SCREENING OF COWPEA (*Vigna unguiculata* (L.) Walp.) TYPES FOR RESISTANCE TO COWPEA APHID BORNE MOSAIC DISEASE

By

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DECLARATION

I hereby declare that this thesis entitled Screening of cowpea (*Vigna unguiculata* (L) Walp) types for resistance to cowpea aphid borne mosaic disease is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree diploma associateship fellowship or other similar title of any other university or society

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CERTIFICATE

Certified that this thesis entitled **Screening of cowpea (Vigna unguiculata (L) Walp) types for resistance to cowpea aphid borne mosaic disease** is a record of research work done independently by Kum **SUDHA KUMARI J S** under my guidance and supervision and that it has not previously formed the basis for the award of any degree fellowship or associateship to her

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INTRODUCTION

INTRODUCTION

Pulses form an important part of Indian dietary which is predominantly vegetarian They supply vegetable proteins as essential adjuncts to the cereal and tuber based diets of the poor in India The average yield of pulses in India is very low One of the major reasons for the low yield is their susceptibility to a number of pests and diseases The use of resistant varieties is one of the cheapest methods of combating pests and diseases in crop plants Provided that the inherited resistance is not associated with any undesirable characteristics such as low yield or poor quality of the produce the use of a resistant pulse variety does not incur any additional cultivation expenses Hence the development of disease and pest resistant pulse varieties is generally considered the most profitable and environment friendly crop improvement programme

The concept of resistance in crop plants has undergone a sea change during the late seventies and eighties so that nobody consider it essential to breed for a very high level of resistance Even moderate resistance or tolerance

to pests and diseases has often given an adequate control in the field particularly when such resistance has been supported by other control measures

Cowpea is an important vegetable and a major pulse crop of South India Virus diseases which cause fifty percent loss in yield have been posing formidable obstacle to step up the production of this crop in this part of the country Cowpea is known to be affected by nineteen types of viruses under natural conditions Of these viruses, cowpea aphid borne mosaic virus (CAMV) is responsible for causing loss in yield to a great extent Yield losses of 13-87 percent have been reported from Iran (Kaiser and Mossahebi 1975) CAMV is readily sap aphid and seed transmissible (Bock and Conti 1974 Ladipo 1977)

The identification of host plant resistance to pests and diseases is an important component of the genetic improvement of cowpea There are many reports from IITA Nigeria about the success of identifying even immune types through screening of large germplasm of cowpea for resistance to mosaic disease (Ladipo and Allen 1979) No such attempt was done in Kerala for grain cowpea improvement in the past

In the present investigation an attempt has been made to isolate either resistant or tolerant cowpea varieties from fifty nine varieties screened against CAMV for further utilization of the type in breeding programmes As a corollary to this main objective the variability heritability genetic advance within and correlations among various characters were also studied The results are presented and discussed in the following pages

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Cowpea (Vigna unguiculata (L) Walp) is an important pulse crop widely grown in Kerala Cowpea aphid borne mosaic virus (CAMV) disease is a very serious malady affecting this crop in all the areas where it is cultivated

A brief review on the screening for CAMV resistance estimation of genetic parameters and studies on correlation and path analysis undertaken in cowpea is given below

Nature of CAMV disease and its transmission

Dale (1949) observed the occurrence of a mosaic disease on Vigna unguiculata at Trinidad The typical symptoms observed for this disease were appearance of dark and light green rings on the leaves and development of irregular yellowish and dark green mottling accompanied by blistering of the leaf lamina

Cowpea aphid borne mosaic virus (CAMV) was first reported from Tanzania by Bock (1973) Later Bock and Conti (1974) reported that the diseased cultivars showed variable amounts of dark green vein banding or interveinal chlorosis leaf distortion blistering and stunting They were of the opinion that a related strain of cowpea aphid borne

mosaic virus cause disease of adzuki bean (Phaseolus angularis) and asparagus bean (Vigna sesquipedalis)

Raheja & Leleji (1974) have reported that an aphid borne virus causing mosaic disease on irrigated cowpea in Nigeria has shown symptoms including widespread mottling chlorosis between veins and vein banding In some cases chlorotic mottling resulted in distinct patterns of light and dark green areas Later edges of infected leaves curled downwards becoming puckered Plants become stunted and bushy Flowering was retarded or inhibited But this disease was not seed borne

Patel et al (1982) reported that the cowpea aphid borne mosaic virus (CAMV) inoculated plants developed pronounced vein clearing inward curling and chlorosis in the first trifoliates followed by typical vein banding puckering and typical mosaic symptoms in the new trifoliates which resulted in stunted growth of the plant

Ramiah and Narayanaswamy (1983) reported that the CAMV induced characteristic mottling and puckering of leaves and stunting of infected plants resulting in considerable yield loss

Chaudhary et al (1987) reported that the symptoms of cowpea mosaic disease caused by Aphis craccivora being

moderate to severe mosaic mottling crinkling and reduction in leaf size dark green vein banding dwarfing of plants fewer pods and retention of green colouring on older leaves

Transmission studies of CAMV

Transmission of cowpea mosaic virus by mechanical methods was first reported by Mc Lean (1941) from Arkansas He reported the use of carborundum as an abrasive for the development of infection Later many reports came from different parts of the world on the sap transmissibility of cowpea mosaic virus [Harjono (1959) Toler (1964) Adsuar (1964) Debot and De Rojas (1967) Kvicala et al (1970) Govindaswamy et al (1970) Khatri and Singh (1974) Diwakar and Mali (1976) Sharma and Varma (1976) Lima et al (1977) Ramachandran and Summanwar (1982) Mazyad et al (1984)]

Govindaswamy et al (1970) reported that the cowpea mosaic virus disease is not seed borne while its transmission through seed has been reported by some earlier workers viz Capoor and Varma (1956) Mc Lean (1941) Nariani and Kandaswamy (1961)

Haque and Chenulu (1972) reported that all stages of the insect vector were equally effective in transmitting CAMV

Bock and Conti (1974) and Ladipo (1976) has reported that CAMV is readily sap aphid- and seed transmissible

Ata Allen and Thottappally (1982) conducted studies on variation in rate of seed transmission of CAMV in cowpea and concluded that the rate of transmission of CAMV through seed is influenced by the cultivar

Different types of inoculation media were used by different scientists for the mechanical transmission of CAMV Phenol water extracts of diseased plants were used by Alconero and Santiago (1972) Sap extracted in 0 05 M phosphate buffer of pH 7 was used by Sharma and Varma (1975) Sap extracted in cooled tris buffer was used by Mali and Kulthe (1980) and sap extracted in distilled water and diluted in the ratio 1 5 was used by Patel and Kuwite (1982) and Patel (1982)

Screening for resistance to CAMV

Screening of cowpea varieties for resistance against CAMV has been done in different places

Govindaswamy et al (1970) have screened one hundred types of cowpea for resistance to the cowpea mosaic isolates both by sap and aphid transmission Ninety eight types were

found susceptible and two (MS 9081 and EC 2085) were found to be tolerant to virus infection both on sap and aphid transmission They have also found that 12 additional varieties of cowpea obtained from IARI were also susceptible to the disease except one (EC-4203)

Ladipo & Allen (1979) have conducted glass house screening of different cowpea varieties for resistance to one Nigerian isolate of CAMV In glass house screening 52 lines were found immune six tolerant and the rest either gave mixed reactions or were susceptible None possessed hypersensitive resistance

Mali et al (1981) studied the resistance of 23 cowpea varieties to bean yellow mosaic CAMV and tobacco ring spot virus and reported C-288 as the only variety immune to bean yellow mosaic virus and CAMV

Patel et al (1982) screened 249 cowpea cultivars/germplasm units by sap inoculations with vein banding strain of CAMV in pot house and under natural epiphytotic in diseased nursery Ten lines proved immune and eight resistant The remaining moderately resistant or susceptible (12) delayed susceptible (30) susceptible to very susceptible (176) and heterogeneous (13)

Atiri and Thottappally (1984) studied on the relative usefulness of mechanical and aphid inoculation as

modes of screening cowpeas for resistance against CAMV Mechanical inoculation was preferred to inoculation by aphids for screening cowpea lines against the virus former being easier quicker and involving fewer variables

Chaudhary et al (1986) have screened 73 lines against mosaic disease transmitted by Aphis craccivora and found seven resistant 25 moderately resistant and the remainder moderately to highly susceptible

Sreelakha (1987) has screened ten lines of cowpea varieties of which the variety C 152 has taken hundred per cent infection on sap inoculation whereas the variety CG-104 was found to be tolerant to the disease showing only 13 33 per cent infection

Mali et al (1988) screened sixty cultivars for the presence of Black eye cowpea mosaic virus (BICMV) and cowpea aphid borne mosaic virus (CAMV) BICMV was identified from nineteen and CAMV from seven They have also found that CAMV was mechanically transmissible by aphids in a non-persistent manner and also through seeds Seed transmission ranged from 0-18 5% for CAMV

Quindere and Barreto (1988) evaluated 81 cowpea genotypes for resistance against various disease infections and found seven resistant to cowpea severe mosaic comovirus and cowpea (aphid borne) mosaic potyvirus thirteen to smut eleven to bacterial blight and four to powdery mildew

Singh (1988) has reported that the breeding lines IT822E16 and IT82D889 were showing multiple virus resistance to cowpea yellow mosaic cowpea aphid borne mosaic cucumber mosaic cowpea mottle southern bean mosaic and cowpea golden mosaic

Genetics of resistance

Preliminary studies by Patel et al (1982) on inheritance of CAMV indicated that immune reaction was controlled by a recessive gene in association with minor/modifier genes and the resistant reaction was governed by a partially dominant gene

Ramiah and Narayanaswamy (1983) had suggested that resistance to CAMV was controlled by a single dominant gene

Reaction to other major pests and diseases

Haque and Chenulu (1972) have reported that all stages of the insect (aphid) were equally effective in transmitting the virus

Panda and Raju (1972) studied the varietal resistance of 12 varieties of green gram (Phaseolus aureus Roxb) to Aphis craccivora (Koch) a vector of bean yellow mosaic virus The incidence of bean yellow mosaic was estimated qualitatively when half the plants were at flowering stage Results indicated that the four varieties

flowering stage Results indicated that the four varieties were resistant to the aphid and virus and eight susceptible In laboratory studies three resistant one moderately resistant and one susceptible variety were artificially infested with the aphid and it was found that the fecundity nymphal weight and duration of life of the aphid on the resistant varieties were less compared to susceptible ones

Bell (1980) evaluated 259 cowpea lines for resistance to aphid and reported PI476 EC4276 V-1 and T422/2 as resistant

Dharorkar and Daware (1980) found that out of the 14 lines evaluated for incidence of aphids lines PI473 and PI476 were completely free from aphid infestation

Thakur et al (1980) identified mung bean (Vigna radiata) lines EC-27087-2 EC 27261-3 and ML 1 as sources of resistance to Cercospora leaf spot caused by Cercospora canescens Resistance to Cercospara canescens was found to be simply inherited and governed by a single dominant gene

Combined inoculation of cowpea with Uromyces appendiculatus and Aphis Craccivora by Chang et al (1981) has reduced plant height by 41 9 per cent and reduced the green leaf area index from the seventh day after inoculation It has also delayed the production of harvestable pods by thirty days Infection by Uromyces appendiculatus reduced

translocation of assimilates from the leaf to the structures (bud flower pots) in its axil

In cowpea the lines Tvu-9836 Tvu 9914 Tvu-9929 Tvu-9930 and Tvu 9944 were resistant to CAMV and cowpea aphids (IITA 1982)

Macfoy and Dabrowski (1984) studied the resistance of Aphis craccivora (Koch) in cowpea under field conditions and revealed that the rate of population growth was significantly higher on Vita 1 and Tvu 946 than on Tvu 310 and 408-P-2

Atiri and Thottappilly (1984) on their studies on settling behaviour and acquisition of CAMV in aphid resistant lines of cowpea reported that aphid activity (eg wide dispersal) was more important in the spread of CAMV than the absolute number of viruliferous alatae

While evaluating the host resistance in cowpea to cowpea aphid Aphis craccivora Koch out of the 83 lines tested under field conditions nine lines were selected for further pot culture experiments Based on the study TVU 889 was recommended as a source of resistance for use in breeding programme (Sulochana et al 1986)

Bata et al (1987) studied the inheritance of resistance to aphid in cowpea and revealed that the resistance is controlled by a single dominant gene

Katiyar and Ram (1987) studied the genetics of rust resistance in pea in four resistant lines ie 179 JP-4 Bateri Brown and Pea 9 in crosses involving T-163 PG-3 and Hans as susceptible testers Study revealed that the resistance is controlled by single dominant gene

Jayappa and Lingappa (1988 a) evaluated 408 accessions of cowpea for resistance to aphids and found that lines Mandya Local MS-370 TVU-2740 P-912 and PI 475 have greater consistency in imparting resistance to aphids

Jayappa and Lingappa (1988) tested ten cultivars of cowpea (V. unguiculata) for resistance to Aphis craccivora The resistant varieties Mandya Local P-912 MS-370 P 1475 and TVU 2740 were least preferred by migrating aphids for feeding purposes They also exhibited antibiosis as evidenced by increased aphid mortality reduced progeny reduced survival period and reduced weight of aphids

Ofuya (1988) has investigated the mechanism of resistance in the resistant cowpea varieties TVU-62 TVU-408 TVU-2740 TVU-3273 TVU 3509 and TVU-9944 to Aphis craccivora with artificial infestation in screened cages It was found to include antibiosis manifested as high mortality

of nymphs reduced weight shortened life span and low fecundity of adults

Pathak (1988) reported four cultivars of cowpea viz ICV-10 ICV-11 ICV-12 and TVU 310 was resistant to aphids at Nairobi Africa

Ahmad et al (1990) conducted screening of 46 Vigna unguiculata genotypes from IITA germplasm collection for tolerance to Aphis craccivora and found considerable variation in seed colour and days to 50% flowering No aphids were recorded on two determinate genotypes comprising one of five brown seeded and one of three purple seeded forms studied and on five indeterminate forms ie two of sixteen white seeded form two of eleven brown seeded form and one of three purple seeded

Ansari et al (1992) have screened 181 accessions of cowpea from germplasm collections at IITA using a simple visual damage scale and 24 accessions showed considerably decreased damage The results were confirmed by rearing aphids on fifteen selected accessions over a ten day period No aphids were found on the accessions 310 $408P_2$ and 801 and six accessions had population of less than 30 aphids compared to 200 400 aphids on susceptible varieties The remaining accessions showed only partial antibiosis and / or tolerance

Genetic variability and correlation studies on vegetative characters of cowpea

Uprety et al (1978) have reported that the biomass is one of the important factors related to seed yield The study also revealed that the efficiency of biomass conversion to grain yield increased significantly when the flowering was early Delayed flowering causes heavy loss to bioconversion efficiency thereby lowering the yield They have also found that plant canopy which is formed by leaf number leaf area and plant height showed a relationship with the total biomass with respect to plant height only It means that the leaf number and leaf area became effective only with respect to height since their correlation separately with yield was not found to be significant

Bell (1980) found that the aphid resistant cowpea accession PI 476 possessed the highest number of hairs

Ferguson et al (1982) opined that glandular haired alfalfa (Medicago sp) were not preferred and thus resistant to spotted alfalfa aphid (Therioaphis maculata)

Natarajaratnam et al (1986) has reported that the seed yield was significantly associated with the plant height

Senanayake and Wijeratne (1988) conducted studies on 17 varieties of cowpea in field and reported that yield was negatively correlated with the number of primary branches

Sharma et al (1988) have reported that the maximum genotypic co-efficient of variation among genotypes of Vigna unguiculata was seen for dry matter yield followed by plant height green forage yield pods/plant seed weight and green pod yield Heritability ranged from 46 9% to 98 0% for days to 50 % maturity Seed yield was positively and significantly correlated with days to first following and days to 50 % maturity Green pod yield was positively correlated with days to first flowering and plant height

Tyagi and Koranne (1988) have reported that the number of branches per plant was positivity and significantly correlated with yield

Thiyagarajan (1989) has studied the genetic variability of yield and component characters on yield and nine related triats in seven parents and their F_1 hybrids on cowpea The estimates of heritability and genetic advance was found to be high for plant height number of seeds/pod and 100 seed weight

Thiyagarajan and Rajasekharan (1989) have reported that seed yield in cowpea is positively associated with

characters like days to maturity plant height number of branches etc but the yield was negatively associated with days to 50% flowering The path analysis revealed that the number of primary branches per plant days to 50 % flowering and pods/plant had high positive direct effect on seed yield

Ahmad et al (1990) screened 46 Vigna unguiculata genotypes for tolerance to A craccivora Two determinate and five indeterminate types were found highly resistant to the aphids The study also revealed considerable variation in seed colour and days to 50% flowering

Patel and Gupta (1992) studied the effect of seed borne mosaic virus on growth and yield of cowpea plants and reported that the seed borne cowpea mosaic virus significantly reduced the plant height fresh and dry weight of shoot and root when compared to healthy plants both in glass house and field conditions

Genetic variability and correlation studies on yield components

Rajendran et al (1979) studied the heritability and intercorrelation of cowpea grown for seed purpose All the characters examined were found to have high heritability He also reported that an ideal plant which gives higher seed yield should preferably flower early have longer peduncles and more number of seeds/pod

Sreekumar et al (1979) evaluated 43 different cowpea genotypes for different genetic parameters The study revealed that all the characters showed positive phenotypic and genotypic correlation with yield High heritability and genetic advance were noticed for 100 grain weight and yield of grains and haulms They have indicated that the selection for those characters will be very rewarding in the improvement of the crop

