YIELD AND ITS COMPONENTS IN GROUNDNUT (*Arachis hypogaea* L.) UNDER PARTIAL SHADE IN COCONUT GARDEN

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DECLARATION

I hereby declare that this thesis entitled "Yield and its components in groundnut (Arachis hypogaea L.) under partial shade in coconut garden" is a bonafide record of research work done by me 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 "Yield and its components in groundnut (*Arachis hypogaea* L.) under partial shade in coconut garden" is a record of research work done independently by Smt. RAJASREE, M.R, 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

Oil seeds constitute an important and ancient component of Indian agricultural system. Groundnut (*Arachis hypogaea* L.) is considered as the "King" of oil seeds constituting 60 per cent of the oil seed production in this country. It is interesting to note that this important oil seed crop is not a native of India, but was introduced hardly a few centuries back. Though India ranks first in the production and acreage of groundnut, its productivity is still very low (Reddy, 1982).

In Kerala, groundnut is cultivated in an area of 11,010 ha with a mean yield of 545 kg/ha (1985-86 report of the Directorate of Economics and Statistics, Kerala). As in most part of India this crop is grown in Kerala mainly under rainfed and low input conditions. Further increase in area and production of this crop in Kerala is possible only through the extension of cultivated area in different agroclimatic zones and by the use of improved seeds.

The major limitation in extending groundnut cultivation in Kerala is the non availability of fresh land for this purpose. Under upland conditions the only land available for this crop is the partial shade of coconut plantations and interspaces of tapioca gardens.

Genetic analysis in groundnut has been attempted previously by many workers in Kerala and elsewhere under open field conditions to suit the major commercial environment available for this crop.

Varietal evaluation programmes to identify suitable types for the intercropping system under partially shaded conditions in coconut gardens have not yet been taken up seriously. In Kerala, coconut palms occupy an area of about seven lakhs hectares. If suitable groundnut types with good yield potential under partially shaded conditions are identified, the area under this crop can be extended considerably. Moreover groundnut being a leguminous crop, it fixes atmospheric nitrogen and thereby increases soil fertility.

The present work was undertaken with the prime objective of identifying superior groundnut genotypes for yield and adaptability under upland partially shaded conditions of coconut gardens in Kerala by genetic evaluation of thirtyone bunch types of groundnut.

The other objectives of the present study are as follows:-

1. To find out the extent of variability present in the population by estimating the parameters like genotypic coefficient of variation, heritability, genetic advance and genetic gain.

2. To find out the association of different characters with yield and also among themselves.

3. To formulate a model based on above studies for selecting groundnut genotypes for yield and adaptability under partially shaded conditions in coconut gardens.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Variability, heritability, genetic advance, correlation and responses are some of the main parameters which help the selection of superior genotypes from genetically diverse population. A brief review of the work done on these aspects in relation to yield and its components in groundnut relevant to the present study are summarised below:

1. Variability

Plant breeding in the true sense relates to the efficient management and utilization of variability. To improve a complex character like yield, information on the nature and magnitude of its variation and the extent of environmental influence on it are necessary.

A sizable part of the phenotypic variation is caused by the environmental influences. The phenotypic variability is the result of variability in the genetic constitution of individuals in a population. Swaminathan (1969) has stated that variability for any character occurring in a population is conditioned to a great extent by the selection sieves, natural and human, through which the population has passed during its phylogenetic history.

Genetic variability in a crop forms the primary prerequisite for achieving genetic improvement. The genetic or heritable portion of the phenotypic variability can be assessed by the genetic parameters such as genotypic coefficient of variation, heritability and genetic advance. The most important genetic parameter which provides an efficient estimation of variability is the coefficient of variation.

Many workers studied the extent of variability on groundnut by working out genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV). But the extent of genetic variability is more important than total variation. Greater the genetic diversity wider would be scope for selection. Their findings are briefly reviewed below:

Venkateswaran (1966) reported considerable variation in the height of the main axis, total leaf area per plant and yield in the bunch type groundnut. Chandramohan et al. (1967) noticed profound variation in weight of haulm and yield. Badwal et al. (1967) reported high genetic variability for 100 kernel weight.

Fiftyone erect types of groundnut were studied by Jaswal and Gupta (1966) to evolve selection criteria. They observed high variability in pod weight and yield. While studying variation in some quantitative characters of nine strains of groundnut evolved at Raichur, Kulkarni and Albuquerque (1967) reported that the height of main axis showed least variability.

During their study Basu and Ashokaraj (1969) found high genotypic coefficient of variation for number of days to flower and haulm weight per plant. A comparatively high genotypic coefficient of variation was recorded by Majumdar _et al_. (1969) for number of leaves. They also observed a wide range of phenotypic variation in period of flowering, 100 pod weight, shelling percentage and yield.

In the spreading type Sangha and Sandhu (1970) noticed high genotypic coefficient of variation for kernel weight, number of pods and yield of pods. Dixit _et al_.(1970) reported that in bunch type the maximum range of variation was in 100 pod weight followed by fodder weight per plant.

After analysing variability present in a collection of bunch and spreading varieties of groundnut under three different environments, Dixit *et al.* (1971) reported a high genotypic variance for height of main axis.

In a study with thirty spreading varieties of groundnut for estimating genetic variability, Khangura and Sandhu (1973) found that the genotypic coefficient of variation was high for pod yield and pod number and was moderate for 100 kernel weight. But it was found to be low for shelling percentage. They also found that the estimate of genotypic coefficient of variation was moderate for pod yield and 100 kernel weight.

Kushwaha and Tawar (1973) while analysing various characters, reported a moderate to high genotypic coefficient of variation for height of main axis and dry weight of fodder. Hundred pod weight and shelling percentage had only low genotypic coefficient of variation.

Mohammed *et al.* (1973) recorded high coefficient of variation for kernel weight and shelling percentage in semispreading and spreading types respectively. In the spreading groundnut varieties Sangha (1973) obtained highest estimate of genotypic and phenotypic coefficient of variation for 100 kernel weight and number of pods per plant. In a study of variability pattern and formulation of selection index for yield, Shettar (1974) found high genetic variability for number of pods.

Patra (1975) reported that the maximum extent of variability was in the height of main axis followed by yield per plant. Phenotypic and genotypic variances were high for the height of main axis. Higher genotypic coefficient of variation was observed for yield per plant. Sivasubramaniam et al. (1977) noticed a high value for genotypic coefficient of variation for height of main stem and number of pods per plant. This showed that these characters can be relied upon for selection.

After an elaborate study of variability in 100 kernel weight and shelling percentage in 234 bunch, 170 semi-spreading and 268 spreading varieties of groundnut, Natarajan et al.(1978) concluded that variation in kernel weight was generally higher in spreading and semi-spreading varieties while variation in shelling percentage was the highest in spreading varieties.

While estimating variability in bunch group of groundnut in relation to the possible genetic gain for the improvement of pod yield and yield attributing characters, Kumar and Yadava (1979) observed high variation for kernel weight and shelling percentage. Phenotypic variance was high for these two characters. Phenotypic and genotypic variances were found to be low for pod yield.

Raja Reddy and Prabhakara Reddy (1979) observed high genotypic and phenotypic coefficients of variation for pod yield. High variability in harvest index was noted by Natarajaratnam (1979). It ranged from 20 to 47 per cent in bunch, 3 to 31 per cent in semi-spreading and 10 to 22 per cent in spreading varieties.

Ramanathan (1980) in his investigation in a population of interspecific hybrids reported that genetic variance for days to flowering has been largely additive. In their studies in the F1 and F2 of six bunch varieties crossed each other Sridharan and Marappan (1980) analysed height of main stem, leaf area, 100 kernel weight, number of pods per plant and yield of pods per plant. They found that the genotypic coefficient of variation was generally high for pod yield.

Venkateswaran (1980) examined variability in a number of lines/varieties belonging to the three habit groups viz., spreading, semi-spreading and bunch. He found that the yield of kernels being more steady and reliable than yield of pods. He also found that the pattern of variability in the different characters varied among the three habit groups and among the different varieties of one and the same habit group.

It is reported by Venkateswaran et al. (1980) that considerable differences in harvest index exist between different varieties. The strain Co-1 has high harvest index of 50.1 per cent whereas Gangapuri has the low harvest index of 35.2 per cent. They have noted that shelling out turn is a highly variable genetic character influenced considerably by environmental factors.

In an analysis of yield components for making selection index, Kuriakose (1981) recorded significant differences in respect of all the fifteen characters studied. He reported that the genotypic coefficient of variation was high for 100 pod weight and 100 kernel weight whereas it was low for shelling percentage. Pod yield showed moderate value for genotypic coefficient of variation but gave higher values for environmental and phenotypic coefficient of variation. In the case of genotypic variance too 100 pod weight recorded high value. The genotypic variance was low for pod yield and shelling percentage. At the phenotypic level the variance was high for 100 pod weight and number of leaves. It was low for shelling percentage.

Nagabhushanam et al. (1982) reported that the genotypic coefficient of variation was high for plant height, pod yield, harvest index and 100 kernel weight whereas it was low for shelling percentage.

After evaluating the genetic variability among 24 bunch type of groundnut, Quadri and Khunti (1982) reported that the genotypic coefficient of variation was high for harvest index, pod yield, dry fodder weight and 100 kernel weight and was found to be low for shelling percentage and days to flowering.

Pushkaran (1983) reported that the genotypic coefficient of variation was the highest for haulm yield. It was relatively high for duration upto flowering. The phenotypic coefficient of variation was found to be low for duration upto flowering and was relatively high for pod yield. The environmental coefficient of variation was found to be low for shelling percentage and relatively high for pod yield.

After analysing genetic variability and yield components in 17 strains belonging to bunch type of groundnut, Kataria et al. (1984) reported that pod yield per plant exhibited maximum range of variability followed by 100 kernel weight and shelling percentage. Phenotypic and genotypic variations were sufficiently high for 100 kernel weight, shelling percentage and pod yield per plant. The highest genotypic coefficient of variation was observed for pod yield per plant. This was followed by 100 kernel weight and shelling percentage.

Reddy et al.(1984) reported that plant type in terms of height and spread accounted for 26 per cent of the total variation in yield.

In a study of estimating the variability in 20 strains each of bunch and spreading types of groundnut grown on rainfed lands, Chauhan and Sukla (1985) found that the phenotypic variability was high for 100 kernel weight and harvest index and was low for shelling percentage and number of pods per plant. The genotypic variance was more or less equal to phenotypic variance for pod yield and 100 kernel weight indicating the possibility of getting response to selection in these characters based on phenotypic expression itself.

Genetic variability and genotype - environment interaction in groundnut were studied by Kandaswami *et al.* (1986). They reported that the phenotypic variability ranged from 1.5 for shelling percentage to 42.9 for plant height and the corresponding values for genotypic coefficient of variation were 10 and 41.4 respectively. Characters like plant height, pod yield, harvest index and 100 kernel weight showed high coefficient of variation whereas shelling percentage and 100 pod weight showed less coefficient of variation.

Phenotypic and genotypic variabilities were studied in 6 parents and 15 F_2s by Patil and Bhapkar (1987). They noticed that the maximum extent of variability was for flowering span and 100 kernel weight. The phenotypic and genotypic variances were highest for flowering span, height of main axis and 100 kernel weight. The phenotypic coefficient of variation was maximum for height of main stem and flowering span. Almost similar trend was observed for genotypic coefficient of variation.

Naidu et al.(1987) reported that phenotypic and genotypic coefficientsof variations were high both in parents and backcross derived progenies for the characters like plant height and pod yield. Shelling percentage recorded low genotypic and phenotypic coefficientsof variation in both parents and back cross derived progenies of groundnut.

2. Heritability and genetic advance

The extent to which the variability of a quantitative character is transferable to the progeny is referred to as heritability for that particular character. It provides a measure of the value of selection for different traits in various genotypes. The total variance of a character consists of a heritable portion, an environmental portion and a portion due to genotype-environment interaction. The heritable portion in turn includes the additive genetic variance which is fixable and the dominance and epistatic variance which are non fixable. The term heritability was first introduced by Fisher(1918) and defined it as the ratio of fixable (additive genetic) variance to the total genetic variance. Robinson et al. (1949) defined heritability as the "additive genetic variance in per cent of the total variance". Heritability was defined both in the broad and narrow sense by Lush(1940).

Heritability in the broad sense estimates the percentage of total genotypic variance over phenotypic variance whereas in the narrow sense, it is the ratio of additive genetic variance to total variance and it takes into account only average effects of genes transmitted from parents to offspring.

The estimate of heritability is useful to the breeder for exercising selection based on the genotypic worth of a trait. Heritability estimate along with genetic gain is more useful in predicting the resultant effect through selection of the best individual (Johnson _et al._, 1955).

In groundnut heritability and genetic advance for most of the characters have been studied by many workers. Some of their findings are briefly reviewed below:

Bernard (1960) recorded that shelling percentage has high heritability than seed yield per plant.

High heritability estimates for height of main shoot (73.7 per cent) and total number of pods per plant (67.8 per cent) were noted by Kulkarni and Albuquerque(1967).

In the analysis of variability, Basu and Ashokaraj (1969) observed high heritability for days to flower, pods per plant and 100 pod weight but moderate heritability for shelling percentage and haulm weight per plant. However, only low heritability was obtained for pod yield. Haulm weight per plant showed moderate heritability with high genetic advance.

Majumdar _et al._(1969) reported high heritability estimates for days to first flowering (96.96 per cent) period of flowering (96.79 per cent) number of leaves (95.59 per cent) and 100 pod weight (95.27 per cent). Moderate heritability was recorded for shelling percentage (81 per cent) while pod yield showed low value (49.69 per cent). High heritability together with high genetic advance (76.19 per cent) was showed by number of leaves. This suggest that this character is controlled by additive gene action.

Dixit _et al._(1970) observed that fodder weight per plant had the highest heritability estimate (96.8 per cent). Heritability for 100 kernel weight was found to be 88.8 per cent while moderate heritability was shown by height of main axis (71.9 per cent) and shelling percentage (72 per cent). He also reported that 100 kernel weight gave high heritability value with high genetic advance (32.34 per cent). Character like fodder weight per plant had comparatively low genetic advance (9.83 per cent), thus, limiting scope for further improvement.

Raman and Sreerangaswamy (1970) reported high heritability and genetic advance for pod yield.

In the bunch group, Sangha and Sandhu (1970) obtained high values for genetic advance for the character pod number. Same trend was maintained by pod number and pod yield in spreading group.

While studying the variability present in a collection of bunch and spreading varieties of groundnut under three different environment, Dixit et al. (1971) noticed high genetic advance expressed as percentage of mean combined with high heritability for the height of main axis (31.46 and 70 per cent respectively). They suggested that improvement by individual plant selection for height of main axis would be most effective.

Kushwaha and Tawar (1973) found high heritability for 100 pod weight, 100 kernel weight and shelling percentage. Pod yield and dry weight of fodder per plant recorded medium heritability values. Height of main axis showed low heritability. They also found very high genetic advance for yield of pods per plant and 100 kernel weight.

A high heritability estimate of 81.97 per cent was noticed for the character 100 kernel weight by Khangura and Sandhu (1973) while analysing thirty spreading varieties of groundnut. They also reported that the heritability estimate was relatively low for pod yield (30.24 per cent) and shelling percentage (27.92 per cent). Genetic advance was also high for 100 kernel weight (33.17). It was found to be moderate for pod yield (23.13) and low for shelling percentage (7.44 per cent).

Sangha (1973) recorded high heritability and genetic advance for number of pods per plant and 100 kernel weight and a medium heritability estimate for pod yield per plant.

While formulating selection index for yield, Shettar (1974) noticed moderate heritability for pod yield.

After estimating heritability and genetic advance in groundnut in the F8 generation, Patra (1975) reported that the highest heritability estimate was obtained for yield per plant. Heritability for height of main axis was more or less equal but was low for shelling percentage. Genetic advance was high for yield per plant and low for shelling percentage. Sangha and Sandhu (1975) noticed high genetic gain for height of main stem, flowering span, 100 kernel weight and pod yield.

In a study of genetic variability, heritability and genetic advance in the F3 progenies of two groundnut crosses for resistance to tikka leaf spot and characters like pod yield and 100 kernel weight, Sandhu and Khehra (1977) noticed that the heritability estimates were high for tikka leaf spot (82 per cent and 77 per cent in the first and second cross respectively) and 100 kernel weight (83 per cent and 57 per cent) and was low for pod yield (28 per cent and 41 per cent). Genetic advance was also found to be high for tikka leaf spot (60.13 and 53.41 per cent) but was low for pod yield (10.55 and 9.01 per cent) and 100 kernel weight (5.24 and 3.70 per cent).

Sivasubramaniam <u>et al</u>.(1977) noticed high estimates of heritability and genetic advance for height of main stem (48 per cent and 22.42 per cent respectively). A low heritability (7 per cent) combined with low genetic advance (6.22 per cent) was recorded by pod yield.

While studying the inheritance of yield components in groundnut, Cahaner (1978) reported high heritability for pod weight.

As a result of their investigation on several semi-spreading varieties of groundnut, Dorairaj et al. (1979) observed high heritability combined with high genetic advance for yield of pods, 100 pod weight and 100 kernel weight. Height of main stem had high heritability with moderate genetic advance.

Kumar and Yadava (1979) studied variability, heritability and genetic advance in 18 elite strains of bunch group of groundnut and reported a high heritability estimate for 100 kernel weight (22.63 per cent), low heritability estimates for pod yield (14.29 per cent) and shelling percentage (11.10 per cent). The expected genetic advance was high for pod yield (6.96 per cent) and 100 kernel weight (6.57 per cent) and low for shelling percentage (1.23 per cent).

Raja Reddy and Prabhakara Reddy (1979) noticed low heritability values for yield (6.64 per cent). The expected genetic advance was high for yield (23.4 per cent). While studying variability, heritability and genetic advance for yield and three yield related characters in fourty bunch types of groundnut, Rao (1979) observed a high heritability for 100 kerenel weight (64 per cent).

Labana et al.(1980) observed a high heritability, estimate of about 74 per cent for 100 kernel weight and low estimate of about 20 per cent for pod yield.

In an interspecific hybrid Ramanathan (1980) reported high estimate of heritability for days to flower and relatively low estimate for number of pods and weight of pods per plant.

After analysing 220 bunch varieties, Rao (1980) reported moderate heritability for pod yield (57 per cent) and shelling percentage (49.5 per cent). But it was reported to be low for 100 seed weight (28 per cent) and plant height (14 per cent).

While studying F1 and F2 of 6 varietal crosses, Sridharan and Marappan (1980) found highest heritability values for height of main stem and yield of pods per plant in TMV-9 x dwarf mutant. In general, values for genetic advance were fairly high for pod yield. The cross TMV-9 x dwarf mutant for plant height and Pol-2 x dwarf mutant for pod yield recorded high genetic advance. It could be suggested therefore that for effective improvement of these traits intensive selection should be practiced in these respective crosses.

In a study with 26 bunch varieties, Kuriakose (1981) obtained low values of heritability and genetic advance for dry weight of haulms, pod yield and height of main axis. Shelling percentage presented high heritability and low genetic advance.

After analysing 50 newly evolved bunch type of groundnut, Harisingh et al. (1982) reported that the broad sense heritability was high for 100 kernel weight (99.40 per cent) and shelling out turn (88.72 per cent), moderate for biological yield per plant (76.41 per cent) and low for pod yield per plant (63.61 per cent) and harvest index (62.50 per cent).

Quadri and Khunti (1982) noticed high heritability estimates for shelling percentage and days to flowering in bunch type of groundnut.

After analysing 23 characters in 80 varieties of groundnut in upland during kharif, Pushkaran (1983) noticed that the heritability in the broad sense was high for spread of flowering (95.06 per cent), 100 pod weight (92.72 per cent), 100 kernel weight (90.21 per cent) and moderate value of 61.34 per cent. Genetic advance expressed as percentage of mean was relatively high for haulm yield (42.26 per cent), duration upto flowering recorded the lowest value (10.77 per cent). Relatively high value of heritability coupled with high genetic advance was recorded by haulm yield and 100 pod weight. Moderate heritability coupled with moderate genetic advance was obtained for pod yield. High heritability and moderate genetic advance were noted for spread of flowering, plant height and 100 kernel weight. While high heritability with low genetic advance was seen for shelling percentage and duration upto flowering.

In a study to determine the major yield components among the productive traits of bunch type of groundnut, Kataria et al.(1984) found high heritability estimates for shelling percentage (99.84 per cent), 100 kernel weight (99.76 per cent) and pod yield per plant (99.71 per cent). The expected genetic advance was found to be high for pod yield per plant (71.32 per cent), 100 kernel weight (34.54 per cent) and shelling percentage (22.46 per cent).

