INVESTIGATIONS ON INTERVARIETAL F_2 HYBRIDS IN COWPEA

BY

B. SUMATHIKUTTY AMMA

THESIS

Submitted in partial fulfilment of the requirements
for the degree of

Master of Science in Agriculture

Faculty of Agriculture
Kerala Agricultural University

Department of Agricultural Botany
COLLEGE OF HORTICULTURE
Vellanikkara - Trichur

1981

D E C L A R A T I O N

I hereby declare that this thesis entitled "INVESTIGATIONS ON INTERVARIETAL F_2 HYBRIDS IN COWPEA" 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.

Vellanikkara,
25--11--1981.

B. SUMATHIKUTTY AMMA.

C E R T I F I C A T E

Certified that this thesis is a record of research work done independently by Miss. Sumathikutty Amma, B. 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.

Vellanikkara,
25--11--1981.

Dr. K.M. Narayanan Namboodiri
Professor of Agricultural Bot
College of Horticulture,
Vellanikkara.

CERTIFICATE

We, the undersigned members of the advisory Committee of Miss. Sumathikutty Amma, B., a candidate for the degree of Master of Science in Agriculture with major in Plant Breeding, agree that the thesis entitled "INVESTIGATIONS ON INTERVARIETAL F_2 HYBRIDS IN COWPEA" may be submitted by Miss. Sumathikutty Amma, B. in partial fulfilment of the requirements for the degree.

(Dr. K.M. Narayanan Namboodiri),
Chairman of the Advisory Committee.

(Dr. T.V. Viswanathan),
Member.

(Dr. K.C. George),
Member.

(Shri. Luckins C.Babu),
Member.

ACKNOWLEDGEMENT

I take this opportunity to acknowledge those who have assisted me to complete my work successfully.

I have immense pleasure to record my deep sense of gratitude and sincere thanks to Dr. K.M. Narayanan Namboodiri, Professor of Agricultural Botany and Chairman of the Advisory Committee, for his valuable guidance and encouragement during the course of this programme and the help rendered for the successful completion of the same.

I avail myself of this opportunity to place on record my heartfelt thanks to Dr. P.C. Sivaraman Nair, Director of Research and former Associate Dean of College of Horticulture, for the facilities provided to me during my studies here. I also wish to express my sincere thanks to Dr. P.K. Gopalakrishnan, Associate Dean for the help rendered to me.

I would like to express my deep sense of gratitude to Dr. T.V. Viswanathan, Associate Professor for his valuable advice and encouragements.

Sincere thanks are due to Dr. K.C. George, Associate Professor of Statistics for the valuable help and encouragements rendered by him.

The help received from Shri. Luckins C.Babu, Assistant Professor of Agricultural Botany is deeply acknowledged.

I would like to express my sincere thanks to Mr. Inasi, K.A., Junior Agricultural Officer, for the advice and assistance given to me.

Sincere thanks are due to all my friends for their kind help at various stages of the investigation.

Thanks are also due to the Indian Council of Agricultural Research, for granting me Junior Fellowship for undergoing the Post-graduate programme.

SUMATHIKUTTY AMMA, B.

Vellanikkara,
25--11--1981.

C O N T E N T S

LIST OF TABLES

LIST OF FIGURES

14. Line graph showing the frequency distribution of F_2 individuals for thickness of seed.

15. Line graph showing the frequency distribution of F_2 individuals for pod yield per plant.

16. Line graph showing the frequency distribution of F_2 individuals for seed yield per plant

INTRODUCTION

INTRODUCTION

Pulses occupy a unique position in Indian Agriculture by virtue of their high protein content and their capacity for fixing nitrogen in their root nodules. These crops have been valued for their food, feed and fodder and have played a very important role in major farming system. Pulses contain nearly 3 times the amount of storage proteins found in cereals.

In India pulses are cultivated over an area of 22.8 million hectares and yield about 13.1 million tonnes of grains. The per capita availability of pulses has progressively declined from 68.5 g in the 1956-1961 period to 43.9 g in the fifth plan period. An adequate supply of pulses at reasonable prices to meet the minimum dietary requirement is essential. Research on pulses has only recently been put to a sound footing in Kerala by the establishment of a subcentre of the All India Co-ordinated Pulses Improvement Project in 1976-77.

Among the pulse crops of Kerala, Cowpea has some unique features of importance. It is cultivated in the uplands during the monsoon season and in the rice fallows of single and double crop wet lands after the harvest of first and second crops of rice. Lack of suitable varieties for the different agro-climatic situations has always been a problem.

In traditional agriculture, pulses have been grown mainly in marginal lands with the result that they have been characterised by spreading, indeterminate growth habit associated with a prolonged maturity duration and non-synchronised pod development. These traditional plant types are not able to take advantage of improved agronomic practices and they cannot be fitted in the intensive cropping patterns.

The present day need in the improvement of pulses, according to experts, is of a two fold nature. Pulses must be shifted in time and space so that they can be provided with some of the improved agronomic environment. The new strategy is based on restructuring of pulses so as to evolve new plant types that can be fitted in a series of multiple and intercropping patterns. The main effort for this is to reduce maturity duration and to induce synchronised development in terms of pod formation. High yielding varieties which are capable of giving two to three times higher yield, can be fitted in double cropping and intercropping sequences and in non-traditional seasons without disturbing the existing crop preference of the farmer for remunerative cereal crops and cash crops. There is also a need to breed varieties that are more responsive to inputs and have the potential to yield well under moisture stress conditions

As the different systems of cultivation in the state require suitable varieties, it has become necessary to identify proper donor varieties. Studies of the present nature will go a long way in the programme of evolution of high yielding varieties, suitable for the different agroclimatic situations of the state. Long range breeding programmes, with precise and definite objectives will have to be launched in order to find out solutions for the problems faced in the present contest. In planning such programmes and implementing the same, studies of the present nature, assume great importance.

Hence the present study has been taken up with the objective of determining the pattern of inheritance of selected characters in the segregating population of intervarietal crosses. A study of this nature will throw much light on the scope of improving the local varieties towards ideal plant types.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

In this section, a brief review of the available literature on the inheritance of important economic characters, is given. In addition to Cowpea, published work on other important pulse crops are also included in the review so as to give an overall picture of the magnitude of the entire problem.

Plant height:

The inheritance of plant height was analysed by Brittingham (1950) in a cross between the subspecies of Vigna i.e. asparagus bean (Vigna sinensis subsp. sesquipedalis) and Catjang bean (Vigna sinensis subsp. cylindrica). He could observe that climbing habit was dominant to bushy habit, which was controlled by a single gene pair 'Tt'.

Norton (1961) observed that growth habit depended on two genes, V for vining habit and T for tallness, based on his study of a cross involving four varieties of southern pea, Vigna sinensis. Thus he concluded that tallness and vining habit were dominant over dwarfness. Report by Singh and Jindle (1971), from their experiments revealed that trailing growth habit was dominant over erect growth habit and the same was controlled by three interacting genes T_1, T_2, and T_3 where T_1 and T_2 were complimentary in action.

Premsekar and Raman (1972) studied the progenies of the hybrid between *Vigna sesquipedalis* and *Vigna sinensis* and observed that growth habit was monogenically inherited. Godhani *et al.* (1978) conducted experiment on epistatic and other genetic variances in *Vigna radiata*. Data from the study of parents, F_1, F_2 and back cross generations of 5 crosses revealed that besides additive effect, dominance, non-additive and epistatic effects were involved in the expression of height.

Ahuja (1980) from his work on diallel analysis of F_2 generation of *Vigna radiata* found over dominance for plant height.

Inasi (1980) in his studies of 16 intervarietal F_1 hybrids in Cowpea observed that in the case of plant height, 25 per cent of hybrids were taller than the tall parent, 18.75 per cent of the hybrids - shorter than the short parent.

Studies conducted by Hilpert (1949) in *Phaseolus vulgaris* revealed that indeterminate plant habit behaved as a simple dominant character over determinate habit. Nakayama (1957) reported that dwarf habit which appeared in the F_2 of the cross of French bean variety Akasando (Red Triple) X Honkintoki, was found to be determined by duplicate recessive genes dev 1 and dev 2. Patil (1960) from his study of inheritance of plant height in Cicer arietinum reported that erect type was dominant over low growing spreading type.

Ortega Ybarra (1968) suggested that in Phaseolus vulgaris, the length of the main stem was controlled by a single dominant gene, but was influenced by the action of modifier genes which in the case of the Cross, Goiana X Costa Rica, had an additive effect and in Goiana X Mexico 450 and Costa Rica X Mexico 450, an overdominance effect. It was suggested that conflicting results reported in the heritability of growth habit were probably due to the varietal nature of the quantitative modifiers. The hybrids between fodder pea varieties differing in plant height manifested heterosis for plant height as reported by Kalinov (1968). It was also stated that, in later stages of growth, tall character proved to be partially or completely dominant over short.

Bliss (1971) conducted studies in beans, Phaseolus vulgaris and concluded that growth habit was controlled by a single gene, with spreading habit dominant to bushy. He also observed that indeterminate habit was controlled by a single dominant gene. Gupta et al. (1978) reported that in mung bean, Phaseolus radiatus, plant height was found to be influenced by additive gene action. Prem Sagar and Chandra (1979) could observe that plant habit was predominantly controlled by additive genes in Phaseolus mungo.

In a study of F_1 generation of cross between inbred lines of *Phaseolus vulgaris*, Malinowski (1955) observed hybrid vigour for plant height. Singh and Jain (1969) crossed seven varieties of mung bean and noticed hybrid vigour over better parent in 20 of the F_1'S.

Till now diverse views exist among scientists regarding the nature of inheritance of plant height.

Number of branches:

In a cross between *Vigna sinensis* subsp. *sesquipedalis* and *Vigna sinensis*, Premsekar *et al.* (1964) found that the hybrids were of intermediate character for number of branches.

Lamprecht (1954) explained that in peas, branching of the stem was conditioned by at least two pairs of genes Fr-fr and Fru-fru, their recessive alleles resulting in highest degree of branching. Singh and Jain (1971) observed that F_1 plants derived from a diallel cross involving seven varieties of mung bean, were heterotic for number of branches. The heterotic effects observed in the F_1 were maintained in the F_2 of some crosses.

Kheradnam and Niknejad (1973), from a study of combining ability in Cowpea, observed that the general and specific combining ability effects were not significant for number of branches per plant. The *per se* performance had high positive relationship with their g.c.a. effects for all characters.

Godhani *et al.* (1978) from a study of parents, F_1, F_2 and back cross generations of five crosses of *Vigna radiata* indicated that additive genes were involved in the control of number of branches per plant.

According to Inasi (1980), 37.5 per cent of the Cowpea F_1 hybrids studied, had increased number of branches than that in the corresponding better parents, while 31.25 per cent of the hybrids were in between the two parental limits.

Flowering duration:

Ojomo (1971) conducted studies on the inheritance of flowering date in Cowpea (*Vigna ungiculata*) by crossing two early flowering exotic and three late flowering local cultivars. Results of the study indicated that early flowering was dominant to late flowering. The number of days to flowering appeared to be controlled by the action of duplicate dominant epistasis between two major genes, designated as Ef1 and Ef2, in the presence of some minor modifying genes. Bordia *et al.* (1973) observed that heritability was high for number of days to flowering. In a study of genetic analysis of flower initiation in

Vigna unguiculata, Tika et al. (1976) showed that there was significant negative heterosis (increased earliness) in some of the hybrids and significant positive heterosis (increased lateness) in few others. In the F_2, plants from one cross showed significant positive heterosis while those from seven other crosses exhibited negative heterosis. It was also observed that flower initiation was governed by additive genetic variance and was highly heritable. Cowpea variety Pusa Phalguni displayed complimentary gene action for earliness while EC 16938, displayed dominant gene action.

Godhani et al. (1978) reported that additive genes were involved in the control of number of days to flowering.

Inasi (1980) obtained varying degrees of hybrid vigour for all the characters viz., commencement, completion and spread of flowering, in the 16 F_1 hybrids studied byhim. Half of the total number of hybrids studied, flowered earlier than the early parent. About 70 per cent of the hybrids were in between the parental limits for completion of flowering and flowering spread.

Hilpert (1949) observed that the time of flowering in Phaseolus vulgaris was influenced primarily by one pair of major genes, the late flowering being dominant over the early. In a cross between Asparagus bean and Catjang bean, Brittingham (1950) found that the F_1 showed intermediate character for the time of flowering. Sakurov (1952) observed heterotic effect in the hybrids obtained by crossing two late flowering varieties. Malinowski (1955) showed that in *Phaseolus vulgaris*, the F_1 hybrid flowered a little earlier than the two parents.

According to Johnson (1957) flowering time was probably determined by one or two major genes and some partially dominant modifiers for late flowering in *Pisum sativum*. Premsekar *et al*. (1964) also recorded heterosis for earliness in flowering in the F_1 hybrids of a cross between *Vigna sesquipedalis* and *Vigna sinensis*.

Balram Singh and Bhatnagar (1966) based on correlation and regression analysis in an F_2 population of mung bean showed that the number of days from seeding to harvesting could be predicted fairly accurately from the number of days from seeding to initiation of flowering, an increase of one day to flower initiation resulting in an increase of 0-63 days in maturity. Kalinov (1968) observed that in crosses between early and late maturing peas, the F_1 plants were intermediate in time of flowering without any reciprocal difference. Bliss (1971) studied the inheritance of time of flowering in *Phaseolus vulgaris* and concluded that two epistatic genes controlled flowering habit, with indeterminateness being dominant.

Empig *et al*. (1971) obtained in the F_2 of crosses among strains of *Phaseolus aureus*, high heritability for number of days to flowering. Singh and Dhaliwal (1971) showed that, in black gram, lateness was dominant over earliness.

Hamad (1976), from a study of parents, F_1 and F_2 of a diallel cross involving five cultivars of snap bean, observed heterosis for number of days to flowering.

Number of flowers per plant:

Norton (1960) studied the inheritance of flowering response in southern pea and concluded that F_1's produced more flowers in the spring and less flowers in the fall than the most abundant and sparse flowering parents. Colins (1967) studied crosses between 21 varieties of lima bean from Boliwia, Peru, El Salvador, Guatimala, Mexico and USA. He observed heterosis for number of flowers per plant.

Lawes and Newaz (1980) observed that in field beans, heterosis for flower number was expressed only in zone 3 (top five nodes of 15).

Inasi (1980), in his studies on intervarietal hybrids in Cowpea obtained heterosis for number of flowers per plant.

Number of pods per plant:

Premsekar et al. (1964) crossed two species of Cowpea, Vigna sinensis subsp. sesquipedalis and Vigna sinensis producing large number of pods. The hybrids showed an inclination to the better parent. Aryeetey and Laing (1973) studied the inheritance of yield components in a cross between two varieties of Vigna unguiculata. It appeared that number of pods per plant was under polygenic control. It was also noted that pod number per plant was consistently correlated with yield. But heritability was low for that character.

Bordia et al. (1973) obtained high genetic advance, in some of the F_1 hybrids of Cowpea for number of pods per plant. Bhaskaraiah et al. (1980) studied hybrid vigour in Cowpea and reported maximum average heterotic effect for pod number per plant. Based on heterosis, it was inferred that pods per plant was an important yield contributing character in Cowpea. Ahuja (1980) reported partial dominance for pods per plant from a diallel analysis of F_2 generation of green gram. Inasi (1980) could observe heterosis for number of pods per plant.

Wester and Jorgensen (1957) showed hybrid vigour in respect of number of pods per plant in a cross between two varieties of lima bean. Johnson (1957) studied the expression of heterosis for number of pods per plant in Pisum sativum. It was revealed that number of pods was governed by partially dominant genes. Bhatnagar and Balram Singh (1964) reported that the F_1 hybrids of Phaseolus aureus showed heterosis for number of pods. Singh and Jain (1971) also reported that heterotic effects were exhibited in the F_1 hybrids of mung bean.

Ibarbia (1968) crossed some double and triple poded varieties of peas to a single poded line and obtained double poded type in F_1 generation. He concluded that triple poded character was governed by two or three genes and the double poded character by eight to nine genes. Krarup and Davis (1970) reported that number of pods per plant was mainly controlled by additive gene system in Pisum sativum. Some deviations might be exhibited due to epistasis or linkage.

Voyest (1972) studied six F_1 hybrids and their parents for number of pods per plant and obtained heterosis in certain hybrids. He also observed that pods per plant might be affected by epistasis.

Sarafi et al. (1973) conducted crosses between varieties of Phaseolus vulgaris, Pinto III (from USA) and Torbat (from Iran) including reciprocals. Heterosis was observed for number of pods per plant and heritability was high for this character. Heterosis was also observed by Hamad (1976) in a few of the hybrids of *Phaseolus vulgaris*. Premsagar and Chandra (1979) obtained heterosis for pod number per plant in the F_1 hybrids of *Phaseolus mungo*. The results suggested non-additive gene action for this character.

Length of pod:

Roy and Richhariaria (1948) reported from a study of a cross between *Vigna sinensis* and *Vigna sinensis* subsp. *sesquipedalis* that in respect of length of pods, the F_1 was found to be intermediate, tending towards a reduction in pod length.

Investigations on the inheritance of pod length in southern pea by Brittingham (1950) suggested heterosis for pod length. It was understood that eight pairs of genes were operating for pod length. Lamprecht (1954) studied the inheritance of pod length in Cowpea and elucidated that intermediately inherited gene Cotr, controlling pod length was carried on chromosome V in the position Cp-Gp-Tc-Cotr-Ust. Premsekar *et al*. (1964) found that in Cowpea F_1 hybrids, pod length showed an intermediate condition. Aryeetey and Laing (1973) reported that pod length was under polygenic control and transgressive segregates were obtained in F_2. He also stated that correlation of yield per plant was negative with pod length. Patel and Telang (1976) also reported that pod length had a marked negative effect on yield. Studies on intervarietal hybrids in Cowpea conducted by Inasi (1980) revealed that heterosis could be obtained for length of pod.

Menzes (1956) reported that mode of inheritance of pod size was uncertain in pigeon pea. Colins (1967) crossed 21 varieties of Lima bean, and obtained heterosis in some of the F_1 hybrids while in some others, intermediate character was expressed. Singh and Jain (1969) from a study in mung bean involving six varieties showed the presence of additive gene effects with some overdominance for pod length. Again Singh and Jain (1971) studied the F_1 hybrids derived from a diallel cross involving seven varieties and reported that all the hybrids exceeded their respective parents with regard to pod length. Godhani et al. (1978) reported that in green gram additive and additive X additive or dominance effects were involved in pod length.

Weight of pod:

Bhatnagar and Balram Singh (1964) studied the F_1 hybrids in mung bean and found that the hybrids were superior to the mean of the parents for single pod weight. Hamad (1976) evaluated the parents, F_1 and F_2 of a diallel cross involving five cultivars and observed hybrid vigour for single pod weight in all cases. Inasi (1980) obtained heterosis for weight of pod, in his studies on intervarietal hybrids in Cowpea.

Number of seeds per pod:

Interspecific hybridisation in Cowpea conducted by Premsekar et al. (1964) revealed that the hybrid mean value for number of seeds per pod was lower than parental mean. Aryeetey and Laing (1973) studied the inheritance of seed number per pod. It appeared to be under polygenic control and transgressive segregation in F_2 was observed for seed number per pod.

Bordia et al. (1973) reported that in Cowpea, grain yield per plant was strongly associated with number of seeds per pod. Bhaskaraiah et al. (1980) reported maximum average heterotic effect in Cowpea for seeds per pod in a diallel cross.

The hybrids showed varying degrees of heterosis for number of seeds per pod as reported by Inasi (1980).

Wester and Jorgensen (1951) carried out hybridisation work between Clark's Bush, Early market, Peerless, Triumph, and Handerson of Lima bean. The F_1 derived from the cross of Clark's Bush X Triumph showed hybrid vigour in respect of number of seeds per pod.

Intervarietal hybridisation in green gram conducted by Bhatnagar and Balram Singh (1964) suggested heterosis in all the hybrids. Partial to over dominance was noted in the diallel cross in *Phaseolus aureus* by Singh & Jain (1969). Dominant genes seemed to govern the inheritance of number of seeds per pod. Empig *et al.* (1970) estimated heritability for seeds per pod in green gram hybrids and stated that genetic variability and heritability were least for seeds per pod.

Krarup and Davis (1970) suggested that ovule number in peas was determined by a simple additive genetic system and that dominance effects were of very little influence. They have also stated that genes governing low ovule number was partially dominant over high ovule number. Voyest (1972) observed high degree of heterosis for number of seeds per pod in all the six hybrids of French bean studied. Godhani *et al.* (1978) observed that in *Vigna radiata*, additive X additive, dominance and additive effects were responsible for the expression of number of seeds per pod.