Govil (1980) has reported from the studies on chickpea that the growth characters pods per plant flower and seed colour were positively associated with yield and negatively correlated with plant height days to flower pod size grain size and wrinkling on seed

Ramachandran et al (1980) from their studies on variability in selected cowpea types reported that the range of variation for varietal means was quite large in respect of days to first harvest inter nodal length weight of pods seeds/pod pods/plant and yield/plot The genotypic coefficient of variation was found to be maximum for yield per plot followed by pods/plant and internodal length Heritability was highest for days to flower followed by days to harvest Genetic advance of percentage mean was found to be maximum for seeds/pod followed by yield/plot and pods/plant

The results of studies conducted by Kumar et al (1983) on cowpea indicated that the selection for pods/peduncle pod length and width peduncle length and days to 50% maturity would increase seed yield

Variability studies undertaken on forty genotypes of cowpea by Dharmalingam and Kadambavanasundaram (1984) had shown that there existed greater variability for the traits harvest index number of pods and seed yield Genetic variability was low for the traits number of seeds per pod pod length and hundred seed weight Harvest index recorded higher heritability estimates

Jagadish Murthy (1984) reported that the selection for all the characters was better in improving yield than selection based on seed yield alone Path co efficient analysis has shown the number of pods/plant as the major yield contributing character

Drabo et al (1985) studied the inheritance of seed size and number per pod in cowpea and reported that for seed size additive dominance model failed to explain differences among generation means but genetic mechanisms varied among crosses For seeds/pod additive dominance and epistatic effects were most important and of similar magnitude

Natarajaratnam et al (1986) reported that the seed yield was strongly associated with pod weight per plant

number of pods per plant number of pod clusters per plant and plant height Path co efficient analysis indicated that the pod weight per plant had the greatest direct effect on seed yield

When seed yield per plant harvest index and ten yield components were investigated in fifty Vigna unguiculata genotypes by Apte et al (1987) high heritability was found for hundred seed-weight seeds per pod and days to maturity Percentage genetic gain was greatest for hundred seed weight plant height branches per plant and seeds per pod Hundred seed weight and seeds per pod were suggested as selection criteria

Senanayake & Wijeratne (1988) have reported that the yield of cowpea is positively correlated with 100 seed weight and pod length

From the studies on genetic variation and correlation in cowpea Sharma et al (1988) revealed that genotypic co-efficient of variation among cowpea genotypes was maximum for dry matter yield followed by plant height green forage yield pods/plants seed weight and green pod yield Seed yield green forage yield and green pod yield were positively and significantly correlated with pods/plant and seeds/pod

Tyagi and Koranne (1988) reported that the seeds/pod was positively and significantly correlated with

yield Seed number per pod had the highest direct positive effect on yield as revealed by path analysis

Singh and Hooda (1989) conducted studies on seed yield and its components in eight white and eighteen coloured seeded cowpea cultivars Results indicated that white seeded cultivars were inferior to the coloured seeded cultivars in number of clusters/plant hundred seed weight- seed yield per plant and especially number of pods per plant and seeds per pod Improvement in these characters is desirable to increase the yield potential of white seeded cultivars

Thiyagarajan (1989) has reported from the studies on genetic variability of yield and component characters that the heritability estimates and genetic advance were high for plant height number of seeds per pod and hundred seed weight

Thiyagarajan and Rajasekharan (1989) have reported the seed yield in cowpea exhibited significant and positive association with clusters and pods per plant pod length and seeds per pod But hundred grain weight exhibited negative association with yield Path analysis revealed that the pods per plant had high positive direct effect on seed yield

Oliveira et al (1990) reported a high direct positive correlation existed between the number of pods/plant and seed production

Raut et al (1990) has reported that the highest positive correlation with seed yield per plant was found for pod number per plant in black gram (vigna mungo)

Patel and Gupta (1992) have studied the effect of seed borne mosaic virus on growth and yield of cowpea and the results indicated that the virus significantly reduced the number of pods produced per plant but not the number of seeds per pod

Savithriamma (1992) studied the genetic variability in cowpea and observed high genotypic variances for all characters except seeds/pod Heritability values ranged from 15 23 percent for number of pods per plant to 71 41 percent for hundred seed weight High heritability was observed for plant height pod length and hundred seed weight High genetic advance was recorded for plant height seed weight per plant and hundred seed weight

MATERIALS AND METHODS

A field experiment was laid out in (59x2) RBD trial with plot size of 1 20x1 65m^2 and a spacing of 25x15cm Sowing was done at the rate of 3-4 seeds per hill and later thinned to thirty plants per plot Sap inoculation was done at the two leaf stage

Sap transmission

Sap transmission was done using standard sap solutions in phosphate buffer prepared as described below

Young leaves of systemically infected cowpea plants showing typical mosaic symptoms were selected and finely crushed using a clean sterile and previously chilled mortar and pestle The standard sap was prepared by crushing the infected leaf of known weight into a fine pulp by adding one ml of the phosphate buffer (0 05 M PH 7 0) to every gram of the infected leaf tissue The resulting pulp was strained through sterilized cotton wool The expressed sap after initial clarification was used as the inoculum

Inoculation was done on young seedlings at two leaf stage by after dusting small quantity of carborundum powder of 600 mesh uniformly on the surface of the leaves and gently rubbing the inoculum with the cotton wool by taking care not to cause excess injury to the leaves Soon after inoculation the leaves were washed with distilled water using

MATERIALS AND METHODS

The investigation was undertaken in the Department of Plant Breeding and Genetics College of Agriculture Vellayani during the period from May 1992 to October 1992

A Materials

Fifty nine cowpea varieties (Vigna unguiculata (L) Walp) were used for the study Seeds of these were collected from various sources as detailed in Table 3 1

B Methods

The cowpea varieties collected were screened for their resistance to cowpea aphid borne mosaic virus (CAMV) through artificial sap inoculation method under field condition The inoculum for sap transmission was maintained by growing C-152 a known susceptible variety in pots These were inoculated with the sap extracted from the leaves of the cowpea plants showing typical symptoms of cowpea aphid borne mosaic virus (Sreelakha 1987) as detailed under the section sap transmission The C-152 variety of cowpea plants to which inoculation was done were used as the source of inoculum This was maintained by repeated transfers on the plants of the same variety by sap inoculation

a wash bottle All the thirty plants in each plot were inoculated

The cultural and manurial practices were followed as per the package of practices recommendations (1989) of the KAU except plant protection measures The crop was left without any spraying of plant protection chemicals for enhancing the pest and disease incidence

Observations recorded

The following observations were taken on ten randomly selected plants from each plot except for CAMV where all plants were observed for the development of symptoms

1 CAMV disease scoring

Observations on the incidence of the disease were recorded by counting the number of plants showing the typical symptoms of CAMV disease (Sreelakha 1987) Even the plants showing mild vein clearing on the primary trifoliate leaves were counted as diseased Disease scoring was done on the 7th 14th 28th and 42nd days after inoculation

2 Days to first flowering

Number of days from sowing of seeds to the opening of the first flower in each plot was recorded

3 Days to maturity

Number of days from sowing of seeds to the harvesting of the last pod in each plot were recorded

4 Plant height at maturity

The height of the mainshoot from ground level to the tip was measured after the last harvest and recorded in centimeters

5 Leaf morphology

The leaves one each from each observational plant were collected and observed under the microscope The number of leaf hairs per unit area (square centimeters) was recorded for each leaf and the mean estimated

6 Number of branches per plant

The number of branches on the main shoot (primary branches) was counted and recorded after the last harvest

7 Number of pods per plant

Total number of pods present on the mainstem and branches after discarding the malformed and underdeveloped ones was counted and recorded

8 Number of seeds per pod

Number of seeds from ten randomly selected pods one each from the observational plants was recorded and their mean worked out

9 Length of pod

Length of pod was measured from one end to another and recorded in centimeters

10 Hundred seed weight

A sample of hundred grains were drawn from each plot and the weight recorded in grams

11 Seed yield per plant

The seeds collected from all the pods of ten observational plants were bulked together and weighed Their average worked out to get the seed yield per plant in grams

12 Reaction to major pests and diseases

Ten observational plants were taken at random and were assessed for its reaction to selected pests and diseases The pests scored were pea aphids and Epilachna beetle and diseases scored were Cercospora leaf spot and rust Standard techniques were followed for these observations as detailed below

Scoring pattern followed for Cercospora leaf spot and Rust (Singh 1980)

Score		Percentage leaf area affected
0	(Highly resistant)	No infection
1	(Resistant)	0 1 - 5
2	(Moderately resistant)	5 1 - 10
3	(Moderately susceptible)	5 1 - 25
4	(Susceptible)	25 1 - 50
5	(Highly susceptible)	Above 50

Statistical analysis

The data collected from the field experiment were subjected to appropriate statistical analysis

(1) to compare the variation with respect to various traits

(2) to estimate the genetic parameters like phenotypic genotypic and environmental components of variance heritability co efficient phenotypic genotypic and environmental correlation co-efficients and genetic advance (Singh and Chaudhary 1979)

Table 3 1 Cowpea varieties used for the screening trial

Treatment No	Variety	Source
V_1	CoVu 882	RRS Kayamkulam
V_2	V 16	RARS Pattambi
V_3	KAU cul 7	RARS Pattambi
V_4	PTB-2	RARS Pattambi
V_5	V-240	RARS Pattambi
V_6	VCP 4	RARS Pattambi
V_7	Covu 771	RRS Kayamkulam
V_8	Varkala local	RRS Kayamkulam
V_9	V-269	RRS Kayamkulam
V_{10}	V-385	RRS Kayamkulam
V_{11}	V-2	RRS Kayamkulam
V_{12}	Covu 8416	RRS Kayamkulam
V_{13}	Covu 8420	RRS Kayamkulam
V_{14}	V-38	RRS Kayamkulam
V_{15}	Covu-7	RRS Kayamkulam
V_{16}	S-448	RRS Kayamkulam
V_{17}	Covu-4	RRS Kayamkulam
V_{18}	Covu 8456	RRS Kayamkulam
V_{19}	Covu 358	RRS Kayamkulam
V_{20}	Covu 810	RRS Kayamkulam
V_{21}	Kottayam local	RRS Kayamkulam
V_{22}	Covu 85020	RRS Kayamkulam
V_{23}	V-322	RARS Pattambi
V_{24}	HG 171	RRS Kayamkulam
V_{25}	Covu 271	RRS Kayamkulam
V_{26}	Kanakamony	RARS Pattambi
V_{27}	V-21	RRS Kayamkulam
V_{28}	Gey-2	RARS Pattambi
V_{29}	Covu 869	RRS Kayamkulam

Contd

Table 3 1 (Contd)

Treatment No	Variety	Source
V_{30}	New Era	RRS Kayamkulam
V_{31}	Co-3	RRS Kayamkulam
V_{32}	Sasthamkotta local	RRS Kayamkulam
V_{33}	V-27	RRS Kayamkulam
V_{34}	CoVu 8447	RRS Kayamkulam
V_{35}	V-87	RRS Kayamkulam
V_{36}	IITA	RARS Pattambi
V_{37}	V-317	RARS Pattambi
V_{38}	V-265	RARS, Pattambi
V_{39}	KAU cul 9	RARS Pattambi
V_{40}	Cowpea 1-26	RARS Pattambi
V_{41}	Vettikkel	RARS Pattambi
V_{42}	Sel 25	RARS Pattambi
V_{43}	V-23	RRS Kayamkulam
V_{44}	V-271	RRS Kayamkulam
V_{45}	Sel 2	RARS Pattambi
V_{46}	Cowpea K	RARS Pattambi
V_{47}	Cherinadu	RARS Pattambi
V_{48}	V-276	RRS Kayamkulam
V_{49}	Sel 32	RARS Pattambi
V_{50}	C-152	RARS Pattambi
V_{51}	RC-19	RARS Pattambi
V_{52}	Sel 30	RARS Pattambi
V_{53}	Manjuri red	RARS Pattambi
V_{54}	Kozhinji payar	RARS Pattambi
V_{55}	Sel 28	RARS Pattambi
V_{56}	Sel 22	RARS Pattambi
V_{57}	S-17	RARS Pattambi
V_{58}	Sel 27	RARS Pattambi
V_{59}	DPLC-210	RARS Pattambi

RESULTS

The data collected on various characters were statistically analysed and the results are presented below

CAMV disease scoring

Mean number of plants infected and the percentage of infection by CAMV in 59 cowpea varieties are given in Table 4 1

Of the 59 varieties screened only two varieties namely V-317 and V-276 showed complete resistance against CAMV In thirty eight varieties symptom of CAMV was first appeared as mild vein clearing on the primary trifoliate leaves six to seven days after the sap inoculation The symptom become severe in the later formed trifoliates which showed mosaic mottling with dark green and light green patches In some cases interveinal areas remained yellow In five varieties namely KAU cul 7 CoVu 358 Guj-2 V 271 and Kozhinjipayar mild mosaic mottling was visible only on the 28th day after inoculation and the percentage incidence remained the same throughout the observation period In thirteen varieties namely CoVu 8416 CoVu 8420 V-38 S-448 CoVu-27 IITA CoVu 869 Co-3 KAU cul9 V-87 sel 25 Cowpea K and S 17 the disease symptom appeared first on the 14th

Table 4 1 Percentage infection of CAMV

Sl No	Variety	7 DAI	14 DAI	28 DAI	42 DAI
1	CoVu 882	4 86 (12 74)	9 74 (18 18)	11 61 (19 92)	19 89 (26 48)
2	V 16	0 84 (5 26)	4 86 (12 74)	8 26 (16 69)	11 61 (19 92)
3	KAU cul-7	0 (0)	0 (0)	4 86 (12 74)	4 86 (12 74)
4	PTB 2	3 45 (10 70)	8 26 (16 69)	12 57 (20 76)	12 57 (20 76)
5	V 240	0 84 (5 26)	0 84 (5 26)	7 57 (15 96)	7 57 (15 96)
6	VCP-4	3 33 (10 52)	3 33 (10 52)	4 86 (12 74)	4 86 (12 74)
7	CoVu 771	1 70 (7 48)	2 57 (9 21)	3 45 (10 70)	3 45 (10 70)
8	Varkala Local	21 64 (27 71)	29 78 (33 06)	34 53 (35 97)	51 74 (45 98)
9	V-269	3 33 (10 52)	7 57 (15 96)	13 94 (21 92)	14 64 (22 49)
10	V-385	6 25 (14 47)	9 74 (18 18)	13 33 (21 41)	13 33 (21 41)
11	V-2	3 45 (10 70)	8 85 (17 30)	15 13 (22 88)	26 98 (31 28)
12	CoVu 8416	0 (0)	1 70 (7 48)	6 67 (14 96)	8 26 (16 69)

Contd

Table 4 1 (Contd)

Sl No	Variety	7 DAI	14 DAI	28 DAI	42 DAI
13	CoVu 8420	0 (0)	13 87 (21 86)	17 54 (24 75)	26 04 (30 67)
14	V-38	0 (0)	4 36 (12 04)	6 25 (14 47)	6 25 (14 47)
15	CoVu 7	3 45 10 70	3 45 (10 70)	4 86 (12 74)	4 86 (12 74)
16	S-448	0 (0)	3 45 (10 70)	5 28 (13 28)	15 13 (22 88)
17	CoVu 4	1 70 (7 48)	7 57 (15 96)	16 67 (24 09)	16 67 (24 09)
18	CoVu 8456	12 57 (20 76)	24 98 (29 98)	31 65 (34 22)	34 92 (36 21)
19	CoVu 358	0 (0)	0 (0)	2 57 (9 21)	2 57 (9 21)
20	CoVu 810	7 57 (15 96)	7 57 (15 96)	11 17 (19 52)	11 17 (19 52)
21	Kottayam Local	1 70 (7 48)	38 16 (38 13)	41 62 (40 16)	41 62 (40 16)
22	CoVu85020	4 86 (12 74)	7 57 (15 96)	10 11 (18 53)	18 06 (25 14)
23	V 322	0 84 (5 26)	1 70 (7 48)	6 25 (14 47)	7 57 (15 96)
24	HG-171	1 70 (7 48)	6 25 (14 47)	6 25 (14 47)	6 25 (14 47)
25	CoVu-27	0 (0)	9 74 (18 18)	12 57 (20 76)	14 64 (22 49)
26	Kanakamony	1 70 (7 48)	1 70 (7 48)	1 70 (7 48)	1 70 (7 48)

Contd

Table 4 1 (Contd)

Sl No	Variety	7 DAI	14 DAI	28 DAI	42 DAI
27	V 21	13 33 (21 41)	21 64 (27 71)	26 60 (31 04)	28 20 (32 06)
28	Guj-2	0 (0)	0 (0)	1 70 (7 48)	1 70 (7 48)
29	CoVu 869	0 (0)	2 57 (9 21)	13 15 (21 26)	16 10 (23 65)
30	New Era	9 74 (18 18)	12 57 (20 76)	15 30 (23 02)	29 08 (32 62)
31	Co 3	0 (0)	3 33 (10 52)	3 45 (10 70)	3 45 (10 70)
32	Sasthamkotta Local	9 74 (18 18)	10 11 (18 53)	13 33 (21 41)	18 06 (25 14)
33	V-27	0 (0)	0 (0)	0 (0)	0 84 (5 26)
34	CoVu 8447	3 33 (10 52)	3 33 (10 52)	5 28 (13 28)	10 11 (18 53)
35	V-87	0 (0)	1 70 (7 48)	7 57 (15 96)	11 61 (19 92)
36	IITA	0 (0)	0 84 (5 26)	0 84 (5 26)	0 84 (5 26)
37	V-317	0 (0)	0 (0)	0 (0)	0 (0)
38	V 265	2 57 (9 21)	5 28 (13 28)	5 28 (13 28)	6 22 (14 44)
39	KAU cul 9	0 (0)	1 70 (7 48)	1 70 (7 48)	3 45 (10 70)
40	Cowpea 1 26	4 86 (12 74)	6 25 (14 47)	18 06 (25 14)	18 06 (25 14)