In 20 strains each of bunch and spreading type of groundnut, Chauhan and Sukla (1985) reported high heritability values for 100 kernel weight (97.88 per cent), number of pods per plant (90.88 per cent) and pod yield per plant (83.83 per cent). Heritability was found to be moderate for shelling percentage (69.94 per cent) and harvest index (61.98 per cent). Genetic advance expressed as percentage of mean was found to be moderate for pod yield (53.25 per cent).

Kandaswamy et al. (1986) recorded high heritability and genetic advance for plant height and moderate heritability estimate ranging from 45 per cent to 62 per cent for shelling percentage, harvest index and pod yield per plant. The low heritability estimates recorded for 100 kernel weight and 100 pod weight indicate that these characters are highly influenced by the environment and might be improved by following pure line selection. Moderate heritability coupled with moderate genetic advance was observed for height of the plant and pod yield. Shelling percentage recorded moderate heritability coupled with low genetic advance whereas 100 kernel weight recorded low heritability coupled with moderate genetic advance.

While estimating genetic variability in six diverse parents belonging to spreading and semispreading types of groundnut, and their F2's, Patil and Bhapkar (1987) reported high heritability for flowering span (99.03 per cent), 100 kernel weight (97.96 per cent), height of main stem (96.89 per cent), shelling percentage (96.24 per cent) and pod yield (92.97 per cent). High genetic advance was found for height of main stem (59.46 per cent), flowering span (49.67 per cent), 100 kernel weight (32.48 per cent) and pod yield (32.06 per cent). It was found to be low for shelling percentage (6.39 per cent).

Naidu _et al_.(1987) reported high heritability and low genetic advance over mean for 100 kernel weight and shelling percentage both in parents and back cross derived progenies of groundnut.

3. Correlation studies

The economic nature of a crop is primarily judged from its yield which in turn is depend upon a number of characters. These characters are quantitative and are often controlled by a large number of genes which individually do not have pronounced effect and to a large extent influenced by changes in the environment. It has been recognised that the knowledge of the relationship among these characters could provide a crop improvement programme.

Correlation studies provide estimates of the degree of association of a character with its components and also among the components. In a programme of breeding for improving the yield potential of a crop information of the interrelationship of yield with other characters is of immense value. This aspect assumes greater importance in groundnut than in any other crops due to the fact that groundnut pods are formed underneath the ground and unless correlations between yield and the external plant characters are established it may not be possible to effect proper selection of plants prior to harvest.

Correlation studies conducted by various workers in groundnut are reviewed below.

Comstock and Robinson (1952) recorded that plant height and number of pods showed positive significant correlation with yield.

Ling (1954) reported that number of pods per plant has pronounced influence on yield. Mistra (1958) noticed strong association between yield and number of pods.

In his attempt for the formulation of selection index for yield, Dorairaj (1962) found significant positive correlation of weight of pods with number of pods in the spreading variety TMV-1. Significant positive correlation was noticed for weight of pods with pod number and height of main axis in the bunch variety TMV-2.

In 73 spreading types of groundnut, Jaswal and Gupta (1966) noticed that pod yield per plant was positively correlated with number of pods.

Mahapatra (1966) found positive correlation of yield with shoot weight and negative correlation with shoot length.

Chandramohan et al. (1967) reported that among the various characters studied, weight of haulm had high positive correlation with yield.

In their study with 173 varieties of groundnut, Lin and Chen (1967) noticed that number of pods per plant had positive correlation with average weight of pods.

Prasad and Srivastava (1968) concluded that yield of unshelled nuts per plant was positively correlated with number of leaves and 100 kernel weight.

In 30 early erect varieties, Lin et al.(1969) analysed seven component characters and reported that number of pods per plant was negatively correlated in the autumn with length of main stem. They also observed positive correlation between number of pods per plant and yield of pods in autumn. The number of pods per plant was positively correlated with shelling percentage in the spring crop. Raman and Sreerangaswamy (1970) reported high positive genotypic and phenotypic correlation coefficient between yield and shelling percentage in the progenies of the hybrid *Arachis hypogaea* x *Arachis monticola*.

Twelve yield components were studied, in the varieties NA-86, Baladi 100 and Gizza which differed in habit, by Moustafa and Sayed (1971) and reported that in Baladi-100 yield was non significantly correlated with main branch length.

Positive significant correlation of pod yield with number of pods, shelling percentage and 100 kernel weight were found by Dholaria et al.(1972). Significant but negative association was seen between shelling percentage and 100 kernel weight.

Patil (1972) in his studies observed that kernel yield was highly correlated with number of pods per plant and days to flower.

Khangura and Sandhu (1973) found that pod yield was positively and significantly correlated with number of pods per plant and shelling percentage.

While analysing various characters, Kushwaha and Tawar (1973) reported a strong positive correlation of pod yield with haulm weight and negative value with days to flowering. The coefficient of correlation between days to flowering and 100 kernel weight was positive. There was strong positive correlation between plant height and straw weight. Significant negative correlation was exhibited by shelling percentage with 100 kernel weight and 100 pod weight.

Phadnis _et al_.(1973) reported that number of pods per plant and seed weight were the most highly correlated characters with yield.

Positive correlation between pod yield and 100 kernel weight was noticed by Sangha (1973).

Coffelt and Hammons (1974) reported that pod yield was having significant positive association with number of pods and plant height.

It was noted by Shettar (1974) that pod yield was positively correlated with height of main axis and 100 kernel weight. But pod yield was negatively correlated with number of days to flowering and shelling percentage.

A strong positive association between pod yield and shelling percentage was found by Kumar and Yadava (1978) while studying interrelationship between yield and yield components in eighteen bunch strainsof groundnut.

Nair (1978) in his studies with two bunch varieties (TMV-2 and TMV-9) recorded that yield of haulms, number of pods per plant and 100 pod weight were significantly and positively correlated with yield.

Rao (1978/79) after analysing the data from 34 bunch type varieties of groundnut, revealed a strong positive correlation between yield and 100 kernel weight, height and days to flowering.

Dorairaj <u>et al</u>.(1979) reported that height of main axis was positively and significantly correlated with 100 pod weight and 100 kernel weight in semi-spreading varieties.

A positive genotypic correlation of harvest index with pod yield was reported by Nataraja Rathnam (1979). Singh <u>et al</u>.(1979) noticed that pod yield was positively and highly associated with number of pods and 100 kernel weight.

Labana *et al.*(1980) found that pod yield was highly and positively correlated with 100 seed weight. The pod yield had a highly significant positive partial correlation with number of pods and 100 kernel weight when the effect of all other variable was eliminated and the maximum contribution to pod yield was from the number of pods followed by 100 kernel weight.

In a study of the germplasm of 220 bunch varieties, Rao(1980) recorded that number of pods and plant height showed positive significant correlation with yield. This suggested that selection for the above characters will be useful for achieving high yield.

Venkateswaran (1980) examined the character associated in a number of lines/varieties belonging to the three habit groups, viz., spreading, semi-spreading and bunch. In the bunch group, he observed significant and positive correlation of yield with shelling percentage, height of main axis and total number of pods.

Kuriakose (1981) studied 15 characters in 26 bunch varieties and the association of these characters at the genotypic and phenotypic level. Genotypic correlation of yield was positive with duration of flowering, 100 pod weight, 100 kernel height of main axis number of leaves and dry weight of haulm.

While carrying out correlation and path coefficient analysis in 26 genotypes of groundnut, Yadava _et al_.(1981) noticed that pod yield was positively associated with days to first flowering and plant height.

Eighteen genotypes of groundnut were studied for character association of yield with its components by Nagabhushanam _et al_. (1982). They reported that the genotypic correlation of pod yield per plant was positive with 100 kernel weight, shelling percentage and harvest index. From the association analysis it was found that shelling out turn, 100 kernel weight and harvest index are the important determinants of pod yield in groundnut.

Pushkaran (1983) reported that genotypic correlation coefficient of yield was positive and significant with haulm yield and it was significant only at 5 per cent level with 100 pod weight. The genotypic correlation coefficient of pod yield was negative but significant at 5 per cent level with height of main shoot. At the phenotypic level, the coefficient of correlation was found to be positive and highly significant with fresh weight of pods and haulm yield. The relationship of pod yield was negative but non significant with height of main shoot. The genotypic correlation coefficient of duration upto flowering was positive and significant with fresh weight of pods, haulm yield, number of leaves, 100 pod weight and shelling percentage, whereas it was significant and negative with height of main shoot and 100 kernel weight. The genotypic coefficient of correlation of height of main shoot was positive and significant with haulm yield and 100 pod weight. But negative with fresh weight of pods and shelling percentage. At the genotypic and phenotypic levels haulm yield was correlated positively and significantly with 100 pod weight and 100 kernel weight. Hundred pod weight and shelling percentage were significantly but negatively correlated at both the phenotypic and genotypic levels.

Wu (1983) reported a negative correlation between height of main axis and pod yield.

In 17 strains belonging to bunch type of groundnut Kataria et al.(1984) reported that 100 kernel weight was positively correlated with shelling percentage and pod yield per plant. Shelling percentage had positive association with 100 kernel weight and such a correlation response is helpful in effecting simultaneous improvement of these traits and consequently pod yield per plant.

Deshmukh *et al.*(1986) reported that the genotypic correlation coefficient between pod yield per plant on the one hand and 100 pod weight and 100 kernel weight on the other were significant.

MATERIALS AND METHODS

MATERIALS AND METHODS

The present investigation was carried out at the Department of Plant Breeding, College of Agriculture, Vellayani from June 1987 to October 1987, using the following materials and methods.

A. MATERIALS

The genetic materials consisted of thirty bunch varieties of groundnut (*Arachis hypogaea* Linn.) collected from International Crop Research Institute for Semi Arid Tropics (ICRISAT) and one bunch variety from the Department of Plant Breeding, College of Agriculture, Vellayani (Table 1).

B. METHODS

Primary evaluation

The thirtyone genotypes were grown during Kharif (June 1987 to October 1987) under partial shade in coconut garden at the College of Agriculture, Vellayani, in a randomised block design with four replications. In each replication the plants were grown in plots of size 2 x 1.8 m at a spacing of 30 x 20 cm. In order to eliminate the border effect due to the presence of coconuts adjacent to experimental plots, a border row was maintained on each open plot side.

Table 1. Details of groundnut germplasm used for the study

I. From International Crop Research Institute for Semi-Arid Tropics (ICRISAT)

Sl. No.	Access-ion No.	Identity	Botanical	Origin
1.	30	RS 101	Fastigiata	Unknown
2.	221	TMV-2	Vulgaris	India
3.	274	TATU	Fastigiata	Brazil
4.	1346	RS 55	Vulgaris	Unknown
5.	1713	PERU No.3	Fastigiata	Peru
6.	1736	A. 13	Fastigiata	Tanzania
7.	2151	U-2-1-25	Fastigiata	Sudan
8.	2224	FAIZPUR	Vulgaris	India
9.	2738	GANGAPURI	Fastigiata	India
10.	3155	BELLOLI LOCAL	Fastigiata	India
11.	3215	U-2-1-5	Fastigiata	Tanzania
12.	3277	U-2-12-5	Fastigiata	USA
13.	3301	FLORIGIANT	Vulgaris	USA
14.	3400	LOCAL 3	Vulgaris	India
15.	3424	NG 387	Fastigiata	India
16.	3556	26-5-2	Vulgaris	India
17.	4544	AH 687	Vulgaris	Unknown

(contd..)

Table 1. (contd..)

Sl. No.	Accession No.	Identity	Botanical	Origin
18.	4593	GFA SPANISH	Vulgaris	USA
19.	4621	PORTO ALEGRE	Fastigiata	Brazil
20.	4749	PI 337394-F	Vulgaris	Argentina
21.	4888	AH 7827	Vulgaris	China
22.	6997	CHIBASHORYU	Vulgaris	Japan
23.	7633	UF 71513	Fastigiata	USA
24.	7827	JL 24	Vulgaris	India
25.	7918	KASAWAYIRA 110	Vulgaris	Zimbabwe
26.	8348	SAMUTASAKORN 7	Vulgaris	Taiwan
27.	8514	RG 319	Fastigiata	S.Africa
28.	8518	RCM 497	Fastigiata	Paraguay
29.	8671	ACC 804	Vulgaris	Indonesia
30.	3208	EC 20970	Vulgaris	Sudan

II. From Department of Plant Breeding, College of Agriculture, Vellayani.

Sl. No.	Accession No.	Identity	Origin
1	Nil	TG-14	India

Healthy seeds were used for sowing at the rate of two seeds per pit. Sowing was done during the third week of June, 1987. Fertilizer application and other agronomic practices were done according to Package of Practices Recommendations of Kerala Agricultural University (1986) (Anon., 1986).

During vegetative phase (20th day after sowing) five plants were selected at random from each plot and the following observations were made.

1. Leaf area index
2. Leaf number
3. Photosynthetic efficiency

At reproductive phase also five plants were selected at random from each plot for taking the following observations:

1. Leaf area index
2. Photosynthetic efficiency
3. Chlorophyll content of leaves
4. Plant height
5. First date of flowering and flowering duration
6. Fresh pod yield per plant and per plot
7. Dry pod yield per plant and per plot
8. Pod number per plant
9. Fresh haulm yield per plant and per plot

10. Dry haulm yield per plant and per plot
11. Mature to immature pod ratio per plant
12. Hundred kernel weight
13. Hundred pod weight
14. Shelling percentage
15. Harvest index
16. Scoring for Cercospora leafspot disease

Periodical shade intensity was also measured in each plot both at vegetative and reproductive phase. The data from the above observations where recorded as detailed below:

Leaf Area Index (LAI)

Leaf area per plant was calculated in square centimeters by plotting the area of all the leaves of a plant on a graph paper. For calculating leaf area index (LAI) the following formula suggested by William (1946) was employed.

$$\text{LAI} = \frac{\text{Total leaf area of the plant}}{\text{Ground area occupied (spacing)}}$$

Average value of the LAI obtained for five observational plants from each plot in each replication was taken as leaf area index per plant.

Number of leaves per plant

The total number of leaves of five randomly selected plants in each plot was counted on the 20th day after sowing and their average worked out.

Chlorophyll content of leaves

Chlorophyll 'a', 'b' and total pigments were estimated by using spectrophotometric method.

A mature leaf (third leaf from the tip of the plant) of each variety was selected from the four replications and chopped. One gram leaf sample was taken, macerated, filtered and made upto 50 ml using 80 per cent acetone. A sample of the made up solution was used as blank in the Bausch and Lomb spectronic 20 spectrophotometer. The absorbance was measured at three different wave lengths viz., 645 nm, 652 nm and 663 nm for estimating the chlorophyll 'a', 'b' and total pigments. Chlorophyll contents were calculated by the following formula suggested by Arnon (1949).

Chlorophyll 'a' =

$$12.7 \text{ (OD at 663)} - 2.69 \text{ (OD at 645)} \times \frac{V}{1000 \times W} \text{ mg/litre}$$

Chlorophyll 'b' =

$$22.9\ (OD\ at\ 645) - 4.68(OD\ at\ 663) \times \frac{v}{1000 \times w}\ mg/litre$$

Total pigments = $OD\ at\ 652 \times \frac{v}{w}$ mg/litre

v = Volume made up

w = weight of the plant sample taken

OD = Optical Density

Photosynthetic efficiency

Photosynthetic efficiency was estimated by noting the dry matter accumulation at vegetative and reproductive phase. Five plants selected at random from each plot were pulled out without damaging the roots and immediately the fresh weights of the plants were recorded in grams using a balance. The plants collected from each plot were kept inside a hot air oven in labelled paper cover with holes and dried at a temperature of 60°C for 72 hrs and weighed to constant weight and expressed in g per plant.

Height of the plant

The plant height was measured from the ground level to the tip of the main stem. This observation was taken at the time of harvest and the mean height was recorded.

First date of flowering and flowering duration

The number of days from sowing to the appearance of flowers in 50 per cent of the plants in each plot was observed and recorded.

The number of days between the first and last flowering in each variety was taken as the duration of flowering.

Fresh pod yield per plant

The mature and immature pods of the five observational plants selected at random from each plot were separated at harvest, cleaned and fresh weight was recorded. Their mean weight was then taken as fresh pod yield per plant.

Fresh pod yield per plot

This was determined by collecting pods from all plants except border plants from each plot in all replications and weighed them after proper cleaning. Fresh pod yield obtained from observation plants of the respective plot was also added to this to get the fresh pod yield per plot.

Dry pod yield per plant

The mature and immature pods in the five observational plants selected from each plot were collected, cleaned, sun dried and recorded the mean weight.

Dry pod yield per plot

From each plot in all replications, pods were collected from all plants, avoiding the border plants. They were then cleaned, sun dried and weighed. Dry pod yield from observational plants of the respective plot was added to this to get the dry pod yield per plot.

Pod number per plant

The mature pods in the five selected observational plants were separated out at the time of harvest and their mean count was taken.

Fresh haulm yield per plant

Five plants were selected at random from each variety in each replications. Pods were removed from them and their fresh haulm weighed. Their mean weight was taken as the fresh haulm yield per plant.

Fresh haulm yield per plot

The haulm yield per plot was recorded by weighing the fresh haulm obtained from each plot in all replications after avoiding haulm of border plants.

Dry haulm yield per plant

The haulm of the five observational plants selected randomly from each plot in each replication was first sun dried and then oven dried to a constant weight at 80°C. The dry matter content of the haulm was recorded in grams. The mean weight was taken as the dry haulm yield per plant.

Dry haulm yield per plot

The dry haulm yield per plot was obtained from the fresh haulm yield per plot and the ratio of dry haulm yield per plant to fresh haulm yield per plant using the following equation:-

$$\text{Dry haulm yield per plot} = \frac{\text{Dry haulm yield per plant}}{\text{Fresh haulm yield per plant}} \times \text{Fresh haulm yield per plot}$$

Ratio of mature to immature pods per plant

The total number of mature and immature pods of the five observational plants selected at random from each plot in each replication were counted and the ratio of the mature to immature pods of each plant was found out. Average of these ratios was taken as the ratio of mature to immature pods per plant.

Hundred kernel weight

Three samples of hundred kernels each were drawn at random from a sample of dry pods of each variety in each replication and the weight was taken separately. The mean weight of a sample in a replication was taken as hundred kernel weight.

Hundred pod weight

Three samples of hundred dry pods were drawn from each variety in each replication and weighed separately. The mean weight of a sample of a replication was taken as the hundred pod weight.

Shelling percentage

Three samples (each weighing 200 g) of pods of each variety in each replication was taken, shelled and the weight of the kernels for each sample was found out separately. Average percentage of the weight of kernels to the dry pod weight of the sample shelled was taken as the shelling percentage.

Harvest index (H.I)

Harvest index was worked out by dividing the dry weight of pods per plot (Economic yield) with the sum total of the weight of the dry pod yield and dry haulm yield per plot (biological yield) and then multiplied by 100 to get the harvest index. The formula is given below:-

$$\text{H.I.} = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

<u>Scoring for Cercospora leaf spot</u>

The plants were scored using the 'Cercospora leaf spot disease rating' suggested by Mayee and Datar (1986) which is given below:

<u>Scale</u>

0 - No symptoms on leaf.

1 - Few small necrotic spots covering 1 per cent or less of leaf area.

3 - Few small necrotic spots covering 1-5 per cent of the leaf area.

5 - Spots coalasing enlarging 6-20 per cent of the leaf area.

7 - Spots enlarging, coalasing to cover 21-50 per cent of the compound leaf area.

9 - Spots enlarging, coalasing to cover 51 per cent or more leaf area.

<u>Periodical measurement of shade intensity</u>

The periodical light intensity was measured in each plot at 12 noon, 2 pm and 4 pm both at vegetative and reproductive phase.

Lux meter (Photomet 300 x Remco India) was used for measuring the shade intensity. First the intensity of light in the open condition was noted (L_1). From all plots in each replication light intensity was measured from five different spots at three different times and their mean value was taken as the light intensity of that particular plot (L_2)for the particular phase. The shade intensity was then calculated by using the following formula:

$$\text{Shade intensity} = \frac{L_1 - L_2}{L_2} \times 100$$

L_1 = light intensity in open

L_2 = light intensity in shade

C. STATISTICAL ANALYSIS

The data collected for biometric traits were tabulated and mean values were subjected to statistical analysis.

1. <u>Analysis of variance and covariance</u>

Analysis of variance and covariance were done

(1) to test whether there was any significant differences between the varieties, with respect to various traits,

(2) to estimate the variance components and

(3) to estimate the correlation coefficients.