Weight of 100-seeds:

Suzuki (1957) could evolve a dwarf strain of Cowpea, named as 62 - 14 - 6 with a 1000 - seed weight of 139 g from a combination of (Mabu (dwarf)) X (Azuki) X Fukushimazairai (Fukushima common). Premsekar *et al*. (1964) have recorded the better performance of interspecific hybrids in Cowpea with respect to 100 - seed weight.

Sene (1968) studied the inheritance of 100 - seed weight in *Vigna unguiculata*. He studied the varieties N58 - 25 (average 100 - seed weight of 8 - 9 g) and N58 - 40 (average 100 - seed weight of 19 - 20 g) and their hybrid progeny. An analysis of variance of the parents, F_2 and F_3 showed that 100 - seed weight had a heritability 0.80 and was mainly under the control of additive genes. Six pairs of genes were thought to be involved, all of these being present in N58 - 40 and one pair in N58 - 25. It was suggested that each gene was responsible for a weight increase of 1.1 g.

Bordia *et al*. (1973) found that heritability was higher for 100 - seed weight in some of the hybrids of Vigna. According to Patel and Telang (1976), 100 - seed weight had an effect on seed yield in Cowpea. Bhaskaraiah *et al*. (1980) observed least heterosis for 100 - seed weight. Ahuja (1980) studied a set of 8 X 8 diallel cross in green gram. The graphical analysis showed overdominance for 100 - seed weight. According to Inasi (1980) heterosis was observed for 100 - seed weight in the intervarietal hybrids of Cowpea studied by him.

Sakurov (1952) observed heterosis for 100 - seed weight in peas. Heterosis for average seed weight was obtained by Johnson (1957) who performed hybridisation in *Pisum sativum*. He also proposed that factors governing this character were partially dominant. Bhatnagar and Balram Singh (1964) obtained F_1 hybrids in green gram which were superior to the mean of the parents for average seed weight. Based on the studies in *Phaseolus vulgaris*, Patil and D'Cruz (1964) stated that factors governing 100 - seed weight were digenic in nature.

In *Cicer arietinum*, the mode of gene action for 100 - seed weight was additive with little dominance as reported by Zafar and Khan (1968). Voyest (1972) analysed six F_1 hybrids and their parents in French bean. Expression of heterosis was low for this character compared to average seed yield. Heterosis was observed for 100 - seed weight by Sarafi *et al.* (1973).

Gupta *et al.* (1978) reported that in mung bean, the trait 100 - seed weight was found to be influenced by additive gene action. Mahamoud and Ibrahim (1980) studied the inheritance of seed weight in broad bean. Seed weight appeared to be controlled either by polygenes or by one to four pairs of major genes and some modifying factors.

Seed size:

Seed size includes three components namely length, breadth and thickness. Inasi (1980) observed heterosis for seed size in the Cowpea hybrids studied. A detailed study of inheritance of seed size in green gram was conducted by Sen and Murthy (1961). Observation on the F_1's of crosses of the small - seeded variety Sonamung with the medium seeded BR 3 and large seeded EB 6 variety indicated that small seeded nature was more or less completely dominant over the medium and large seeded classes. The F_1's of crosses between two medium seeded parents and between two large - seeded varieties of Phaseolus aureus had evolved from small seeded types through accumulation of additive recessive gene with an effect on seed weight.

Colins (1967) reported that crosses between varieties of Phaseolus lunatus differing in seed size generally gave intermediate values. He reported heterosis for seed size, when the hybrids were derived from parents with same sized seeds. Results of the experiments conducted in mung bean by Singh and Jain (1969) suggested the presence of additive gene effects with some overdominance for seed size.

Voyest (1972) obtained heterosis for seed size in some of the F_1 hybrids of French bean. The result also suggested that the genetic control of seed size was additive in nature. Hybridisation between two wild accessions of Cowpea and six cultivated varieties was carried out by Rawal et al. (1976).

In every cross involving two wild accessions, the seed weight along with seed size was reduced significantly. Lawes and Newaz (1980) observed positive heterosis for seed size in F_1 hybrids of field bean.

Yield of pods per plant:

Capinpin and Irabagon (1950) reported heterosis for pod yield in the F_2 generation of Vigna. Bhaskaraiah et al. (1980) reported heterosis for pod yield from a diallel cross in Cowpea. Godhani et al. (1979) found that dominance and non-additive epistatic effects predominated in the expression of pod yield. The graphical analysis of the F_2 generation of green gram by Ahuja (1980) showed partial dominance for pod yield per plant. The study conducted by Inasi (1980) revealed that, in the case of pod yield, 50 per cent of the hybrids surpassed the better parent, while 37.5 per cent were in between the parental limits. Maximum heterosis of 430.36 per cent was shown by the hybrid P.118 X (C.152 X N.E-1) for pod yield per plant.

Bhatnagar and Balram Singh (1964) reported that in mung bean, pod yield of F_1 hybrids was higher than that of the better parent. Colins (1967) also noticed heterosis for pod yield in the F_1 hybrids of lima bean. Analysis of a diallel cross in *Phaseolus aureus* by Singh and Jain (1969) revealed that F_1 plants had exceeded their parents in yield. Hamad (1976), in his studies on inheritance of yield components in some of the hybrids in *Phaseolus vulgaris* reported heterosis for number of pods per plant.

Yield of seeds per plants:

Capinpin and Irabagon (1950) reported that the F_2 generations of numerous intervarietal crosses of *Vigna sesquipedalis* produced seeds weighing on an average, more than those of the original parents. Premsekar *et al*. (1964) have reported that the hybrids obtained from a cross between *Vigna sinensis* subsp. *sesquipedalis* and *Vigna sinensis* have come on par with *Vigna sinensis* in respect of seed yield per plant. Bruter (1965) obtained a new variety of Cowpea by conducting an interspecific hybridisation between *Vigna sinensis*, *Vigna sesquipedalis* and *Vigna catjang* which showed high seed weight compared with the parents.

The study of inbreeding depression in Cowpea by Bapna Chain Singh (1976) showed that most of the F_2 population exhibited slight reduction in yield compared to the F_1, some did not show any change, while in a few cases the yield of the F_2'S tended to increase over that of the F_1's.

Rawal *et al*. (1976) reported significant reduction for seed weight in F_1 hybrids resulted by crossing wild and cultivated varieties of Cowpea. They suggested that the presence of genetic barriers prevented the exchange of genes between various forms of Cowpea. Godhani et al. (1979) suggested that dominance effects were predominant in the expression of seed yield in green gram. According to Ahuja (1980) seed yield showed partial dominance in green gram. Jatasra (1980) based on the diallel analysis in Cowpea found that both additive and non-additive type of gene actions were involved in the inheritance of kernel weight. Inasi (1980) based on his studies of 16 intervarietal F_1 hybrids in Cowpea, could observe that 43.75 per cent of the hybrids out-yielded the better parent, while 50 per cent of them remained within the parental limits for this character.

Wester and Jorgensen (1951) reported heterosis for seed yield in lima bean hybrids. It was also noted that closer genetical relationship between two parents could account for the total absence of hybrid vigour in their F_1 progeny. Experiments on heterosis in Cajanus cajan by Solomon et al. (1957) reported an increase in grain yield upto 24.5 per cent over that of the parents.

Bhatnagar and Balram Singh (1964) studied heterosis for seed yield in mung bean hybrids. They could obtain in the hybrids, seed yield considerably higher than that in the better parent. Colins (1967) reported heterosis for seed yield per plant, in some hybrids of lima bean. Crosses between varieties differing in various characters gave intermediate values for yield.

According to Singh and Jain (1971) based on their observations on some of the hybrids in Phaseolus aureus, seed yield per plant was governed by factors which were partially dominant. Hamad (1976) observed high degree of heterosis for seed yield in the F_1 population of snap bean and it appeared to be controlled by additive genes.

Tiwari and Ramanujam (1976) from a study of partial diallel analysis in mung bean, reported that in the F_1, non-additive effects predominated for seed yield per plant in the summer season, but additive effects were also appreciable in the rainy season.

Krarup and Davis (1970) observed that in peas, an additive gene system was controlling weight of seeds per plant. Some deviation from additivity probably due to epistasis or linkage was indicated by a deviation of the F_1 from the mid-parental value.

Sarafi et al. (1976) studied the F_1's and F_2's from crosses, including reciprocals effected between the Phaseolus vulgaris cultivars Torbat and Pinto III. Heterosis was obtained in the initial crosses for seed yield and no heterosis was obtained in the F_2. Lawes and Newaz (1980) studied the genetic control of the distribution of seed yield in field beans. Heterosis for seed yield was expressed in zone 1 (first 5 nodes) followed by zone 3 (top five nodes of 15). When means of parents, F_1's and F_2's were considered the three zones always ranked as zone 1 > zone 2 > zone 3 in their percentage contribution to seed yield.

MATERIALS AND METHODS

MATERIALS AND METHODS

A. Materials

The present study forms a continuation of an ongoing research project of the Department of Agricultural Botany of the College of Horticulture, Vellanikkara.

In a study on the genetic evaluation of Cowpea germplasm conducted during 1977-79, the 202 varieties studied were grouped into 17 distinct clusters. Inter-varietal crosses in 16 combinations of 15 parents chosen from 15 different clusters were effected and their F_1's evaluated during 1979-80.

Seeds collected from the F_1 plants of the following 16 cross combinations at the rate of 2 families per cross available in the Department of Agricultural Botany were made use of in the present study.

Sl. No.	Combination of	
	Clusters	Parents
1.	1 X 10	No. 62 X IC. 20729
2.	3 X 2	Pusa Phalguni X GP.PLS. 63
3.	3 X 8	Pusa Phalguni X Kolingipayar
4.	5 X 15	GP.PLS. 139 X P.118
5.	15 X 5	P.118 X GP.PLS. 139
6.	6 X 8	Red Seeded Selection X Kolingipayar

Sl. No.	Combination of Clusters	Combination of Parents
7.	8 X 6	Kolingipayar X Red Seeded Selection
8.	6 X 9	Red Seeded Selection X GPT. 536
9.	7 X 15	GP.MS. 9314 X P.118
10.	10 X 6	IC. 20729 X Red Seeded Selection
11.	12 X 16	Pattambi local-1 X Kolingipayar-white
12.	14 X 16	Pannithodan-early X Kolingipayar-white
13.	15 X 13	P.118 X (C.152 X N.E.1)
14.	16 X 17	Kolingipayar-white X Mancheri-black
15.	17 X 16	Mancheri-black X Kolingipayar-white
16.	17 X 8	Mancheri-black X Kolingipayar

B. Methods

One hundred seeds in each of the 32 F_2 families representing the above 16 crosses were sown in non-replicated study plot during June-September 1980, with a spacing of one meter between rows & half a meter between plants in a row. Ten plants in each of the parents were also grown side by side. After digging the plot of size 70 X 50 metres size, the land was thrown into ridges and furrows. Seeds were sown at the rate of two seeds per hill. Later at the two leaf stage, it was thinned out to one plant per hill. Ammonium sulphate, Super phosphate and Muriate of potash at the rate of 20: 30: 10 kg/ha of N, P and K respectively, were applied one week after sowing.

Plant protection measures were taken at appropriate time. A second application of Ammonium sulphate at the rate of 10 kg/ha of N, was given at the time of earthing up, 25 days after sowing.

Observations on 16 characters viz., plant height, number of branches, commencement, completion and spread of flowering, number of flowers and pods per plant, length, weight and number of seeds per pod, weight of hundred seeds, length, breadth and thickness of seed, pod as well as seed yields per plant were recorded from all the available F_2 hybrids and ten plants in each of their respective parents as detailed below:

1. Plant height:

Plant height was measured in meters from the base of the plant to the tip of the tallest branch at the time of last harvest.

2. Number of branches:

The number of branches arising from the main stem of each plant was counted at maturity of the plants.

3. Flowering commencement:

The number of days from seeding to the opening of the first flower in a plant was taken as the commencement of flowering of that plant.

4. <u>Flowering completion</u>:

The number of days from seeding to the opening of the last flower in a plant was taken as the completion of flowering of that plant.

5. <u>Flowering spread</u>:

The duration in days from the commencement to completion of flowering of individual plants was estimated as flowering spread.

6. <u>Number of flowers per plant</u>:

Flowers opened in each day was counted and the total per plant arrived at.

7. <u>Number of pods per plant</u>:

Dry pods were harvested at regular intervals from each plant and kept separately. The total number of pods from each plant was counted.

8. <u>Length of pod</u>:

Length of ten pods taken at random from each individual plant was measured in cm. The average length of these ten pods was then calculated.

9. Weight of pod:

The weight of ten pods used for length measurements, was recorded in g using an electric balance.

10. Number of seeds per pod:

Pods which were used in the above two cases were utilise to estimate seeds per pod. Then mean number of seeds per pod was found out.

11. Weight of 100 - seeds:

From each plant one hundred well developed and dried seeds were selected and weight in g was estimated using a sensitive top-loading balance.

12. Length, breadth and thickness of seed:

Length, breadth and thickness of 5 seeds from each plant were estimated in cm using the Mitutoyo Dial Thickness Gage.

13. Pod yield per plant:

After drying, the weight of all the pods obtained from a single plant was recorded in g.

14. Seed yield per plant:

The dried pods were threshed and seeds were extracted and weight of seeds extracted from all the pods obtained from a single plant was estimated in g.

15. Statistical analysis:

The mean value for each character was estimated on individual plant basis. The data collected were statistically analysed and arithmetic mean, coefficient of variation, frequency distribution of individuals for each character etc. were estimated.

RESULTS

RESULTS

Results of observations recorded from all the available F_2 plants of the 32 families, representing 16 intervarietal crosses in Cowpea along with ten plants in each of their 15 parents, in respect of plant height, number of branches, commencement, completion and spread of flowering, number of flowers per plant, number of pods per plant, length and weight of individual pods, number of seeds per pod, weight of 100 - seeds, length, breadth and thickness of seeds, pod as well as seed yields per plant are presented in Tables I to XVI. As the data refer to F_2 generation, they have been processed into frequency tables, by selecting suitable class intervals, so as to include all the individual segregants, ranging from maximum to minimum and the results have been presented along with mean, range and coefficient of variation.

Plant height:

Results of observations, pertaining to the frequency distribution of individuals of parents and F_2's based on plant height are presented in Table I.

(TABLE - I)

The observed mean heights of the 15 parents studied, are found to vary from 0.77 m, in Red Seeded Selection, to 2.20 m, in G152 X N.E-1. With reference to the 16 hybrids studied, maximum mean plant height of 2.03 m has been given by the cross, 17 X 8 i.e. Mancheri black X Kolingipayar and the minimum of 1.02 m by the cross 5 X 15 i.e. GP.PLS. 139 X P.118.

The results indicate a greater amount of variability in the hybrids as compared to their parents, as is shown by the increased magnitude of coefficient of variation. In the three cases where, direct and reciprocals hybrids have been studied, it can be said, within the limits of acceptable error, that there is no reciprocal difference in plant height.

In general, the F_2 results indicate, a polygenic inheritance for plant height as evidenced by the continuous distribution of F_2 frequencies in most of the cases and an agreement of F_2 means with that of the parents. However, except in a few cases, the distribution appears to be skewed, towards dwarfness. Transgressive segregation is also seen in a few cases

<u>Number of Branches:</u>

Observations on the frequency distribution of F_2 individuals and their 15 parents based on number of branches are presented in Table II.

(TABLE - II)

The results presented in the above table indicate that the parental mean for number of branches varies from 2.88 in Kolingipayar and Pannithodan-early to 5.00 in variety C.152 X N.E.1. Among the 16 hybrids studied, it can be seen that the cross GP.PLS. 139 X P.118 has the maximum number of branches with a value of 5.54 and the cross IC. 20729 X Red Seeded Selection has the minimum with a value of 1.70.

The hybrids are having a higher value of coefficient of variation, which indicates the greater degree of variability present in the hybrids, when compared to their parents. Reciprocal differences are also seen in some cases.

The F_2 results indicate that this character is having continuous variation as is indicated by the distribution of F_2 frequencies in eight out of 16 crosses studied. In the other cases, an accumulation of frequency towards lesser number of branches is seen. Results also indicate that within the limits of acceptable error, the F_2 mean agrees with that of parents. However, in most of the cases the value tends towards less number of branches. Transgressive segregation is also seen in a few cases.

Commencement of flowering:

Data pertaining to the frequency distribution of F_2

individuals and their parents based on commencement of flowering are presented in Table III.

(TABLE - III)

From the results in the above table, it is seen that, among the 15 parents studied, Pusa Phalguni is the earliest and Kolingipayar is the latest to commence flowering with mean values of 44.00 and 62.67 days respectively. With reference to the 16 hybrids studied, a range of 46.48 to 58.79 days has been given by the cross, 15 X 5 i.e. P.118 X GP.PLS. 139 and 5 X 15 i.e. GP.PLS. 139 X P.118 respectively.

From the results, it is also observed that, there is a greater amount of variability in all the hybrids as compared to their parents, which is indicated by the higher value of coefficient of variation. In the three cases, where direct and reciprocal hybrids have been studied, except in one, it can be said that there is no reciprocal difference for this character.

In general, the F_2 frequencies show a continuous distribution and the F_2 means agree with that of the parents, thereby indicating a polygenic inheritance for commencement of flowering. In certain cases, a few F_2 individuals are seen to have surpassed the parents which indicates transgressive segregation for this character.

Completion of flowering:

Results of observations, pertaining to the frequency distribution of individuals of parents and F_2's based on completion of flowering are presented in Table IV.

(TABLE - IV)

The observed means for number of days to complete flowering are found to vary from 65.04 days in Pusa Phalguni to 81.54 days in GP.PLS. 139. Among the hybrids, the mean for this character varies from a maximum of 79.44 in 17 X 8 i.e. Mancheri black X Kolingipayar to 75.25 in 6 X 9 i.e. Red Seeded Selection X GPT. 536.

In most of the cases, the magnitude of coefficient of variation is higher for the hybrids, compared to their parents. In the three cases, where direct and reciprocal hybrids have been studied, it can be said that within the limits of acceptable error, there is no reciprocal difference for number of days to complete flowering.

The F_2 results indicate, a polygenic inheritance for completion of flowering as evidenced by the continuous distribution of F_2 frequencies and an agreement of F_2 means with that of parents in most of the cases. But the distribution appears to be skewed towards more number of days to complete flowering.

Transgressive segregation towards lesser number of days to complete flowering is seen in nine out of sixteen crosses studied. In the rest given, no transgression is seen.

Flowering spread:

Table V gives the data on the frequency distribution of F_2 individuals and their parents for spread of flowering.

(TABLE - V)

Among the parents, the observed mean spread is maximum in GPT. 536 with a value of 31.88 days and minimum in GP.PLS. 139 with a value of 20.59 days. The observed mean spread for the hybrids ranges from 32.85 days in 15 X 5 (P.118 X GP.PLS. 139) to 20.64 in 5 X 15 (GP.PLS. 139 X P.118).

A greater amount of variability is shown by some of the hybrids compared to their parents as is shown by the increased magnitude of coefficient of variation. No appreciable reciprocal difference is seen. The F_2 results indicate a polygenic inheritance for flowering spread as evidenced by the continuous variation in F_2 and an agreement of F_2 means with that of parents in majority of the cases. In most of the cases, the hybrids have surpassed the parents indicating transgressive segregation for this character.

Number of flowers per plant:

Results of observations, pertaining to the frequency distribution of F_2 individuals and parents based on number of flowers per plant are presented in Table VI.

(TABLE - VI)

The mean number of flowers per plant for the fifteen parents studied is found to vary from 97.30 in variety C.152 X N.E-1 to 18.07 in variety Pannithodan - early. With reference to the 16 hybrids, maximum mean number of flowers of 72.06 has been given by the cross 17 X 16 (Mancheri - black X Kolingipayar - white) and the minimum of 31.13 by the cross 8 X 6 (Kolingipayar X Red Seeded Selection).

The results indicate that in most of the cases, the hybrids vary greatly compared to their parents as shown by the higher magnitude of coefficient of variation. As far as the direct and reciprocal hybrids are concerned, there is considerable difference in the three cases studied.

The F_2 frequencies of the hybrids are distributed continuously in nine out of sixteen crosses with few individuals surpassing the parental limits in certain cases. In the rest of seven crosses studied, there is an accumulation of F_2 frequencies towards lesser number of flowers.

The results also indicate that in 11 crosses, the F_2 mean is above that of the respective parents. But in 5, it is below the same in the respective parental varieties.

<u>Number of pods per plant</u>:

Data regarding the frequency distribution of F_2 individuals and their parents for number of pods per plant are presented in Table VII.