Contd

Table 4 1 (Contd)

Sl No	Variety	7 DAI	14 DAI	28 DAI	42 DAI
41	Vettikkel	0 84 (5 26)	1 70 (7 48)	21 06 (27 30)	21 06 (27 30)
42	Sel 25	0 (0)	6 22 (14 44)	25 49 (30 31)	25 49 (30 31)
43	V-23	4 86 (12 74)	8 26 (16 69)	11 17 (19 52)	13 15 (21 26)
44	V 271	0 (0)	0 (0)	3 45 (10 70)	3 45 (10 70)
45	Sel 2	1 70 (7 48)	2 57 (9 21)	2 57 (9 21)	2 57 (9 21)
46	Cowpea K	0 (0)	0 84 (5 26)	1 70 (7 48)	1 70 (7 48)
47	Cherinadu	0 84 (5 26)	8 26 (16 69)	16 67 (24 09)	21 64 (27 71)
48	V-276	0 (0)	0 (0)	0 (0)	0 (0)
49	Sel 32	23 08 (28 70)	34 70 (36 08)	38 61 (38 40)	38 61 (38 40)
50	C-152	18 06 (25 14)	41 66 (40 18)	55 07 (48 30)	58 46 (49 85)
51	RC-19	6 25 (14 47)	7 57 (15 96)	13 15 (21 26)	16 10 (23 65)
52	Sel 30	1 70 (7 48)	6 67 (14 96)	9 74 (18 18)	9 74 (18 18)
53	Manjeri red	0 84 (5 26)	4 36 (12 04)	8 26 (16 69)	11 17 (19 52)
54	Kozhinjipayar	0 (0)	0 (0)	0 84 (5 26)	0 84 (5 26)

Contd

Table 4 1 (Contd)

Sl No	Variety	7 DAI	14 DAI	28 DAI	42 DAI
55	Sel 28	20 40 (26 84)	34 53 (35 97)	34 53 (35 97)	36 37 (37 07)
56	Sel 22	3 45 (10 70)	3 45 (10 70)	4 36 (12 04)	6 36 (14 50)
57	S-17	0 (0)	1 70 (7 48)	4 36 (12 04)	6 36 (14 50)
58	Sel 27	16 67 (24 08)	18 97 (25 81)	18 97 (25 81)	20 40 (26 81)
59	DPLC-210	0 84 (5 26)	2 57 (9 21)	2 57 (9 21)	2 57 (9 21)
	F(58 58)	2 38**	2 07**	2 19**	2 72**
	S E	5 37	6 94	6 99	6 63
	C D	15 42	19 92	20 05	19 03

DAI Days after inoculation

Figures in parenthesis represent the transformed percentage in angles

** Significant at 1 per cent level of probability

day of inoculation and percentage infection remained very low or medium low till the end of the observation period except for Covu 8420 and sel 25 which showed a h gher percentage of infection (26 04 and 25 49 respecti ely)

The incidence of CAMV was significant among varieties at different periods of observation Variety C-152 recorded the highest percentage of infection (58 46) followed by Varkala local (51 74)

Apart from the two varieties viz v-317 and v-276 which showed a zero infection of CAMV there were sixteen varieties which showed an infection percentage below five to be mentioned as highly tolerant and seven others with infection percentage above five and below ten to be mentioned as tolerant

Varietal effect on vegetative characters

The mean varietal response to different vegetative characters are presented in Table 4 2 and their distribution as per different values ranges in Tables 4 3 to 4 7

Significant differences existed among variables with respect to days to first flowering days to maturity plant height at maturity and number of primary branches per plant But there was no significant difference among varieties for the number of hairs per unit leaf area

Table 4 2 The mean data on five vegetative characters

Sl No	Variety	No of days to First flowering	No of days to maturity	plant height at maturity (cms)	No of hairs per one cm^2 leaf area	No of primary branches plant
1	CoVu 882	40 00	71 00	113 70	3 00	1 95
2	V-16	39 50	68 50	65 70	0 66	4 40
3	KAU cul-7	35 50	64 00	87 35	0 00	2 60
4	PTB-2	29 50	59 50	77 35	0 17	1 25
5	V-240	37 00	72 50	126 70	1 00	3 05
6	VCP 4	42 00	60 00	129 20	2 00	1 55
7	CoVu 771	41 50	58 00	76 90	2 00	1 60
8	Varkala Local	41 50	62 50	49 55	1 00	3 60
9	V-269	41 00	65 00	86 45	0 00	2 95
10	V 385	42 00	68 50	62 95	11 00	2 60
11	V 2	42 00	71 00	97 25	5 50	2 65
12	CoVu 8416	42 00	67 00	68 20	2 30	3 25
13	CoVu 8420	41 00	64 50	84 60	3 00	2 20
14	V-38	38 00	56 50	79 80	0 00	3 55
15	CoVu-7	38 00	64 50	75 55	3 65	1 95
16	S-448	36 00	58 00	103 13	0 15	2 20
17	CoVu-4	38 00	61 50	109 50	1 80	2 00
18	CoVu 8456	37 00	66 50	96 40	0 00	2 55
19	CoVu 358	38 00	62 50	54 00	0 50	1 95
20	CoVu 810	40 50	62 50	145 10	3 50	1 65

Contd

Table 4 2 (Contd)

Sl No	Variety	No of days to First flowering	No of days to maturity	plant height at maturity (cms)	No of hairs per one cm^2 leaf area	No of primary branches plant
21	Kottayam Local	36 00	66 50	55 45	1 50	2 70
22	CoVu 85020	41 00	64 50	64 10	1 50	3 10
23	V-322	38 50	68 50	90 80	1 70	2 70
24	HG-171	40 50	68 00	61 70	0 00	2 30
25	CoVu-271	41 00	64 50	74 40	1 00	3 85
26	Kanakamony	39 00	65 50	112 00	1 34	2 90
27	V-21	37 00	71 00	99 90	5 17	2 15
28	Gui-2	36 00	64 00	92 20	0 15	1 60
29	CoVu 869	40 50	69 00	71 90	0 25	2 60
30	New Era	42 50	72 50	93 60	2 50	3 70
31	Co-3	41 00	64 50	95 55	2 00	2 90
32	Sastham kotta Local	43 50	66 00	101 55	2 00	3 70
33	V-27	41 00	65 00	100 35	1 00	2 95
34	CoVu 8447	40 50	58 00	133 70	4 253	2 55
35	V 87	40 50	64 50	113 60	2 50	2 35
36	IITA	41 00	64 00	48 80	0	2 60
37	V-317	39 50	71 50	91 15	0 50	2 55
38	V-265	41 50	56 00	82 50	1 25	2 75
39	KAU cul 9	40 00	63 50	54 00	1 30	2 20
40	Cowpea 1-26	38 00	64 00	60 00	2 25	1 20
41	Vettikkel	39 50	57 50	57 70	4 30	2 00

Contd

Table 4 2 (Contd)

Sl No	Variety	No of days to First flowering	No of days to maturity	plant height at maturity (cms)	No of hairs per one cm^2 leaf area	No of primary branches plant
42	Sel 25	41 50	73 00	122 10	0	2 65
43	V 23	38 00	67 50	92 50	0 50	3 50
44	V-271	36 00	70 50	92 55	3 65	3 20
45	Sel 2	41 50	59 00	82 40	3 25	3 15
46	Cowpea K	42 00	66 50	80 20	3 50	2 20
47	Cherinadu	39 00	56 50	104 65	1 00	2 50
48	V 276	40 50	67 50	108 70	0	2 95
49	Sel 32	41 00	67 00	128 75	1 67	1 90
50	C-152	38 00	62 50	80 05	4 80	2 40
51	RC-19	35 50	57 50	61 10	1 17	2 95
52	Sel 30	40 50	71 50	80 35	4 75	2 35
53	Maneri red	43 50	68 00	115 85	1 00	2 75
54	Kozhinji payar	34 00	57 00	54 40	3 65	2 65
55	Sel 28	42 50	70 00	119 55	2 65	2 20
56	Sel 22	37 50	68 50	123 75	0	2 60
57	S-17	41 00	65 00	124 05	3 50	3 00
58	Sel 27	42 00	70 00	123 24	6 00	2 50
59	DPLC-210	43 00	68 00	55 45	0 65	2 45
	F(58 58)	2 843**	3 768**	5 031**	1 446	10 976**
	C D	4 491	6 912	31 97	4 810	0 560
	S E	1 560	2 396	11 09	1 670	0 190

** Significant at 1 per cent level of significance

Days to first flowering

The mean data are given in Table 4 2 and their range in Table 4 3

The mean values for days to first flowering varied from 29 5 in PTB 2 to 43 5 in Sasthamkotta local and Manjeri red Mean values of 51 varieties exceeded the general mean 36 5

Days to maturity

The mean data are given in Table 4 2 and the distribution of varieties in various mean days ranges in Table 4 4

The mean values for days to maturity varied from 56 in V-265 to 73 in selection 25 Mean values of thirty seven varieties exceeded the general mean 64 5

Plant height at maturity

The mean data are given in Table 4 2 and the range in Table 4 5

Plant height was found to be maximum in variety CoVu 810 which had an average of 141 5 cm Minimum plant height at maturity was observed in the variety IITA which

Table 4 3 Days to first flowering

No of days	Varieties
< 35	PTB-2 Kozhinjipayar
36 40 (25 varieties)	KAU cul9 CoVu 882 V 317 vettikkel V-16 Cherinadu Kanakamony V-322 Cowpea 1 26 V-23 V 38 CoVu 7 CoVu 4 CoVu-358 C-152 Sel 22 V 21 V-240 CoVu-8456 Guj-2 V 271 Kottayam local S-448 RC-19 KAU cul 7
41 - 45 (32 varieties)	CO-3 Manjeri red DPLC-210 New Era Sasthamkotta local Sel 28 VCP-4 V-385 V-2 CoVu-8416 Cowpea K Sel 25 Sel 2 CoVu-771 Varkala local CoVu-85020 CoVu-271 V27 IITA V 269 CoVu 8420 Sel 32 S-17 CoVu 869 CoVu-810 CoVu 8447 V 87 V 276 HG-171 Sel 30

Table 4 4 Days of maturity

Days to maturity	Varieties
55 60 (12 varieties)	VCP 4 PTB-2 Sel-2 S-448 Covu-771 CoVu-8447 Vettikkel RC 19 Kozhinjipayar V 38 Cherinadu V-265
61 65 (19 varieties)	V 87 V-269 S-17 Covu 85020 CoVu 271 CoVu-8420 CoVu-7 New Era Cowpea 1-26 KAU cul 7 Guj-2 IITA KUL cul 9 CoVu-810 Varkala local C-152 CoVu-358 CoVu-4
66 - 70 (19 varieties)	Sel 28 Sel 27 CoVu-869 V322 V-16 V385 Sel 22 HG-171 Manjeri red DPLC 210 V-23 V 276 CoVu 8416 Sel 32 Cowpea K Kottayam local CoVu-8456 Sasthamkotta local Kanakamony
71 -75 (9 varieties)	Sel 25 V240 New Era V-317 Sel 30 V-2 V-21 CoVu-822 V-271

Table 4 5 Plant height at maturity

Height in cms	Varieties
≤ 60 (9 varieties)	Varkala local IITA Cowpea 1 26 Vettikkel Kottayam local DPLC-210 Kozhinjipayar KAU cul 9 CoVu 358
61 - 80 (12 varieties)	CoVu 8416 V 16 CoVu 85020 V 385 HG 171 RC-19 V-38 PTB 2 CoVu 771 CoVu-7 CoVu 271 CoVu 869
81 100 (18 varieties)	KAU cul 7 V-269 CoVu 8420 sel 2 V 265 sel 30 cowpea K C-152 V 21 V-2 CoVu 8456 Co-3 New Era V 271 V-23 Guj-2 V-317 V-322
101 - 120 (11 varieties)	CoVu 4 V 276 Cherinadu S-448 Sasthamkotta local V-27 Sel 28 Manjeri red CoVu 882 V-87 Kanakamony
≥ 121 (9 varieties)	VCP-4 Sel 32 V 240 S-17 Sel 22 Sel 27 Sel 25 CoVu 810 CoVu 8447

Table 4 6 Average number of hairs per unit area of leaf (cm^2)

No of hairs/unit area of leaf (cm^2)	varieties
Nil (9 varieties)	V-269 HG 171 IITA KAU cul 7 CoVu 8456 Sel 22 V-38 Sel 25 V-276
0 1 - 1 (15 varieties)	V-27 Varkala local CoVu 271 Cherinadu V-240 Manjeri red V 16 DPLC-210 V-317 CoVu 358 V-23 CoVu 869 PTB-2 Guj-2 S-448
1 1 2 0 (13 varieties)	Co 3 Sasthamkotta local CoVu 771 VCP 4 CoVu-4 Sel 32 V-322 Kottayam local CoVu 85020 Kanakamony V-265 KAU Cul RC-19
2 1 3 (7 varieties)	CoVu 882 CoVu 8420 Sel 28 New Era V-87 CoVu 8416 Cowpea 1 26
3 1 4 (7 varieties)	CoVu 7 V-271 Kozhinjipayar CoVu 810 Cowpea K S-17 Sel 2
> 4 1 (8 varieties)	C 152 Sel 30 Vettikkal CoVu 8447 V-3858 Sel 27 V-2 V-27

Table 4 7 Average number of primary branches per plant

No of primary branches/plant	varieties
≤ 2 (12 varieties)	CoVu-4 Vettikkal CoVu-7 CoVu 358 CoVu 882 Sel 32 CoVu 810 Guj-2 CoVu 771 VCP-4 PTB 2 Cowpea 1-26
2 1 - 3 (35 varieties)	S-17 V 27 V 276 V-269 RC-19 Kanakamony Co-3 v-265 Manjeri red V-322 Kottayam local Sel 25 V-385 V-2 Kozhinjipayar CoVu 869 KAU cul 7 IITA Sel 22 V-317 CoVu 8456 Cherinadu Sel 27 CoVu 8447 DPLC-210 C-152 Sel 30 V 87 HG-171 S-448 KAU cul 9 Sel 28 CoVu 8420 Cowpea K V-21
3 1 4 (12 varieties)	CoVu 271 New Era Sasthamkotta local Varkala local V 38 V-23 CoVu 8416 V-271 Sel 2 CoVu 85020 V-240 V-16

had an average of 48 4 cm Mean value of twenty-five varieties exceeded the general mean 94 5 cm

Number of hairs per unit leaf area

The mean data are presented in Table 4 2 and the range in Table 4 6

There was no significant difference among varieties with respect to this character In most varieties leaf hairs were present only on nerve region Hairs were absent in the varieties V-269 HG 171 IITA KAU cul 7 CoVu 8456 V 38 Sel 25 V-276 and Sel 22 Maximum number of hairs was observed in the variety V 385 with an average of 11/cm2 area

Number of primary branches/plant

The mean data are given in Table 4 2 and the range in Table 4 7 The mean values for the number of primary branches per plant varied from 1 2 in cowpea 1 26 to 4 4 in V 16 Majority of varieties recorded an average of 2 5 primary branches per plant

Varietal effect on yield contributing characters

The mean varietal response to different yield contributing characters are presented in Table 4 8 and their range in Table 4 9 to 4 13 Significant differences were

Table 4 8 Varietal response on five yield contributing characters

Sl No	Variety	No of pods/ plant	No of seeds/ pod	Length of pod (cms)	100 seed weight (g)	Seed yield/ plant (g)
1	CoVu 882	11 05	7 85	12 42	10 40	9 31
2	V-16	16 65	12 80	13 24	8 79	16 55
3	KAU Cul-7	14 05	8 50	11 17	9 39	10 29
4	PTB-2	16 95	10 65	10 64	8 41	17 50
5	V 240	12 00	11 05	14 76	7 77	10 15
6	VCP-4	7 10	10 75	13 06	8 43	7 20
7	Co Vu 771	10 00	12 45	11 37	7 29	10 12
8	Varkala Local	14 20	9 50	11 08	9 45	12 55
9	V-269	11 15	11 20	14 75	8 01	11 70
10	V-385	12 20	11 95	13 64	9 68	13 79
11	V-2	13 60	12 90	14 26	9 86	13 20
12	CoVu 8416	15 15	13 55	14 73	9 86	17 05
13	CoVu 8420	13 05	11 35	12 99	7 12	10 45
14	V-38	15 10	12 20	14 08	10 07	17 60
15	CoVu-7	12 30	13 25	13 02	10 95	15 75
16	S-448	13 35	12 45	16 37	12 86	20 05
17	CoVu 4	14 00	11 70	13 58	9 95	15 25
18	CoVu 8456	12 30	11 95	15 61	11 20	16 22
19	CoVu 358	11 50	12 35	16 04	13 07	17 44
20	CoVu 810	12 95	12 35	11 18	6 50	9 68

Contd

Table 4 8 (Contd)

