GENETIC VARIABILITY, HERITABILITY, GENETIC ADVANCE, CORRELATION AND PATH ANALYSIS IN VIRGINIA BUNCH GROUP OF GROUNDNUT

(Arachis hypogaea L.)

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(*Arachis hypogaea* L.)

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ABSTRACT

The present experiment was undertaken with the objective of gathering information pertaining to magnitude of variability, heritability, genetic advance, correlation and path analysis among thirteen different plant characters viz, pod yield per plant, days to 50% flowering, plant height, number of primary branches per plant, days to maturity, number of mature pods per plant, kernel yield per plant, 100 pods weight, 100 kernels weight, shelling percentage, harvest index, oil content and protein content. The experiment consisted of 45 genotypes was laid out in randomized block design with three replication during Kharif - 2002 at Regional Oilseed Research Station, Gujarat Agricultural University, Talod, District :Sabarakantha.

The analysis of variance revealed considerable genetic differences among genotypes for all the characters indicating sufficient variability is present in the population. Moreover, genotypic variance was higher than environmental variance for all the characters.

The high genotypic coefficient of variation and phenotypic coefficient of variation were observed for kernel yield per plant, pod yield per plant, harvest index and number of mature pods per plant. The moderate values were observed for number of primary branches per plant, 100 kernels weight, plant height, protein content and 100 pods weight. The low values were found for shelling percentage, oil content, days to 50% flowering and days to maturity.

Broad sense heritability was higher for 100 pods weight, oil content, protein content, harvest index, shelling percentage, 100 kernels weights, days to 50% flowering and days to maturity.

The high genetic advance was exhibited by 100 pods weight followed by shelling percentage and 100 kernels weight. The expected genetic advance as percentage of mean was high for kernel yield per plant followed by harvest index.

In general, the genotypic correlation coefficients were relatively higher than the phenotypic correlation coefficients. Correlations computed between pod yield and its components indicated a positive and significant correlation of pod yield with plant height, shelling percentage, oil content, 100 pods weight, 100 kernels weight, harvest index, number of mature pods per plant and kernel yield per plant. While it was negatively correlated with number of primary branches per plant, days to 50% flowering and days to maturity.

The path coefficient analysis of pod yield and twelve causal variables revealed that high direct effect were exerted by number of mature pods per plant, kernel yield per plant and 100 kernels weight. These traits exhibited positive and significant correlations with pod yield per plant, therefor these characters may be considered as the most important yield attributing characters.

Based on above findings, it was suggested that more emphasis should be given to number of mature pods per plant, kernel yield per plant and 100 kernels weight in selection to increase pod yield in groundnut.

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CERTIFICATE

This is to certify that the thesis entitled **"GENETIC VARIABILITY, HERITABILITY, GENETIC ADVANCE, CORRELATION AND PATH ANALYSIS IN VIRGINIA BUNCH GROUP OF GROUNDNUT** (*Arachis hypogaea* L.)" submitted by **PATEL R.M.** in partial fulfillment of the requirement for the degree of **MASTER OF SCIENCE (Agriculture)** in the subject of **PLANT BREEDING AND GENETICS** of the S. D. Agricultural University is a record of bonafide research work carried out by him under my guidance and supervision and the thesis has not previously formed the basis for the award of any diploma, degree or other similar title.

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Place : Sardarkrushinagar. **(N. H. PATEL)**

Date : 30.09.2004 **MAJOR ADVISOR**

DECLARATION

This is to declare that whole research work reported in this thesis in partial fulfilment of the requirement for the degree of **MASTER OF SCIENCE (Agriculture)** in the subject of **PLANT BREEDING AND GENETICS** by the undersigned is the result of investigation done by him under the guidance and supervision of **Dr N. H. PATEL**, Research Scientist, Potato Research Station, S.D. Agricultural University, DEESA and that no part of the work has been submitted for any other degree.

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Place: Sardarkrushinagar **(R. M. PATEL)**

Date: 30 - 9 - 04

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I. INTRODUCTION

The cultivated groundnut (*Arachis hypogaea* L.) has its origin in South America. It is now commercially grown in over 100 countries in the world and plays an important role in the economy of several countries. India accounts about 40 percent of the world area and 30 percent of the world production of groundnut.

In India groundnut is the principal oilseed crop and contributes about 35 percent of the area and 40 percent of the production of the oilseed crops grown in the country. It is cultivated in an area of about 4.3 million hectares with the production of about 7.8 million tones of pods. Among the major groundnut growing states, Gujarat ranks first in production and second in area in the country and occupies a predominant place in Hand Picked Selected groundnut trade. The Hand Picked Selected (HPS) groundnut mainly exported from Saurashtra region of Gujarat state.

Though India is the second largest groundnut producing country in the world, its share in the world edible groundnut market is about one lakh tones during the last one decade, which is only 1.3 percent of the total groundnut production of the country (Singhal, 1999)

Groundnut is valued for both edible oil and confectionery purposes. About two thirds of the crop produced in the world crushed to extract oil and one third used to make other edible products.

Groundnut kernels consumed as raw, boiled, roasted or fried and used in a variety of culinary preparations like peanut candy, peanut butter, chocolates, chicki, etc.

The HPS groundnuts fetch premium in the international market. Although India was one of the prominent supplier of confectionary groundnuts in the past (up to 1976), its share in the world market dwindled due to the stringent quality control measurers adopted by the importers. The groundnut trade in the past was restricted to hand picked selected seeds from small seeded cultivars mainly because of non-availability of cultivars with bold seed and good seed quality. Therefore, there is an urgent need to breed and develop bold seeded and good quality confectionery groundnut varieties to boost Indian share groundnut export in the world market.

Groundnut is a self pollinated allotetraploid legume with 2n = 40 chromosomes. Its quick growth, short duration and photo insensitive nature enable the plant breeders to raise two crops in a year, thereby reducing the maturity period of improvement. It also has broad spectrum of variability in yield and confectionery characters like seed size (0.1-1.4g), seed length(4-23mm), seed width (5-13mm), oil (31-55%), test color, protein (16-34%), sugar (5-16%), amino acids and fatty acids composition, The Virginia runner and Virginia bunch varieties of groundnut belonging to sub species *hypogaea* are generally bold in seed size, high yielding and late in maturity. The Spanish and Valencia varieties belonging to sub species *fastigata* are comparatively small seeded, poor yielder and early maturing. All these four botanical types are cross compatible and considered as potential sources of genetic variability. Hence inter sub specific hybridization has often been recommended for the improvement of groundnut (Wynne and Coffelt, 1975, Gibbons, 1976)

Exploitation of genetic variability in the available germplasm is a prerequisite in breeding programme for increasing yield and improving quality.

