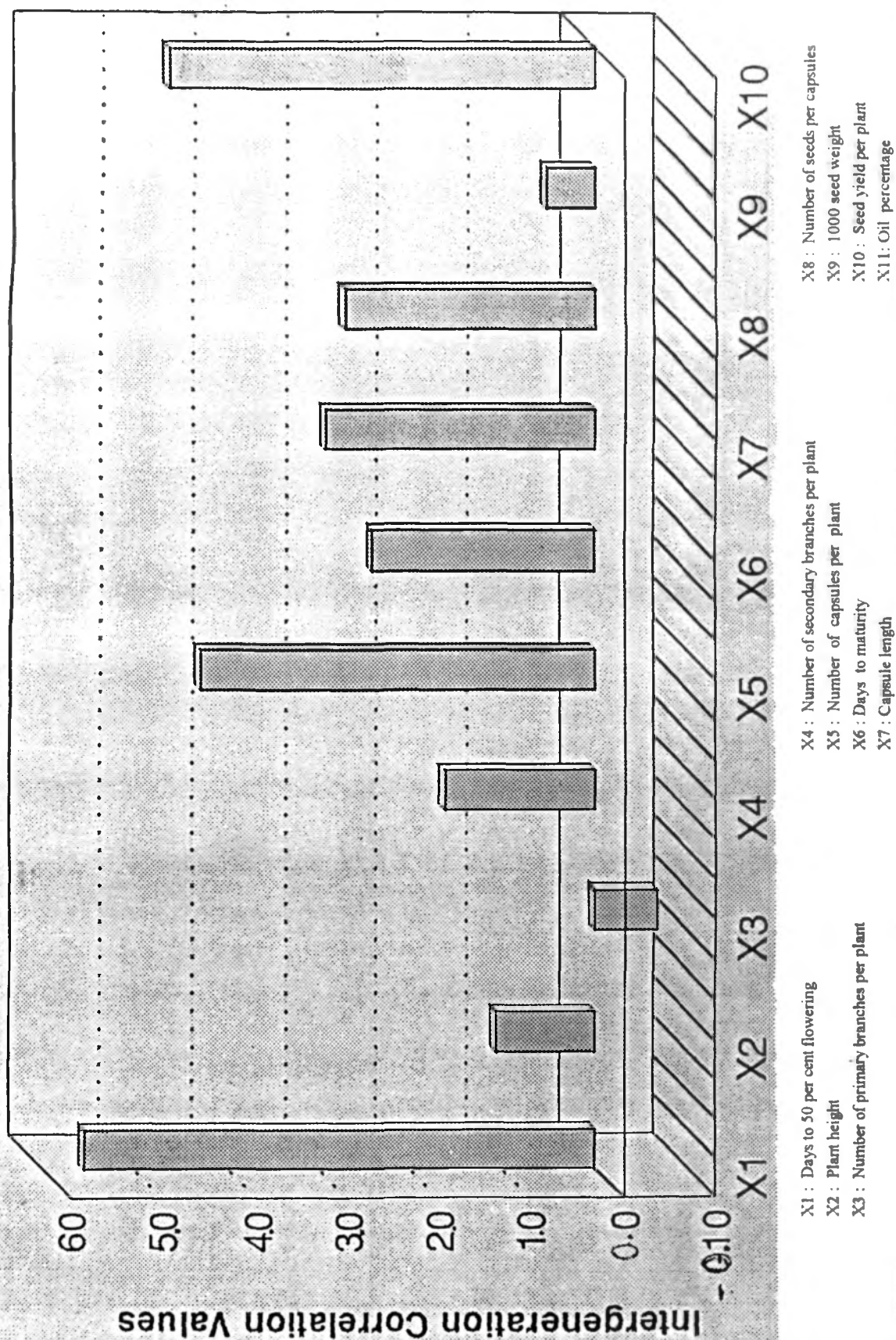
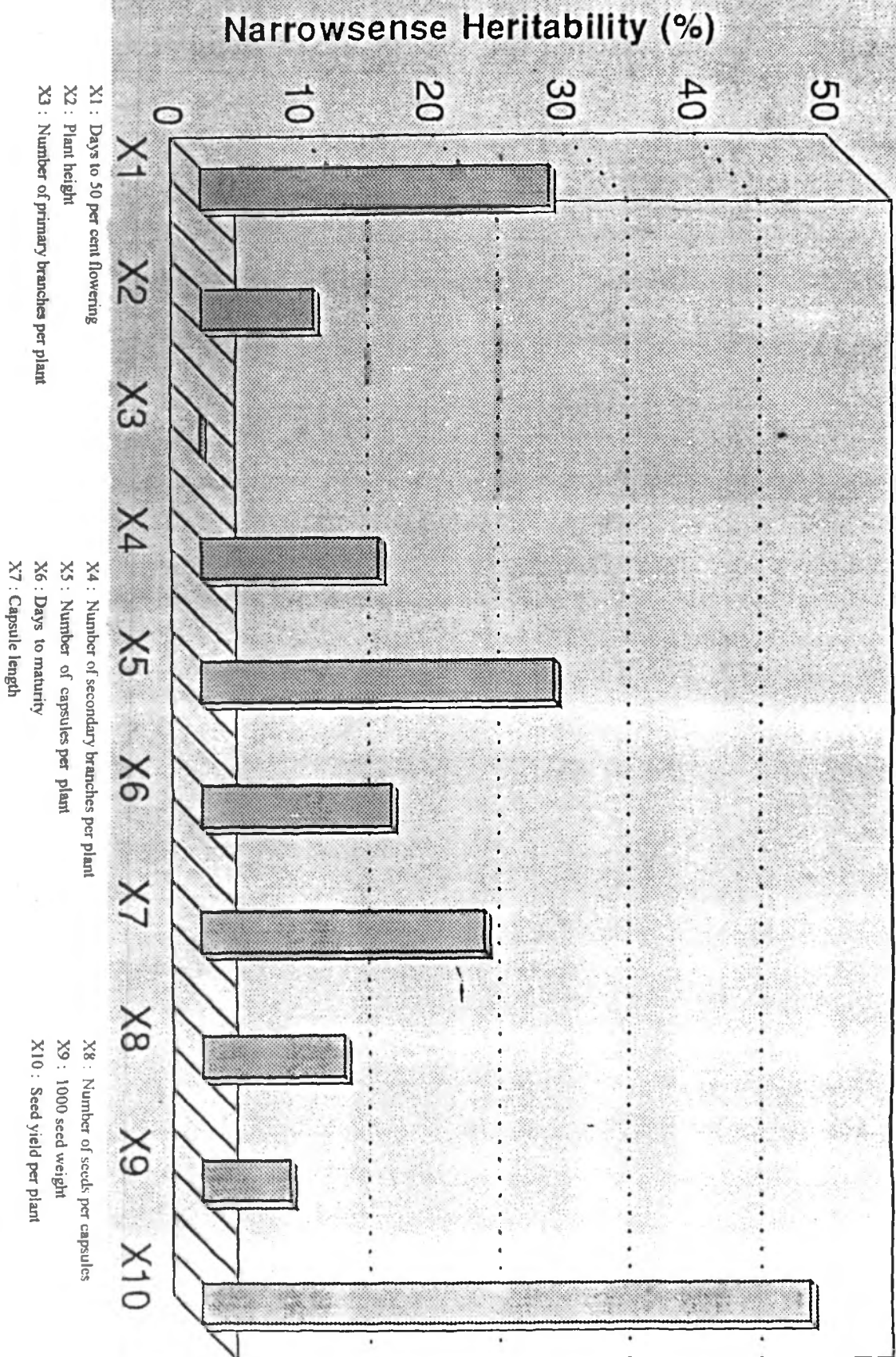