Sl No	Variety	No of pods/ plant	No of seeds/ pod	Length of pod (cms)	100 seed weight (g)	Seed yield/ plant (g)
21	Kottayam Local	17 00	10 55	12 28	8 39	13 33
22	CoVu 85020	13 15	11 95	14 09	9 28	15 13
23	V-322	13 00	14 15	15 61	8 87	15 28
24	HG 171	11 05	11 65	28 45	15 88	14 39
25	CoVu-27	15 65	11 80	13 69	9 37	15 75
26	Kanakamony	14 90	13 30	14 28	11 83	22 60
27	V-21	14 85	13 00	13 10	10 60	20 40
28	Guj-2	15 70	10 50	10 71	7 65	16 08
29	CoVu 869	14 95	10 50	10 97	6 39	9 31
30	New Era	16 95	12 60	15 39	11 84	22 32
31	Co-3	9 95	9 10	13 21	8 93	7 90
32	Sastham kotta Local	11 05	9 95	10 33	8 67	8 95
33	V-27	12 10	14 15	15 78	10 88	18 64
34	CoVu 8447	9 75	11 20	12 66	16 09	18 41
35	V 87	12 35	13 25	15 69	12 12	19 34
36	IITA	10 15	11 15	13 67	12 82	13 44
37	V-317	11 10	10 60	12 70	9 37	10 90
38	V-265	10 00	13 20	14 97	12 98	17 30
39	KAU cul 9	11 10	11 05	14 12	10 98	13 90
40	Cowpea 1-26	13 00	11 85	13 68	11 27	16 35
41	Vettikkel	7 60	8 05	10 52	11 49	7 53

Contd

Table 4 8 (Contd)

Sl No	Variety	No of pods/ plant	No of seeds/ pod	Length of pod (cms)	100 seed weight (g)	Seed yield/ plant (g)
42	Sel 25	7 45	10 15	31 90	16 69	16 30
43	V-23	9 05	12 75	13 85	10 05	11 75
44	V 271	13 30	12 00	14 17	9 03	13 60
45	Sel 2	12 70	10 75	15 17	13 53	12 55
46	Cowpea K	10 30	13 90	17 99	10 14	13 30
47	Cherinadu	13 85	11 35	14 45	12 03	16 55
48	V-276	14 50	11 75	14 02	9 45	16 15
49	Sel 32	9 85	14 05	30 23	11 55	15 30
50	C 152	12 45	11 65	11 65	7 59	10 65
51	RC 19	12 85	11 80	13 33	7 74	11 30
52	Sel 30	9 60	10 50	12 98	9 89	9 59
53	Manjeri red	7 35	12 45	16 92	16 62	14 40
54	Kozhinji payar	15 40	12 25	10 59	6 07	10 77
55	Sel 28	5 85	14 99	15 69	10 92	24 37
56	Sel 22	4 80	11 20	16 29	13 72	7 43
57	S-17	6 70	11 25	17 62	19 05	20 65
58	Sel 27	5 95	12 80	17 15	12 71	9 60
59	DPLC-210	11 85	12 30	14 40	8 23	11 45
	F(58 58)	2 21**	2 65**	2 57	8 19**	2 81**
	C D	5 68	2 60	2 34	2 73	7 01
	S E	1 97	0 90	0 81	0 95	2 43

** Significant at 0 01 level of probability

observed among varieties with respect to all the five characters studied viz number of pods per plant number of seeds per pod length of pod hundred seed weight and seed yield per plant

Number of pods per plant

The mean data are presented in Table 4 8 and their distribution in Table 4 9

The variety Kottayam local recorded the highest mean value for number of pods per plant (17) It was least for the variety Sel 22 (4 8) PTB 2 V-16 New Era Guj-2 CoVu 271 Kozhinjipayar CoVu 8416 and V-38 were statistically on par with Kottayam local Fourty two varieties had mean values above the general mean (10 4)

Number of seeds per pod

The mean data are presented in Table 4 8 and range in Table 4 10

The mean value for the number of seeds per pod varied from 7 85 in CoVu 882 to 14 99 in Sel 28 The varieties V-322 V-27 and Sel 32 were statistically on par with Sel 28 in number of seeds per pod Mean values of thirty five varieties exceeded the general mean (11 42)

Table 4 9 Average number of pods per plant

No of pods/plant	varieties
≤ 10 (15 varieties)	22 V-265 CoVu 771 Co-3 Sel 32 CoVu 8447 Sel 30 V 23 Vettikkel Sel 25 Manjeri red VCP-4 S-17 Sel 27 Sel 28
10 1 15 (35 varieties)	CoVu 869 Kanakamony V-21 V-276 Varkala local KAU cul 7 CoVu-4 Cherinadu V-2 S 448 V 271 CoVu 85020 CoVu 8420 V-322 Cowpea 1 26 CoVu 810 RC 19 Sel 2 C-152 V-87 CoVu-7 CoVu 8456 V-385 V 27 V-240 DPLC-210 V 269 CoVu 358 KAU cul 9 V-317 HG 171 CoVu 882 Sasthamkotta local Cowpea K IITA
≥ 15 (9 varieties)	Kottayam local PTB-2 V-16 New Era Guj-2 CoVu 271 Kazhinjipayar CoVu 8416 V-38

Table 4 10 Average number of seeds per pod

No of seeds/pod	varieties
< 11 (15 varieties)	Varkala local Co3 Sasthamkotta local Vettikkel KAU cul 7 CoVu 882 Sel 2 VCP-4 PTB-2 V 317 Kottayam local Sel 30 CoVu 869 Guj-2 Sel 25
11 1 - 12 (20 varieties)	V-271 CoVu 8456 V 385 CoVu 85020 Cowpea 1-26 CoVu 271 RC 19 V-276 CoVu-4 C-152 HG 171 Cherinadu CoVu 8420 S-17 CoVu 8447 Sel 22 V-269 IITA V-240 KAU cul 9
12 1 - 13 (14 varieties)	V-27 V 2 V-16 Sel 27 V-23 New Era CoVu 771 S-448 Manjeri red CoVu 810 CoVu 358 DPLC 210 Kozhinjipayar V-38
> 13 (10 varieties)	KAU cul 9 IITA CoVu-7 CoVu 8416 V 21 Cherinadu Sel 28 V-322 Sel 32 Kanakamony

Table 4 11 Average length of pod in centimeters

Lengh of pod (cm)	Varieties
10 12 (12 varieties)	CoVu 869 Guj-2 PTB 2 Kozhinjipayar Vettikkal Sastamkotta local C-152 Cherinadu CoVu 771 CoVu 810 KAU cul 7 Varkala local
12 1 14 (18 varieties)	CoVu 8420 Sel 30 V317 CoVu 8447 CoVu 882 Kottayam local V-23 CoVu 271 Cowpea 1-26 IITA V-385 CoVu 4 RC-19 V-16 Co-3 V-21 VCP 4 CoVu7
41 1 16 (19 varieties)	V-265 V-240 V 269 CoVu 8416 DPLC-210 KAU Cul 9 Kanakamany V-2 V-271 CoVu 85020 V 38 V-276 V-27 Sel 28 V-87 CoVu 8456 V 322 Sel-2 New era
16 1-18 (7 varieties)	Manjeri red S 448 Sel 22 CoVu 358 Cowpea K S-17 Sel 27
>18 (3 varieties)	Sel 25 Sel 32 HG-171

Table 4 12 Hundred seed weight in gram

Weight (g)	Varieties
≤ 8 (9 Varieties)	Kozhinjipayar CoVu 869 CoVu 810 CoVu 8420 CoVu 771 C 152 Guj 2 RC-19 V-240
8 1-10 (21 varieties)	V-269 DPLC 210 Kottayam local PTB-2 VCP-4 Sasthamkotta local V-16 V-322 CO-3 Varkala local V-276 V-385 V 2 CoVu 8416 Sel 30 CoVu 4 V-27 Covu-85020 V-37 Covu-271 KAU cul 7
10 1-12 (15 varieties)	V 23 V-38 Cowpea K CoVu 882 V 21 V-27 Sel 28 CoVu-7 KAU Cul 9 New Era Covu 8456 cowpea 1-26 Vettikkel sel 32 Kanakamony
12 1 14 (9 varieties)	Cherinadu V-87 Sel 27 IITA S 448 V-265 CoVu 358 Sel 2 Sel 22
> 14 (5 varieties)	HG 171 CoVu 8447 Manjeri red Sel 25 S-17

Table 4 13 Average seed yield per plant

Weight (g)	Varieties
≤ 8 (4 varieties)	Co 3 Vettikkel Sel 22 VCP-4
9 1 12 (17 varieties)	Sasthamkotta local CoVu 882 CoVu 869 Sel 30 Sel27 CoVu 810 CoVu 771 V 240 KAU Cul 7 CoVu 8420 C-152 Kozhinjipayar V 317 RC 19 DPLC 210 V-269 V-23
12 1-15 (10 varieties)	Sel 2 Varkala local Cowpea K IITA Kottayam local V-271 V-385 KAU Cul 9 HG 171 Manjeri red
15 1-18 (19 varieties)	CoVu 85020 CoVu 4 V-322 V-271 CoVu 7 CoVu 271 Guj 2 V-276 V-2 CoVu 8456 Sel 25 Cowpea 1-26 Cherinadu V-16 CoVu 8416 V-265 CoVu 358 PTB 2 V-38
≥ 19 (9 varieties)	CoVu 8447 V-27 V 87 S-448 V-21 S-17 New Era Kanakamony Sel 28

Length of pod

The mean data are presented in Table 4 8 and the range in Table 4 11

The mean value for the length of pod varied from 10 33 cm in Sasthamkotta local to 31 90 cm in Sel 25 Sel 32 were statistically on par with Sel 25 Only three varieties namely HG 171 Sel 25 and Sel 32 exceeded the general mean 20 cm

Hundred seed weight

The mean data are presented in Table 4 8 and the range in Table 4 12

The mean values with respect to this character varied from 6 07 g in Kozhinjipayar to 19 05 g in S-17 Twelve varieties had the mean values above the general mean 12 55g

Seed yield per plant

The mean data are presented in Table 4 8 and the range in Table 4 13

Maximum mean value for seed yield per plant was observed for the variety Sel 28 (24 37 g) and the minimum for

VCP-1 (7 20g) Mean values of twenty two varieties exceeded the general mean (15 79 g)

Genetic parameters

The magnitude of phenotypic genotypic and environmental components of variation observed on various biometric characters of cowpea along with other genetic parameters are presented in Table 4 14

The characters days to first flowering number of hairs per unit area of leaf number of pods per plant number of seeds per pod seed yield per plant CAMV rust disease and Epilachna infestation were found to be more influenced by the environment than genotype

The variations in days to maturity plant height at maturity number of primary branches per plant length of pod hundred seed weight Cercospora infection and pea aphid infestation were found to be more influenced by the genotype

a) Genotypic variance

Maximum genotypic variance was observed by plant height at maturity (495 23) and the lowest value for genotypic variance (0 38) was given by the number of hairs per unit area of leaf

b) Phenotypic variance

Plant height at maturity recorded maximum phenotypic variance (790 94) and minimum phenotypic variance was recorded by the number of hairs per unit area of leaf (0 45)

c) Genotypic co-efficient of variation (GCV)

GCV was found to be maximum for cercospora leaf spot (72 73%) followed by rust disease (70 03%) and CAMV infection (68 07%) The minimum GCV was observed for days to first flowering (5 33%)

d) Phenotypic co-efficient of variation (PCV)

Highest PCV was observed for number of hairs per unit area of leaf (128 94%) followed by rust disease (99 78%) and CAMV infection (96 44%) PCV was found to be least (7 7%) for days to first flowering

e) Heritability

Heritability estimates varied from 18 23% to 95 51% Among fifteen characters analysed number of hairs per unit area of leaf had the lowest heritability (18 23%) High heritability values were observed for length of pod (95 51%) number of primary branches (83 30%) and hundred seed weight (78 23%)

Table 4 14 Genotypic (VG) environmental (VE) and phenotypic (VP) components of variance genotypic (GVC) and phenotypic (PCV) and coefficient of variation heritability (H^2) and genetic advance (G A)

Sl No	Character	Mean	VG	VE	VP	GCV	PCV	H^2 (%)	GA on % mean
1	Days to first flowering	39 58	4 45	4 85	9 29	5 33	7 70	47 34	7 59
2	Days to maturity	65 05	11 45	15 90	27 35	6 13	8 04	58 06	9 62
3	Plant height at maturity (cm)	89 72	495 23	245 71	740 94	24 80	30 34	66 84	41 78
4	Number of hairs / unit area of leaf	2 02	1 24	5 56	6 80	65 05	128 94	18 23	48 41
5	Number of primary branches per plant	2 59	0 38	0 07	0 45	23 69	25 97	83 30	44 56
6	Number of pods per plant	11 99	4 72	7 76	12 48	18 11	29 46	37 79	22 94
7	Number of seeds per plant	11 73	1 34	1 63	2 97	9 87	14 68	45 21	13 68
8	Length of pod (cm)	14 57	16 31	1 32	17 63	27 72	28 82	95 51	54 92
9	Hundred seed weight (g)	10 50	6 42	1 79	8 20	24 12	27 27	78 23	43 94
10	Seed yield per plant (g)	14 20	10 71	11 82	22 54	23 06	33 43	47 56	32 75
11	CAMV (number of plants infected	19 78	181 29	182 59	363 89	68 07	96 44	49 81	22 48
12	Cercospora leaf spot (Score)	1 42	1 06	0 49	1 55	72 73	87 56	68 98	97 88
13	Rust disease (Score)	1 29	0 82	0 84	1 66	70 03	99 78	49 26	58 06
14	Pea aphid infestation (Score)	1 50	0 49	0 34	0 83	46 79	60 62	59 58	65 87
15	Epilachna infestation (Score)	1 29	0 34	0 69	1 03	44 98	78 79	32 58	29 84

Genetic advance in percentage mean

The expected genetic advance expressed as percentage mean revealed large difference among fifteen characters studied It ranged from 7 59 to 97 88 per cent The highest GA was observed for cercospora leaf spot infection (97 88 percent) followed by pea aphid infestation (65 87 per cent)

When heritability and genetic advance were together considered Cercospora leaf spot infection (68 98 and 97 88 per cent) and length of pod (95 51 and 54 92 per cent) were found superior to other characters

Reaction to major pests and diseases

Mean scores recorded for Cercospora leaf spot rust disease pea aphids and damage caused by Epilachna beetle are presented in Table 4 17

Cercospora leaf spots were observed as angular brown to red spots with grey or brown centre with a reddish purple margin Scoring system of Singh (1980) were followed

There was significant difference among varieties with respect to this character No infection was noticed on varieties KAU cul 7 Varkala local S-448 Kanakamony and Sasthamkotta local Infection was found to be high for CoVu

882 (3 16) followed by V-16 (3 08) The fifty nine varieties screened for this disease were classified on the basis of disease reaction as follows

Table 4 15 Distribution of varieties to Cercospora leaf spot

Disease reaction	Number of varieties
Highly resistant	4
Resistant	33
Moderately resistant	10
Moderately susceptible	10
Susceptible	2
Highly susceptible	Nil
Total	59

Rust disease was observed as numerous brown eruptive pustules mostly on the under surface of the leaves The scores showed a significant difference among varieties Infection was found to be high for V-16 (3 04) The disease incidence was found to be less severe for other varieties The fifty nine varieties were classified on the basis of disease reaction as follows

Table 4 16 Distribution of varieties to rust disease

Disease reaction	Number of varieties
Highly resistant	6
Resistant	35
Moderately resistant	14
Moderately susceptible	2
Susceptible	1
Total	59

Infestation of pea aphids on fifty nine cowpea varieties were found to be significantly different among varieties Colonies of nymphs and adults infested on the tender growing shoots flowers and young pods Infested parts dry off None of the varieties showed zero infestation The variety CoVu 869 recorded the least score (0 15) followed by CoVu 4 (0 3) Highest infestation was observed in variety Vettikkel (3 24) The varieties were classified on the basis of pest reaction as follows

Table 4 17 Mean score recorded for major deseases and pests

Sl No	Variety	Cercospora leaf spot	Rust	Pea aphids	Epilachna beetle
1	CoVu 882	3 16(2 04)	0 82(1 35)	2 35(1 83)	1 76(1 66)
2	V 16	3 08(2 02)	3 04(2 01)	1 34(1 53)	1 86(1 69)
3	KAU Cul 7	0(1 00)	1 07(1 44)	2 03(1 74)	1 34(1 53)
4	PTB-2	0 96(1 40)	0 59(1 26)	1 59(1 61)	1 19(1 48)
5	V-240	0 28(1 13)	0 59(1 26)	1 76(1 66)	0 61(1 27)
6	VCP-4	1 22(1 49)	0 19(1 09)	1 28(1 51)	0 04(1 02)
7	Co Vu 771	0 80(1 34)	0(1 00)	0 88(1 37)	0(1 00)
8	Varkala Local	0(1 00)	0(1 00)	0 59(1 26)	0 88(1 37)
9	V-269	0 90(1 38)	0 54(1 24)	1 19(1 48)	1 07(1 44)
10	V-385	0 61(1 27)	1 43(1 56)	1 69(1 64)	0 88(1 37)
11	V 2	1 37(1 54)	0(1 00)	2 13(1 77)	0 32(1 15)
12	CoVu 8416	1 04(1 43)	1 16(1 47)	2 76(1 94)	1 10(1 45)
13	CoVu 8420	2 39(1 84)	1 19(1 48)	2 13(1 77)	0 54(1 24)
14	V-38	0 51(1 23)	0 85(1 36)	1 76(1 66)	0 66(1 29)
15	CoVu-7	0 96(1 40)	0 04(1 02)	0 90(1 38)	1 07(1 44)
16	S-448	0(1 00)	1 69(1 64)	1 66(1 63)	0 44(1 20)
17	CoVu-4	0 54(1 24)	0(1 00)	0 30(1 14)	0 32(1 15)
18	Covu 8456	2 13(1 77)	1 10(1 45)	2 20(1 79)	0 96(1 40)