The studies of heritability, genetic coefficient of variance and genetic advance are essential as high values of these parameters suggest additive gene effects, Burton (1952) had suggested that G.C.V. together with heritability estimates would give the best picture of the amount of advance to expect by selection. All these parameters considered in conjunction to bring effective improvement in yield and other complex characters, Knowledge of genetic variability and association between yield and other important traits is helpful in selecting suitable plant type.

It is also essential to have knowledge of correlation between characters contributing towards pod yield. The variability estimates of quantitative characters and intensity of association between these in groundnut is of particular interest. This becomes more important as main component of yield is pod. As pod develops under ground, association with aerial morphological characters is very essential as these can serve as a guideline for selecting better genotypes. Yield is a complex character governed by several other yield attributing traits. Since, most of the yield attributing traits are quantitatively inherited and highly affected by environment, it is difficult to judge whether the observed variability is inheritable or not. The primary parameters like genotypic and phenotypic variances, genetic advance, genetic gain and heritability are useful in understanding the nature of inheritance of different traits.

The study of extent of association between characters has been suggested to be valuable in assessing importance of various component characters affecting pod yield. The correlation coefficient indicated the degree of relationship between characters but it alone does not give clear picture of associationship between yield and its components. In this context, path analysis techniques of Wright (1921) elucidated for plant breeding problems by Dewey and Lu (1959) is an important tool, which partition the correlation co efficient into direct and indirect effects of the independent variable on the dependent variable i.e. Pod yield and it permits examination of the specific forces acting to produce a given correlation and measure the relative importance of each factor.

The present study was conducted on 45 Virginia bunch cultivars of groundnut to study the following aspects.

1. To find out genotypic and phenotypic variability present in material for different economic characters.
2. To estimate the heritability and genetic advance for different characters.
3. The extent of phenotypic, genotypic and environmental correlations between different economic characters.
4. To know the direct and indirect effect of yield contributing characters through path coefficient analysis.

II. REVIEW OF LITERATURE

Research on groundnut is gaining momentum due to oil shortages in the country. There is a great awareness among the farmers to grow this crop in large areas. Due to this awareness, the breeders are becoming more interested in this crop for building new genotypes, which will be better suitable for changing agriculture. The literature pertaining to variability, heritability, genetic advance, and correlation and path coefficients reviewed below

2.1 GENETIC VARIABILITY, HERITABILITY AND GENETIC ADVANCE

Kulkarni and Albuquerque (1967) studied 9 different strains of groundnut and found high heritability for the height of main stem, number of primary branches and number of mature pods and also high genotypic coefficient of variation for number of primary branches.

While studying variability and genetic advance in 60 varieties of groundnut, Badwal et al (1968) found high genetic variability and expected genetic advance for seed size, days to 50 % flowering and seeds per pod. Oil content also had high genetic variability, but low expected genetic advance.

Ashokaraj (1969) studies a set of 14 groundnut varieties for number of days to flowering, pods per plant and 100 kernels weight, the genotypic coefficient of variation found to be high for number of days to flower and pods per plant. He concluded that selection for days to flowering and number of pods per plant might base on phenotypic performance.

During their investigation in 45 different varieties of groundnut, Majmudar et al (1969) observed wide range of variation for period of flowering, number of branches per plant, number of nodes per plant, days to maturity, number of mature pods, number of leaves, number of peg bearing nodes, 100 pods weight, shelling percentage and pod yield. The highest genotypic coefficient of variation reported for number of branches followed by number of leaves, number of bearing nodes and length of pod. High heritability estimates in the broad sense were recorded for days to maturity, length of pod, days to flower, period of flowering, number of leaves, 100 kernels weight and number of branches, while moderate heritability was obtained for shelling percentage and low estimates for number of mature pods and pod yield. They further found high heritability together with high genetic advance for number of branches, number of leaves and number of pods. They interpreted that high heritability obtained for these characters was probably due to additive gene effects.

Dixit et al. (1970) conducted variability and heritability studies in 108 bunch varieties of groundnut. They found wide range of variation for primary branches per plant and average number of kernels per pod. They also reported high heritability estimates for number of primary branches per plant, green weight of pods per plant, 100 pods weight, 100 kernels weight and average number of kernel per pod. However, low heritability observed in dry weight of mature pods per plant, shelling percentage and other characters.

Sangha and Sandhu (1970) studied genetic variability in 27 bunch and 27 spreading varieties of groundnut. They observed that genotypic coefficient of variation and genetic advance in the erect group were very high for secondary nodes per secondary and primary branches and in the spreading group, for 100-kernels weight and the number of pods per plant. They concluded that the material offered considerable scope for improvement in these characters. They also observed that 100 kernels weight in both the groups had the highest heritability estimates. Secondary branches per plant, one seeded pods, lateral spread and number of pods in bunch group and lateral spread and one seeded pod in spreading group showed moderate values. The lowest heritability was recorded for the vegetative nodes per secondary branches in the bunch group and for fruiting nodes per primary branch in spreading group.

Dixit et al.(1971) studied genotypic and phenotypic variability, heritability and genetic advance in 57 varieties of bunch and spreading types of groundnut under three environments. They recorded the maximum range of variation for weight of green mature pods and low variation in number of primary branches per plant, phenotypic and genotypic variances were higher than in spreading group. Phenotypic and genotypic coefficients of variation were higher for the number of secondary branches and weight of mature pods per plant. Heritability estimates were higher for number of primary branches, number of secondary branches, height of the main stem and number of nodes on main stem.

Dholaria (1971) investigated genetic variability, heritability and genetic advance in 20 spreading and 20 bunch varieties of groundnut under two fertility level. For high fertility level, high heritability estimates were obtained for number of pods per plant, number of branches per plant, yield of kernel per plant and 100 kernels weight in spreading group, while high expected genetic gain were observed for number of pods per plant and 100 kernels weight in bunch group.

Sangha (1973) recorded that in spreading group 100-kernels weight exhibited maximum genotypic as well as phenotypic coefficient of variation, heritability and genetic advance followed by number of nodes per plant and pod yield per plant. Number of pods per plant had high genetic variation, but low expected genetic advance.

While studying genetic variability in 30 genotypes of spreading groundnut, Khangura and Sandhu

(1973) showed that phenotypic and genotypic coefficient of variation were comparatively high for the pod yield and the number of mature pods per plant and low for oil content and shelling percentage. High heritability estimates observed for 100-kernels weight followed by oil content and length of the primary branches. They concluded that characters having high heritability might not show high genetic advance.