(Singh and Chaudhary, 1979)

The extent of phenotypic variation for any character is the sum of the genetic and environmental effects and can be determined as suggested by Kempthorne (1957), as follows.

$$V(P) = V(G) + V(E) + 2\,Cov(G,E)$$

where $V(P) = \sigma_p^2(x)$ = variance due to phenotype

$V(G) = \sigma_g^2(x)$ = variance due to genotype

$V(E) = \sigma_e^2(x)$ = variance due to environment

$Cov(G,E)$ = Covariance between genotype and environment

If the genotype and environment are independent $Cov(G,E)$ is equal to zero, so that

$$V(P) = V(G) + V(E)$$
$$\sigma_p^2(x) = \sigma_g^2(x) + \sigma_e^2(x)$$

If there are observations on two characters x and y on each individual, the extent of covariance between x and y due to the genotype and environment can be estimated, as suggested by Kempthorne (1957), as follows:

$$Cov(x,y) = Cov(G(x,y)) + Cov(E(x,y))$$

or $\sigma_p(x,y) = \sigma_g(x,y) + \sigma_e(x,y)$

Where

$\sigma_p(x,y)$ = Phenotypic covariance between x and y

$\sigma_g(x,y)$ = Genotypic covariance between x and y

$\sigma_e(x,y)$ = Environmental covariance between x and y

If the experiment is designed in a randomised complete block design with 'V' treatments and 'r' replications, the estimates of $\sigma_p^2(x)$, $\sigma_p^2(y)$, $\sigma_g^2(x)$, $\sigma_g^2(y)$, $\sigma_e^2(x)$, $\sigma_e^2(y)$, $\sigma_p(x,y)$, $\sigma_g(x,y)$ and $\sigma_e(x,y)$ are obtained from the analysis of variance and covariance (Table 2).

2. <u>Coefficient of variation</u>

The coefficient of variation is a unitless measurement and is used for comparing the extent of variation between different characters measured in different scales.

Phenotypic coefficient of variation (PCV):

$$\text{PCV for character x} = \frac{\sigma_p(x)}{\bar{x}} \times 100$$

Genotypic coefficient of variation (GCV):

$$\text{GCV for character x} = \frac{\sigma_g(x)}{\bar{x}} \times 100$$

Where $\sigma_p(x)$ and $\sigma_g(x)$ are the phenotypic and genotypic standard deviations respectively, and $\bar{x}$ is the mean of the character x.

Table 2. Analysis of variance/covariance

Source	df	M.Sxx	Expectation of M.Sxx	M.S.P (x,y)	Expectation of MSP(x,y)	MS (yy)	Expectation of MSyy
Block	(r-1)	B_{xx}		$B_{x,y}$		B_{yy}	
Treatment	(v-1)	V_{xx}	$\sigma_e^2(x) + r\sigma_g^2(x)$	$V_{x,y}$	$\sigma_e(x,y)+r\sigma_g(x,y)$	V_{yy}	$\sigma_e^2(y)+r\sigma_g^2(y)$
Error	(r-1)(v-1)	E_{xx}	$\sigma_e^2(x)$	$E_{x,y}$	$\sigma_e(x,y)$	E_{yy}	$\sigma_e^2(y)$
Total	rv-1	T_{xx}		$T_{x,y}$		T_{yy}	

Hence we have the following estimates

$$\sigma_g^2(x) = \frac{1}{r}(V_{xx} - E_{xx}) \qquad \sigma_e^2(x) = E_{xx}$$

$$\sigma_g^2(y) = \frac{1}{r}(V_{yy} - E_{yy}) \qquad \sigma_e^2(y) = E_{yy}$$

$$\sigma_g(x,y) = \frac{1}{r}(V_{x,y} - E_{x,y}) \qquad \sigma_e(x,y) = E_{x,y}$$

3. Heritability (H^2)

Heritability in the broad sense is the fraction of the total variance which is heritable and was estimated as a percentage following Jain (1982) as -

$$H^2 = \frac{\sigma_g^2}{\sigma_p^2} \times 100$$

Where H^2 = Heritability in the broad sense

σ_g^2 = Genotypic variance

σ_p^2 = Phenotypic variance

Heritability provides a measure of genetic variance ie, the variance upon which all the possibilities of changing the genetic composition of the population through selection depends.

4. Genetic advance under selection (G.A.)

Genetic advance is a measure of the change in the mean phenotypic level of the population produced by the selection and depends upon heritability of the character and selection differential.

$$G.A. = \frac{K\, H^2\, \sigma_p}{\bar{x}}$$

Where $\bar{\bar{x}}$ is the mean of the character x and K is the selection differential which is 2.06 at 5 per cent intensity of selection in large samples (Allard, 1960).

5. <u>Correlations</u>

The phenotypic correlation coefficient between x and y was estimated as :

$$r_p(x,y) = \frac{\sigma_p(x,y)}{\sigma_p(x) \times \sigma_p(y)}$$

Where $\sigma_p(x,y)$ is the phenotypic covariance between x and y

$\sigma_p(x)$ = standard deviation of the character x

$\sigma_p(y)$ = standard deviation of the character y

The genotypic correlation coefficient between x and y was estimated as

$$r_g(x,y) = \frac{\sigma_g(x,y)}{\sigma_g(x) \times \sigma_g(y)}$$

Where $\sigma_g(x,y)$ is the genotypic covariance between x and y

$\sigma_g(x)$ = standard deviation of the character x

$\sigma_g(y)$ = standard deviation of the character y

Critical value of 'r' corresponding to 122 degrees of freedom at 5 per cent level of significance was used for the test of significance for phenotypic correlation coefficient (Fisher and Yates, 1957).

RESULTS

RESULTS

The data collected on the various morphological physiological and chemical attributes were statistically analysed and the results obtained are presented below:-

1. <u>Mean performance of individual traits</u>

The mean performance of each of the thirtyone genotypes for the twentyeight characters under study are furnished in Table 3 and the values of general mean and range in Table 4. The retransformed mean values for shade intensity measured at vegetative and reproductive phase were shown in Table 5 and general mean and range in Table 6. The analysis of variance for twentyeight characters were presented in Table 7.

The thirtyone varieties of groundnut selected for the investigation exhibited significant differences for all the characters studied except for dry matter addition (both on fresh weight and dry weight basis) at vegetative phase, dry pod yield per plant, chlorophyll-a, chlorophyll-b and total pigments.

The analysis of variance for shade intensity observed on the plot at three different times of the day at vegetative and reproductive phase did not show any significant difference in magnitude as seen from Table 8.

The mean values for plant height in the varieties varied from 66.3 cm in ICG 8348 to 100.3 cm in ICG 274. The varieties TG-14, ICG 7918, ICG 1736, ICG 4544, ICG 3277, ICG 3556, ICG 8514, ICG 1346, ICG 3215, ICG 221 were found to be on par with ICG 274 having the maximum height. The mean values of sixteen types were above the general mean (85.25 cm).

Though dry matter addition on fresh weight basis during vegetative phase did not show significant differences among the varieties, the mean value was highest for ICG 8518 (58.63 g) and lowest for ICG 3155 (35.00 g). Fourteen types had mean value above the general mean of 46.54 g. Dry matter addition on dry weight basis during vegetative phase also did not show significant differences among the varieties. However ICG 3208 recorded the highest mean value (10.00 g) and ICG 3155 recorded the least (5.75 g) for this character. Mean values of fourteen types were above the general mean (9.46 g).

The mean values for first date of flowering varied from 24.25 in ICG 3208, ICG 8671, ICG 8348, ICG 6997 to 21.50 in ICG-30. The varieties ICG 221, ICG 2151, ICG 3400, ICG 3424, ICG 3556, ICG 4888 and ICG 7918 were on par with ICG 3208, ICG 8671, ICG 8348 and ICG 6997 having the maximum value for this character. Mean values of sixteen types exceeded the general mean (22.92 days).

The mean values of duration of flowering ranged from 87.75 to 96.25 days. Among the treatments ICG 3208 has recorded the maximum mean value for this trait (96.25). It was lowest in ICG 8518 (87.75). The variety ICG 3277 was on par with ICG 3208 having the highest mean value for this character. ICG 7633, ICG 3556, ICG 8761 and ICG 221 were on par with ICG 3277 having the second highest mean value for this character. Mean values of sixteen types exceeded the general mean (92.43).

In the case of pod yield per plant on fresh weight basis, the mean values ranged from 6.8 g in ICG 8514 to 13.78 g in ICG 4593. The varieties ICG 7633, ICG 274, ICG 3277, ICG 3556, ICG 3301, ICG 1713, ICG 4544, ICG 4749, ICG 2224 and ICG 1736 were on par with ICG 4593. Fourteen types had got the mean values above the general mean (9.82 g).

The varieties did not show significant difference with respect to dry pod yield per plant. However ICG 7633 recorded the highest mean value of 10.33 g and ICG 2738 recorded the lowest (4.8 g). The mean values of fourteen types were above the general mean (7.05 g).

In the case of pod number per plant, the mean values ranged from 16.4 in ICG 4593 to 6.45 in ICG 2738. The mean values of ICG 3556, ICG 7633, ICG 1713, TG-14, ICG 3301, ICG 274 and ICG 3424 were found to be on par with ICG 4593 which was having the maximum value for this character. Mean values of fifteen types exceeded the general mean (10.28).

ICG 4593 recorded the highest mean value for haulm yield per plant on fresh weight basis (124.25 g). It was the lowest for ICG 8671 (57.50 g). ICG 3556, ICG 2224, ICG 1346 and ICG 1713 were statistically on par with ICG 4593 having the maximum value. The mean values of eleven types were above the general mean (83.19 g).

The mean values of haulm yield per plant on dry weight basis varied from 11.63 g in ICG 3215 and ICG 3400 to 24.45 g in TG-14. The mean values of ICG 2224 and ICG 1346 were statistically on par with TG-14 which was having the maximum value. ICG 2224, ICG 3556 and ICG 3277 were statistically on par with ICG 1346 having the second highest mean value (21.45 g) for this character. Eleven types had got mean values above the general mean (16.25 g).

In the case of mature to immature pod ratio, ICG 7633 recorded the highest mean value of 6.83. ICG 1736 has the lowest mean value of 1.72 for this character. ICG 3301 was found to be on par with ICG 7633, ICG 274 and ICG 4749 were on par with ICG 3301 having the second highest mean value for this character. Eleven types had got mean values above the general mean (3.44).

The mean values of hundred pod weight varied from 162.63 g in ICG 274 to 72.00 g in ICG 4593. ICG 2151 was on par with ICG 8514. ICG 3277, ICG 4621 and ICG 3155 were on par with TG-14. The mean values of thirteen types were above the general mean (97.55).

In the case of hundred kernel weight the maximum mean value was recorded by ICG 3215 (50.00 g). It was minimum in ICG 1346 (31.75 g). ICG 3301 was on par with ICG 3215. ICG 1736, ICG 7827, ICG 4621, ICG 6997, ICG 8514, ICG 274 and ICG 30 were on par with ICG 2151, having the third highest mean value for this character. The mean values of seventeen types were above the general mean (41.08 g).

ICG 3208 has recorded the highest mean value of 73.25 per cent with respect to shelling percentage. ICG 2224 has recorded the lowest value of 59.50 per cent. ICG 221, ICG 3424, ICG 4593 and ICG 7827 were statistically on par with ICG 3208 having the maximum value for this character. Fourteen types were having the mean values above the general mean (65.91 per cent).

In the case of pod yield per plot on fresh weight basis, ICG 274 has recorded the maximum mean value of 822.50 g. ICG 4888 has recorded the lowest value of 473.75 g. ICG 3277, ICG 1713, ICG 221, ICG 3215 and ICG 2224 were on par with ICG 274. The mean values of fifteen types were above the general mean (638.29 g).

The mean values of pod yield per plot on dry weight basis ranged from 290.00 g in ICG 8518 to 677.50 g in ICG 274. ICG 3215 was on par with ICG 274. ICG 2224, ICG 3301, ICG 6997, ICG 3208, ICG 8348 and TG-14 were on par with ICG 3215 having the second highest mean value. Thirteen types were having the mean values above the general mean (477.74 g).

ICG 3208, ICG 6997 and ICG 8348 have recorded the highest mean value of 4.5 kg for haulm yield per plot on fresh weight basis. The lowest mean value of 3.13 kg for this character was recorded by ICG 1713. ICG 274, ICG 8514, ICG 4544 and TG-14 were on par with ICG 3208, ICG 8348 and ICG 6997. The mean values of thirteen types exceeded the general mean (3.68 kg).

In the case of haulm yield per plot on dry weight basis, ICG 274 has recorded the maximum mean value (1068.40g). It was lowest in ICG 1713 (543.93 g), TG-14 and ICG 8348 were on par with ICG 274 having the maximum mean value. Twelve types were having the mean values above the general mean (723.17 g).

The mean values of harvest index ranging from 52 per cent in ICG 3215 to 29.89 per cent in ICG 8514. The mean values of ICG 4749 and ICG 1713 were on par with that of ICG 2224 having the second highest mean value for this character (47.77 per cent) . The mean values of fifteen types exceeded the general mean (39.97 per cent).

In the case of dry matter addition on fresh weight basis, during reproductive phase, ICG 4593 has recorded the highest mean value (138.03 g). ICG 3400 has recorded the lowest value of 66.08 g. ICG 3556, ICG 2224, ICG 1713 and ICG 1346 were on par with ICG 4593. The mean values of ten types were above the general mean (93.09 g).

In the case of dry matter addition on dry weight basis during reproductive phase, TG-14 has recorded the maximum mean value of 33.25 g whereas ICG 3400 has recorded the minimum mean value of 17.13 g for this character. ICG 4593, ICG 3556, ICG 2224, ICG 3277 and ICG 1346 were statistically on par with TG-14. Fourteen types were having the mean values above the general mean (23.32 g).

Leaf area index during vegetative phase did not show significant difference among the varieties. Moreover ICG 8514 recorded the highest mean value of 0.46 and ICG 3400 recorded the lowest (0.25). Fourteen types had mean values above the general mean (0.35).

The mean values of leaf area index during reproductive phase ranged from 1.04 for ICG 1736 to 3.61 for ICG 1713. ICG 2151, ICG 7827, ICG 7633, ICG 274, ICG 30, ICG 8514, ICG 8518, TG-14 and ICG 3208 were statistically on par with ICG 1713. The mean values of sixteen types were above the general mean (2.63).

Though leaf number during vegetative phase did not show significant difference among the varieties, the mean value was highest for ICG 4749, ICG 7827 and ICG 8671 (17.25) whereas ICG 2151 recorded the least (9.25). The mean values of fifteen types were above the general mean (13.99).

Table 3. Mean values of twentyeight characters studied in groundnut

Sl. No.	Cultivar	Height of the plant (cm)	Dry matter addition during vegetative phase (fresh weight (g)	Dry matter addition during vegetative phase dry weight (g)	First date of flowering (days)	Duration of flowering (days)	Pod yield per plant fresh weight (g)	Pod yield per plant dry weight (g)	Pod number per plant (No.)	Haulm yield per plant (fresh weight) (g)	Haulm yield per plant (dry weight) (g)	Mature to immature pod ratio	100 - pod weight (g)	100 - Kernel weight (g)	Shelling percentage (%)
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.	ICG 30	81.43	46.63	7.00	21.50	90.50	7.45	5.10	6.70	61.38	13.25	2.20	110.63	45.50	61.88
2.	ICG 221	89.08	43.63	6.38	23.25	94.25	8.25	6.13	11.35	79.75	12.70	2.96	89.63	35.50	72.00
3.	ICG 274	100.30	49.50	8.75	22.00	93.00	12.38	8.18	12.45	79.00	19.05	5.69	162.63	45.50	66.38
4.	ICG 1346	89.85	39.38	6.75	23.00	92.00	9.73	6.70	9.59	107.50	21.45	2.94	72.00	31.75	62.00
5.	ICG 1713	87.13	45.50	6.25	22.75	91.75	10.92	7.93	13.65	107.50	18.73	3.40	88.90	39.25	64.13
6.	ICG 1736	93.30	43.13	6.50	21.75	91.75	10.40	7.45	7.70	83.38	17.20	1.72	100.25	46.75	70.38
7.	ICG 2151	83.08	48.38	7.88	23.25	91.25	8.83	5.90	8.30	79.63	15.00	3.55	131.13	48.00	63.38
8.	ICG 2224	86.70	47.44	6.75	23.00	93.50	10.40	7.45	10.15	113.63	21.40	3.33	88.38	34.00	59.50
9.	ICG 2738	88.85	52.13	8.00	21.75	89.75	6.95	4.80	6.45	71.25	14.83	2.32	115.13	39.25	65.25
10.	ICG 3155	84.50	35.00	5.75	22.00	94.00	7.80	5.73	6.65	77.25	16.03	1.95	122.15	47.00	64.63
11.	ICG 3215	89.55	43.13	7.00	22.00	92.75	9.93	6.73	8.10	79.00	11.63	2.53	93.75	50.00	60.88
12.	ICG 3277	91.58	49.63	7.25	22.25	95.25	11.73	8.90	9.50	94.00	20.13	3.48	125.50	44.75	60.00
13.	ICG 3301	82.13	46.50	8.00	22.75	90.75	11.53	7.88	12.60	78.25	18.80	6.17	100.38	49.50	70.25
14.	ICG 3400	79.60	36.63	6.25	23.25	93.25	8.18	5.50	7.55	57.90	11.65	3.26	82.50	42.25	66.63
15.	ICG 3424	80.83	45.50	8.75	23.75	89.75	11.13	8.25	12.20	93.50	17.80	4.50	78.88	36.00	71.63
16.	ICG 3556	91.14	39.38	6.75	23.75	94.75	11.55	8.35	14.75	115.75	20.78	3.39	81.28	38.25	67.25
17.	ICG 4544	91.60	43.63	6.00	23.75	90.25	10.78	8.05	11.50	75.00	14.80	3.65	72.50	32.25	72.88
18.	ICG 4593	88.47	46.63	6.00	23.00	89.00	13.78	9.88	16.40	124.25	19.60	3.08	72.00	31.75	71.13
19.	ICG 4621	80.30	49.75	7.75	21.75	94.75	9.98	7.20	9.45	74.00	14.55	3.03	122.13	46.25	60.25
20.	ICG 4749	74.08	48.88	7.50	22.00	91.00	10.68	8.05	11.60	79.50	13.43	5.32	82.50	34.43	64.38
21.	ICG 4888	86.10	46.13	6.50	23.25	93.25	8.85	6.33	8.55	92.75	17.98	2.99	99.25	44.50	69.25
22.	ICG 6997	82.45	43.88	7.13	24.25	92.25	9.80	7.05	11.65	75.25	12.93	2.98	87.00	46.25	65.75
23.	ICG 7633	80.35	44.25	6.50	23.00	95.00	13.03	10.33	14.15	75.50	14.90	6.83	79.75	42.75	68.25
24.	ICG 7827	79.23	41.50	6.25	24.00	93.00	7.88	5.38	8.80	69.75	13.98	2.30	82.25	46.75	71.00
25.	ICG 7918	93.48	56.13	9.13	23.75	93.75	9.10	6.63	11.05	75.25	14.68	4.73	79.63	35.75	62.00
26.	ICG 8348	66.30	47.38	8.75	24.25	91.25	9.05	6.53	10.90	76.50	16.03	3.69	98.40	42.50	61.50
27.	ICG 8514	89.85	44.23	7.63	22.75	93.75	6.80	4.83	6.70	70.63	13.05	1.87	132.13	46.00	62.13
28.	ICG 8518	84.60	58.63	8.75	21.75	87.75	8.03	5.78	7.15	83.50	16.05	2.78	90.50	36.00	65.00
29.	ICG 8671	74.75	46.75	7.50	24.25	94.25	9.18	6.38	9.15	57.50	12.95	4.13	81.13	42.75	66.88
30.	ICG 3208	77.60	57.38	10.00	24.25	96.25	8.65	6.38	10.50	76.75	14.05	3.25	75.50	34.25	73.25
31.	TG-14	94.65	56.25	9.33	22.50	91.00	11.85	8.80	13.35	94.00	24.45	2.72	126.00	38.00	63.38
	C.D(0.05 per cent)	11.574	N.S	N.S	1.165	1.228	3.954	N.S	4.552	22.051	3.948	1.122	4.125	2.552	2.337

Table 3. (contd..)