Fig. 30. Narrow-sense heritability for 10 quantitative characters by discriminant function in F_3 generation of Cross-III (C30P8 X Madhavi)



DISCUSSION

V. DISCUSSION

All forms of plant improvement activities through breeding contemplate an eventual boost in genetic potential for yield. Since yield is polygenically controlled and highly influenced by environment, selection based on yield alone is not effective. The breeder, hence, delves into proposition of selecting for yield indirectly through yield-associated and highly heritable characters, after eliminating environmental components of phenotypic variation (Mather 1949).

Estimation of variability in the source population and estimations of important genetic parameters are indispensable in the formulation of breeding schemes that involve indirect selection. Correlation study tests the strength of association of yield components with yield. Path analysis final out the direct and indirect effects on yield by such yield attributing characters. The relative contributions of strongly yield- accretive traits to yield by selecting more than one character at a time is unraveled by comparing the relative efficiencies of selections based on discriminant function constructed using these character combinations, further which identify the superior segregants.

The value of selection in early generation is established by intergeneration correlation, which helps in arriving, at narrow sense heritability. By adopting analytical approaches the present study was contemplated in F_2 and F_3 generations of three crosses in sesame and the results of the study are discussed here.

5.1 Variability, heritability and Genetic Advance

5.1.1. Variability

Variation in the population limits the improvement of a character in the population. Hence assessment of existing variability is very essential in the formulation of objectives in a breeding programme.

In the present investigation, the range of variation was high for all the characters in F_2 as well as in F_3 generation.