Shettar (1974) studied variability in 42 varieties of groundnut. He reported greater genetic variability for number of secondary branches, total number of pods, days to flowering, number of primary branches and 100 seeds weight.

Kushwaha and Tawar (1974) studied genotypic and phenotypic variability, heritability genetic advance in 36 Indian and 4 African varieties of groundnut. They obtained the highest genotypic coefficient of variability for pod yield per plant and lowest for 100 pods weight. Phenotypic and genotypic variance, were lowest for number of primary branches and highest for stem height. Heritability estimates varied from 26.84 percent for the number of immature pods per plant to 99 percent for days to maturity. Expected genetic advance were high for the number of primary branches.

Patra (1975) studied heritability and genetic advance for seven quantitative traits in 25 OG hybrids of groundnut in F_8 generation and found maximum, range of variation for height of main stem. Minimum range observed for days to maturity. Phenotypic and genotypic coefficient of variation was highest for pod yield per plant followed by number of immature pods per plant. He also found high heritability estimates for above characters. High expected genetic advance recorded for number of primary branches per plant followed by yield per plant.

Sangha and Sandhu (1975) recorded highest heritability and genetic advance expressed as percentage of mean for the 100 seeds weight in 27 varieties of groundnut.

During their investigation on genetic variability, heritability and genetic advance in 25 varieties of groundnut, Sivasubramanian et al (1977) observed significant varietals differences for all characters except pod yield and number of nodes per plant, They suggested that high genotypic coefficient of variation, heritability and genetic advance for height of main stem and number of pods per plant could be relied upon for exercising selection. Moderate heritability and genetic advance were noticed for the number of flower produced. Number of primary branches and length of primary branches showed uniformly lower genetic advance as percentage of mean.

Natarajan et al. (1978) studied the variability in kernel weight and shelling percentage in 234 bunch, 170 semi-spreading and 268 spreading varieties of groundnut. They recorded that 100-kernels weight had high range in semi-spreading type followed by spreading and bunch, while in the case of shelling percentage, semi-spreading group had high value followed by bunch and spreading.

Singh et al. (1982) studied genetic variability and heritability in 50 newly evolved varieties of groundnut. They observed significant differences among the genotypes and high range of variation for pod: peg ratio, number of pods per plant, harvest index and 100 kernels weight. The differences between phenotypic and genotypic variation were higher for pod: peg ratio, biological yield, harvest Index and pod yield. The broad sense heritability was low for pod: peg ratio, biological yield, harvest index and pod yield and high for 100 kernels weight, shelling percentage and number of undeveloped pods.

Parkashkumar and Yadav (1982) evaluated 22 genotypes of groundnut. They found substantial amount of genetic variability for yield components and oil content.

Qadri and Khunti (1982) studied 12 quantative characters in 24 genotypes and observed high genotypic variation for harvest index, pod yield, dry fodder weight, pods per plant, pegs per plant and 100 seeds weight. Broad sense heritability was high for all the characters.

Deshmukh et al. (1986) studied genetic variability in 22 varieties of Virginia bunch groundnut. They observed phenotypic coefficient of variation were higher than genotypic coefficient. They also reported that heritability were higher for 100 pods weight, plant height, 100 seeds weight, shelling percentage and oil content.

Nadaf and Habib (1987) evaluated 83 diverse origin genotypes of groundnut. They found genotypic variability was high for number and length of secondary branches and low for oil content and shelling percentage. Days to 50% flowering and 100 seeds weight had high heritability.

Kale and Dhoble (1988) studied genetic variability in 7 genotypes of groundnut. They observed genotypic coefficient of variability ranged from 14.3(seeds/plant to 27.4(pegs/plant) and high phenotypic variation for pods per plant followed by yield per plant. Plant height showed maximum genetic advance. Highest heritability were noted for plant height, yield per plant and pegs per plant.

During their investigation on genetic variability in 50 accessions from gerplasm collection, Vadodaria and Patel (1990) observed the phenotypic coefficient of variation was higher than genotypic coefficient of variation for all characters. The most direct components of pod yield, 100 seeds weight, harvest index and number of mature pods had high heritability and genetic advance as percentage of mean provide good opportunity to improve pod yield.

Mishra and Yadav (1992) studied genetic variability in 20 genotypes. They found high genotypic coefficient of variation for100 kernels weight, pod yield and kernel yield coupled with high heritability and genetic advance.

Ganesan and Sudhakar (1995) studied seven yield related characters in 29 genotypes and observed primary branches per plant had the highest genetic variability coupled with high heritability and genetic advance.

Sumathi and Ramanathanan (1995) studied 14 related trails in hybrids (F_1 and F_4 generation) from crosses between 5 SB and 2 VB parents and observed PCV was higher than GCV in both the generations for all characters. High GCV estimates obtained for plant height, number of primary branches and number of flowers in both generations. High GCV also observed for pod yield, number of mature pods and kernel yield in F_4 generation. High heritability coupled with high genetic advance observed for number of primary branches in F_4 generation.

Uddin et al. (1995) Studied seven yield components in 23 divergent groundnut genotypes and high genotypic coefficient of variation were obtained for seed yield per plant, primary branches per plant, plant height and 100 seeds weight.

Heritability values were high for all of the characters. All the characters except days to maturity and shelling percentage had moderate to high genetic advance.

Salara and Gowda (1998) studied F_2 progenies derived from crosses between 3 SB cultivars (sub spp. *Fastigiata)* and 4 VB cultivars (sub spp. *Hypogeaea*) crossed for yield related traits. Sufficient variability existed in the crosses for selection to be elective for various characters. Pod Yield and pod number exhibited high coefficient of variation values and genetic advance compared to test weight, shelling percentage and sound mature kernel percentage exhibited the maximum variability.

Yadav et al. (1998} Studied seven yield and quality related traits in 34 strains varieties of SB groundnut. High phenotypic and genotypic coefficient of variability observed for pod yield per plant and 100-pods weight. Heritability was high for all the characters under study. Genetic advance was highest for pod yield per plant followed by 100-pods weight and 100-kernels weight. High heritability coupled with high genetic advance observed for pod yield per plant, 100-pod weights and 100-kernels weight.

Rudraswamy et al. (1999) Studied parental, F_1, F_2 and F_3 generations of six crosses of groundnut. The result revealed that number of secondary branches, number of immature pods, pod yield per plant and shelling percentage, the genetic advance was moderate because of high heritability and variability.

Venkatramana (2001) evaluated 30 genotypes for genetic parameters. He found high genotypic coefficient of variation for oil yield, 100- kernels weight and kernel yield. Broad sense heritability estimates were high for oil content, 100 kernels weight and sound mature kernel percentage. High heritability estimates combined with genetic advance observed for 100- kernels weight.