Sl.No.	Cultivar	Pod yield per plot fresh weight (g)	Pod yield per plot dry weight (g)	Haulms yield per plot fresh weight (kg)	Haulms yield per plot dry weight (g)	Harvest index (%)	Dry matter addition during reproductive phase fresh weight (g)	Dry matter addition during reproductive phase dry weight (g)	Leaf area index at vegetative phase	Leaf area index at reproductive phase	Leaf number at vegetative phase (No.)	Disease scoring for cercospora leaf spot	Chlorophyll - a (mg/litre)	Chlorophyll - b (mg/litre)	Total pigments (mg/litre)
		16	17	18	19	20	21	22	23	24	25	26	27	28	29
1.	ICG 30	571.25	440.00	3.25	700.53	38.55	68.83	18.35	0.35	2.91	13.75	3.0	11.99	16.05	41.75
2.	ICG 221	743.25	410.00	3.75	607.23	40.28	88.00	19.08	0.30	2.35	12.50	4.5	12.03	15.78	43.25
3.	ICG 274	822.50	677.50	4.38	1068.40	39.03	91.38	27.23	0.27	3.12	10.25	6.0	10.33	14.46	36.38
4.	ICG 1346	702.50	488.75	3.73	744.12	39.67	117.23	28.15	0.37	2.43	14.75	5.5	10.80	14.87	39.38
5.	ICG 1713	753.75	430.00	3.13	543.93	44.22	118.42	26.65	0.41	3.61	14.75	6.5	11.58	15.98	42.50
6.	ICG 1736	566.25	407.50	3.25	670.63	38.03	93.77	24.65	0.37	1.04	13.50	6.0	12.41	17.46	46.38
7.	ICG 2151	591.25	468.75	3.63	683.11	40.55	88.45	20.90	0.33	3.51	9.25	5.5	11.78	16.73	42.75
8.	ICG 2224	740.00	578.75	3.38	634.90	47.77	124.03	28.85	0.36	2.38	12.75	7.0	11.62	16.87	43.38
9.	ICG 2738	636.25	447.50	3.50	732.57	38.47	78.20	19.63	0.40	2.37	14.75	5.5	11.82	13.93	42.25
10.	ICG 3155	667.50	417.50	3.38	704.46	37.27	87.55	21.75	0.35	2.45	13.75	5.5	11.65	16.91	42.88
11.	ICG 3215	742.50	596.25	3.75	549.98	52.00	88.92	19.85	0.32	2.65	12.50	4.5	11.87	16.38	43.88
12.	ICG 3277	767.50	517.50	3.88	832.46	39.10	105.73	28.28	0.33	2.35	16.25	6.0	11.74	16.35	43.88
13.	ICG 3301	717.50	576.25	3.38	817.69	41.50	29.78	26.68	0.31	2.55	13.50	5.5	10.86	14.86	39.63
14.	ICG 3400	637.50	465.00	3.25	658.21	41.51	66.08	17.13	0.25	1.93	14.00	6.0	12.44	16.54	44.75
15.	ICG 3424	607.50	476.25	3.38	635.73	42.90	104.63	23.55	0.34	2.24	13.25	6.5	12.13	16.20	44.38
16.	ICG 3556	532.50	415.00	3.38	606.18	40.80	127.30	29.13	0.33	2.44	10.00	5.0	11.53	15.76	42.25
17.	ICG 4544	726.25	602.50	4.25	838.89	41.86	85.78	29.15	0.42	2.75	15.50	6.0	11.05	15.71	39.88
18.	ICG 4593	538.75	445.00	3.75	603.14	42.52	138.03	29.48	0.32	2.76	12.25	5.5	11.37	16.39	41.25
19.	ICG 4621	577.50	480.00	3.55	656.75	42.24	83.98	21.75	0.37	2.93	15.00	5.5	11.90	16.90	43.88
20.	ICG 4749	625.00	492.50	3.63	611.28	44.70	90.18	21.48	0.41	2.05	17.25	6.0	11.39	16.06	42.50
21.	ICG 4888	473.75	392.50	3.25	628.64	38.42	101.60	24.30	0.28	2.30	13.75	6.5	11.31	15.42	41.25
22.	ICG 6997	693.75	568.75	4.50	773.32	42.43	85.05	19.98	0.39	2.83	16.50	6.5	11.43	15.70	41.38
23.	ICG 7633	560.00	435.00	3.50	690.71	38.73	88.53	25.23	0.31	3.28	15.50	6.0	11.88	15.52	45.00
24.	ICG 7827	652.50	493.75	3.83	768.42	39.20	77.63	19.35	0.29	3.46	13.00	5.5	11.49	16.39	40.75
25.	ICG 7918	525.00	427.50	3.25	634.17	40.27	84.35	21.30	0.42	1.70	17.25	5.5	11.62	15.07	40.25
26.	ICG 8348	591.25	552.50	4.50	948.58	36.87	85.55	22.70	0.30	2.44	11.00	5.0	11.08	17.02	42.50
27.	ICG 8514	612.50	345.00	4.38	806.22	29.89	77.43	17.88	0.46	2.87	15.25	5.5	12.22	16.89	45.00
28.	ICG 8518	483.75	290.00	3.63	695.40	30.42	91.52	21.83	0.39	2.80	15.25	6.5	11.49	16.70	43.88
29	ICG 8671	653.75	380.00	3.38	704.86	35.43	66.68	19.33	0.35	2.71	12.75	6.0	12.28	17.23	42.13
30	ICG 3208	695.00	565.00	4.50	826.43	40.65	85.37	21.18	0.41	2.77	17.25	6.0	12.48	16.49	43.63
31	TG-14	673.75	537.50	4.00	1041.39	33.60	105.85	33.25	0.43	2.79	16.75	6.5	11.24	16.11	40.13
	C.D(0.05 per cent)	93.419	68.495	0.622	131.249	4.191	23.805	5.942	N.S	1.036	N.S	1.443	1.318	N.S	N.S

Table 4. General mean and range for twentyeight characters studied in groundnut

Sl. No.	Character	General mean	Range
1.	Height of the plant (cm)	85.25	66.30 - 100.30
2.	Dry matter addition during vegetative phase (fresh weight)(g)	46.54	35.00 - 58.63
3.	Dry matter addition during vegetative phase(dry weight) (g)	7.38	5.75 - 10.00
4.	First date of flowering (days)	21.92	21.50 - 24.25
5.	Duration of flowering (days)	92.43	87.75 - 96.25
6.	Pod yield per plant(fresh weight)(g)	9.82	6.80 - 13.78
7.	Pod yield per plant(dry weight)(g)	7.05	4.80 - 10.33
8.	Pod number of plant	10.28	6.45 - 16.40
9.	Haulm yield per plant (fresh weight)(g)	83.19	57.50 - 124.25
10.	Haulm yield per plant (dry weight)(g)	16.25	11.63 - 24.45
11.	Mature to immature pod ratio	3.44	1.72 - 6.83
12.	100 - pod weight (g)	97.55	72.00 - 162.63
13.	100 - kernel weight (g)	41.08	31.75 - 50.00
14.	Shelling percentage (per cent)	65.91	59.50 - 73.25
15.	Pod yield per plot (fresh weight) (g)	638.29	473.75 - 822.50
16.	Pod yield per plot(dry weight)(g)	477.74	290.00 - 627.50

(contd..)

Table 4. (contd.)

Sl. No.	Character	General mean	Range
17.	Haulm yield per plot (fresh weight)(kg)	3.68	3.13 - 4.50
18.	Haulm yield per plot (dry weight)(g)	723.17	543.93 -1068.40
19.	Harvest index (per cent)	39.97	29.89 - 82.00
20.	Dry matter addition during reproductive phase (fresh weight) (g)	93.09	66.08 - 138.03
21.	Dry matter addition during reproductive phase (dry weight)(g)	23.32	17.13 - 33.25
22.	Leaf area index at vegetative phase	0.35	0.25 - 0.46
23.	Leaf area index at reproductive phase	2.63	1.04 - 3.61
24.	Leaf number at vegetative phase	13.99	9.25 - 17.25
25.	Disease scoring for Cercospora leaf spot	5.71	3.00 - 7.00
26.	Chlorophyll-a (mg/litre)	11.64	10.35 - 12.48
27.	Chlorophyll-b (mg/litre)	16.10	13.93 - 17.46
28.	Total pigments (mg/litre)	42.35	36.38 - 46.38

Table 5. Mean values of shade intensity measured at vegetative and reproductive phase

	Cultivar	(Transformed) shade intensity during veg. phase at 12 noon (klux)	Retransformed mean	(transformed) mean Shade intensity during veg. phase at 2 P.M. (Klux)	Retransformed mean	(transformed) Shade intensity during veg. phase at 4 P.M. (Klux)	Retransformed mean	(transformed) Shade intensity during rep. phase at 2 P.M. (Klux)	Retransformed mean	(transformed) Shade intensity during reproductive phase at 4 P.M. (Klux)	Retransformed mean	(transformed) Shade intensity during reprod. phase at 12 Noon (Klux)	Retransformed mean
		30		31		32		33		34		35	
1.	ICG 30	(27.28)	21.02	(40.26)	41.78	(49.12)	57.20	(43.39)	47.22	(62.19)	78.26	(21.13)	13.00
2.	ICG 221	(30.84)	26.29	(35.03)	32.96	(23.19)	15.50	(31.34)	27.07	(50.11)	58.90	(28.16)	22.29
3.	ICG 274	(26.69)	20.19	(27.37)	21.15	(14.65)	6.40	(40.29)	41.85	(48.63)	56.35	(27.21)	20.93
4.	ICG1346	(22.26)	14.36	(30.04)	25.08	(33.26)	30.10	(35.52)	33.78	(59.35)	74.05	(13.91)	5.77
5.	ICG 1713	(23.75)	16.23	(24.66)	17.42	(23.81)	16.30	(22.96)	15.23	(64.32)	81.26	(15.97)	7.58
6.	ICG 1736	(28.14)	22.26	(31.93)	27.99	(44.64)	49.40	(29.79)	24.69	(50.78)	60.06	(21.20)	13.09
7.	ICG 2151	(27.56)	21.42	(35.77)	34.18	(47.37)	54.10	(42.34)	45.39	(58.44)	72.64	(27.63)	21.52
8.	ICG 2224	(29.28)	23.94	(28.16)	22.29	(25.84)	19.10	(47.22)	53.90	(55.60)	68.12	(40.86)	42.82
9.	ICG 2738	(24.94)	17.79	(29.27)	23.92	(39.66)	40.70	(30.63)	25.98	(35.27)	33.37	(11.00)	3.65
10.	ICG 3155	(26.59)	20.05	(39.20)	39.98	(53.00)	63.80	(25.97)	19.18	(41.07)	43.18	(25.26)	18.23
11.	ICG 3215	(23.34)	15.71	(26.71)	20.22	(49.18)	57.30	(34.65)	32.35	(40.53)	42.26	(13.26)	5.34
12.	ICG 3277	(20.32)	12.07	(31.17)	26.80	(56.62)	69.70	(23.21)	15.55	(61.79)	77.69	(15.24)	6.90
13.	ICG 3301	(22.37)	14.49	(24.74)	15.55	(36.81)	35.90	(33.12)	29.87	(57.90)	71.80	(38.54)	38.85
14.	ICG 3400	(28.89)	23.37	(30.54)	25.84	(47.07)	53.60	(29.40)	24.11	(56.20)	69.09	(34.62)	32.30
15.	ICG 3424	(23.86)	16.37	(43.38)	47.20	(48.41)	56.00	(17.64)	9.19	(52.52)	63.00	(21.16)	13.04
16.	ICG 3556	(30.93)	26.44	(32.45)	28.81	(42.89)	46.30	(44.74)	49.58	(56.59)	69.72	(16.09)	7.68
17.	ICG 4544	(23.20)	15.54	(35.04)	32.98	(45.19)	50.30	(47.49)	54.38	(58.74)	73.10	(14.32)	6.12
18.	ICG 4593	(31.75)	27.71	(32.35)	28.65	(34.28)	31.70	(52.04)	62.20	(43.45)	47.32	(22.36)	14.48
19	ICG 4621	(23.51)	15.93	(29.68)	24.54	(37.36)	36.80	(30.40)	25.62	(60.78)	76.20	(29.32)	23.99
20	ICG 4749	(28.32)	22.52	(35.93)	34.45	(29.09)	23.60	(45.57)	51.03	(46.12)	51.98	(19.62)	11.28
21.	ICG 4888	(27.98)	22.03	(38.41)	38.62	(44.83)	49.70	(36.54)	35.48	(61.95)	77.93	(29.82)	24.75
22.	ICG 6997	(25.33)	18.32	(31.82)	27.81	(46.07)	51.90	(37.66)	37.35	(60.34)	75.55	(30.00)	25.02
23.	ICG 7633	(26.07)	19.33	(31.55)	27.39	(45.64)	51.20	(30.48)	25.76	(56.77)	69.99	(20.39)	12.15
24.	ICG 7827	(23.60)	16.04	(31.34)	27.06	(48.10)	55.40	(31.02)	26.57	(56.55)	69.65	(16.64)	8.21
25.	ICG 7918	(20.51)	12.28	(21.75)	13.74	(34.91)	32.80	(19.04)	10.65	(45.91)	51.63	(13.47)	5.43
26.	ICG 8348	(20.90)	12.74	(28.82)	23.25	(38.95)	39.50	(29.03)	23.56	(61.26)	76.92	(21.74)	13.73
27.	ICG 8514	(29.79)	24.70	(28.89)	23.35	(38.02)	37.90	(40.92)	42.93	(57.15)	70.60	(15.03)	6.73
28.	ICG 8518	(32.96)	29.62	(31.74)	27.70	(49.53)	57.90	(37.66)	37.34	(52.39)	62.79	(27.47)	21.29
29.	ICG 8671	(26.31)	19.66	(30.24)	25.37	(40.66)	42.40	(19.66)	11.32	(55.90)	68.59	(19.49)	11.14
30.	ICG 3208	(31.44)	27.23	(30.39)	25.61	(30.76)	26.10	(24.97)	17.84	(45.98)	51.75	(24.31)	16.96
31.	TG -14	(36.37)	35.19	(31.19)	26.83	(35.68)	34.00	(28.33)	22.53	(46.69)	52.98	(32.23)	28.46
	C.D(0.05 per cent)	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S	N.S

Table 6. General mean and range for shade intensity

Sl. No.	Period	General mean	Range
I.	Vegetative phase		
1.	at 12 noon	26.62	20.32 - 36.37
2.	at 2 P.M.	31.61	21.75 - 43.39
3.	at 4 P.M.	39.82	14.65 - 56.62
II.	Reproductive phase		
1.	at 12 noon	22.82	11.00 - 40.86
2.	at 2 P.M.	33.65	17.64 - 52.04
3.	at 4 P.M.	53.59	35.27 - 64.32

Table 7. Analysis of variance for twentyeight characters studied in groundnut

Sl. No.	Character	Mean sum of squares: Replication df = 3	Mean sum of squares: Treatment df = 30	Mean sum of squares: Error df = 90	F value for treatment
1.	Height of the plant (cm)	68.688	199.260	67.653	2.946**
2.	Dry matter addition on fresh weight basis during vegetative phase (g)	309.896	125.291	136.152	0.920
3.	Dry matter addition on dry weight basis during vegetative phase (g)	18.409	5.017	5.324	0.942
4.	First date of flowering (days)	17.753	3.073	0.686	4.479**
5.	Duration of flowering (days)	18.750	16.254	0.761	21.356**
6.	Pod yield per plant (fresh weight)(g)	20.339	12.722	7.896	1.611*
7.	Pod yield per plant (dry weight)(g)	18.325	8.011	5.937	1.349
8.	Pod number per plant	14.782	27.808	10.466	2.657**
9.	Haulm yield per plant (fresh weight(g)	347.229	1079.779	245.564	4.397**
10.	Haulm yield per plant (dry weight)(g)	4.569	42.907	7.870	5.452**
11.	Mature to immature pod ratio	0.394	6.098	0.636	9.584**
12.	100 pod weight (g)	4.167	1986.458	8.592	231.208**
13.	100 kernel weight (g)	7.989	130.272	3.289	39.680**
14.	Shelling percentage (per cent)	1.000	69.263	2.759	25.104**
15.	Pod yield per plot (fresh weight (g)	3222.667	29448.530	4407.511	6.681**
16.	Pod yield per plot(dry weight)(g)	2610.000	28349.600	2369.444	11.965**

(contd..)

Table 7. (contd.)

Sl. No.	Character	Mean sum of squares			F value for treatment
		Replication df = 3	Treatment df = 30	Error df = 90	
17.	Haulm yield per plot (fresh weight)(kg)	0.064	0.716	0.916	3.659**
18.	Haulm yield per plot (dry weight)(g)	2040.000	65686.800	8700.045	7.550**
19.	Harvest index (per cent)	7.188	75.622	8.871	8.524**
20.	Dry matter addition on fresh weight basis during reproductive phase(g)	359.417	1220.863	286.188	4.226**
21.	Dry matter addition on dry weight basis during reproductive phase (g)	38.429	66.423	171.833	3.725**
22.	Leaf area index at vegetative phase	4.049	1.145	1.642	0.697
23.	Leaf area index at reproductive phase	0.739	1.122	0.542	2.071**
24.	Leaf number at vegetative phase	55.771	18.058	16.777	1.076
25.	Disease scoring for Cercospora leaf spot	1.118	2.385	1.052	2.368**
26.	Chlorophyll-a (mg/ litre)	8.411	1.019	0.877	1.161
27.	Chlorophyll-b (mg/litre)	29.483	2.831	3.729	0.759
28.	Total pigments (mg/litre)	226.734	16.429	16.292	1.008

* Significant at 5% level

** Significant at 1% level

Table 8. Analysis of variance for shade intensity

Sl. No.	Period	Mean sum of squares			F value
		Replication df = 3	Treatment df = 30	Error df =90	
I	During vegetative phase				
1.	at 12 noon	104.284	61.439	49.744	1.235
2.	at 2 p.M.	46.167	87.491	55.640	1.572
3.	at 4 p.M.	49.797	377.395	82.700	4.563
II.	During reproductive phase				
1.	at 12 noon	619.369	325.283	329.637	0.987
2.	at 2 p.M.	127.417	223.219	151.989	1.769
3.	at 4 p.M.	574.329	329.726	239.855	0.999

In the case of Cercospora leaf spot disease the mean values of disease score varied from 7 in ICG 2224 to 3 in ICG 30. The mean values of TG-14, ICG 8518, ICG 4888, ICG 6997, ICG 3424, ICG 1713, ICG 274, ICG 1736, ICG 3277, ICG 4544, ICG 4749, ICG 7633 and ICG 8671 were on par with ICG 2224. Sixteen types had mean values above the general mean (5.71).

Though the content of chlorophyll-a did not show significant difference among the varieties, the mean value was highest for ICG 3208 (12.48 mg/litre) and lowest for ICG 274 (10.33 mg/litre). The mean values of fifteen types exceeded the general mean (11.64 mg/litre).

Chlorophyll- b and total pigments also did not show significant difference among the varieties.

2. Variability studies

The variabilities for the twenty eight characters as estimated on the basis of phenotypic and genotypic coefficients of variation (PCV and GCV) are furnished in Table 9. The phenotypic coefficient of variation and genotypic coefficient of variation estimates are also presented graphically (Fig.1).

Table 9. Phenotypic and genotypic coefficients of variation (per cent) for twentyeight characters studied in groundnut

Sl. No.	Character	Phenotypic coefficient of variation (P.C.V)	Genotypic coefficient of variation (G.C.V)
1.	Height of the plant (cm)	11.67	6.73
2.	Dry matter addition during vegetative phase (fresh weight)(g)	24.62	..
3.	Dry matter addition during vegetative phase (dry weight)(g)	31.03	..
4.	First date of flowering (days)	4.94	3.37
5.	Duration of flowering (days)	2.33	2.13
6.	Pod yield per plant (fresh weight)(g)	30.72	11.16
7.	Pod yield per plant (dry weight)(g)	36.04	10.21
8.	Pod number per plant	37.43	20.25
9.	Haulm yield per plant (fresh weight)(g)	25.62	17.36
10.	Haulm yield per plant (dry weight)(g)	25.09	18.21
11.	Mature to immature pod ratio	41.13	33.96
12.	100-pod weight (g)	22.99	22.79
13.	100- kernel weight (g)	14.41	13.72
14.	Shelling percentage (per cent)	6.68	6.19

(contd..)

Table 9. (contd.)

Sl. No.	Character	Phenotypic coefficient of variation (P.C.V)	Genotypic coefficient of variation (G.C.V)
15.	Pod yield per plot (fresh weight)(g)	16.18	12.39
16.	Pod yield per plot(dry weight (g)	19.71	16.87
17.	Haulm yield per plot (fresh weight(kg)	15.52	9.79
18.	Haulm yield per plot (dry weight)(g)	20.95	16.51
19.	Harvest index (per cent)	12.65	10.22
20.	Dry matter addition during reproductive phase(fresh weight)(g)	24.49	16.42
21.	Dry matter addition during reproductive phase (dry weight)(g)	23.48	14.95
22.	Leaf area index at vegetative phase	34.99	..
23.	Leaf area index at reproductive phase	31.52	14.48
24.	Leaf number at vegetative phase	29.50	4.04
25.	Disease scoring for Cercospora leaf spot	20.61	10.11
26.	Chlorophyll - a(mg/litre)	8.24	1.61
27.	Chlorophyll - b(mg/litre)	11.63	..
28.	Total pigments (mg/litre)	9.54	0.44

.. Not estimable

Fig.1. Phenotypic and genotypic coefficients of variation for twentyeight characters.