The mean days taken to flowering was lowest for Cross - I, followed by Cross - II and Cross - III in both the generation. The mean plant height was highest for Cross - II followed by Cross - III and Cross - I. Cross - III recorded highest mean for number of primary branches per plant in both the generation which was followed by Cross - I and Cross - II. Number of secondary branches recorded highest mean for Cross - II in F_2 generation and Cross - III in F_3 generation which was followed by Cross - III and Cross - I in F_2 generation and Cross - II and Cross - I in F_3 generation. Highest mean for number of capsules per plant was showed by Cross-III in both the generation, followed by Cross - I and Cross - II. Days to maturity recorded highest mean in Cross - I in both the generations which was followed by Cross - III and Cross - II. Highest mean for capsule length was noticed by Cross - III in both the generation followed by Cross - I and Cross - II. Number of seeds per capsule recorded highest mean in Cross - II in both the generation followed by Cross - III and Cross - I. 1000 seed weight and highest mean in Cross - I in F_2 and Cross - III in F_3 generation. It was followed by Cross - II and Cross - III in F_2 generation and Cross - I and Cross - II in F_3 generation. Highest mean seed yield was obtained in Cross - III for both the generation which was followed by Cross - II and Cross - I. Oil percentage recorded highest mean in Cross - I followed by Cross - II and Cross - III in F_3 generation.

These variations definitely accounts by the influence of environmental and genotype X environmental components of variations. Since these variations are not heritable, the interest is to apportion the phenotypic variations in to heritable (genetic) and non heritable (environmental) components. Therefore, the components of variations such as PCV and GCV, heritability and expected genetic advance as percent mean (GAM) were computed for ten charaters in F_2 and for 11 charecters in F_3 generation.

High GCV and PCV values were observed for number of secondary branches in both generation of Cross I and Cross II, but CGV was moderate and PCV was high in F_2 and F_3 of the Cross III. In F_3 generation of Cross - II in both the generations PCV and GCV was high for yield. This is in confirmation with Sawanth (1971), Gupta (1975), Gupta and Gupta (1977), Yadava *et al.* (1980), Rai *et al.* (1981), Shadakshari *et al.* (1984), Kandaswamy *et al.* (1990), Reddy and Dorairaj (1990), Patel *et al.* (1993), Fendel and Penso (1994).

Moderate GCV and PCV was observed for plant height (except in F_3 generation of Cross - III), number of primary branches, number of capsules per plant, 1000 seed weight (only in F_2 generation of Cross - III) and for yield except in Cross II in both the generation.

The characters day to flowering, (except in F_3 generation of Cross I and II), Days to maturity, capsule length (except in Cross II) number of seeds per capsule, 1000 seed weight (except in F_2 generation of Cross - III) and oil percentage (except in Cross - II, where it was moderate) exhibited low PCV and GCV in both the generations of all the crosses. Similar results reported by Krantikumar *et al.* (1979) and Murgesan *et al.* (1988).

The differences between PCV and GCV was not much for days to flowering, plant height, number of capsules, days to maturity, capsule length (except in F_3 generation of Cross-II), number of seeds per capsule (except in F_3 generation of Cross - II), 1000 seed weight (only in F_2 generation of all the crosses), seed yield per plant and oil percentage, indicating that they are less influenced by the environment. On the other hand the PCV and GCV for number primary branches, number of secondary branches, 1000 seed weight in F_3 generation of all the crosses showed wide differences, suggesting considerable amount of environmental influence in the manifestation of these characters. Thus the phenotypic variation was not a realistic one, but a ratio of genotypic and phenotypic variance, which is nothing but heritability.

5.1.2. Heritability and Genetic Advance.

Heritability was found to be high for days to flowering (except in F_3 generation of Cross-1), for plant height (except in F_3 generation of Cross - M) number of capsules per plant, Days to maturity (only in F_2 generation of Cross - I , and Cross - I), capsule length (one in F_2 generation), number of seeds per capsule (except in F_3 generation of Cross - II), 1000 seed weight (in F_2 generation and F_3 generation of Cross - I) and oil percentage. Similar results have been reported by Bhargava and Saxena (1964), Mohanthg and Sinha (1965), Darbal (1967) Darbal and Holenkar (1971), Swanth (1971), Chaudhary et. al. (1977), Parama Shivam and Prasad, (1981), Shivaprakash (1982), Zahn *et al.* (1983), John *et al.* (1993), Patel *et al.* (1993) and Fendel and Penso (1994).

Moderate heritability was observed for plant height, number of primary branches, number of secondary branches in F_2 generation and in F_3 generation except for Cross-I and Cross-II, value for days to maturity, number of seeds per capsule (in F_3 generation only), capsule length in F_3 generation the Cross-II and Cross-I. The results are in conformity with earlier reports of Pathak and Dixit (1986) but contradictory to the results of Chandra Prakash (1983) and Li (1988).

Low heritability was noticed for number of secondary branches per plant in F_3 generation

of Cross - I and Cross - II, capsule length, 1000 seed weight in F₃ generation of Cross - II. This is in confirmation with chandra prakash (1983) and Li (1988).

Heritability estimates represent the relative genetic strength of the characters and indicate the efficiency of selection systems. However their scope is restricted as they are prone to change with change in environment. (Swarup and Chaugle, 1962). Hence the use of heritability coupled with genetic advance is more reliable (Johnson *et al.* 1955) in forming selection procedure.