(TABLE - VII)

Much variation is noted among parents and hybrids for this character. With respect to the parents, the mean variation ranges from 7.88 in Red Seeded Selection to 41.10 in variety C.152 X N.E.1. In the case of hybrids, the cross 3 X 2 (Pusa Phalguni X GP.PLS.63) is having minimum number of pods per plant (15.12) and the cross 5 X 15 (GP.PLS. 139 X P.118) - the maximum number (48.83).

The hybrids are having a higher value for coefficient of variation compared to their parents thereby indicating higher degree of variability in them. Reciprocal difference is also noticed in some cases.

The overall performance of hybrids indicates that a greater proportion of them have lesser number of pods as is shown by an accumulation of F_2 frequency there. The results also indicate that in four out of sixteen cases studied, the F_2 has a mean value which is less than that of the parents and in the remaining twelve cases it is more than that in the respective parents.

Length of pod:

The results pertaining to the frequency distribution of F_2 individuals as well as parents on pod length are furnished in Table VIII.

(TABLE - VIII)

The above table reveals that the variety-10 (IC. 20729) has the maximum mean pod length of 25.37 cm and variety-16 (Kolingipayar-white) - the minimum pod length of 7.80 cm. Among the hybrids, the values for pod length range from 11.56 cm in the cross 5 X 15 (GP.PLS. 139 X P.118) to 20.26 cm in 14 X 16 (Pannithodan Early X Kolingipayar - white).

In the three case, where direct and reciprocal hybrids are studied, within the limits of acceptable error, there is no reciprocal difference in the expression of this character. The results indicate that coefficient of variation is higher for most of the hybrids compared to their parents thereby showing greater amount of variability present in the hybrids. The results also indicate a continuous distribution of F_2 frequencies. The means of the F_2's when compared with that of their parents, show that there is no significant difference between them. Thus it is seen that the character length of pod is having a polygenic inheritance. In a few cases the hybrids have surpassed their parents in pod length.

Pod weight:

Observations on the frequency distribution of F_2 individuals and their parents based on pod weight are given in Table IX.

(TABLE - IX)

The mean pod weights for the 15 parents studied vary from 0.45 g in variety-16 (Kolingipayar-white) to 2.91 g in variety-10 (IC. 20729) which indicate that there is not much variation among varieties for this character. The highest value for pod weight is noted in the cross 14 X 16 (Pannithodan-Early X Kolingipayar-White) (2.10 g) and lowest in the cross 5 X 15 (0.99 g) (GP.PLS. 139 X P.118). The cross 14 X 16 is having a wide range of pod weight. A higher degree of variability is noted in all the hybrids. This is indicated by the magnitude of coefficient of variation.

Among the reciprocal hybrids studied, there is not much reciprocal difference seen in pod weight. From the results it is seen that, the hybrids vary continuously in F_2, even though the distribution is skewed towards less pod weight in most of the cases. In majority of the cases, the F_2 means agree with those of the parents. Out of the 16 hybrids, transgressive segregation is seen in a few cases. These results indicate that this character is governed by polygenes.

Number of seeds per pod:

Data pertaining to the frequency distribution based on this character for F_2's and parents are presented in Table X.

(TABLE - X)

The observed mean for number of seeds per pod of the 15 parents studied is found to vary from 7.09 in Kolingipayar-white to 14.18 in variety GP.PLS. 63. Among the hybrids a maximum value of 12.85 in 10 X 6 (IC. 20729 X Red Seeded Selection) and a minimum value of 8.13 in 3 X 2 (Pusa Phalguni X GP.PLS. 63) are observed. Most of the hybrids are having a higher value of coefficient of variation, compared to their parents thereby indicating greater amount of variability in F_2 as compared to their parents. There is no significant difference between the three direct and reciprocal hybrids studied.

The F_2 frequencies show a normal distribution but skewed towards more number of seeds and also in most cases, the F_2 mean values agree with the means of their parents. This indicates polygenic inheritance for this character. Transgressive segregation is also observed in a few cases.

100 - Seed weight:

Observations on the frequency distribution of F_2 individuals and their parents are given in Table XI.

(TABLE XI)

From the data presented, it can be seen that much variation occurs among the parents and hybrids. Among the parents, the maximum 100 - seed weight is expressed by variety 10 (IC. 20729) and minimum - by variety 16 (Kolingipayar-white) with values of 15.90 g and 5.30 g respectively. In the case of hybrids, the maximum value of 13.00 g is exhibited by the hybrid 15 X 5 (P.118 X GP.PLS. 139) while the minimum value of 7.57 g is shown by its reciprocal hybrid 5 X 15.

Out of the 16 hybrids studied, in most of the cases, coefficient of variation is higher in the hybrids compared to the parental values thereby indicating greater amount of variability in them. In the three cases, where direct and reciprocal hybrids are studied, except in one case, there is no significant difference in 100 - seed weight. In this case also continuous distribution of the F_2 frequencies is seen thereby indicating polygenic pattern of inheritance. Transgressive segregates are obtained in most of the cases.

Length of seed:

Data on the frequency distribution of this character are presented in Table XII.

(TABLE - XII).

The range in the mean seed length among the parents is observed to be from 1.118 cm for the variety IC. 20729 to 0.566 cm for the variety GP.PLS. 139. With respect to the hybrids, the mean length ranges from 0.897 cm for the cross 14 X 16 (Pannithodan-early X Kolingipayar-white) to 0.686 cm for the cross 5 X 15 (GP.PLS. 139 X P.118) and 8 X 6 (Kolingipayar X Red Seeded Selection). Reciprocal difference is also noted in one of the crosses.

From the results, it is seen that there is higher amount of variability among the hybrids. This is indicated by the higher values of coefficient of variation shown by the hybrids.

In general, the results from the frequency distribution of the hybrids show that it is continuously varying which is characteristic of quantitative inheritance. The F_2 means show values above and below the mean of their parents in a few cases.

Breadth of seed:

Results of observations on the frequency distribution of this character are given in Table XIII.

(TABLE - XIII)

Among the varieties wide variation is noted unlike in the hybrids. Parental mean ranges from 0.408 cm in Kolingipaya white to 0.681 cm in GP.MS. 9314. In the hybrids minimum seed breadth is shown by the cross GP.PLS. 139 X P.118 and maximum by P.118 X GP.PLS. 139, the values being 0.477 cm and 0.641 cm respectively.

The coefficient of variation is seen to be high in the hybrids. This indicates that the hybrids are more variable than their parents. Reciprocal difference is shown only in one case.

In general, the results indicate a polygenic pattern of inheritance which is indicated by the continuous distribution of F_2 frequencies and an agreement of the F_2 means with those of the parents in most of the cases.

Thickness of seed:

The data on frequency distribution are presented in Table XIV.

(TABLE - XIV)

This character is showing the least variation among the varieties as compared to the different characters studied. The variety GP.MS. 9314 possess the maximum value of 0.510 cm and variety Kolingipayar-white - the minimum of 0.344 cm. Among the hybrids, the range is from 0.485 cm to 0.368 cm for the cross 15 X 5 (P.118 X GP.PLS. 139) and 5 X 15 respectively.

The magnitude of coefficient of variation, is higher in the hybrids. The reciprocal hybrids 5 X 15 and 15 X 5 show much difference in seed thickness. The F_2 data show continuous distribution and in most cases the F_2 means do not differ from the mean of the parents. This shows that seed thickness is governed by polygenes.

Pod yield (g)

Results of observations on pod yield per plant for the 15 parents and 16 F_2 hybrids are presented in Table XV.

(TABLE- XV)

A wide range of variation is noticed in the parents as well as hybrids. Among the parents, maximum pod yield is given by the variety 13 (C.152 X N.E-1) and the minimum - by the variety Red Seeded Selection, their mean pod yields being 66.31 g and 5.86 g respectively. With reference to the hybrids, the mean pod yield ranges from 16.96 g for the hybrid 3 X 2 (Pusa Phalguni X GP.PLS. 63) and 46.03 g for the cross 5 X 15 (GP.PLS. 139 X P.118).

The coefficient of variation is seen to be more in the hybrids as compared to their parents thereby indicating a wide range of variation in them as compared to their parents. In all cases of reciprocal hybrids, significant difference is noticed.

The frequency distribution of pod yield shows an accumulation of individuals towards lower yields. In five out of sixteen crosses studied, the F_2 mean is less than that of the respective parents. In the remaining cases, it is more than those in the parents.

Seed Yield (g):

Observations on the frequency distribution of parents and hybrids are presented in Table XVI.

(TABLE- XVI)

Among the parents, highest value for seed yield is shown by the variety 13 (C.152 X N.E-1) and lowest - by the variety 6 (Red Seeded Selection) with their mean values ranging from 39.76 g to 5.36 g respectively. The hybrid 3 X 2 (Pusa Phalguni X GP.PLS. 63) is having the minimum seed yield of 12.58 g and the hybrid 5 X 15 (GP.PLS. 139 X P.118) - the maximum of 32.55 g.

Among the 16 hybrids studied, a higher degree of variability is shown by the hybrids in most of the cases as indicated by the magnitude of coefficient of variation. The parents also show considerable variability for this character. Reciprocal difference is also noticed in all the three cases.

The classes with less seed yield are observed to be more in number. A comparison of the F_2 means with that of the parents reveals that in three out of 16 crosses studied, the F_2 mean is less than that of the parents and in the remaining cases, it is more than that in the corresponding parents.

DISCUSSION

DISCUSSION

Results of observations, on 16 economic characters recorded from all the available F_2 plants belonging to 32 families representing the 16 intervarietal crosses in Cowpea, along with the same from ten plants in each of the 15 parental types have been fully analysed and presented. It remains now to discuss the results obtained as a whole, so as to draw valid conclusions from the same. An attempt in these line has been made in this Chapter.

Cowpea, an important pulse crop of Kerala, because of its adaptability and easiness of cultivation, is grown under highly contrasting situations in the State. The grain - production - oriented rice fallow culture during summer, demands high yielding, bushy, erect varieties with early synchronised flowering, so as to avoid huge expenditure on multiple harvest. Varieties with larger pods or even smaller ones, if their number compensates the size, with good number of heavy seeds per pod will be highly advantageous for this system.

The highly sophisticated system of Cowpea culture in summer rice fallows, for exclusive vegetable purposes followed in certain northern areas like Mancheri in the State, requires trailing varieties with long fleshy pods, with a wide flowering spread so as to ensure vegetable supply for a longer period. Here, a highly synchronised flowering may not be desirable at all, since a good amount of labour for cultivation comes from the family itself. Small poded varieties with larger number of seeds per pod may also be undesirable in this system, in so far as the produce is solely for vegetable purpose.

The third main system of Cowpea culture followed in the State, is during the rainy khariff season in uplands and homesteads. Dual purpose varieties are preferred in this system, since a portion of the produce is used as vegetable and another as grain. Short statured bushy types with shade tolerance and good yield are preferred.

Thus the varietal requirements in Cowpea, in the State vary considerably from place to place and from situation to situation. Thus when short statured bushy varieties are preferred in the grain - production - oriented rice fallow culture and also in uplands and homesteads, tall trailing varieties are preferred by farmers of Mancheri, who cultivate Cowpea in rice fallows specifically for vegetable purpose. When synchronised flowering with large number of grains per pod is preferable at one place, it is protracted flowering with lesser number of seeds per pod that is desirable in another place. Number of seeds per pod and also its fleshiness are important in places where Cowpea is cultivated for dual purpose. Thus the task of Cowpea breeders in the State, at the present juncture is of a diverse nature in so far as the requirements vary considerably.

It would be highly speculative, if one desires to produce a single variety possessing all the desirable attributes for satisfying the needs of the farmers and the consumers. A more realistic approach in situations like this appears to be to produce different varieties combining the desirable attributes required for the diverse situations by suitable means. One of the means by which, this can be achieved is through combination breeding in which desirable genes are pooled from different sources in so far as they are found distributed in different varieties. Thus, the scope of the present study in selecting 15 types or varieties belonging to 15 different clusters, each variety possessing one or the other contrasting traits to the maximum, as parents in the programme and crossing them and studying the progenies in the segregating generation is amply justifiable. It is also worthwhile to critically examine, to what extent the results obtained in the present investigation are capable of answering the various problems posed before us.

The plant type concept is gaining wider acceptance in recent years. An ideal plant type is one which has a morphological framework capable of efficient conversion of various inputs into final yield in a particular environment. Thus instead of considering unit characters, plant breeders are now looking for an individual having an ideal and harmonious combination of different characteristics. Because of the reasons enumerated earlier, definition of an ideal plant type, in Cowpea cannot be spelt out, since the requirements vary widely from situation to situation. Bushy dwarf stature is desirable in majority of the areas though, however, tall twining habit is advantageous in limited specialised areas. Synchronised flowering and also protracted flowering assume importance in different situations. High yield coupled with short duration is uniformly desirable in all situations and places. An assessment of the results obtained in the present investigation, in these angles is worth attempting.

Stature and branching are the two important aspects which decide the physical framework of the plant. Short stature coupled with profuse branches makes the plant bushy whereas tall plant with sparse branches will give the plant a lean and lanky appearance. In Cowpea, both tall as well as dwarf plants are in demand under different situations. An examination of the data for plant height reveals that this is inherited as a polygenic character in all the 16 crosses studied (Vide Fig.1). Continuous variation in the F_2 and a wider range of variability

Fig.1. Line graph showing the frequency distribution of F_2 individuals for plant height.

1 X 10 (No. 62 X IC. 20729)

3 X 2 (Pusa Phalguni X GP.PLS. 63)

3 X 8 (Pusa Phalguni X Kolingipayar)

5 X 15 (GP.PLS. 139 X P.118)

15 X 5 (P.118 X GP.PLS. 139)

6 X 8 (Red Seeded Selection X Kolingipayar)

8 X 6 (Kolingipayar X Red Seeded Selection)

6 X 9 (Red Seeded Selection X GPT. 536)

7 X 15 (GP.MS. 9314 X P.118)

10 X 6 (IC. 20729 X Red Seeded Selection)

12 X 16 (Pattambi local-1 X Kolingipayar-white)

14 X 16 (Pannithodan-early X Kolingipayar-white)

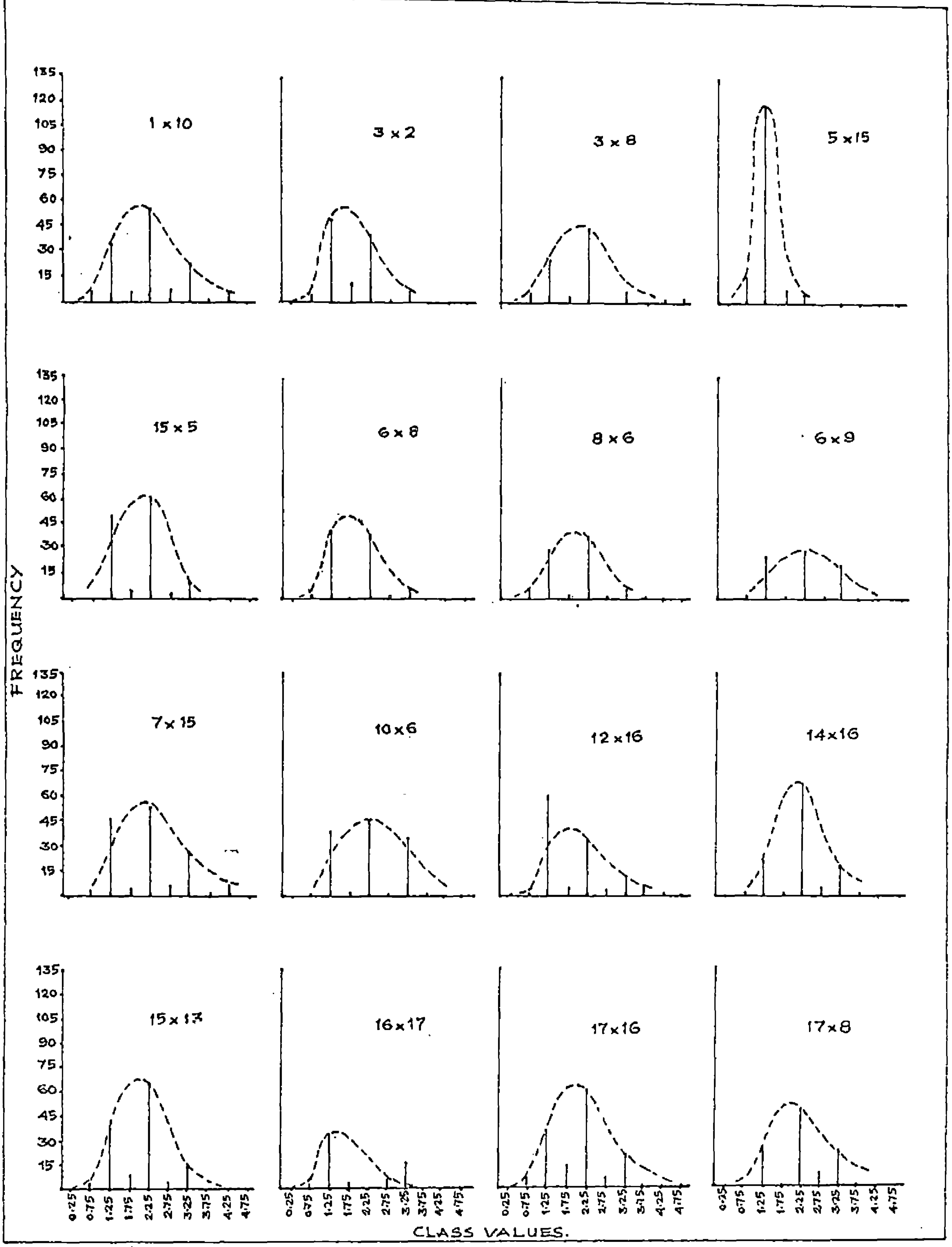
15 X 13 (P.118 X (C.152 X N.E.1)

16 X 17 (Kolingipayar-white X Mancheri-black)

17 X 16 (Mancheri-black X Kolingipayar-white)

17 X 8 (Mancheri-black X Kolingipayar)

-FIG-1-



FREQUENCY
135
120
105
90
75
60
45
30
15
1 x 10
3 x 2
3 x 8
5 x 15
15 x 5
6 x 8
8 x 6
6 x 9
7 x 15
10 x 6
12 x 16
14 x 16
15 x 17
16 x 17
17 x 16
17 x 8
0·25
0·75
1·25
1·75
2·25
2·75
3·25
3·75
4·25
4·75
CLASS VALUES.

as indicated by a higher magnitude of the coefficient of variation are in support of the above view. Transgressive segregation observed in fourteen out of the sixteen crosses suggests the possible involvement of large number of genes in the inheritance of this trait, thereby confirming the above view. Out of the fourteen crosses, where transgressive segregation is observed, when a double sided transgression is seen in five, only a single sided transgression is exhibited in the rest nine of which, in seven it is towards tallness and in two - towards dwarfness. Thus there appears to be great scope for selection for either dwarf or tall plants as the case may be, in the segregating generations of the crosses under question. The absence of transgression in the two crosses studied, may perhaps be due to the non-sharing of contributing genes by the two parents involved in the cross. However, this needs further confirmation. Further, in fourteen out of sixteen crosses studied, the F_2 mean is found to be more than the corresponding mean of the two parents and in the other two it is observed to be less than that of the corresponding parents. This may possibly be due to recombination of factors for tallness or for dwarfness in the F_2 thereby releasing genetic variability and pushing the F_2 mean towards the tall or the dwarf parent resulting in skewness in the distribution. Taking all the above facts into account it may be concluded, that height is inherited as a quantitative character. Genotypic differences in the parents may account for the differential behaviour of the F_2 hybrids of the 16 intervarietal crosses.

Results of observations on the inheritance of primary branches in the 16 hybrids, suggest a polygenic nature of inheritance only in eight cases, since an approximate normal distribution of frequencies is seen only in them (Fig.2). A wider variability as evidenced by the magnitude of coefficient of variation and transgressive segregation in all the above 8 crosses are evidences in support of quantitative inheritance for number of branches in them. When double sided transgression is seen in four out of the above eight crosses, only single sided transgression viz., towards more number of branches in three crosses and towards less number of branches in one cross is realised. This suggests the possibility of obtaining segregants having more number of branches in the segregating population of the above crosses. The F_2 means in five out of the eight crosses appear to be above the corresponding means of their parents and in the remaining three, it seems to be less than that of the corresponding parents. This may possibly be because of recombination of factors for number of branches and releasing genetic variability in the F_2 resulting in shifting the mean this way or that way. Thus in general, in the above 8 crosses, it may be concluded that number of branches is inherited as a polygenic character.

In the remaining eight crosses studied, the F_2 distribu-

Fig.2. Line graph showing the frequency distribution of F_2 individuals for number of branches per plant.