Jayalakashmi et al. (2001) studied 21 crosses of groundnut to estimate the range of variation, heritability and genetic advance for five characters in F_2 and F_3 generations. High heritability and high genetic advance observed for kernel yield, harvest index and mature pods per plant in both the generations.

Abhay et al. (2002) evaluated 22 germplams lines to study genetic variability. They observed significant differences for all the characters. Pod yield per plant, 100-kernels weight and kernel yield per plant had high heritability and genetic advance. High heritability accompanied with low genetic advance for days to 50 % flowering, days to maturity, shelling percentage and oil content.

2.2 CORRELATION COEFFICIENTS

Before attempting to improve any character, it is necessary to understand its effect on other characters, knowledge of the interrelationship among various characters help in proper planning of the breeding programme. If several characters are related, improvement in one of them results in shaping the other characters. The study of correlation in groundnut crop is of particular importance as pods the main component of yield formed underground. The establishment of association between the aerial morphological characters and the pod yield is essential for making effective selection before harvest. With this in view, both genotypic as well as phenotypic associations among various characters have studied.

Dorairaj (1962) found that the final yield positively and significantly correlated with pod number and number of secondary branches in spreading type groundnut. Where as, in bunch type groundnut, the weight of pods was positively and significantly correlated with the pod number, mean number of pods in the primary branches, number of secondary branches, mean length of the primary branches, height of main axis and number of nodes in the main axis in order of decreasing values.

Jaswal and Gupta (1966) found that in 73 spreading types groundnut, pod yield per plant is positively correlated with the number of mature pods, the total number of gynophores, the number of secondary branches and the lateral spread. From partial regression analysis, it found that yield was dependent on the first two characters only.

Mahapatra (1966) in correlation studies on 6 varieties of groundnut observed total yield to be positively correlated with shoot weight, root weight and nodule number per plant, but negatively correlated with pod length.

Chandramohan et al.(1967) studied correlation coefficients in quantitative characters in TMV-2, a bunch variety of groundnut and found a high correlation between the number of mature pods per plant and plant weight. These both characters had high and positive correlation with yield.

Badwal et al.(1968) studied correlation in a collection of 60 varieties including spreading, bunch and semi-spreading types of groundnut. The study revealed that pod yield largely influenced by the number of mature pods and 100-kernels weight. They also showed that earliness in the semi-spreading group, number of seeds per pod in the bunch group had same influence to pod yield, but the number of secondary branches and shelling percentage did not have any effect on pod size.

Sanjeeviah et al.(1970) studied correlation between stern node height and pod yield in 11 bunch types of groundnut, they observed that the number of nodes per plant within 10 cm from the ground positively correlated with pod weight per plant.

Sangha and Sandhu (1970) conducted correlation studies in 27 bunch and 27 spreading varieties of groundnut. They recorded that genotypic correlation coefficients were generally higher than phenotypic ones. In the bunch group, pod yield was positively associated with number of nodes, but was negatively associated with lateral spread and number of vegetative nodes per primary and secondary branch. In the spreading group, pod yield was positively associated with 100-kernels weight and negatively with number of primary and secondary branches and number of nodes per branch.

Moustafa and Sayid (1971) conducted correlation studies in 3 groundnut varieties which differed in their growth habit. They noted that pod yield positively correlated with all the characters, except in one variety in which yield was not significantly correlated with main branch length. They also established that main branch length and number of pods per plant had much influence on yield.

During their study of correlation between yield and five yield attributes in 20 spreading varieties of groundnut under high and low fertility levels, Dholaria et al (1972) found that pod yield was significantly and positively correlated with number of nodes per plant, number of primary branches per plant and seed weight per plant.

Phadnis et al. (1973) studied correlation coefficients of yield and five yield components in 60 varieties of groundnut and found that number of pods per plant and seed weight was highly correlated with yield.

Sangha (1973) observed correlation in spreading types of groundnut between the yield and its components and recorded that pod yield was positively correlated with 100-kernels weight and negatively with secondary and primary branches at phenotypic level. He also found that number of pods per plant and 100-kernels weight had high positive relationship with pod yield. The number of pods per plant contributed maximum towards the variability in pod yield closely followed by 100- kernels weight.

Coffelt and Hammons (1974) studied correlations of nine characters in parental and inter specific cross population of groundnut. They observed significant positive correlation in all the populations between number of pods and pod weight, number of seeds and seed weight, pod weight and number of seeds and seed weight and number of pods per plant.

Shettar (1974) studied selection index for yield in 42 varieties of groundnut. He found that pod yield had positive correlation with height of main axis, number of pods in the main axis, mean length of primary branches, number of secondary branches, number of nodes in secondary branches, number of mature pods and 100 kernels weight. It had negative correlation with number of days to flowering, shelling percentage and mature pod.

Sangha and Sandhu (1975) studied 27 varieties of groundnut and found high positive association of 100 seeds weight with lateral spread. This character showed negative correlation with number of pods.

While studying correlation between pod yield, fruit size and maturity in early generation after crossing Virginia and Spanish types of groundnut, Mohammid (1977) indicated that seed yield had positive correlation with maturity and pod size.

Natarajan et al. (1978) found positive correlation of pod yield with 100 kernels weight and oil content at phenotypic level in 30 bunch type varieties of groundnut, while number of pods per plant had negative association with 100 pods weight and 100 kernels weight, but shelling percentage showed a positive correlation with them.

Singh et al. (1979) studied yield and its attributes in P_2 population of cross involving spreading and bunch variety, yield showed high positive association with number of pods per plant and 100-kernels weight. Fruiting nodes per secondary branch, number of pods and 100-kernels weight showed positive association with each other. They also noted that number of pods per plant and 100-kernels weight had the maximum pod yield.

Swamy Rao (1979) studied 12 characters for correlation coefficients in bunch type groundnut and found that the number of pods per plant, pod: peg ratio and oil content were highly and positively associated. Oil content was positively associated with pod: peg ratio and pod yield, as the 'r' values were highly significant. There was no association between plant height, number of branches per plant, shelling percentage and 100 seeds weight with yield, while all these characters and number of pods per plant had no association with the oil content.

Balaiah et al. (1980) reported correlation coefficients between yield and yield components in F_2 generation of 105 Virginia bunch types. They found that yield was significantly and positively correlated with number of primary and secondary branches per plant and the number of mature pods.

Khunti (1980) studied correlation coefficient in 24 bunch and 24 spreading types of groundnut. He observed positive and significant phenotypic and genotypic correlation for pod yield with number of pods and 100 kernels weight in both types and negatively days to flowering for phenotypic and with days to maturity for genotypic association. He recorded that pod yield was also associated with harvest index and shelling percentage in bunch type, while days to flowering and oil percentage in spreading type for genotypic correlation.