In the present study high heritability coupled with high genetic advance was noticed for characters seed yield, number of capsules per plant in both the generation of all the crosses, for plant height, and for 1000 seed weight in F₂ generation of all the crosses and for oil percentage in F₃ generation of all crosses, indicating additive gene action. Similar results reported by Gupta and Gupta (1977), Paramashivam and Prasad (1981), Kandaswamy *et al.* (1990), Reddy and Dorairaj (1990) Govindarasu *et al.* (1990), Patel *et al.* (1993), John *et al.* (1993), Fendal and Penso (1994), Mishra *et al.* (1994), Raganatha *et al.* (1994) and Patil and Sheriff (1996).

High Heritability with moderate genetic advance was observed for number of primary branches in F₃ generation for all the crosses. Similar findings were reported by Chavan and Chopda (1982), Li (1988) and Fendal and Penso (1994).

Further high heritability with low genetic advance was observed for characters Days to maturity in F₂ generation of Cross - I and for number of seeds per capsule in F₃ generation of Cross - III, indicating non additive gene action. In the present study high heritability with high genetic advance was noticed for characters plant height, number of capsules per plant, seed yield and oil percentage which indicates the response to selection in positive direction.

5.2 Character Association

It is important to understand the relationship between the two metric traits in the individuals of a population as it would be possible to bring about genetic improvement in one character by selection of other. Grafius (1957) opined that there may not be any gene for yield as such but operate only through its components. Hence, the study of character association will be useful in selecting the yield attributes.

The association between two characters can be ascertained by phenotypic correlations which is determined from measurements of two characters in number of individuals of the segregating population. Sharma and Asaw (1977) opined that the study of character association in segregating generation would be of special importance since more genotypes are available.

In the present investigation, phenotypic correlation between seed yield and some of its component characters were studied and results are discussed below.

Seed yield per plant had highly significant and positive correlation with plant height number of capsules per plant and capsule length. Similar results were also reported by Sikka and Gupta (1949), Khidir and Osman (1970), Dixt (1975), Parama Shivam and Prasad (1980), Chavan and Chopde (1981), Reddy (1984) Ranganatha *et al.* (1985), Ramakrishnan and Sundrapandian ((1992), Biswas and Akbar (1995) and Patil and Sheriff (1996).

It was also noticed that seed yield, per plant was highly significantly and positively correlated with number of primary branches in F_2 generation of Cross-I and $1F_3$ generation of Cross-I and

Cross - II, with days to maturity in F_2 generation of Cross - I and F_3 generation of Cross - I

and Cross - II, with days to maturity in F_2 generation of all crosses and in F_3 generation of Cross - II and Cross - III, with number of seeds per capsule in F_2 generation of Cross - I and Cross - II and in F_3 generation of Cross - I, with 1000 seed weight in F_3 generation of cross - I and Cross - II. This is in confirmation with Gupta and Gupta (1977), Shadakshari (1984) Ranganath (1985), Majumder et al. (1987) and Li (1988), while negative association of seed yield per plant with number seeds per capsule and with 1000 seed weight was reported by Rong and Wu (1989) and Deshmuk and Chavan (1990).

Significant positive correlation of seed yield per plant was noticed with number primary branches per plant in F_2 generation of Cross - II, with number of secondary branches per plant and with days to maturity in F_3 generation cross - I, with number of seeds per Capsule in F_3 generation of Cross - II, and with 1000 seed weight in F_3 generation of Cross - III. This is in confirmation with Sikka and Gupta (1949) Dixit (1975), Gupta and Gupta (1977), Venkatachari (1979), Chavan and Chopde (1981), Shadakshari (1984), Ranganatha (1985), Narkede et al. (1991), Ranganatha et al. (1994), Biswas and Akbar (1995), Mishra (1995) and Patil and Sheriff (1996).

Days to flowering had highly significant negative correlation with yield in F_2 generation of all the crosses and with F_3 generation of Cross - I. This is in contrast to findings of Imbrahim et al. (1983), Shadakshari (1984), and Patil and Sheriff (1996). It also exhibited highly significant negative association with plant height, number of capsules per plant, capsule length and number of seeds per capsule in F_2 generation and F_3 generation (except for capsule length and capsules per plant. in F_3 generation of Cross - II and Cross - III respectively). Similar results reported by

Ibrahim *et al.* (1983), Shadakshari (1984), Patil and Sheriff (1996).

Highly significant positive correlation with days to flowering was observed in F_2 generation of Cross - I, Cross - II, with 1000 seed weight in F_2 generation of Cross - III, with number of seeds and 1000 seed weight in F_3 generation of Cross - II and with number of capsules per plant, and capsule length in F_3 generation of Cross - III.