1. Height of the plant
2. Dry matter addition during vegetative phase (fresh weight)
3. Dry matter addition during vegetative phase (dry weight)
4. First date of flowering.
5. Duration of flowering
6. Pod yield per plant (fresh weight)
7. Pod yield per plant (dry weight)
8. Pod number per plant
9. Haulm yield per plant (fresh weight)
10. Haulm yield per plant (dry weight)
11. Mature to immature pod ratio
12. 100 - pod weight
13. 100 - kernel weight
14. Shelling percentage
15. Pod yield per plot (fresh weight)
16. Pod yield per plot (dry weight)
17. Haulm yield per plot (fresh weight)
18. Haulm yield per plot (dry weight)
19. Harvest index
20. Dry matter addition during reproductive phase (fresh weight)
21. Dry matter addition during reproductive phase (dry weight)
22. Leaf area index at vegetative phase
23. Leaf area index at reproductive phase
24. Leaf number at vegetative phase
25. Disease scoring for Cercospora leaf spot
26. Chlorophyll-a
27. Chlorophyll-b
28. Total pigments

Fig.1. Phenotypic and genotypic coefficients of variation for twenty eight characters

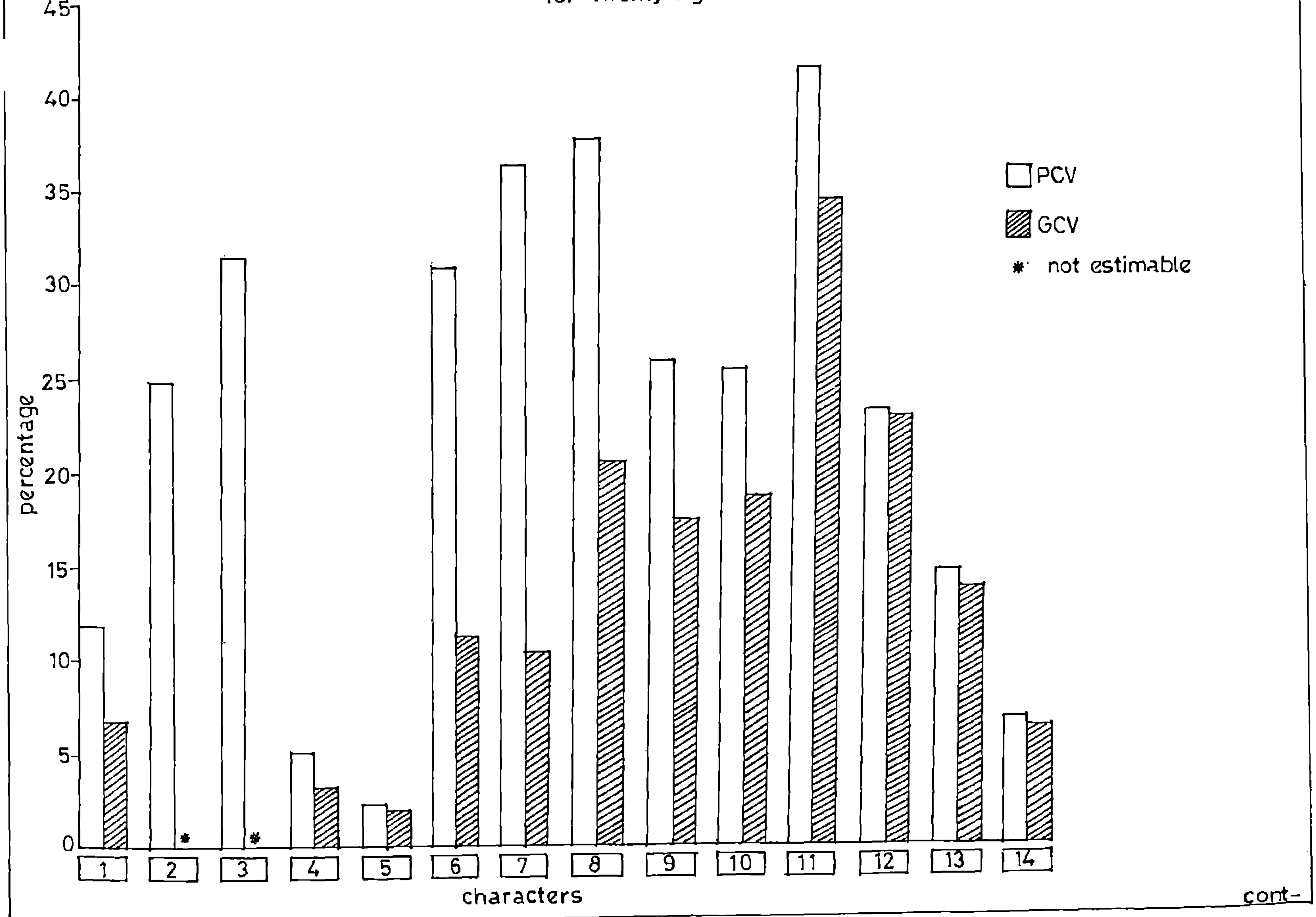

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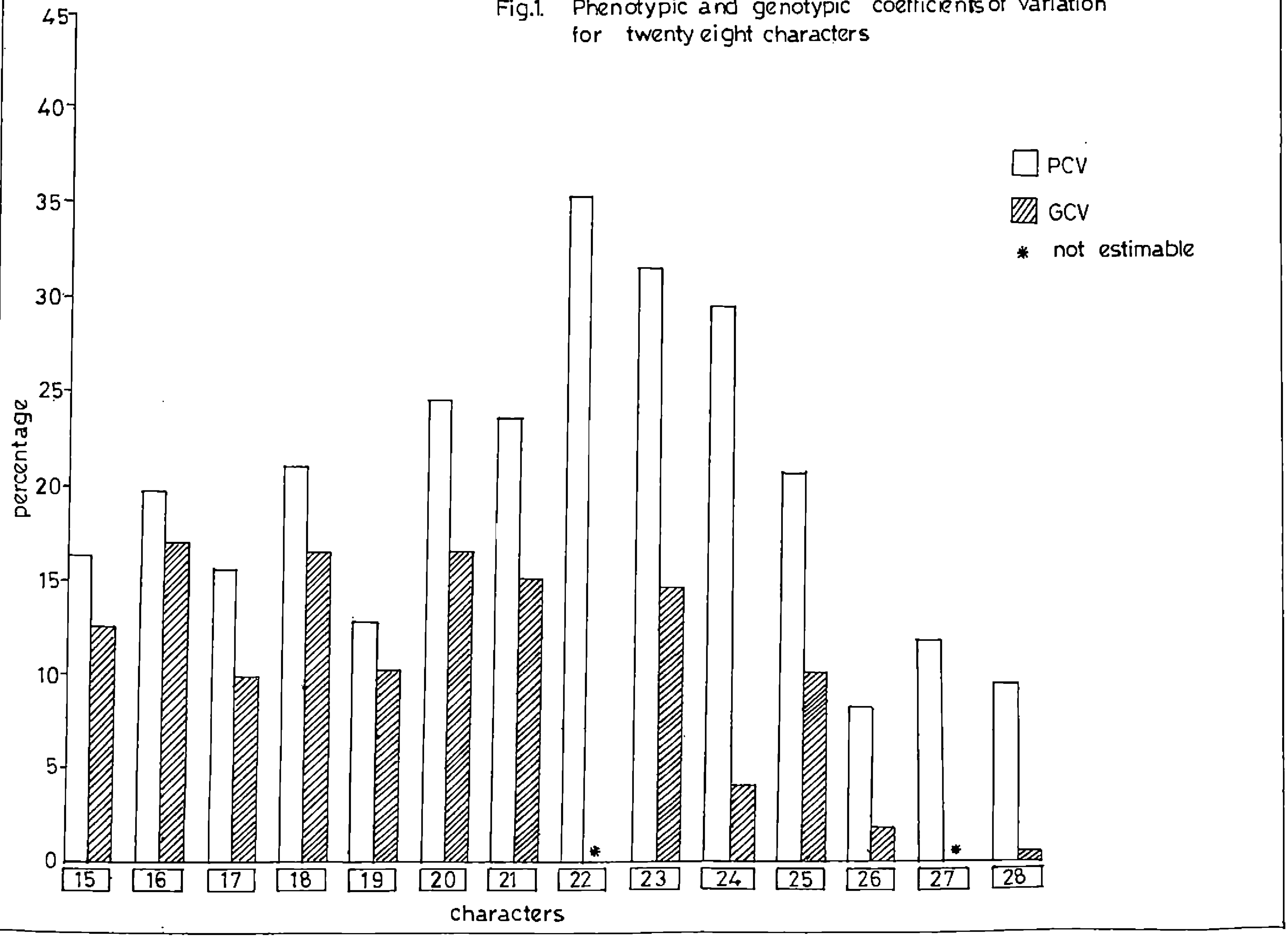
Fig.1. Phenotypic and genotypic coefficients of variation for twenty eight characters



The highest phenotypic coefficient of variation was observed for mature to immature pod ratio (41.13 per cent) followed by pod number per plant (37.43 per cent), pod yield per plant on dry weight basis (36.04 per cent) and leaf area index at vegetative phase (34.99 per cent), while duration of flowering had the lowest value (2.33 per cent). Mature to immature pod ratio has also showed the highest genotypic coefficient of variation (33.96 per cent) followed by hundred pod weight (22.79 per cent) pod number per plant (20.25 per cent), haulm yield per plant on dry weight basis (18.21 per cent) and haulm yield per plant on fresh weight basis (17.36 per cent) while total pigment had the lowest value (0.44 per cent).

3. Genetic analysis

Estimate of heritability genetic advance and genetic gain studied are furnished in Table 10 and Fig.2. In general the heritability estimates were medium to high for most of the characters studied. Highest heritability estimate was recorded for hundred pod weight (98.29 per cent) followed by 100 kernel weight (90.61 per cent), shelling percentage (85.77 per cent), duration of flowering (83.58 per cent) pod yield per plot on dry weight basis (73.27 per cent) and mature to immature pod ratio (68.21 per cent).

Low values of heritability including negative values were observed for chlorophyll-a (3.84 per cent), leaf number at vegetative phase (1.87 per cent), leaf area index at vegetative phase (-8.19 per cent), chlorophyll-b (-6.39 per cent), dry matter addition on fresh weight basis during vegetative phase (- 2.03 per cent) and dry matter addition on dry weight basis during vegetative phase (- 1.46 per cent).

Mature to immature pod ratio recorded the maximum genetic gain (57.85 per cent) followed by hundred pod weight (46.55 per cent), pod yield per plot on dry weight basis (29.75 per cent), haulm yield per plant on dry weight basis (27.20 per cent) and hundred kernel weight (26.89 per cent). Low values of genetic gain including negative one were recorded by dry matter addition on dry weight basis during vegetative phase (-0.92 per cent) dry matter addition on fresh weight basis during vegetative phase (-1.03 per cent), chlorophyll-b (-1.55 per cent) leaf area index at vegetative phase (-5.71 per cent) total pigments (0.05 per cent) chlorophyll-a (0.65 per cent) leaf number at vegetative phase (1.07 per cent).

Table 10. Heritability, Genetic advance and Genetic gain (per cent) for twentyeight characters studied in groundnut

Sl. No.	Character	Heritability (H^2) in %	Genetic advance (G.A) at 5%	Genetic gain (GG) in %
1.	Height of the plant (cm)	32.72	6.76	7.93
2.	Dry matter addition during vegetative phase (fresh weight)(g)	-2.03	-0.48	-1.03
3.	Dry matter addition during vegetative phase (dry weight)(g)	-1.46	-0.07	-0.92
4.	First date of flowering (days)	46.52	1.09	4.76
5.	Duration of flowering (days)	83.58	3.71	4.01
6.	Pod yield per plant (fresh weight)(g)	13.25	0.82	8.35
7.	Pod yield per plant (dry weight)(g)	8.03	0.42	5.96
8.	Pod number per plant (number)	29.28	2.32	22.57
9.	Haulm yield per plant (fresh weight)(g)	45.93	20.16	24.23
10.	Haulm yield per plant (dry weight)(g)	52.67	4.42	27.20
11.	Mature to immature pod ratio	68.21	1.99	57.85
12.	100-pod weight (g)	98.29	45.41	46.55
13.	100 kernel weight (g)	90.61	11.05	26.89
14.	Shelling percentage (per cent)	85.77	7.78	11.80
15.	Pod yield per plot (fresh weight)(g)	58.68	124.86	19.56
16.	Pod yield per plot (dry weight) (g)	73.27	142.11	29.75

(contd.)

Table 10. (contd.)

Sl. No.	Character	Heritability (H^2) in %	Genetic advance (G.A) at 5%	Genetic gain (GG) in %
17.	Haulm yield per plot (fresh weight) (kg)	39.93	0.47	12.77
18.	Haulm yield per plot (dry weight) (g)	62.09	193.74	26.79
19.	Harvest index (per cent)	65.29	6.79	16.99
20.	Dry matter addition during reproductive phase (fresh weight)(g)	44.95	21.11	22.68
21.	Dry matter addition during reproductive phase (dry weight) (g)	40.52	4.57	19.59
22.	Leaf area index at vegetative phase	-8.19	-0.02	-5.71
23.	Leaf area index at reproductive phase	21.12	0.36	13.69
24.	Leaf number at vegetative phase	1.87	0.15	1.07
25.	Disease scoring for Cercospora leaf spot	24.07	0.58	10.16
26.	Chlorophyll - a (mg/litre)	3.84	0.08	0.65
27.	Chlorophyll - b (mg/litre)	-6.39	-0.25	-1.55
28.	Total pigments (mg/litre)	0.21	0.02	0.05

Fig.2. Heritability and genetic gain for twentyeight characters.

1. Height of the plant
2. Dry matter addition during vegetative phase (fresh weight)
3. Dry matter addition during vegetative phase (dry weight)
4. First date of flowering
5. Duration of flowering
6. Pod yield per plant (fresh weight)
7. Pod yield per plant (dry weight)
8. Pod number per plant
9. Haulm yield per plant (fresh weight)
10. Haulm yield per plant (dry weight)
11. Mature to immature pod ratio
12. 100 - pod weight
13. 100 - kernel weight
14. Shelling percentage
15. Pod yield per plot (fresh weight)
16. Pod yield per plot (dry weight)
17. Haulm yield per plot (fresh weight)
18. Haulm yield per plot (dry weight)
19. Harvest index
20. Dry matter addition during reproductive phase (fresh weight)
21. Dry matter addition during reproductive phase (dry weight)
22. Leaf area index at vegetative phase
23. Leaf are index at reproductive phase
24. Leaf number at vegetative phase
25. Disease scoring for Cercospora leaf spot
26. Chlorophyll - a
27. Chlorophyll - b
28. Total pigments

Fig.2. Heritability and genetic gain for twenty eight characters

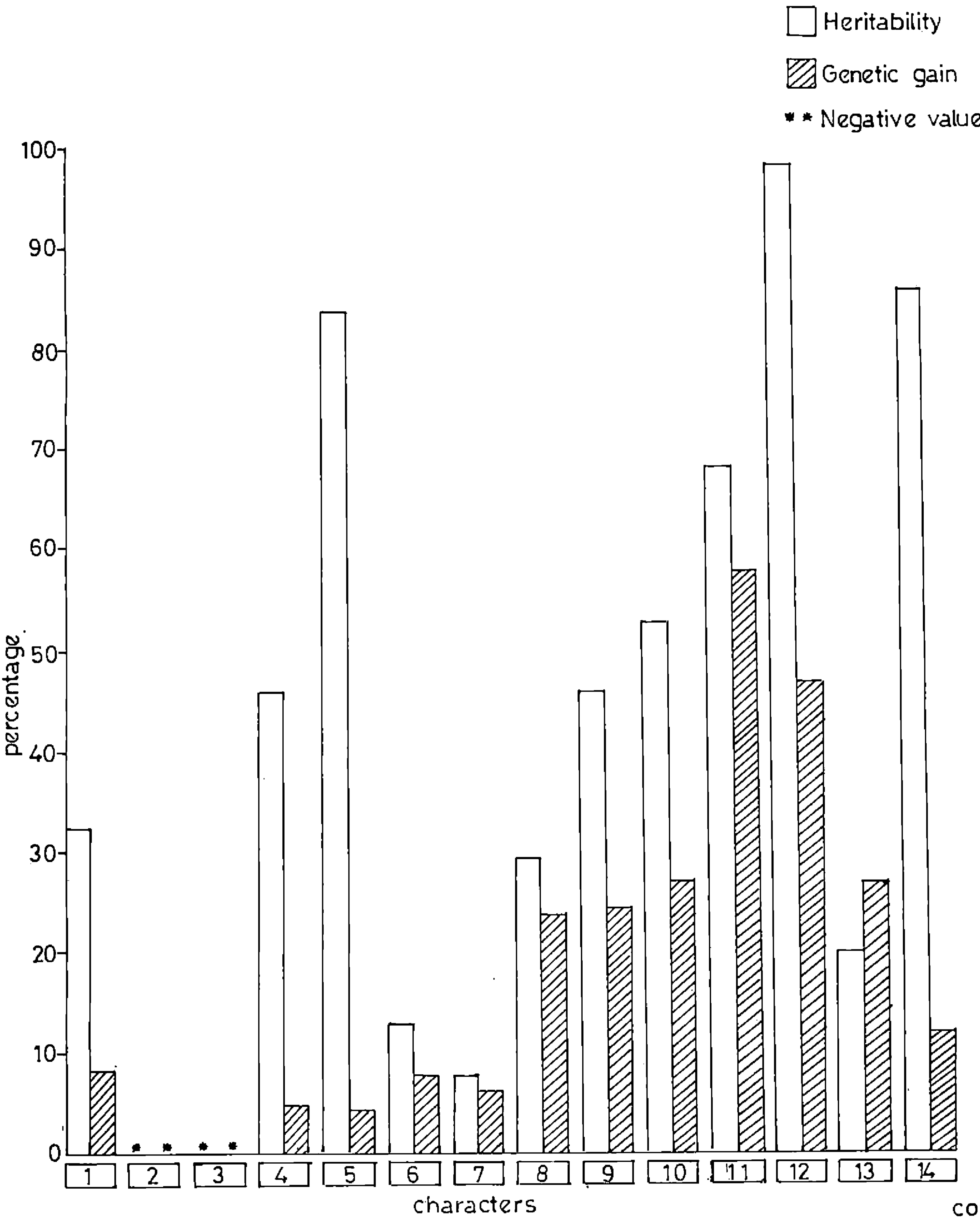


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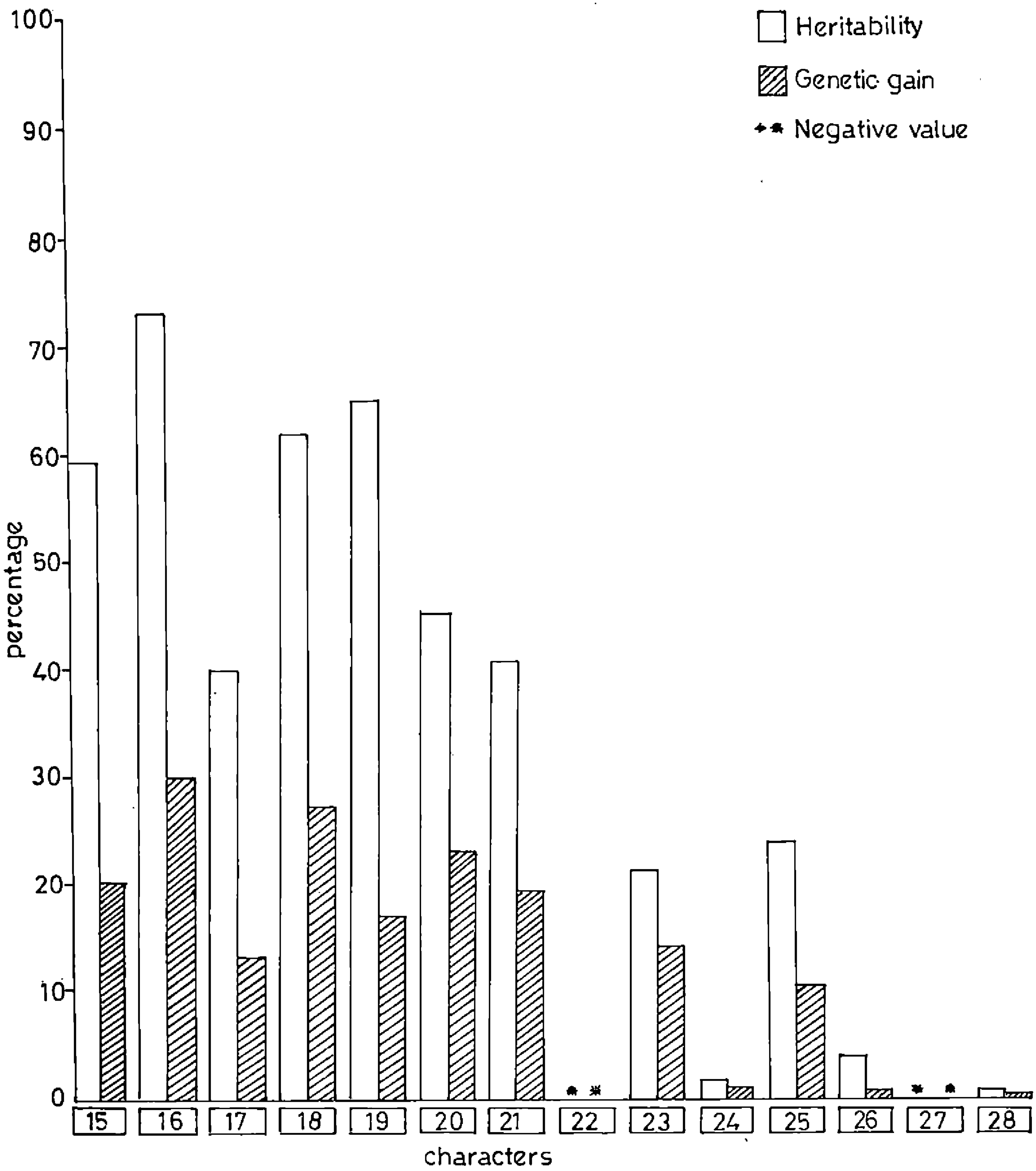
Fig.2. Heritability and genetic gain for twentyeight characters



High heritability coupled with high genetic advance was recorded by hundred pod weight, mature to immature pod ratio and dry pod yield per plot. High heritability with low genetic gain was recorded by duration of flowering. Moderate heritability with high genetic advance was recorded by fresh pod yield per plant, Pod number per plant and dry matter addition on fresh weight basis during reproductive phase. High heritability with moderate genetic advance was recorded by harvest index. Moderate heritability with moderate genetic advance was observed for leaf area index at reproductive phase, Cercospora leaf spot disease score, haulm yield per plot on fresh weight basis and dry matter addition on dry weight basis during reproductive phase. Moderate heritability with low genetic advance was recorded by height of the plant.