Deshmukh et al.(1986) studied correlation and path coefficients in 22 varieties of Virginia bunch groundnut. They found pod yield positively and significantly correlated with number of pods per plant, 100 pods weight, 100 seeds weight and shelling percentage.

Uddin et al. (1995) studied seven yield components in 23 divergent genotypes. They observed pod yield per plant was positively and significantly correlated with days to maturity, number of pods per plant, plant height and primary branches per plant.

Sumathi and Ramanathanan (1995) studied correlation and path analysis in F_3 and F_4 generation of inter specific crosses in groundnut. They observed that the pod yield was positively correlated with number of matured pods, 100-kernels weight, number of flowers, number of pegs and peg flower ratio.

Salara and Gowda (1998) studied F_2 progenies derived from crosses between 3 SB cultivars (sub spp. *Fastigiala)* and 4 VB cultivars (sub spp. *Hypogaea)*. They found pod number and test weight were highly correlated with pod Yield.

While studying correlation analysis of growth and yield component. Singh and Singh (1999) reported that yield improvement could achieved by selection for 50% flowering, plant height, number of primary branches, number and weight of pods per plant and 100-kernels weight.

Azad and Hamid (2000) studied correlation and path analysis in 9 breeding lines. They observed number of pods, kernel yield and 100 pods weight. showed positive and significant genotypic and phenotypic correlation with pod yield.

Abhay et al.(2002) studied 22 germplasm lines for correlation and path analysis and observed pod yield exhibited significant association with shelling percentage and kernel yield.

2.3 PATH COEFFICIENT ANALYSIS

A path coefficient is simply a standardized partial regression coefficient and as such measures the direct influence of one variable upon another and permits the separation of the correlation coefficients into components of direct and indirect effects. This method originally developed by Wright (1921) and worked-out by Dewey and Lu (1959) for plant population. Animal breeders and geneticist had used this method quite widely.

Little information is available in groundnut crop on path coefficient to determine the direct and indirect effects of the yield attributes on the total yield.

During the study of path coefficient in 30 spreading varieties of groundnut for five traits, Khangura and Sandhu (1972) found that length of primary branch had the highest positive direct effect on pod yield and all other characters were affected indirectly by this trait, while number of mature pods had positive direct effect.

Chandola et al. (1973) studied path coefficient analysis of yield and four yields attributes of bunch types of groundnut. They observed that number of pods per plant had a high direct effect on yield. Number of secondary branches per plant had negative direct effect. Number of primary branches and green pod weight per plant had positive direct effect on yield.

Khunti (1980) studied path coefficient in groundnut and found that 100-kernels weight had high direct effect on pod yield in both the groups, while number of pods in bunch and number of pegs in spreading group had high direct contribution to pod yield. Days to maturity had high negative direct effect on pod yield in spreading and low effect in bunch type.

Yadav et al. (1981) studied path coefficient in 26 genotypes of groundnut and concluded that pod number and primary branches had maximum direct effect on pod yield. Besides these traits, days to first flowering and plant height also affected pod yield directly.

Parkashkumar and Yadav (1982) observed path coefficient in 22 genotypes of groundnut and worked out direct and indirect effects. They found that number of pods, days to maturity; primary branches and 100-kernels weight had positive direct effect on pod yield. In general, oil content noticed to have negative direct as well as indirect effect on yield.

Deshmukh et al, (1986) observed path coefficient in 22 varieties. They found that number of pods per plant, 100 pods weight, 100-kernels weight and shelling percentage had high positive direct effects on pod yield

Baydar and Bayaraktar (1994) carried out studies on path coefficient analysis in 6 cultivar of Virginia type groundnut and found that shell ratio had a direct negative effect on seed yield per plant; it had a negative effect through pod weight. They further suggested that in breeding for increased seed yield, pods weight per plant should be primary selection criteria.

Uddin et al,(1995) studied path analysis and found that days to maturity, primary branches per plant and number of pods per plant had large direct effects on seed yield per plant.

Hoque and Chowdhary (1997) carried out path analysis and found that 100 pods weight, primary branches per plant and number of pods per plant were related with pod yield through direct effects.

Azad and Hamid (2000) studied path analysis and revealed that high direct effects of number of pods on pod yield followed by 100 pods weight and kernel yield.

Bera and Das (2000) evaluated 44 genotypes of groundnut for path coefficient in three year at two locations and revealed that positive direct contribution of pods per plant and harvest index to the seed yield.

Santos et al. (2000) studied correlation and path coefficient for pod yield components in groundnut. They found that pod yield had the highest positive effect on seed production.

Abhay et al. (2002) studied 22 germplams for path coefficient and revealed that shelling percentage and kernel yield were major components of pod yield.

III. MATERIALS AND METHODS

The present investigation on genetic variability heritability, genetic advance, correlation and pat analysis was conducted at Regional Oilseed Researc Station, Gujarat Agricultural University, TALOD, and Dist Sabarkantha during Kharif - 2002.

3.1 EXPERIMENTAL MATERIAL

The material for the present investigatio consisted of 45 Virginia bunch type varieties of groundnu (*Arachis hypogaea* L.) obtained from the collectio maintained by Research Scientist (Groundnut), Gujara Agricultural University, Junagadh. The varieties wer selected on the basis of their wide variability and pas performance. The genotypes included in the experiment wit their parentage are listed in Table 3.1

3.2 EXPERIMENTAL DETAILS

The experiment was laid out in a randomized bloc design with three replications. The experimental plo consisted of two rows of six meter length with row to ro spacing of 0.60 meter and plant to plant spacing within row was 0.15 meter. All the recommended agronomi practices and plant protection measures were followe timely for successful raising of the crop.

3.3 CHARACTERS STUDIED AND OBSERVATIONS RECORDED

From each plot ten competitive plants wer randomly selected from each genotype to record all th characters except for days to flowering and days t maturity. Detailed procedure adopted for recordin observations was as under.