Plant height recorded highly significant positive correlation with number of capsules per plant, days to maturity, capsule length and seed yield per plant in both the generation (except for number of capsules per plant in Cross - I in F_3 generation). This also true for number of seeds per capsule (except Cross - III) in both the generation. These findings are in confirmation with Sikka and Gupta (1948), Khidir & Osman (1970), Paramshivam and Prasad (1980), Chavan and Chopda (1981), Shadakshari *et al.* (1984), Ramakrishnan and Sundrapandian (1990), Babu and Shivasubramanian (1992), Biswas and Akbar (1995) and Patil and Sheriff (1996). It also exhibited highly significant negative correlation with days to flowering in both the generation for all the crosses (except F_3 generation of Cross - III) and with oil percentage in F_3 generation of Cross - II and Cross - III. Further highly significant positive correlation was also observed with number of primary branches per plant in Cross - III of both the generation and in F_3 generation of Cross-II. Similar results were reported by Shadakshari (1984). Significant positive correlation was noticed for number of secondary branches per plant in Cross - III in F_2 generation and with number of primary branches per plant, number of secondary branches per plant, and with number of capsules per plant in F_3 generation of Cross - I, with 1000 seed weight in F_3 generation of Cross - I and with number of seeds per capsule in F_3 generation of Cross - III.

Number of primary branches showed highly significant positive correlation with seed yield per plant in Cross - I and Cross - II in both the generation, with number of capsules per plant in F_3 generation of Cross - III, with number of Secondary branches in F_2 generation of Cross - I and with plant height in F_3 generation of Cross - III. Such results were also reported by Sikka and Gupta (1949), Dixit (1975), Gupta and Gupta (1977), Chavan and Chopde (1981), Shadakshari (1984), Narkhede *et al.* (1991), Ranganatha *et al.* (1994), Biswas and Akbar (1995), Nfishra (1995) and Patil and Sheriff (1996). Significant positive correlation was noticed with number of capsules per plant in Cross - I, with capsule length in Cross - I in F_2 generation and in F_3 generation, with number of seeds per capsule in Cross - I, with number of capsules per plant, number of seeds per capsule and 1000 seed weight in Cross II and with days to maturity and number of seeds per capsule in Cross - III. This is in agreement with Patil and Sheriff (1996). It was also observed that days to flowering had significant negative correlation with this character in F_3 generation of Cross - III.

Number of secondary branches per plant exhibited significant positive correlation with days to maturity in F_2 generation of Cross - III. with seed yield per plant in of Cross - I and with capsule length of Cross - III in F_3 generation. This is in confirmation with Vanishri *et al.* (1994), Biswas and Akbar (1995) and Patil and Sheriff (1996)

Highly significant positive correlation of number of capsules per plant was observed with seed yield per plant in both the generation for all the cross, with days to maturity, capsule length and number of seeds per capsule in F_2 generation of Cross - I and Cross - II, with plant height (except in Cross - I in F_3 generation), in all the crosses in both the generations with capsule length in F_3 generation Cross - I. Sikka and Gupta (1949), Desai *et al.* (1976), Ibrahim *et al.* (1983),

Capsule length exhibited highly significant positive correlation with plant height in both the generation of all the crosses, with 6 number of capsules per plant in F_2 generation Cross - II and Cross - II and with Cross - III of F_3 generation, with number of seeds per capsule in Cross - I of both the generation and Cross - II, with seed yield in both the generation of all the number of primary branches showed highly significant positive correlation with yield in Cross - I and Cross - II in both the generation and with number of capsules per plant in F_3 generation of Cross - III and with number of Secondary branches in F_2 generation of Cross - III, and with plant height in F_3 generation of Cross - III. Such results are also reported by Dixit (1975), Gupta and Gupta (1977), Chavan and Chopde (1981), Shadakshari (1984), Narkede *et al.* (1991), Biswas and Akbar (1995). Significant positive correlation was with capsule length in Cross - II in F_2 generation and in F_3 generation with number of seeds per capsule in Cross - I, number of capsules per plant, number of seeds per capsule and 1000 seed weight in Cross - II and with days to maturity and number of seeds per capsule in Cross - III. This is in agreement with patil (1993).

Number of seeds per capsule had strong positive association with plant height in Cross - I and Cross - II of both the generation, with number of capsules per plant in F_2 generation of Cross - I and Cross - II and in F_3 generation of Cross - III, with capsule length in F_2 generation of Cross - I and F_3 generations of Cross - I and Cross - II, with 1000 seed weight in F_3 generation of Cross - I, with seed yield per plant in F_2 generation of Cross - I and Cross - II and F_3 generation of Cross - I. Further positive significant correlation was also noticed with capsule length in Cross - II of F_2 generation, number of primary branches per plant in all crosses of F_3 generation, with days to maturity and with 1000 seed weight in Cross - II, with plant height in F_2 generation. These results are in agreement with Gupta and Gupta (1977), Godawath and Gupta (1986), Majumdar *et al.* (1987), Li and Zhang (1991), Narkede *et al.* (1991), Biswas and Akbar (1995) and Patil and Sheriff (1996). However Rong and Wu (1989) reported negative

association between number of seeds per capsule and seed yield per plant. It also showed highly significant negative association with oil percentage in Cross - II of F_3 generation.