Contd

Table 4 17 (Contd)

Sl No	Variety	Cercospora leaf spot	Rust	Pea aphids	Epilachna beetle
19	CoVu 358	0 61(1 27)	0 44(1 20)	0 46(1 21)	0 49(1 22)
20	CoVu 810	0 99(1 41)	0 44(1 20)	0 46(1 21)	1 04(1 43)
21	Kottayam Local	0 61(1 27)	0 39(1 18)	1 16(1 47)	0(1 00)
22	CoVu85020	1 50(1 58)	0 35(1 16)	0 96(1 40)	1 07(1 44)
23	V-322	0 59(1 26)	0 30(1 14)	0 59(1 26)	0 49(1 22)
24	HG-171	1 79(1 67)	1 02(1 42)	0 96(1 40)	0 80(1 34)
25	CoVu 27	0 96(1 40)	0 04(1 02)	0 49(1 22)	0 61(1 27)
26	Kanakamony	0(1 00)	0 32(1 15)	1 46(1 57)	0 54(1 24)
27	V-21	0 80(1 34)	1 66(1 63)	1 28(1 51)	0 93(1 39)
28	Guj-2	0 99(1 41)	0(1 00)	2 13(1 77)	0 88(1 37)
29	CoVu 869	1 62(1 62)	1 19(1 48)	0 15(1 07)	0 90(1 38)
30	New Era	0 90(1 38)	2 03(1 74)	1 25(1 50)	0 10(1 05)
31	Co 3	2 76(1 94)	0 39(1 18)	1 69(1 64)	0 82(1 35)
32	Sastham kotta Local	0(1 00)	0 49(1 22)	0 54(1 24)	1 10(1 45)
33	V 27	2 80(1 95)	0 64(1 28)	0 59(1 26)	0 80(1 36)
34	CoVu 8447	2 72(1 93)	2 31(1 82)	1 76(1 66)	0 58(1 24)
35	V-87	2 65(1 91)	1 16(1 47)	1 62(1 62)	0 64(1 28)

Contd

Table 4 17 (Contd)

Sl No	Variety	Cercospora leaf spot	Rust	Pea aphids	Epilachna beetle
36	IITA	1 86(1 69)	1 04(1 43)	1 40(1 55)	0 61(1 28)
37	V 317	2 10(1 76)	0 32(1 15)	1 04(1 43)	1 19(1 48)
38	V 265	0 96(1 40)	0 99(1 41)	0 41(1 19)	0 16(1 47)
39	KAU cul 9	0 28(1 13)	0 32(1 15)	2 13(1 77)	1 28(1 51)
40	Cowpea 1-26	0 61(1 27)	0 30(1 14)	2 10(1 76)	1 07(1 44)
41	Vettikkel	0 46(1 21)	0 64(1 28)	3 24(2 06)	0 77(1 33)
42	Sel 25	0 77(1 33)	0 64(1 28)	1 19(1 48)	0 80(1 34)
43	V-23	2 39(1 84)	0 80(1 34)	1 43(1 56)	1 19(1 48)
44	V 271	0 39(1 18)	0 19(1 09)	0 66(1 29)	1 19(1 48)
45	Sel 2	1 37(1 54)	1 72(1 65)	0 49(1 22)	1 07(1 44)
46	Cowpea K	0 69(1 30)	0 93(1 39)	2 06(1 75)	0 74(1 32)
47	Cherinadu	0 04(1 02)	0(1 00)	1 69(1 64)	0 04(1 02)
48	V 276	0 30(1 14)	0 61(1 27)	1 28(1 51)	0 14(1 08)
49	Sel 32	2 13(1 77)	1 76(1 66)	0 49(1 22)	0(1 00)
50	C 152	0 49(1 22)	0 74(1 32)	1 89(1 70)	0(1 00)
51	RC-19	0 04(1 02)	0 35(1 16)	2 29(1 84)	0 10(1 05)
52	Sel 30	0 23(1 11)	0 69(1 30)	0 10(1 05)	0 39(1 18)
53	Manjeri red	0 49(1 22)	0 42(1 19)	0 23(1 11)	0 04(1 02)

Contd

Table 4 17 (Contd)

Sl No	Variety	Cercospora leaf spot	Rust	Pea aphids	Epilachna beetle
54	Kozhinji payar	1 40(1 55)	0 30(1 14)	1 16(1 47)	0 10(1 05)
55	Sel 28	0 80(1 34)	0 15(1 07)	1 50(1 58)	0(1 00)
56	Sel 22	0 25(1 12)	0 59(1 26)	1 19(1 48)	0 46(1 21)
57	S 17	1 69(1 64)	0 37(1 17)	0 49(1 22)	0 42(1 19)
58	Sel 27	2 57(1 89)	0 15(1 07)	2 39(1 84)	0 39(1 18)
59	DPLC 210	0 04(1 02)	1 04(1 43)	0 23(1 11)	1 46(1 57)
	F(58 58)	5 01**	2 86**	3 43**	2 04**
	S E	0 13	0 13	0 13	0 13
	C D	0 38	0 38	0 37	0 36

Figures in parenthesis represent the transformed values

** Significant at 1 per cent level of probability

Table 4 18 Distribution of varieties to Pea aphid infestation

Pest reaction	Number of varieties
Highly resistant	Nil
Resistant	21
Moderately susceptible	25
Susceptible	12
Highly susceptible	1
Total	59

Infestation of Epilachna beetle was also found to be significantly different among varieties Zero infestation was recorded in varieties CoVu 771 Kottayam local Sel 32 C-152 and Sel 28 None of the varieties showed very high infestation Based on disease reactions the fifty nine varieties were classified as follows

Table 4 19 Distribution of varieites to Epilachna beetle

Disease reaction	Number of varieties
Highly resistant	5
Resistant	36
Moderately susceptible	18
Total	59

Correlation analysis

The results are presented in Table 4 20

Days to first flowering recorded a positive and significant genotypic correlation with days to maturity number of hairs per unit area of leaf number of branches per plant number of seeds per pod length of pod and hundred seed weight Number of pods per plant and pea aphid infestation recorded a significant negative correlation

Days to maturity recorded a positive significant genotypic correlation with number of hairs per unit leaf area and length of pod

Plant height at maturity recorded a significant positive correlation genotypically with length of pod hundred seed weight and cercospora leaf spot infection A negative significant correlation existed between number of branches per plant number of pods per plant and epilachna beetle infestation

Number of hairs per unit area of leaf recorded a significant negative correlation with CAMV number of pods per plant length of pod and pea aphid infestation

Number of branches per plant recorded a significant positive correlation genotypically with number of pods per plant and incidence of rust disease

Number of pods per plant recorded a positive significant genotypic correlation with incidence of rust and Epilachna infestation A negative correlation existed between length of pod and hundred seed weight

Number of seeds per pod recorded a significant positive correlation with length of pod and seed yield per plant and negative association with infestation by pea aphids and Epilachna beetle

Length of pod recorded a high positive and significant correlation genotypically with hundred seed weight and seed yield per plant

Hundred seed weight recorded positive and significant correlation with seed yield per plant and rust incidence

Seed yield per plant recorded a significant positive correlation with rust incidence and negative correlation with CAMV infection

CAMV was significantly and negatively correlated with Epilachna infestation

Epilachna beetle infestation recorded a high positive and significant genotypic correlation with rust disease and Cercospora leaf spot

Table 4.20. Genotypic correlation co-efficient among pairs of characters

	Days to 1st Flowering	Days to maturity	Plant ht. at maturity	No. of hairs/ unit leaf area	No. of branches plant	No. of pods/ plant	No. of seeds per pod	Length of pod (cm)	100 seed weight (gms)	Seed yield per plant (gms)	CAMV	cerco-spora	Rust	Pea aphids	Epilachna beetle
Days to 1st Flowering	--	0.3292** (2.65)	0.2367 (1.86)	0.4247** (3.51)	0.3385** (2.74)	0.6651** (6.73)	0.2770** (2.20)	0.3345** (2.70)	0.3776** (2.75)	0.0271 (0.21)	0.0638 (0.49)	0.1438 (1.12)	0.1344 (1.03)	0.3119** (2.50)	0.0794 (0.61)
Days to maturity		--	0.2369 (1.86)	0.2930** (2.33)	0.2314 (1.81)	0.1284 (0.99)	0.1257 (0.97)	0.4018** (3.34)	0.0892 (0.68)	0.1094 (0.84)	0.1489 (1.15)	0.1564 (1.16)	0.1787 (1.32)	0.1746 (1.35)	0.1452 (1.12)
Plant height at maturity			--	0.0488 (0.37)	0.2669** (2.11)	0.6641** (6.76)	0.1054 (0.81)	0.2582** (2.04)	0.3564** (2.91)	0.0796 (0.61)	0.0146 (0.11)	0.2943** (2.35)	0.0870 (0.67)	0.1150 (0.88)	0.4255** (3.57)
Leaf morphology (No. of hairs/ unit area of leaf)				--	0.1377 (1.06)	0.2620** (2.07)	0.1880 (1.46)	0.2889** (2.30)	0.0084 (0.06)	0.1186 (0.91)	0.4441** (3.71)	0.2148 (1.67)	0.2295 (1.80)	0.4106** (3.34)	0.2384 (1.87)
Number of branches/plant					--	0.2884** (2.29)	0.1150 (0.88)	0.0195 (0.15)	0.0339 (0.26)	0.1434 (1.10)	0.0352 (0.27)	0.0683 (0.52)	0.2741** (2.17)	0.1814 (1.40)	0.1880 (1.46)
Number of pods/plant						--	0.0041 (0.03)	0.5057** (4.46)	0.7022** (7.51)	0.0304 (0.23)	0.0285 (0.22)	0.1822 (1.41)	0.3254** (2.62)	0.0997 (0.76)	0.4532** (3.87)
Number of seeds per pod							--	0.3236** (2.60)	0.0939 (0.72)	0.6771** (7.01)	0.1713 (1.32)	0.1499 (1.15)	0.1278 (0.98)	0.2886** (2.30)	0.3747** (3.08)
Length of pod (cm)								--	0.6029** (0.76)	0.2727** (2.16)	0.0577 (0.44)	0.1921 (1.49)	0.2461 (1.93)	0.2096 (1.63)	0.1319 (1.01)
Hundred seed weight (gms)									--	0.4451** (3.79)	0.1338 (1.03)	0.1690 (1.31)	0.2642** (2.09)	0.0927 (0.71)	0.1046 (0.80)
Seed yield per plant (gms)										--	0.3074** (2.46)	0.0896 (0.69)	0.3834** (3.16)	0.1237 (0.95)	0.1213 (0.93)
CAMV											--	0.0038 (0.03)	0.0284 (0.22)	0.1306 (0.98)	0.5541** (5.07)
cercospora												--	0.4134** (2.61)	0.1274 (0.95)	0.3717** (2.44)
Rust													--	0.1134 (0.85)	0.5772** (5.38)
Pea aphids														--	0.1077 (0.81)
Eplachna															--

** Significant at 0.01 level of probability

Genetic divergence

The results are presented in Table 4 21 and 4 22

The analysis of variance showed a significant difference among the fifty nine varieties for all the ten biometric characters The fifty nine varieties were grouped in eight clusters using the clustering technique (Table 4 21) Among 59 varieties 25 varieties have fallen under cluster I fifteen varieties under cluster II nine varieties under cluster III four varieties under cluster IV two varieties each under cluster V and VI and one variety each under cluster VII and VIII respectively

The intra and inter cluster average distances (Table 4 22) showed that the intra cluster distance was lesser than the inter cluster distance The intra cluster average values of D2 was maximum in cluster VI (28 36) and minimum in cluster III (20 44) The maximum divergence was observed between cluster V and cluster VII (D value - 144 21) The minimum divergence was observed between cluster II and cluster V (D value - 27 18)

Table 4 21 Clustering pattern of 59 cowpea varieties

Cluster No	Varieties
I	KAU Cul 7 PTB-2 CoVu 771 V-269 V-2 CoVu 8420 V38 CoVu 7 CoVu 8456 V-322 V 21 Guj-2 New Era Co 3 V 27 Sasthamkotta local V-317 V 265 V-23 V 271 Sel-2 Cowpea K C-152 Sel-3 V 87
II	V-16 V-385 CoVu 8416 CoVu 358 Kottayam local CoVu 85020 HG-171 CoVu 271 CoVu 869 KAU cul 9 Cowpea 1-26 Vettikkel RC 19 Kozhinjipayar DPLC 210
III	CoVu 882 S 448 CoVu-4 V276 Kanakamony Manjeri red Sel-27 Sel 25 chen nadu
IV	V-240 VCP-4 Sel 32 Sel 22
V	Varkala local IITA
VI	Sel 28 S 17
VII	CoVu 810
VIII	CoVu 8447

Table 4 22 The inter and intra cluster distance

Cluster	I	II	III	IV	V	VI	VII	VIII
I	24 04	45 48	40 85	62 05	61 46	59 25	88 06	73 74
II		22 35	76 81	101 36	28 18	92 77	122 82	111 72
III			20 44	31 83	91 99	34 01	55 23	40 30
IV				21 84	116 96	38 97	34 02	28 99
V					23 32	110 63	144 21	128 64
VI						28 36	55 62	33 90
VII							-	20 41
VIII								-

Table 4 23 Cluster means for ten biometric characters

Sl No	Characters \ Cluster number	I	II	III	IV	V	VI	VII	VIII
1	Days to first flowering	39 27	39 40	39 80	39 40	41 25	41 75	40 50	40 50
2	Days to maturity	63 16	64 43	64 72	67 00	63 10	67 50	62 50	58 00
3	Plant height at maturity	89 58	61 40	111 59	127 10	49 18	121 80	145 10	133 70
4	No of hairs per unit leaf area	2 04	2 13	1 87	1 17	0 50	3 10	3 50	4 25
5	No of primary branches per plant	2 61	2 64	2 46	2 28	3 10	2 60	1 65	2 45
6	No of pods per plant	12 32	13 27	11 92	8 44	12 17	6 28	12 95	9 75
7	No of seeds per pod	11 74	11 63	11 88	11 76	10 33	13 12	12 35	11 20
8	Length of pod	14 30	14 25	14 99	18 59	12 38	16 66	11 18	12 66
9	Hundred seed weight	9 96	9 77	11 99	10 37	11 14	14 98	6 50	16 09
10	Seed yield per plant	13 93	13 60	15 91	10 02	13 00	22 51	9 68	18 41

DISCUSSION

DISCUSSION

The essential steps in a resistance breeding programme are identification of a suitable source for resistance and the incorporation of the genes responsible for the resistance into susceptible higher yielders through appropriate techniques A programme of breeding aimed at the improvement of yield and pest and disease resistance characters require adequate information on the extent of character variation available in the population It is also essential to have an understanding of heritability and genetic advance of economically important characters and correlation between pairs of those characters for achieving the same aim Selection based on yield alone is not very efficient Selection for the major components that contribute to yield is considered more efficient

The present study was therefore undertaken for identifying the degree of resistance in fifty nine cowpea varieties to CAMV and its relation with yield and its components The varietal reaction to Cercospora leafspot rust pea aphids and Epilachna infestation were also assessed The results obtained are discussed in the following sections

CAMV disease scoring

The screening trials have indicated that among the fifty nine varieties screened only two varieties namely V-317 and V-276 showed complete resistance against CAMV Sixteen varieties were highly tolerant seven varieties tolerant and the rest susceptible to CAMV infection (Table 4 1 Fig 1) The susceptible ones showed wide variation in the infection percentage The C 152 and New Era were found to be highly susceptible to CAMV infection in pot culture study conducted by Sreelakha in 1987 This finding is in agreement with the present results But her finding that CO 3 was suspectible to CAMV is contrary to the observation in the present study where it showed only a very low infection rate (3 33 percent) This type of variation in the results is expected since the variability studies have shown that the CAMV disease incidence is highly influenced by environment This indicates the necessity of screening plants under laboratory conditions to confirm resistance for CAMV

Out of the fifty nine varieties screened thirty eight varieties have developed CAMV symptoms six to seven days after inoculation In thirteen varieties symptoms were visible fourteen days after inoculation and in five varieties viz KAU cul 7 CoVu 358 Guj - 2 V-271 and Kozhinjipayar the first symptom was seen only 28 days after inoculation But one variety namely V-271 has shown any

