# GENOTYPE X ENVIRONMENT INTERACTION FOR YIELD AND ITS COMPONENTS IN SESAMUM

BY

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THESIS

SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENT
FOR THE DEGREE OF
MASTER OF SCIENCE IN AGRICULTURE
FACULTY OF AGRICULTURE
KERALA AGRICULTURAL UNIVERSITY

DEPARTMENT OF PLANT BREEDING
COLLEGE OF AGRICULTURE
VELLAYANI, TRIVANDRUM

1984

## DECLARATION

I hereby declare that this thesis entitled "Genotype x Environment interaction for yield and its components in sesamum", is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship, or other similar title of any other University or Society.

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Vellayani,
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CERTIFICATE

Certified that this thesis, entitled "Genotype x Environment interaction for yield and its components in sesamum" is a record of research work done independently by Kum. GEETHA, P., under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to her.

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ACKNOWLEDGEMENT

I extend my sincere gratitude to Dr.V. Gopinathan Nair, Professor and Head of the Department of Plant Breeding, and Chairman of my Advisory Committee for suggesting the research problem, expert guidance, constant inspiration and encouragement throughout the attempt and in the preparation of this thesis.

I am indebted to Shri. K. Gopakumar, Associate Professor of Plant Breeding, Shri. R. Balakrishnan Asan, Assistant Professor of Statistics and Smt. S. Santhakumari, Associate Professor, Rice Research Station, Kayamkulam, members of my Advisory Committee for their valuable help in carrying out the programme.

I am also highly thankful to Shri.K. Balakrishna Pillai, Associate Professor of Entomology, Rice Research Station, Kayamkulam, for permitting me to carry out the experiment at the Station. I also thank the Kerala Agricultural University for awarding me the fellowship.

Finally, I wish to acknowledge gratefully, the help extended to me by the staff and students of the Department of Plant Breeding.

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# INTRODUCTION

# INTRODUCTION

Sesamum (Sesamum indicum L.) is an important and ancient oil yielding species cultivated extensively in India, Burma, Indochina, China, Japan, the hotter and drier parts of Africa and the Mediterranean region. In the recent years, its cultivation has been receiving much attention in the U.S.A., Mexico and parts of Latin America. Sesamum is grown for its seed and the oil it contains. The seed is high in oil content (50 to 60%) but low in protein (25%). It is rich in calcium, phosphorus and vitamin E and is highly nutritious. The oil is highly stable (Nair and Mehra, 1970).

In India, sesamum is grown in an area of 2.4 million hectares producing nearly 0.5 million tonnes of seed every year. India stands second in sesamum seed production with 24.6 per cent of the world's total production. It is grown in the central states both as kharif and rabi crop. Sesamum is also the most important annual oilseed crop of Kerala, grown in an area of 17500 hectares yielding 4700 tonnes of seed per year. It is cultivated in wetlands during summer (January to April) and in uplands during rabi (August to December).

Lack of high yielding varieties suited to the different soil types and seasons is the main factor limiting the production of sesamum in this State. Kayamkulam-1 and Kayamkulam-2 are the two improved varieties already released for cultivation. Kayamkulam-1 is single poded and four loculed whereas Kayamkulam-2 is multipoded and four loculed. Types of sesamum with multipoded and multiloculed conditions have already been identified, at the Department of Plant Breeding, College of Agriculture, Vellayani. The increased seed production potential of these types over the single poded and four loculed varieties have also been recognised. Preliminary evaluation to assess the production potential of these types has indicated that the multiloculed types give higher seed yield than the others.

The present study has been undertaken to make a more detailed evaluation of the types for their productivity under rice fallow and upland conditions. This will enable the identification of high yielding varieties suited to both the locations. Moreover, evaluation during the different seasons at the two locations will enable an estimation of genotype x environment interaction of these types and their phenotypic stability under diverse soil types and seasonal conditions. An estimation of genotypic and phenotypic correlations between seed yield and its components and also between the different morphological characters is also attempted. This will enable the selection for yield based on component and correlated characters and the identification of superior varieties of high stability.

# REVIEW OF LITERATURE

## REVIEW OF LITERATURE

Seed yield in sesamum is a polygenic trait. Direct selection for this character may therefore be often misleading. The components that determine the yield are the best indices. The more important components of seed yield are the number of pods per plant, number of pods per axil, number of locules per pod, number of seeds per pod and weight of thousand seeds. Therefore a knowledge of the association between the important morphological attributes and seed yield shall help in identifying promising varieties. Such associations may be controlled either genetically or by various environmental factors. Grafius (1959) suggested that there may not be genes for yield *per se* but will be for the various components, the multiplicative interaction of which results in the manifestation of yield. Langham (1960) reported that the examination of numerous varieties in Venezuela has revealed the occurrence of sufficient genetic variability to make it possible to develop lines suited to different commercial requirements.

I. Variability and correlation.

A wide range of variability is available in sesamum. This can be exploited through selection for development of new superior varieties. A detailed description of the works already done on the assessment of variability for the important characters in sesamum and the correlation of characters with yield, is presented below.

1. <u>Duration upto flowering</u>.

Shrivas and Kaushal (1972) reported that the plant habit and number of days to flowering are variable and depend on the soil type. Highly significant differences for the number of days to flowering was observed by Trehan et al.(1975 b). Shukla and Verma (1976) reported that the genotypic coefficient of variability was low for this character while heritability and coheritability were high and that early flowering types could be selected for rainfed areas. Yadava et al. (1980) reported high phenotypic variability for number of days to first flowering and 50 per cent flowering. They concluded that the number of days to 50 per cent flowering had high direct effects on seed yield. Mohanty and Sinha (1965) reported low heritability for duration upto flowering. Sawant (1971) observed high heritability associated with high genetic advance for number of days to flower initiation and number of days to first fruit development. In a genetic variability study, Chaudhary et al. (1977) reported that number of days to initial flowering and 50 per cent flowering were highly heritable and under the control of additive gene action. Dixit (1976) in a study of the inheritance of yield and its components found that both additive and dominance effects were important for days to flowering. In the same study he further reported that the epistatic gene action was also important for this character.

Khidir and Osman (1970) in a correlation study in 90 sudanese cultivars reported that seed yield per plant was not positively correlated with time to flowering. Osman and Khidir (1974) reported high positive correlation between seed yield and number of days to flowering. But Naphade and Kolte (1974/1975) and Dixit (1975) reported negative correlation between seed yield and number of days to flowering. Shukla and Verma (1976) reported negative genotypic, phenotypic and environmental correlations between days to 50 per cent flowering and seed yield. Positive correlations between seed yield per plant and number of days to first flowering and 50 per cent flowering were also reported by Chaudhary et al. (1977). In a study of correlation and path analysis of yield components in 82 $M_2$ progenies obtained by Gamma irradiation of the varieties 58-2, 85 and D7-11-1, Chauan and Chopde (1981) revealed strong phenotypic and genotypic correlations between seed yield per plant and number of days to 50 per cent flowering and also that genotypic correlation was higher than phenotypic correlation.

2. <u>Duration upto maturity.</u>

In a variability study of sesame in Rajasthan, Kumar et al. (1967) found that the number of days to maturity was the least variable character. Poehlman and Borthakur (1969) have reported that varieties of sesame vary in their maturity period from 80 to 150 days and that early maturing varieties are preferred if yields are not adversely affected by the earliness. They have also reported that earliness and lateness are controlled by a single pair of genes. Trehan et al. (1975 b) reported highly significant difference for growth period among different varieties. Yadava et al. (1980) observed high phenotypic variability for number of days to maturity, in a study of nine characters in 22 Sesamum indicum forms in Haryana. In a variability and heritability study on yield and its components in 25 varieties of sesamum grown during the rainy season, Solanki and Paliwal (1981) found that the genotypic and phenotypic variances were high for number of days to maturity. High heritability combined with high genetic advance indicated additive gene action.

Anides (1963) reported that number of days to maturity and seed yield are positively correlated. Khidir and Osman (1970) reported that seed yield per plant was not correlated with maturity. Osman and Khidir (1974) on the other hand reported that the number of days to maturity and seed yield are positively correlated. Kaushal et al. (1969) in a study to determine the oil content at various stages of maturity found that harvesting sesamum plants when the capsules had turned yellow and the leaves had dropped gave the highest (53.4 per cent) seed oil content.

The oil analysis report on the world sesame collection in U.S.A. showed that early plants had a higher oil content than mid-season and late plants (Anon. 1972). The report also showed that earliness, yellow seeds and large seeds were correlated with lower iodine values and earliness and yellow seeds were correlated with high oleic and low linoleic acid contents. Baradi (1972) observed that the dwarf single stemmed varieties usually mature earlier than the tall branched ones.

Rheenen (1981 d) from studies of the cross Yandev 55 x X30/115 calculated that by early picking of capsules the next growth cycle (generation) could be advanced by two to three weeks and for early maturing material this could shorten the cycle by 16 to 25 per cent. Narayanan and Reddy (1982) in a field comparison between early and late varieties during a monsoon season, observed that early varieties were shorter than late ones. Leaf senescence was faster towards maturity in early varieties than late ones. Late varieties produced more root, leaf and stem dry matter, while early ones produced a higher proportion of reproductive parts.

3. Height of plants.

Ram (1930) in a study of 30 types of sesamum from an all India collection reported that the various types differed in height. Hiltebrandt (1932) found that the average plant height in sesamum was 100 to 200 cm. According to him the maximum height was observed in late, many branched forms. Trehan et al. (1975 b) reported that various types of sesamum differed in height. Yadava et al. (1980) reported high phenotypic variability for this character. According to Dabral (1967), plant height had high heritability value. Muhammad et al. (1970 b) in an attempt for determining the relationship between yield and its components in sesamum, observed that the dispersion of values for this character varied widely with varieties and the range of variation was 50.6 to 72.9 cm. Sawant (1971) observed high heritability associated with high genetic advance for plant height. Chaudhary et al. (1977) reported that plant height was highly heritable and under the control of additive gene action. They also observed that the tall varieties gave higher yields than the dwarf varieties. Dixit (1976) observed that both additive and dominance effects were important for length of the main fruiting branch.

Positive correlation between height of plant and seed yield was reported by Angarita (1962) and Dabral (1967). Positive correlation of seed yield per plant with stem height was also reported by Khidir and Osman (1970). EL Nadi and Lazim (1974) and Kaushal et al. (1974) reported significant and positive correlation between seed yield and height of main stem. Ekbote and Tayyab (1974), Naphade and Kolte (1974/1975) and Dixit (1975) on the other hand reported negative correlation between seed yield and plant height. Sanjeevaiah and Joshi (1974) reported that environment had little effect on plant height. They found positive genotypic correlation between plant height and number of nodes on main branch followed by plant height and number of main branches. Delgado and Yermanos (1975) reported significant positive correlation between seed yield per unit area and plant height. Gupta (1976) also reported positive correlation of seed yield with height of plants and height of fruit bearing branches. Murugesan et al. (1979 b) reported negative phenotypic correlation of plant yield with height at which first capsule is formed. Paramasivam and Prasad (1980) and Chauan and Chopde (1981) also reported positive correlation of seed yield with plant height. Oil analysis report on the world sesame collection in U.S.A. showed that short plants had clear oil while tall plants had light green oil (Anon. 1972).

4. Number of pods per axil.

Sesamum pods vary in their number in each leaf axil.

Joshi (1961) reported that depending on the number of flowers in each axil, the number of pods may be one to three in different varieties. Those types which bear three flowers in each axil may develop only one or two pods instead of all the three under unfavourable growing conditions, like crowding, drought, deficiency of nutrients etc. When flowers are borne singly the two laterals are seen as rudimentary buds at the base of the flower. Presence of four or five pods per axil in certain cases was also reported by Langham (1945).

Single poded type is dominant over multipoded type with monogenic inheritance (Pal, 1934; Langham, 1945; Sikka and Gupta, 1948; Culp, 1960; John, 1980). Multipoded types are preferred over the single poded types as they produce more number of pods per unit length of the stem. Ram (1930) found an association between the number of locules per pod and number of pods per axil. Eight loculed pods were invariably borne singly in leaf axils and four loculed pods occurred either singly or in groups of two or three in an axil. Gupta and Gupta (1977) reported that number of pods per axil and yield showed high heritability estimates combined with a high genotypic coefficient of variation and a high expected genetic advance. Number of pods per axil was one of the most effective characters for selection.

Kobayashi (1981) classified about 24 types of sesamum on the basis of phyllotaxis, nectary number per axil, carpel number per capsule and capsule number per axil. Advanced types with three capsules per axil, no nectaries, opposite phyllotaxis and two or four carpels are considered most appropriate for seed production. Rheenen (1981 a) reported that the three capsules per leaf axil character had no yield advantage in a composite population, developed by intercrossing lines with different capsule numbers, through 11 generations. He concluded that the character has a neutral or near neutral effect on yield.

5. Number of pods per plant.

Number of pods per plant was described as one of the main yield contributing characters. Hiltebrandt (1932) reported that the number of pods per plant vary from 40 to 400. Kumar et al. (1967) in a variability study in sesame reported the number of capsules on the main shoot as the most variable quantitative character studied. Gupta (1975) observed high genotypic coefficient of variation for capsules per plant. Shukla and Verma (1976) in a correlation and heritability study in 28 sesame genotypes observed that the genotypic coefficient of variation was low for the number of capsules per main branch while heritability and co-heritability were high. Solanki and Paliwal (1981) in a study of 25 varieties of sesamum grown during the rainy season found that the genotypic and phenotypic variances were high for number of capsules per plant. In the same study they also observed that high heritability combined with high genetic advance for the number of capsules per plant indicated additive gene action. The high genetic advance indicated that number of capsules per plant can be increased through selection. Mohanty and Sinha (1965) found that the number of pods per plant was highly heritable and therefore can be depended upon for selection. High heritability and high genetic advance were also reported by Paramasivam and Prasad (1981).

Dabral (1967) in a variability and correlation study of 25 selections of Sesamum orientale. L observed that yield was positively correlated with number of capsules. Number of pods per plant was identified as the major component of seed yield per plant by numerous other workers (Asthana and Rai, 1970; Dixit, 1974, 1975 ; Kaushal et al. 1974; Osman and Khidir, 1974; Shukla and Verma, 1976; Gupta and Gupta, 1977; Murugesan et al. 1979 b; Paramasivam and Prasad, 1980; Yadava et al. 1980; Chauan and Chopde, 1981; Rai et al. 1981). Sanjeevaiah and Joshi (1974) reported that the seed yield was highly correlated with number of pods on the main stem. Delgado and Yermanos (1975) reported that seed yield per unit area was positively correlated with number of capsules per plant. Shukla and Verma (1976) reported significant and positive phenotypic and environmental correlation values between yield and number of pods per main branch and number of pods per plant.

6. Length of pod.

Pods in sesamum vary much in their size and length. Hiltebrandt (1932) observed that the average length and width of the pod to be 4.1 and 0.9 cm respectively. The variation in the length of pods in relation to its position to stem was found to be inconsiderable. Lopez and Mazzani

(1964) reported significant difference for the length of pod and also observed a correlation between pod length and number of seeds. According to Purseglove (1968) average length and width of pod are 3 and 1 cm respectively. Wide range of variability for this character was also reported by Debral and Holker (1971), Trehan et al. (1975 b) and Paramasivam and Prasad (1981). Murugesan et al. (1979 a) observed that the genotypic and phenotypic coefficients of variation were very low for capsule length. High heritability for capsule length was reported by Solanki and Paliwal (1981). Rheenen (1981 b) observed that the long capsule character had no yield advantage in a composite population developed by intercrossing lines with different capsule lengths through 11 generations.

A significant positive correlation between seed yield and pod length was observed by many workers (Phadnis et al. 1970; Khidir and Osman, 1970; Debral and Holker, 1971; Ekbote and Tayyab, 1974; Gupta and Gupta, 1977; Chouan and Chopde, 1981). But Chaudhary et al. (1977) reported negative correlation between seed yield and length of pod.

7. Number of locules per pod.

Number of locules in a pod ranges from four to eight in sesamum. Ram (1930) reported that eight loculed pods were invariably borne singly or in groups of two or three in axils. Hiltebrandt (1932) considered the number of

carpels to be an important character. He found that the major group of sesamum consists of two carpels (four locules). The other group, restricted to Japan, consists of four carpels (eight locules) in a capsule. In bicarpellate varieties the two carpels are primarily two loculed and become four loculed by the growth of false septa. Similarly eight loculed pods are developed from quadri-carpellate ovary by the development of false septa (Joshi, 1961). He also noticed 12 and 16 loculed pods. Four loculed condition was perfectly dominant over many loculed (6 to 8) condition and the character is controlled by a single gene (Nohara, 1933; John, 1934; Langham, 1945; John, 1980; Rheenen, 1981b).
Rheenen (1981 c) also reported that the multiloculed condition had no yield advantage in a composite population, developed by intercrossing lines with different locule numbers, through 11 generations. Muhammed et al. (1970 b) reported that the number of locules per pod was positively correlated with seed yield.

8. Number of seeds per pod.

Krishnamurthy et al. (1960) reported that the number of seeds per pod was the least affected by environment and also highly related to yield. This trait is a good criterion for selection for improvement in yield. Lopez and Mazzani (1964) reported significant differences between cultivars with respect to seed number. Dobral and Holker (1971) reported that there was a wide range of variability in the number of seeds per pod. They also reported high heritability for this character. Sawant (1971) observed high phenotypic and genotypic coefficients of variability and maximum expected genetic advance for number of seeds per pod. Trehan et al. (1975 b) also reported significant difference among varieties for this character. Solanki and Paliwal (1981) reported high heritability combined with high genetic advance for this character.

High positive correlation between seed yield and number of seeds per pod was reported by Khidir and Osman (1970), Gupta and Gupta (1977) and Solanki and Paliwal (1981). Muhammad et al. (1970 b) observed correlation between yield per plant and number of seeds per locule. Delgado and Yermanos (1975) reported that the seed yield per unit area was positively correlated with number of seeds per pod. But Chavan and Chopde (1981) reported negative effect of number of seeds per pod on seed yield.

9. Weight of thousand seeds.

Average weight of thousand seeds varied rather widely according to the position of pods on the stem from 3.5 g for the lower nodes to 2.5 g for upper nodes (Joshi, 1961). Weight of thousand seeds varied widely in sesamum as reported by Lopez and Mazzani (1964), Debral and Holker (1971) and Trehan et al. (1975 b). High heritability and genetic advance for seed weight was reported by Bhargava and

Saxena (1964) and as such this trait is of considerable value for plant selection. Sawant (1971) also reported high heritability associated with high genetic advance for this character. Gupta and Gupta (1977) observed the heritability estimate for thousand seed weight to be 62.87 per cent. Solanki and Paliwal (1981) also reported high heritability for thousand seed weight.

Significant positive correlation between seed yield and thousand seed weight in sesamum was reported by many workers (Muhammed and Stephen, 1964; Khidir and Osman, 1970; Debral and Holker, 1971; EL Nadi and Lazim, 1974; Gupta and Gupta, 1977; Yadava et al. 1980). Delgado and Yermanos (1975) reported that seed yield per unit area was positively correlated with hundred seed weight. But Naphade and Kolte (1974/1975) reported that seed yield was directly but negatively affected by hundred seed weight. Lopez and Mazzani (1964) observed no correlation between thousand seed weight and length of pods.

10. Seed yield per plant.

Yield per plant in sesamum was highly variable (Debral and Holker, 1971; Gupta, 1975; Paramasivam and Prasad, 1981). Sawant (1971) observed high genotypic and phenotypic coefficients of variation and maximum expected genetic advance for yield per plant. Chaudhary et al. (1977) observed that the yield per plant was highly heritable and under the control of additive gene action. Dixit (1975) reported that additive and dominance effects were important for yield per plant. Gupta and Gupta (1977) also observed high heritability estimates combined with a high genotypic coefficient of variation and a high expected genetic advance.

Seed yield per plant was highly and positively correlated to duration upto flowering (Osman and Khidir, 1974; Chaudhary et al. 1977; Chauan and Chopde, 1981), duration upto maturity (Anides, 1963; Osman and Khidir, 1974), height of plants and number of pods per plant (Dabral, 1967; Khidir and Osman, 1970; Dixit, 1974; 1975; Kaushal et al. 1974; Salazar and Oñoro, 1975; Gupta, 1976; Murugesan et al. 1979b; Paramasivam and Prasad, 1980; Chauan and Chopde, 1981; Rai et al. 1981), length of pod (Phadnis et al. 1970; Khidir and Osman, 1970; Ekbote and Tayyab, 1974; Gupta and Gupta, 1977; Chauan and Chopde, 1981). Seed yield also had a positive correlation with number of locules per pod (Muhammad et al. 1970 b), number of seeds per pod (Khidir and Osman, 1970; Muhammad et al. 1970 b; Gupta and Gupta, 1977; Solanki and Paliwal, 1981) and weight of thousand seeds (Khidir and Osman, 1970; Dabral and Holker, 1971; EL Nadi and Lazim, 1974; Gupta and Gupta, 1977; Yadava et al. 1980). Angarita (1962) had also reported a positive correlation of seed yield with some of these characters. Seed yield was reported to be negatively correlated to duration upto flowering, maturity, height of plant, length of pod and weight of thousand seeds (Khidir and Osman, 1970; Naphade and Kolte, 1974/1975; Dixit, 1975; Chaudhary et al. 1977).

11. Oil content.

Oil content and colour are important in assessing the quality of sesamum. Oil content is polygenically controlled by relatively few genes (Culbertson, 1954; Culp, 1959; Poelhman and Borthakur, 1969).

Mazzani (1959 b) reported that the average oil content of five branched varieties was 56.6 per cent and five nonbranched varieties was 54.5 per cent and the difference was significant. Mazzani (1959 a) in another study of variation, observed that the seed oil content of seven sesame cultivars was more influenced by environmental effect than by inherent difference between cultivars. Poelhman and Borthakur (1969) reported that the oil content in sesamum ranges from 45 to 60 per cent. They also reported that the white and bold seeded varieties have higher oil content, than brown or black and small seeded ones. Also the heritability value for oil was reported to be 50 per cent. Kaushal et al. (1969) in a study of oil content in sesamum at various stages reported that harvesting sesamum plants when the capsules had turned yellow and the leaves have dropped gave the highest

(58.4%) seed oil. Wide variations in oil and protein content were reported by Singh and Gupta (1973) in 28 strains of sesamum. Brar and Yermanos (1973) reported that the oil composition varied according to genotype. El-Tinay et al. (1976) reported a range of 42.2 to 52.2 per cent for seed oil content in 20 varieties. Brar (1982) analysed 27 introductions from 10 countries and found that the variation of oil content was 46 to 58 per cent.

Oil analysis report on the world sesame collection of U.S.A. (Anon. 1972) noted the following correlations.

a) Short plant had clear oil whilst tall plants had light green oil.

b) Early plants had a higher oil content than mid season and late plants.

c) Earliness, yellow seeds and large seeds were correlated with lower iodine value.

d) Earliness and yellow seeds were correlated with high oleic and low linoleic acid content.

Positive correlation between colour of seeds and oil content was noticed. Hiltebrandt (1932) and Kawanishi (1953) reported that the lighter the colour of the seeds, the higher was the oil content. Baradi (1972) reported that the black seeded varieties are richer in oil content than white seeded varieties. But El-Shamma and Al-Hassen (1973) reported that seeds from white seeded varieties have the highest percentage of oil (59.1 to 59.8), the red, grey and black seeded varieties contained 57.1 to 57.9, 54.3 to 57.4 and 52.5 to 56.5 per cent oil respectively.

II. Genotype x environment interaction

Variety x environment interactions are of major significance to plant breeders as these have an important bearing on the stability of improved varieties. The larger the interactions, the lower are the chances of progress under selection in a breeding programme( Constock and Moll, 1963). A study of genotype x environment interactions can therefore lead to successful evaluation of genotypes (Saini et al. 1977). Such investigations can lead to the selection of more stable and superior genotypes. Murugesan et al. (1979 b) in a study of five quantitative characters viz., plant height, height at which first capsule is formed, total number of capsules per plant, number of primary branches and number of secondary branches, in sesamum observed strong genotype x environment interactions.