1000 seed weight showed highly significant positive correlation with plant height number of seeds per capsule and seed yield per plant of Cross - I, with seed yield per plant in Cross - II and with plant height in Cross - III of F_3 generation only. It had significant positive association with capsule length in Cross - III of F_2 generation, with plant height, number of primary branches per plant, number of capsules per plant capsule length days to maturity and number of seeds per capsules in Cross - III of F_3 generation. While it had negative association with days to flowering in F_2 and F_3 generation of Cross - III and Cross - II respectively. Similar observations were also recorded by Desai et al. (1976), Gupta and Gupta (1977), Rao and Venkatachari (1979) Yadva et al. (1980) Sharma and Chavan (1981), Shadhashari (1984) Li (1988), Lee and Zhag(1991), Vanishri et al. (1994), Biswas and Akbar (1995) and patil and Sheriff (1996), while negative association of 1000 seed weight with seed yield per plant was reported by Rong and Wu (1984), Ibrahim et al. (1986) and Deshmah and Chavan (1990).

Oil percentage recorded highly significant positive association with number of seeds per capsule only in F_3 generation of Cross - III. Desai et al. (1976), Vadhani et al. (1992), Shadhashari (1984), Vanishri et al. (1994) and Chandrashekar and Reddy (1993) observed positive association of oil percentage with number of seeds per capsule. It had highly significant negative association with seed yield per plant in F_3 generation of all the crosses, with plant height number of capsules per plant, capsule length, with number of seeds per capsule in Cross - II and Cross - III and with days to maturity in Cross - II in F_3 generation.

From the present investigation it is clear that character like plant height, number of capsules

per plant, capsule length and number of seed per capsule was highly positively correlated and days to flowering was highly negatively correlated with seed yield per plant and needs to be considered for selection.

5.3 Path Co-efficient analysis.

The path coefficient is simply standardized partial regression coefficient (Wright, 1921). Since yield is a complex character and is influenced by several characters which are mutually associated mere correlation study is not sufficient to reveal the direct and indirect effects of different character on yield. Path coefficient analysis was done for five characters Viz., Days to flowering, plant height, number of capsules per plant, capsule length and number of seeds per capsules which showed consistent correlation with seed yield in both the generation in all the crosses. Days to flowering in F_2 and F_3 had low nonsignificant direct effect and indirect on yield (except in F_2 generation of Cross - III where it had negative significant direct effect) while indirect effect of this through number of seeds per capsule was significant and negative in F_2 generation of Cross - I and Cross - II.

Except Cross - III of F_2 generation plant height exhibited significant positive direct effect on seed yield per plant in all the crosses in both the generation. This is the reason for the significant positive correlation with seed yield per plant. Apart from this, significant indirect effect of plant height capsule length in all the crosses of F_2 generation and via number of seeds per capsule in Cross - II of F_2 generation was noticed. In F_3 generation plant height had significant indirect effect via, number of seeds per capsule, via number of capsules per plant in Cross - II and Cross - III.

The direct effect of number of capsules per plant was positive and significant in F_2 generation of Cross - I and all the crosses in F_3 generation while it was non significant in Cross - II and Cross - III of F_2 generation. It also exhibited significant positive indirect effect via capsule length in both the generation (except in Cross - I and Cross - III of F_3 generation), via number of seeds per capsule in F_2 generation of Cross - I, via plant height in F_3 generation of Cross - II and Cross - III. This shows that selection for number of capsules along with capsule length, number of seeds per capsule and plant height would be effective. similar results are also reported by Gupta (1976) Shadakshari (1984) and Patil and Sheriff (1996).

The direct effect of capsule length was positive and significant in all the cases. Therefore it had highly significant positive correlation with seed yield per plant in all the crosses in both the generations. It also exerted significant positive indirect effect through plant height in Cross - I and Cross - II in F_2 generations in Cross - I and Cross - III in F_3 generation, through number of capsules per plant and number of seeds per capsules in Cross - I of F_2 generation, and with number of seeds per capsule in F_3 generation of Cross - I. This was in contrast to findings of Gupta and Gupta (1977), and in agreement with Chavan and Chopda (1981).

Number of seeds per capsule had significant positive direct effect on seed yield in F_2 generation of Cross - I and Cross - II and Cross - I of F_3 generation and it was non significant in rest of the cases. Similar results were reported by Bhele et al. (1987) and Majumdar et al. (1987). Number of seeds per capsules also exerted positive indirect effect on seed yield through plant height and number of capsules per plant in F_2 generation of Cross - I. It had significant negative indirect effect through number of capsules per plant in Cross - II and Cross - III in F_3 generation on seed yield per plant.