TABLE - 3.1. LIST OF GENOTYPES WITH THEIR PARENTAGE

SR.NO.	GENOTYPES	PARANTAGE
1	JVB - 161	TMV - 10 X JYOTI
2	JVB - 263	GAUG - 10 X PI - 393517
3	JSSP - 8	M - 13 X ASARIA MUTANDE
4	JSSP - 16	JSSP - 2 X GNLM
5	JVB - 349	GG - 20 X ICGV - 86325
6	JVB - 345	GG - 20 X TGV - 2
7	JVB - 170	M - 13 X 27 - 5 - 1
8	JVB - 262	GAUG - 10 X PI - 405122
9	JVB - 134	M - 13 X GDM
10	JSSP - 5	GAUG - 1 X R - 33 - 1
11	JSSP - 13	M - 13 X J - 11
12	JSSP - 10	M - 13 X R - 33 - 1
13	JVB - 244	M - 13 X NCAC - 17509
14	JVB - 265	RSB - 87 X CGC - 3
15	JVB - 342	JSP - 21 X TVG - 5
16	JVB - 343	GG - 11 X CSMG - 9101
17	JVB - 331	JSSP - 5 X NO 18
18	JVB - 368	JSSP - 7 X CSMG - 9101
19	JVB - 353	JSSP - 5 X CSMG - 9101
20	JVB - 148	M - 13 X JL - 24
21	JVB - 357	GG - 20 X NCAC - 1705
22	JVB - 302	GG - 20 X PI - 407454
23	GG - 20	GAUG - 10 X R - 33 - 1

TABLE - 3.1 CONTINUE...

SR.NO.	GENOTYPES	PARANTAGE
24	JSSP - 17	JSSP - 2 X GDM
25	JSSP - 9	M - 13 X G - 201
26	JSSP - 6	GAUG - 10 X TMV - 10
27	JSSP - 14	GAUG - 10 X PI - 337394F
28	JVB - 194	ICGS - 3 X(R-33-1 x NCAC-2214
29	JVB - 347	GG - 20 X TVG - 5
30	JVB - 359	JSSP - 5 X RG - 244
31	JVB - 356	GG - 20 X RG - 244
32	JVB - 348	GG - 20 X CSMG - 9101
33	JVB - 352	GG - 20 X NCAC - 927
34	JVB - 303	GG - 20 X CHICO
35	JVB - 361	JSSP - 7 X RG - 244
36	JVB - 202	NO 25 X JL - 24
37	JVB - 260	ICGS - 61 X ICG(CGS) - 49
38	JVB - 330	JSSP - 5 X J - 32
39	JVB - 369	GG - 20 X BAU - 16
40	JVB - 354	GG - 20 X PI - 381622
41	JVB - 153	M - 13 X 28 - 4 - 1
42	JVB - 363	JSSP -5 X JYOTI
43	JVB - 137	JSSP - 4 X G - 2012
44	JVB - 230	M - 13 X TG - 1
45	KADIRI - 3	SELECTION FROM R - 33 - 1

3.3.1 **Days to 50% flowering**: The number of days required from date of sowing to date of appearance flowering of 50% plants.

3.3.2 **Days to maturity**: The number of days from date of sowing to the date on which more than 50% pods showed mature.

3.3.3 **Plant height**: The final plant height measured in cm from the base of plant to tip of main axis at maturity.

3.3.4 **Number of primary branches per plant**: The total number of primary branches counted per plant at the time of harvest.

3.3.5 **Number of mature pods per plant**: The total number of mature pods counted per plant at the time of harvest.

3.3.6 **Pod yield per plant**: The total pod yield per plant weighted in gram after drying for 15 days in sun light.

3.3.7 **Kernel yield per plant**: The total kernel yield per plant weighted in gram after drying for 15 days in sun light.

3.3.8 **100-pods weight**: One hundred pods were randomly collected from the randomly selected ten plants and weighted in grams.

3.3.9 **100-kernels weight**: One hundred randomly selected kernels counted and weighted in grams.

3.3.10 Shelling percentage: It was worked out from the mean yield of ten plants as per formula given as under

$$S.P. = \frac{\text{Yield of kernels per plant}}{\text{Yield of pods per plant}} \times 100$$

3.3.11 Harvest Index: It is the ratio of economic yield (pod yield) to the biological yield (total dry matter) expressed in percentage.

$$H.I. = \frac{\text{Total pod yield per plant}}{\text{Total biological yield per plant}} \times 100$$

3.3.12 Oil content: Oil content was determined by using Nuclear Magnetic Resonance (NMR) technique at Main Castor Mustard Research Station, G.A.U., Sardarkrushinagar. For determination of oil content 4 gm seeds oven dried at 105°C for 4 hours were fed to NMR Model.

3.3.13. Protein content: Representative samples of seed taken at maturity from each plot and oven dried at 60°C for 24 hours and then powdered by mechanical grinder. The nitrogen content in seeds was determined with micro Kjeldhals method (Jackson 1967) which then multiplied by 6.25 (Conversion factor) to determine the protein content.

3.4 STATISTICAL ANALYSIS:

Replication wise mean values of individual characters were used to various statistical analyses with the helps of computer software. The procedures used were as under:

3.4.1 ANALYSIS OF VARIANCE

The mean data obtained for each character analyzed by the usual standard statistical procedure outlined by Panse and Sukhatme (1978) which formatted as given in ANOVA table.

The statistical model was $Yij = M + G_i + R_j + e_{ij}$

Where,

Y_{ij} = Yield of the i^{th} genotype in the j^{th} replication

i = 1, 2, 3….g

j = 1, 2, 3….r

G_j = i^{th} genotype effect

R_j = j^{th} replication effect

e_{ij} = Uncontrolled variation associated with the i^{th} genotype and j^{th} replication

A N O V A

Source of variation	d. f.	Sum of square	Mean square	Expected mean square
Replications (r)	(r-1)	RSS	MS_1	$6^2e + g6^2r$
Genotypes (g)	(g-1)	GSS	MS_2	$6^2e + r6^2g$
Error (e)	(r-1)(g-1)	ESS	MS_3	6^2e
Total	(rg- 1)	TSS		

Where,

r = number of replications

g = number of genotypes

6^2e = variance due to error

6^2r = variance due to replication

6^2g = variance due to genotype

MS_1 = mean squares for replication

MS_2 = mean squares for genotype

MS_3 = mean squares for error

The standard error for differences between treatment means was calculated by using the following formula:

$$S.Em. = \frac{(2\ MS_3)^{0.5}}{r}$$

Where,

MS_3 = error mean sum of square

r = number of replications

The critical differences to compare the mean of various genotypes were calculated by using the following formula.

$$C.D = S.Em. \times (2)^{0.5} \times t$$

Where,

S.Em= standard error of the difference of treatment means to be compared

t = table value of't'at 1% or 5% degrees of freedom of error mean square

The coefficient of variation (C.V. %) was receiving by using following formula.

$$C.V.\ \% = \frac{(MS_3)^{0.5}}{\bar{X}} \times 100$$

Where,

MS_3 = error mean sum of square

$\bar{X}$ = population mean

3.5. VARIABILITY PARAMETERS

3.5.(i) Mean:

It computed by dividing the sum of all observations in a sample *by* their number. Thus,

$$\bar{X} = \frac{\sum Xij}{n}$$

Where,

$\bar{X}$ = population mean

X_{ij} = observations of individual of i^{th} treatment and j^{th} replication

n = total number of observations

3.5.(ii) Range

It is the difference between the lowest and the highest mean values for each character.