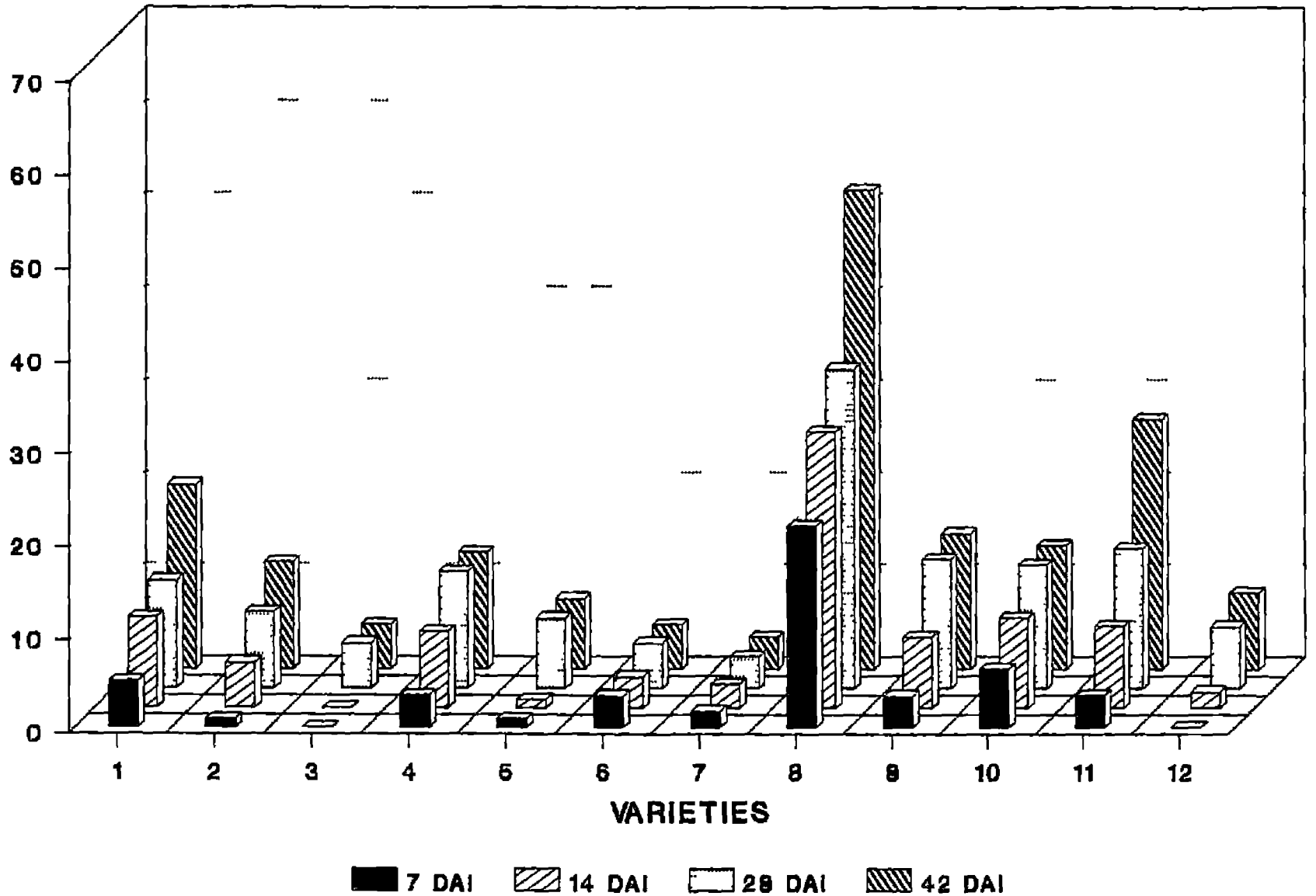
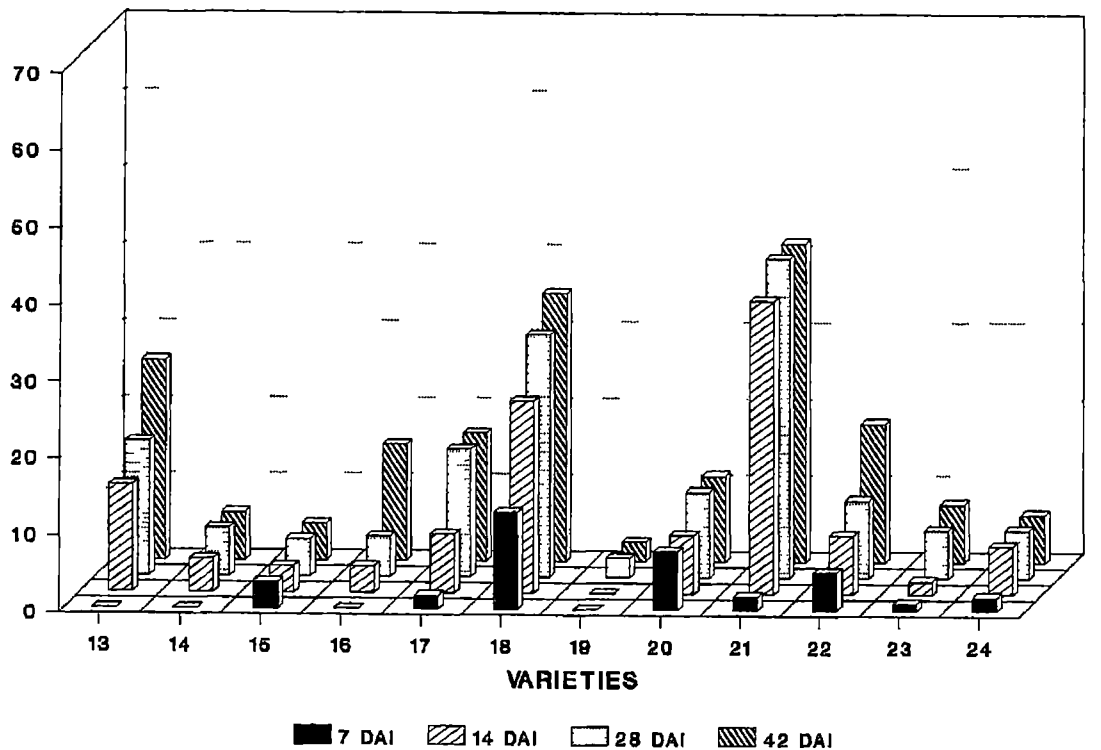


Fig 1 Percentage infection of CAMV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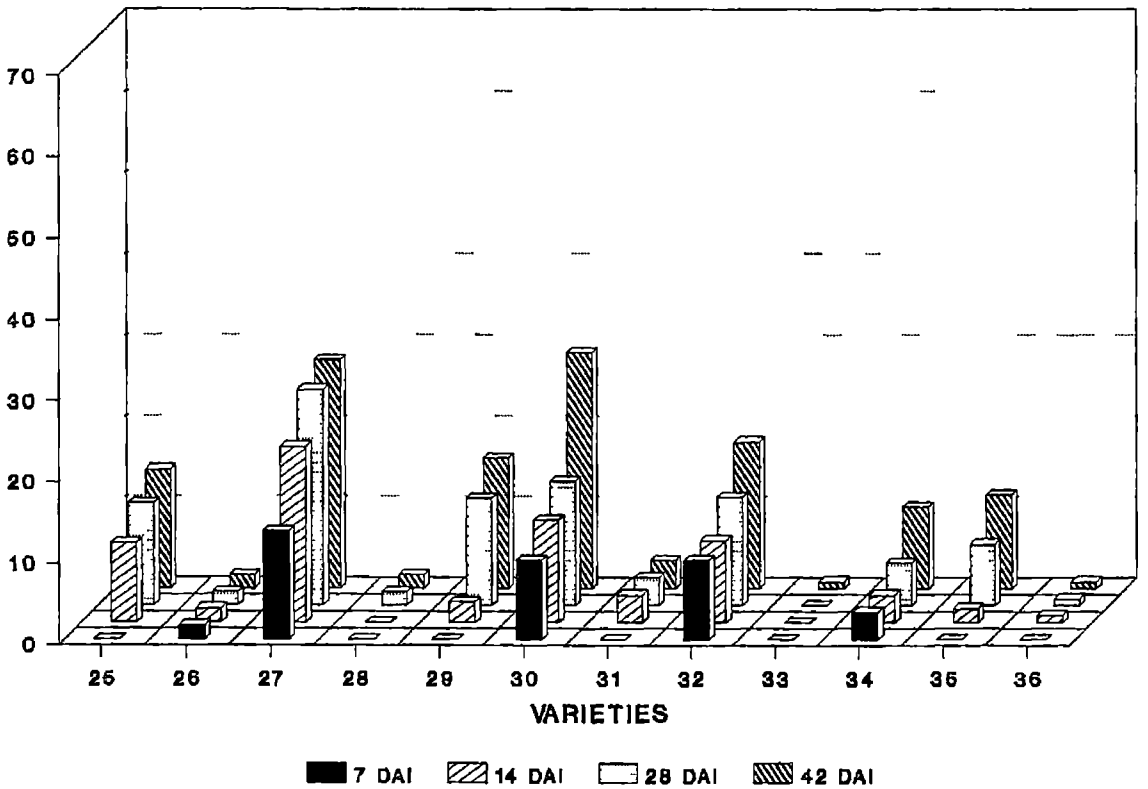
VARIETIES
7 DAI
14 DAI
28 DAI
42 DAI

Fig 1 Contd.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28 DAI
42 DAI

Fig 1 Contd

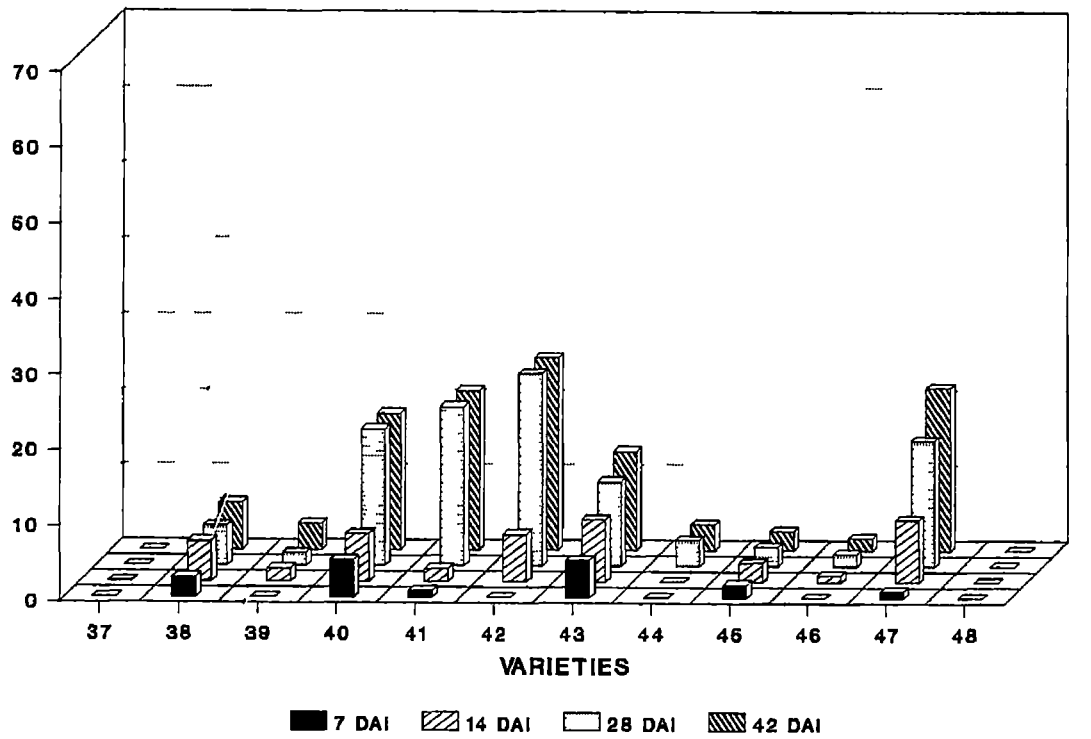
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Fig 1 Contd

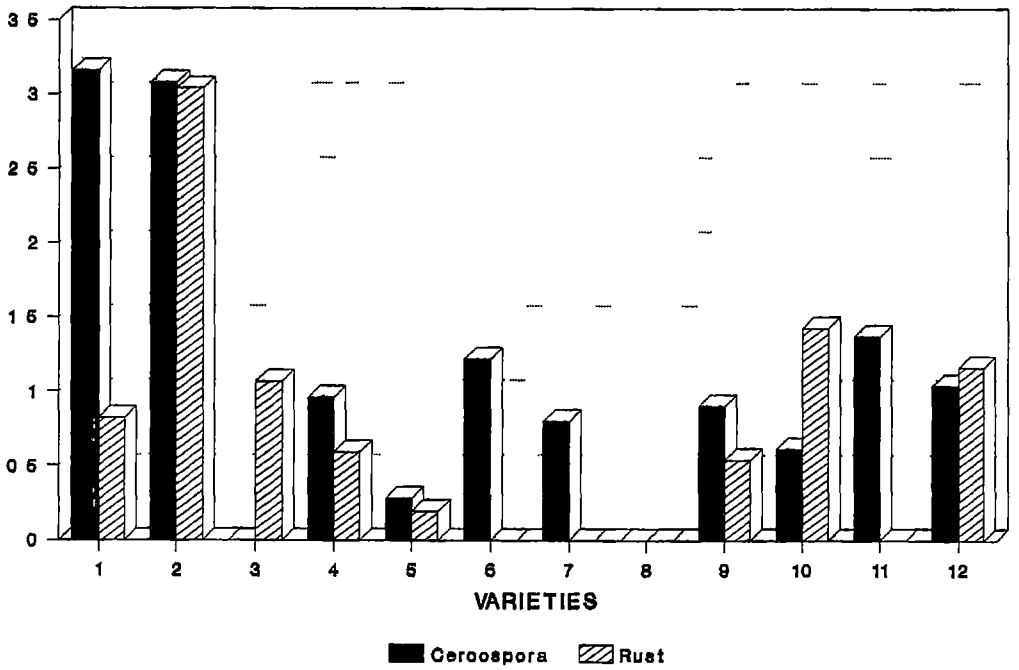
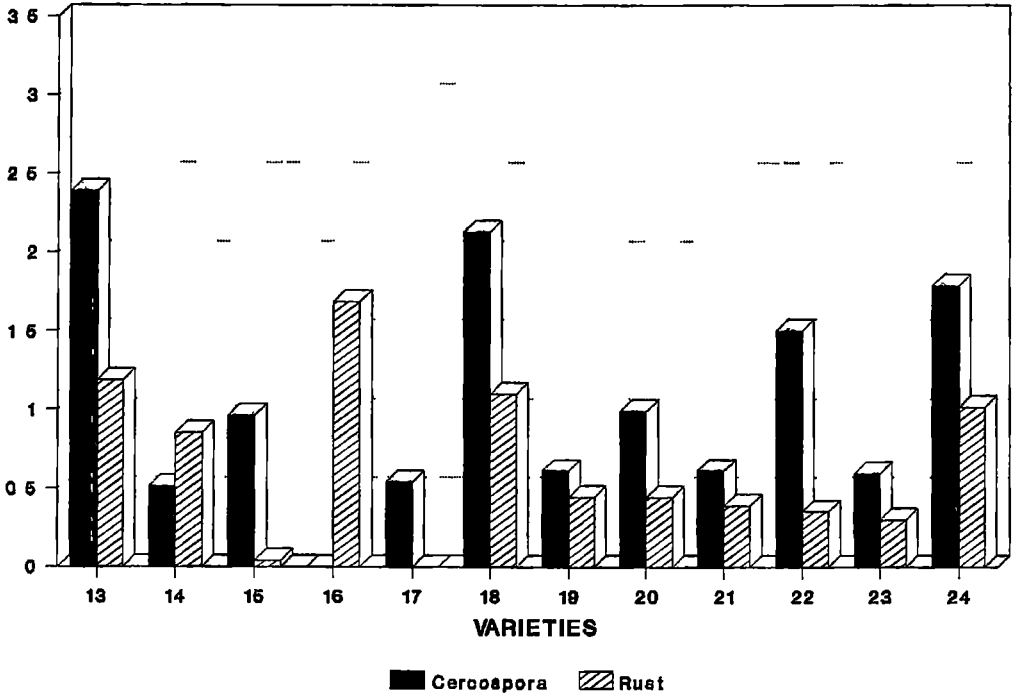


Fig 2 Mean score recorded for major diseases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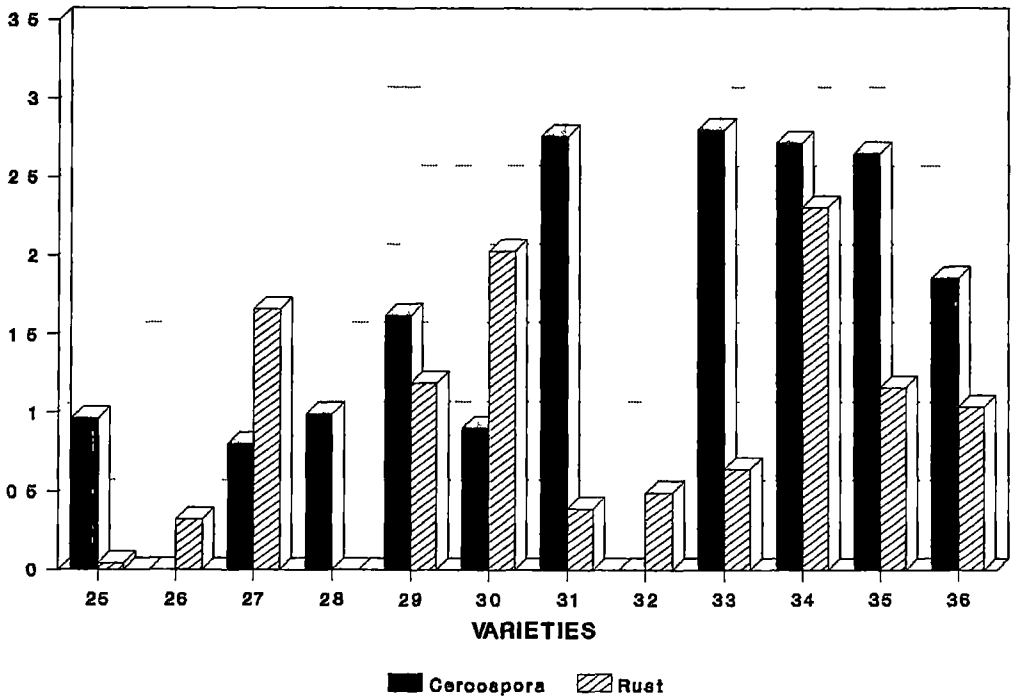
VARIETIES
Cercospora
Rust