Sandhu and Khehra (1977) reported a significant genotype x environment interaction for pod yield, hundred seed weight and length of primary and secondary branches in groundnut, but not for number of mature pods, number of primary branches and oil content. Yadava and Kumar (1978 b) in a study of the genotype x environment interactions for pod yield and number of days to maturity in 15 bunch varieties grown in four environments observed that the variety Faizpur 1-5, was early and stable for both traits in all four environments. Yadava and Kumar (1978 a) in an assessment of phenotypic stability of yield and its components in 11 semispreading varieties grown in three environments they further reported that the magnitude of the linear component of the interaction was high for pod yield, 100 kernel weight and oil content. Wynne and Isleib (1978) reported a substantial cultivar x location x year second order interaction for yield. They also observed that both cultivar x location and cultivar x year interactions were small as compared with the variation among cultivars. Tai and Hammons (1978) in a study of the genotype x environment interaction effects in peanut varieties reported that the first and second order interactions varied under different treatments and for different factors. They also reported that the cultivar effect would be consistently present, especially for shell yield and size factors.

Yadava and Kumar (1979 b) in a study of the phenotypic stability for yield components and oil content in bunch group of groundnut reported significant genotype x environment interaction for all the characters. Yadava and Kumar (1979 a) also reported that the linear portion of the genotype x environment interaction was significant for pod yield and maturity, while the non-linear portion was significant for maturity only. Mercer-Quarshie (1980) in a genotype x environment interaction study in groundnut reported that while the cultivar x year interaction was not significant for most yield components, the cultivar x location interaction was significant for seed yield and hundred seed weight. The interaction cultivar x location x year was large and highly significant. He concluded that in this area, cultivar should be evaluated for one or more years at 8 locations.

Rawat and Anand (1977) reported genotype x environment interaction for yield in mustard. They also reported that height and yield per plant were the characters affected by variety x site interaction, implying that prolonged natural selection had produced genic combinations which confer the capacity to adapt to diverse environments and withstand seasonal fluctuations. Schuster and Klein (1978) reported variety x location interactions for yield and protein content. Labana et al. (1980) in an evaluation of 25 strains of mustard in nine environments observed highly significant genotype x environment interaction. The highly significant first order interaction (genotype x sowing date and genotype x fertility) had higher magnitude of variance than the second order interaction (genotype x sowing date x fertility) although it was also highly significant. Posselt (1980) reported that the genotype x environment interactions were low for seed yield, oil yield, thousand seed weight and oil percentage in rape and that for seed yield and oil yield stability decreases with increasing yields.

III. Varietal evaluation.

Evaluation of indigenous and exotic varieties have been attempted by various workers. Anon. (1959) described Venezuela 51 and Venezuela 52 as the most promising sesamum varieties among the imported ones. Morada (purple) received from Venezuela also give significantly higher yields than local varieties. Aries (1961) reported the variety China Rojo which yielded significantly more and showed better agronomic characters than others. Gupta et al. (1963) reported that line 5 was superior in yield and disease resistant, in a trial with 15 lines of sesamum. Wakankar and Mahadik (1963) observed that out of the several indigenous and introduced varieties tested two selections made from local materials viz., Gwalior 5 and Gwalior 35 were suitable for Madhya Pradesh. Studies on the comparative performance of indigenous strains of sesamum revealed that T.85 (Maharashtra) gave 76.5 per cent increased yield over local variety and 104 per cent over that of TMV-3 at Karur (Muhammad et al. 1965). Baluch et al. (1966) in a trial with 10 varieties reported that the highest average seed yield and oil content were given by the dwarf cultivar, S-17 followed by S-18 (7.7 and 47.4 per cent), S-20 (7.1 and 48.4 per cent) and S-19 (7.0 and 47.2 per cent). The difference in seed yields were not significant. Baluch and Majidano (1966) isolated about 18 highly promising strains from 62 native and exotic strains of sesamum. Banerjee et al. (1966) reported that in comparison with 7 other strains over 4 years, B.67 variety gave higher seed and oil yield and was suitable for the sandy loams of West Bengal. Aryo et al. (1967) found that the variety Acarigua was outstanding for seed yield under the hot sandy conditions of Savannah. Russel et al. (1967) studied the performance of 16 varieties and reported that in general, shattering varieties gave higher yields than non-shattering types. Patel and Gopani (1967) selected two tall strains P.T.58-35 and P.T.57-96 from nearly 1000 single plant selections. They contained 2 per cent more oil than local varieties and in trials with local varieties produced higher yields. The seed of early maturing P.T.58-35 is white and that of P.T.57-96 is brown.

Muhammad et al. (1970 a) observed that in trials, KRR.I (Sil 752) showed superiority over the local variety in seed and oil yields. Nair et al. (1975) isolated a true breeding, mutant possessing more than one capsule per leaf axil and with normal branching from the variety Kayamkulam-1. Trehan et al. (1974) in an evaluation of 30 indigenous and 24 introduced varieties for oil and protein content in India found that ES.21 and ES.22 from the U.S.A. had the highest oil content and cross 91-99 from Andhra Pradesh and N.66-173 from Jabalpur had higher protein contents.

Nakagawa et al. (1976) reported that in a varietal trial with nine sesamum cultivars, Venezuela 51 was best with a seed yield of 991 kg per hectare followed by Morada indehiscente with 594 kg per hectare. Asthana and Narain (1977) reported that in a field trial of 20 sesamum strains, C-1036 and TMV-3 produced the highest yields. Nakagawa et al. (1978) studied various agronomic characters with sesame cultivars, Venezuela 61, Morada and Morda indehiscent and reported that Venezuela 51 was the best in both seed yield and dwarf habit. The yield was significantly higher than that of the other two varieties. Saha and Bhargava (1980) in the physiological analysis of the growth, development and yield of sesame observed that NP.6 had a higher seed yield than the four other genotypes studied. This was attributed to the higher number of seeds per plant which was due to the production of a large number of capsules. Trehan et al. (1975 a) reported that the oil percentage was positively and significantly correlated with seed length, seed thickness and hundred seed weight. Hence, seed thickness and seed length are important for the improvement of oil in sesame. They also reported non-significant negative correlation between protein and oil contents.

An improved variety, Kayamkulam-1 was evolved at Kayamkulam by pure-line selection in the local variety during 1971. This is a short duration high yielding variety adapted to summer rice fallows with 20 to 30 per-cent higher seed yield over the local variety. A spontaneous multipoded mutant was also isolated later from this variety. A multipoded variety with higher yield potential viz., Kayamkulam-2 was evolved at the same station during 1981 as the derivative of a cross between Kayamkulam-1 and PT-58-35. John (1980) isolated several multipoded and multiloculed types from a germplasm maintained at Vellayani. Khader (1982) in an evaluation of the productivity of these selected sesamum types observed that they are highly variable for several morphological characters and that all of these except length of pod and thousand seed weight were influenced by seasonal differences. He also observed that number of locules per pod, number of seeds per pod and thousand seed weight have positive association with seed yield. The contribution of number of pods per plant to yield was however highly irregular. The multiloculed varieties, in general were reported to be higher in seed yield, longer in duration and higher in oil content than the other varieties. The variety No.42-1 recorded the highest seed yield with maximum oil content.

# MATERIALS AND METHODS

# MATERIALS AND METHODS

The materials comprised of 15 selected types and varieties of sesamum. Types $V_1$ to $V_9$ were selections from the germplasm collection maintained at the Department of Plant Breeding, Vellayani. Preliminary studies have indicated that these types have high yield potential. Varieties $V_{10}$ to $V_{15}$ were obtained from the Rice Research Station, Kayamkulam. Nine of the 15 varieties are multipoded and four loculed (Varieties No. 1, 2, 3, 4, 5, 11, 12, 14 and 15), four are single poded and multiloculed (Varieties No. 6, 7, 8 and 9) and the remaining two (Varieties No.10 and 13) are single poded and four loculed. They differed in duration, plant height and seed colour. The sources and description of the types and varieties are presented in table-1.

The field experiments for comparative evaluation of these varietiies were laid out in rice fallows during summer (January to April) 1982 at the Rice Research Station, Kayamkulam and in uplands during rabi (August to December) 1982 at the College of Agriculture, Vellayani, employing a randomised block design with two replications. Each plot consisted of seven rows of seventeen plants each, at a spacing of 30 cm between the rows and 15 cm between the plants. A random sample of ten plants per variety per replication was taken for recording the observations listed 1 to 9 below. Observations on items 10 and

Table 1. Sources and description of sesamum types and varieties

| Variety No. | Name of variety | Region to which the variety belongs | Duration upto maturity (days) | Height of plant (cm) | Number of pods per axil | Number of locules per pod | Number of seeds per pod | Seed colour |
|---|---|---|---|---|---|---|---|---|
| $V_1$ | $S_1$-914-1 | Coimbatore | 78 | 105 | 1-3 | 4 | 56 | Brown |
| $V_2$ | P.28-1 | Punjab | 82 | 95 | 1-3 | 4 | 63 | White |
| $V_3$ | Mutant K-1 | Kerala | 83 | 83 | 1-3 | 4 | 55 | Black |
| $V_4$ | GPIII-2-1 | Gujarat | 84 | 85 | 1-3 | 4 | 57 | Black |
| $V_5$ | P.10-1 | Punjab | 85 | 88 | 1-3 | 4 | 60 | White |
| $V_6$ | P.38-1 | Punjab | 88 | 115 | 1 | 6-8 | 103 | White |
| $V_7$ | P.28-2 | Punjab | 86 | 110 | 1 | 4-8 | 103 | White |
| $V_8$ | No.42-1 | West Bengal | 86 | 108 | 1 | 6-8 | 101 | Brown |
| $V_9$ | P.23-1 | Punjab | 92 | 100 | 1 | 4-8 | 97 | White |
| $V_{10}$ | Kayamkulam-1 | Kerala | 75 | 95 | 1 | 4 | 55 | Black |
| $V_{11}$ | PT-58-35 | Gujarat | 76 | 85 | 1-3 | 4 | 53 | Brown |
| $V_{12}$ | Culture 7-1 | Kerala | 76 | 100 | 1-3 | 4 | 58 | Brown |
| $V_{13}$ | KRR-1 | Tamilnadu | 74 | 110 | 1 | 4 | 55 | Brown |
| $V_{14}$ | Kayamkulam-2 | Kerala | 75 | 83 | 1-3 | 4 | 63 | Brown |
| $V_{15}$ | TMV-2 | Tamilnadu | 76 | 105 | 1-3 | 4 | 64 | Black |

11 were made on bulk seeds of each variety.

1. Duration upto flowering: Number of days from sowing to opening of first flower.
2. Duration upto maturity: Number of days from sowing to harvest.
3. Height of plants: Length of the plant from soil level to the tip of the main shoot.
4. Number of pods per axil: Mean number of pods in the central three pod bearing axils.
5. Number of pods per plant: Total number of pods formed in a plant.
6. Length of pod: Length of the pod selected to represent the plant.
7. Number of locules per pod: Number of locules present in the pod, selected to represent the plant.
8. Number of seeds per pod: Total number of seeds in the pod, selected to represent the plant.
9. Seed yield per plant: Seeds from all pods of a plant were collected together and weighed.
10. Weight of thousand seeds: A bulk sample of 5 g was drawn from each variety. The number of seeds in this sample was counted. The weight in g for thousand seeds was calculated.
11. Oil content: The oil content in percentage for each variety was estimated by the cold percolation method suggested by Kartha and Sethi (1957). A sample of 0.5 g

seeds was weighed out in a glass mortar along with 0.5 g of glass powder and 1.0 g of anhydrous sodiumsulphate. This was ground well and transferred to a glass percolator fixed on a stand. The mixture was packed in the percolator in layers alternating with cotton wool. 20 ml of carbon-tetrachloride was poured in four splits, at intervals of 5 minutes. The percolate consisting of the oil dissolved in the solvent was collected in a previously weighed petridish with a few bits of blotting paper. The solvent was completely evaporated by oven drying at 60 to 70°C. The petridish containing the oil residue was weighed again. The difference between the final weight and the initial weight of the petridish gave the weight of the oil in 0.5 g of the seed sample. The oil content in percentage of the seed was calculated.

The data collected from the two experiments were tabulated and subjected to statistical analysis adopting the proceedure outlined by Panse and Sukhatme (1954).

I. Analysis of variance.

The data for each character were analysed separately for both the locations. The pooled data were also analysed.

i) For each location:

| Sources of variation | Degrees of freedom | Sum of squares | Mean squares | 'F' ratio |
|---|---|---|---|---|
| Replications | r-1 | $\frac{\sum_{j} Rj^2}{v} - C = SSR$ | SSR/(r-1)=MSR | MSR/MSE |
| Varieties | v-1 | $\frac{\sum_{i} Vi^2}{r} - C = SSV$ | SSV/(v-1)=MSV | MSV/MSE |
| Error | (r-1)(v-1) | SST-(SSR+SSV) =SSE | SSE/(r-1)(v-1) =MSE | |
| Total | rv-1 | $\sum_{ij} Yij^2 - C = SST$ | | |

Where r = number of replications

v = number of varieties

SSR = Sum of squares for replications

SSV = Sum of squares for varieties

SSE = Sum of squares for error

SST = Total sum of squares

MSR = Mean square for replications

MSV = Mean square for varieties

MSE = Mean square for error

The significance of the 'F' value was tested with reference to the 'F' table. The varieties were compared by using the value of the critical difference given by,

$$CD = t(r-1)(v-1) \sqrt{\frac{2MSE}{r}}.$$

$\sqrt{\frac{MSE}{r}}$ = Standard error of the mean.

ii) Pooled analysis:

Prior to pooling, the mean squares for error at the two locations were tested for their similarity by applying the 'F' test. For data, for which the mean squares for error were similar, the following analysis was done.

| Sources of variation | Degrees of freedom | Sum of squares | Mean squares | 'F' ratio |
|---|---|---|---|---|
| Locations | l-1 | $\frac{\sum_{j}^{l} Lj^2}{v} - C = SSL$ | SSL/(l-1)=MSL | |
| Varieties | v-1 | $\frac{\sum_{i}^{l} Vi^2}{l} - C = SSV$ | SSV/(v-1)=MSV | MSV/MSVL |
| Variety x location | (v-1)(l-1) | SST-(SSL+SSV) =SSVL | SSVL/(v-1)(l-1) =MSVL | MSVL/MSE |
| Pooled error | $de_1+de_2$ | $SSE_1+SSE_2=SSE$ | $SSE/(de_1+de_2)$ = MSE | |

Where,

| | | |
|---|---|---|
| l | = | number of locations |
| v | = | number of varieties |
| $de_1$ | = | error degrees of freedom for the first location |
| $de_2$ | = | error degrees of freedom for the second location |
| SSL | = | Sum of squares for location |
| SSV | = | Sum of squares for varieties |
| SSVL | = | Variety x location sum of squares |

SST = Total sum of squares

SSE = Pooled error sum of squares

MSL = Mean square for location

MSV = Mean square for varieties

MSVL = Mean square for variety x location interaction

MSE = Mean square for pooled error

The significance of the 'F' ratio for the variety x location interaction as well as for varietal differences was tested with reference to 'F' table.

For data for which the mean squares for error were dissimilar, the procedure of weighted analysis of variance was done as follows:

Weight for each location = (Wi) = $\frac{r}{Si^2}$

where, r = number of replications and

$Si^2$ = error mean square of the corresponding character.

WiPi for each location where Pi's are the place totals for the corresponding character.

$\Sigma$Witi for each variety, where ti's are means for each variety at each location.

Si = columnwise sum of squares

The various items in the analysis of varience were calculated as follows:

Total sum of squares $= \sum WiSi - C = SST$

where, $C = \frac{G^2}{t \sum Wi}$, $G = \sum(\sum Witi) = \sum WiPi$ and

$t$ = number of varieties.

Location sum of squares $= \frac{1}{t} \sum (WiPi^2) - C = SSL$

Variety sum of squares $= \frac{\sum(\sum Witi)^2}{\sum Wi} - C = SSV$

Variety x location sum of squares = Total sum of squares - locations sum of squares - variety sum of squares = SSVL

| Sources of variation | Sum of squares |
|---|---|
| Locations | SSL |
| Varieties | SSV |
| Variety x Location | SSVL |
| Total | SST |

For testing the significance of variety x location interaction, the value of $\frac{(n-4)(n-2)}{n(n+v-3)} I$ was compared with the table value of $\chi^2$ having $\frac{(l-1)(v-1)(n-4)}{(n+v-3)}$ degrees of freedom,

where, n = degrees of freedom for error

v = number of varieties

l = number of locations

I = SSVL

The significant $\chi^2$ value indicated that the varieties varied with locations with respect to the particular character. Hence the relevent varietal difference were tested by comparing the variety and interaction mean squares obtained from an unweighted analysis.

| Sources of variation | Degrees of freedom | Sum of squares | Mean squares | 'F' ratio |
|---|---|---|---|---|
| Locations | l-1 | $\frac{\sum_j Lj^2}{v} - C = SSL$ | SSL/(l-1)=MSL | |
| Varieties | v-1 | $\frac{\sum_i Vi^2}{l} - C = SSV$ | SSV/(v-1)=MSV | MSV/MSVL |
| Variety x location | (v-1)(l-1) | SST-(SSL+SSV) =SSVL | SSVL/(v-1)(l-1)=MSVL | |
| Total | vl-1 | $\sum_{ij} Yij^2 - C = SST$ | | |

Where, l = number of locations

v = number of varieties

SSL = Sum of squares for location

SSV = Sum of squares for varieties

SSVL = Variety x location sum of squares

SST = Total sum of squares

The significance of the 'F' ratio was tested with reference to the 'F' table.

The non significant $\chi^2$ value indicated the absence of interaction. No general test of overall treatment difference appears to be available in the absence of interaction. Hence the test for individual degrees of freedom was adopted to compare the varietal means.

## II. Variations:

i) Variances:

The genotypic, environmental and phenotypic variances were estimated as follows for each character in each location.

Genotype variance (Vg) = $\frac{MSV-MSE}{r}$

Environmental variance (Ve) = MSE

Phenotypic variance (Vp) = Genotypic variance (Vg) + Environmental variance (Ve)

ii) Coefficients of variation:

The genotypic and phenotypic coefficients of variation for each character in each location were calculated as follows.

Genotypic coefficient of variation (CVg) = $\frac{\sqrt{Vg} \times 100}{Mean}$

Phenotypic coefficient of variation (CVp) = $\frac{\sqrt{Vp} \times 100}{Mean}$

where, mean is the general mean of all 15 varieties for the particular character.

## III. Correlations

i) Covariances:

The genotypic, environmental and phenotypic covariances were computed as follows:

Genotypic covariance between x1 and x2 (Cov.g1,g2)

$$= \frac{MSPV - MSPE}{r}$$

where, MSPV = Mean sum of products between varieties

MSPE = Mean sum of products for error

Environmental covariance (Cov.e1,e2) = MSPE

Phenotypic covariance (Cov.p1,p2) = Genotypic covariance (Cov.g1,g2) + Environmental covariance (Cov.e1,e2)

ii) Correlations:

The genotypic and phenotypic correlations were computed as follows:

$$\text{Genotypic correlation coefficient } (\gamma g) = \frac{(Cov.g1,g2)}{\sqrt{Vg1 \times Vg2}}$$

where, (Cov.g1,g2) = Genotypic covariance between the two characters.

Vg1 = Genotypic variance of the first character

Vg2 = Genotypic variance of the second character

$$\text{Phenotypic correlation coefficient } (\gamma\ p) = \frac{(Cov.p1,p2)}{\sqrt{Vp1 \times Vp2}}$$

where, (Cov.p1,p2) = Phenotypic covariance between the two characters

$V_{p1}$ = Phenotypic variance of the first character

$V_{p2}$ = Phenotypic variance of the second character

The correlation coefficients were tested for their significance with reference to the critical values given in student's t-table.

# RESULTS

## RESULTS

The data in respect of the 11 characters at the two locations were statistically analysed for each location separately as well as for the two locations together. The variances and coefficients of variation for each character were estimated for both the locations. The correlations between characters were also computed. The results of the analysis are interpreted and presented.

I. <u>Analyses of variance</u>.

1. <u>Duration upto flowering</u>.

The analyses of variance for the number of days to flowering, for each location, as well as for the two locations together are presented in Appendix 1. There was no significant difference in the number of days among the 15 varieties at both the locations. The mean number of days of the 15 varieties is given in table 2 and figure 1.

The significant 'F' value in the test of homogenity of error mean squares indicated, that the error mean squares at the two locations were dissimilar. Hence a weighted analysis was done for determining the variety x location interaction. The non-significant $\chi^2$ value for the variety x location sum of squares indicated that the interaction was not significant. Hence the varieties did not differ from location to location with respect to flowering duration. The varietal means were compared with those of the two

Table 2. Number of days to flowering.

| Variety No. | Name of varieties | Rice fallows (Summer) | Uplands (Rabi) | Pooled means |
|---|---|---|---|---|
| $V_1$ | $S_1$-914-1 | 37.1 | 42.5 | 39.8 |
| $V_2$ | P.28-1 | 37.1 | 37.7 | 37.4 |
| $V_3$ | Mutant K-1 | 37.4 | 39.9 | 38.7 |
| $V_4$ | GP.III-2-1 | 38.1 | 40.2 | 39.2 |
| $V_5$ | P.10-1 | 37.6 | 38.5 | 38.1 |
| $V_6$ | P.38-1 | 38.4 | 38.7 | 38.6 |
| $V_7$ | P.28-2 | 37.6 | 39.7 | 38.7 |
| $V_8$ | No.42-1 | 37.8 | 38.8 | 38.3 |
| $V_9$ | P.23-1 | 38.4 | 42.3 | 40.4 |
| $V_{10}$ | Kayamkulam-1 | 37.1 | 40.8 | 39.0 |
| $V_{11}$ | PT-58-35 | 36.9 | 38.7 | 37.8 |
| $V_{12}$ | Culture 7-1 | 37.4 | 38.7 | 38.1 |
| $V_{13}$ | KRR-1 | 37.7 | 40.2 | 39.0 |
| $V_{14}$ | Kayamkulam-2 | 37.7 | 40.6 | 39.2 |
| $V_{15}$ | TMV-2 | 37.9 | 42.1 | 40.0 |
| | C.D. | NS | NS | - |

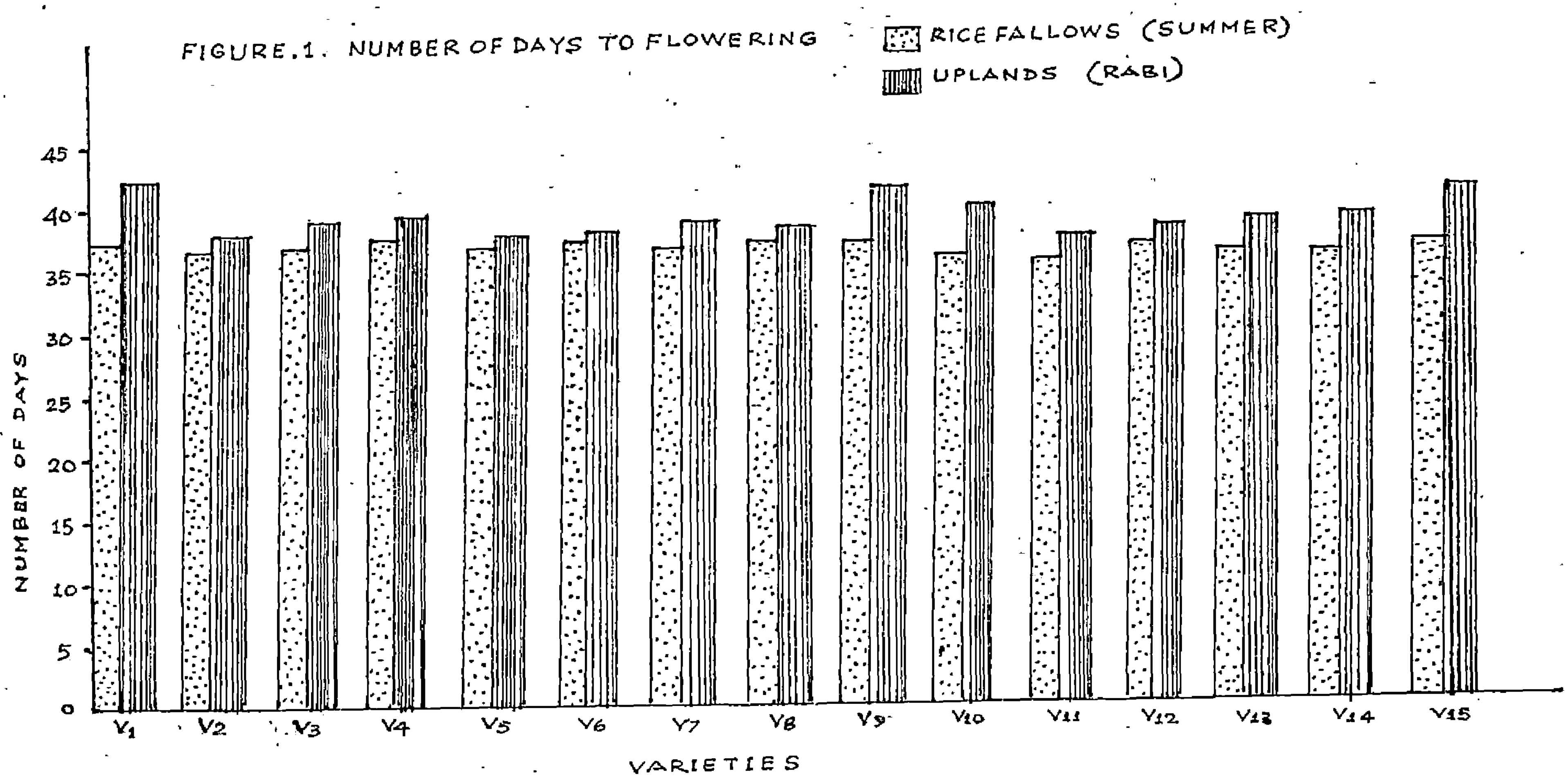


FIGURE.1. NUMBER OF DAYS TO FLOWERING
RICE FALLOWS (SUMMER)
UPLANDS (RABI)
NUMBER OF DAYS
0
5
10
15
20
25
30
35
40
45
V1
V2
V3
V4
V5
V6
V7
V8
V9
V10
V11
V12
V13
V14
V15
VARIETIES

standard varieties Kayamkulam-1 ($V_{10}$) and Kayamkulam-2 ($V_{14}$) by adopting the test for individual degrees of freedom. The results indicated that varieties S1-914-1 ($V_1$), P.28-1 ($V_2$), Mutant K-1 ($V_3$), GP.III-2-1 ($V_4$), P.10-1 ($V_5$), P.28-2 ($V_7$), No.42-1 ($V_8$), PT-58-35 ($V_{11}$), Culture 7-1 ($V_{12}$), KRR-1 ($V_{13}$) and TMV-2 ($V_{15}$) to be on par with Kayamkulam-1. But P.38-1 ($V_6$) and P.23-1 ($V_9$) differed significantly from Kayamkulam-1. All varieties were found to be on par with Kayamkulam-2.