4. Correlation studies

The genotypic and phenotypic coefficients were estimated which are prescribed under the following heads.

(a) Correlation between dry pod yield per plot and its components.

(b) Correlation among the yield components.

<u>Correlation between dry pod yield per plot and its components</u>

The genotypic and phenotypic correlation coefficients are presented in Table 11 , Fig. 3 and 4. The genotypic correlation coefficients were in general higher than the phenotypic correlation coefficients.

Genotypic correlation of dry pod yield per plot was found positive with fresh pod yield per plot (r = 0.6908), dry pod yield per plant (r = 0.6670), fresh pod yield per plant (r = 0.6593), harvest index (r = 0.5610), haulm yield per plot on dry weight basis (r = 0.4945) and haulm yield per plot on fresh weight basis (r = 0.4872). Characters like pod number per plant, dry matter addition on fresh and dry weight basis during reproductive phase, mature to immature pod ratio, height of the plant, hundred pod weight, hundred kernel weight, Cercospora leaf spot disease score, duration of flowering, leaf area index at reproductive phase and haulm yield per plant on fresh and dry weight basis were also showed positive association with dry pod yield per plot. A negative association of this character was found with leaf number at vegetative phase (r = -0.2908) and shelling percentage (r = - 0.0244).

Table 11. Genotypic and phenotypic correlation coefficients of dry pod yield per plot with twentyfour characters studied in groundnut

Sl. No.	Character	Genotypic correlation coefficient (r_g)	Phenotypic correlation coefficient (r_p)
1.	Height of the plant (cm)	0.1413	-0.0160
2.	Dry matter addition during vegetative phase (fresh weight)(g)	..	0.0168
3.	Dry matter addition during vegetative phase (dry weight)(g)	..	0.0996
4.	First date of flowering (days)	0.1797	0.0369
5.	Duration of flowering (days)	0.0912	0.0308
6.	Pod yield per plant (fresh weight) (g)	0.6593	0.2044*
7.	Pod yield per plant(dry weight)(g)	0.6670	0.1305
8.	Pod number per plant (number)	0.3984	0.1619
9.	Haulm yield per plant (fresh weight)(g)	0.0260	0.0198
10.	Haulm yield per plant (dry weight) (g)	0.1942	0.0905
11.	Mature to immature pod ratio	0.3407	0.2615**
12.	100-pod weight (g)	0.1395	0.1273
13.	100-kernel weight (g)	0.0592	0.0665
14.	Shelling percentage (per cent)	-0.0244	0.0043
15.	Pod yield per plot (fresh weight) (g)	0.6908	0.7541**

(contd..)

Table 11. (contd..)

Sl. No.	Character	Genotypic correlation coefficient (r_g)	Phenotypic correlation coefficient (r_p)
16.	Haulm yield per plot (fresh weight)(kg)	0.4872	0.4984**
17.	Haulm yield per plot (dry weight)(g)	0.4945	0.4701**
18.	Harvest index (per cent)	0.5610	0.4946**
19.	Dry matter addition during reproductive phase (fresh weight)(g)	0.0683	0.0424
20.	Dry matter addition during reproductive phase (dry weight)(g)	0.3468	0.1490
21.	Leaf area index at vegetative phase	..	-0.0332
22.	Leaf area index at reproductive phase	0.1252	0.0506
23.	Leaf number at vegetative phase	-0.2908	-0.0311
24.	Disease scoring for Cercospora leaf spot	0.0946	0.0362

* Significant at 5% level

** Significant at 1 % level

.. Not estimable

Fig.3. Genotypic correlation coefficient of dry pod yield per plot with twentyfour characters.

1. Height of the plant
2. Dry matter addition during vegetative phase (fresh weight)
3. Dry matter addition during vegetative phase (dry weight)
4. First date of flowering
5. Duration of flowering
6. Pod yield per plant (fresh weight)
7. Pod yield per plant (dry weight)
8. Pod number per plant
9. Haulm yield per plant (fresh weight)
10. Haulm yield per plant (dry weight)
11. Mature to immature pod ratio
12. 100 - pod weight
13. 100 - kernel weight
14. Shelling percentage
15. Pod yield per plot (fresh weight)
16. Haulm yield per plot (fresh weight)
17. Haulm yield per plot (dry weight)
18. Harvest index
19. Dry matter addition during reproductive phase (fresh weight)
20. Dry matter addition during reproductive phase (dry weight)
21. Leaf area index at vegetative phase
22. Leaf area index at reproductive phase
23. Leaf number at vegetative phase
24. Disease scoring for Cercospora leaf spot

Fig.3. Genotypic correlation coefficient of dry pod yield per plot with twenty four characters

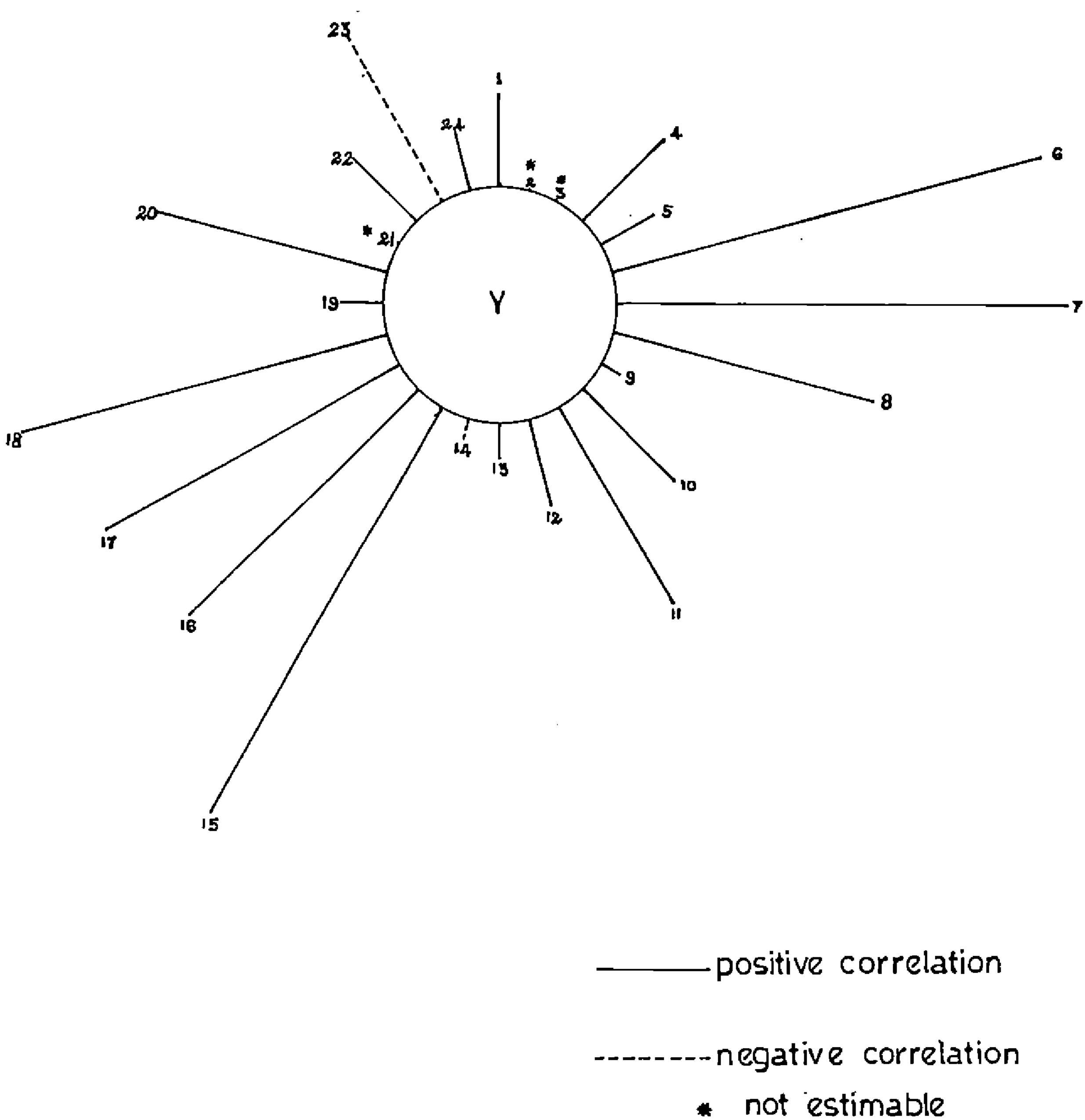
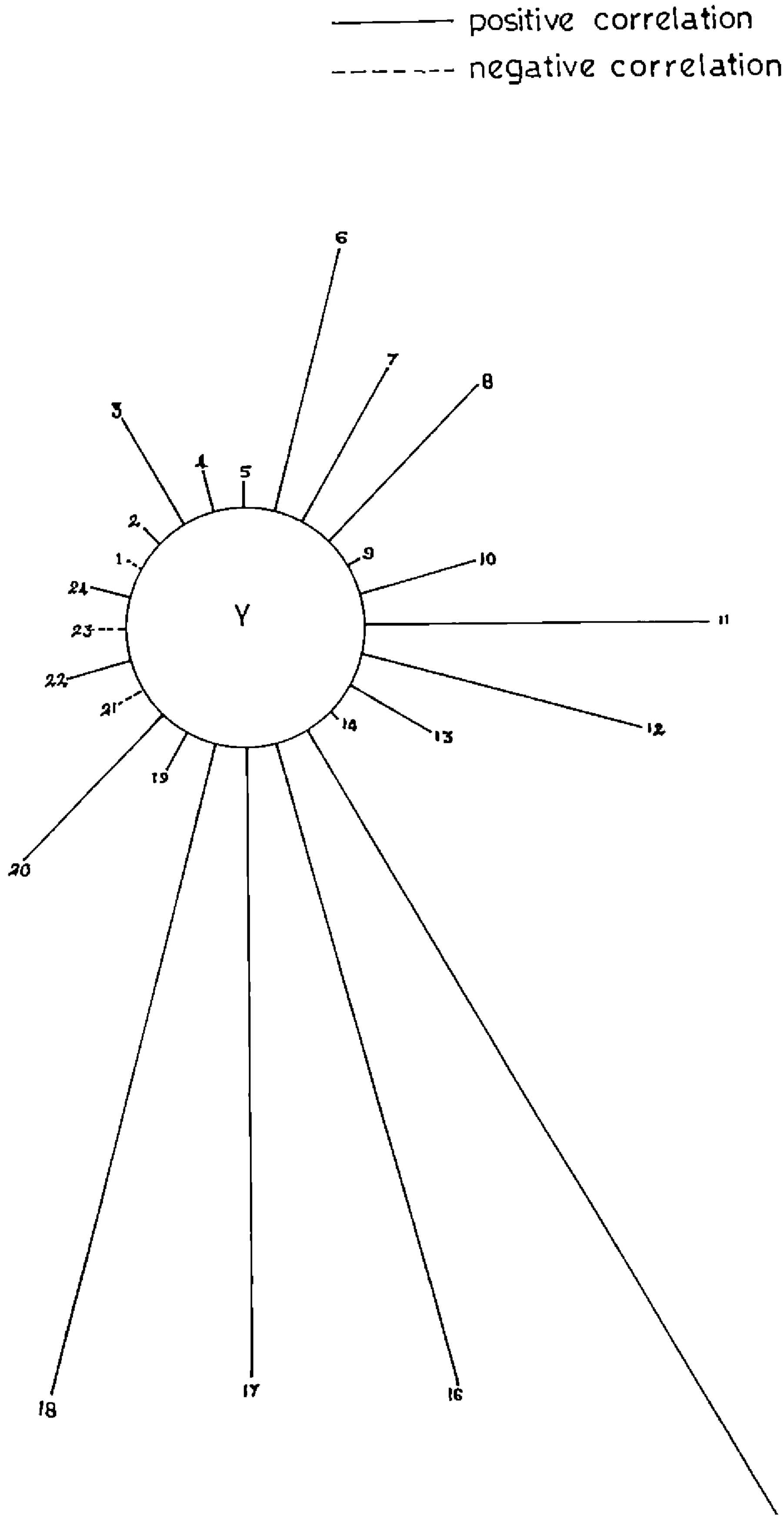


Fig.4. Phenotypic correlation coefficient of dry pod yield per plot with twentyfour characters.

1. Height of the plant
2. Dry matter addition during vegetative phase (fresh weight)
3. Dry matter addition during vegetative phase (dry weight)
4. First date of flowering
5. Duration of flowering
6. Pod yield per plant (fresh weight)
7. Pod yield per plant (dry weight)
8. Pod number per plant
9. Haulm yield per plant (fresh weight)
10. Haulm yield per plant (dry weight)
11. Mature to immature pod ratio
12. 100-pod weight
13. 100- kernel weight
14. Shelling percentage
15. Pod yield per plot (fresh weight)
16. Haulm yield per plot (fresh weight)
17. Haulm yield per plot (dry weight)
18. Harvest index
19. Dry matter addition during reproductive phase (fresh weight)
20. Dry matter addition during reproductive phase (dry weight)
21. Leaf area index at vegetative phase
22. Leaf area index at reproductive phase
23. Leaf number at vegetative phase
24. Disease scoring for Cercospora leaf spot

Fig. 4. Phenotypic correlation coefficient of dry pod yield per plot with twenty four characters



The phenotypic correlation of dry pod yield per plot was positive and significant with fresh pod yield per plot (r = 0.7541), haulm yield per plot on fresh weight basis (r = 0.4984), harvest index (r = 0.4946) and haulm yield per plot on dry weight basis (r = 0.4701). Significant positive association was also observed with mature to immature pod ratio and fresh pod yield per plant. Negative and non significant association of dry pod yield per plot was found with leaf number and leaf area index at vegetative phase and height of the plant. Rest of the characters showed positive and non significant association with dry pod yield per plot.

Correlation among the components

The estimates of correlation coefficients at the genotypic and phenotypic levels are given in Table 12.

At the genotypic level, association of height of the plant was found positive with dry matter addition on dry weight basis during reproductive phase (r = 0.5596), haulm yield per plant on dry weight basis (r = 0.5477), haulm yield per plant on fresh weight basis (r = 0.4713), dry matter addition on fresh weight basis during reproductive phase (r = 0.4706), hundred pod weight (r = 0.4208), fresh pod yield per plant (r = 0.3712) and pod yield per plot on fresh weight basis (r = 0.3339). Dry pod yield per plant, Cercospora leaf spot disease score, haulm yield per plot on dry weight basis, leaf number at vegetative phase, pod number per plant and haulm yield per plot on fresh weight basis also showed positive association with height of the plant. The association was found to be negative with first date of flowering (r = -0.5170), mature to immature pod ratio (r = -0.2149) and leaf area index at reproductive phase (r = -0.2033). Remaining characters also showed negative association with plant height.

The phenotypic association of height of the plant was positive and significant with haulm yield per plant on dry weight basis (r=0.3026), dry matter addition on fresh weight basis during reproductive phase (r = 0.2577), haulm yield per plant on fresh weight basis (r = 0.2472), 100 pod weight (r = 0.2292), fresh pod yield per plant (r = 0.1972), Dry matter addition on dry weight basis during reproductive phase, dry pod yield per plant, pod number per plant, duration of flowering, fresh pod yield per plot and leaf area index at vegetative phase showed positive non significant association with height of the plant. Rest of the characters showed negative and non significant association with this character.

At the genotypic level positive association was observed between dry matter addition on fresh weight basis during vegetative phase and dry matter addition on dry weight basis during vegetative phase (r =0.1210). At the phenotypic level the association was found positive and significant only with dry matter addition on dry weight basis during vegetative phase (r = 0.7431). First date of flowering, haulm yield per plan on fresh and dry weight basis, mature to immature pod ratio, 100 pod weight, 100 kernel weight , haulm yield per plot on fresh and dry weight basis, dry matter addition on fresh weight basis during reproductive phase, leaf area index and leaf number at vegetative phase and Cercospora leaf spot disease score have shown positive and non significant association with dry matter addition on fresh weight basis during vegetative phase. All the remaining characters showed negative association with this character.

Dry matter addition on dry weight basis during vegetative phase showed positive and significant phenotypic association with leaf area index at vegetative phase (r = 0.1950). Characters like first date of flowering, flowering duration, fresh pod yield per plant, pod number per plant, haulm yield per plot on fresh and dry weight basis, haulm yield per plant on dry weight basis, mature to immature pod ratio, 100 pod weight and hundred kernel weight showed positive and non significant association and the rest of the characters showed negative and non-significant association with dry matter addition on dry weight basis during vegetative phase.

Genotypic association of first date of flowering was found to be positive with haulm yield per plot on fresh weight basis (r = 0.4866), pod number per plant (r = 0.4826), shelling percentage (r = 0.4506), Cercospora leaf spot disease score (r = 0.3070) and leaf area index at reproductive phase (r = 0.2725). Duration of flowering, fresh and dry pod yield per plant, mature to immature pod ratio, fresh pod yield per plot, haulm yield per plot on dry weight basis and harvest index have also shown positive association with first date of flowering. Remaining characters showed negative association with first date of flowering. At the phenotypic level its association was positive and significant with duration of flowering (r = 0.3952), shelling percentage (r = 0.2730) and pod number per plant (r = 0.1994). Haulm yield per plot on fresh weight basis, dry pod yield per plant, mature to immature pod ratio, leaf area index and leaf number at vegetative phase, dry matter addition on fresh weight basis during reproductive phase and Cercospora leaf spot disease score have exhibited positive and non significant association with first date of flowering whereas the remaining characters except hundred pod weight, showed non significant, negative association with this character. Hundred pod weight showed negative and significant association with first date of flowering.

At the genotypic level, duration of flowering has shown positive association with fresh pod yield per plot (r = 0.2817), leaf number at vegetative phase (r = 0.2215), and 100 kernel weight (r = 0.2166). Pod yield per plant on fresh and dry weight basis, mature to immature pod ratio, hundred pod weight, haulm yield per plot on fresh and dry weight basis, harvest index and leaf area index at reproductive phase also showed positive association with this character. Rest of the characters also showed negative association with duration of flowering. Hundred kernel weight alone showed positive and significant phenotypic association (r = 0.2117) with duration of flowering. But it showed positive non significant association with dry pod yield per plant, pod number per plant, mature to immature pod ratio, hundred pod weight, pod yield perplot on fresh weight basis, haulm yield per plot on dry weight basis, harvest index and leaf number at vegetative phase. Negative non significant association was shown by rest of the characters.