The phenotypic, genotypic and environmental components of variance estimated as explained by Johnson *et al* (1955).

3.5. (iii) Genotypic variance (6^2g)

It is the variance contributed by genetic causes or the occurrence of differences among individuals due to differences in their genetic make-up. It was calculated as under.

$$6^2g = \frac{MS_2 - MS_3}{r}$$

Where,

6^2g = genotypic variance

MS_2 = genotypic mean sum of square of the character

MS_3 = error mean sum of square of the character

r = number of replications

3.5.(iv) Phenotypic variance (6^2p)

It is the sum of the variance contributed by genetic causes and environmental factors. It was calculated as under.

$$6^2p = 6^2g + 6^2e$$

Where,

6^2p = phenotypic variance

6^2g = genotypic variance

6^2e = error variance

3.5. (v) Environmental variance (6^2e)

The mean square of error called the environmental variance.

$$6^2e = MS_3$$

3.5. (vi) Coefficient of variation (C.V.%)

The phenotypic and genotypic coefficient of variation was calculated by the formula suggested by Burton (1952).

(a) Phenotypic coefficient of variation (PCV)

$$PCV\ (\%) = \frac{\sigma p}{\bar{X}} \times 100$$

Where,

σp = phenotypic standard deviation

$\bar{X}$ = mean value of the character

(b) Genotypic coefficient of variation (GCV)

$$GCV\ (\%) = \frac{\sigma g}{\bar{X}} \times 100$$

Where,

σg = genotypic standard deviation

$\bar{X}$ = mean value of the character

3.5. (vii) Heritability (broad sense)

Heritability is the heritable portion of the phenotypic variance.

In broad sense, it was calculated using the formula proposed by Allard(1960)

$$h^2 = \frac{\sigma^2 g}{\sigma^2 p} \times 100$$

Where,

$\sigma^2 g$ = genotypic variance

$\sigma^2 p$ = phenotypic variance

3.5. (viii) Expected genetic advance (G.A.)

Expected genetic advance represents the shifts in a population towards superior side under selection pressure after single generation of selection. It was calculated by the methodology suggested by Allard (1960) at 5 % selection intensity using the constant ' K ' as 2.06

$$G.A. = h^2 (b) \times K \times \sigma p$$

Where,

h^2 (b) = heritability (broad sense)

σp = phenotypic standard deviation

K =constant(selection intensity at 5%)

3.5. (ix) Genetic advance as percentage of mean

The expected genetic advance expressed in percentage of mean was calculated by the method suggested by Johnson *et al* (1955)

$$G.A. \text{ as } \% \text{ of mean} = \frac{G.A.}{\bar{X}} \times 100$$

Where,

G. A. = expected genetic advance

$\bar{X}$ = mean of the character

3.6.3 CORRELATION COEFFICIENT ANALYSIS

The phenotypic, genotypic and environmental correlation coefficients for all the characters worked out with pod yield. The data were subjected to co variance analysis from which different components of mean sum of products estimated.

A N O V A

Source	d.f.	M S P	Expected M S P
Replication(r)	(r-1)		
Genotypes(g)	(g-1)	MSP_1	$Co6^2e+ Co6^2g_{1.2}$
Error	(r-1) (g-1)	MSP_2	$Co6^2e_{1.2}$

Where,

MSP_1 = mean sum of products due to genotypes between character 1^{st} and 2^{nd}

MSP_2 = mean sum of products due to error between character 1^{st} and 2^{nd}

r = number of replications

The genotypic, phenotypic and error variances and co-variances were used for calculating the genotypic, phenotypic and environmental correlation coefficient respectively (Al.Jibouri *et al* 1958).

3.6. (a) Genotypic correlation coefficient

$$rg_{1.2} = \frac{Co6^2g_{1.2}}{(6^2g_1 \times 6^2g_2)^{0.5}}$$

Where,

$Co6^2g_{1.2}$ = genotypic covariance for a pair of character 1st and 2nd

6^2g_1 = genotypic variance for a character 1st

6^2g_2 = genotypic variance for a character 2nd

3.6. (b) Phenotypic correlation coefficient

$$rp_{1.2} = \frac{Co6^2p_{1.2}}{(6^2p_1 \times 6^2p_2)^{0.5}}$$

Where,

$Co6^2p_{1.2}$ = phenotypic covariance for a pair of character 1st and 2nd

6^2p_1 = phenotypic variance for a character 1st

6^2p_2 = phenotypic variance for a character 2nd

3.6. (c) Environmental correlation coefficient

$$re_{1.2} = \frac{Co6^2e_{1.2}}{(6^2e_1 \times 6^2e_2)^{0.5}}$$

Where,

$Co\sigma^2e_{1.2}$ = environmental covariance for a pair of character 1^{st} and 2^{nd}

σ^2e_1 = environmental variance for character 1^{st}

σ^2e_2 = environmental variance for character 2^{nd}

The phenotypic correlation was tested by 't' for their significance which was suggested by Fisher and Yates (1963)

$$t = \frac{r}{(1 - r^2)^{0.5}} \times (n - 2)^{0.5}$$

Where,

t = calculated value of 't'

r = correlation coefficients

n = total number of observations

Compare this calculated 't' with table 't' at (n-2) d.f. at 5% and 1% level.

The genotypic correlation tested by transforming ' r ' to a quantity ' z '.

This sample value of z distributed approximately normally with mean zero and variance (n-3). It follows that z (n-3) is a standard normal deviate corresponding to a degrees of freedom. There for if z (n-3) exceeds 1.96 and 2.576 z is said to be significance at 5 and 1 %, respectively. In other words, correlation coefficients(r) are significant if z is significant.

3.7.4 PATH COEFFICIENT ANALYSIS

The genotypic correlation coefficient data subjected to path coefficient analysis. The analysis carried out by the method suggested by Dewey and Lu (1959)

The genotypic correlation among 12 characters partitioned into their direct and indirect effects on pod yield.

Causal variable and their direct and indirect effects on pod yield estimated as under.