2. Duration upto maturity.

The analyses of variance for the number of days to maturity, for each location, as well as for the two locations together are presented in Appendix-2. Highly significant difference among the 15 varieties was noted for this character at both the locations. The mean number of days to maturity are given in table-3 and figure-2.

A comparison of the varieties in the rice fallows (summer) may be made as follows:

$\overline{V_5\ V_6\ V_7\ V_8}\ \ \overline{V_{10} V_{12}\ V_{14}}\ \ \overline{V_1\ V_4\ V_9\ V_{11}}\ \ \overline{V_2\ V_3\ V_{13}\ V_{15}}$

Varieties P.10-1 ($V_5$), P.38-1 ($V_6$), P.28-2 ($V_7$) and No.42-1 ($V_8$) had the maximum number of days (83 days) to maturity. P.28-1 ($V_2$), Mutant K-1 ($V_3$), KRR-1 ($V_{13}$) and TMV-2 ($V_{15}$) were the earliest to mature (77 days). Kayamkulam-1 ($V_{10}$) matured in 79 days and was on par with Kayamkulam-2 ($V_{14}$) and Culture 7-1 ($V_{12}$).

The varieties in uplands (rabi) may be compared as

Table 3. Number of days to maturity.

| Variety No. | Name of varieties | Rice fallows (Summer) | Uplands (Rabi) | Pooled means |
|---|---|---|---|---|
| $V_1$ | $S_1$-914-1 | 78 | 87 | 83 |
| $V_2$ | P.28-1 | 77 | 86 | 82 |
| $V_3$ | Mutant K-1 | 77 | 83 | 80 |
| $V_4$ | GP.III-2-1 | 78 | 86 | 82 |
| $V_5$ | P.10-1 | 83 | 88 | 86 |
| $V_6$ | P.38-1 | 83 | 83 | 83 |
| $V_7$ | P.28-2 | 83 | 88 | 86 |
| $V_8$ | No.42-1 | 83 | 88 | 86 |
| $V_9$ | P.23-1 | 78 | 86 | 82 |
| $V_{10}$ | Kayamkulam-1 | 79 | 87 | 83 |
| $V_{11}$ | PT-58-35 | 78 | 87 | 83 |
| $V_{12}$ | Culture 7-1 | 79 | 86 | 83 |
| $V_{13}$ | KRR-1 | 77 | 88 | 83 |
| $V_{14}$ | Kayamkulam-2 | 79 | 87 | 83 |
| $V_{15}$ | TMV-2 | 77 | 85 | 81 |
| | C.D. | 0 | 0 | NS |

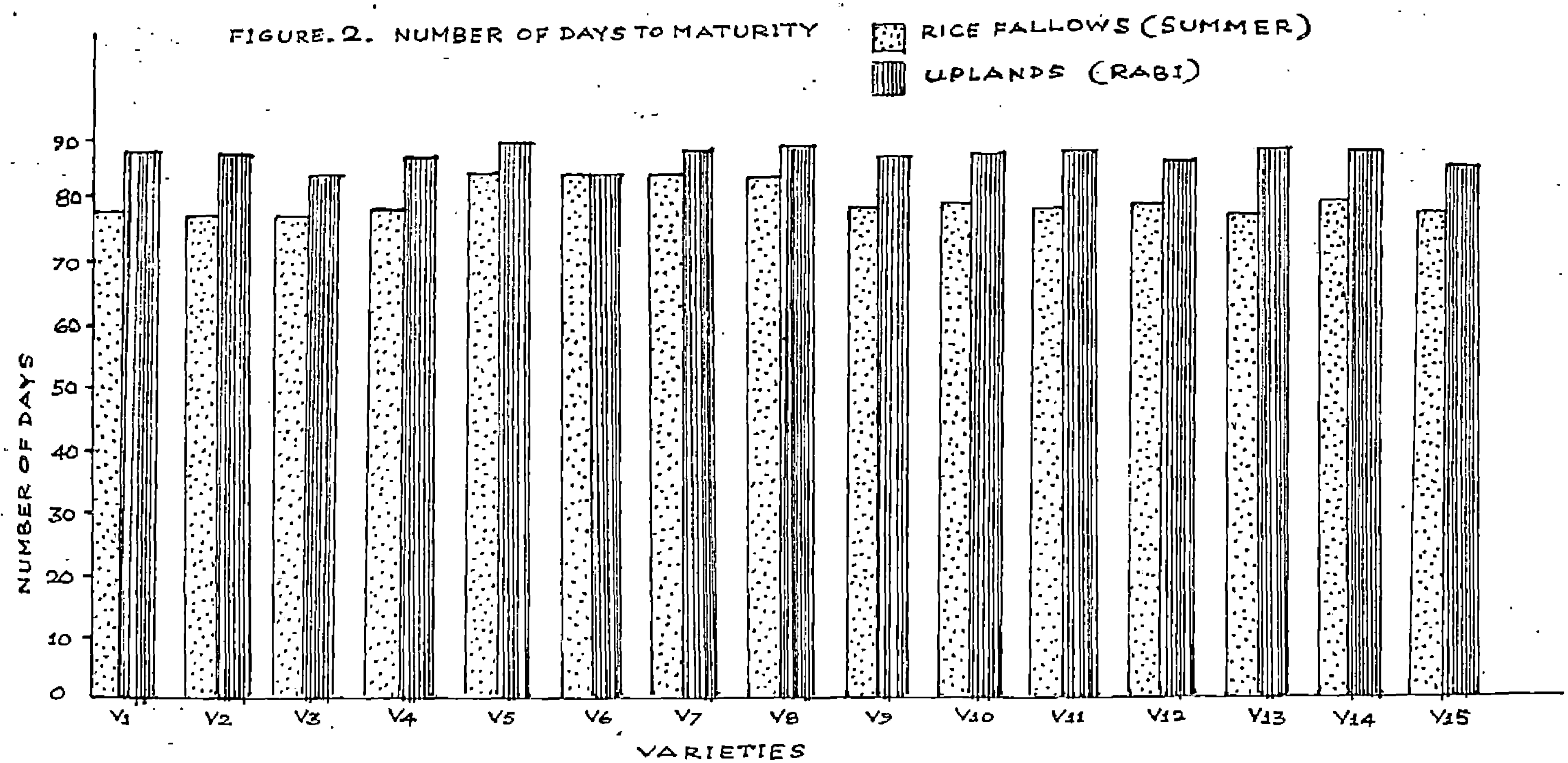


FIGURE. 2. NUMBER OF DAYS TO MATURITY
RICE FALLOWS (SUMMER)
UPLANDS (RABI)
NUMBER OF DAYS
0
10
20
30
40
50
60
70
80
90
V1
V2
V3
V4
V5
V6
V7
V8
V9
V10
V11
V12
V13
V14
V15
VARIETIES

follows:

$\overline{V_5\ V_7\ V_8\ V_{13}}$ $\overline{V_1\ V_{10}\ V_{11}\ V_{14}}$ $\overline{V_2\ V_4\ V_9\ V_{12}}$ $V_{15}\ \overline{V_3\ V_6}$

Varieties P.10-1 ($V_5$), P.28-2 ($V_7$), No.42-1 ($V_8$) and KRR-1 ($V_{13}$) had the maximum number of days to maturity (88 days). Mutant K-1 ($V_3$) and P.38-1 ($V_6$) were the earliest to mature (83 days). Kayamkulam-1 ($V_{10}$) matured in 87 days and was on par with S1-914-1 ($V_1$), PT-58-35 ($V_{11}$) and Kayamkulam-2 ($V_{14}$).

The non-significant 'F' value in the test of homogenity of error mean squares indicated that the error mean squares at the two locations were similar. Hence the simple analysis of variance was adopted, for determining the variety x location interaction. The significant 'F' value in the pooled analysis indicates that the varieties differ from location to location with respect to maturity. For all varieties except P.38-1 ($V_6$), the duration was more in uplands than in rice fallows. The duration at both locations was the same for P.38-1 ($V_6$). The non-significant 'F' value for varieties indicated that the varieties did not differ in maturity period, when the two locations were considered together.

3. <u>Height of plants</u>.

The analyses of variance for each location as well as the pooled analysis are given in Appendix-3. The highly significant 'F' value for varieties in rice fallows revealed that the 15 varieties differ significantly at this location. But the non-significant 'F' value for varieties in uplands revealed that there was no difference among them at this location. The mean height of plants of the 15 varieties is presented in table 4 and figure-3.

A comparison of the heights of varieties in rice fallows (summer) may be made as follows:

$V_7\ V_5\quad V_1\quad V_6\ V_9\ V_1\ V_8\ V_{12}\quad V_{13}\quad V_2\quad V_{10}\ V_{15}\ V_{11}\quad V_4\ V_3$

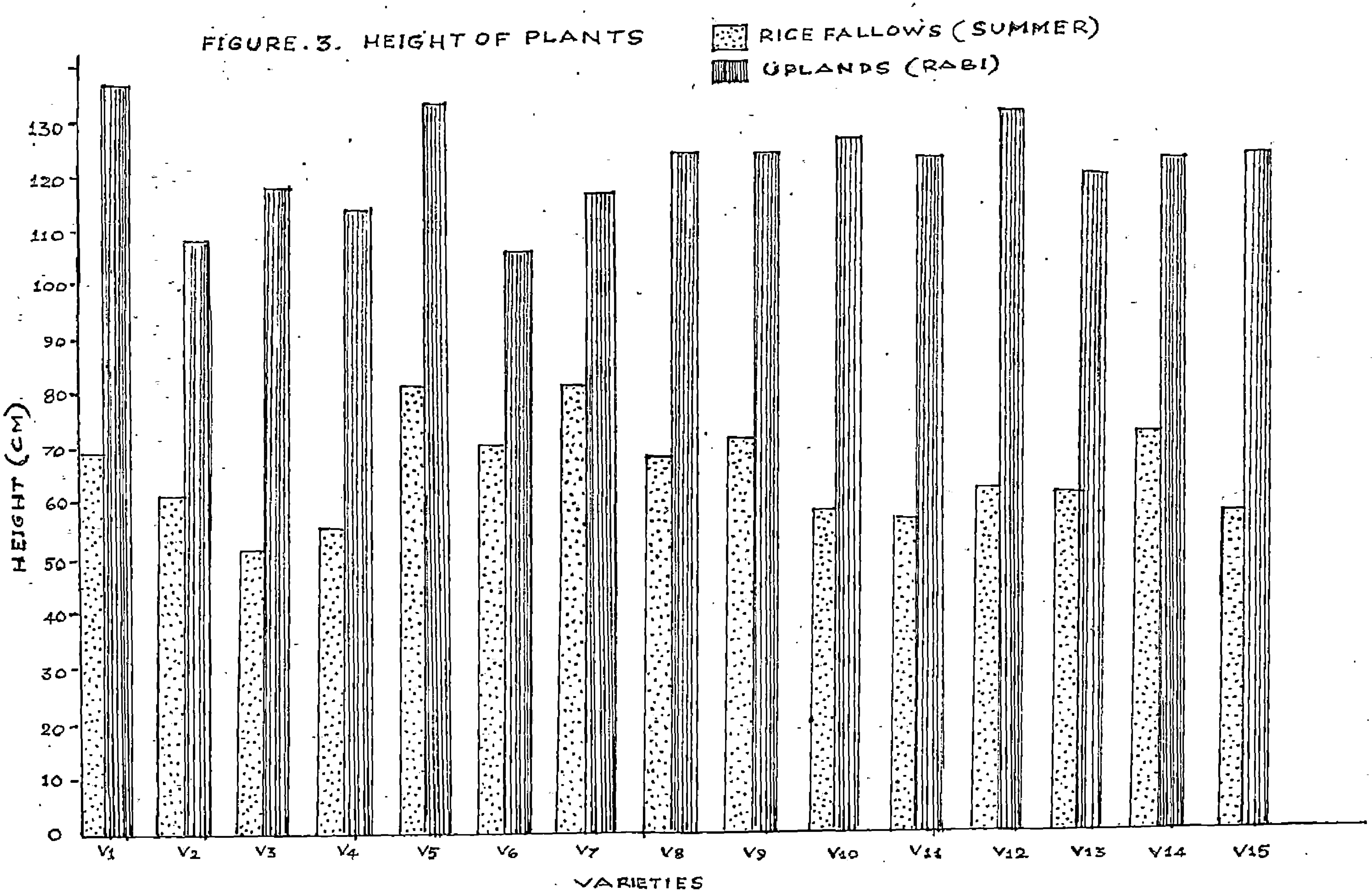
The variety P.28-2 ($V_7$) recorded the maximum height (81.9 cm) and was on par with P.10-1 ($V_5$). These two varieties were significantly taller than all the others including the two recommended varieties viz., Kayamkulam-1 ($V_{10}$) and Kayamkulam-2 ($V_{14}$). Mutant K-1 ($V_3$) was the shortest (51.4 cm) and was on par with GP.III-2-1 ($V_4$). Kayamkulam-1 had a height of 59.6 cm and was on par with TMV-2 ($V_{15}$), PT-58-35 ($V_{11}$) and GP.III-2-1 ($V_4$). Kayamkulam-2 was taller with a mean height of 73.3 cm and was on par with P.38-1 ($V_6$), P.23-1 ($V_9$), S1-914-1 ($V_1$) and No.42-1 ($V_8$).

The significant 'F' value in the test of homogenity of error mean squares indicated that the error mean squares at the two locations were dissimilar. Hence the weighted analysis was done for determining the variety x location interaction. The significant $\chi^2$ value for the variety x location sum of squares indicated that the interaction was

Table 4. Height of plants (cm).

| Variety No. | Name of varieties | Rice fallows (Summer) | Uplands (Rabi) | Pooled means |
|---|---|---|---|---|
| $V_1$ | $S_1$-914-1 | 69.9 | 137.2 | 103.6 |
| $V_2$ | P.28-1 | 61.5 | 108.4 | 85.0 |
| $V_3$ | Mutant K-1 | 51.4 | 118.5 | 85.0 |
| $V_4$ | GP.III-2-1 | 56.9 | 114.1 | 85.5 |
| $V_5$ | P.10-1 | 81.8 | 134.3 | 108.1 |
| $V_6$ | P.38-1 | 72.6 | 107.7 | 90.2 |
| $V_7$ | P.28-2 | 81.9 | 117.2 | 99.6 |
| $V_8$ | No.42-1 | 69.1 | 125.2 | 97.2 |
| $V_9$ | P.23-1 | 72.5 | 125.2 | 98.9 |
| $V_{10}$ | Kayamkulam-1 | 59.6 | 128.1 | 93.9 |
| $V_{11}$ | PT-58-35 | 57.4 | 124.0 | 90.7 |
| $V_{12}$ | Culture 7-1 | 62.7 | 133.0 | 97.9 |
| $V_{13}$ | KRR-1 | 62.2 | 121.6 | 91.9 |
| $V_{14}$ | Kayamkulam-2 | 73.3 | 124.2 | 98.8 |
| $V_{15}$ | TMV-2 | 59.2 | 126.7 | 93.0 |
| | C.D. | 7.68 | NS | NS |

FIGURE. 3. HEIGHT OF PLANTS



significant. Hence the varieties differed from location to location. Further, an unweighted analysis was done to compare the varieties. The non-significant 'F' value in this analysis revealed that there was no significant varietal differences.

4. Number of pods per axil.

The analysis of variance is presented in Appendix-4. The non-significant 'F' value for varieties in rice fallows indicated that there was no significant difference among the 15 varieties. In uplands, on the other hand, significant differences were observed among the varieties. The mean number of pods per axil for each variety is given in table 5.

A comparison of the 15 varieties in uplands (rabi) may be made as follows:

$V_{15}$ $V_3$ $V_4$ $V_{12}$ $V_{14}$ $V_1$ $V_2$ $V_{11}$ $V_5$ $V_6$ $V_7$ $V_8$$V_9$ $V_{10}$ $V_{13}$

The variety TMV-2 ($V_{15}$) produced the maximum number of pods per axil (2.23). This was on par with Mutent K-1 ($V_3$), GP III-2-1 ($V_4$) and Culture 7-1 ($V_{12}$), but was significantly superior to Kayamkulam-2 ($V_{14}$) which recorded a mean value of only 1.77. Among the nine multipoded varieties compared, P.10-1 ($V_5$) recorded the minimum number of pods per axil (1.00).

The significant 'F' value in the test of homogenity of error mean squares indicated that the error mean squares

Table 5. Number of pods per axil.

| Variety No. | Name of varieties | Rice fallows (Summer) | Uplands (Rabi) | Pooled means |
|---|---|---|---|---|
| $V_1$ | $S_1$-914-1 | 1.00 | 1.75 | 1.38 |
| $V_2$ | P.28-1 | 1.02 | 1.45 | 1.24 |
| $V_3$ | Mutant K-1 | 1.00 | 2.13 | 1.57 |
| $V_4$ | GP.III-2-1 | 1.02 | 2.08 | 1.55 |
| $V_5$ | P.10-1 | 1.00 | 1.00 | 1.00 |
| $V_6$ | P.38-1 | 1.00 | 1.00 | 1.00 |
| $V_7$ | P.28-2 | 1.00 | 1.00 | 1.00 |
| $V_8$ | No.42-1 | 1.00 | 1.00 | 1.00 |
| $V_9$ | P.23-1 | 1.00 | 1.00 | 1.00 |
| $V_{10}$ | Kayamkulam-1 | 1.00 | 1.00 | 1.00 |
| $V_{11}$ | PT-58-35 | 1.00 | 1.40 | 1.20 |
| $V_{12}$ | Culture 7-1 | 1.03 | 1.90 | 1.47 |
| $V_{13}$ | KBR-1 | 1.00 | 1.00 | 1.00 |
| $V_{14}$ | Kayamkulam-2 | 1.18 | 1.77 | 1.48 |
| $V_{15}$ | TMV-2 | 1.06 | 2.23 | 1.65 |
| | C.D. | NS | 0.420 | NS |

indicated that the error mean squares at the two locations were dissimilar. Hence a weighted analysis was done for determining the variety x location interaction. The highly significant $\chi^2$ value for the variety x location sum of squares indicated that the interaction was significant and hence the varieties differed from location to location. Further, an unweighted analysis was done to compare the varietal means. The non-significant 'F' value in this analysis revealed that there was no significant difference among the varieties.

5. Number of pods per plant

The analysis of variance for the number of pods per plant is presented in Appendix-5. The highly significant 'F' value for the varieties in rice fallows indicated that there was significant variation for this character at that location. But the 'F' value for the varieties in uplands was not significant. The mean number of pods per plant is presented in table 6 and figure 4.