Highly positive genotypic correlation of fresh pod yield per plant was noticed with dry pod yield per plant (r = 1.0140) dry matter addition on dry weight basis during reproductive phase (r = 0.8972), dry matter addition on fresh weight basis during reproductive phase (r = 0.8657), pod number per plant (r = 0.8607), haulm yield per plant on fresh weight basis (r = 0.8590) and haulm yield per plant on dry weight basis (r = 0.8574). Mature to immature pod ratio, shelling percentage, pod yield per plot and haulm yield per plot on fresh weight basis , harvest index and Cercospora leaf spot disease score were also showed positive association with fresh pod yield per plant, whereas hundred kernel weight, leaf area index during reproductive phase and leaf number at vegetative phase showed negative association with this character. At the phenotypic level highly significant and positive association was shown by fresh pod yield per plant with dry pod yield per plant (r = 0.9716) and pod number per plant (r= 0.8375). Haulm yield per plant on fresh and dry weight basis, mature to immature pod ratio, harvest index and dry matter addition on fresh and dry weight basis during reproductive phase have also exhibited positive and significant association with fresh pod yield per plant, leaf number at vegetative phase, hundred kernel weight, hundred pod weight and haulm yield per plot on fresh weight basis showed negative and non significant association while the remaining characters showed non significant and positive association with this character.

At the genotypic level very high positive association of dry pod yield per plant was noticed with haulm yield per plant on fresh weight basis (r = 1.0075), dry matter addition on fresh weight basis during reproductive phase (r = 1.0052), dry matter addition on dry weight basis during reproductive phase (r = 0.9781), haulm yield per plant on dry weight basis (r = 0.9696) and pod number per plant (r = 0.9407). Cercospora leaf spot disease score, mature to immature pod ratio, harvest index, shelling percentage, fresh pod yield per plot, fresh and dry haulm yield per plot and leaf number at vegetative phase also showed positive association with this character. Rest of the characters showed negative association with dry pod yield per plant. Dry pod yield per plant showed positive and significant phenotypic association with pod number per plant haulm yield per plant on fresh and dry weight basis, mature to immature pod ratio and dry matter addition on fresh and dry weight basis during reproductive phase . The following characters viz., 100-pod weight, 100 kernel weight, fresh pod yield per plot and fresh haulm yield per plot have shown negative and non significant association with dry pod yield per plant whereas the remaining characters showed positive and non significant association with dry pod yield per plant.

Pod number per plant exhibited positive genotypic association with dry matter addition on fresh weight basis during reproductive phase ($r = 0.6944$), haulm yield per plant on fresh weight basis ($r = 0.6881$), mature to immature pod ratio ($r = 0.6208$) and dry matter addition on dry weight basis during reproductive phase ($r = 0.6170$). Positive association of this character was also noticed with haulm yield per plot on fresh weight basis, shelling percentage, haulm yield per plant on dry weight basis, leaf area index at reproductive phase and Cercospora leaf spot disease score whereas hundred pod weight, leaf number at vegetative phase and hundred kernel weight exhibited negative association with pod number per plant. Remaining characters showed positive non significant association. At the phenotypic level pod number per plant has shown positive significant association with haulm yield per plant on fresh and dry weight basis, shelling percentage, dry matter addition on fresh weight basis and dry weight basis during reproductive phase. Negative significant association was shown by mature to immature pod ratio, hundred pod weight and hundred kernel weight. Leaf area index and leaf number at vegetative phase and pod yield and haulm yield per plot on fresh weight basis showed non significant negative association with pod number per plant. Remaining characters showed non significant positive association with this character.

Significant positive phenotypic correlation of haulm yield per plant on fresh weight basis was noticed with haulm yield per plant on dry weight basis, harvest index, Cercospora leaf spot disease score and dry matter addition on fresh and dry weight basis during reproductive phase. At the genotypic level these characters except Cercospora leaf spot disease score showed positive significant association with haulm yield per plant on fresh weight basis. Characters like mature to immature pod ratio, hundred pod weight, 100 kernel weight, leaf number at vegetative phase, shelling percentage, pod yield per plot on fresh weight basis, haulm yield per plot on fresh and dry weight basis and leaf area index at reproductive phase have shown negative association with haulm yield per plant on fresh weight basis.
Haulm yield per plant on fresh weight basis showed non significant and negative phenotypic association with mature to immature pod ratio, 100 pod weight, shelling percentage, pod yield per plot on fresh weight basis, leaf number at vegetative phase and haulm yield per plot on fresh weight basis. But significant negative association of this character was noticed with haulm yield per plot on dry weight basis and 100 kernel weight.

Genotypic correlation of haulm yield per plant on dry weight basis was found to be positive with dry matter addition on dry weight basis during reproductive phase (r = 1.0001), dry matter addition on fresh weight basis during reproductive phase (r = 0.7667), Cercospora leaf spot disease score (r = 0.5424), haulm yield per plot on dry weight basis (r = 0.3487). At the phenotypic level haulm yield per plant on dry weight basis showed positive and significant association with dry matter addition on dry weight basis (r = 0.8751) and dry matter addition on fresh weight basis (r = 0.8341) during reproductive phase. Haulm yield per plot on fresh weight basis, 100 kernel weight, leaf number at vegetative phase, shelling percentage, harvest index and leaf area index at reproductive phase showed negative association with haulm yield per plant on dry weight basis at the genotypic level, whereas 100 kernel weight alone showed negative and significant association with haulm yield per plant on dry weight basis at the phenotypic level. Shelling percentage and fresh haulm yield per plot exhibited non significant and negative association with this character.

Mature to immature pod ratio showed positive genotypic correlation with dry matter addition on dry weight basis during reproductive phase (r = 0.2396) leaf number (r = 0.2436), Cercospora leaf spot disease score (r = 0.2622) and harvest index (r = 0.2114). Shelling percentage, pod yield per plot on fresh weight basis, haulm yield per plot on dry weight basis, dry matter addition on fresh weight basis during reproductive phase and leaf area index at reproductive phase also showed positive association with this character. But it showed negative association with hundred pod weight, hundred kernel weight and haulm yield per plot on fresh weight basis. Mature to immature pod ratio showed positive and significant phenotypic association with dry matter addition or dry weight basis during reproductive phase (r = 0.2353). But characters like shelling percentage, Cercospora leaf spot disease score pod yield per plot on fresh weight basis, haulm yield per plot on dry weight basis, dry matter addition on fresh weight basis and leaf area index at reproductive phase showed non significant and positive association with this character. Hundred kernel weight, leaf number at vegetative phase, haulm yield per plot on fresh weight basis, leaf area index at vegetative phase and hundred pod weight showed negative and non significant association with mature to immature pod ratio.

At the genotypic level, hundred pod weight showed positive association with hundred kernel weight (r= 0.5708), haulm yield per plot on dry weight basis (r = 0.5392), leaf area index at reproductive phase (r = 0.3000), pod yield per plot on fresh weight basis (r = 0.2460) and haulm yield per plot on fresh weight basis (r= 0.2287). Shelling percentage, harvest index, leaf number at vegetative phase, dry matter addition on fresh weight basis during reproductive phase and Cercospora leaf spot disease score exhibited negative association with this character.

Hundred pod weight showed positive and significant phenotypic association with hundred kernel weight (r = 0.5399), haulm yield per plot on dry weight basis (r = 0.4236) and pod yield per plot on fresh weight basis (r = 0.1986). Negative and significant association of this character was noticed with shelling percentage and harvest index whereas leaf area index and leaf number at vegetative phase, Cercospora leaf spot disease score and dry matter addition on fresh weight basis during reproductive phase showed non significant and negative association with hundred pod weight. Remaining characters showed positive and non significant association with this character.

Hundred kernel weight showed positive genotypic association leaf area index at reproductive phase (r = 0.2618). It also showed positive association with pod yield per plot on fresh weight basis and haulm yield per plot on dry weight basis. Leaf number at vegetative phase, dry matter addition on fresh and dry weight basis during reproductive phase, harvest index, haulm yield per plot on fresh weight basis and Cercospora leaf spot disease score exhibited negative association with hundred kernel weight. At the phenotypic level hundred kernel weight showed negative and significant association with dry matter addition on fresh weight basis during reproductive phase (r = -0.3541), dry matter addition on dry weight basis during reproductive phase (r = -0.2408) and shelling percentage (r = -0.1958). The association was positive and non significant with pod yield per plot on fresh weight basis and haulm yield per plot on dry weight basis and leaf area index at reproductive phase. Rest of the characters showed negative and non significant association with hundred kernel weight.

Positive genotypic association of shelling percentage was found with haulm yield per plot on fresh weight basis (r = 0.0657) and Cercospora leaf spot disease score (r = 0.1417). At the phenotypic level it showed negative and non significant with pod yield per plot on fresh weight basis, harvest index, leaf area index and leaf number at vegetative phase and dry matter addition on fresh and dry weight basis during reproductive phase whereas haulm yield per plot on fresh and dry weight basis Cercospora leaf spot disease score and leaf area index at reproductive phase have shown positive and non significant association with shelling percentage. Pod yield per plot on fresh weight basis, harvest index, leaf area index and leaf number at vegetative phase dry matter addition on fresh and dry weight basis and leaf area index at reproductive phase exhibited negative genotypic association with shelling percentage.

Pod yield per plot on fresh weight basis has shown positive genotypic association with haulm yield per plot on dry weight basis (r = 0.4146), haulm yield per plot on fresh weight basis (r = 0.3818) and harvest index (r = 0.3252). Dry matter addition on dry weight basis during reproductive phase, leaf area index at reproductive phase and Cercospora leaf spot disease score also showed positive association with fresh pod yield per plot whereas leaf number at vegetative phase, dry matter addition on fresh weight basis during reproductive phase showed negative association with this character. At the phenotypic level this character showed positive and significant association with haulm yield per plot on fresh weight basis (r = 0.4395), haulm yield per plot on dry weight basis (r = 0.3903) and harvest index (r = 0.3340). Dry matter addition on fresh weight basis during reproductive phase and Cercospora leaf spot disease score showed non significant negative association with pod yield per plot on fresh weight basis. Dry matter addition on dry weight basis, leaf area index at reproductive phase, leaf area index and leaf number at vegetative phase showed positive and non significant association with this character.

Haulm yield per plot on fresh weight basis showed positive genotypic association with haulm yield per plot on dry weight basis (r = 0.6623), leaf number at vegetative phase (r = 0.4537), and leaf area index at reproductive phase (r = 0.3544). Harvest index and dry matter addition on fresh weight basis during reproductive phase showed negative association with this character. Cercospora leaf spot disease and dry matter addition on dry weight basis during reproductive phase. At the phenotypic level haulm yield per plot on fresh weight basis showed positive and significant association with haulm yield per plot on dry weight basis (r = 0.7218). Dry matter addition on fresh weight basis during reproductive phase showed negative and non significant association whereas harvest index showed negative and significant association with haulm yield per plot on fresh weight basis. Leaf area index and leaf number at vegetative phase, leaf area index at reproductive phase and Cercospora leaf spot disease score showed positive and non signification association.

Haulm yield per plot on dry weight basis showed positive genotypic association with dry matter addition on dry weight basis during reproductive phase (r = 0.3511) and leaf number at vegetative phase (r = 0.2755). Leaf area index at reproductive phase and Cercospora leaf spot disease score also showed positive association with this character. But harvest index and dry matter addition on fresh weight basis during reproductive phase showed negative association with haulm yield per plot on dry weight basis. At the phenotypic level it showed positive and non-significant association with dry matter addition on dry weight basis during reproductive phase, leaf area index at reproductive phase, leaf number and Cercospora leaf spot disease score. Dry matter addition on fresh weight basis during reproductive phase and harvest index showed negative and significant association with haulm yield per plot on dry weight basis. Leaf area index at vegetative phase showed non significance negative association.

Genotypic association of harvest index was found to be negative with leaf number at vegetative phase (r = -0.5561) dry matter addition on fresh weight basis during reproductive phase (r = -0.2988) and leaf area index at reproductive phase. Positive and significane phenotypic association of this character was found with dry matter addition on fresh weight basis during reproductive phase whereas it showed negative and non significance association with leaf area index at vegetative and reproductive phase, leaf number and Cercospora leaf spot disease score.

Dry matter addition on fresh weight basis during reproductive phase showed positive genotypic association with dry matter addition on dry weight basis during reproductive phase (r = 0.8219) and Cercospora leaf spot disease score (r = 0.4530). It showed negative association with leaf number at vegetative phase (r = -0.7984) and leaf area index at reproductive phase. At the phenotypic level it showed significance positive association with dry matter addition on dry weight basis (r = 0.8218). But non significant positive phenotypic association of dry matter addition on fresh weight basis was noticed with leaf area index at vegetative and reproductive phase and Cercospora leaf spot disease score. Leaf number at vegetative phase and leaf area index during reproductive phase showed negative and non significance association with this character.

At the genotypic level dry matter addition on dry weight basis during reproductive phase showed positive association with Cercospora leaf spot disease score ($r = 0.5710$). Leaf number at vegetative phase showed negative association with this character ($r = -0.3025$). At the phenotypic level this character showed negative and non significant association with leaf area index at reproductive phase and leaf number at vegetative whereas positive non significant association was reported by leaf area index at vegetative phase and Cercospora leaf spot disease score.

Leaf area index at vegetative phase showed positive significant positive association with leaf number at vegetative phase ($r = 0.6566$) whereas this character showed negativo association with leaf area index at reproductive phase. Cercospora leaf spot disease score showed positive and non significant association with this character.

At the genotypic level leaf area index at reproductive phase has got negative association with leaf number ($r = -0.5218$) and Cercospora leaf spot disease score ($r = -0.0266$). At the phenotypic level this character showed negative and non significant association with leaf number ($r = -0.1319$). But Cercospora leaf spot disease score has shown positive and non significance association with leaf area index at reproductive phase ($r = 0.0239$).

Both at phenotypic and genotypic level leaf number at vegetative phase showed positive association with Cercospora leaf spot disease score ($r_p = 0.1380$, $r_g = 1.3155$).

Plate 1. General view of the experimental field

Plate.2. ICG 4544 Promising variety identified
for partially shaded conditions

Promising varieties identified for partially shaded condition

Plate 3. ICG 3556

Plate 4. ICG 2224

Promising varieties identified for partially shaded condition

◀ Plate 5. ICG 274

Plate. 6. TG 14 ▶

DISCUSSION

DISCUSSION

Crop improvement, in general depends on the magnitude of genetic variability and extent to which the desirable characters are heritable. For initiating an effective breeding programme, evaluation of genetic variability on hand is indispensable. Such an evaluation can be done by suitable genetic parameters such as genotypic coefficient of variation, heritability estimate and association analysis. Only meagre information is available on the genetic variability present for various quantitative characters in groundnut especially under partial shade environment. The present study was hence taken up to estimate basic parameters of quantitative variability in groundnut grown as intercrop in coconut garden.

VARIABILITY

Groundnut is a self-pollinated species with very limited intervarietal variability. Intensive selection for yield and its component characters to suit local conditions and demand has further narrowed down the variability in the population.

Variance and coefficient of variation helps to measure the variability of a population. Phenotypic variability cannot be utilized for varietal improvement.

A knowledge of the extent of genetic variability is therefore important. So it is necessary to partition the overall variability into heritable and non heritable components.

The wider variation of gross range in the height of plant, haulm yield per plant on fresh weight basis, 100 pod weight, pod yield per plot on fresh and dry weight basis and dry matter addition on fresh weight basis during reproductive phase indicates that selection for these characters amongst the varieties would be more effective.

In the present study estimates of variance components showed little difference between phenotypic and genotypic variances for characters ∠ Table 13 ∠viz., first date of flowering (V_g = 0.597, V_p = 1.283) duration of flowering (V_g = 3.873, V_p = 4.634), mature to immature pod ratio (V_g = 1.365, V_p = 2.002), 100 pod weight (V_g = 494.467, V_p = 503.058), haulm yield per plot on fresh weight basis (V_g = 0.130, V_p = 0.326) and leaf area index at reproductive phase (V_g = 0.145, V_p = 0.687). This indicates that variation observed in these characters was mainly due to genetic causes and that environment had limited influence over them. On the other hand characters like height of the plant

Table 13. Phenotypic and genotypic variance for twentyeight characters studied in groundnut

Sl. No.	Character	Genotypic variance (V_g)	Phenotypic variance (V_p)
1.	Height of the plant (cm)	32.902	100.550
2.	Dry matter addition during vegetative phase (fresh weight) (g)	-2.715	133.436
3	Dry matter addition during vegetative phase (dry weight)(g)	-0.077	5.246
4.	First date of flowering(days)	0.597	1.283
5.	Duration of flowering (days)	3.873	4.634
6.	Pod yield per plant(fresh weight)(g)	1.206	9.102
7.	Pod yield per plant (dry weight)(g)	0.518	6.455
8.	Pod number per plant (number)	4.335	14.802
9.	Mature to immature pod ratio	1.365	2.002
10.	Haulm yield per plant (fresh weight)(g)	208.554	454.118
11.	Haulm yield per plant (dry weight)(g)	8.760	16.630
12.	100 - pod weight(g)	494.467	503.058
13.	100 - kernel weight(g)	31.746	35.035
14.	Shelling percentage (per cent)	16.626	19.385

(contd..)

Table 13. (contd.)

Sl. No.	Character	Genotypic variance (V_g)	Phenotypic variance (V_p)
15.	Pod yield per plot (fresh weight) (g)	6260.256	10667.770
16.	Pod yield per plot (dry weight)(g)	6495.039	8864.483
17.	Haulm yield per plot (fresh weight)(kg)	0.130	0.326
18.	Haulm yield per plot (dry weight)(g)	14246.820	22946.740
19.	Harvest index (per cent)	16.688	25.559
20.	Dry matter addition during reproductive phase (fresh weight)(g)	233.662	519.856
21.	Dry matter addition during reproductive phase (dry weight)(g)	12.147	29.980
22.	Leaf area index at vegetative phase	-0.001	0.015
23.	Leaf area index at reproductive phase	0.145	0.687
24.	Leaf number at vegetative phase	0.320	17.097
25.	Disease scoring for Cercospora leaf spot	0.333	1.385
26.	Chlorophyll-a(mg/litre)	0.035	0.912
27.	Chlorophyll-b(mg/litre)	-0.224	3.505
28.	Total pigments (mg/litre)	0.034	16.326

(V_g = 32.902, V_p = 100.55), pod yield per plant on fresh weight basis (V_g = 1.206, V_p = 9.102), pod yield per plant on dry weight basis (V_g = 0.518, V_p = 6.455), haulm yield per plant on fresh weight basis (V_g = 4.335, V_p = 14.802), haulm yield per plant on dry weight basis (V_g = 208.544, V_p = 454.118), 100 kernel weight (V_g = 331.746, V_p = 35.035), pod yield per plot on fresh weight basis (V_g = 6260.256, V_p = 10667.770) and haulm yield per plot on dry weight basis (V_g = 14246.820, V_p = 22946.740)showed wide differences between phenotypic and genotypic variances indicating the greater influence of environment over them.

Coefficient of variation is another means for expressing the amount of variability. In the present study phenotypic and genotypic coefficients of variation were highest for mature to immature pod ratio. Relatively high values of phenotypic coefficient of variation with correspondingly high values of genotypic coefficient of variation were recorded for pod number per plant, haulm yield per plant on fresh and dry weight basis, 100 pod weight and dry matter addition on fresh weight basis during reproductive phase. This suggests that there is scope for the improvement of these characters through selection. Dry matter addition on dry weight basis during vegetative phase, pod yield per plant on fresh and dry weight basis, leaf area index at vegetative and reproductive phase and the leaf number at vegetative phase recorded high values of phenotypic coefficient of variation.

In the present study phenotypic coefficient of variation was found to be more or less equal to genotypic coefficient of variation for 100 pod weight, duration of flowering and shelling percentage indicating the possibility of getting response to selection in these characters based on phenotypic expression.

High values of genotypic coefficient of variation observed for pod number per plant in the present study is in conformity with the findings of Khangura and Sandhu(1973), Sangha (1973), Shettar (1974) and Sivasubramaniam et al.(1977). Relatively high value of genotypic coefficient of variation observed for haulm weight per plant in the present study is in conformity with the findings of Basu and Ashokaraj (1969), Dixit et al. (1970), Kushwaha and Tawar (1973), Quadri and Khunti (1982) and Pushkaran (1983). The high phenotypic coefficient of variation as reported by Sangha (1973) for number of pods per plant in spreading type is found in conformity with the present study.

High values of coefficient of variation observed for the above characters indicated a high variability, which was mainly due to genetic cause and the environment had only a meagre influence on them.

Height of the plant showed a low genotypic and phenotypic coefficients of variation in the present investigation, as against observations by Venkateswaran (1966); Dixit et al. (1971); Kushwaha and Tawar (1973); Patra (1975); Sivasubramaniam et al. (1977); Nagabhushanam et al.(1982); Kandaswami et al.(1986) and Naidu et al.(1987). The difference may be due to the partial shade condition under which the present experiment was conducted.