1 X 10 (No. 62 X IC. 20729)

3 X 2 (Pusa Phalguni X GP.PLS. 63)

3 X 8 (Pusa Phalguni X Kolingipayar)

5 X 15 (GP.PLS. 139 X P.118)

15 X 5 (P.118 X GP.PLS. 139)

6 X 8 (Red Seeded Selection X Kolingipayar)

8 X 6 (Kolingipayar X Red Seeded Selection)

6 X 9 (Red Seeded Selection X GPT. 536)

7 X 15 (GP.MS. 9314 X P.118)

10 X 6 (IC. 20729 X Red Seeded Selection)

12 X 16 (Pattambi local-1 X Kolingipayar-white)

14 X 16 (Pannithodan-early X Kolingipayar-white)

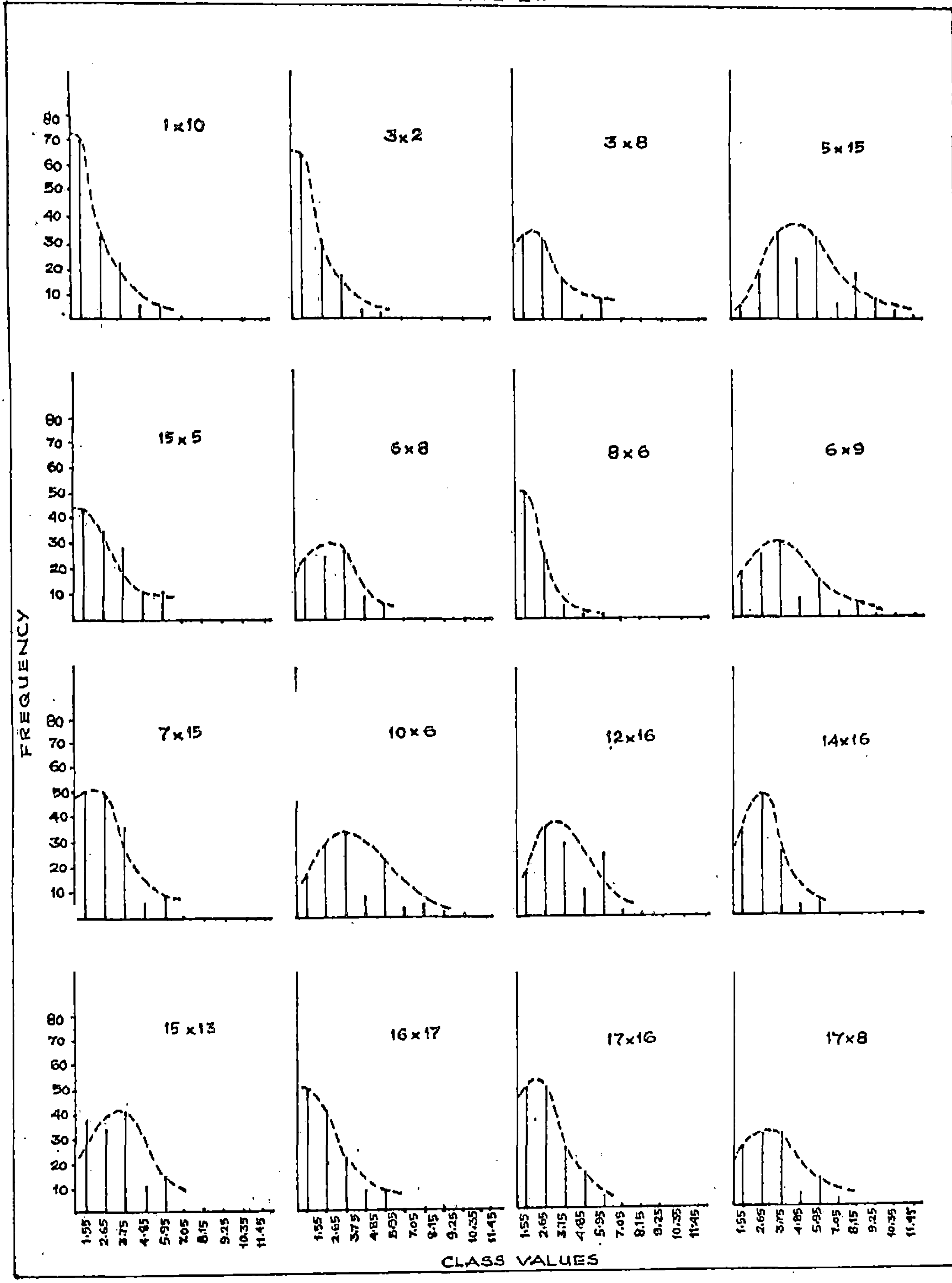
15 X 13 (P.118 X (C.152 X N.E.1)

16 X 17 (Kolingipayar-white X Mancheri-black)

17 X 16 (Mancheri-black X Kolingipayar-white)

17 X 8 (Mancheri-black X Kolingipayar)

- FIG - 2 -


1x10
3x2
3x8
5x15
15x5
6x8
8x6
6x9
7x15
10x6
12x16
14x16
15x13
16x17
17x16
17x8
FREQUENCY
80
70
60
50
40
30
20
10
1.55
2.65
3.75
4.85
5.95
7.05
8.15
9.25
10.35
11.45
CLASS VALUES

tion appears to be one sided, since there is an accumulation of frequencies towards lower number of branches. One of the possible reasons for this seems to be the limited size of the F_2 population studied in the present investigation. However, this needs further experimental support. Reciprocal difference observed in two out of three cases in the present study suggests the possible involvement of cytoplasm which needs further confir mation.

Duration is another important aspect that has to be considered. From the economic point of view, it is always desirable to have an individual capable of producing the maximum in the minimum possible time. One of the means by which a breeder achieves this objective is through a process of screening of individuals based on per day yield. This takes care of productivity and maturity period of a genotype simultaneously. The term duration denotes the time interval from seeding to harvest. This can be broadly divided into vegetative and productive periods. Any reduction in either of the two or in both will result in an ultimate reduction in duration. In Cowpea, a shorter vegetative phase is desirable in all situations but with reference to productive phase synchronised flowering result ing in single harvest is desirable in commercial cultivation where as protracted flowering seems to be ideal in homestead cultivation in order to ensure a continuous supply of vegetable Cowpea over a longer period. Thus, commencement of flowering, completion of flowering and flowering spread are important aspects in Cowpea culture.

Results of the present investigation with reference to commencement and completion of flowering and also its spread indicate the possible role of large number of genes, in the expression of the above trait. Continuous variation in the F_2 with varying degrees of skewness, transgressive segregation and a wide range of variability as evidenced by the magnitude of coefficient of variation etc. observed in all the F_2's studied, support the above view (Fig. 3,4 & 5). Transgressive segregation, either to one side or to both the sides, suggests the possibility of realising individuals with extreme values. The F_2 means, within the limits of acceptable error, can be considered to agree with the mean of the respective parents. No appreciable reciprocal difference is detectable with reference to the above three traits.

Considering the above facts together, it may be concluded that commencement of flowering, completion of flowering and flowering spread are inherited as quantitative characters. The results also indicate that there is immense possibility of obtaining early derivatives from the above crosses through selection. This is in support of the results of Kuruvila Thomas (1972).

Fig-3

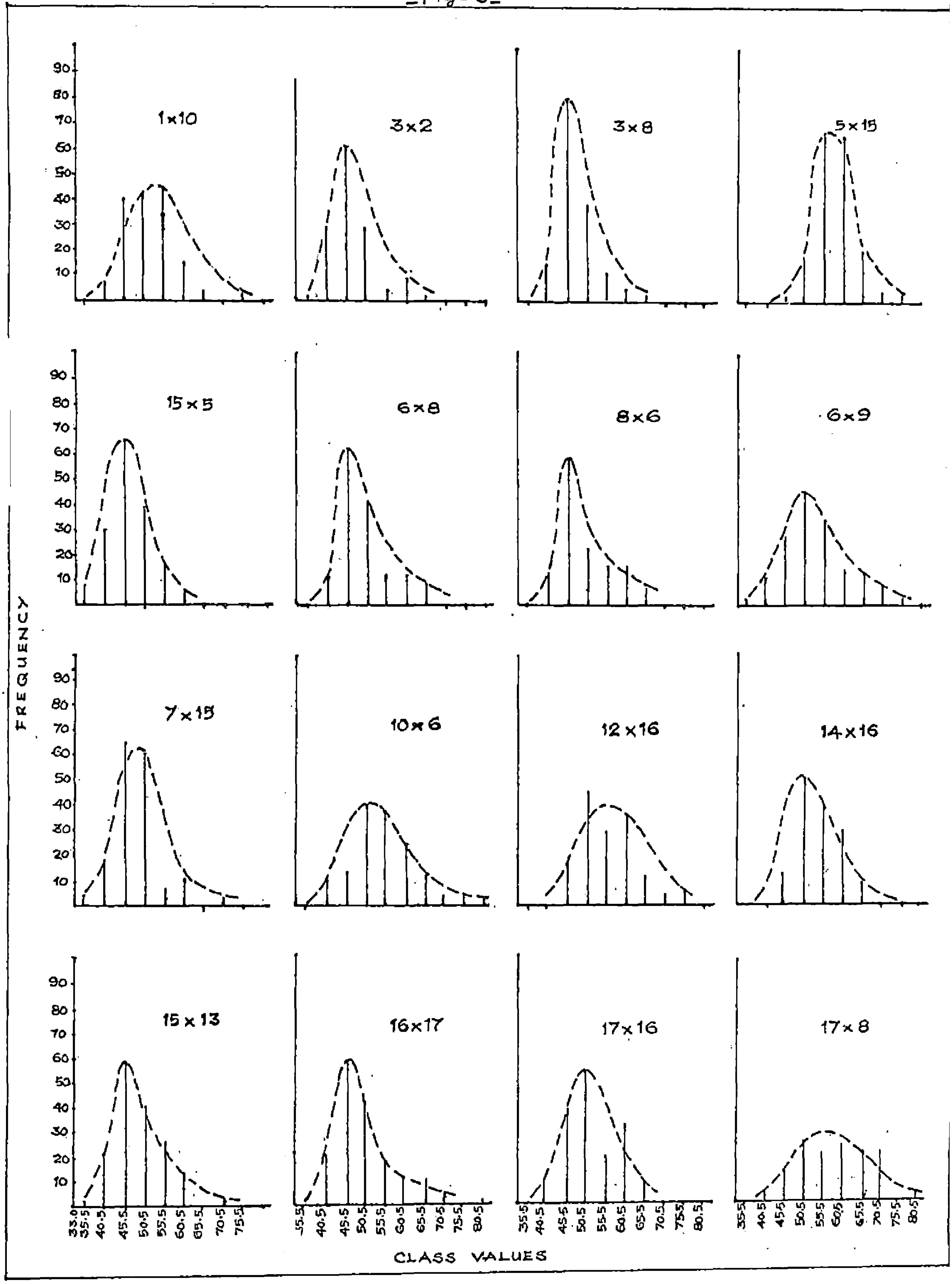
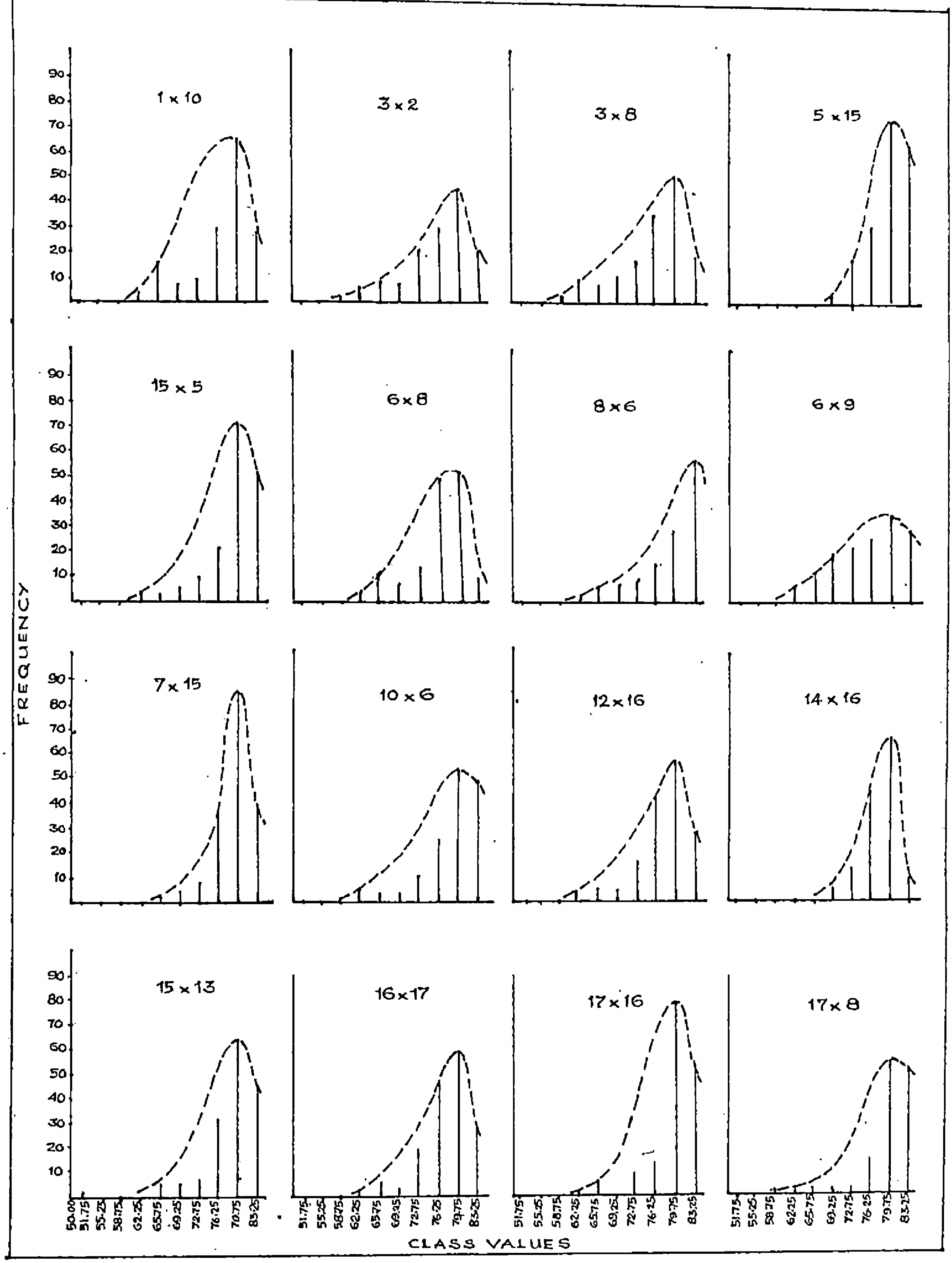

1×10
3×2
3×8
5×15
15×5
6×8
8×6
6×9
7×15
10×6
12×16
14×16
15×13
16×17
17×16
17×8
FREQUENCY
CLASS VALUES

Fig.4. Line graph showing the frequency distribution of F_2 individuals for completion of flowering.

1 X 10	(No. 62 X IC. 20729)
3 X 2	(Pusa Phalguni X GP.PLS. 63)
3 X 8	(Pusa Phalguni X Kolingipayar)
5 X 15	(GP.PLS. 139 X P.118)
15 X 5	(P.118 X GP.PLS. 139)
6 X 8	(Red Seeded Selection X Kolingipayar)
8 X 6	(Kolingipayar X Red Seeded Selection)
6 X 9	(Red Seeded Selection X GPT. 536)
7 X 15	(GP.MS. 9314 X P.118)
10 X 6	(IC. 20729 X Red Seeded Selection)
12 X 16	(Pattambi local-1 X Kolingipayar-white)
14 X 16	(Pannithodan-early X Kolingipayar-white)
15 X 13	(P.118 X (C.152 X N.E.1)
16 X 17	(Kolingipayar-white X Mancheri-black)
17 X 16	(Mancheri-black X Kolingipayar-white)
17 X 8	(Mancheri-black X Kolingipayar)

-FIG. 4-

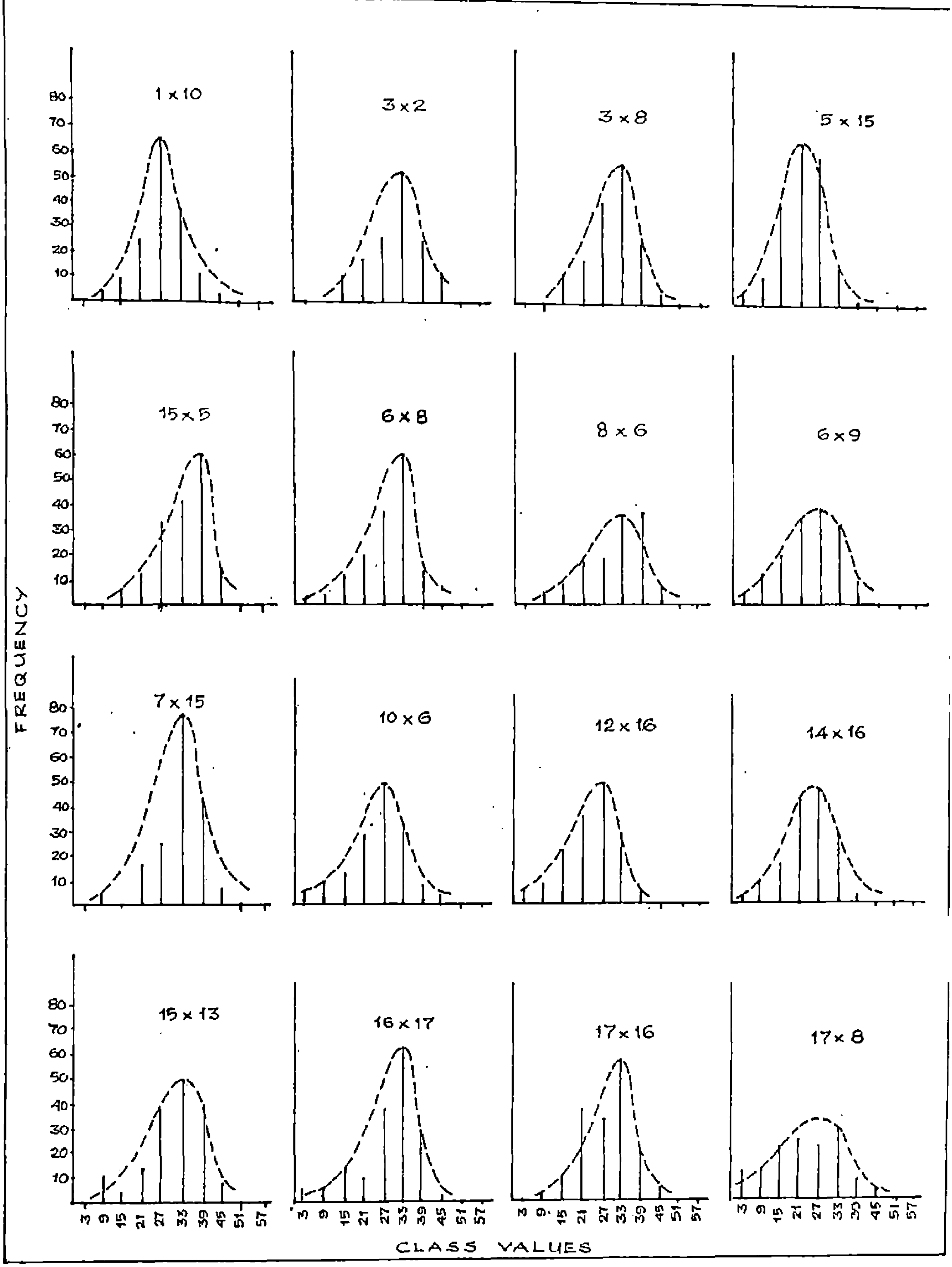


FREQUENCY
1 x 10
3 x 2
3 x 8
5 x 15
15 x 5
6 x 8
8 x 6
6 x 9
7 x 15
10 x 6
12 x 16
14 x 16
15 x 13
16 x 17
17 x 16
17 x 8
CLASS VALUES

Fig.5. Line graph showing the frequency distribution of F_2 individuals for flowering spread.