From the above study it was observed that the highest direct effect on seed yield per plant was exerted by capsule length followed by number of seeds per capsule, number of capsules per plant and plant height. This is agreement with the findings of Phandis *et al.* (1970), Ekbote and Tayyab (1974), Kaushal *et al.* (1974), Sanjeevaiah and Joshi (1974), Gupta and Gupta (1977) Yadava *et al.* (1980), Chavan and Chopde (1981), Thangavelu and Rajashekaran (1983), Reddy *et al.* (1984), Shadakshari (1984), Bhele *et al.* (1987), Mujamdar *et al.* (1987), Rong and Wu (1989), Reddy and Haripriya (1991) and Patil and Sheriff (1996).

5.4 Selection Indices

After unraveling the intricates of yield and yield associated characters to study the cause and effects, discriminant functions were constructed for highly yield accretive characters to determine the combination of characters that would give the best yield. Given the limitation of selecting for more than one character at a time, the combination also included single, two, three, four and five characters in conjunction. Smith (1936) opined that selection indices provide the means for making use of correlated characters for higher efficiency in selecting for yield.

Mahadevappa and Ponnaiya (1965) constructed a discriminant function for yield in finger millet but its efficiency was not worked out. The present study was undertaken to evaluate selection indices for seed yield and test the relative efficiency.

In this study, five highly yield accretive characters viz., Plant height, number of capsules per plant, capsule length, number of seeds per capsule and 1000 seed weight were considered in Cross - I and Cross - II. In Cross - III instead of number of seeds per capsule days to maturity was considered. Seed yield was considered as dependent variable.

Among single character selection indices, the best selection index was found to be 1 000 seed weight in Cross - I and Cross - II. This is in confirmation with Nie *et al.* (1991) in Safflower and Venkatesh Bhat and Sheriff (1994) in finger millet. In Cross - III the best selection index was for capsule length.

For each additional character up to five the efficiency of the selection indices increased.

Among all the discriminant functions for selection, a combination of five characters recorded highest relative efficiency in Cross - II and Cross - III, but Cross - I showed less efficiency than direct selection for yield alone. This is in agreement with Dhagat *et al.* (1973), Sandhu *et al.* (1974), in finger millet, Nandan and Pandya (1980) in Lentil, Reddy (1984) in little millet, Lee and Chang (1986) in sesamum, Abraham and Borthakar (1987) in fox tail millet, Basavaraja and Sheriff (1992), in finger millet, Milaland and Varma (1991), Mathur and Gupta (1992) in niger, Thirthamallappa and Sheriff (1992) in Kenaf, Venkatesh Bhatt and Sheriff (1994) in finger millet. In Cross - I the selection index for the combination of 5 characters was found to be less efficient than direct selection for yield alone. Similar findings were reported by Sing and Dalal (1980) in soyabean, Mathur and Gupta (1992) in niger.

In the present study genetic advance using discriminant functions was very less in all the crosses, which is due to high environmental influence. From these results it could be concluded that the selection criterion based on plant height, number of capsules per plant, number of seeds per capsule, capsule length and 1000 seed weight would be effective in increasing the seed yield in sesame.

5.5 Intergeneration correlation and Narrow sense heritability.

The value of early generation selection is tested by intergeneration correlation and narrow sense heritability. High mean and high heritability is the main criterion for selection in segregating F₂ generation. However elimination of environmental variance and eliminating the genetic variance that is being inherited down from F₂ to F₃ generation by parent-off spring regression helps in knowing the nature of inheritance and possible selections. The bearing that F₂ has on F₃ which is referred as real genetic potential is more realistic estimate than the individual value of parents. Like that heritability estimates serve as an important guide in exercising selection in different populations (Burton, 1952).

The present study indicated that high positive significant intergeneration correlations for days to flowering, number of capsules per plant and seed yield per plant in all the crosses, for Days to maturity in Cross - I, for plant height and 1000 seed weight in Cross - II, and for capsule length in Cross - III. This is in confirmation with Mahmud and Kramer (1957) in soyabean. Ravikumar (1988) obtained significant positive correlation for plant height and number of fingers in finger millet, Basavaraja (1990), obtained highly significant positive correlation for plant height and length of ear in finger millet but both reported nonsignificant inter generation correlation for grain yield. However Bhat (1991) in finger millet reported highly significant positive inter generation correlation for grain yield per plant and total ear weight. The present findings were in contrast with Anand and torrie (1963) in Soybean, Briggs and Shebeski (1971), Knott and Kramar (1975) in wheat and Virupakshappa (1982) in cowpea and Gupta et al. (1988) in foxtail millet. The present study also indicated the additive gene action.

Significant positive correlation was noticed for number of seeds per capsule in Cross - I, for number of primary branches per plant and capsule length in Cross -II, for days to maturity and number of seeds per capsule in Cross - III. Ravikumar (1988) in foxtail millet, Basavaraja (1990) in finger millet and Venkatesh Bhatt (1991) reported similar findings for the length of the ear and number of fingers per plant. Ranganatha *et al.* 1994 reported significant intergeneration correlation for days to maturity in sesame.