The 15 varieties in the rice fallows (summer) may be compared as follows:

$V_7$ $V_5$ $V_6$ $V_{10}$ $V_2$ $V_9$ $V_4$ $V_{13}$ $V_{14}$ $V_{12}$ $V_{15}$ $V_1$ $V_3$ $V_{11}$ $V_8$

P.28-2 ($V_7$) recorded the maximum number of pods per plant (36.7) and was on par with P.10-1 ($V_5$). These two varieties produced significantly more number of pods than all the other varieties. No.42-1 ($V_8$) recorded the minimum

Table 6. Number of pods per plant.

| Variety No. | Name of varieties | Rice fallows (Summer) | Uplands (Rabi) | Pooled means |
|---|---|---|---|---|
| $V_1$ | $S_1$-914-1 | 11.8 | 40.2 | 26.0 |
| $V_2$ | P.28-1 | 17.6 | 39.0 | 28.3 |
| $V_3$ | Mutant K-1 | 11.8 | 42.7 | 27.3 |
| $V_4$ | GP.III-2-1 | 17.1 | 46.6 | 31.9 |
| $V_5$ | P.10-1 | 31.1 | 30.9 | 31.0 |
| $V_6$ | P.38-1 | 22.4 | 18.5 | 20.5 |
| $V_7$ | P.28-2 | 36.7 | 31.5 | 34.1 |
| $V_8$ | No.42-1 | 10.6 | 27.4 | 19.0 |
| $V_9$ | P.23-1 | 17.6 | 38.7 | 28.2 |
| $V_{10}$ | Kayamkulam-1 | 17.7 | 37.1 | 27.4 |
| $V_{11}$ | PT-58-35 | 11.6 | 58.0 | 34.8 |
| $V_{12}$ | Culture 7-1 | 13.0 | 39.1 | 26.1 |
| $V_{13}$ | KRR-1 | 16.0 | 30.4 | 23.2 |
| $V_{14}$ | Kayamkulam-2 | 15.0 | 27.6 | 21.3 |
| $V_{15}$ | TMV-2 | 12.5 | 36.7 | 24.6 |
| | C.D. | 6.53 | NS | NS |

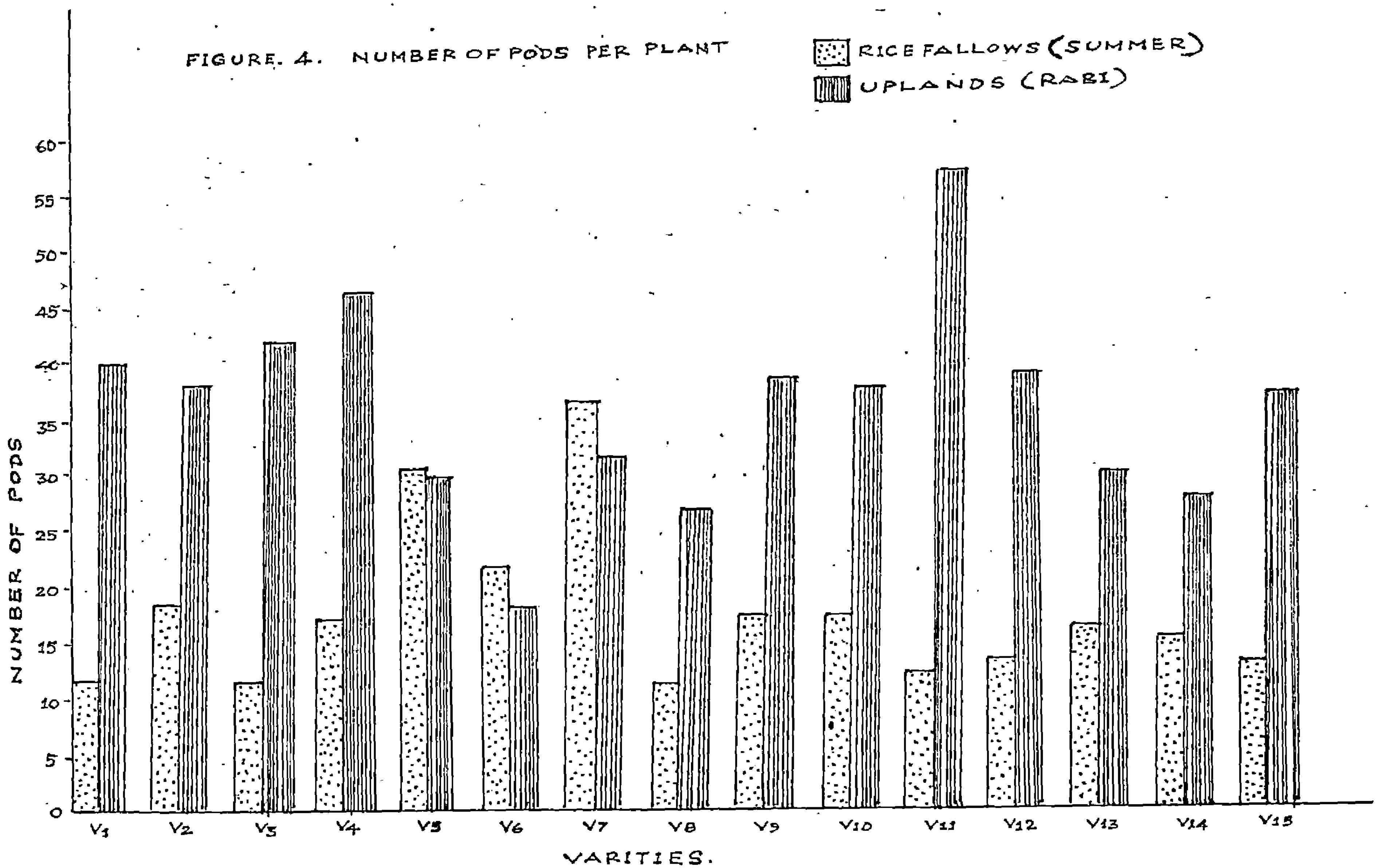


FIGURE. 4. NUMBER OF PODS PER PLANT
RICE FALLOWS (SUMMER)
UPLANDS (RABI)
NUMBER OF PODS
0
5
10
15
20
25
30
35
40
45
50
55
60
V1
V2
V3
V4
V5
V6
V7
V8
V9
V10
V11
V12
V13
V14
V15
VARITIES.

number of pods (10.6) and was on par with PT-58-35 ($V_{11}$), Mutant K-1 ($V_3$), S1-914-1 ($V_1$), TMV-2 ($V_{15}$), Culture 7-1 ($V_{12}$), Kayamkulam-2 ($V_{14}$) and KRR-1 ($V_{13}$). Kayamkulam-1 ($V_{10}$) was on par with P.28-1 ($V_2$), P.23-1 ($V_9$), GP.III-2-1 ($V_4$), KRR-1 ($V_{13}$), Kayamkulam-2 ($V_{14}$), Culture 7-1-($V_{12}$), TMV-2 ($V_{15}$), S1-914-1 ($V_1$), Mutant K-1 ($V_3$) and PT-58-35 ($V_{11}$). Kayamkulam-2 ($V_{14}$) was on par with Culture 7-1 ($V_{12}$), TMV-2 ($V_{15}$), $S_1$-914-1 ($V_1$), Mutant K-1 ($V_3$), PT-58-35 ($V_{11}$) and No.42-1 ($V_8$).

The significant 'F' value in the test of homogenity of error mean squares indicated that the error mean squares at the two locations were dissimilar. Hence a weighted analysis was done for determining the variety x location interaction. The $\chi^2$ value for the variety x location sum of squares was highly significant. This indicated that the varieties varied from location to location. Further, in the unweighted analysis done to compare the varietal means, the non-significant 'F' value for varieties indicated that there was no significant varietal difference.

6. Length of pod.

The analysis of variance is presented in Appendix-6. The highly significant 'F' value for varieties at both the locations indicated that the varieties were significantly different in rice fallows as well as in uplands. The mean length of pod for the 15 varieties is given in table 7.

Table 7. Length of pod (cm).

| Variety No. | Name of varieties | Rice fallows (Summer) | Uplands (Rabi) | Pooled means |
|---|---|---|---|---|
| $V_1$ | $S_1$-914-1 | 1.83 | 2.08 | 1.96 |
| $V_2$ | P.28-1 | 2.46 | 3.31 | 2.89 |
| $V_3$ | Mutant K-1 | 1.82 | 2.14 | 1.98 |
| $V_4$ | GP.III-2-1 | 2.05 | 2.18 | 2.12 |
| $V_5$ | P.10-1 | 2.62 | 2.89 | 2.76 |
| $V_6$ | P.38-1 | 2.42 | 2.49 | 2.46 |
| $V_7$ | P.28-2 | 2.34 | 2.78 | 2.56 |
| $V_8$ | No.42-1 | 2.51 | 2.87 | 2.69 |
| $V_9$ | P.23-1 | 2.39 | 2.46 | 2.43 |
| $V_{10}$ | Kayamkulam-1 | 2.16 | 2.28 | 2.22 |
| $V_{11}$ | PT-58-35 | 2.05 | 2.33 | 2.19 |
| $V_{12}$ | Culture 7-1 | 2.14 | 2.39 | 2.27 |
| $V_{13}$ | KRR-1 | 2.01 | 2.36 | 2.19 |
| $V_{14}$ | Kayamkulam-2 | 2.21 | 2.49 | 2.35 |
| $V_{15}$ | TMV-2 | 2.21 | 2.34 | 2.28 |
| | C.D. | 0.139 | 0.520 | - |

The varieties in rice fallows (summer) may be compared as follows:

$V_5$ $V_8$ $V_2$ $V_6$ $V_9$ $V_7$ $V_{14}$ $V_{15}$ $V_{10}$ $V_{12}$ $V_{11}$ $V_4$ $V_{13}$ $V_1$ $V_3$

Variety P.10-1 ($V_5$) recorded the maximum pod length (2.62 cm) and was on par with No.42-1 ($V_8$). The minimum length of pod (1.82 cm) was recorded by Mutant K-1 ($V_3$) which was on par with $S_1$-914-1 ($V_1$). Kayamkulam-1 ($V_{10}$) recorded a pod length of 2.16 cm and was on par with Culture 7-1 ($V_{12}$), PT-58-35 ($V_{11}$) and GPIII-2-1 ($V_4$). Kayamkulam-2 ($V_{14}$) recorded a mean pod length of 2.21 cm and was on par with TMV-2 ($V_{15}$), Kayamkulam-1 ($V_{10}$) and Culture 7-1 ($V_{12}$).

The varieties in uplands (rabi) may be compared as follows:

$V_2$ $V_5$ $V_8$ $V_7$ $V_6$ $V_{14}$ $V_9$ $V_{12}$ $V_{13}$ $V_{15}$ $V_{11}$ $V_{10}$ $V_4$ $V_3$ $V_1$

P.28-1 ($V_2$) recorded the highest pod length (3.31 cm) and was on par with P.10-1 ($V_5$) and No.42-1 ($V_8$). The lowest value was recorded by $S_1$-914-1 ($V_1$) with a mean of 2.08 cm which was on par with Mutant K-1 ($V_3$), GPIII-2-1 ($V_4$), Kayamkulam-1 ($V_{10}$), PT-58-35 ($V_{11}$), TMV-2 ($V_{15}$), KRR-1 ($V_{13}$), Culture 7-1 ($V_{12}$), P.23-1 ($V_9$), Kayamkulam-2 ($V_{14}$) and P.38-1 ($V_6$).

The significant 'F' value in the test of homogenity of error mean squares indicated that the error mean squares at the two locations were dissimilar. Hence the weighted analysis was done for determining the variety x location interaction. The non-significant $\chi^2$ value for the variety location sum of squares indicated that the interaction was not significant. Hence the varieties did not vary with locations with respect to the length of pods. The test for individual degrees of freedom adopted to compare the varietal means with that of the two standard varieties Kayamkulam-1 ($V_{10}$) and Kayamkulam-2 ($V_{14}$) indicated that P.28-1 ($V_2$), GPIII-2-1 ($V_4$), PT-58-35 ($V_{11}$), Culture 7-1 ($V_{12}$) and TMV-2 ($V_{15}$) were on par with Kayamkulam-1. But varieties $S_1$-914-1 ($V_1$), Mutant K-1 ($V_3$), P.10-1 ($V_5$), P.38-1 ($V_6$), P.28-2 ($V_7$), No.42-1 ($V_8$), P.23-1 ($V_9$) and KRR-1 ($V_{13}$) differed significantly from Kayamkulam-1. Varieties P.28-1 ($V_2$), Culture 7-1 ($V_{12}$) and TMV-2 ($V_{15}$) were on par with Kayamkulam-2. The rest of the varieties were significantly different from Kayamkulam-2. Varieties $S_1$-914-1 ($V_1$), Mutant K-1 ($V_3$), GPIII-2-1 ($V_4$), Kayamkulam-1 ($V_{10}$), PT-58-35 ($V_{11}$) and KRR-1 ($V_{13}$) recorded lower values than Kayamkulam-2 and the remaining four varieties produced longer pods than Kayamkulam-2.

7. <u>Number of locules per pod.</u>

The analyses of variance for each location as well as for both locations together is given in Appendix-7.

The highly significant 'F' ratios for varieties at both the locations indicated that the varieties differed significantly irrespective of the location. The mean number of locules per pod is given in table 8.

The varieties in the rice fallows (summer) may be compared as follows:

$$V_8 \; V_9 \; V_7 \; V_6 \; \overline{V_1 \; V_2 \; V_3 \; V_4 \; V_5 \; V_{10} \; V_{11} \; V_{12} \; V_{13} \; V_{14} \; V_{15}}$$

Among the four multiloculed varieties, No.42-1 ($V_8$) recorded the maximum number of locules per pod (7.3) and the lowest value of 5.6 was recorded by P.38-1 ($V_6$). The remaining eleven varieties were four loculed.

The varieties in uplands (rabi) may be compared as follows:

$$V_6 \; V_8 \; \overline{V_9 \; V_7} \; \overline{V_1 \; V_2 \; V_3 \; V_4 \; V_5 \; V_{10} \; V_{11} \; V_{12} \; V_{13} \; V_{14} \; V_{15}}$$

Among the four multiloculed varieties, P.38-1 ($V_6$) recorded the maximum number of locules per pod (7.1) and the lowest value of 6.1 was recorded by P.28-2 ($V_7$). No.42-1 ($V_8$) with 6.8 locules was intermediate. The remaining eleven varieties were four loculed.

The non-significant 'F' value in the test of homogenity of error mean squares indicated that the error mean squares at the two locations were similar. Hence the simple analysis of variance was adopted for determining the variety x location interaction. The highly significant 'F' value for variety x location interaction in the

Table 8. Number of locules per pod.

| Variety No. | Name of varieties | Rice fallows (Summer) | Uplands (Rabi) | Pooled means |
|---|---|---|---|---|
| $V_1$ | $S_1$-914-1 | 4.0 | 4.0 | 4.0 |
| $V_2$ | P.28-1 | 4.0 | 4.0 | 4.0 |
| $V_3$ | Mutant K-1 | 4.0 | 4.0 | 4.0 |
| $V_4$ | GP.III-2-1 | 4.0 | 4.0 | 4.0 |
| $V_5$ | P.10-1 | 4.0 | 4.0 | 4.0 |
| $V_6$ | P.38-1 | 5.6 | 7.1 | 6.4 |
| $V_7$ | P.28-2 | 5.8 | 6.1 | 6.0 |
| $V_8$ | No.42-1 | 7.3 | 6.8 | 7.1 |
| $V_9$ | P.23-1 | 6.0 | 6.2 | 6.1 |
| $V_{10}$ | Kayamkulam-1 | 4.0 | 4.0 | 4.0 |
| $V_{11}$ | PT-58-35 | 4.0 | 4.0 | 4.0 |
| $V_{12}$ | Culture 7-1 | 4.0 | 4.0 | 4.0 |
| $V_{13}$ | KRR-1 | 4.0 | 4.0 | 4.0 |
| $V_{14}$ | Kayamkulam-2 | 4.0 | 4.0 | 4.0 |
| $V_{15}$ | TMV-2 | 4.0 | 4.0 | 4.0 |
| | C.D. | 0.17 | 0.25 | 0.45 |

pooled analysis indicated that the number of locules per pod in these varieties varied with locations. Further, the highly significant 'F' value for varieties indicated that there was significant difference among the 15 varieties, even if the performance in both the locations was considered together.

The pooled means may be compared as follows:

$$V_8 \; V_6 \; V_9 \; V_7 \; V_1 \; V_2 \; V_3 \; V_4 \; V_5 \; V_{10} \; V_{11} \; V_{12} \; V_{13} \; V_{14} \; V_{15}$$

Among the four multiloculed varieties, No.42-1 ($V_8$) recorded the maximum number of locules per pod (7.1). P.28-2 ($V_7$) recorded the minimum number (6.0). This was on par with P.23-1 ($V_9$) and P.38-1 ($V_6$). All the remaining eleven varieties were four loculed.

8. Number of seeds per pod.

The analyses of variance for each location as well as for both the locations are presented in Appendix-8. The 'F' values for varieties were highly significant at both the locations, indicating that the varieties differed irrespective of the location. The mean number of seeds per pod for the 15 varieties is given in table 9 and figure-5.

The varieties in rice fallows (summer) may be compared as follows:

$$V_8 \; V_9 \; V_7 \; V_6 \; V_5 \; V_{14} \; V_2 \; V_{12} \; V_{15} \; V_4 \; V_{10} \; V_{13} \; V_{11} \; V_1 \; V_3$$

Table 9. Number of seeds per pod.

| Variety No. | Name of varieties | Rice fallows (Summer) | Uplands (Rabi) | Pooled means |
|---|---|---|---|---|
| $V_1$ | $S_1$-914-1 | 46.4 | 51.5 | 49.0 |
| $V_2$ | P.28-1 | 58.0 | 65.3 | 61.7 |
| $V_3$ | Mutant K-1 | 45.3 | 48.3 | 46.8 |
| $V_4$ | GP.III-2-1 | 50.9 | 56.1 | 53.5 |
| $V_5$ | P.10-1 | 65.4 | 72.8 | 69.1 |
| $V_6$ | P.38-1 | 76.9 | 92.7 | 84.8 |
| $V_7$ | P.28-2 | 84.3 | 94.4 | 89.4 |
| $V_8$ | No.42-1 | 100.7 | 100.4 | 100.6 |
| $V_9$ | P.23-1 | 87.8 | 95.0 | 91.4 |
| $V_{10}$ | Kayamkulam-1 | 49.2 | 54.0 | 51.6 |
| $V_{11}$ | PT-58-35 | 47.2 | 55.6 | 51.4 |
| $V_{12}$ | Culture 7-1 | 55.3 | 58.4 | 56.9 |
| $V_{13}$ | KHR-1 | 47.5 | 57.0 | 52.3 |
| $V_{14}$ | Kayamkulam-2 | 58.5 | 60.6 | 59.6 |
| $V_{15}$ | TMV-2 | 51.4 | 61.2 | 56.3 |
| | C.D. | 5.71 | 8.34 | 4.53 |

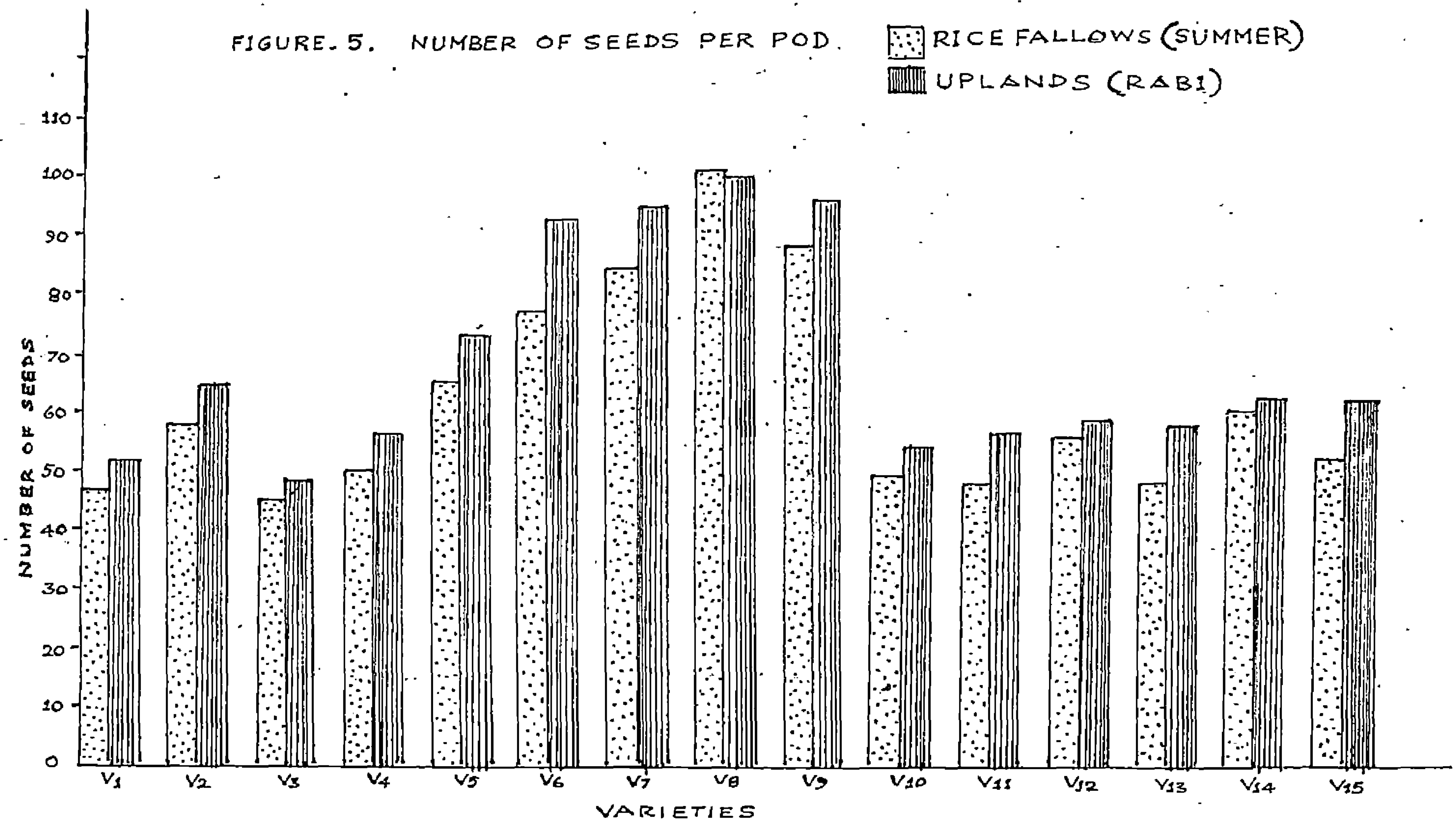


FIGURE. 5. NUMBER OF SEEDS PER POD.
RICE FALLOWS (SUMMER)
UPLANDS (RABI)
NUMBER OF SEEDS
0
10
20
30
40
50
60
70
80
90
100
110
V1
V2
V3
V4
V5
V6
V7
V8
V9
V10
V11
V12
V13
V14
V15
VARIETIES

No.42-1 ($V_8$) produced the maximum number of seeds per pod (100.7). The minimum number of seeds per pod (45.3) was recorded by Mutant K-1 ($V_3$), which was on par with $S_1$-914-1 ($V_1$), PT-58-35 ($V_{11}$), KRR-1 ($V_{13}$), Kayamkulam-1 ($V_{10}$) and GPIII-2-1 ($V_4$). Kayamkulam-1 was on par with KRR-1 ($V_{13}$), PT-58-35 ($V_{11}$), $S_1$-914-1 ($V_1$) and Mutant K-1 ($V_3$). Kayamkulam-2 ($V_{14}$) was on par with P.28-1 ($V_2$) and Culture 7-1 ($V_{12}$).

The varieties in the uplands (rabi) may be compared as follows:

$$V_8 \; V_9 \; V_7 \; V_6 \; V_5 \; V_2 \; V_{15} \; V_{14} \; V_{12} \; V_{13} \; V_4 \; V_{11} \; V_{10} \; V_1 \; V_3$$

No.42-1 ($V_8$) recorded the maximum number of seeds per pod (100.4). This was, however, on par with the remaining three multiloculed varieties viz., P.23-1 ($V_9$), P.28-2 ($V_7$) and P.38-1 ($V_6$). The minimum number (48.3) was recorded by Mutant K-1 ($V_3$) which was on par with $S_1$-914-1 ($V_1$), Kayamkulam-1 ($V_{10}$), PT-58-35 ($V_{11}$) and GP.III-2-1 ($V_4$). Kayamkulam-1 was on par with PT-58-35 ($V_{11}$), GP III-2-1 ($V_4$), KRR-1 ($V_{13}$), Culture 7-1 ($V_{12}$), Kayamkulam-2 ($V_{14}$) and TMV-2 ($V_{15}$). Kayamkulam-2 was on par with Culture 7-1 ($V_{12}$), KRR-1 ($V_{13}$), PT-58-35 ($V_{11}$) and Kayamkulam-1.

The non-significant 'F' value in the test of homogenity of error mean squares indicated that the error mean squares at the two locations were similar. Hence the simple analysis of variance was adopted for determining the variety x location interaction. The non-significant 'F' value for variety x location interaction in the pooled analysis indicated that the number of seeds per pod did not vary from location to location. The significant 'F' value for the varieties indicated that there was significant difference among the varieties irrespective of the location.

The pooled means can be compared as follows:

$$V_8\ V_9\ V_7\ V_6\ V_5\ V_2\ V_{14}\ V_{12}\ V_{15}\ V_4\ V_{13}\ V_{10}\ V_{11}\ V_1\ V_3$$

No.42-1 ($V_8$) recorded the maximum number of seeds (100.6) per pod. This was significantly higher than the number in all the other varieties. Mutant K-1 ($V_3$) recorded the lowest number of seeds (46.8) per pod, which was on par with $S_1$-914-1 ($V_1$). Kayamkulam-1 ($V_{10}$) recorded a mean number of 51.6 seeds. The pods of Kayamkulam-2 had slightly larger number of seeds (59.6).

9. <u>Seed yield per plant</u>.

The analyses of variance for each location as well as for both the locations together are given in Appendix-9. The significant 'F' values for varieties at both locations indicated that the varieties differed in seed yield at both locations. The mean seed yield per plant is presented in table 10 and figure-6.