1 X 10	(No. 62 X IC. 20729)
3 X 2	(Pusa Phalguni X GP.PLS. 63)
3 X 8	(Pusa Phalguni X Kolingipayar)
5 X 15	(GP.PLS. 139 X P.118)
15 X 5	(P.118 X GP.PLS. 139)
6 X 8	(Red Seeded Selection X Kolingipayar)
8 X 6	(Kolingipayar X Red Seeded Selection)
6 X 9	(Red Seeded Selection X GPT. 536)
7 X 15	(GP.MS. 9314 X P.118)
10 X 6	(IC. 20729 X Red Seeded Selection)
12 X 16	(Pattambi local-1 X Kolingipayar-white)
14 X 16	(Pannithodan-early X Kolingipayar-white)
15 X 13	(P.118 X (C.152 X N.E.1)
16 X 17	(Kolingipayar-white X Mancheri-black)
17 X 16	(Mancheri-black X Kolingipayar-white)
17 X 8	(Mancheri-black X Kolingipayar)

-FIG-5-


1 x 10
3 x 2
3 x 8
5 x 15
15 x 5
6 x 8
8 x 6
6 x 9
7 x 15
10 x 6
12 x 16
14 x 16
15 x 13
16 x 17
17 x 16
17 x 8
FREQUENCY
80
70
60
50
40
30
20
10
3
9
15
21
27
33
39
45
51
57
CLASS VALUES

Yield is the primary objective of any breeding programme. Cowpea which is no exception to this, is mainly grown for its edible green pods as vegetables and also for its mature grains rich in proteins. Hence pod yield and seed yield assume importance in the case of Cowpea.

Yield in Cowpea just like in any other crop, cannot be considered as one single unit. It is a complex character, conditioned by various components. For example, pod yield in Cowpea is primarily determined by number of flowers per plant, number of pods per plant, length and weight of individual pod, etc. whereas seed yield is conditioned by number of seeds per pod, weight of hundred seeds, size of the seed as determined by its length, breadth and thickness. These components are normally expected to have a positive relationship with ultimate yield. Among these, number of flowers and pods borne on individual plants, must be reckoned as factors having a bearing on not only pod but also seed yields, an intensified expression of the same resulting in an increased yield of both.

Results of observations in the present investigation for number of flowers per plant indicate a polygenic nature of inheritance in nine out of sixteen crosses studied, as indicated by continuous variation and wider range variability in F_2 (Fig. 6). Transgressive segregation observed in seven out of the above nine

Fig.6. Line graph showing the frequency distribution of F_2 individuals for number of flowers per plant.

1 X 10 (No. 62 X IC. 20729)

3 X 2 (Pusa Phalguni X GP.PLS. 63)

3 X 8 (Pusa Phalguni X Kolingipayar)

5 X 15 (GP.PLS. 139 X P.118)

15 X 5 (P.118 X GP.PLS. 139)

6 X 8 (Red Seeded Selection X Kolingipayar)

8 X 6 (Kolingipayar X Red Seeded Selection)

6 X 9 (Red Seeded Selection X GPT. 536)

7 X 15 (GP.MS. 9314 X P.118)

10 X 6 (IC. 20729 X Red Seeded Selection)

12 X 16 (Pattambi local-1 X Kolingipayar-white)

14 X 16 (Pannithodan-early X Kolingipayar-white)

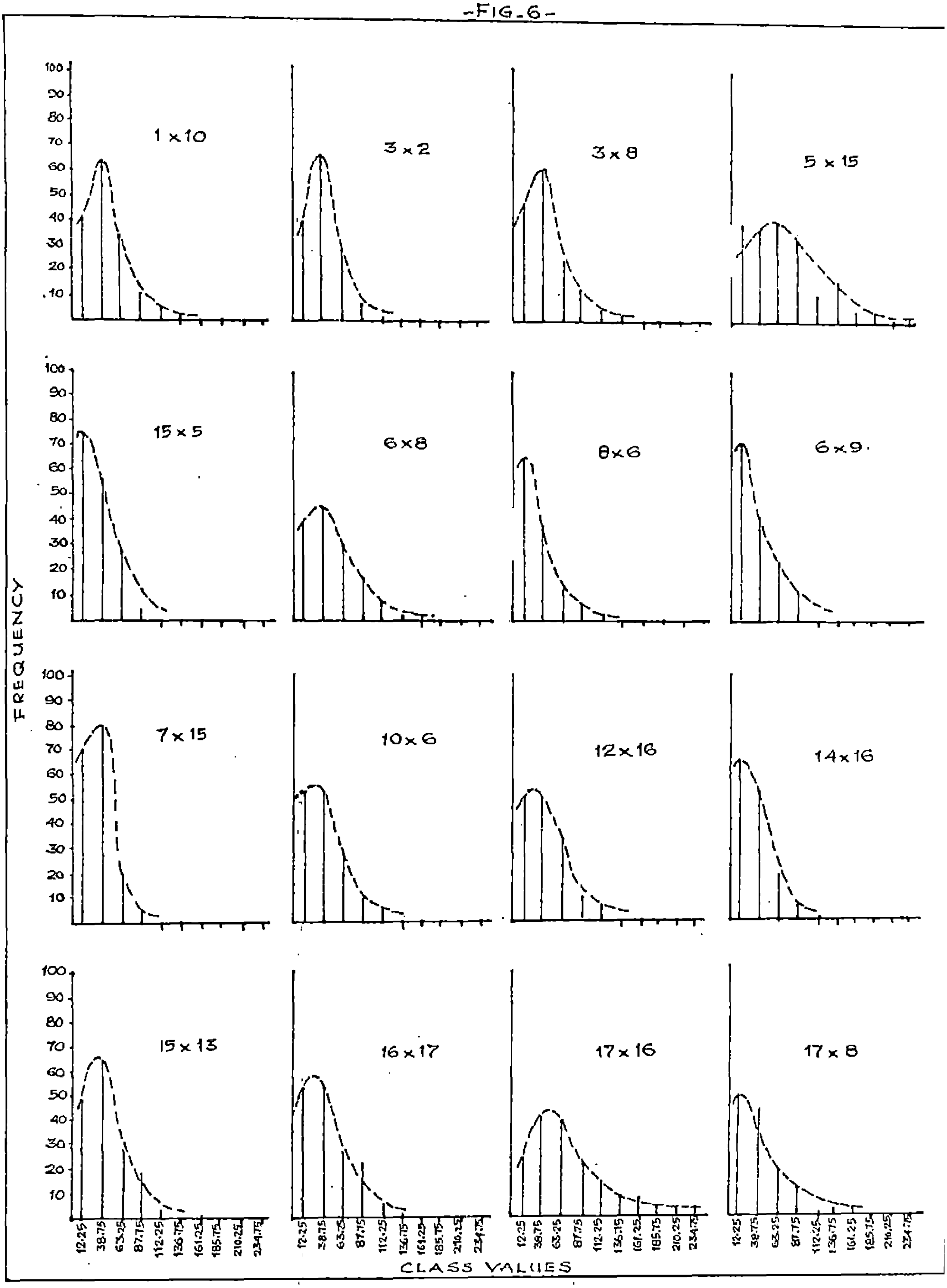
15 X 13 (P.118 X (C.152 X N.E.1)

16 X 17 (Kolingipayar-white X Mancheri-black)

17 X 16 (Mancheri-black X Kolingipayar-white)

17 X 8 (Mancheri-black X Kolingipayar)

-FIG_6-


FREQUENCY
1 x 10
3 x 2
3 x 8
5 x 15
15 x 5
6 x 8
8 x 6
6 x 9
7 x 15
10 x 6
12 x 16
14 x 16
15 x 13
16 x 17
17 x 16
17 x 8
100
90
80
70
60
50
40
30
20
10
12.25
38.75
63.25
87.75
112.25
136.75
161.25
185.75
210.25
234.75
CLASS VALUES

cases, suggests the involvement of large number of genes in the inheritance of number of flowers per plant, thereby supporting the above view. Out of the seven crosses where transgressive segregation is observed, a double sided transgression is seen in four and a single sided - in the remaining three of which, it is towards more number of flowers per plant in two and towards less number of flowers per plant in one. Absence of transgressive segregation in the two cases may, perhaps, be due to the non- sharing of contributing genes by the two parents involved in the cross. Again, in six out of the nine cases, the F_2 mean is found to be slightly more than the same in the corresponding parents and in the remaining three, it is observed to be less than that of the corresponding parents. This may possibly be because of recombination of genes for more number of flowers per plant or less number of flowers per plant, thereby, releasing genetic variability and pushing the F_2 mean towards one side or the other resulting in a skewed distribution.

In the remaining seven crosses studied, the F_2 frequency distribution does not appear to be normal. It is seen to be one sided, since there seems to be an accumulation of frequencies towards less number of flowers per plant. Non-recovery of segregants representing classes on the other side of the curve may, perhaps, be due to the small size of the F_2 population. However, this demands further experimental evidence. Reciprocal difference observed in certain cases, suggests the possible role of cytoplasm in the expression of this character. This also needs further confirmation.

With reference to number of pods per plant, results of the present study indicate an accumulation of frequencies towards lower number of pods per plant (Fig. 7). The distribution is also one sided and not normal. Limited size of the F_2 population studied in the present case, may perhaps be one of the reasons for this peculiar behaviour. However, this needs confirmation. Further, continuous variation observed in the F_2 of all the crosses studied, does not permit one to group the F_2 individuals into clear cut phenotypic classes and to consider this as a qualitative character. Hence a study involving large number of F_2 plants in all the above crosses can only explain the nature of inheritance of number of pods per plant. Reciprocal difference observed in the present case, is suggestive of the possible role of cytoplasm. However, this has to be confirmed by further studies.

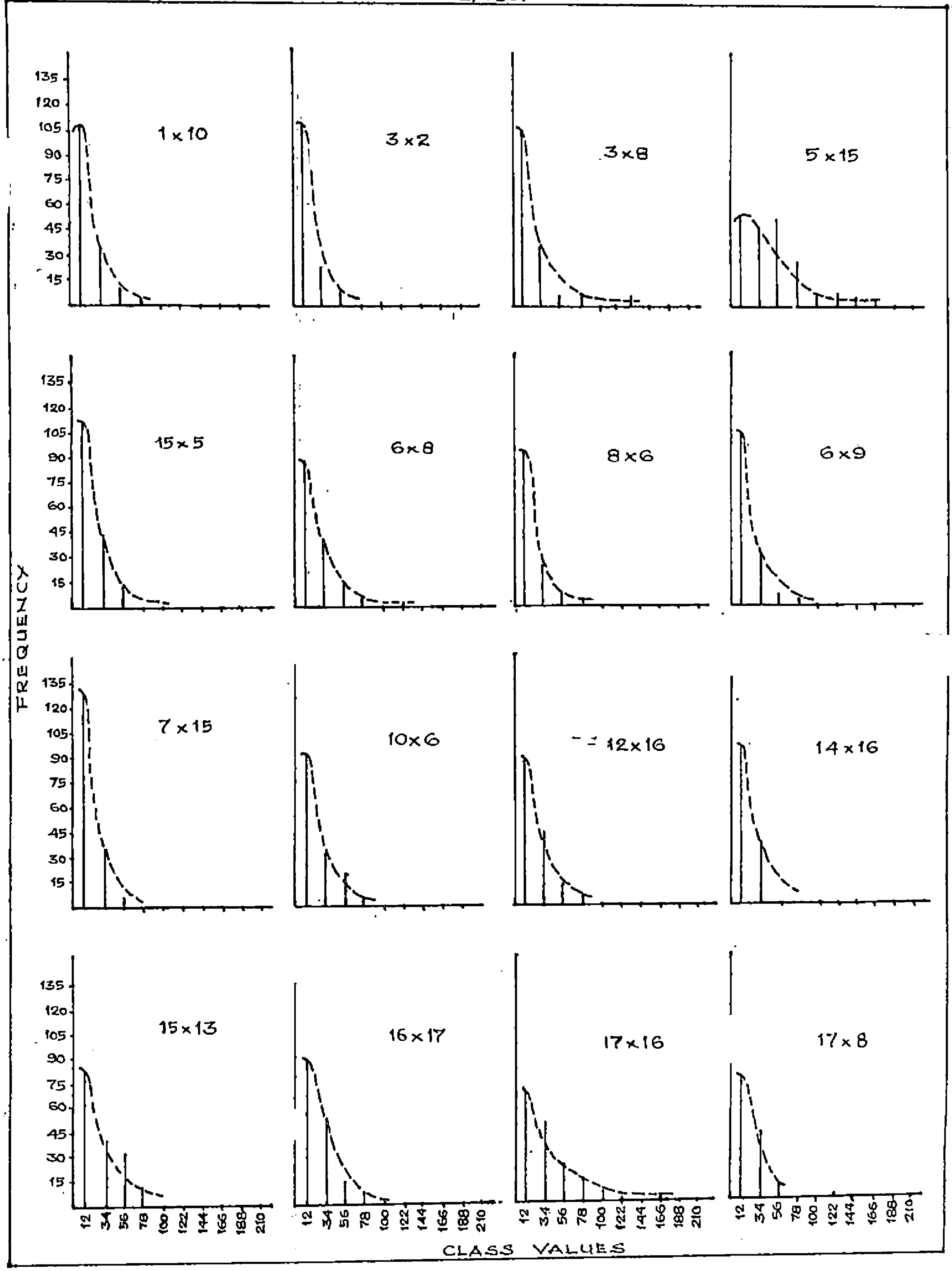
Length and weight of individual pods must be considered as components having a direct relationship with pod yield, since longer and heavier pods will naturally result in higher pod yield

Results of observations on length and weight of individual

Fig.7. Line graph showing the frequency distribution of F_2 individuals for number of pods per plant.

1 X 10	(No. 62 X IC. 20729)
3 X 2	(Pusa Phalguni X GP.PLS. 63)
3 X 8	(Pusa Phalguni X Kolingipayar)
5 X 15	(GP.PLS. 139 X P.118)
15 X 5	(P.118 X GP.PLS. 139)
6 X 8	(Red Seeded Selection X Kolingipayar)
8 X 6	(Kolingipayar X Red Seeded Selection)
6 X 9	(Red Seeded Selection X GPT. 536)
7 X 15	(GP.MS. 9314 X P.118)
10 X 6	(IC. 20729 X Red Seeded Selection)
12 X 16	(Pattambi local-1 X Kolingipayar-white)
14 X 16	(Pannithodan-early X Kolingipayar-white)
15 X 13	(P.118 X (C.152 X N.E.1)
16 X 17	(Kolingipayar-white X Mancheri-black)
17 X 16	(Mancheri-black X Kolingipayar-white)
17 X 8	(Mancheri-black X Kolingipayar)

-FIG-7-


1 x 10
3 x 2
3 x 8
5 x 15
15 x 5
6 x 8
8 x 6
6 x 9
7 x 15
10 x 6
12 x 16
14 x 16
15 x 13
16 x 17
17 x 16
17 x 8
FREQUENCY
135
120
105
90
75
60
45
30
15
12
34
56
78
100
122
144
166
188
210
CLASS VALUES

pods indicate a polygenic nature of inheritance for these traits in all the 16 crosses studied (Fig. 8 & 9). Continuous variation and wider range of variability as indicated by the magnitude of coefficient of variation in F_2 are factors in support of the above. Transgressive segregation, either one sided or both sided, observed in majority of the hybrids, further confirms the involvement of large number of genes. Within the limits of acceptable error, the F_2 means can be said to agree with those of the respective parents. Absence of reciprocal difference indicates the complete genic control of the above traits.

Out of the four components of pod yield studied in the present investigation, all except number of pods per plant, are observed to have a polygenic nature of inheritance. But the present results of pod yield, do not suggest either quantitative or qualitative nature of inheritance to the same. In all 16 crosses studied no normal distribution, characteristic of quantitative inheritance, is seen in the F_2 (Fig. 15). An accumulation of frequency towards lower yields is seen and as such the curve is only one sided. However, in the one sided curve, the variation appears to be continuous, making it difficult to group the segregants into clear cut phenotypic classes, characteristic of qualitative inheritance. A study with large sized F_2 population can only explain the situation.

Seed yield is primarily determined by number of seeds

Fig.8. Line graph showing the frequency distribution of F_2 individuals for length of individual pod.

1 X 10 (No. 62 X IC. 20729)

3 X 2 (Pusa Phalguni X GP.PLS. 63)

3 X 8 (Pusa Phalguni X Kolingipayar)

5 X 15 (GP.PLS. 139 X P.118)

15 X 5 (P.118 X GP.PLS. 139)

6 X 8 (Red Seeded Selection X Kolingipayar)

8 X 6 (Kolingipayar X Red Seeded Selection)

6 X 9 (Red Seeded Selection X GPT. 536)

7 X 15 (GP.MS. 9314 X P.118)

10 X 6 (IC. 20729 X Red Seeded Selection)

12 X 16 (Pattambi local-1 X Kolingipayar-white)

14 X 16 (Pannithodan-early X Kolingipayar-white)

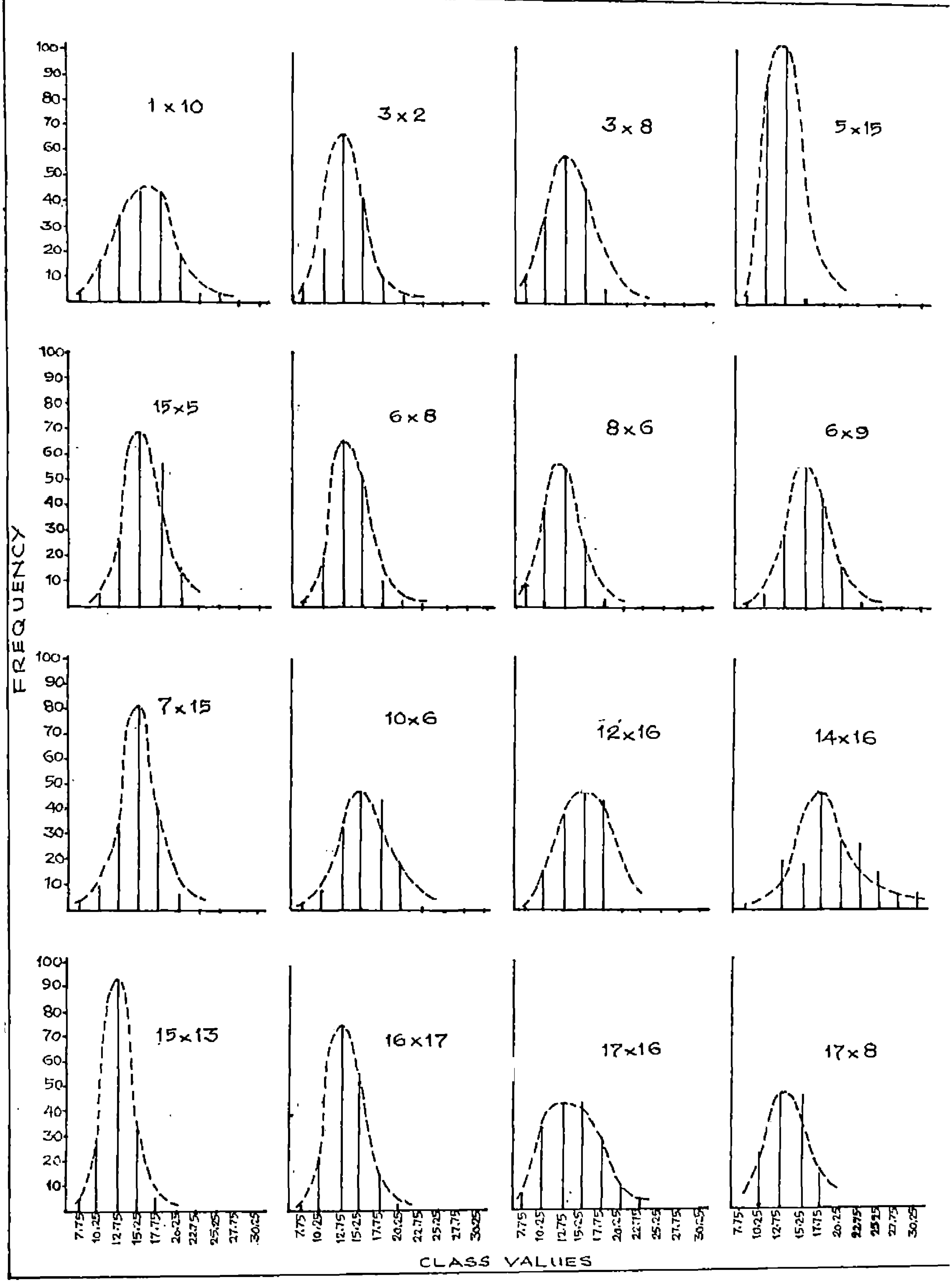
15 X 13 (P.118 X (C.152 X N.E.1)

16 X 17 (Kolingipayar-white X Mancheri-black)

17 X 16 (Mancheri-black X Kolingipayar-white)

17 X 8 (Mancheri-black X Kolingipayar)

-FIG 8-



FREQUENCY
100
90
80
70
60
50
40
30
20
10
1 x 10
3 x 2
3 x 8
5 x 15
15 x 5
6 x 8
8 x 6
6 x 9
7 x 15
10 x 6
12 x 16
14 x 16
15 x 13
16 x 17
17 x 16
17 x 8
7.75
10.25
12.75
15.25
17.75
20.25
22.75
25.25
27.75
30.25
CLASS VALUES

Fig.9. Line graph showing the frequency distribution of F_2 individuals for weight of individual pod.