Fig 2 Contd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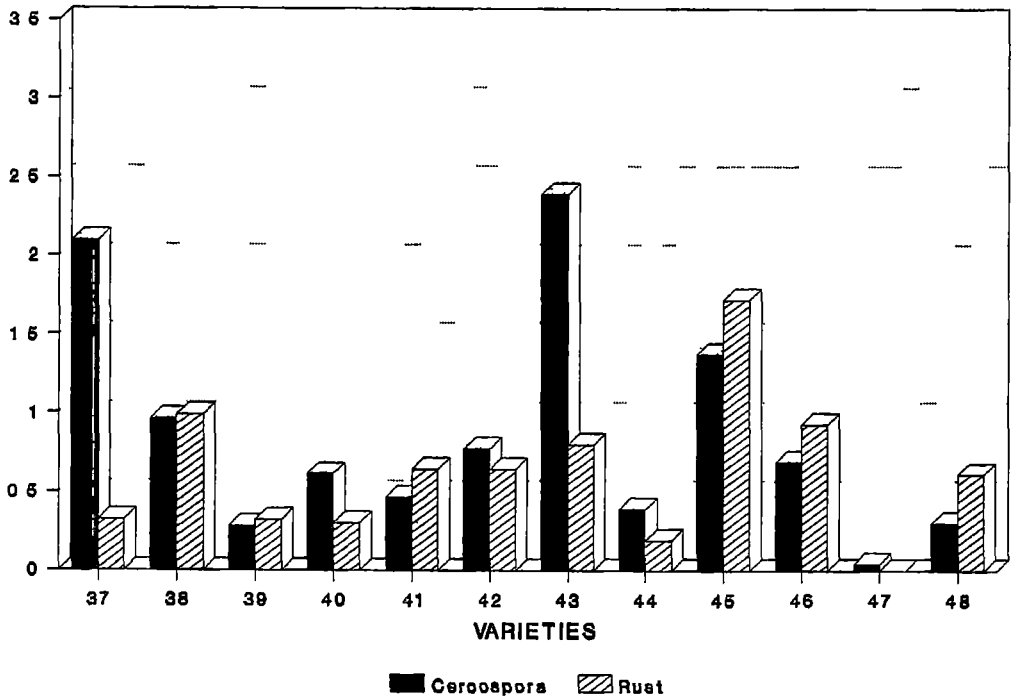
VARIETIES
Cercospora
Rust

Fig 2 Contd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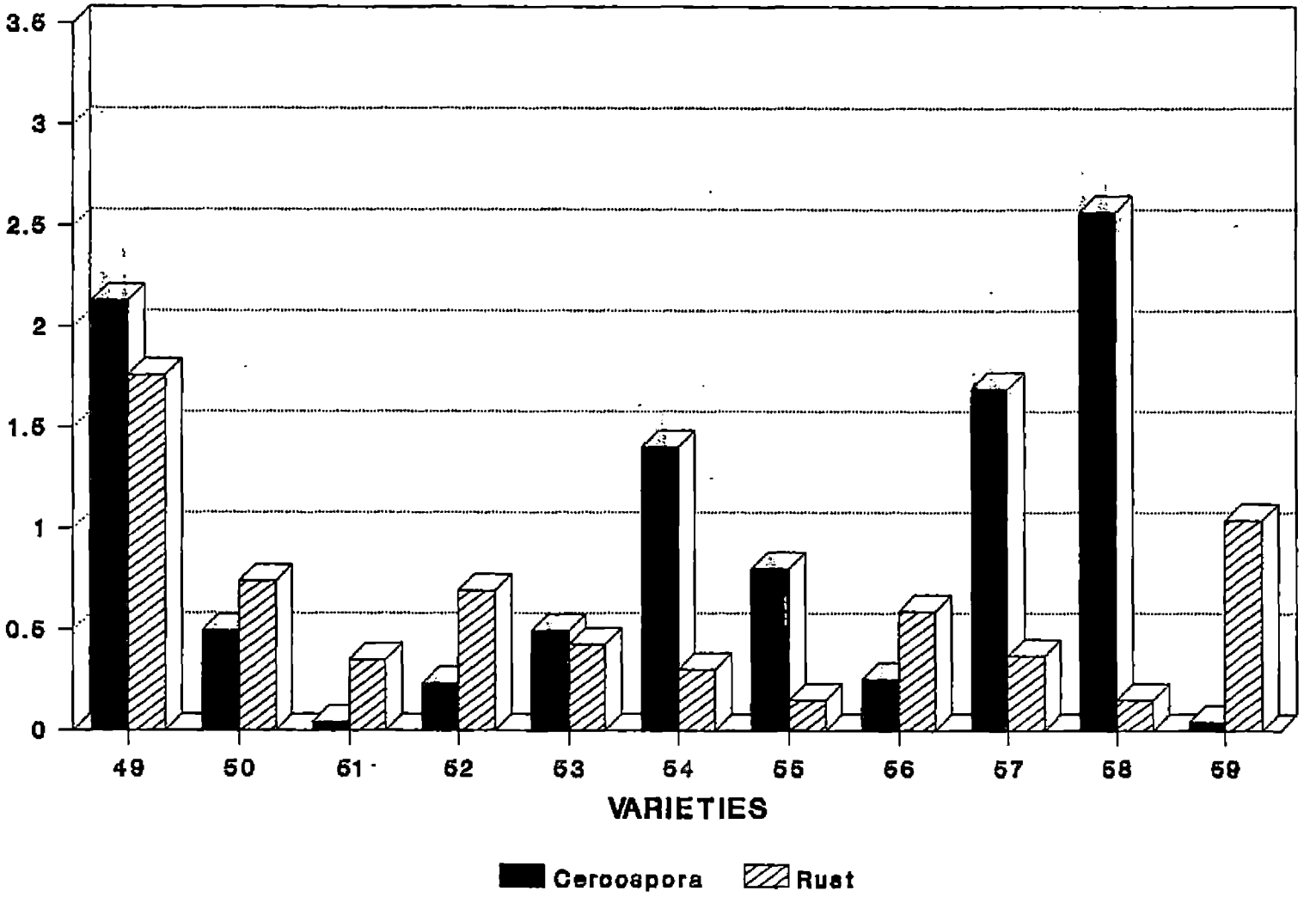
VARIETIES
Cercospora
Rust

Fig 2 Contd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VARIETIES
Cercospora
Rust

Fig. 2. Contd...

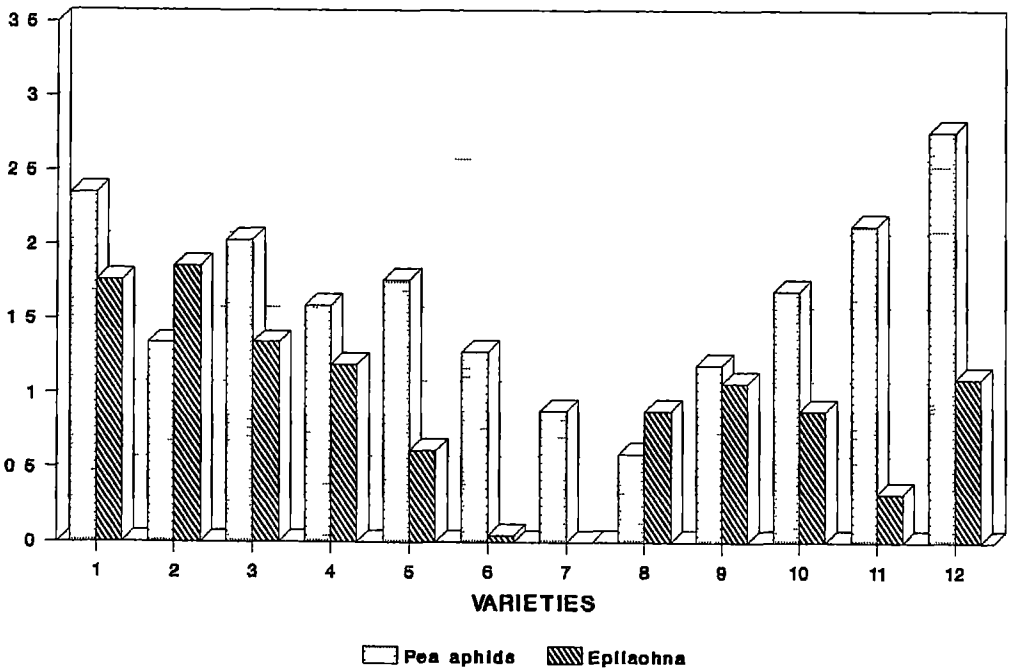
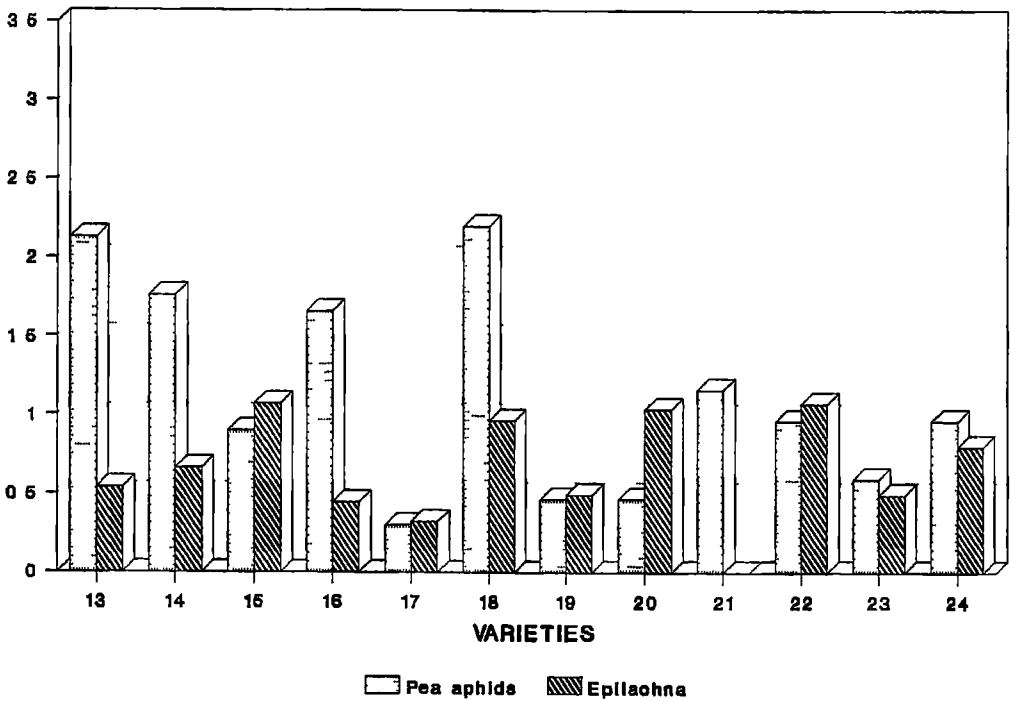


Fig 3 Mean score recorded for major pests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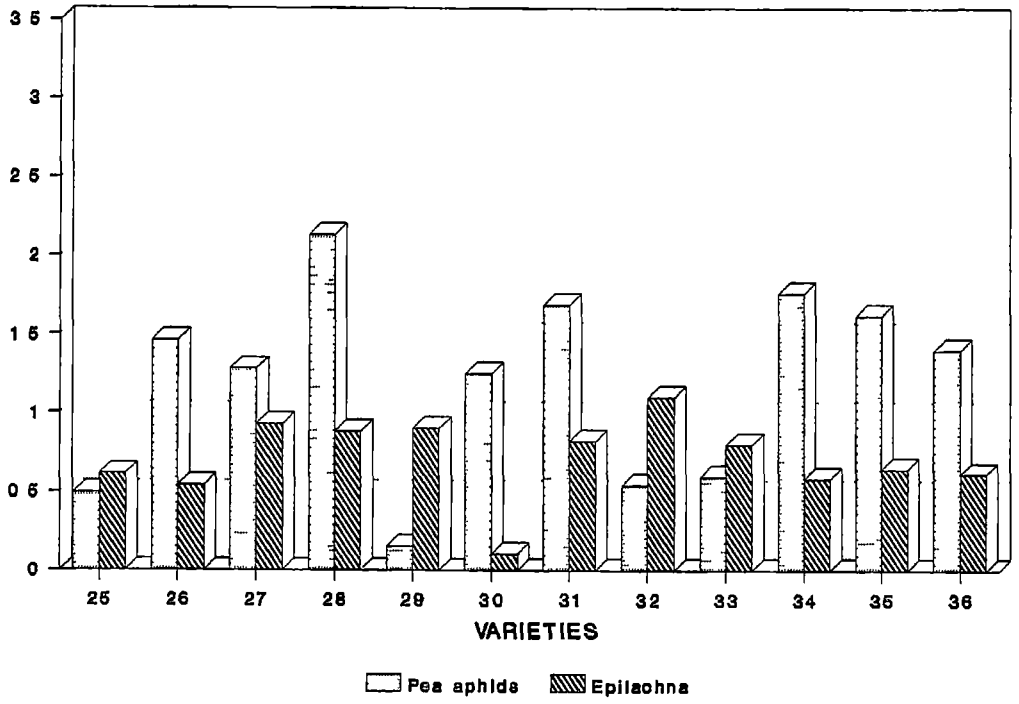
VARIETIES
Pea aphids
Epilachna

Fig 3 Contd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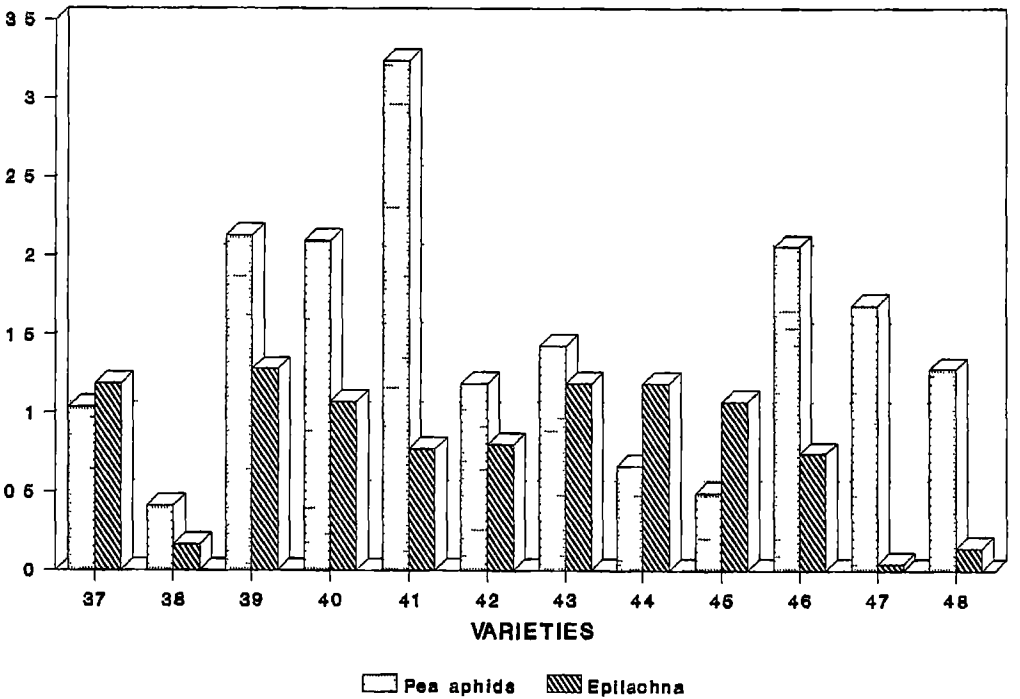
VARIETIES
Pea aphids
Epilachna

Fig 3 Contd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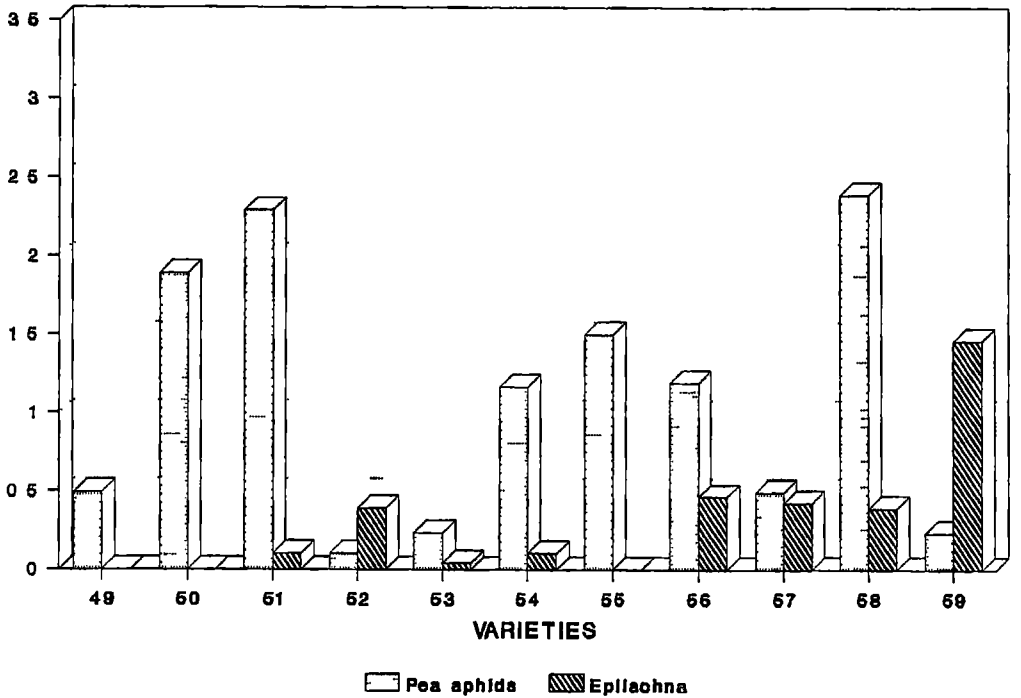
VARIETIES
Pea aphids
Epilachna