A high phenotypic coefficient of variation reported by Majumdar et al.(1969); Raja Reddy and Prabhakara Reddy(1979); Kuriakose (1981), Pushkaran (1983); Kataria et al.(1984); Kandaswami et al.(1986) and Naidu et al. (1987) for pod yield per plant is in agreement with the present observation. But in the present study high values of phenotypic coefficient of variation with correspondingly low values of genotypic coefficient of variation was observed for pod yield per plant indicating a high influence of environment on the expression of this character under partial shade conditions.

In the present study it was observed that genotypic coefficient of variation was low for first date of flowering.

Similar results were reported by Quadri and Khunti (1982). As against this Basu and Ashokaraj (1969) reported a high genotypic coefficient of variation for this character.

Patil and Bhapkar (1987) reported a high genotypic coefficient of variation for duration of flowering. But it was found to be low in the present study. Low genotypic and phenotypic coefficient of variation observed for first date of flowering and flowering duration in the present investigation indicated that genetic variability and environmental effects are generally low on the expression of these characters under partial shade conditions.

In the present study dry haulm yield per plant recorded a high genotypic and phenotypic coefficients of variation. Similar results were reported by Chandramohan _et al._ (1967) ; Basu and Ashokaraj (1969), Dixit _et al._ (1970), Kushwaha and Tawar (1973) and Quadri and Khunti (1982).

In the present investigation genotypic coefficient of variation was found to be high for 100 pod weight. This finding agrees with the earlier findings of Dixit _et al._ (1970) and Kuriakose (1981). High phenotypic coefficient of variation observed for this character in the present study is in agreement with the findings of Majumdar _et al._ (1969).

But Kushwaha and Tawar (1973) and Kandaswami et al. (1986) got low values of phenotypic and genotypic coefficientsof variation for this character.

Hundred kernel weight in this study exhibited a moderate genotypic and phenotypic coefficientsof variation. Khangura and Sandhu (1973) also made a similar observation for this character in the spreading type. Badwal et al. (1967), Mohammed et al. (1973), Sangha (1973), Natarajan et al. (1978), Kumar and Yadava (1979), Kuriakose (1981), Nagabhushanam et al. (1982), Quadri and Khunti (1982), Kataria et al.(1984), Chauhan and Sukla (1985), Kandaswami et al.(1986) and Patil and Bhapkar (1987) have reported a high genotypic coefficient of variation for this character.

In the present study shelling percentage recorded a low genotypic coefficient of variation. Similar results were reported by Khangura and Sandhu (1973), Kushwaha and Tawar (1973), Kuriakose (1981), Nagabhushanam et al.(1982) and Quadri and Khunti (1982). Contrary to this Mohammed et al. (1973), Natarajan et al.(1978), Kumar and Yadava (1979) and Kataria et al. (1984) have reported high coefficient of variation for shelling percentage.

Harvest indices have got only moderate phenotypic and genotypic coefficients of variation in the present study. A high variability in harvest index was noted by Natarajaratnam (1979), Venkateswaran (1980), Chauhan and Sukla (1985), Quadri and Khunti (1982) and Kandaswami *et al*. (1986) probably due to the open field conditions under which they have conducted the experiment.

HERITABILITY, GENETIC ADVANCE AND GENETIC GAIN

Heritability estimate provides an exact and precise information of the influence of environment on various characters. Johnson *et al*. (1955) have suggested that heritability estimates along with genetic gain is more useful than heritability value alone in predicting the resultant effect and selecting the best individual. Heritability estimates have found to be helpful in making selection of superior genotype on the basis of phenotypic performance.

The characters in the order of magnitude of heritability obtained in the present study were hundred pod weight (98.29 per cent), hundred kernel weight (90.61 per cent), shelling percentage (85.77 per cent), duration of flowering (83.58 per cent), dry pod yield per plot (73.27 per cent), mature to immature pod ratio (68.21 per cent), harvest index (65.29 per cent) and dry haulm yield per plot (62.09 per cent). Bernard (1960), Dixit *et al*. (1970), Kushwaha and Tawar(1973), Kuriakose (1981), Harisingh et al.(1982), Quadri and Khunti (1982), Pushkaran (1983), Kataria et al. (1984) Patil and Bhapkar (1987) and Naidu et al. (1987) have reported similar results in shelling percentage. High heritability observed for hundred pod weight in the present investigation is in agreement with the results reported by Cahaner (1978).

High heritability observed for the duration of flowering, as reported by Majumdar et al. (1969), Pushkaran (1983) and Patil and Bhapkar (1987) found to agree with the present finding. Contrary to the present result for harvest index, a low heritability estimate was reported by Harisingh et al. (1982) and a moderate value by Chauhan and Sukla (1985) and Kandaswami et al. (1986). High values of heritability for the above characters indicate that genetic factors are important in the expression of these characters, while environment plays relatively a limited role in bringing about phenotypic variability.

Heritability estimates have been found to be helpful in making selection of superior genotypes on the basis of phenotypic performance of the quantitative characters. But heritability does not give a clear picture of the genetic progress. For this, genetic advance and genetic gain should be considered along with heritability values (Johnson et al. 1955).

Genetic advance expressed as percentage of mean was high for mature to immature pod ratio (57.85 per cent), 100 pod weight (46.55 per cent) dry pod yield per plot (29.75 per cent), dry haulm yield per plant (27.20 per cent), 100 kernel weight (26.89 per cent) dry haulm yield per plot (26.79 per cent) fresh haulm yield per plant (24.23 per cent) and pod number (22.57 per cent). Genetic gain was least for chlorophyll 'a' (0.65 per cent).

Cahaner (1978), Dorairaj et al. (1979) and Pushkaran (1983) have reported high genetic advance for hundred pod weight. Genetic advance for 100 kernel weight as reported by Dixit et al. (1970), Sangha (1973), Kushawaha and Tawar (1973), Sangha and Sandhu (1975), Dorairaj et al. (1979), Kataria et al. (1984) and Patil and Bhapkar (1987) was found to coincide with the observation of the present study. The high genetic advance obtained in respect of dry haulm yield per plant is in agreement with the findings of Pushakaran (1983). However findings of Dixit et al.(1970) and Kuriakose (1981) with regard to this character wqs contrary to the present observation.

In the present study dry pod yield per plot, dry haulm yield per plot and 100 pod weight, hundred kernel weight and mature to immature pod ratio have got high heritability combined with high genetic advance.

Pushkaran (1983) and Dorairaj _et al_.(1979) have reported similar observation for 100 pod weight. High heritability combined with high genetic advance observed for the above characters indicate that this character is controlled by additive gene action and that improvement by individual plant selection for this character would be more effective.

High heritability combined with low genetic advance was obtained for duration of flowering, shelling percentage and harvest index. Kuriakose (1981), Pushkaran (1983), Patil and Bhapkar (1987) and Naidu _et al_. (1987) have observed similar result for shelling percentage. High heritability with low genetic advance indicates non-additive gene action, which greatly limit the scope for improvement of these characters through selection (Panse,1957).

The present study indicated a moderate heritability and low genetic advance for first date of flowering and height of the plant. Sivasubramaniam _et al_. (1977) and Kandaswami _et al_. (1986) have reported moderate heritability with moderate genetic advance for height of the plant. Contrary to the present finding, Dixit et al. (1971) and Sangha and Sandhu (1975) reported a high genetic advance for height of the plant. Pushkaran (1983) reported high heritability coupled with low genetic advance for first date of flowering whereas in the present study moderate heritability coupled with low genetic advance was observed for this character. Characters like pod number per plant, pod yield per plant, 100 kernel weight, leaf number at vegetative phase, leaf area index at reproductive phase, disease rating for cercospora leaf spot and chlorophyll-a exhibited low heritability and genetic advance in the present study. Kumar and Yadava (1979) have reported low heritability and genetic advance for 100 kernel weight. Kandaswami et al. (1986) has reported a low heritability estimate for 100 kernel weight.

The results as reported by Kuriakose (1981) and Sivasubramaniam et al.(1977) for pod yield per plant was found to coincide with results of the present study. As against this result, Raman and Sreerangaswamy (1970), Kushwaha and Tawar (1973), Patra (1975), Dorairaj et al(1979) and Patil and Bhapkar (1987) have observed a high heritability and genetic advance for pod yield per plant.

A high heritability and genetic advance noticed by Sandhu and Khehra (1977) for Cercospora leaf spot is contrary to the present finding. As against the present finding, Sangha (1973) reported high heritability and genetic advance for number of pods per plant. But the results reported by Ramanathan (1980) coincide with the results of present finding for this character.

Low heritability and genetic advance observed for the above characters in the present study indicate that these characters are under the profound influence of environmental factors and will give only a poor response for selection especially under the partial shade situation.

CORRELATION

The association analysis in this study revealed that the genotypic correlations were in general of higher magnitude than the corresponding phenotypic correlations. These findings are in conformity with the results reported by Pushkaran (1983).

In the present investigation height of the plant had a positive association with pod yield. This finding is in agreement with the results reported by Comstock and Robinson (1952), Dorairaj (1962), Coffelt and Hammons (1974), Shettar (1974), Rao (1978/79), Rao (1980), Venkateswaran (1980), Yadava *et al.* (1981) and Moustafa and Sayed (1971) have reported positive and non significant association between height of the plant and yield, but a negative significant association between plant height and yield was reported by Mahapatra (1966), Kuriakose (1981) and Wu (1983).

Positive genotypic correlation was observed between first date of flowering and pod yield in the present study. Rao (1978/79) and Yadava *et al.* (1981) have reported a similar results. But a negative association between these characters was reported by Kushwaha and Tawar (1973) and Shettar (1974).

In the present investigation a positive association was observed between yield per plot and yield per plant.

Results reported by Comstock and Robinson (1952), Ling (1954), Mistra (1958), Dorairaj (1962), Jaswal and Gupta (1966), Lin and Chen (1967), Dholaria *et al.* (1972) Phadnis *et al.* (1973), Coffelt and Hammons (1974), Nair (1978), Singh *et al.* (1979), Rao (1980), Venkateswaran (1980), Labana *et al.* (1980) and Khangura and Sandhu (1973) were in agreement with the present finding for the positive association between pod number and yield.

Positive association observed between haulm yield per plant and yield in the present study is in conformity with the findings of Mahapatra (1966). Chandramohan et al. (1967), Kushwaha and Tawar (1973) and Nair (1978). Contrary to this finding Kuriakose (1981) reported a negative association for this character with yield.

In the present investigation, 100 pod weight and yield exhibited positive association. This is in agreement with the results reported by Nair (1978), Kuriakose (1981), Pushkaran (1983) and Deshamukh et al. (1986).

Findings of Prasad and Srivastava (1968), Dholaria et al. (1972), Sangha (1973), Shettar (1974), Rao (1978/79), Singh et al. (1979). Labana et al. (1980), Kuriakose (1981) Nagabhushanam et al. (1982), Kataria et al. (1984) and Deshamukh et al.(1986) for the association of 100 kernel weight and yield were in agreement with the result of the present investigation.

Negative association observed between shelling percentage and yield in the present study is in conformity with the results obtained by Shettar (1974). But a positive association was reported by Raman and

Sreerangaswamy (1970), Dholaria *et al.* (1972), Khangura and Sandhu (1973), Kumar and Yadava (1979), Venkateswaran (1980), Kuriakose (1981) and Nagabhushanam *et al.* (1982) for the above characters. This anomalous correlation between shelling percentage and pod yield obtained in the present study may be due to the effect of partial shade on the sink source relationship leading to the development of pods.

Other characters which showed positive association with yield in the present study were haulm yield per plot on fresh and dry weight basis and mature to immature pod ratio and photosynthetic efficiency during reproductive phase.

Harvest index exhibited a positive association with yield in the present study. This is in agreement with the findings of Natarajaratnam (1979).

In the present study a low positive association was observed between disease rating for Cercospora leaf spot and yield. Negative association reported for leaf number with yield in the present investigation is in conformity with the findings of Kuriakose (1981). Cercospora leaf spot disease score exhibited a low positive association with yield. This indicates that the disease has not affected the yield adversely. This is logical when we consider the fact that the disease symptoms appeared only very late in the season and the disease scores indicating moderate resistance to moderate susceptibility (3-7).

Among the yield components also, the genotypic correlations were higher than the corresponding phenotypic correlations (Table 12).

In the present investigation height of the plant showed positive correlation with haulm yield per plant, pod number and hundred pod weight. The first date of flowering showed a negative association with the height of the plant. Contrary to the present finding Lin et al. (1969) reported a negative correlation between height of the plant and pod number per plant. Results reported by Kushwaha and Tawar (1973), Pushkaran (1983) for the association between height of the plant and haulm yield per plant are in conformity with the present observation. Dorairaj et al. (1979) and Pushkaran (1983) also reported a positive significant correlation between plant height and hundred pod weig . As in the present study Dorairaj *et al.*(1979) got positive and significant association between plant height and 100 kernel weight. This finding is contrary to the result of the present study where a negative association was observed between plant height and 100 kernel weight.

The plant height showed negative association with shelling percentage which coincides with the findings of Pushkaran (1983).

It was found that the association of first date of flowering and 100 kernel weight was negative. Kushwaha and Tawar (1973) found a positive association between first date of flowering and 100 kernel weight. Pushkaran (1983) also observed a negative association between first date of flowering and 100 kernel weight as in the present study. This result indicates that simultaneous improvement of the above two character cannot be achieved by applying selection. Results obtained in this study for the association of first date of flowering with 100 pod weight and haulm weight per plant are contrary to the findings of Pushkaran (1983) whereas positive association observed between first date of flowering and shelling percentage is in agreement with the findings of Pushkaran (1983).

In the present investigation first date of flowering exhibited negative association with 100 kernel weight and height of the plant. Kushwaha and Tawar (1973) reported a positive association between first date of flowering and 100 kernel weight. Pushakaran (1983) also observed negative and significant association between first date of flowering and 100 kernel weight and plant height.

Lin et al. (1969) reported a negative correlation between pod number and height of the plant, a positive significant correlation between pod number per plant and shelling percentage. Present study also showed a positive association between pod number and shelling percentage. This indicates that selection for pod number would result in the simultaneous improvement of shelling percentage. But the association between pod number per plant and plant height as reported by Lin et al. (1969) is contrary to the present finding.

Haulm yield per plant showed positive association with 100 pod weight and negative association with hundred kernel weight and shelling percentage.
Pushakaran (1983) also reported similar association between haulm yield per plant and 100 pod weight. But he reported a positive association between haulm yield per plant and

100 kernel weight as against the present finding. Pushkaran (1983) reported a negative and significant association between hundred pod weight and shelling percentage which is in agreement with the result of present study.

In the present study shelling percentage exhibited a negative association with 100 kernel weight and 100 pod weight. Kushwaha and Tawar (1973) got the same result as in the present study. Dholaria *et al*. (1972) and Pushkaran (1983) observed a negative and significant association between shelling percentage and 100 pod weight whereas Kataria *et al*. (1984) reported a positive association between shelling percentage and 100 kernel weight.

In conclusion the present study revealed the possibility of selecting a higher yielding bunch type groundnut variety, suitable for growing under partial shade condition, by looking for the tallest, earliest flowering and vegetatively maximum vigorous individual plant .

SUMMARY

SUMMARY

A research programme was carried out at the Department of Plant Breeding, College of Agriculture, Vellayani, during Kharif, 1987, with the objective of estimating genetic variability, heritability and genetic advance and correlation of pod yield with other yield components in groundnut varieties under partially shaded conditions in coconut gardens.

Thirtyone varieties of groundnut were evaluated under partially shaded conditions in the interspaces of coconut plantation adopting a randomised block design with four replications. Data on the following characters viz., leaf number (at vegetative phase), height of the plant, chlorophyll content of the leaves, first date of flowering, duration of flowering, fresh and dry pod yield per plant and per plot, fresh and dry haulm yield per plant and per plot, pod number per plant, mature to immature pod ratio, 100 kernel weight, 100 pod weight, shelling percentage, harvest index and Cercospora leaf spot disease score during reproductive phase, photosynthetic efficiency, leaf area index and intensity of shade in each plot (at vegetative and reproductive phases) were collected.

The data were subjected to analysis of variance and the genotypic and phenotypic coefficients of variation (GCV and PCV respectively), heritability (H^2) in the broad sense and genetic advance (G.A.) were estimated and the genotypic and phenotypic correlations worked out.

The important results obtained in this study are the following:-

Analysis of variance for twentyfour characters revealed significant differences among the varieties for height of the plant, first date of flowering, flowering duration, fresh pod yield per plant, pod number per plant, mature to immature pod ratio, pod yield per plot on fresh and dry weight basis, 100 pod weight, 100 kernel weight, shelling percentage, haulm yield per plant and per plot on fresh and dry weight basis, harvest index, photosynthetic efficiency during reproductive phase, leaf area index at reproductive phase and Cercospora leaf spot disease score indicating the presence of high variability for these characters. Analysis of variance for chlorophyll pigments (Chlorophyll-a, b and total pigments) during reproductive phase revealed that there was no significant difference in the chlorophyll pigments among the thirtyone varieties. Shade intensity observed in each plot at three different times of the day during vegetative and reproductive phases of the crop also did not show any significant difference in magnitude, indicating the presence of uniform shade conditions in the experimental field.

High genotypic and phenotypic coefficients of variation were observed for the characters like mature to immature pod ratio, pod number per plant, haulm yield per plant on fresh and dry weight basis, hundred pod weight and dry matter addition on fresh and dry weight basis (photosynthetic efficiency) during reproductive phase, indicating the presence of greater genetic variability and better scope for the genetic improvement of these characters by means of selection.

High heritability estimates were recorded for hundred pod weight, hundred kernel weight, shelling percentage, duration of flowering, dry pod yield per plot, mature to immature pod ratio, harvest index and dry haulm yield per plot, revealing the lesser influence of the environment in the expression of these characters.

Genetic advance as percentage of mean was higher for characters such as mature to immature pod ratio, hundred pod weight, dry pod yield per plot, dry haulm yield per plant, 100 kernel weight and dry haulm yield per plot. High heritability combined with high genetic advance was recorded for 100 pod weight, 100 kernel weight, dry pod yield per plot, dry haulm yield per plot and mature to immature pod ratio, suggesting the reliability of these characters during selection programmes for the improvement of this crop.

Correlation analysis of dry pod yield per plot with twentyfour characters indicated that characters viz., fresh pod yield per plot, fresh and dry pod yield per plant, pod number per plant, harvest index, haulm yield per plot on fresh and dry weight basis and photosynthetic efficiency during reproductive phase recorded relatively high and positive genotypic correlation with dry pod yield per plot.

Based on the results of this study it is concluded that for selecting a higher yielding bunch type of groundnut, suitable for growing under partially shaded conditions, we have to look for the tallest, earliest flowering and maximum vigorous individual plant. It is suggested that these characters may be taken into consideration by groundnut breeders during selection programmes for developing high yielding groundnut varieties suited to partially shaded conditions in coconut gardens.

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* Original not seen.

ABSTRACT

A study on the parameters of variability, heritability and genetic advance and correlation of pod yield with other components were undertaken in thirtyone varieties of groundnut to select genotypes having good yield and adaptability under partially shaded conditions of coconut gardens. The study was conducted during Kharif 1987 at the Department of Plant Breeding, College of Agriculture, Vellayani, by raising the varieties in a randomised block design with four replications.

Analysis of variance revealed significant differences among varieties for the characters like plant height, first date of flowering, flowering duration, pod yield per plant on fresh weight basis, pod number per plant, mature to immature pod ratio, pod yield per plot on fresh and dry weight basis, 100 pod weight, 100 kernel weight, shelling percentage, haulm yield per plant and per plot on fresh and dry weight basis, harvest index, photosynthetic efficiency at reproductive phase, leaf area index at reproductive phase and Cercospora leaf spot disease score.

Analysis of variance for chlorophyll-a, b and total pigments revealed that there was no significant difference among the varieties with respect to chlorophyll pigment content.

Analysis of variance for shade intensity measured in each plot during vegetative and reproductive phase indicated the presence of uniform shade in the experimental field.

High genotypic and phenotypic coefficients of variations, heritability and genetic advance were observed for hundred pod weight and mature to immature pod ratio, suggesting the reliability of these characters during the selection programme for the improvement of this crop.

Correlation analysis of dry pod yield per plot with twentyfour characters revealed that fresh pod yield per plot, fresh and dry pod yield per plant, pod number per plant, haulm yield per plot on fresh and dry weight basis, harvest index and photosynthetic efficiency during reproductive phase showed relatively high genotypic correlation with dry pod yield per plot.

The study indicated that for selecting an ideal plant type of groundnut for partially shaded conditions we have to look for the tallest, earliest flowering and vegetatively maximum vigorous individual plant.