1 X 10	(No. 62 X IC. 20729)
3 X 2	(Pusa Phalguni X GP.PLS. 63)
3 X 8	(Pusa Phalguni X Kolingipayar)
5 X 15	(GP.PLS. 139 X P.118)
15 X 5	(P.118 X GP.PLS. 139)
6 X 8	(Red Seeded Selection X Kolingipayar)
8 X 6	(Kolingipayar X Red Seeded Selection)
6 X 9	(Red Seeded Selection X GPT. 536)
7 X 15	(GP.MS. 9314 X P.118)
10 X 6	(IC. 20729 X Red Seeded Selection)
12 X 16	(Pattambi local-1 X Kolingipayar-white)
14 X 16	(Pannithodan-early X Kolingipayar-white)
15 X 13	(P.118 X (C.152 X N.E.1)
16 X 17	(Kolingipayar-white X Mancheri-black)
17 X 16	(Mancheri-black X Kolingipayar-white)
17 X 8	(Mancheri-black X Kolingipayar)

-FIG-9-

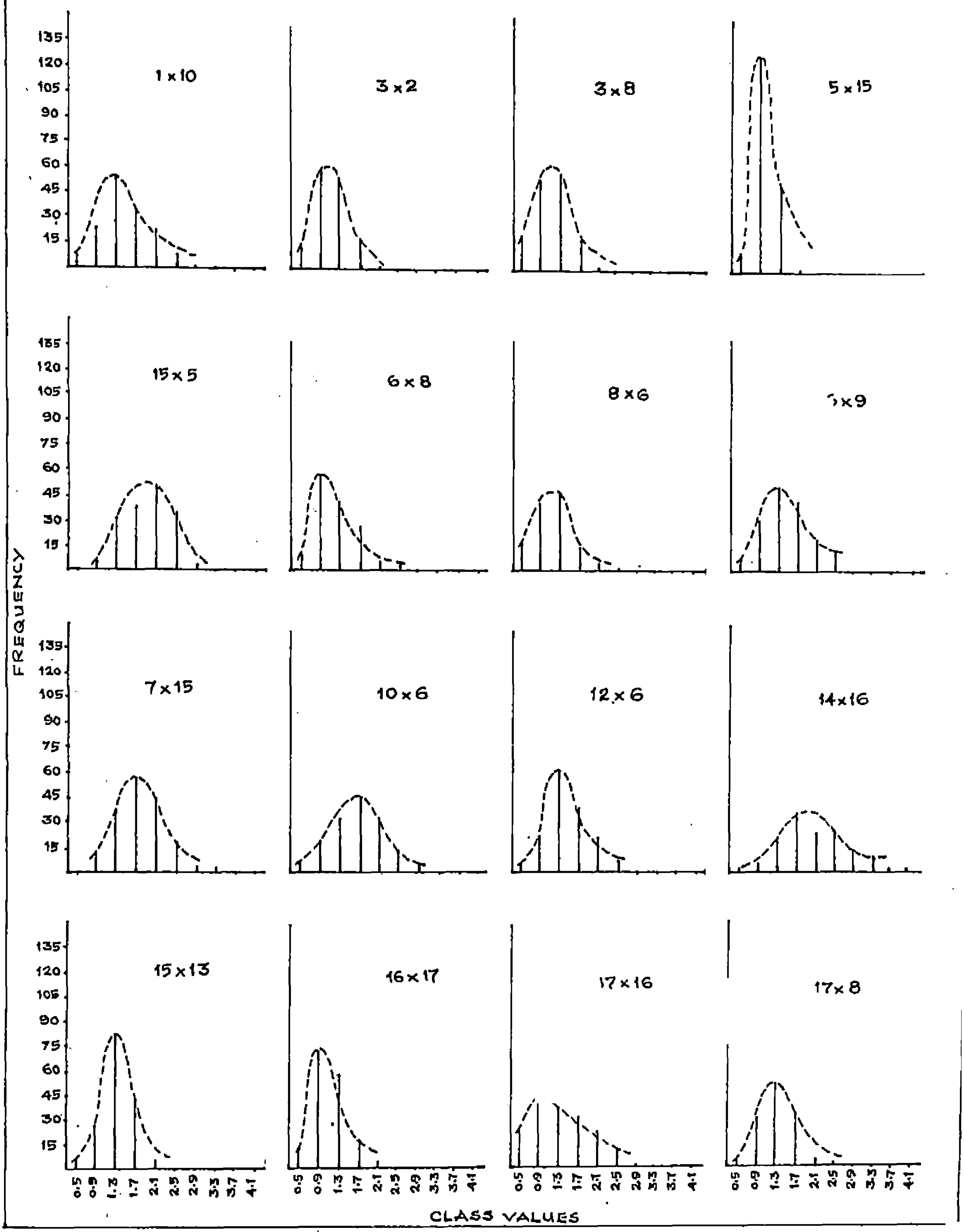

FREQUENCY
135
120
105
90
75
60
45
30
15
1x10
3x2
3x8
5x15
15x5
6x8
8x6
7x15
10x6
12x6
14x16
15x13
16x17
17x16
17x8
0.5
0.9
1.3
1.7
2.1
2.5
2.9
3.3
3.7
4.1
CLASS VALUES

Fig.15. Line graph showing the frequency distribution of F_2 individuals for pod yield per plant.

1 X 10 (No. 62 X IC. 20729)

3 X 2 (Pusa Phalguni X GP.PLS. 63)

3 X 8 (Pusa Phalguni X Kolingipayar)

5 X 15 (GP.PLS. 139 X P.118)

15 X 5 (P.118 X GP.PLS. 139)

6 X 8 (Red Seeded Selection X Kolingipayar)

8 X 6 (Kolingipayar X Red Seeded Selection)

6 X 9 (Red Seeded Selection X GPT. 536)

7 X 15 (GP.MS. 9314 X P.118)

10 X 6 (IC. 20729 X Red Seeded Selection)

12 X 16 (Pattambi local-1 X Kolingipayar-white)

14 X 16 (Pannithodan-early X Kolingipayar-white)

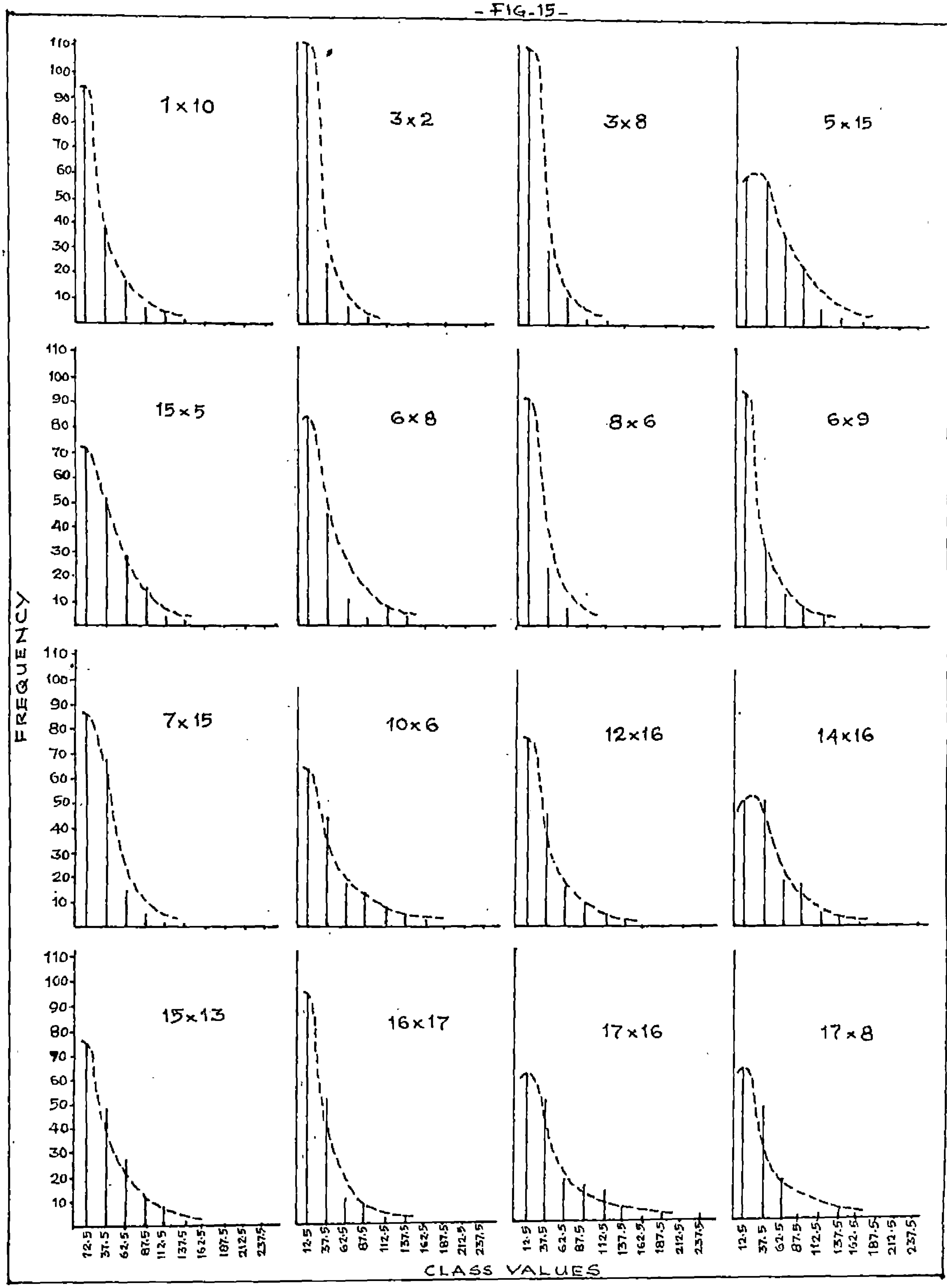
15 X 13 (P.118 X (C.152 X N.E.1)

16 X 17 (Kolingipayar-white X Mancheri-black)

17 X 16 (Mancheri-black X Kolingipayar-white)

17 X 8 (Mancheri-black X Kolingipayar)

- FIG-15 -



1×10
3×2
3×8
5×15
15×5
6×8
8×6
6×9
7×15
10×6
12×16
14×16
15×13
16×17
17×16
17×8
FREQUENCY
CLASS VALUES
12.5
37.5
62.5
87.5
112.5
137.5
162.5
187.5
212.5
237.5

per pod, weight of 100 - seeds and size of individual seeds as determined by their length, breadth and thickness. An intensified expression of the above traits will naturally result in increased seed yield.

Results of observations on number of seeds per pod and weight of 100 - seeds indicate continuous variation and wider range of variability as determined by the magnitude of coefficient of variation in all the sixteen F_2's studied (Fig. 10 & 11). Transgressive segregation, either one sided or both sided is also seen for both of the traits in question in fifteen out of sixteen crosses studied. Within the reasonable limits of error, the F_2 means are also found to agree with those of the corresponding parents. The above facts suggest that number of seeds per pod and weight of 100 - seeds are inherited as quantitative characters controlled by polygenes.

Size of the seed, another component of seed yield, is determined by its length, breadth and thickness. Results of the present study with reference to length, breadth and thickness of individual seed, suggest a polygenic nature of inheritance to these traits, since the variation in the F_2 is seen to be continuous for all the three traits studied in all the sixteen F_2 hybrids (Fig. 12, 13 & 14). The variability for these traits is found to be greater in the F_2's as compared to the same in

Fig.10. Line graph showing the frequency distribution of F_2 individuals for number of seeds per pod.

1 X 10 (No. 62 X IC. 20729)

3 X 2 (Pusa Phalguni X GP.PLS. 63)

3 X 8 (Pusa Phalguni X Kolingipayar)

5 X 15 (GP.PLS. 139 X P.118)

15 X 5 (P.118 X GP.PLS. 139)

6 X 8 (Red Seeded Selection X Kolingipayar)

8 X 6 (Kolingipayar X Red Seeded Selection)

6 X 9 (Red Seeded Selection X GPT. 536)

7 X 15 (GP.MS. 9314 X P.118)

10 X 6 (IC. 20729 X Red Seeded Selection)

12 X 16 (Pattambi local-1 X Kolingipayar-white)

14 X 16 (Pannithodan-early X Kolingipayar-white)

15 X 13 (P.118 X (C.152 X N.E.1)

16 X 17 (Kolingipayar-white X Mancheri-black)

17 X 16 (Mancheri-black X Kolingipayar-white)

17 X 8 (Mancheri-black X Kolingipayar)

Fig.11. Line graph showing the frequency distribution of F_2 individuals for 100 - seed weight.

1 X 10 (No. 62 X IC. 20729)

3 X 2 (Pusa Phalguni X GP.PLS. 63)

3 X 8 (Pusa Phalguni X Kolingipayar)

5 X 15 (GP.PLS. 139 X P.118)

15 X 5 (P.118 X GP.PLS. 139)

6 X 8 (Red Seeded Selection X Kolingipayar)

8 X 6 (Kolingipayar X Red Seeded Selection)

6 X 9 (Red Seeded Selection X GPT. 536)

7 X 15 (GP.MS. 9314 X P.118)

10 X 6 (IC. 20729 X Red Seeded Selection)

12 X 16 (Pattambi local-1 X Kolingipayar-white)

14 X 16 (Pannithodan-early X Kolingipayar-white)

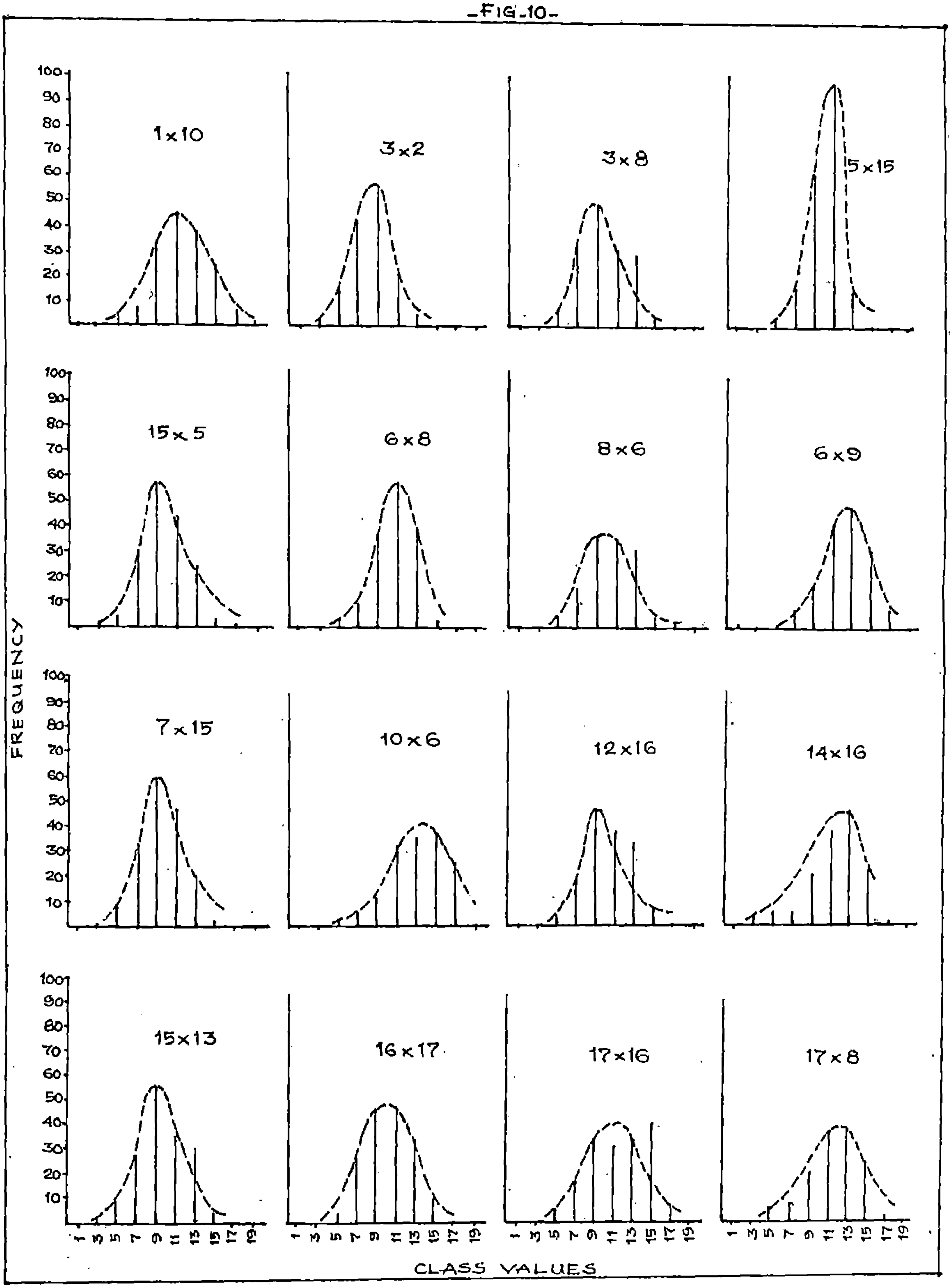
15 X 13 (P.118 X (C.152 X N.E.1)

16 X 17 (Kolingipayar-white X Mancheri-black)

17 X 16 (Mancheri-black X Kolingipayar-white)

17 X 8 (Mancheri-black X Kolingipayar)

-FIG-10-



1x10
3x2
3x8
5x15
15x5
6x8
8x6
6x9
7x15
10x6
12x16
14x16
15x13
16x17
17x16
17x8
FREQUENCY
CLASS VALUES

Fig.11. Line graph showing the frequency distribution of F_2 individuals for 100 - seed weight.