Fig 3 Contd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VARIETIES
Pea aphids
Epilachna

Fig 3 Contd

symptom only 42 days after inoculation This difference in the development of CAMV symptom among varieties may be due to variation in virus concentration required for the build up of symptoms which is highly influenced by environment especially under field conditions In this connection it may be remembered that there is very little correlation between CAMV incidence and aphid population as seen in the correlation studies (Table 4 16) At the same time pea aphid infestation is highly influenced by the host genotype as seen from the variability studies This inferences indicate the independence of virus build up and aphid population in cowpea This may be due to the differences in the mechanism of resistance for virus and aphids in cowpea Atiri and Thottappilly (1985) have also similarly reported that aphid activity such as wide dispersal was more important in the spread of CAMV than the absolute number of viruliferous insects on the plant under field condition

Variability

A programme of breeding aimed at the improvement of characters related to yield and disease resistance require adequate information on the extent of variation available in the population Variance and co-efficient of variation help to measure the variability in a population It is necessary to partition the overall variability into heritable and non heritable components

In the present study phenotypic and genotypic variances were maximum for plant height and minimum for number of branches per plant This finding is in agreement with Lakshmi and Goud (1977)

The differences among the genotypes were highly significant for all the characters studied except for number of hairs per unit area of leaf The estimates of variance components have shown only little difference between phenotypic and genotypic variances for the characters viz number of primary branches per plant length of pod number of seeds per pod hundred seed weight Cercospora leaf spot rust disease pea aphid infestation and Epilachna infestation (Table 4 14) This indicates that variations observed in these characters were mainly due to genetic causes and that environment had only negligible influence over them Hence there is better scope of improvement of these characters through selection This observation is in agreement with Apte et al (1987) who have found that the difference between genetic variance and phenotypic variance were low for number of branches per plant pod length and hundred seed weight in cowpea Veeraswamy (1973) also observed that only little difference existed between phenotypic and genotypic variance for number of branches per plant and number of seeds per pod in cowpea

In the present study plant height at maturity was seen highly influenced by environment since the values for genotypic and phenotypic variances have shown wide difference (Table 4 14) This result agrees with the findings of Apte et al (1987) The CAMV infection was also observed to be highly influenced by the environment

Genetic parameters

Among the fifteen biometric characters studied high values of genotypic coefficient of variation were observed for the intensity of Cercospora leaf spot (72 73) rust disease (70 03) and CAMV infection (68 07) (Fig 4) Comparatively high GCV values were also observed for number of hairs per unit area of leaf (65 05) length of pod (27 72) plant height at maturity (24 80) hundred seed weight (24 12) number of primary branches per plant (23 69) and seed yield per plant (23 06) The high GCV values indicate the high degree of genetic variability in these characters and suggests scope for better selection for these characters in breeding programme Days to flowering days to maturity and number of seeds per pod have recorded low PCV and GCV indicating little scope for improvement of these traits through selection Low GCV estimate for number of seeds per pod was in accordance with the findings by Bapna and Joshi (1973) Lakshmi and Goud (1977) and Dharmalingam

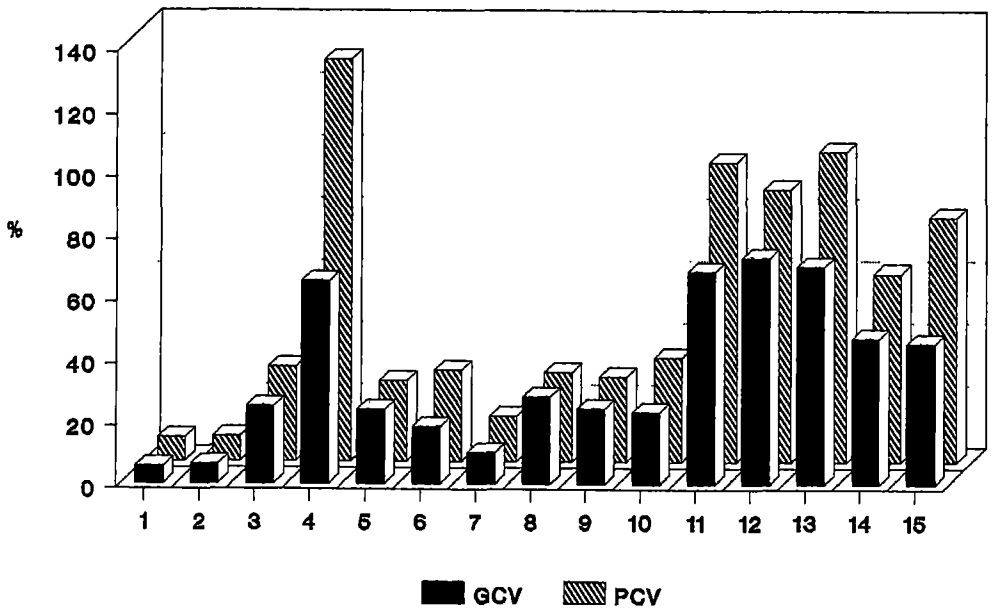

Fig 4 Phenotypic and Genotypic co-efficients of variation for fifteen characters

and Kadambavanasundaram (1984) In green gram also similar findings were reported by Parameswaran and Rajasekharan (1980)

Among fifteen biometric characters analysed for PCV and GCV the number of hairs per unit leaf area exhibited maximum difference revealing the predominantly environmental influence affecting this character (Fig 4) The minimum difference was recorded by pod length showing stability of this trait This is in agreement with the findings of Dharmalingam and Kadambavanasundaram (1984) Heritability values ranged from 18 23 to 95 51 percent High heritability values were observed for length of pod (95 51 percent) number of primary branches per plant (83 30 percent) and hundred seed weight (78 23 percent) Burton (1952) has suggested that GCV together with heritability estimate would give the best picture of the extent of advance to be expected of a selection In the present study length of pod number of primary branches per plant and hundred seed weight recorded high heritability and high GCV values indicating that they are less influenced by environment and are amenable to selection Similar reports were made by Singh and Mehndiratta (1969) Sreekumar et al (1979) and Savithriamma (1992) for hundred seed weight and Veeraswamy et al (1973) for length of pod Moderate value of heritability were recorded for days to maturity plant height at maturity

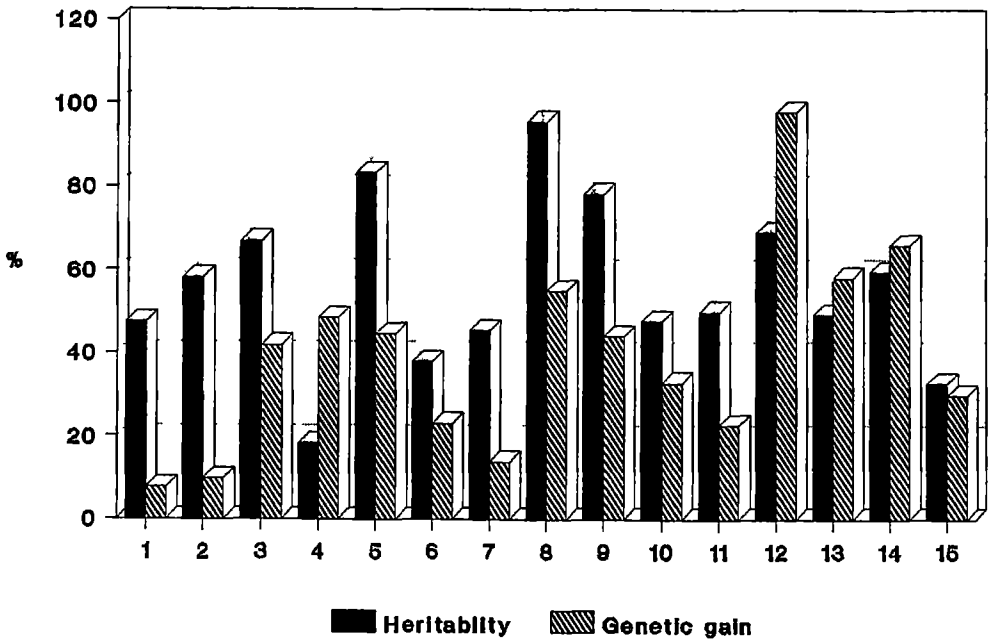

Fig 5 Heritability and genetic gain for fifteen characters

number of seeds per pod length of pod and seed yield per plant This result agrees with the findings of Apte et al (1987) except for seed yield per plant Veeraswamy et al (1973) have also recorded moderate heritability values for the characters height of plant number of branches number of pods per plant number of seeds per pod and seed yield Sreekumar et al (1979) observed moderate heritability values for days to flowering days to maturity and number of seeds per pod In the present study moderate heritability values were also observed for CAMV incidence Cercospora leaf spots rust disease symptoms and epilachna infestation This indicates the effectiveness of selection on these characters for improvement of the crop for major pest and disease resistance The diverged PCV and GCV together with the very low heritability values for this character indicate its ephemeral nature in the context of selection for resistance to pests and diseases in cowpea Genetic advance on percentage mean ranged from 7 59 to 97 88 percent The highest GA was observed for Cercospora leaf spot infection (97 88 percent) followed by pea aphid infestation (65 87 percent) rust disease incidence (58 06 percent) and length of pod (54 92 percent) Genetic advance was observed to be minimum for days to first flowering (7 59) (Fig 5)

In the present study low heritability value was observed for number of hairs per unit leaf area

Genetic advances

It has been suggested by Johnson et al (1955) that heritability together with genetic advance will bring out the advance expected from the selected plants In the present study high heritability together with high genetic advance was observed for length of pod number of primary branches per plant and hundred seed weight A high value for both heritability and genetic advance suggests that the character is governed by additive genes (Panse 1957) Similar observations for hundred seed weight and plant height at maturity were reported by Sreekumar et al (1979) Apte et al (1987) Thyagarajan (1989) and Savithriamma (1992) According to Ramachandran et al (1980) the genetic advance expressed as percentage of mean was found to be maximum for seeds per pod But in the present study this value was found to be very low for seeds per pod (13 68 percent) This may be due to the fact that the field experiment of the present study was mainly laid out for the screening of plants against CAMV and hence kept devoid of any plant protection measure Such stress conditions might have influenced the pod length adversely and variably

Correlation Studies

Inorder to obtain the association of traits genotypic correlation co-efficients were worked out between

pairs of fifteen characters The results are presented in Table 4 16

In the present study length of pod hundred seed weight and number of seeds per pod were found to be the most important yield contributing characters Senanayaka and Wijerantane (1988) Sharma et al (1988) in cowpea and Raut et al (1990) in black gram have reported positive and significant association of yield with these characters

Once identified the source of resistance breeding for disease resistance requires information on the association of resistance with other economic characters The progress in breeding may be hampered if there is undesirable relationships among economically important traits in relation

In the present study the CAMV infection was seen negatively and significantly correlated with seed yield per plant and number of hairs per unit area of leaf Pea aphid infestation was also observed to be negatively correlated with seed yield but the correlation coefficient was insignificant The negative correlation between disease/pest incidence and seed yield is quite expected and was reported by many authors like Renie Alex (1988) and Mendoza et al (1987)

Guna Singhe et al (1988) in soyabean found less pubescent and glaborus isolines of non persistently transmitted viruses elicited greater probing activity than did densely pubescent isolines Field spread of soyabean mosaic virus was negatively correlated with density of pubescence Sorrenson et al (1985) reported in alfalfa that aphid resistant lines were least preferred for colonization by the insects and the growing tips of resistant lines were highly pubescent Such mechanism of resistance through glandular hairs which produce exudates which trap insects and reduce the damage by pests are reported by many authors (Mc Kinney 1938 Gentile et al 1968)

Genetic Divergence

All the 59 varieties were grouped into eight clusters (Table 4 17) Among 59 varieties 25 varieties have fallen under cluster I fifteen varieties under cluster II nine varieties under cluster III four varieties under cluster IV two varieties under cluster V and VI and one variety each under cluster VII and VIII

The intracluster and intercluster average D^2 values (Table 4 18) showed that the intracluster distance was lesser than the intercluster distance suggesting that the cluster were homogeneous within themselves and heterogeneous among

SUMMARY

themselves The intracluster average value of D^2 was maximum in cluster VI (804 54) and minimum in cluster III (417 82) The maximum divergence was observed between cluster V and VII (D^2 value - 20797 24) The minimum divergence was observed between cluster II and cluster V (D^2 value - 794 14) As the genetic distance between the two selected parents increase the chance of getting better combinations are enhanced (Allard 1960) So the parents chosen from cluster V and VII are likely to produce better recombinants with wider adaptability

SUMMARY

A field experiment with fifty-nine cowpea varieties (Vigna unguiculata (L) Walp) in 59 x 2 RBD was undertaken in the Department of Plant Breeding and Genetics College of Agriculture Vellayani during the Kharif of 1992 The main objective of the experiment was to screen the varieties for resistance to cowpea aphid borne mosaic virus (CAMV) through mechanical inoculation method The primary leaves were inoculated with CAMV isolate extracted from the young leaves of the infected plants with 0 05 M phosphate buffer of pH 7 0 using 600 mesh carborundum as an abrasive Apart from CAMV the incidence of Cercospora rust disease pea aphid and Epilachna beetle were also noted For conducting genetic analyses observations on ten bio metric characters viz days to first flowering days to maturity plant height at maturity number of hairs per unit leaf area number of branches per plant number of pods per plant number of seeds per pod length of pod hundred seed weight and seed yield per plant were also taken The various findings from the study are summarised below

Among the fifty nine varieties screened for resistance to CAMV only two varieties namely V 317 and V-276 have shown complete resistance with zero infection while C-152 recorded the highest percentage of infection followed by

Varkala local The incidence of CAMV was significant among varieties at different periods of observation There were sixteen varieties which showed an infection percentage below five to be mentioned as highly tolerant and seven with infection percentage above five and below ten to be mentioned as tolerant

Analysis of variances for fourteen characters namely days to first flowering days to maturity plant height at maturity number of primary branches per plant number of pods per plant number of seeds per pod length of pod hundred seed weight seed yield per plant CAMV incidence Cercospora leaf spot infection rust disease infection pea aphid and epilachna beetle infestation have shown significant differences among the varieties The one character which was insignificant among the varieties was the number of hairs per unit area of leaf

High values of GCV and PCV were observed for the intensity of Cercospora leaf spot rust disease CAMV and number of hairs per unit area of leaf The three characters which have recorded low PCV and GCV indicating little scope for improvement through selection were days to first flowering days to maturity and number of seeds per pod

High heritability estimates were recorded for length of pod number of primary branches per plant and

hundred seed weight revealing the lesser influence of environment on the expression of these characters

Genetic advance as percentage mean was higher for Cercospora leaf spot infection Pea aphid infestation rust disease infection length of pod number of hairs per unit leaf area number of primary branches per plant and hundred seed weight When heritability and genetic advance were together considered Cercospora leaf spot infection and length of pod were found superior to other characters

With reference to the reaction to major pests and diseases other than CAMV KAU cul 7 S-448 Kanakamony and Sasthamkotta local have recorded zero infection for Cercospora leaf spot and were grouped as highly resistant Rust disease infection was found to be high for the variety V-16 Six varieties were observed to be highly resistant to this disease Pea aphid infestation was found to be maximum in Vettikkel and minimum in CoVu 869 followed by CoVu 4 None of the varieties recorded zero infestation for this pest Zero infestation was recorded for Epilachna beetle in varieties CoVu 771 Kottayam local Sel 32 C-152 and Sel 38

Correlation studies have revealed that the seed yield per plant has shown a positive significant correlation with number of seeds per pod length of pod and hundred seed weight But CAMV infection recorded a negative correlation

with seed yield per plant

Based on genetic divergence studies 59 varieties were grouped into eight clusters The intra cluster average value was found to be less than inter cluster distance indicating homogeneity within the clusters The maximum divergence was observed between cluster V and VII indicating their better utility as parent source for a recombination breeding programme

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SCREENING OF COWPEA (*Vigna unguiculata* (L.) Walp.) TYPES FOR RESISTANCE TO COWPEA APHID BORNE MOSAIC DISEASE

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ABSTRACT OF A THESIS
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ABSTRACT

The screening of fifty nine cowpea varieties through sap inoculations for CAMV resistance under field conditions has shown two varieties namely V-317 and V 276 as highly resistant Other sixteen varieties were found highly tolerant seven tolerant and the remaining thirty four susceptible

Analysis of variance revealed significant differences among varieties for days to first flowering days to maturity plant height at maturity number of primary branches per plant number of pods per plant number of seeds per pod length of pod hundred seed weight seed yield per plant CAMV disease incidence Cercospora leaf spot infection rust disease infection Pea aphid infestation Epilachna beetle infestation Analysis of variance for number of hairs per unit area of leaf has no significant difference among varieties

High values of GCV PCV heritability and genetic advance were observed for length of pod number of primary branches per plant and hundred seed weight suggesting the reliability of these characters during selection programme for their improvement

Observations on the reactions to major pests and diseases other than CAMV have shown four varieties as highly resistant to Cercospora leaf spot six varieties to rust disease infection five varieties to Epilachna beetle infestation and none to pea aphid infestation

Correlation analysis has revealed positive significant correlation of seed yield per plant with number of seeds per pod length of pod and hundred seed weight

Genetic divergence using Mahalanobis s D^2 technique was studied on 59 cowpea varieties Based on this they were grouped in eight clusters Intra cluster distance was less than inter cluster distance The maximum divergence was observed between cluster V and VII