High narrow sense heritability was observed for seed yield per plant in Cross - I and Cross - III, for number of capsule in Cross - II. This is in accordance with Mohammed and kramer (1951) while in contrast to the findings of Ravikumar (1988) and Shantakumar (1988) in foxtail millet. Basavaraja (1990) reported high heritability for number of productive tillers per plant, plant height and number of finger per tillers in finger millet, and Ranganatha *et al.* 1994) in sesame

From these findings it could be concluded that selection for seed yield, number of capsular per plant is effective. It could also be concluded that these characters are controlled by additive genes which was found by Mahamud I and Kramer (1951) Ravikumar (1988), Shantappa (1988) and Venkatesh Bhat (1990), but in contrast to findings of and Basavaraja (1991).

From the present study it was revealed that indirect selection for plants which are early flowering, tall stature with more number of capsules per plant with lengthy capsules and more number of seeds per capsules would increase the yield potential of sesame. It was also found simultaneous improvement of yield and oil percentage is not possible, since they were found to be negatively correlated to each other. The present promising line in F_2 lines could be further evaluated to get high yielding sesame varieties.

SUMMARY

VI SUMMARY

The F_2 and F_3 generations of three sesame crosses viz., R 843602 X Madhavi, DORS 102 X Madhavi and C30P8 X Madhavi were studied for variability in different quantitative characters, phenotypic correlation between yield and yield accretive characters, the direct and indirect contributions of yield - accretive components to yield, formulation of selection indices for yield in F_3 generation and Intergeneration correlation and narrow sense heritability.

The F_2 and F_3 generations of the above mentioned crosses were grown at G.K.V.K. farm, University of Agricultural Sciences, Bangalore, during Kharief 1995 and Summer 1996, respectively. The observations were recorded on ten metric traits in F_2 generation and on 11 traits in F_3 generation, viz., days to flowering, plant height, number of primary branches per plant, number of secondary branches per plant, number of capsules per plant, days to maturity, capsule length, number of seeds per capsule, 1000 seed weight, seed yield per plant and oil percentage (which studied only in F_3 generation). These observations were recorded on 110 random plants in F_2 and considering lines were in the range of mean of F_2 plus and minus one standard deviation in respect to yield were considered. The important findings are summarised below.

Analysis of variance was highly significant for all the characters in F_3 generation. the range for different characters was high in both the generations. The genotypic and phenotypic coefficient of variation (GCV and PCV) were high for yield and number of secondary branches per plant. High PCV was noticed for capsule length. Moderate GCV and PCV was noticed for plant height, number of primary branches per plant, number of capsules per plant and 1000 seed weight. Low GCV and PCV was observed for days to flowering, days to maturity, number of seeds per capsule and oil percentage.

High heritability coupled with high genetic advance was observed for seed yield per plant, plant height, number of seeds per capsule, 1000 seed weight and for number of capsules per plant which suggests that these characters are controlled by additive genes.

Correlation study indicated that high positive correlation of seed yield per plant was observed with plant height, number of capsules per plant, capsule length, number of seeds per capsule in almost all the crosses in both the generations. Days to flowering recorded highly significant negative correlation with seed yield per plant. In majority of cases 1000 seed weight and number of secondary branches per plant exhibited non significant correlation with seed yield per plant.

Phenotypic path coefficient analysis revealed that the highest direct effect on seed yield per plant was exerted by number of seeds per capsule in Cross - I, in both the generation and Cross - II in F_2 generation and by capsule length in Cross - II in both the generation and in Cross - III in F_3 generation. Other characters which showed significant correlation with seed yield per plant had either significant direct effect or indirect effect through other characters.

Discriminant function analysis in F_3 generations revealed that combination of characters plant height, number of capsule per plant, capsule length, number of seeds per capsule, and 1000 seed weight in Cross - I and Cross - II and by replacing number of seeds per capsule with days to maturity in Cross - III was highly efficient for the indirect selection for higher seed yield in sesame.

Intergeneration correlation indicated that high positive intergeneration correlation for days to flowering, number of capsules per plant and for seed yield per plant for all the crosses and for days to maturity in Cross - I, for plant height and 1000 seed weight in Cross - II and for capsule length in Cross - III. This suggests that these characters could be considered for selection in early generation for improving the yield.

Narrow sense heritability was high for seed yield per plant in Cross - I and Cross - III for number of capsules per plant in Cross - II. It was found that among three crosses, Cross - III was high yielding compared to other two crosses. But the Cross - I recorded highest Oil percentage among three Crosses. Cross - II recorded moderate yield and moderate oil percentage.

From the present investigation it could be concluded that adoption of indirect selection in segregating populations in sesame be based on related component traits particularly days to flowering, plant height, number of capsules per plant, capsule length, number of seeds per capsule and direct selection in early generation for yield was found to be effective.

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*Originals not seen.

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