1 X 10 (No. 62 X IC. 20729)

3 X 2 (Pusa Phalguni X GP.PLS. 63)

3 X 8 (Pusa Phalguni X Kolingipayar)

5 X 15 (GP.PLS. 139 X P.118)

15 X 5 (P.118 X GP.PLS. 139)

6 X 8 (Red Seeded Selection X Kolingipayar)

8 X 6 (Kolingipayar X Red Seeded Selection)

6 X 9 (Red Seeded Selection X GPT. 536)

7 X 15 (GP.MS. 9314 X P.118)

10 X 6 (IC. 20729 X Red Seeded Selection)

12 X 16 (Pattambi local-1 X Kolingipayar-white)

14 X 16 (Pannithodan-early X Kolingipayar-white)

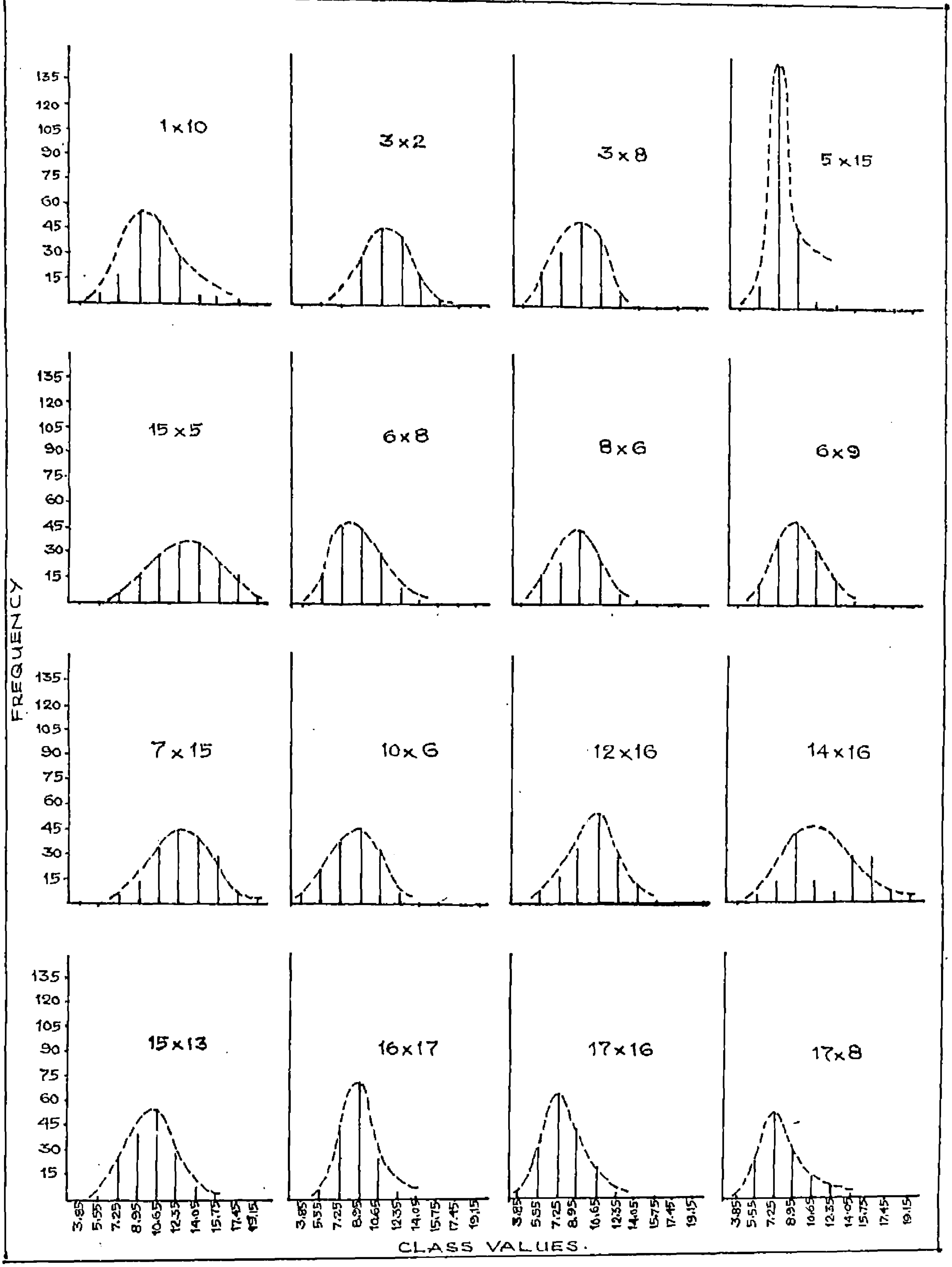
15 X 13 (P.118 X (C.152 X N.E.1)

16 X 17 (Kolingipayar-white X Mancheri-black)

17 X 16 (Mancheri-black X Kolingipayar-white)

17 X 8 (Mancheri-black X Kolingipayar)

-FIG-11-

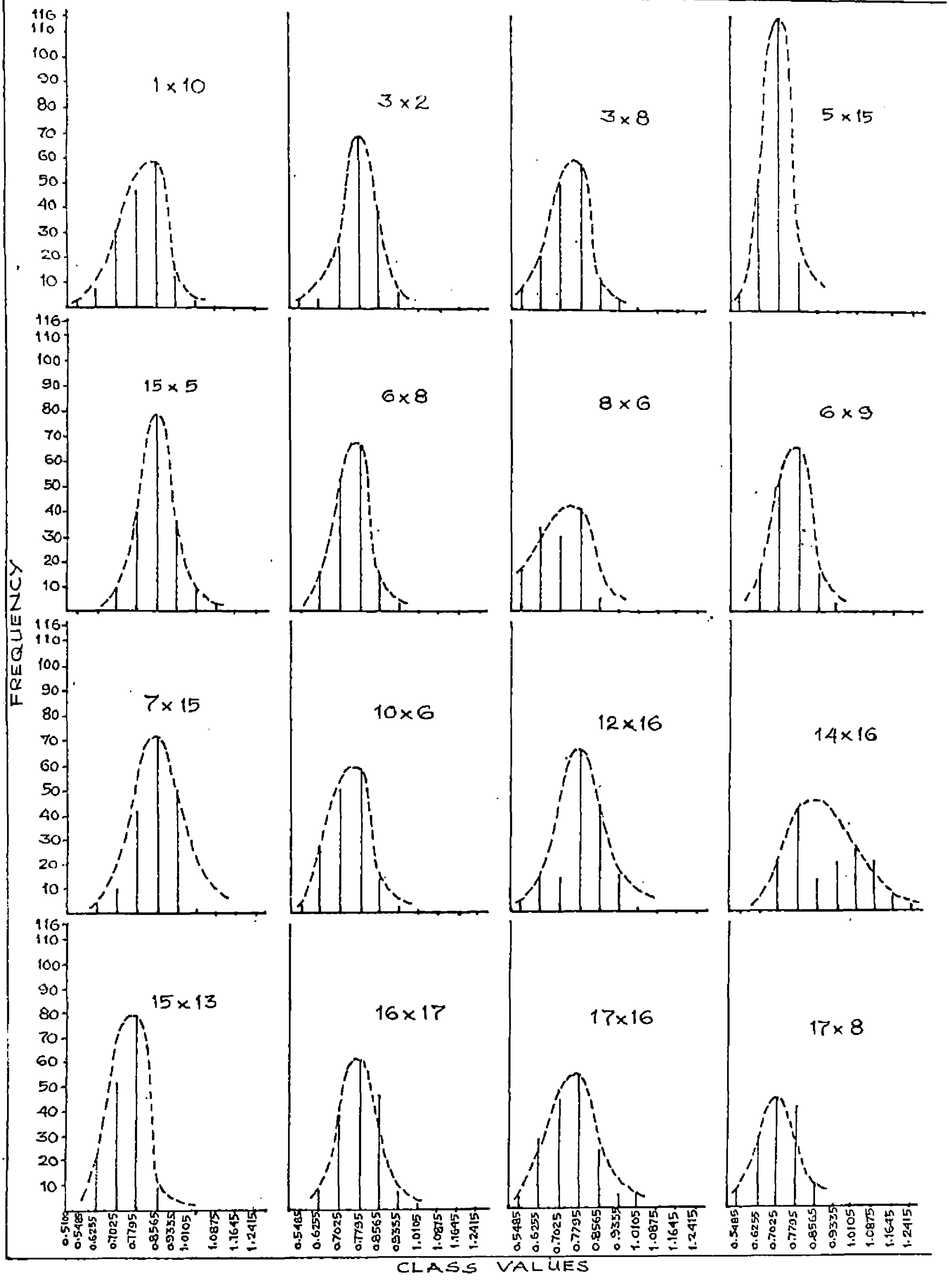


FREQUENCY
135
120
105
90
75
60
45
30
15
1x10
3x2
3x8
5x15
15x5
6x8
8x6
6x9
7x15
10x6
12x16
14x16
15x13
16x17
17x16
17x8
3.85
5.55
7.25
8.95
10.65
12.35
14.05
15.75
17.45
19.15
CLASS VALUES.

Fig.12. Line graph showing the frequency distribution of F_2 individuals for length of seed.

1 X 10	(No. 62 X IC. 20729)
3 X 2	(Pusa Phalguni X GP.PLS. 63)
3 X 8	(Pusa Phalguni X Kolingipayar)
5 X 15	(GP.PLS. 139 X P.118)
15 X 5	(P.118 X GP.PLS. 139)
6 X 8	(Red Seeded Selection X Kolingipayar)
8 X 6	(Kolingipayar X Red Seeded Selection)
6 X 9	(Red Seeded Selection X GPT. 536)
7 X 15	(GP.MS. 9314 X P.118)
10 X 6	(IC. 20729 X Red Seeded Selection)
12 X 16	(Pattambi local-1 X Kolingipayar-white)
14 X 16	(Pannithodan-early X Kolingipayar-white)
15 X 13	(P.118 X (C.152 X N.E.1)
16 X 17	(Kolingipayar-white X Mancheri-black)
17 X 16	(Mancheri-black X Kolingipayar-white)
17 X 8	(Mancheri-black X Kolingipayar)

-FIG-12-



FREQUENCY
CLASS VALUES
1 x 10
3 x 2
3 x 8
5 x 15
15 x 5
6 x 8
8 x 6
6 x 9
7 x 15
10 x 6
12 x 16
14 x 16
15 x 13
16 x 17
17 x 16
17 x 8
116
110
100
90
80
70
60
50
40
30
20
10
0.516
0.5485
0.6255
0.7025
0.7795
0.8565
0.9335
1.0105
1.0875
1.1645
1.2415

Fig.13. Line graph showing the frequency distribution of F_2 individuals for breadth of seed.

1 X 10 (No. 62 X IC. 20729)

3 X 2 (Pusa Phalguni X GP.PLS. 63)

3 X 8 (Pusa Phalguni X Kolingipayar)

5 X 15 (GP.PLS. 139 X P.118)

15 X 5 (P.118 X GP.PLS. 139)

6 X 8 (Red Seeded Selection X Kolingipayar)

8 X 6 (Kolingipayar X Red Seeded Selection)

6 X 9 (Red Seeded Selection X GPT. 536)

7 X 15 (GP.MS. 9314 X P.118)

10 X 6 (IC. 20729 X Red Seeded Selection)

12 X 16 (Pattambi local-1 X Kolingipayar-white)

14 X 16 (Pannithodan-early X Kolingipayar-white)

15 X 13 (P.118 X (C.152 X N.E.1)

16 X 17 (Kolingipayar-white X Mancheri-black)

17 X 16 (Mancheri-black X Kolingipayar-white)

17 X 8 (Mancheri-black X Kolingipayar)

-FIG-13-

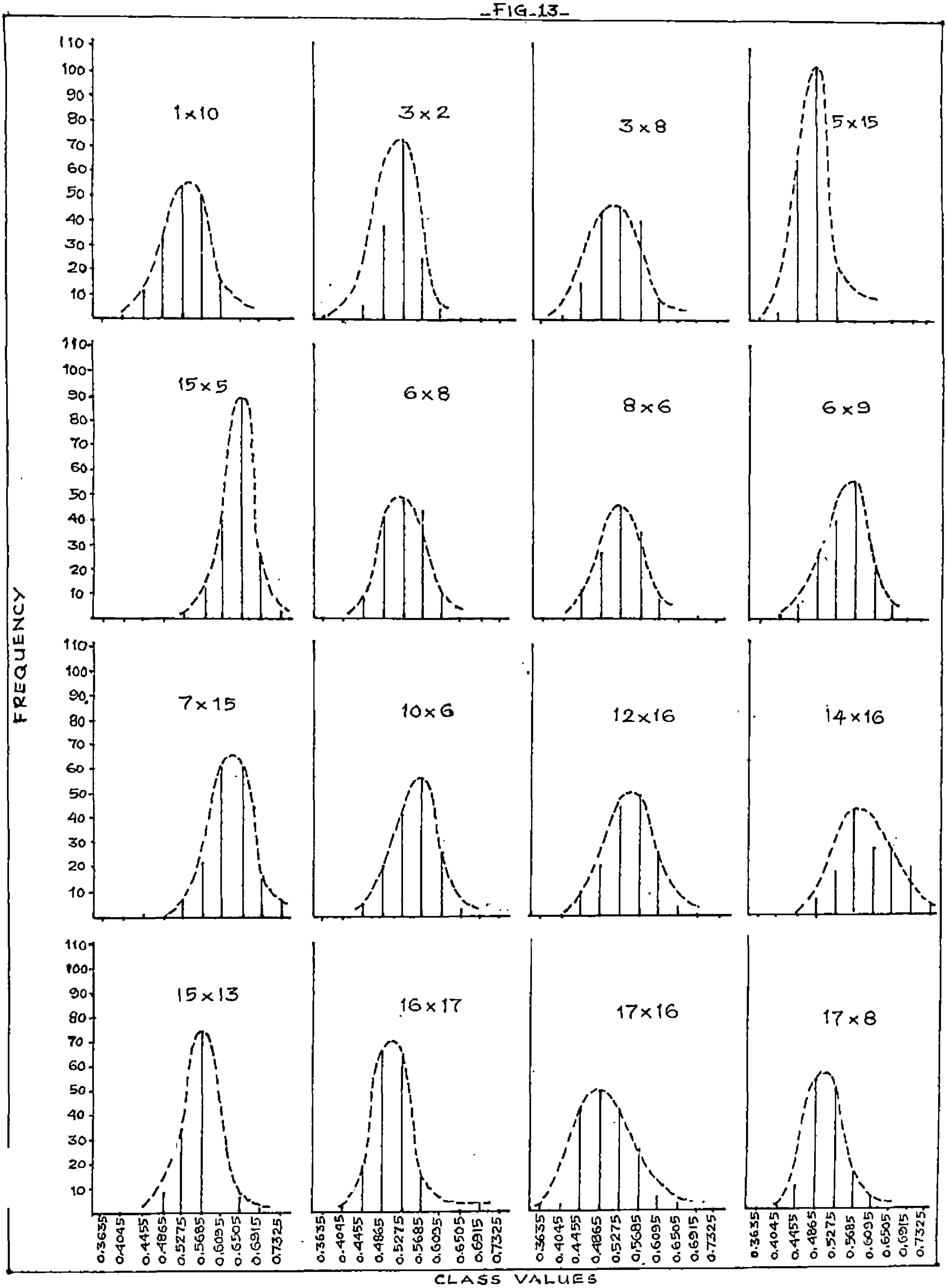

FREQUENCY
110
100
90
80
70
60
50
40
30
20
10
1×10
3×2
3×8
5×15
15×5
6×8
8×6
6×9
7×15
10×6
12×16
14×16
15×13
16×17
17×16
17×8
0.3635
0.4045
0.4455
0.4865
0.5275
0.5685
0.6095
0.6505
0.6915
0.7325
CLASS VALUES

Fig.14. Line graph showing the frequency distribution of F_2 individuals for thickness of seed.

1 X 10 (No. 62 X IC. 20729)

3 X 2 (Pusa Phalguni X GP.PLS. 63)

3 X 8 (Pusa Phalguni X Kolingipayar)

5 X 15 (GP.PLS. 139 X P.118)

15 X 5 (P.118 X GP.PLS. 139)

6 X 8 (Red Seeded Selection X Kolingipayar)

8 X 6 (Kolingipayar X Red Seeded Selection)

6 X 9 (Red Seeded Selection X GPT. 536)

7 X 15 (GP.MS. 9314 X P.118)

10 X 6 (IC. 20729 X Red Seeded Selection)

12 X 16 (Pattambi local-1 X Kolingipayar-white)

14 X 16 (Pannithodan-early X Kolingipayar-white)

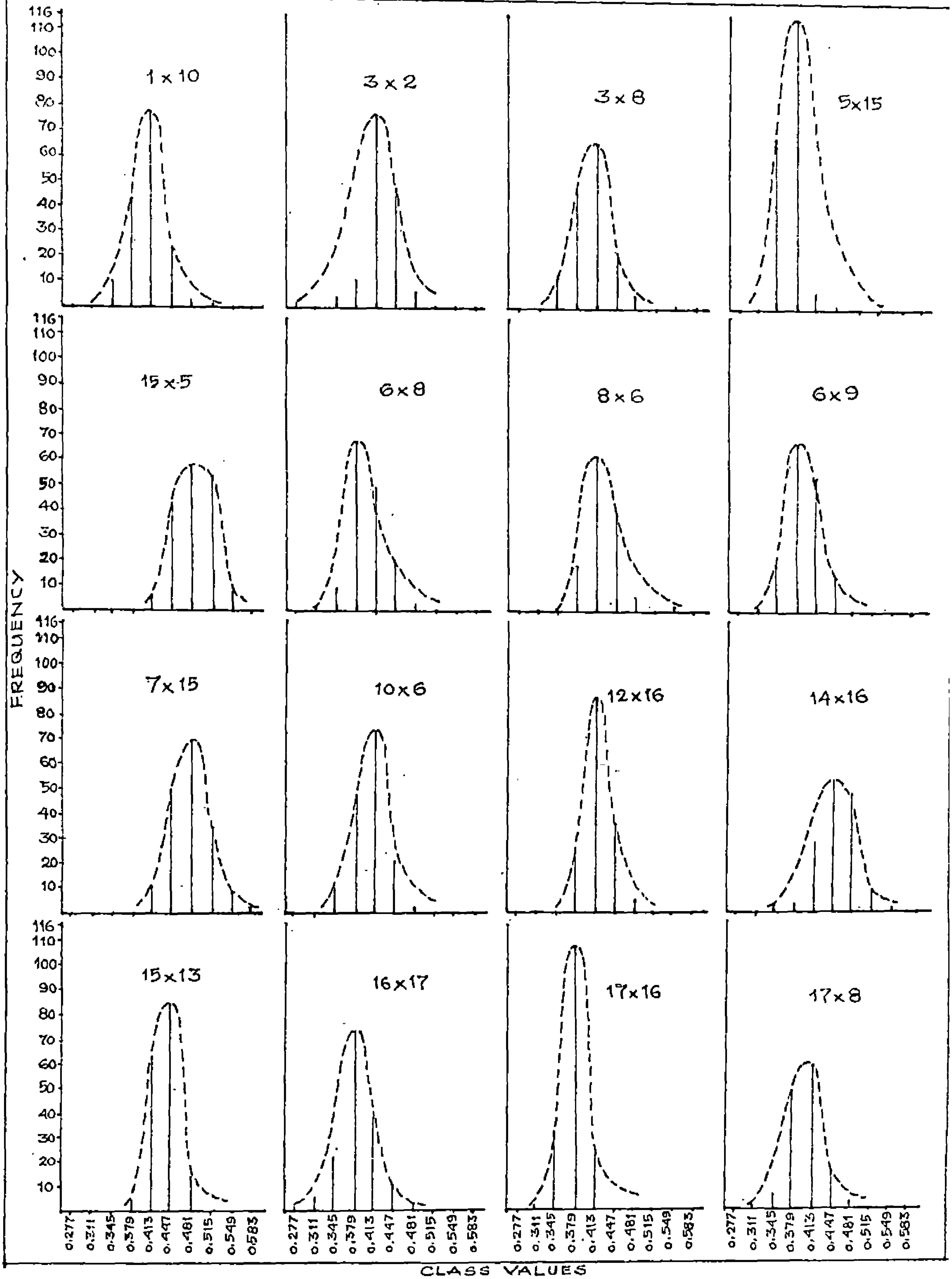
15 X 13 (P.118 X (C.152 X N.E.1)

16 X 17 (Kolingipayar-white X Mancheri-black

17 X 16 (Mancheri-black X Kolingipayar-white)

17 X 8 (Mancheri-black X Kolingipayar)

-FIG. 14-



1 x 10
3 x 2
3 x 8
5 x 15
15 x 5
6 x 8
8 x 6
6 x 9
7 x 15
10 x 6
12 x 16
14 x 16
15 x 13
16 x 17
17 x 16
17 x 8
FREQUENCY
116 110 100 90 80 70 60 50 40 30 20 10
0.277 0.311 0.345 0.379 0.413 0.447 0.481 0.515 0.549 0.583
CLASS VALUES

the parents, as indicated by the magnitude of coefficient of variation. A one sided or two sided transgression is seen for all the three traits in majority of the crosses studied, thereby indicating the involvement of large number of genes in the inheritance of these characters. Within the limits acceptable error, the F_2 means can be said to agree with those of the respective parents, thereby supporting the above view. Reciprocal difference observed in one out of the three cases studied for all the three characters suggest the possible role of cytoplasm in the control of the traits. However, this needs further experimental support.

Results of seed yield obtained in the present study, do not agree with those of its components. When components like number of seeds per pod, weight of 100 - seeds, length, breadth and thickness of seed are observed to be inherited as quantitative characters, the nature of inheritance of seed yield itself based on the results obtained cannot be said to be either quantitative or qualitative. Absence of normal distribution in the F_2, in all the sixteen crosses studied, does not permit us to suggest quantitative nature of inheritance to seed yield (Fig. 16). The curve obtained in the present case is seen to be one sided as there is an accumulation of frequency towards lesser seed yield. Even in the one sided curve, the variation seems to be continuous, thereby rendering it difficult to group the F_2 individuals into clear cut phenotypic classes as in the case of qualitative inheri-

Fig.16. Line graph showing the frequency distribution of F_2 individuals for seed yield per plant.