Table 10. Seed yield per plant (g).

| Variety No. | Name of varieties | Rice fallows (Summer) | Uplands (Rabi) | Pooled means |
|---|---|---|---|---|
| $V_1$ | $S_1$-914-1 | 1.14 | 3.07 | 2.11 |
| $V_2$ | P.28-1 | 2.28 | 4.85 | 3.57 |
| $V_3$ | Mutant K-1 | 1.20 | 4.21 | 2.71 |
| $V_4$ | GP.III-2-1 | 1.95 | 4.02 | 2.99 |
| $V_5$ | P.10-1 | 3.92 | 5.41 | 4.67 |
| $V_6$ | P.38-1 | 3.89 | 3.68 | 3.79 |
| $V_7$ | P.28-2 | 2.24 | 5.33 | 3.79 |
| $V_8$ | No.42-1 | 1.76 | 5.31 | 3.54 |
| $V_9$ | P.23-1 | 2.32 | 6.01 | 4.17 |
| $V_{10}$ | Kayamkulam-1 | 2.08 | 4.38 | 3.23 |
| $V_{11}$ | ET-58-35 | 1.31 | 5.91 | 3.61 |
| $V_{12}$ | Culture 7-1 | 1.36 | 5.14 | 3.25 |
| $V_{13}$ | KRR-1 | 1.79 | 3.23 | 2.51 |
| $V_{14}$ | Kayamkulam-2 | 1.87 | 3.17 | 2.52 |
| $V_{15}$ | TMV-2 | 1.56 | 3.12 | 2.34 |
| | C.D. | 0.565 | 1.661 | NS |

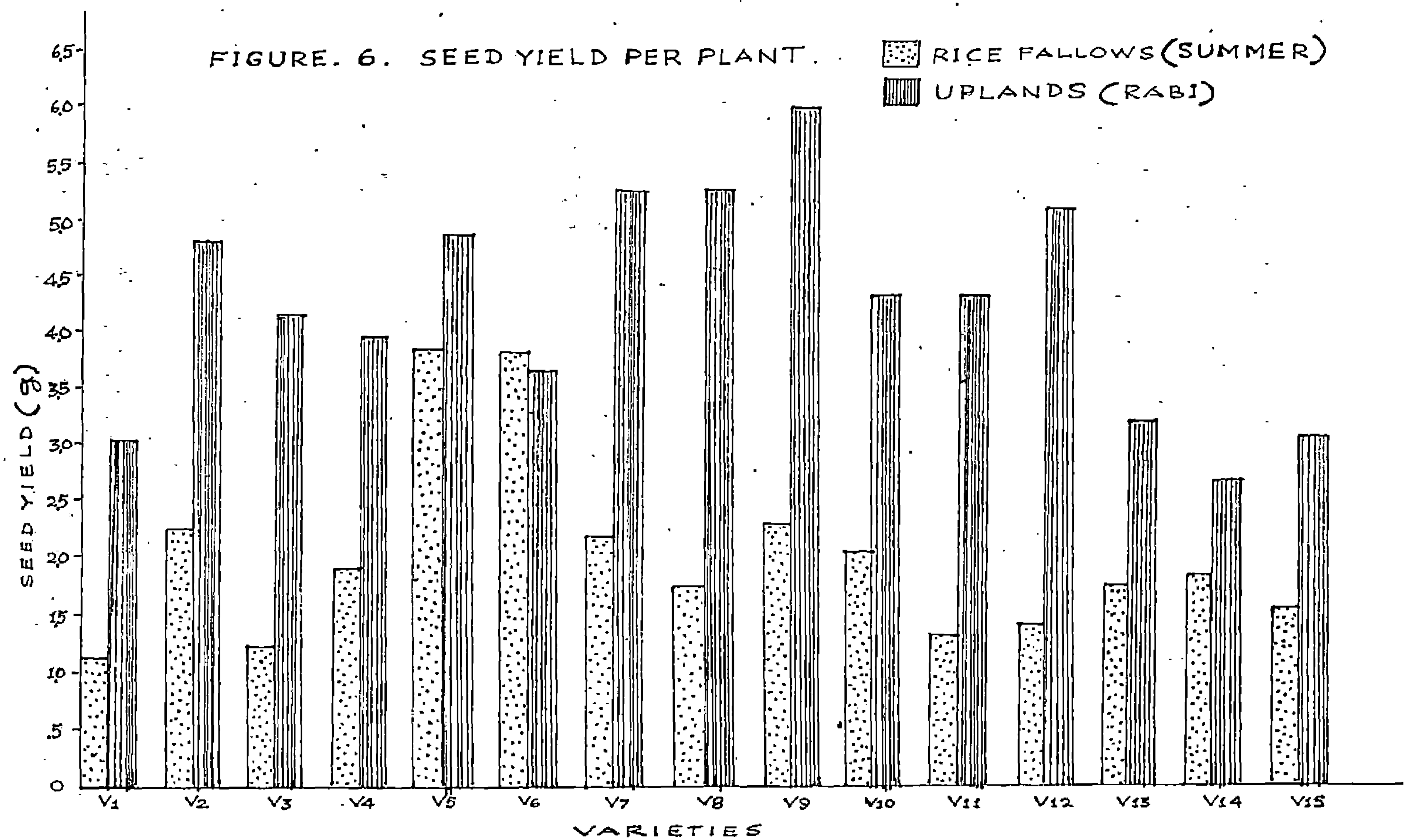


FIGURE. 6. SEED YIELD PER PLANT.
RICE FALLOWS (SUMMER)
UPLANDS (RABI)
SEED YIELD (g)
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
.5
0
V1
V2
V3
V4
V5
V6
V7
V8
V9
V10
V11
V12
V13
V14
V15
VARIETIES

The varieties in rice fallows (summer) may be compared as follows:

$V_5\ V_6\ V_9\ V_2\ V_7\ V_{10}\ V_4\ V_{14}\ V_{13}\ V_8\ V_{15}\ V_{12}\ V_{11}\ V_3\ V_1$

P.10-1 ($V_5$) recorded the highest seed yield of 3.92 g per plant and was on par with P.38-1 ($V_6$). The lowest mean seed yield per plant (1.14 g) was recorded by $S_1$-914-1 ($V_1$). This was on par with Mutant K-1 ($V_3$), PT-58-35 ($V_{11}$), Culture 7-1 ($V_{12}$) and TMV-2 ($V_{15}$). Kayamkulam-1 ($V_{10}$) recorded a mean seed yield of 2.08 g which was on par with GPIII-2-1 ($V_4$), Kayamkulam-2 ($V_{14}$), KRR-1 ($V_{13}$), No.42-1 ($V_8$) and TMV-2 ($V_{15}$). Kayamkulam-2 with a mean of 1.87 g was on par with KRR-1 ($V_{13}$), No.42-1 ($V_8$), TMV-2 ($V_{15}$), Culture 7-1 ($V_{12}$) and PT-58-35 ($V_{11}$).

The varieties in uplands (rabi) may be compared as follows:

$V_9\ V_{11}\ V_5\ V_7\ V_8\ V_{12}\ V_2\ V_{10}\ V_3\ V_4\ V_6\ V_{14}\ V_{13}\ V_{15}\ V_1$

P.23-1 ($V_9$) recorded the maximum seed yield of 6.01 g per plant. This was on par with PT-58-35 ($V_{11}$), P.10-1 ($V_5$), P.28-2 ($V_7$), No.42-1 ($V_8$), Culture 7-1 ($V_{12}$), P.28-1 ($V_2$) and Kayamkulam-1 ($V_{10}$). As in rice fallows $S_1$-914-1 ($V_1$) recorded the minimum seed yield of 3.07 g. This was on par with TMV-2 ($V_{15}$), KRR-1 ($V_{13}$), Kayamkulam-2 ($V_{14}$), P.38-1 ($V_6$), GP.III-2-1 ($V_4$), Mutant K-1 ($V_3$) and Kayamkulam-1.

The significant 'F' value in the test of homogenity of error mean squares indicated that the error mean squares at the two locations were dissimilar. Hence a weighted analysis was done for determining the variety x location interaction. The highly significant $\chi^2$ value for the variety x location sum of squares indicated that seed yield per plant varied from location to location. Further, in the unweighted analysis done to compare the varietal means, the non-significant 'F' value for the varieties indicated that the varieties did not differ substantially in seed yield.

10. Weight of thousand seeds.

The analyses of variance for each location as well as for both the locations together are presented in Appendix-10. The highly significant 'F' values for varieties at both the locations revealed that there was significant difference among the 15 varieties. The mean weight of thousand seeds for the 15 varieties is given in table 11 and figure-7.

The varieties in rice fallows (summer) may be compared as follows:

$V_5$ $V_6$ $V_{15}$ $V_{11}$ $V_{12}$ $V_{10}$ $V_4$ $V_2$ $V_3$ $V_8$ $V_{14}$ $V_{13}$ $V_7$ $V_1$ $V_9$

Table 11. Weight of thousand seeds (g).

| Variety No. | Name of varieties | Rice fallows (Summer) | Uplands (Rabi) | Pooled means |
|---|---|---|---|---|
| $V_1$ | $S_1$-914-1 | 2.41 | 2.55 | 2.48 |
| $V_2$ | P.28-1 | 2.71 | 3.15 | 2.93 |
| $V_3$ | Mutant K-1 | 2.61 | 2.61 | 2.61 |
| $V_4$ | GP.III-2-1 | 2.73 | 2.57 | 2.65 |
| $V_5$ | P.10-1 | 3.61 | 3.32 | 3.47 |
| $V_6$ | P.38-1 | 3.42 | 2.96 | 3.19 |
| $V_7$ | P.28-2 | 2.52 | 3.24 | 2.88 |
| $V_8$ | No.42-1 | 2.57 | 3.10 | 2.84 |
| $V_9$ | P.23-1 | 2.17 | 2.40 | 2.29 |
| $V_{10}$ | Kayamkulam-1 | 2.76 | 2.86 | 2.81 |
| $V_{11}$ | PT-58-35 | 2.83 | 2.67 | 2.75 |
| $V_{12}$ | Culture 7-1 | 2.77 | 2.80 | 2.79 |
| $V_{13}$ | KRR-1 | 2.54 | 2.69 | 2.62 |
| $V_{14}$ | Kayamkulam-2 | 2.55 | 2.57 | 2.56 |
| $V_{15}$ | TMV-2 | 2.95 | 2.55 | 2.75 |
| | C.D. | 0.472 | 0.214 | 0.369 |

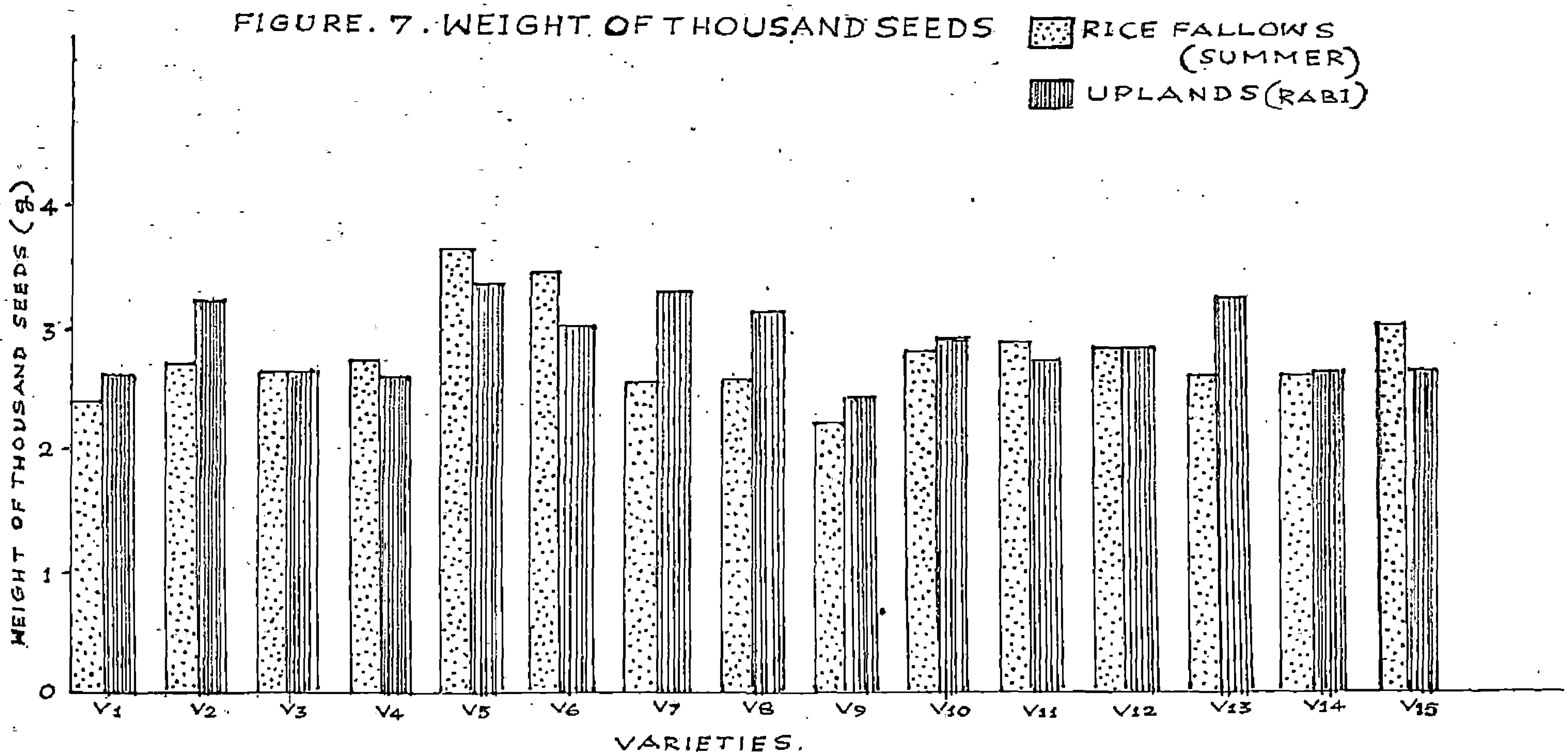


FIGURE. 7. WEIGHT OF THOUSAND SEEDS
RICE FALLOWS (SUMMER)
UPLANDS (RABI)
WEIGHT OF THOUSAND SEEDS (g)
0
1
2
3
4
V1
V2
V3
V4
V5
V6
V7
V8
V9
V10
V11
V12
V13
V14
V15
VARIETIES.

P.10-1 ($V_5$) recorded the maximum weight for thousand seeds (3.61 g). This was on par with P.38-1 ($V_6$). The minimum weight of 2.17 g was recorded by P.23-1 ($V_9$). This was on par with $S_1$-914-1 ($V_1$), P.28-2 ($V_7$), KRR-1 ($V_{13}$), Kayamkulam-2 ($V_{14}$), No.42-1 ($V_8$) and Mutant K-1 ($V_3$). Kayamkulam-1 ($V_{10}$) recorded a mean weight of 2.76 g and was on par with GPIII-2-1 ($V_4$), P.28-1 ($V_2$), Mutant K-1 ($V_3$), No.42-1 ($V_8$), Kayamkulam-2 ($V_{14}$), KRR-1 ($V_{13}$), P.28-2 ($V_7$) and $S_1$-914-1 ($V_1$). Kayamkulam-2 recorded a weight of 2.55 g.

The varieties in uplands (rabi) may be compared as follows:

$V_5$ $V_7$ $V_2$ $V_8$ $V_6$ $V_{10}$ $V_{12}$ $V_{13}$ $V_{11}$ $V_3$ $V_4$ $V_{14}$ $V_1$ $V_{15}$ $V_9$

P.10-1 ($V_5$) recorded the maximum weight for thousand seeds (3.32 g) in uplands also. This was on par with P.28-2 ($V_7$) and P.28-1 ($V_2$). Similarly, P.23-1 ($V_9$) recorded the minimum weight of 2.40 g at this location also. This was on par with TMV-2 ($V_{15}$), $S_1$-914-1 ($V_1$), Kayamkulam-2 ($V_{14}$), GPIII-2-1 ($V_4$) and Mutant K-1 ($V_3$). Kayamkulam-1 ($V_{10}$) recorded a mean weight of 2.86 g and Kayamkulam-2, 2.57 g.

The significant 'F' value in the test of homogenity of error mean squares indicated that the error mean squares at the two locations were dissimilar. Hence a weighted analysis was done for determining the variety x location interaction. The highly significant $\chi^2$ value for the variety x location sum of squares indicated that the varieties differed from location to location with respect to this character. In the unweighted analysis done to compare varietal means, the significant 'F' value for varieties revealed that the varieties varied in the mean weight of thousand seeds irrespective of locations.

The pooled means may be compared as follows:

$$V_5 \; V_6 \; \overline{V_2 \; V_7 \; V_8 \; V_{10} \; V_{12} \; V_{11} \; V_{15} \; V_4 \; V_{13} \; V_3} \; \overline{V_{14} \; V_1 \; V_9}$$

P.10-1 ($V_5$) recorded the maximum weight for thousand seeds (3.46 g). This was significantly higher than the seed weight of all the other varieties. P.23-1 ($V_9$) recorded the lowest weight of 2.29 g. This was on par with $S_1$-914-1 ($V_1$) and Kayamkulam-2 ($V_{14}$). Kayamkulam-1 ($V_{10}$) recorded 2.81 g whereas Kayamkulam-2 ($V_{14}$) recorded 2.56 g.

11. Oil content.

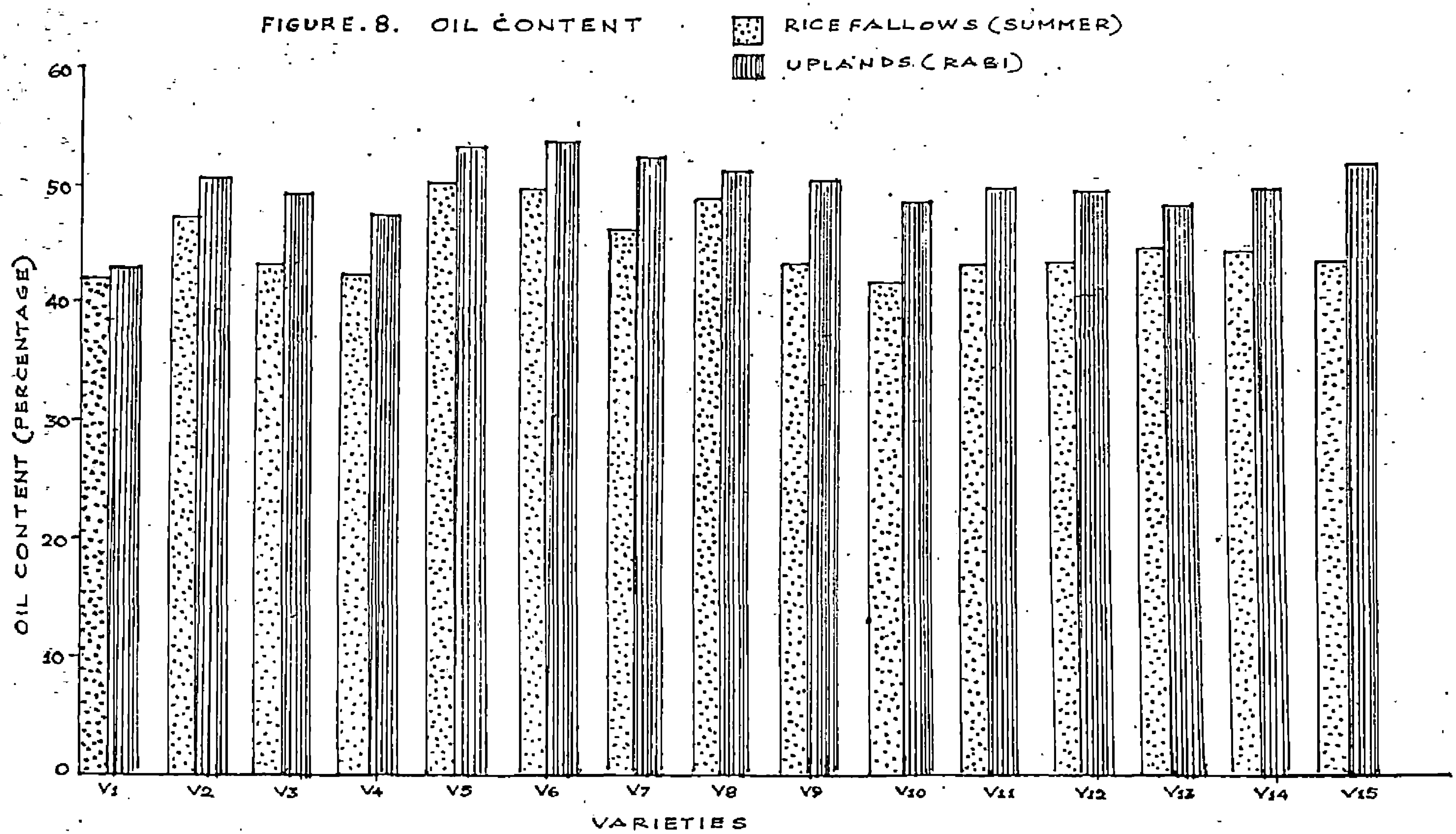
The analyses of variance for each of the two locations and also for the locations together are presented in Appendix-11. The 'F' values for varieties at both the locations were highly significant, indicating substantial difference among the 15 varieties for oil content. The mean values for oil content for the 15 varieties are given in table 12 and figure-8.

The values in rice fallows (summer) can be compared as follows:

Table 12. Oil content (Percentage)

| Variety No. | Name of varieties | Rice fallows (Summer) | Uplands (Rabi) | Pooled means |
|---|---|---|---|---|
| $V_1$ | $S_1$-914-1 | 42.0 | 43.4 | 42.7 |
| $V_2$ | P.28-1 | 47.3 | 50.6 | 49.0 |
| $V_3$ | Mutant K-1 | 43.1 | 49.3 | 46.2 |
| $V_4$ | GP.III-2-1 | 42.4 | 47.6 | 45.0 |
| $V_5$ | P.10-1 | 50.1 | 53.2 | 51.7 |
| $V_6$ | P.38-1 | 49.5 | 53.6 | 51.6 |
| $V_7$ | P.28-2 | 46.3 | 52.5 | 49.4 |
| $V_8$ | No.42-1 | 48.7 | 51.4 | 50.1 |
| $V_9$ | P.23-1 | 43.3 | 50.4 | 46.9 |
| $V_{10}$ | Kayamkulam-1 | 41.5 | 48.3 | 44.9 |
| $V_{11}$ | PT-58-35 | 42.8 | 49.1 | 46.0 |
| $V_{12}$ | Culture 7-1 | 43.2 | 49.3 | 46.3 |
| $V_{13}$ | KRR-1 | 44.4 | 48.1 | 46.3 |
| $V_{14}$ | Kayamkulam-2 | 44.4 | 49.6 | 47.0 |
| $V_{15}$ | TMV-2 | 43.0 | 51.6 | 47.3 |
| | C.D. | 1.05 | 1.40 | 2.10 |

FIGURE. 8. OIL CONTENT



$\overline{V_5}\ \overline{V_6}\ V_8\ V_2\ V_7\ \overline{V_{13}}\ V_{14}\ \overline{V_9}\ V_{12}\ V_3\ V_{15}\ \overline{V_{11}}\ V_4\ V_1\ V_{10}$

P.10-1 ($V_5$) recorded the maximum oil content of 50.1 per cent. This was on par with P.38-1 ($V_6$). Kayamkulam-1 ($V_{10}$) recorded the minimum value of 41.6 per cent. This was on par with $S_1$-914-1 ($V_1$) and GRIII-2-1 ($V_4$). Kayamkulam-2 ($V_{14}$) recorded a value of 44.4 per cent.

The values in uplands (rabi) may be compared as follows:

$\overline{V_6\ V_5\ V_7}\ \overline{V_{15}}\ V_8\ V_2\ V_9\ V_{14}\ V_3\ V_{12}\ V_{11}\ \overline{V_{10}}\ V_{13}\ V_4\ V_1$

P.38-1 ($V_6$) recorded the maximum oil content of 53.6 per cent. This was on par with P.10-1 ($V_5$) and P.28-2 ($V_7$). The minimum value of 43.4 per cent was recorded by $S_1$-914-1 ($V_1$).

The non-significant 'F' value in the test of homogenity of error mean squares indicated that the error mean squares at the two locations were similar. Hence the simple analysis of variance was adopted for determining the variety x location interaction. The highly significant 'F' value for variety x location interaction in the pooled analysis indicated that the oil content of varieties varied with locations. Further, the highly significant 'F' value for the varieties indicated that the varieties differed substantially in oil content irrespective of the locations.

The oil content was higher in uplands during rabi than the rice fallows during summer for all the 15 varieties.

The pooled means may be compared as follows:

$V_5$ $V_6$ $V_8$ $V_7$ $V_2$ $V_{15}$ $V_{14}$ $V_9$ $V_{12}$ $V_{13}$ $V_3$ $V_{11}$ $V_4$ $V_{10}$ $V_1$

P.10-1 ($V_5$) recorded the highest percentage of oil (51.7). This was on par with P.38-1 ($V_6$) and No.42-1 ($V_8$). The minimum value of 42.7 per cent was recorded for $S_1$-914-1 ($V_1$). Kayamkulam-1 ($V_{10}$) and Kayamkulam-2 ($V_{14}$) recorded oil contents of 44.9 and 47.0 per cent respectively.

II. <u>Variances and coefficients of variation.</u>

The genotypic, environmental and phenotypic variances were calculated for each of the 11 characters and two locations separately. The genotypic and phenotypic coefficients of variation were also computed separately for each character and location.

The estimates for rice fallows are presented in table 13. Number of days to flowering showed a higher environmental variance (0.414) than the genotypic variance (0.005). Number of days to maturity recorded zero environmental variance and hence the genotypic and phenotypic variances were the same (5.924). Height of plants showed very high genotypic variance (77.156) than the environmental variance (12.835) to give a high phenotypic variance (89.991). Number of pods per axil exhibited mostly similar genotypic

Table 13. Mean, variance and coefficients of variation in rice fallows (Summer).

| Sl. No. | Characters | General mean | Variance | | | Coefficients of variation | |
|---|---|---|---|---|---|---|---|
| | | | Genotypic | Environmental | Phenotypic | Genotypic | Phenotypic |
| 1. | Number of days to flowering | 37.6 | 0.005 | 0.414 | 0.419 | 0.188 | 1.722 |
| 2. | Number of days to maturity | 79.3 | 5.924 | 0 | 5.924 | 3.071 | 3.071 |
| 3. | Height of plants (cm) | 66.1 | 77.156 | 12.835 | 89.991 | 13.289 | 14.352 |
| 4. | Number of pods per axil | 1.02 | 0.001 | 0.002 | 0.003 | 3.100 | 5.370 |
| 5. | Number of pods per plant | 17.5 | 51.222 | 9.256 | 60.478 | 40.897 | 44.439 |
| 6. | Length of pod (cm) | 2.21 | 0.055 | 0.004 | 0.059 | 10.612 | 10.991 |
| 7. | Number of locules per pod | 4.6 | 1.114 | 0.006 | 1.120 | 22.945 | 23.007 |
| 8. | Number of seeds per pod | 61.6 | 305.723 | 7.098 | 312.821 | 28.385 | 28.712 |
| 9. | Seed yield per plant (g) | 2.04 | 0.681 | 0.069 | 0.750 | 40.452 | 42.452 |
| 10. | Weight of thousand seeds (g) | 2.75 | 0.109 | 0.048 | 0.157 | 12.005 | 14.408 |
| 11. | Oil content (%) | 44.8 | 8.004 | 0.239 | 8.243 | 6.315 | 6.409 |

and environmental variances (0.001 and 0.002 respectively). The phenotypic variance was also consequently very low (0.003). Number of pods per plant showed high genotypic variance (51.222) and phenotypic variance (60.478) with low environmental variance (9.256). Length of pod exhibited higher genotypic variance (0.055) than the environmental variance (0.004). Number of locules per pod showed very high genotypic variance (1.114) in comparison with the environmental variance (0.006), the phenotypic variance being 1.120. Number of seeds per pod also showed high genotypic variance (305.723) in relation to the environmental variance (7.098). The genotypic variance for seed yield per plant (0.681) was also higher than the environmental variance (0.069). Weight of thousand seeds showed high genotypic variance (0.109) than environmental variance (0.048). Oil content showed high genotypic and phenotypic variances (8.004) and 8.243 respectively) with low environmental variance (0.239).

The genotypic coefficient of variation was highest for number of pods per plant (40.897) closely followed by seed yield per plant (40.452). This was followed by number of seeds per pod, number of locules per pod, height of plants, weight of thousand seeds, length of pod, oil content, number of pods per axil and number of days to maturity. Days to flowering recorded the lowest genotypic coefficient of variation (0.188). Phenotypic coefficient of variation also followed a similar pattern with the highest value for number of pods per plant (44.439) and the lowest for number of days to flowering (1.722).

The estimates for uplands is presented in table 14. Number of days to flowering showed a lower genotypic variance (0.340) and a higher environmental variance (3.762). Number of days to maturity had zero environmental variance and hence the genotypic and phenotypic variances were the same (2.667). Height of plants showed a very high environmental variance (99.888) when compared to the genotypic variance (26.009). The high phenotypic variance (125.897) was mostly due to environmental contribution. Number of pods per axil showed higher genotypic variance (0.214) than environmental variance (0.038). Number of pods per plant also showed higher environmental variance (95.677) than the genotypic variance (38.741). Length of pod had slightly lower environmental variance (0.059) than genotypic variance (0.082). Number of locules per pod had high genotypic variance (1.405) and low environmental variance (0.014). Number of seeds per pod had a very high genotypic variance (320.911) than the environmental variance (15.121).

Seed yield per plant had slightly higher genotypic variance (0.756) than environmental variance (0.600). Weight of thousand seeds had higher genotypic variance (0.081) than environmental variance (0.010). The genotypic variance for oil content was 6.359 with a low environmental variance of 0.429 and a phenotypic variance of 6.788.

Table 14. Mean, variance and coefficients of variation in uplands (Rabi).

| Sl. No. | Characters | General mean | Variance | | | Coefficients of variation | |
|---|---|---|---|---|---|---|---|
| | | | Genotypic | Environmental | Phenotypic | Genotypic | Phenotypic |
| 1. | Number of days to flowering | 39.9 | 0.340 | 3.762 | 4.102 | 1.461 | 5.076 |
| 2. | Number of days to maturity | 86.3 | 2.667 | 0 | 2.667 | 1.892 | 1.892 |
| 3. | Height of plants (cm) | 123.0 | 26.009 | 99.888 | 125.897 | 4.146 | 9.122 |
| 4. | Number of pods per axil | 1.45 | 0.214 | 0.038 | 0.252 | 31.904 | 34.620 |
| 5. | Number of pods per plant | 36.3 | 38.741 | 95.677 | 134.418 | 17.147 | 31.939 |
| 6. | Length of pod (cm) | 2.49 | 0.082 | 0.059 | 0.141 | 11.500 | 15.080 |
| 7. | Number of locules per pod | 4.7 | 1.405 | 0.014 | 1.419 | 25.220 | 25.345 |
| 8. | Number of seeds per pod | 68.2 | 320.911 | 15.121 | 336.032 | 26.267 | 26.879 |
| 9. | Seed yield per plant (g) | 4.47 | 0.756 | 0.600 | 1.356 | 19.452 | 26.051 |
| 10. | Weight of thousand seeds (g) | 2.80 | 0.081 | 0.010 | 0.091 | 10.164 | 10.774 |
| 11. | Oil content (%) | 49.9 | 6.359 | 0.429 | 6.788 | 5.054 | 5.221 |

The genotypic coefficient of variation was highest for number of pods per axil (31.904) followed by number of seeds per pod, number of locules per pod, seed yield per plant, number of pods per plant, length of pod, weight of thousand seeds, oil content, height of plants, days to maturity and the lowest for number of days to flowering (1.461). The phenotypic coefficient of variation was also highest for number of pods per axil (34.620) followed by number of pods per plant, number of seeds per pod, seed yield per plant, number of locules per pod, length of pod, weight of thousand seeds, height of plants, oil content, number of days to flowering and the lowest for number of days to maturity (1.892).

III. Correlations between characters:

The correlations among the eleven characters were computed in all possible combinations. The genotypic and phenotypic correlation coefficients were estimated separately for each location.

i) Genotypic correlations:

The correlation coefficients for the two locations are presented in table 15. In rice fallows (upper triangular portion of the table 15), 45 out of the 55 genotypic correlations were positive and the remaining 10 were negative. Seed yield per plant was positively and significantly correlated with number of days to flowering, number of days to maturity, height of plants, number of

Table 15. Genotypic correlation coefficients

| Sl. No. | Characters | No. of days to flowering | No. of days to maturity | Height of plants | No. of pods per axil | No. of pods per plant | Length of pod | No. of locules per pod | No. of seeds per pod | Seed yield per plant | Weight of thousand seeds | Oil content |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Number of days to flowering | - | 1.00** | 1.00** | 1.00** | 0.83** | 1.00** | 1.00** | 1.00** | 1.00** | 1.00** | 1.00** |
| 2. | Number of days to maturity | -0.07 | - | 0.77** | -0.11 | 0.65** | 0.67** | 0.63** | 0.72** | 0.68** | 0.33 | 0.76** |
| 3. | Height of plants | 1.00** | 0.77** | - | 0.24 | 0.72** | 0.68** | 0.47 | 0.66** | 0.63** | 0.22 | 0.63** |
| 4. | Number of pods per axil | 0.71** | -0.67** | 0.05 | - | -0.29 | -0.06 | -0.34 | -0.20 | -0.22 | -0.05 | -0.13 |
| 5. | Number of pods per plant | 0.44 | 0.01 | -0.25 | 0.55* | - | 0.56* | 0.19 | 0.36 | 0.70** | 0.52* | 0.54* |
| 6. | Length of pod | -1.00** | 0.35 | -0.80** | -0.48 | -0.62* | - | 0.55* | 0.75** | 0.75** | 0.44 | 0.82** |
| 7. | Number of locules per pod | -0.19 | -0.12 | -0.55* | -0.58* | -0.79** | 0.34 | - | 0.95** | 0.24 | -0.20 | 0.48 |
| 8. | Number of seeds per pod | -0.32 | 0.11 | -0.40 | -0.65** | -0.83** | 0.60* | 0.95** | - | 0.42 | -0.03 | 0.62** |
| 9. | Seed yield per plant | -1.00** | 0.33 | -0.27 | -0.57* | -0.09 | 0.49 | 0.38 | 0.54* | - | 0.82** | 0.78** |
| 10. | Weight of thousand seeds | -1.00** | 0.14 | -0.30 | -0.59* | -0.57* | 0.91** | 0.30 | 0.44 | 0.49* | - | 0.61* |
| 11. | Oil content | -1.00** | -0.15 | -0.69** | -0.38 | -0.78** | 0.71** | 0.55* | 0.68** | 0.42 | 0.59* | - |

Coefficients given in the upper and lower triangular portions correspond to rice fallows and uplands respectively

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

pods per plant, length of pod, weight of thousand seeds and oil content. It was positively but non-significantly correlated with number of locules per pod and number of seeds per pod whereas the correlation with number of pods per axil was negative but non-significant.

Number of days to flowering was significantly and positively correlated with all the ten characters.

Days to maturity was significantly and positively correlated with all characters except weight of thousand seeds to which it was positively and non-significantly correlated and number of pods per axil to which it was negatively but non-significantly correlated.

Height of plants was positively and significantly correlated with number of days to flowering, number of days to maturity, number of pods per plant, length of pod, number of seeds per pod, seed yield and oil content. It had positive but non-significant correlation with number of pods per axil, number of locules per pod and weight of thousand seeds.

Number of pods per axil was positively and significantly correlated with number of days to flowering, positively and non-significantly correlated with height of plants and negatively but non-significantly correlated with the remaining eight characters.

Number of pods per plant had positive significant correlation with number of days to flowering, days to maturity, height of plants, length of pod, weight of thousand seeds, seed yield and oil content, but had non-significant positive correlation with number of locules per pod and number of seeds per pod. However, it had a negative but non-significant correlation with number of pods per axil.

Length of pod had significant positive correlation with all characters except weight of thousand seeds with which it had positive non-significant correlation and number of pods per axil with which it had negative non-significant correlation.

Number of locules per pod had positive significant correlation with days to flowering, days to maturity, length of pod and number of seeds per pod, but non-significant correlation with height of plants, number of pods per plant, seed yield and oil content. It had however negative non-significant correlation with number of pods per axil and weight of thousand seeds.

Number of seeds per pod was positively and significantly correlated with number of days to flowering, days to maturity, height of plants, length of pod, number of locules per pod, and oil content. It had positive non-significant correlation with number of pods per plant and seed yield, and had negative non-significant correlation with number of pods per axil and weight of thousand seeds.

Weight of thousand seeds in turn was positively and significantly correlated with number of days to flowering, number of pods per plant, seed yield per plant and oil content, but its correlations with days to maturity, height of plants and length of pod were not significant. It had negative but non-significant correlation with number of pods per axil, number of locules per pod and number of seeds per pod.

Oil content was positively and significantly correlated with all characters except number of locules per pod with which it had a non-significant correlation and for number of pods per axil with which it had a negative but non-significant correlation.

In uplands (lower triangular portion of table 15) 26 out of the 55 correlations were positive and the remaining 29 were negative. Seed yield was positively and significantly correlated with number of seeds per pod. It had positive but non-significant correlation with days to maturity, length of pod, number of locules per pod, weight of thousand seeds and oil content. With number of pods per plant and height of plants it had negative but non-significant correlation and negative significant correlation with days to flowering and number of pods per axil.

Number of days to flowering was positively and significantly correlated with height of plants and number of pods per axil. It had positive non-significant correlation with number of pods per plant, but negative significant correlation with length of pod, weight of thousand seeds, seed yield per plant and oil content. The correlations with days to maturity number of locules per pod and number of seeds per pod were, however, negative but non-significant.

Days to maturity was positively and significantly correlated with height of plants but with number of pods per plant, length of pods, number of seeds per pod, weight of thousand seeds and seed yield, it had non-significant correlation. With number of pods per axil it had negative significant correlation and with days to flowering, number of locules per pod and with oil content it had negative non-significant correlation.

Height of plants had positive significant correlation with days to flowering and days to maturity and positive non-significant correlation with number of pods per axil. However, the correlations with length of pods, number of locules per pod and oil content were negative and significant but with number of pods per plant, number of seeds per pod, weight of thousand seeds and seed yield the correlations were negative and non-significant.

Number of pods per axil had positive significant correlation with days to flowering and number of pods per plant but positive non-significant correlation with height of plants. The correlation was, however, negative and significant with number of days to maturity, number of locules per pod, number of seeds per pod, weight of thousand seeds and seed yield per plant but non-significant with length of pod and oil content.

Number of pods per plant had positive significant correlation with number of pods per axil and non-significant correlation with days to flowering and days to maturity. With length of pod, number of locules per pod, number of seeds per pod, weight of thousand seeds and oil content, the correlation was negative and significant, whereas with height of plants and seed yield it was negative and non-significant.

Length of pod had significant positive correlation with number of seeds per pod, weight of thousand seeds and oil content and non-significant correlation with days to maturity, number of locules per pod and seed yield. With days to flowering, height of plants, and number of pods per plant its correlation was negative and significant and with number of pods per axil it was negative and non-significant.

Number of locules per pod had significant positive correlation with number of seeds per pod and oil content; positive non-significant correlation with length of pod, weight of thousand seeds and seed yield; negative significant correlation with height of plants, number of pods per axil, and number of pods per plant, and negative non-significant correlation with days to flowering and maturity.

Number of seeds per pod had positive significant correlation with length of pod, number of locules per pod, seed yield and oil content; positive non-significant correlation with days to maturity and weight of thousand seeds; negative significant correlation with number of pods per axil and number of pods per plant and negative non-significant correlations with days to flowering and height of plants.

Weight of thousand seeds had positive significant correlation with length of pod and oil content; non-significant correlation with days to maturity, number of locules per pod, number of seeds per pod and seed yield; negative significant correlation with days to flowering, number of pods per axil, number of pods per plant and negative non-significant correlations with height of plants.

Oil content had positive significant correlation with length of pod, number of locules per pod, number of seeds per pod and weight of thousand seeds; positive non-significant correlation with seed yield; negative significant correlation with days to flowering, height of plants and number of pods per plant and negative non-significant correlation with number of pods per axil.

ii) Phenotypic correlations:

The correlation coefficients for the two locations are presented in table 16. In rice fallows (upper triangular portion of table 16) 45 out of 55 correlations were positive

Table 16. Phenotypic correlation coefficients

| Sl. No. | Characters | No. of days to flowering | No. of days to maturity | Height of plants | No. of pods per axil | No. of pods per plant | Length of pod | No. of locules per pod | No. of seeds per pod | Seed yield per plant | Weight of thousand seeds | Oil content |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Number of days to flowering | - | 0.19 | 0.28 | -0.04 | 0.16 | 0.19 | 0.37 | 0.36 | 0.25 | 0.01 | 0.20 |
| 2. | Number of days to maturity | -0.02 | - | 0.72** | -0.06 | 0.60* | 0.65** | 0.62* | 0.71** | 0.66** | 0.28 | 0.75** |
| 3. | Height of plants | 0.22 | 0.35 | - | 0.01 | 0.71** | 0.58* | 0.46 | 0.61* | 0.59* | 0.14 | 0.58* |
| 4. | Number of pods per axil | 0.17 | -0.62 | 0.08 | - | -0.13 | 0.01 | -0.21 | -0.10 | -0.10 | -0.11 | -0.12 |
| 5. | Number of pods per plant | 0.10 | 0.01 | 0.25 | 0.40 | - | 0.48 | 0.17 | 0.36 | 0.68** | 0.24 | 0.48 |
| 6. | Length of pod | -0.30 | 0.27 | -0.14 | -0.44 | -0.24 | - | 0.52* | 0.72** | 0.73** | 0.39 | 0.79** |
| 7. | Number of locules per pod | -0.10 | -0.11 | -0.27 | -0.54* | -0.45 | 0.25 | - | 0.94** | -0.22 | -0.18 | 0.47 |
| 8. | Number of seeds per pod | -0.15 | 0.11 | -0.20 | -0.61* | -0.45 | 0.48 | 0.92** | - | 0.42 | -0.09 | 0.61* |
| 9. | Seed yield per plant | -0.16 | 0.25 | 0.16 | -0.33 | 0.46 | 0.41 | 0.24 | 0.39 | - | 0.60* | 0.74** |
| 10. | Weight of thousand seeds | -0.55* | 0.13 | -0.14 | -0.53* | -0.32 | 0.68** | 0.28 | 0.43 | 0.33 | - | 0.53* |
| 11. | Oil content | -0.31 | -0.15 | -0.26 | -0.37 | -0.38 | 0.53* | 0.51* | 0.65** | 0.35 | 0.52* | - |

Coefficients given in the upper and lower triangular portions correspond to rice fallows and uplands respectively

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

and remaining 10 were negative. Seed yield was positively and significantly correlated with height of plants, number of pods per plant, length of pod, weight of thousand seeds and oil content. It had positive non-significant correlation with days to flowering, number of locules per pod and number of seeds per pod but negative non-significant correlation with number of pods per axil.

Number of days to flowering had non-significant positive correlation with all characters except number of pods per axil with which it had negative non-significant correlation.

Days to maturity had significant positive correlation with all characters except days to flowering and weight of thousand seeds with which it had non-significant correlations and with number of pods per axil it had negative non-significant correlation.

Height of plants was positively and significantly correlated with days to maturity, number of pods per plant, length of pod, number of seeds per pod, seed yield and oil content, but positively and non-significantly correlated with days to flowering, number of pods per axil, number of locules per pod and weight of thousand seeds.

Number of pods per axil was negatively and non-significantly correlated with all the characters except days to flowering, height of plants and length of pod with which it was positively correlated.

Number of pods per plant was significantly and positively correlated with days to maturity, height of plants and seed yield while it had positive non-significant correlation with the rest of the characters except number of pods per axil with which it had negative significant correlation.

Length of pod was positively and significantly correlated with days to maturity, height of plants, number of locules per pod, number of seeds per pod, seed yield and oil content, and positively and non-significantly correlated with days to flowering, number of pods per axil, number of pods per plant and weight of thousand seeds.

Number of locules per pod had positive significant correlation with days to maturity, length of pod and number of seeds per pod and positive non-significant correlation with days to flowering, height of plants, number of pods per plant, seed yield and oil content. It had negative non-significant correlation with number of pods per axil and weight of thousand seeds.

Number of seeds per pod had positive significant correlation with days to maturity, height of plants, length of pod, number of locules per pod and oil content. It had positive non-significant correlation with days to flowering, number of pods per plant and seed yield.and negative non-significant correlation with number of pods per axil and weight of thousand seeds.

Weight of thousand seeds had significant positive correlation with seed yield and oil content; non-significant positive correlation with days to flowering, days to maturity, height of plants, number of pods per plant and length of pod but negative non-significant correlation with number of pods per axil, number of locules per pod and number of seeds per pod.

Oil content was positively and significantly correlated with days to maturity, height of plants, length of pod, number of seeds per pod, weight of thousand seeds and seed yield and positively and non-significantly correlated with days to flowering, number of pods per plant and number of locules per pod. It had negative but non-significant correlation with number of pods per axil.

In uplands (lower triangular portion of table 16) 29 out of 55 correlations were positive. Seed yield had positive non-significant correlation with all characters except days to flowering and number of pods per axil with which it had negative but non-significant correlation.

Days to flowering had positive non-significant correlation with height of plants, number of pods per axil and number of pods per plant; negative significant correlation with weight of thousand seeds and negative non-significant correlation with the rest of the characters.

Days to maturity had positive non-significant correlation with height of plants, number of pods per plant, length of pod, number of seeds per pod, weight of thousand seeds and seed yield. But, with number of days to flowering, number of pods per axil, number of locules per pod and oil content, the correlation was negative and non-significant.

Height of plants had positive non-significant correlation with days to flowering, days to maturity, number of pods per axil, number of pods per plant and seed yield and negative, but non-significant correlation with the rest of the characters.

Number of pods per axil had positive but non-significant correlation with days to flowering, height of plants and number of pods per plant; negative significant correlation with number of locules per pod, number of seeds per pod and weight of thousand seeds and negative but non-significant correlation with days to maturity, length of pod, seed yield and oil content.

Number of pods per plant had negative non-significant correlation with all the characters except seed yield, days to flowering, days to maturity, height of plants and number of pods per axil with which it had positive significant correlation.

Length of pod had positive significant correlation with weight of thousand seeds and oil content; positive non-significant correlation with days to maturity, number of locules per pod, number of seeds per pod and seed yield and negative non-significant correlation with days to flowering, height of plants, number of pods per axil and number of pods per plant.

Number of locules per pod had positive significant correlation with number of seeds per pod and oil content; positive non-significant correlation with length of pod, weight of thousand seeds and seed yield; negative significant correlation with number of pods per axil and negative but non-significant correlation with days to flowering, days to maturity, height of plants and number of pods per plant.

Number of seeds per pod had positive significant correlation with number of locules per pod and oil content. It had positive non-significant correlation with days to maturity, length of pod, weight of thousand seeds and seed yield; negative significant correlation with number of pods per axil; and negative non-significant correlation with days to flowering, height of plants and number of pods per plant.

Weight of thousand seeds had significant positive correlation with length of pod and oil content; positive non-significant correlation with days to maturity, number of locules per pod, number of seeds per pod and seed yield; negative significant correlation with days to flowering and number of pods per axil; and negative non-significant correlation with height of plants and number of pods per plant.

Oil content had significant positive correlation with length of pod, number of locules per pod, number of seeds per pod and weight of thousand seeds; and positive non-significant correlation with seed yield. It had negative non-significant correlation with the rest of the characters.

In rice fallows, the genotypic correlations were, in general, higher than the phenotypic correlations for number of days to flowering, height of plants, number of pods per axil, number of pods per plant, length of pod, weight of thousand seeds, seed yield per plant and oil content. For days to maturity, number of locules per pod and number of seeds per pod, the genotypic and phenotypic correlations were almost similar. In uplands, the genotypic correlations were higher for all characters except number of days to maturity and number of locules per pod for which the genotypic and phenotypic correlations were almost similar.

# DISCUSSION

## DISCUSSION

Sesamum is an important annual oilseed crop. In Kerala, it is mainly cultivated in rice fallows during summer (January-April) and in uplands during rabi (August-December). Lack of high yielding varieties suited to the different soil types and seasons is the main factor limiting the production of sesamum in the state. Two improved varieties evolved in Kerala are Kayamkulam-1 and Kayamkulam-2, the former is single poded and the latter is multipoded. These two varieties are recommended for the summer rice fallows.

A wide range of variability is available in sesamum which can be exploited through selection. Several types with multipoded or multiloculed condition have already been identified at the Department of Plant Breeding, College of Agriculture, Vellayani (John, 1980). The higher seed production potential of these types has already been recognised (Khader, 1982). The present investigation aims at a more detailed evaluation of these types for their productivity under rice fallow and upland conditions and the identification of superior varieties suited to both the locations. An attempt is also made to assess the phenotypic stability of these types under the two soil and seasonal conditions, through the estimation of genotype x environment interaction and also to correlate the different characters between themselves and with seed yield. The results are discussed and conclusions drawn.