1 X 10 (No. 62 X IC. 20729)

3 X 2 (Pusa Phalguni X GP.PLS. 63)

3 X 8 (Pusa Phalguni X Kolingipayar)

5 X 15 (GP.PLS. 139 X P.118)

15 X 5 (P.118 X GP.PLS. 139)

6 X 8 (Red Seeded Selection X Kolingipayar)

8 X 6 (Kolingipayar X Red Seeded Selection)

6 X 9 (Red Seeded Selection X GPT. 536)

7 X 15 (GP.MS. 9314 X P.118)

10 X 6 (IC. 20729 X Red Seeded Selection)

12 X 16 (Pattambi local-1 X Kolingipayar-white)

14 X 16 (Pannithodan-early X Kolingipayar-white)

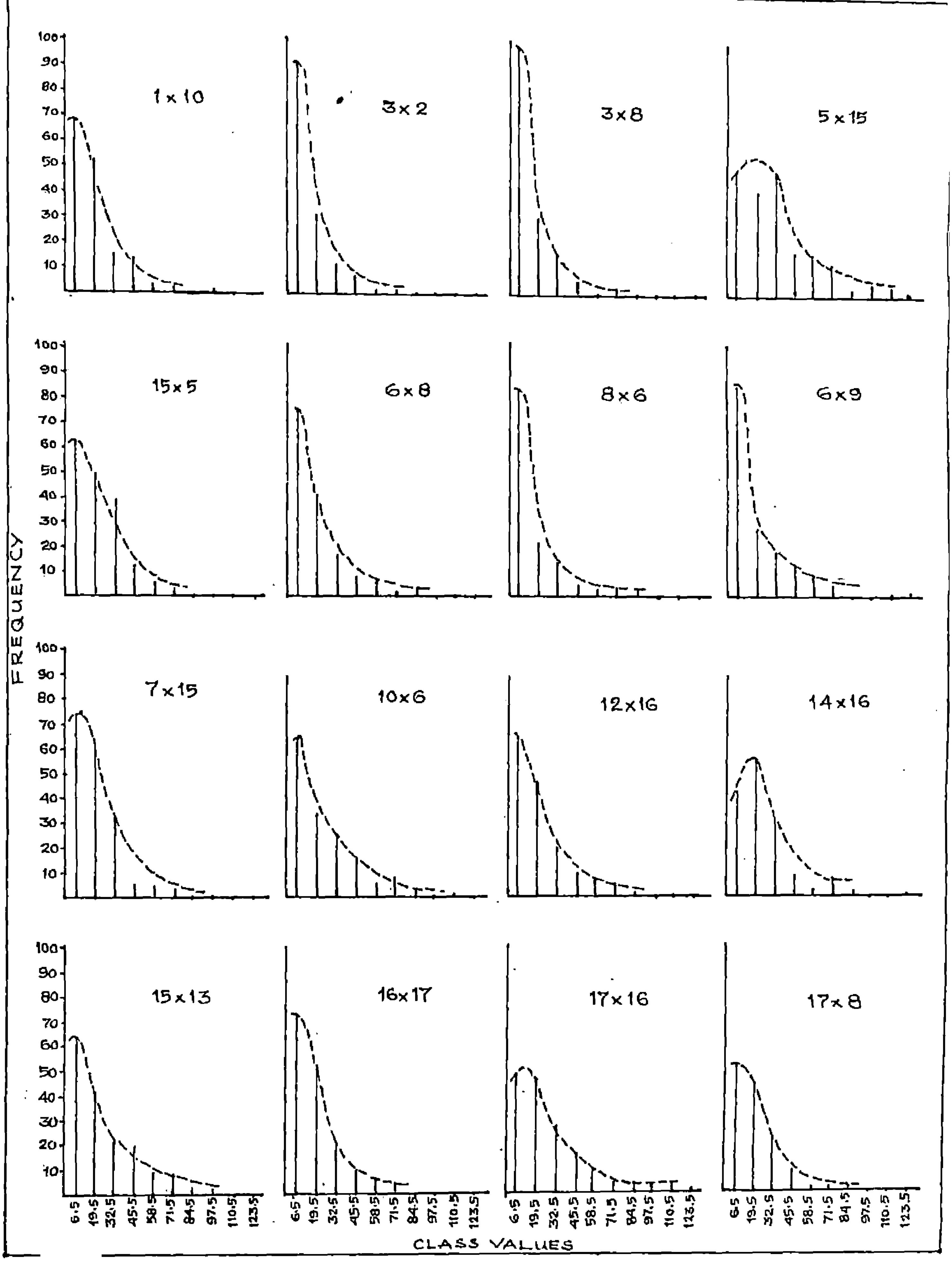
15 X 13 (P.118 X (C.152 X N.E.1)

16 X 17 (Kolingipayar-white X Mancheri-black)

17 X 16 (Mancheri-black X Kolingipayar-white)

17 X 8 (Mancheri-black X Kolingipayar)

-FIG.16-


FREQUENCY
1x10
3x2
3x8
5x15
15x5
6x8
8x6
6x9
7x15
10x6
12x16
14x16
15x13
16x17
17x16
17x8
CLASS VALUES

tance. Further studies involving large sized F_2 population, alone can throw light on this.

Considering yield as the primary criterion an assessment of the 16 crosses for their suitability to the different situations where Cowpea is grown in the State is worth attempting. For the grain-production-oriented rice fallow culture of Cowpea where early, erect, bushy, grain types with synchronised flowering are preferred, the results of the present study indicate that crosses 5 X 15 (GP.PLS. 139 X P.118) and 6 X 8 (Red Seeded Selection X Kolingipayar) are the suitable ones since they can throw segregants best suited to those conditions. For the specialised system of Cowpea culture practised in summer rice fallows, exclusively for vegetable purposes in certain northern parts of the State like Mancheri where early, trailing, vegetable types with wide flowering spread are preferred, crosses 14 X 16 (Pannithodan-early X Kolingipeyar-white), 17 X 16 (Mancheri-black X Kolingipayar-white) and 10 X 6 (IC. 20729 X Red Seeded Selection) appear to be the ideal ones. For the third type of Cowpea culture practised in uplands during the khariff season and also in homesteads where early, short bushy dual purpose types with synchronised flowering are desirable, crosses 5 X 15 (GP.PLS. 139 X P.118) and 6 X 8 (Red Seeded Selection X Kolingipayar) seem to be the ideal ones.

SUMMARY

SUMMARY

The reported investigations were carried out in the Department of Agricultural Botany of the College of Horticulture, Vellanikkara during the years 1979-'81. The pattern of segregation of 16 economic characters was studied in 32 F_2 families of 16 intervarietal crosses in Cowpea and the following conclusions have been drawn.

Plant height, commencement, completion and spread of flowering, length and weight of individual pods, number of seeds per pod, weight of 100 - seeds, length, breadth and thickness of seed etc. are inherited as quantitative characters controlled by either polygenes or by a few major genes whose action is suitably modified by minor genes.

Number of branches in eight and number of flowers per plant in nine out of sixteen crosses are also inherited quantitatively.

REFERENCES

REFERENCES

Ahuja, S.L. (1980). Diallel analysis in F_2 generation of green gram (Vigna radiata (L.) Wilczek). Thes. Absts. 1980. 6 : 2.

Aryeetey, A.N. and Laing, E. (1973). Inheritance of the yield components and their correlation with yield in Cowpea (Vigna ungiculata (L.) Walp). Plant Breed. Abstr. 44 : 2 : 1236.

*Balram Singh and Bhatnagar, P.S. (1966). Correlation studies in mung bean. Plant Breed. Abstr. 36 : 4 : 5295.

Bhaskaraiah, K.B., Shivashankar, G., and Virupakshappa, K. Year Indian J. Genet. 40 : 2 : 334 - 337.

Bhatnagar, P.S. and Balram Singh (1964). Heterosis in mung bean. Indian J. Genet., 24 : 89 - 91.

Bliss, F.A. (1971). Inheritance of growth habit and time of flowering in beans, Phaseolus vulgaris (L.). J. Amer. Soc. Hort. Sci. 96 (6) : 715 - 717.

Bordia, P.C., Yadevendra, J.P. and Sudhirkumar (1973). Genetic variability and correlation studies in Cowpea (Vigna sinensis (L.) Savi.). Rajasthan J. Agri. Sci. (1973) 4 : 1 : 39 - 44.

Brittingham, W.T. (1950). The inheritance of date of pod maturity, pod length, seed shape and seed size in the southern pea, Vigna sinensis. Proc. Amer. Soc. Hort. Sci. 56 : 381 - 88.

*Bruter, D.P. (1965). Interspecific hybrids of the Cowpea (Vigna) and prospects for their use in Maladavia. Bul. Akad. Stii. RSS Moldov (Bull. Acad. Sci. Moldar. SSR) 1965 : No.9 : 89-94. from Ref. Z (Ref. J.) 1966 : Abst. 7. 55.112 (Russian) Plant Breed. Abstr. 39 : 4 : 7898.

Capinpin, J.M. and Irabagon, T.A. (1950). A genetic study of pod and seed characters in Vigna. Philipp. Agric. 1950 : 33 : 263 - 77.

*Colins, S. (1967). Heterosis in Phaseolus Lunatus L. (Lima bean). Agric. tec. Mex. 1967 : 2 : 291 - 98. Plant Breed. Abstr. 39 : 3 : 5870.

Empig, L.T., Lantican, R.M. and Escuro, P.B. (1970). Heritability estimates of quantitative characters in mung bean, (Phaseolus aureus Roxb.). Crop. Sci. 10 : 240 - 41.

Godhani, P.R., Jaisani, B.G., Patel, G.J. (1978). Epistastic and other genetic variances in green gram varieties. Gujarat. Agrl. Univ. Res. J. (1978). 4 (1) : 1 - 6.

Gupta, S.N., Arora, N.D., Singh, R.K. and Choudhary, B.D. (1978 Combining ability and gene action in mung bean. Indian J. Heredity 1978. 10 (1) : 59 - 66.

*Hamad, I.A. (1976). Inheritance of yield, yield components, number of days to flowering, plant height and incidence of interlocular cavitation of pods in snap beans (Phaseolus vulgaris L.). Diss. Abst. (1976). 36 : 8 : 3701B-3708. Plant Breed. Abstr. 47 : 12 : 12183.

*Hilpert, M.M. (1949). Genetic studies in Phaseolus vulgaris. Summ. Ph.D. Thes. Univ. 1949 : 3 : 19 - 20. Plant Breed. Abstr. 20 (2) : 1950.

*Ibarbia (1968). Inheritance of pod number per node and other characters affecting yield of peas, Pisum sativum L. Diss. Abst. 1968 : 28 : Order No. 67-15, 748 : 2199B-2003. Plant Breed. Abstr. 39 : 3856.

Inasi, K.A. (1980). Investigations on intervarietal hybrids in Cowpea. Thesis submitted by Inasi, K.A. (1980) and approved for M.Sc. (Ag.) Degree of Kerala Agricultural University.

Jatasra, D.S. (1980). Combining ability for grain weight in Cowpea. Indian J. Genet. (1980) 40 : 2 : 330 - 333.

*Johnson, K.W. (1957). Inheritance studies in peas, Pisum sativum L. Diss. Abst. 1957 : 17 : Publ. No. 22, 369 : 1862. Plant Breed. Abstr. 28 : 3 : 3530.

*Kalinov, B. (1968). A study of the inheritance of plant height and growth period in peas. Genet. and Pl. Breed., Sofia, 1968 : No. 4 : 295 - 310. Plant Breed. Abstr. 39 : 5909.

Kheradnam, M. and Niknejad, M. (1973). Combining ability in Cowpeas (Vigna sinensis L.) Zeitschrift fur Pflanzenzuchtung (1971) 66 (4) 312 - 316. Coll. Agric. Pahlavi Univ. Shiraz, Iran. Plant Breed. Abstr. 43 : 2 : 1602.

Krarup, A. and Davis, D.W. (1970). Genetic control of ovule number in peas, (Pisum sativum L.). Crop. Sci. 10 : 517 - 518.

Kuruvila Thomas (1972). Studies on intervarietal hybrids in Cowpea. M.Sc.(Ag.) Thesis submitted to K.A.U. in 1972.

*Lamprecht, H. (1954). Further studies on inheritance of pod width in Pisum. Agric. Hort. Genet. Landskrona 1954 : 12 : 202 - 210. Plant Breed. Abstr. 25 : 4 : 2532.

*Lawes, D.A. and Newaz, M.A. (1980). Genetical control of the distribution of seed yield in field beans. Welsh Pl. Breed. Sta., U.K. Plant Breed. Abstr. 51 : 3 : 2677.

Mahamoud, S.A. and Ibrahim, A.A. (1980). Inheritance of seed weight in broad bean, Vicia faba L. Res. Bulle. Faculty of Agriculture, Ain Shams University (1978). 854 : pp. 16. Abst. Trop. Agric. 1979. 5 (8) 26273.

*Malinowski, E. (1955). Hybrid vigour in Phaseolus and Petunia. Bull. Acad. Polon. Sci. 1955 cl. 11 : 3 : 181 - 88. Plant Breed. Abstr. 26 : 1 : 1955.

*Menezes, O.B. (1956). Genetics and improvement of the peigion pea, (C. indicus Sprenq.). Ceres. Minas Gerais 1956. 10 : No. 55 : 20 - 44. Plant Breed. Abstr. 28 : 1 : 1052.

*Nakayama, R. (1957). Genetical studies of French beans, on the inheritance of abnormal dwarfness. Plant Breed. Abstr. 29 : 3 : 3249.

*Norton, J.D. (1961). Inheritance of growth habit and flowering response of southern pea, Vigna sinensis. Diss. Abst. 1961 : 22 : Order No. Mil. 61-2126 : 36, (Abst.). Plant Breed. Abstr. 32 : 3 : 4082.

Ojomo, O.A. (1971). Inheritance of flowering date in Cowpeas (Vigna unguiculata (L.) Walp. Trop. Agric. 1971 : 48 : 279 - 282.

*Ortega Ybarra, S. (1968). Contribution to the study of heritability of growth habit in Ph. vulgaris L. Agron. Trop. Venezuela 1968 : 18 : 87 - 115. Plant Breed. Abstr. 39 : 3 : 5850.

Patel, O.P. and Telang, S.W. (1976). A path analysis of yield components in Cowpea (Vigna sinensis L.) JNKVV. Res. J. 1976 : Publ. 1979. 10 : 3 : 227 - 229.

Patil, J.A. and D'Cruz, R. (1964). Inheritance of seed size in gram, Cicer arietinum. Poona Agri. Coll. Mag. 1964 : 54 : Nos. 3 & 4 : 21 - 22.

Patil, J.A. (1959). Inheritance study in gram. Curr. Sci. 1959. 28 : 508.

Prem Sagar and Chandra, S. (1979). Heterosis and combining ability in Urd bean. Indian J. Genet. 37 : 3 : 420 - 424.

Premsekar, S. (1967). Studies on interspecific hybrids in Vigna (V. sesquipedalis (L.) Fruw. X V. sinonsis (L.) Savi.) and their derivatives. Dissertation approved for M.Sc. (Ag.) Degree of TNAU.

Premsekar, S. and Raman, V.S. (1972). A genetic analysis of progenies of the hybrid Vigna sinensis L. Savi and Vigna sesquipedalis L. Fruw. Madras Agric. J. (1972) 59 (9) 449 - 456.

Rawal, K.M., Rachie, K.O. and Franchowiak, J.P. (1976). Reduction in size of the seed in crosses between wild and cultivated species of Cowpeas. Heredity (1976) 67 : 4 : 253 - 254.

Roy, R.S. and Richharia, R.W. (1948). Breeding and inheritance studies in Cowpea - Vigna sinensis. J. Amer. Soc. Agron. 40 : 479 - 89.

*Sakurov, V.Z. (1952). Increasing the vitality of pea varieties. Selekcija i. Semenovodstvo (Breeding and Seed growing 1952. No. 7. 43 - 49 (Russian). Plant Breed Abstr. 23 : 3 : 1053.

*Sarafi, A., Amirshahi, M.C. and Seadati, K. (1973). Heterosis and heritability for yield components in reciprocal F_1 and F_2 hybrids of two American and Iranian bean varieties of Phaseolus vulgaris Plant Breed. Abstr. 44 : 12 : 9130.

*Sarafi, A., Yazdi - Samadi, B. and Zali, A.A. (1976). Heterosis and heritability for yield and yield components in F_1 and F_2 generations of a bean cross. Iranian J. agric. Res. 1976. 4 (1) : 3 - 6. Plant Breed. Abstr. 50 : 10 : 1980.

Sen, N.K. and Murthy, A.S.N. (1960). Inheritance of seed weight in green gram (Phaseolus aureus Roxb.). Genetics 45 : 1559 - 62.

*Sene, D. (1968). Genetic determination of earliness in Vigna ungiculata (L.) Walp. Plant Breed. Abstr. 38 : 3 : 5593.

*Singh, B.C. (1976). Inbreeding depression in Cowpea. Plant Breed. Abstr. 47 : 1977.

Singh, K.B. and Dhaliwal, H.S. (1971). Combining ability and genetic of days to 50% flowering in blackgram (Phaseolus mungo Roxb.). Indian J. agric Sci. 1971 : 41 : 8 : 719 - 723.

Singh, K.B. and Jain, R.P. (1969). Heterosis of mung bean. Indian J. Genet. 1969 : 29 : 251 - 260.

Singh, K.B. and Jain, R.P. (1971). Combining ability for pod length and seed size in mung bean. Indian J. Genet 1971 : 31 : 1 : 145 - 148.

Singh, K.B. and Jain, R.P. (1971). Analysis of diallel cross in Phaseolus aureus Roxb. Theoretical and Applied Genetics (1971) 41 : 6 : 279 - 281.

Singh, K.B. and Jindia, L.N. (1971). Inheritance of bud and pod colour, pod attachment and growth habit in Cowpea. Crop Sci. 11 : 6 : 928 - 929.

Solomon, S., Argkar, G.P., Salanki, M.S. and Morbad, I.R. (19570. A study of heterosis in *Cajanus cajan* (L.). *Indian J. Genet.* 1957 : *17* : 1 : 90 - 95.

*Suzuki, A. (1957). On breeding a dwarf Cowpea. *Nippon. agric. Res. Inst.* 1957. No. 8 : 53 - 58 (Japanese). *Plant Breed. Abstr.* *28* : 4 : 4873.

*Tika, S.B., Sharma, R.K. and Mathu, J.R. (1976). Genetic analysis of flower initiation in Cowpea (*Vigna unguiculata*) (L.) Walp.). *Zeitzchrift fur Pflanzenzuchtung* (1976) 77 : 1 : 23 - 29 (En, de, 6 ref) Cotton Res. *Plant Breed. Abstr.* *47* : 3 : 3829.

*Tiwari, A.S. and Ramanujam, S. (1976). Partial diallel analysis of combining ability in mung bean. *Plant Breed. Abstr.* *47* : 1977.

*Voysest, V.O. (1972). The effect of heterosis on yield and its primary components in French bean, *Phaseolus vulgaris* L. *Investicaciones Agropecuarias* (1972) *3* : 1 : 10 - 16. *Plant Breed. Abstr.* *44* : 2 : 9131.

*Wester, R.E. and Jorgensen, H. (1951). Hybrid vigour in Lima beans. *Proc. Amer. Soc. Hort. Sci.* 1951 : *57* : 305 - 309. *Plant Breed. Abstr.* *22* : 1 : 1546.

Zafar, A.M. and Khan, M.A. (1968). Genetic studies in gram (*Cicer arietinum* L.). Comparative studies on gram hybrids and their parents. *W. Pak. J. Agric. Res.* 1968. *6*. No. 3.

*Originals not seen.

APPENDIX

INVESTIGATIONS ON INTERVARIETAL F_2 HYBRIDS IN COWPEA

BY

B. SUMATHIKUTTY AMMA

ABSTRACT OF A THESIS

Submitted in partial fulfilment of the requirements

for the degree of

Master of Science in Agriculture

Faculty of Agriculture

Kerala Agricultural University

Department of Agricultural Botany

COLLEGE OF HORTICULTURE

Vellanikkara - Trichur

1981

ABSTRACT

Cowpea (Vigna ungiculata) is the major pulse crop cultivated in Kerala where the average yield of pulses in general and Cowpea in particular is very low even under modern agronomic practices. This low productivity is mainly due to the absence of high yielding varieties suited for the different agro-climatic conditions. The varietal requirements in Cowpea, in the State vary because of the highly contrasting system of cultivation and this compels Cowpea breeders to evolve varieties of different combinations of plant, pod and seed characters. This is possible by producing different varieties combining the desirable attributes required for the diverse situations by suitable means. One of the ways by which, this can be achieved is through combination breeding in which desirable genes are pooled from different sources.

In a previous study conducted in the Department of Agricultural Botany, the 202 genotypes were grouped into 17 distinct clusters. Representing 15 clusters, 15 varieties were chosen for intervarietal hybridisation and their F_1's evaluated during 1979-80.

Seeds collected from the F_1 plants of the 16 intervarietal crosses along with their parents were used for the study. Two families in each of the 16 crosses were studied along with their

respective parents for the pattern of inheritance of 15 economic characters. Most of the characters were found to be inherited as quantitative characters controlled by either polygenes or by a few major genes with their action being suitably modified by minor genes.

The crosses 5 X 15 (GP.PLS. 139 X P.118) and 6 X 8 (Red Seeded Selection X Kolingipayar) were identified as suitable ones for grain - production and also for using as dual purpose Cowpea culture since they might throw segregants best suited to those purposes. For the specialised system of Cowpea culture practised in summer rice fallows exclusively for vegetable purpose, the crosses 14 X 16 (Pannithodan-early X Kolingipayar-white), 17 X 16 (Mancheri-black X Kolingipayar-white) and 10 X 6 (IC. 20729 X Red Seeded Selection) appeared to be the ideal ones.