Varietal comparison:

There was no significant difference in the number of days to flowering among the varieties at both the locations. This was contrary to the significant differences observed by Trehan et al. (1975 b). Kayamkulam-1 and Kayamkulam-2 had the same flowering duration in rice fallows. But they were late in flowering in uplands. The multipoded varieties were slightly late in flowering than the other varieties in uplands. The difference among varieties in the number of days to maturity was however significant at both the locations. Trehan et al. (1975 b) reported highly significant difference for growth period among different varieties. The maturity period of the varieties ranged from 77 to 83 days in rice fallows and 83 to 88 days in the uplands. Poelhman and Borthakur (1969) reported that varieties of sesame vary in their maturity period from 80 to 150 days. Hence, all the 15 varieties are early in duration. Kayamkulam-1 and Kayamkulam-2 recorded the same period of maturity irrespective of the location (79 days in the rice fallows and 87 days in uplands) P.38-1 needed 83 days at both the locations. The multiloculed varieties were in general late maturing.

The varieties differed significantly in height of plants only in rice fallows. Ram (1930) and Trehan et al. (1975 b) reported that various types of sesamum differed in plant height. The height ranged from 51 to 82 cm in rice fallows and from 108 to 137 cm in uplands. Hiltebrandt (1932) found that the average plant height in sesamum was 100 to 200 cm. Hence, all the varieties are short statured. P.28-2 had the maximum height in rice fallows, but in uplands this type was still taller. The multiloculed varieties were in general taller than the other varieties in rice fallows.

There was no significant difference in the number of pods per axil among the varieties in rice fallows. The multi-poded condition was not fully expressed at this location. On the other hand, the difference in uplands was significant because of a better expression of this character. Joshi (1961) reported that depending on the number of flowers in each axil, the number of pods may be one to three in different varieties and that those types which bear three flowers in each axil may develop only one or two pods instead of three under unfavourable growing conditions. Langham (1945) reported the presence of four or five pods per axil in certain varieties. The maximum number of pods per axil was produced by TMV-2 in uplands. Kayamkulam-2, a multipoded variety had a better expression in uplands than in the rice fallows. P.10-1, a multipoded variety was single-poded at both locations indicating the very low expression of this character. The multiloculed varieties were single poded. Ram (1930) found a similar association that eight loculed pods were invariably borne singly and four loculed pods occurred either singly or in groups of two or three in an axil. The difference among varieties in respect of number of pods per plant was significant in rice fallows only. Kumar et al. (1967) in a variability study in sesame reported that the number of capsules on the main shoot is the most variable quantitative character. The number of pods varied from 10.6 to 36.7 in rice fallows. Among the multipoded varieties, P.10-1 produced the maximum number of pods per plant. Hiltebrandt (1932) reported that the number of pods per plant varies from 40 to 400. P.10-1 was consistent at both the locations. Most of the varieties yielded a larger number of pods in uplands than in rice fallows.

The varieties differed significantly in length of pod in rice fallows as well as in uplands. Wide range of variability for this character was also reported by Lopez and Mazzani (1964), Debral and Holker (1971), Trehan et al. (1975 b) and Paramasivam and Prasad (1981). Most of the varieties recorded a higher pod length in uplands than in rice fallows. P.10-1 produced pods with the maximum length in rice fallows and the pods were still longer in uplands. The pods of P.28-1 had the maximum length in uplands. Significant differences were recorded in number of locules per pod irrespective of the location. Joshi (1961) reported 12 and 16 loculed pods. In rice fallows P.38-1 exhibited variability in expressivity, producing four, six and eight loculed pods whereas in uplands majority of the plants produced only six and eight loculed pods. No.42-1 produced six and eight loculed pods at both locations.

The varieties differed significantly in number of seeds per pod at both the locations. Such differences among varieties was observed by Lopez and Mazzani (1964) and Trehan et al. (1975 b). The multiloculed varieties produced comparitively larger number of seeds indicating their high seed production potential. No.42-1 produced the maximum number of seeds and was consistent at both the locations. On the other hand, Mutant K-1 had the minimum number of seeds per pod at both the locations. There was significant difference among the varieties in weight of thousand seeds also at both the locations. Such variations were reported by Lopez and Mazzani (1964), Debral and Holker (1971) and Trehan et al. (1975 b). Joshi (1961) reported that the mean weight of thousand seeds varied rather widely within a plant according to the position of pods on the stem. P.10-1 recorded the maximum seed weight in rice fallows and uplands. On the other hand, P.23-1 recorded the minimum weight at both the locations.

Seed yield of the varieties differed significantly at both locations. Yield per plant was reported to be highly variable by Debral and Holker (1971), Gupta (1975) and Paramasivam and Prasad (1981). P.10-1 recorded the highest seed yield in rice fallows. This multipoded variety produced larger number of pods per plant. In uplands, P.23-1 recorded the maximum seed yield. This is a multiloculed variety which produced a larger number of seeds per pod.

Oil content of the varieties also differed significantly at both the locations. Such wide variations in oil content were reported by Singh and Gupta (1973) in sesamum. The oil content of the 15 varieties ranged from 41.5 to 50.1 per cent in rice fallows and 43.4 to 53.6 per cent in uplands. Poelhman and Borthakur (1969) reported that the oil content in sesamum ranges from 45.0 to 60.0 per cent. EL Tinay et al. (1976) reported a range of 42.2 to 52.2 per cent for seed oil content. Brar (1982) analysed 27 introductions from ten countries and found that the variation in oil content was 46.0 to 58.0 per cent. P.10-1 and P.38-1 recorded the maximum oil content in rice fallows and uplands respectively. They recorded high oil contents at the alternate location also. White seeded varieties recorded high oil content at both locations. Hiltebrandt (1932), Kawanishi (1953), Poelhman and Borthakur (1969) and EL-Shamma and AL-Hassan (1973) reported that the lighter the colour of seeds the higher was the oil content and that white seeded varieties have higher oil content than black or brown seeded varieties. Baradi (1972) on the other hand reported that the black-seeded varieties are richer in oil content than white seeded varieties.

In general, there was significant difference among the varieties at both locations for days to maturity, length of pod, number of locules per pod, number of seeds per pod, weight of thousand seeds, seed yield per plant and oil content. For height of plants and number of pods per plant there was significant difference only in rice fallows and for number of pods per axil, the varieties differed only in uplands. For days to flowering there was no significant difference at both the locations.

The multiloculed varieties have higher seed yield, longer duration and higher oil content when compared to the four loculed variet ies at both the locations. In rice fallows, the multiloculed varieties P.38-1, P.23-1 and P.28-2 recorded high seed yield with larger number of pods per plant and larger number of seeds per pod. In uplands, P.23-1 gave the highest seed yield followed by P.28-2 and No.42-1. They had larger number of seeds per pod. These multiloculed varieties recorded higher seed weight at both locations. P.10-1 a multipoded variety gave high yields consistently irrespective of the location. It produced larger number of pods per plant, and had the maximum seed weight at both locations. This variety was outstanding for other characters such as height of plants, length of pod, number of seeds per pod and oil content. Among the multipoded varieties it had the maximum number of seeds per pod and oil content. The two recommended varieties Kayamkulam-1 and Kayamkulam-2 were low yielders when compared to the multiloculed varieties and the multipoded variety P.10-1.

Variety x Location interaction:

The variety x location interaction was not significant for number of days to flowering implying that the varieties did not differ from location to location. Further, a comparison of the pooled varietal means with means of the two standard varieties Kayamkulam-1 and Kayamkulam-2, indicated that most of the varieties were on par with Kayamkulam-1 and all varieties with Kayamkulam-2. The interaction was however highly significant for number of days to maturity. Hence, the varieties differed from location to location with respect to the maturity period. P.38-1 was consistent at both locations. The duration for all varieties was more in uplands than in rice fallows. Yadava and Kumar (1979 a) reported that the genotype x environment interaction was significant for days to maturity in groundnut.

The height of plants in the varieties was different from location to location. All varieties were taller in uplands than in rice fallows. Murugesan et al. (1979 b) and Rawat and Anand (1978) have also reported genotype x environment interaction for height of plants, in sesamum and mustard respectively.

The interaction was highly significant for number of pods per axil indicating that the varieties differed from location to location for this character. The multipoded condition was better expressed in uplands due to the higher vigour of plants, than in rice fallows. In respect of number of pods per plant also the interaction was highly significant indicating that the varieties differed from location to location for this character also. Sandhu and Khehra (1977) and Yadava and Kumar (1978 a) have also reported significant genotype x environment interaction for pod yield in groundnut.

Length of pod was not significantly different at the two locations indicating that this character is relatively stable. The multiloculed varieties produced longer pods irrespective of the location. But, for number of locules per pod the interaction was highly significant implying that the number of locules per pod varies with location. The variety No.42-1 produced larger number of locules irrespective of the location.

The interaction for number of seeds per pod was not significant. So the varieties did not differ from location to location indicating the stability of this character over the two locations. No.42-1, a multiloculed variety recorded the maximum number of seeds per pod at both locations and was consistent. However, weight of thousand seeds significantly differed with locations. Yadava and Kumar (1978 a) and Mercer-Quarshie (1980) reported that the genotype x environment interaction was high for hundred kernel weight in groundnut. Posselt (1980) on the other hand reported that the interaction was low for thousand seed weight in rape.

Seed yield significantly differed at the two locations indicating that the yield potential of varieties varied from location to location. Yield was generally higher in uplands than in rice fallows. Wynne and Isleib (1978) reported a substantial cultivar x location x year second order interaction for yield in groundnut. Mercer-Quarshie (1980), Rawat and Anand (1977) and Posselt (1980) also reported significant cultivar x location interaction for seed yield in groundnut, mustard and rape respectively. P.10-1 and the multiloculed varieties were high yielding at both the locations. Oil content of seeds also differed from location to location. In general, the oil content was higher in uplands. Yadava and Kumar (1978 a, 1979 b) reported that the genotype x environment interaction was high and significant for oil content in groundnut. Posselt (1980), on the other hand reported that the interaction was low for oil percentage in rape.

The variety x location interaction was thus highly significant for days to maturity, height of plants, number of pods per axil, number of pods per plant, number of locules per pod, weight of thousand seeds, seed yield per plant and oil content, indicating that the varieties vary from location to location with respect to these characters. On the contrary the interaction was not significant for days to flowering, length of pods and number of seeds per pod, indicating that these characters are stable irrespective of the environment.

The interaction for seed yield was highly significant indicating that the character is not stable over locations. As such, a direct selection for yield may often be misleading and selection has to be done based on the components of yield.

The major components are number of pods per plant, number of seeds per pod and weight of thousand seeds. Number of seeds per pod was stable over the locations whereas the other two characters varied between locations. No.42-1 recorded the largest number of seeds per pod at both the locations and was also consistent. The number of seeds per pod being a stable character could be better relied upon in selection programmes than the other components of seed yield.

Variance and coefficient of variation:

Number of days to flowering showed a lower genotypic variance than the environmental variance at both the locations. Of the eleven characters studied, days to flowering had the lowest genotypic and phenotypic coefficients of variation in rice fallows. In uplands also this character had the lowest genotypic coefficient of variation, but the phenotypic coefficient of variation was slightly high. These results indicate that the character shows very little genetic variability at both the locations. A low genotypic coefficient of variability was also reported by Shukla and Verma (1976) in sesamum. Yadava et al. (1980) reported a high phenotypic variability for number of days to flowering. The genotypic and phenotypic variances for number of days to maturity were the same at both locations. These variances were lower in uplands than in the rice fallows. The low genotypic and phenotypic coefficients of variation indicate low variability for this character. Kumar et al. (1967) found that the number of days to maturity was the least variable character. But Yadava et al. (1980) observed high phenotypic variability for number of days to maturity.

Height of plants exhibited high genotypic and phenotypic variances in rice fallows. In uplands, the phenotypic variance was high when compared to the genotypic variance, due to the high environmental variance. The character is highly influenced by environment at this location. But Sanjeevaiah and Joshi (1974) reported that environment had little effect on plant height. The genotypic and phenotypic coefficients of variation were high in rice fallows, but low in uplands. Yadava et al. (1980) also reported high phenotypic variability for this character. Muhammad et al. (1970 b) observed that the dispersion of values for this character varied widely with varieties.

Number of pods per axil exhibited mostly similar genotypic and environmental variances in rice fallows whereas in the uplands the genotypic variance was higher than the environmental variance. The high genotypic variance denotes high heritability for this character. This character exhibits low genotypic and phenotypic coefficients of variation in rice fallows. But in uplands it had the highest genotypic and phenotypic coefficients of variation, indicating high variability. Gupta and Gupta (1977) reported that number of pods per axil had high genotypic coefficient of variation.

Number of pods per plant, on the other hand showed higher genotypic variance than the environmental variance in rice fallows. The high phenotypic variance in uplands was mostly due to environmental contribution, exhibiting the influence of environment on this character. Solanki and Paliwal (1981) reported high genotypic and phenotypic variances for number of capsules per plant. The genotypic and phenotypic coefficients of variation were high at both locations and was highest for this character in rice fallows implying greater amount of variability. Since, number of pods per plant is one of the main yield components the high genotypic coefficient of variation is of immense practical value in selecting high yielding varieties in sesamum. Gupta (1975) observed high genotypic coefficient of variation for number of capsules per plant whereas Shukla and Verma (1976) reported low values.

The genotypic variance was higher than the environmental variance for length of pod at both the locations. Number of locules per pod also showed a similar trend. The genotypic and phenotypic coefficients were comparitively higher for both the characters. Murugesan et al. (1979 a) however observed that the genotypic and phenotypic coefficients of variation were very low for capsule length.

Number of seeds per pod also showed a very high genotypic variance in relation to the environmental variance at both the locations. Krishnamurthy et al. (1960) also reported that the number of seeds per pod was the least affected by environment. This character also recorded a comparitively high genotypic and phenotypic coefficients of variation at both locations. Sawant (1971) also reported similar results. The high variability coupled with stable nature makes this character important in selecting high yielding varieties.

The genotypic variance was higher than environmental variance for weight of thousand seeds at both the locations. This character also recorded higher genotypic and phenotypic coefficients of variation. The high variability is of value in selection programmes since it is also an important component of seed yield.

In respect of seed yield at both the locations, the genotypic variance was higher than the environmental variance. In rice fallows, the genotypic and phenotypic coefficients of variation were also high. In uplands also seed yield had higher genotypic and phenotypic coefficients of variation than the other characters. Sawant (1971) and Gupta and Gupta (1977) also obtained similar results. The above results indicate that seed yield is a highly variable character not influenced by the environment.

Oil content also recorded higher genotypic variance than the environmental variance at both the locations. Hence the character is under strong genetic control. But Mazzani (1959 a) reported that seed oil content of seven sesame cultivars was more influenced by environment than by inherent differences between cultivars. This character had comparitively lower genotypic and phenotypic coefficients of variation indicating that this is a less variable character.

In general, all characters except days to flowering and maturity, recorded higher genotypic variance than environmental variance. Number of pods per plant had the highest genotypic and phenotypic coefficients of variation in rice fallows whereas number of pods per axil recorded the highest value in uplands. Days to flowering recorded the lowest genotypic and phenotypic coefficients of variation, in rice fallows whereas in uplands, genotypic coefficient of variation was lowest for days to flowering and phenotypic coefficient of variation was lowest for days to maturity.

High genotypic variance indicates that the characters are genetically controlled and hence highly heritable. Such characters especially yield components like number of pods per plant, number of seeds per pod and seed weight are important in selecting high yielding varieties. These components also recorded high genotypic and phenotypic coefficients of variation at both locations. Hence, they can be relied upon for improvement of yield through selection. The multiloculed varieties which produced larger number of seeds per pod with higher seed weight were found to be high yielders. Such varieties can be selected for improving the yield potential in sesamum.

Correlation:

Seed yield in rice fallows had significant positive genotypic and phenotypic correlations with number of days to maturity, height of plants, number of pods per plant, length of pod, weight of thousand seeds and oil content. In uplands, however seed yield had significant positive genotypic correlation with number of seeds per pod only. With days to maturity, length of pod, number of locules per pod, weight of thousand seeds and oil content, the genotypic correlations were positive but non-significant. Thus seed yield was positively correlated with most of the characters including its components significantly in rice fallows but non-significantly in uplands. Significant correlations of seed yield with other characters have been reported by many workers such as Khidir and Osman (1970), Osman and Khidir (1974), Dixit (1974, 1975), Shukla and Verma (1976), Gupta and Gupta (1977), Yadava et al. (1980) and Chauan and Chopde (1981). Seed yield was reported to be negatively correlated with duration upto flowering, height of plants, length of pod and weight of thousand seeds by Naphade and Kolte (1974/1975), Dixit (1975) and Chaudhary et al. (1977). The results thus generally indicate that seed yield increases with increase in duration, height, number of pods per plant, length of pod, number of locules per pod, number of seeds per pod and weight of thousand seeds. At both locations, the late maturing multiloculed varieties which produced more number of pods per plant and seeds per pod were high yielding. The decrease in yield with increase in height of plants was however not significant.

Duration upto flowering in rice fallows had positive and significant genotypic correlation with the other characters. In the uplands, it had significant positive genotypic correlation with height of plants and number of pods per axil. With weight of thousand seeds, length of pod, seed yield and oil content its genotypic correlations were significantly negative. Osman and Khidir (1974) reported high positive correlation between seed yield and number of days to flowering. Chauan and Chopde (1981) also recorded strong phenotypic and genotypic correlations between seed yield per plant and number of days to 50 per cent flowering. Duration upto maturity in rice fallows had significant positive genotypic and phenotypic correlations with height of plants, number of pods per plant, length of pod, number of locules per pod, number of seeds per pod, seed yield and oil content. In uplands, this character had positive and significant genotypic correlation with height of plants only. Osman and Khidir (1974) reported that the number of days to maturity and seed yield were positively correlated. At both locations, height of plants, number of pods per plant, length of pod, number of seeds per pod, weight of thousand seeds and seed yield were found to increase with days to maturity. Narayanan and Reddy (1982) observed that early varieties were shorter in height than late ones and they produce a higher proportion of reproductive parts. The late maturing multiloculed varieties, in general gave higher seed yields. Oil content was also found to increase with increase in maturity period in rice fallows.

Height of plants in rice fallows had significant positive genotypic and phenotypic correlations with days to maturity, number of pods per plant, length of pod, number of seeds per pod, seed yield and oil content. With days to flowering the genotypic correlation alone was positive and significant. In uplands, it had positive significant genotypic correlations with days to flowering and days to maturity. With length of pod, number of locules per pod and oil content, the genotypic correlations were significantly negative. Positive correlation between seed yield and height of plants was reported by Dabral (1967), Khidir and Osman (1970), Chaudhary et al. (1977), Kaushal et al. (1974), Paramasivam and Prasad (1980), Chauan and Chopde (1981) and Delgado and Yermanos (1975). On the other hand Ekbote and Tayyab (1974), Naphade and Kolte (1974/1975) and Dixit (1975) reported negative correlation between seed yield and plant height. Murugesan et al. (1979 b) also reported negative phenotypic correlation of seed yield with height at which first capsule is formed. In rice fallows, seed yield increased with increase in plant height. A similar trend was observed with number of pods per plant also. In rice fallows, the oil content increased with increase in plant height whereas in uplands the association was found to be the reverse.

Number of pods per plant in rice fallows had significant positive genotypic and phenotypic correlations with days to maturity, height of plants and seed yield. With days to flowering, length of pod, weight of thousand seeds and oil content, the genotypic correlations alone were positive and significant. In uplands, this character had significant positive genotypic correlation with number of pods per axil. With length of pod, number of locules per pod, number of seeds per pod and oil content, the genotypic correlations were negative and significant. Number of pods per plant was identified as the major component of yield by Krishnamurthy et al. (1960), Khidir and Osman (1970), Dixit (1974, 1975), Ekbote and Tayyab (1974), Naphade and Kolte (1974/1975), Gupta and Gupta (1977), Yadava et al. (1980) and Rai et al. (1981). Delgado and Yermanos (1975) reported that seed yield per unit area was positively correlated with number of capsules per plant. In rice fallows, seed yield increased significantly with increase in the number of pods per plant.

The genotypic and phenotypic correlations of length of pod with days to maturity, height of plants, number of locules per pod, number of seeds per pod, seed yield and oil content were positive and significant in rice fallows. With days to flowering and number of pods per plant, the genotypic correlations alone were positive and significant. In uplands, length of pod had significant positive genotypic and phenotypic correlations with weight of thousand seeds and oil content. With number of seeds per pod, the genotypic correlation alone was significantly positive. With days to flowering, height of plants and number of pods per plant, it had significant negative genotypic correlations. Positive correlations between seed yield and pod length were observed by Phadnis et al. (1970), Khidir and Osman (1970), Debral and Holker (1971), Ekbote and Tayyab (1974), Gupta and Gupta (1977) and Chauan and Chopde (1981). Number of seeds per pod and consequently seed yield were found to increase with increase in the length of pod at both locations.

Number of locules per pod had significant positive genotypic and phenotypic correlations with days to maturity, length of pod and number of seeds per pod in rice fallows. With number of days to flowering the genotypic correlation alone was significant and positive. In uplands, it had significant positive genotypic and phenotypic correlations, with number of seeds per pod and oil content. With number of pods per axil, the genotypic and phenotypic correlations were significantly negative. With height and number of pods per plant the genotypic correlations alone were significantly negative. A positive correlation between number of locules per pod and seed yield was reported by Muhammad et al. (1970 b). Number of seeds per pod, seed yield and oil content increased with increase in the number of locules per pod. The multiloculed varieties gave higher yields than the four loculed varieties.

In rice fallows, number of seeds per pod had significant positive genotypic and phenotypic correlations with days to maturity, height of plants, length of pod, number of locules per pod and oil content. In uplands, it had significant positive genotypic and phenotypic correlations with number of locules per pod and oil content. With length of pod and seed yield the genotypic correlations alone were significant and positive. With number of pods per plant, the genotypic correlation alone was negative and significant. High positive correlation between seed yield and number of seeds per pod was reported by Krishnamurthy et al. (1960), Khidir and Osman (1970), Gupta and Gupta (1977) and Solanki and Paliwal (1981). Muhammad et al. (1970 b) observed correlation between seed yield per plant and number of seeds per locule. Number of seeds per pod increased with increase in the length of pod and number of locules. Seed yield in turn increased with increase in the number of seeds per pod.

Weight of thousand seeds, in rice fallows had significant positive genotypic and phenotypic correlations with seed yield and oil content. With number of pods per plant the genotypic correlation alone was significant and positive. In uplands, it had significant positive genotypic and phenotypic correlations with length of pod and oil content. Positive significant correlation between seed yield and thousand seed weight was reported by Muhammad and Stephen (1964), Khidir and Osman (1970), Debral and Holker (1971), EL Nadi and Lazim (1974), Gupta and Gupta (1977) and Yadava et al. (1980).

Positive genotypic and phenotypic correlations of oil content with most of the characters were observed in rice fallows. In uplands, oil content had significant and positive genotypic and phenotypic correlations with length of pod, number of locules per pod, number of seeds per pod and weight of thousand seeds. In general, oil content increased with increase in length of pod, number of locules per pod and seed yield at both locations. The late maturing, multi-loculed varieties which produced larger number of seeds and high seed yield have high oil content also. Trehan et al. (1975 a) reported that the oil percentage was positively and significantly correlated with seed length, seed thickness and hundred seed weight and hence seed weight was important for the improvement of oil in sesame. The white seeded varieties had invariably high oil content at both the locations. Similar results were reported by Poelhman and Borthakur (1969) and EL-Shamma and AL-Hassan (1973).

Thus, seed yield had significant positive genotypic and phenotypic correlations with most of the characters in rice fallows whereas in uplands, it had significant positive genotypic correlation with number of seeds per pod only. Hence, increase in seed yield could be obtained through selection for number of seeds per pod irrespective of the locations. Number of pods per plant in rice fallows increased with height of plants whereas in uplands, it increased with the number of pods per axil. Number of seeds per pod increased with number of locules per pod at both the locations. The multiloculed varieties recorded a larger number of seeds per pod. Seed yield also increased with increase in seed weight. So this can also be considered as an important component of yield.

Seed yield and its components:

The primary components of seed yield in sesamum are number of pods per plant, number of seeds per pod, and weight of thousand seeds. The multiloculed varieties in general gave higher yield per plant at both the locations than the four loculed varieties. This is mainly due to the larger number of seeds per pod. P.10-1 a multipoded variety also gave high yields, consistently at both locations.

P.28-2 in rice fallows and PT-58-35 in uplands bearing maximum number of pods gave very high seed yields. The multipoded variety P.10-1 which gave the maximum yield in rice fallows also produced larger number of pods. P.38-1 and P.23-1 the high yielders in rice fallows and uplands respectively gave medium number of pods. These results indicate that yield is very much influenced by number of pods per plant.

P.38-1 and P.23-1 the highest yielders among the multiloculed varieties in rice fallows and uplands respectively produced large number of seeds per pod. Larger number of seeds per pod were produced by P.10-1 also, the highest yielder in rice fallows. $S_1$-914-1 having lower number of seeds per pod produced low yields at both the locations. A significant positive correlation was observed between seed yield and number of seeds per pod.

The maximum weight for thousand seeds was recorded by P.10-1, which was high yielding at both the locations. P.38-1 which gave high thousand seed weight in rice fallows and uplands gave high seed yield. In general, the multiloculed varieties with high thousand seed weight gave high seed yields also indicating that seed yield increases with increase in thousand seed weight.

The analysis of seed yield thus reveals that the character is highly influenced by its components and that they have to be considered in improving yield. The multiloculed varieties gave high yields particularly due to the larger number of seeds per pod and high thousand seed weight. So these components are more important in selection programmes for improving yield. Seed yield can also be increased through recombination of the component characters which have a bearing on yield particularly the multiloculed and multipoded characters. Further, the high oil content, and earliness can also be recombined into such varieties.

# SUMMARY

# SUMMARY

Sesamum is an important annual oilseed crop of India. It is also the most important annual oilseed crop of Kerala, grown in rice fallows during summer and uplands during rabi. Lack of high yielding varieties suited to the different soil types and seasons is the main factor limiting the production of sesamum in the state. Two improved varieties, Kayamkulam-1 and Kayamkulam-2 have already been released. Varieties with multipoded and multiloculed condition have already been identified. The multiloculed types were found to give higher yields than the others. A study was undertaken to make a more detailed evaluation of these types so as to identify suitable varieties for both the locations. The genotype x environment interaction of these types was estimated and their phenotypic stability assessed under the different seasonal conditions.

The field trials with 15 varieties were laid out in rice fallows during January to April, 1982 at Kayamkulam and in uplands during August to December, 1982 at Vellayani. A random sample of ten plants per variety per replication was taken for recording the observations on duration upto flowering, and maturity, height of plants, number of pods per axil and per plant, length of pod, number of locules per pod, number of seeds per pod, weight of thousand seeds, seed yield and oil content. The analysis of variance for each location as

well as the pooled analysis were done. The variances and coefficients of variation for each character and for each location were estimated. Correlations between seed yield and other characters and also between the different characters were worked out.

The varieties did not differ significantly in duration upto flowering at either of the two locations. But they showed highly significant difference among themselves for duration upto maturity, length of pod, number of locules per pod, number of seeds per pod, seed yield per plant, weight of thousand seeds and oil content. The variety No.42-1 produced the maximum number of seeds per pod, at both the locations and was consistent. The multiloculed varieties produced larger number of seeds per pod and higher seed yield per plant at both locations. P.10-1 was high yielding and recorded the maximum weight for thousand seeds at both the locations. The varieties P.10-1 and P.38-1 recorded the maximum oil content in rice fallows and uplands respectively. The varieties showed significant difference in height of plants and number of pods per plant in rice fallows. P.10-1 was consistent at both the locations with respect to number of pods per plant. The varieties showed significant difference for number of pods per axil in uplands. TMV-2 produced the maximum number of pods per axil in uplands.

The variety x location interaction was highly significant for characters such as days to maturity, height of plants, number of pods per axil, number of pods per plant, number of locules per pod, seed yield per plant, weight of thousand seeds and oil content. This indicates that the varieties vary from location to location with respect to these characters. The variety x location interaction was not significant for characters like days to flowering, length of pod and number of seeds per pod, indicating that the varieties do not vary from place to place with respect to these characters.

The genotypic, environmental and phenotypic variances were low at both locations for days to flowering, days to maturity, number of pods per axil, length of pod, number of locules per pod, yield per plant and thousand seed weight. On the other hand, the variances were high for height of plant, number of pods per plant, number of seeds per pod and oil content. In rice fallows, number of pods per plant had the highest genotypic and phenotypic coefficients of variation, closely followed by seed yield per plant, number of seeds per pod and number of locules per pod. In uplands, number of pods per axil had the highest genotypic and phenotypic coefficients of variation.

The genotypic and phenotypic correlation coefficients of seed yield was significant and positive with all characters except number of pods per axil in rice fallows. In uplands, it had significant positive genotypic correlation with number of seeds per pod. Number of pods per plant had significant positive genotypic and phenotypic correlations with height of plants in rice fallows, and with number of pods per axil in uplands. Number of seeds per pod showed significant positive genotypic and phenotypic correlations with number of locules per pod at both the locations. The multiloculed varieties recorded higher number of seeds per pod. Oil content increased with increase in length of pod and seed yield at both the locations.

In general, the multiloculed varieties were higher in seed yield, longer in duration and higher in oil content at both the locations. In rice fallows, varieties P.10-1, P.38-1, P.23-1, P.28-1 and P.28-2 recorded high seed yields. In uplands, P.23-1, PT-58-35, P.10-1, P.28-2 and No.42-1 recorded high seed yields. P.10-1 was found to be consistent at both the locations. The multiloculed varieties, P.38-1, P.28-2, No.42-1 and P.23-1 produced larger number of pods per plant and seeds per pod. Kayamkulam-1 and Kayamkulam-2, the two recommended varieties were low yielding when compared to the multiloculed varieties.

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*Original not seen

# APPENDICES

Appendix-1. Analysis of variance for number of days to flowering.

i) Rice fallows (Summer)

| Sources of variation | Degrees of freedom | Sum of squares | Mean squares | 'F' ratio |
|---|---|---|---|---|
| Replications | 1 | 0.1133 | 0.1133 | 0.27 |
| Varieties | 14 | 5.9375 | 0.4241 | 1.02 |
| Error | 14 | 5.8008 | 0.4143 | |
| Total | 29 | 11.8516 | | |

ii) Uplands (Rabi)

| Sources of variation | Degrees of freedom | Sum of squares | Mean squares | 'F' ratio |
|---|---|---|---|---|
| Replications | 1 | 0.1250 | 0.1250 | 0.03 |
| Varieties | 14 | 62.1953 | 4.4425 | 1.18 |
| Error | 14 | 52.6640 | 3.7617 | |
| Total | 29 | 114.9843 | | |

iii) Pooled: Weighed analysis

| Sources of variation | Sum of squares |
|---|---|
| Location | 39.7825 |
| Varieties | 16.6198 |
| Variety x Location | 13.9278 |
| Total | 70.3301 |

Appendix-2. Analysis of variance for the number of days to maturity.

i) Rice fallows (Summer)

| Sources of variation | Degrees of freedom | Sum of squares | Mean squares | 'F' ratio |
|---|---|---|---|---|
| Replications | 1 | 0 | 0 | 0 |
| Varieties | 14 | 165.8700 | 11.8479 | $\infty$** |
| Error | 14 | 0 | 0 | |
| Total | 29 | 165.8700 | | |

ii) Uplands (Rabi)

| Sources of variation | Degrees of freedom | Sum of squares | Mean squares | 'F' ratio |
|---|---|---|---|---|
| Replications | 1 | 0 | 0 | 0 |
| Varieties | 14 | 74.6700 | 5.3336 | $\infty$** |
| Error | 14 | 0 | 0 | |
| Total | 29 | 74.6700 | | |

iii) Pooled

| Sources of variation | Degrees of freedom | Sum of squares | Mean squares | 'F' ratio |
|---|---|---|---|---|
| Locations | 1 | 374.5300 | 374.5300 | |
| Varieties | 14 | 72.8000 | 5.2000 | 1.53 |
| Variety x Location | 14 | 47.4700 | 3.3907 | $\infty$** |
| Pooled error | 28 | 0 | 0 | |

**Significant at 1% level of probability

Appendix-3. Analysis of variance for height of plants.

i) Rice fallows (Summer)

| Sources of variation | Degrees of freedom | Sum of squares | Mean squares | 'F' ratio |
|---|---|---|---|---|
| Replications | 1 | 58.0000 | 58.0000 | 4.52 |
| Varieties | 14 | 2340.0609 | 167.1472 | 13.02** |
| Error | 14 | 179.6874 | 12.8348 | |
| Total | 29 | 2577.7473 | | |

ii) Uplands (Rabi)

| Sources of variation | Degrees of freedom | Sum of squares | Mean squares | 'F' ratio |
|---|---|---|---|---|
| Replications | 1 | 1.1250 | 1.1250 | 0.01 |
| Varieties | 14 | 2126.6849 | 151.9062 | 1.52 |
| Error | 14 | 1398.4376 | 99.8884 | |
| Total | 29 | 3526.2481 | | |

iii) Pooled: Weighted analysis

| Sources of variation | Sum of squares |
|---|---|
| Locations | 860.1723 |
| Varieties | 170.6146 |
| Variety x Location | 32.9345 * |
| Total | 1063.7214 |

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

Appendix-3 (contd)

iv) Pooled: Unweighted analysis

| Sources of variation | Degrees of freedom | Sum of squares | Mean squares | 'F' ratio |
|---|---|---|---|---|
| Locations | 1 | 24265.014 | 24265.0140 | |
| Varieties | 14 | 1304.515 | 93.1796 | 1.40 |
| Variety x Location | 14 | 928.571 | 66.3265 | |
| Total | 29 | 26498.100 | | |

Appendix-4. Analysis of variance for the number of pods per axil.

i) Rice fallows (Summer)

| Sources of variation | Degrees of freedom | Sum of squares | Mean squares | 'F' ratio |
|---|---|---|---|---|
| Replications | 1 | 0.0011 | 0.0011 | 0.50 |
| Varieties | 14 | 0.0618 | 0.0044 | 2.08 |
| Error | 14 | 0.0297 | 0.0021 | |
| Total | 29 | 0.0925 | | |

ii) Uplands (Rabi)

| Sources of variation | Degrees of freedom | Sum of squares | Mean squares | 'F' ratio |
|---|---|---|---|---|
| Replications | 1 | 0.0010 | 0.0010 | 0.03 |
| Varieties | 14 | 6.5353 | 0.4668 | 12.16** |
| Error | 14 | 0.5374 | 0.0384 | |
| Total | 29 | 7.0738 | | |

iii) Pooled: Weighted analysis

| Sources of variation | Sum of squares |
|---|---|
| Locations | 137.1505 |
| Varieties | 49.2329 |
| Variety x Location | 150.3451** |
| Total | 336.7285 |

**Significant at 1% level of probability

Appendix-4. (Contd.)

iv) Pooled: Unweighted analysis.

| Sources of variation | Degrees of freedom | Sum of squares | Mean squares | 'F' ratio |
|---|---|---|---|---|
| Locations | 1 | 1.3882 | 1.3882 | |
| Varieties | 14 | 1.7757 | 0.1268 | 1.17 |
| Variety x Location | 14 | 1.5228 | 0.1088 | |
| Total | 29 | 4.6867 | | |

Appendix-5. Analysis of variance for the number of pods per plant.

i) Rice fallows (Summer)

| Sources of variation | Degrees of freedom | Sum of squares | Mean squares | 'F' ratio |
|---|---|---|---|---|
| Replications | 1 | 4.2969 | 4.2969 | 0.46 |
| Varieties | 14 | 1563.7846 | 111.6989 | 12.07** |
| Error | 14 | 129.6781 | 9.2556 | |
| Total | 29 | 1697.6577 | | |

ii) Uplands (Rabi)

| Sources of variations | Degrees of freedom | Sum of squares | Mean squares | 'F' ratio |
|---|---|---|---|---|
| Replications | 1 | 4.7695 | 4.7695 | 0.05 |
| Varieties | 14 | 2424.2353 | 173.1597 | 1.81 |
| Error | 14 | 1339.4843 | 95.6774 | |
| Total | 29 | 3768.4897 | | |

iii) Pooled: Weighted analysis

| Sources of variation | Sum of squares |
|---|---|
| Locations | 100.8484 |
| Varieties | 142.3635 |
| Variety x Location | 51.9399** |
| Total | 295.1518 |

**Significant at 1% level of probability

Appendix-5. (Contd.)

iv) Pooled: Unweighted analysis

| Sources of variation | Degrees of freedom | Sum of squares | Mean squares | 'F' ratio |
|---|---|---|---|---|
| Locations | 1 | 2647.0345 | 2647.0345 | |
| Varieties | 14 | 632.2320 | 45.1594 | 0.46 |
| Varieties x Location | 14 | 1361.8555 | 97.2754 | |
| Total | 29 | 4641.1220 | | |

Appendix-6. Analysis of variance for the length of pod.

i) Rice fallows (Summer)

| Sources of variation | Degrees of freedom | Sum of squares | Mean squares | 'F' ratio |
|---|---|---|---|---|
| Replication | 1 | 0.0001 | 0.0001 | 0.02 |
| Varieties | 14 | 1.6126 | 0.1152 | 27.18** |
| Error | 14 | 0.0593 | 0.0042 | |
| Total | 29 | 1.6720 | | |

ii) Uplands (Rabi)

| Sources of variation | Degrees of freedom | Sum of squares | Mean squares | 'F' ratio |
|---|---|---|---|---|
| Replications | 1 | 0.0027 | 0.0027 | 0.05 |
| Varieties | 14 | 3.1262 | 0.2233 | 3.80** |
| Error | 14 | 0.8221 | 0.0587 | |
| Total | 29 | 3.9509 | | |

iii) Pooled: Weighed analysis

| Sources of variation | Sum of squares |
|---|---|
| Locations | 36.9342 |
| Varieties | 420.5110 |
| Variety x Location | 16.8389 |
| Total | 474.2841 |

**Significant at 1% level of probability

Appendix-7. Analysis of variance for the number of locules per pod.

i) Rice fallows (Summer)

| Sources of variation | Degrees of freedom | Sum of squares | Mean squares | 'F' ratio |
|---|---|---|---|---|
| Replications | 1 | 0.0117 | 0.0117 | 1.87 |
| Varieties | 14 | 31.2886 | 2.2349 | 355.99** |
| Error | 14 | 0.0879 | 0.0063 | |
| Total | 29 | 31.3882 | | |

ii) Uplands (Rabi)

| Sources of variation | Degrees of freedom | Sum of squares | Mean squares | 'F' ratio |
|---|---|---|---|---|
| Replications | 1 | 0.0051 | 0.0051 | 0.37 |
| Varieties | 14 | 39.5281 | 2.8234 | 202.89** |
| Error | 14 | 0.1948 | 0.0139 | |
| Total | 29 | 39.7280 | | |

iii) Pooled:

| Sources of variation | Degrees of freedom | Sum of squares | Mean squares | 'F' ratio |
|---|---|---|---|---|
| Locations | 1 | 0.0750 | 0.0750 | |
| Varieties | 14 | 34.1680 | 2.4406 | 27.55** |
| Varieties x Location | 14 | 1.2400 | 0.0886 | 8.77** |
| Pooled error | 28 | 0.2827 | 0.0101 | |

**Significant at 1% level of probability

Appendix-8. Analysis of variance for the number of seeds per pod

i) Rice fallows (Summer)

| Sources of variation | Degrees of freedom | Sum of squares | Mean squares | 'F' ratio |
|---|---|---|---|---|
| Replications | 1 | 5.9375 | 5.9375 | 0.84 |
| Varieties | 14 | 8659.6225 | 618.5442 | 87.14** |
| Error | 14 | 99.3750 | 7.0982 | |
| Total | 29 | 8764.9545 | | |

ii) Uplands (Rabi)

| Sources of variation | Degrees of freedom | Sum of squares | Mean squares | 'F' ratio |
|---|---|---|---|---|
| Replications | 1 | 21.1875 | 21.1875 | 1.40 |
| Varieties | 14 | 9197.1841 | 656.9418 | 43.45** |
| Error | 14 | 211.6874 | 15.1205 | |
| Total | 29 | 9430.0593 | | |

iii) Pooled:

| Sources of variations | Degrees of freedom | Sum of squares | Mean squares | 'F' ratio |
|---|---|---|---|---|
| Locations | 1 | 324.4606 | 324.4606 | |
| Varieties | 14 | 8818.3972 | 629.8860 | 62.66** |
| Variety x Location | 14 | 111.1387 | 7.9385 | 0.71 |
| Pooled error | 28 | 311.0624 | 11.1094 | |

**Significant at 1% level of probability

Appendix-9. Analysis of variance for seed yield per plant.

i) Rice fallows (Summer)

| Sources of variation | Degrees of freedom | Sum of squares | Mean squares | 'F' ratio |
|---|---|---|---|---|
| Replications | 1 | 0.0913 | 0.0913 | 1.31 |
| Varieties | 14 | 20.0406 | 1.4315 | 20.61** |
| Error | 14 | 0.9723 | 0.0694 | |
| Total | 29 | 21.1041 | | |

ii) Uplands (Rabi)

| Sources of variation | Degrees of freedom | Sum of squares | Mean squares | 'F' ratio |
|---|---|---|---|---|
| Replications | 1 | 0.6006 | 0.6006 | 1.00 |
| Varieties | 14 | 29.5530 | 2.1109 | 3.52* |
| Error | 14 | 8.3933 | 0.5995 | |
| Total | 29 | 38.5469 | | |

iii) Pooled: Weighed analysis

| Sources of variation | Sum of squares |
|---|---|
| Locations | 263.7857 |
| Varieties | 275.2547 |
| Variety x Location | 62.8065** |
| Total | 601.8459 |

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

Appendix-9. (Contd.)

iv) Pooled: Unweighted analysis

| Sources of variation | Degrees of freedom | Sum of squares | Mean squares | 'F' ratio |
|---|---|---|---|---|
| Locations | 1 | 44.1117 | 44.1117 | |
| Varieties | 14 | 14.2938 | 1.0210 | 1.36 |
| Variety x Location | 14 | 10.5030 | 0.7502 | |
| Total | 29 | 68.9085 | | |

Appendix-10. Analysis of variance for weight of thousand seeds.

i) Rice fallows (Summer)

| Sources of variation | Degrees of freedom | Sum of squares | Mean squares | 'F' ratio |
|---|---|---|---|---|
| Replications | 1 | 0.0141 | 0.0141 | 0.29 |
| Varieties | 14 | 3.7402 | 0.2672 | 5.52** |
| Error | 14 | 0.6779 | 0.0484 | |
| Total | 29 | 4.4322 | | |

ii) Uplands (Rabi)

| Sources of variation | Degrees of freedom | Sum of squares | Mean squares | 'F' ratio |
|---|---|---|---|---|
| Replications | 1 | 0.0060 | 0.0060 | 0.60 |
| Varieties | 14 | 2.4046 | 0.1718 | 17.20** |
| Error | 14 | 0.1398 | 0.0100 | |
| Total | 29 | 2.5504 | | |

iii) Pooled: Weighted analysis

| Sources of variation | Sum of squares |
|---|---|
| Locations | 1.3716 |
| Varieties | 261.7196 |
| Variety x Location | 56.0357** |
| Total | 319.1269 |

**Significant at 1% level of probability

Appendix-10. (Contd.)

iv) Pooled: Unweighted analysis

| Sources of variation | Degrees of freedom | Sum of squares | Mean squares | 'F' ratio |
|---|---|---|---|---|
| Locations | 1 | 0.0068 | 0.0068 | |
| Varieties | 14 | 2.2205 | 0.1586 | 2.67* |
| Variety x Location | 14 | 0.8298 | 0.0593 | |
| Total | 29 | 3.0571 | | |

*Significant at 5% level of probability

Appendix-11. Analysis of variance for oil content.

i) Rice fallows (Summer)

| Sources of variation | Degrees of freedom | Sum of squares | Mean squares | 'F' ratio |
|---|---|---|---|---|
| Replications | 1 | 0.1367 | 0.1367 | 0.57 |
| Varieties | 14 | 227.4646 | 16.2475 | 68.11** |
| Error | 14 | 3.3398 | 0.2386 | |
| Total | 29 | 230.9413 | | |

ii) Uplands (Rabi)

| Sources of variation | Degrees of freedom | Sum of squares | Mean squares | 'F' ratio |
|---|---|---|---|---|
| Replications | 1 | 0.1875 | 0.1875 | 0.44 |
| Varieties | 14 | 184.0624 | 13.1475 | 30.68** |
| Error | 14 | 6.0000 | 0.4286 | |
| Total | 29 | 190.2498 | | |

iii) Pooled:

| Sources of variation | Degrees of freedom | Sum of squares | Mean squares | 'F' ratio |
|---|---|---|---|---|
| Locations | 1 | 193.0400 | 193.0400 | |
| Varieties | 14 | 178.7405 | 12.7670 | 6.62** |
| Variety x Location | 14 | 26.9475 | 1.9275 | 5.77** |
| Pooled error | 28 | 9.3398 | 0.3336 | |

**Significant at 1% level of probability

# NOTYPE X ENVIRONMENT INTERACTION FOR YIELD AND ITS COMPONENTS IN SESAMUM

BY

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ABSTRACT OF A THESIS
SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENT
FOR THE DEGREE OF
MASTER OF SCIENCE IN AGRICULTURE
FACULTY OF AGRICULTURE
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1984

ABSTRACT

A detailed evaluation of the production potential of 15 multipoded and multiloculed types and varieties available at the Department of Plant Breeding, College of Agriculture, Vellayani, was undertaken to select suitable varieties for the summer rice fallows and rabi uplands. The study also aimed at the estimation of genotype x environment interaction, the phenotypic stability of these varieties and the correlations of different characters including seed yield. The field trials were laid out at two locations viz., summer rice fallows at Kayamkulam and rabi uplands at Vellayani.

The analysis of variance in respect of each character for each location, as well as for both the locations together was done. There was no significant difference between the varieties for number of days to flowering, at both the locations. But they differed significantly for days to maturity, length of pod, number of locules per pod, number of seeds per pod, seed yield per plant, weight of thousand seeds and oil content. There was significant difference for height of plants and number of pods per plant in rice fallows and for number of pods per axil in uplands.

The variety x location interaction was highly significant for days to maturity, height of plants, number of pods per axil, number of pods per plant, number of locules per pod, seed yield per plant, weight of thousand

seeds and oil content. On the contrary, the interaction was not significant for days to flowering, length of pod and number of seeds per pod. There were significant varietal differences for number of locules per pod, number of seeds per pod, weight of thousand seeds and oil content irrespective of the location.

Height of plants, number of pods per plant and number of seeds per pod, had very high genotypic, phenotypic and environmental variances at both the locations. Oil content also had high variances. In rice fallows, number of pods per plant had the highest genotypic and phenotypic coefficients of variation, closely followed by seed yield per plant, number of seeds per pod and number of locules per pod. In uplands, number of pods per axil had the highest genotypic and phenotypic coefficients of variation. This was closely followed by number of seeds per pod, number of locules per pod and seed yield in respect of genotypic coefficient of variation and by number of pods per axil, number of pods per plant, number of seeds per pod and seed yield in respect of phenotypic coefficient of variation.

The genotypic and phenotypic correlation coefficients for seed yield in rice fallows were positive with all characters except number of pods per axil. In uplands, it had significant genotypic correlation with number of seeds per pod. The correlations between other characters were also estimated.

The multiloculed varieties, in general gave high seed yield and oil content. White seeded varieties had higher oil content than the brown or black seeded ones. The multiloculed varieties were late maturing when compared to the multipoded varieties. P.10-1 was consistent with high seed yield at both locations. The other important high yielding varieties were P.38-1, P.23-1, P.28-1 and P.28-2 in summer rice fallows and P.23-1, PT-58-35, P.28-2 and No.42-1 in rabi uplands. P.10-1, P.23-1 and P.28-2 were high yielding in rice fallows as well as in uplands, which makes them suitable for both the locations.