The path coefficient obtained by solving a set of simultaneous equations as below.

$$r_{1y} = P_{1y} + r_{12}P_{2y} + r_{13}P_{3y} + \ldots + r_{1i}p_{iy} + \ldots + r_{1}nPny$$

$$r_{2y} = P_{2y} + r_{21}P_{1y} + r_{23}P_{3y} + \ldots + r_{2i}p_{iy} + \ldots + r_{2n}P_{ny}$$

$$\vdots \qquad \vdots \qquad \vdots \qquad \vdots$$

$$r_{ny} = P_{ny} + r_{n1}P_{2n} + r_{n3}P_{3n} + \ldots + r_{n(n-1)}p_{ny} + \ldots + r_{nn}P_{ny}$$

Where,

r_{1y} to r_{iy} = represents correlation coefficients between causal character,1 to n and dependent character yield (y)

r_{i3} to $r_{i(i-1)}$ = represents correlation coefficients among causal characters (independent variables)

P_{ny} = represents path coefficients between one component character and yield

$r_{n2}, r_{n3}..., r_{nx}$ = represents correlation coefficients between that character and other yield component in turn

The fowling genotypic correlation in a matrix form as:

Matrix - A Matrix - C Matrix - B

$$\begin{bmatrix} r_{1y} \\ r_{2y} \\ r_{3y} \\ \vdots \\ r_{ny} \end{bmatrix} \qquad \begin{bmatrix} r_{11} r_{12} r_{13} \ldots r_{1n} \\ r_{21} r_{22} r_{23} \ldots r_{2n} \\ r_{31} r_{32} r_{33} \ldots r_{3n} \\ \vdots \quad \vdots \quad \vdots \qquad \vdots \\ r_{n1} r_{n2} r_{n3} \ldots r_{nn} \end{bmatrix} \qquad \begin{bmatrix} P_{1Y} \\ P_{2Y} \\ P_{3Y} \\ \vdots \\ P_{ny} \end{bmatrix}$$

Where,

r_{12} = r_{21} and so on

r_{1y} = correlation between 1st component character and yield

The technique followed for inversion of the "c" matrix using partioning method of matrix inversion.

Path coefficient P_{ij} obtained as follows.

$$Pij = (C^{-1}) \times A$$

Where,

$$C^{-1} = \begin{vmatrix} C_{11} & C_{12} & C_{13} & \dots & C_{1i} & \dots & C_{1n} \\ C_{21} & C_{22} & C_{23} & \dots & C_{2i} & \dots & C_{2n} \\ \vdots & \vdots & \vdots & & \vdots & & \vdots \\ C_{i1} & C_{i2} & C_{i3} & \dots & C_{ii} & \dots & C_{in} \\ C_{n1} & C_{n2} & C_{n3} & \dots & C_{ni} & \dots & C_{nn} \end{vmatrix}$$

The indirect effects for a particular character were obtained by multiplication of direct path and correlation coefficient between those two characters respectively.

$$\text{Indirect effect} = r_{ij} \times p_{ij}$$

Where,

$i = 1, 2, \ldots n$

$J = 1, 2, \ldots n$

$P_{ij} = P_{1y} \times P_{2y} \times \ldots\ldots\ldots\ldots \times P_{ny}$

The residual factor which represents the variation in yield an accounted for this association, calculated from the following formula proposed by Wright (1921).

$$\text{Residual effect PRY} = (1-R^2)^{0.5}$$

Where,

$$R^2 = P_{1y}\, r_{1y} + P_{2y}\, r_{2y} + \ldots\ldots + P_{ny}\, r_{ny}$$

All the statistical and genetical analysis was carried out on computer by Department of Agricultural Statistics, C.P. College of Agriculture, S.D. Agricultural University, Sardarkrushinagar.

IV. EXPERIMENTTAL RESULTS

The present study undertaken to investigate genetic variability, heritability, genetic advance, correlation and path analysis among different characters of Virginia bunch group of groundnut. The results of present investigation in groundnut (*Arichis hypogea* L.) are presented in the following sub sections.

4.1 Analysis of variance

4.2 Mean performance and phenotypic variability

4.3 Variance components

4.4 Genotypic and phenotypic coefficients of variation

4.5 Heritability

4.6 Genetic advance and genetic advance expressed as percentage of mean

4.7 Correlation coefficients

4.8 Path coefficient analysis

4.1 ANALYSIS OF VARIANCE

The analysis of variance for thirteen different characters under study is presented in Table 4.1. The results revealed that mean sum of squares due to genotypes were highly significant for all the characters indicating the presence of sufficient amount of variability in the material used.

TABLE -4.1

Analysis of Variance for 13 characters of groundnut genotypes

Sr. No.	Characters	Mean sum of square			SEm ±	C. D. at 5%
		Replication d. f. (2)	Genotypes d. f. (44)	Error d. f(88)		
1	Pod yield / plant (gm)	14.168	59.314**	7.310	1.561	4.283
2	Days to 50% flowering	0.452	08.974**	0.520	0.416	1.142
3	Plant height. (cm)	8.891	73.360**	6.145	1.431	3.927
4	No. of primary branches / plant	0.255	02.324**	0.276	0.304	0.834
5	No. of mature pods /plant	9.641	42.627**	3.932	1.145	3.141
6	Days to maturity	6.156	57.439**	2.746	0.957	2.625
7	Kernel yield / plant (gm)	3.951	36.498**	3.139	1.023	2.806
8	100pods wt. (gm)	6.519	384.355**	4.860	1.273	3.492
9	100kernels wt. (gm)	3.696	102.787**	3.446	1.072	2.941
10	Shelling (%)	2.894	104.352**	3.240	1.039	2.851
11	Harvest Index (%)	0.877	71.050**	1.833	0.782	2.144
12	Oil content (%)	0.627	35.327**	0.636	0.460	1.263
13	Protein content (%)	0.536	25.152**	0.538	0.423	1.162

*, ** significant at 5% and 1% levels, respectively

4.2 MEAN VALUES AND PHENOTYPIC VARIABILITY

The mean values of forty-five genotypes of groundnut for all the thirteen characters are given in Appendix - I. The range of phenotypic variability along with general mean and the standard error of mean are presented in Table 4.2. Character wise mean performance and range of phenotypic variability are described as under.

4.2.1 Days to 50% flowering

Maximum days to 50% flowering was recorded for JVB - 134 (31.333) followed by JVB - 137 (31.000),JVB - 359(30.667),JVB - 161(30.000),JVB - 343(30.333),JVB - 148 (30.000),JVB - 330 (30.333),JVB - 153 (30.000) and JVB - 230 (30.000).Minimum days to 50% flowering was recorded for JSSP - 17 (24.667) followed by JVB - 202 (25.667) and JVB - 262 (25.000). This character showed narrow range of phenotypic variability (24.667 - 31.333) with general mean 28.459.

4.2.2 Plant Height

The range of phenotypic variability for plant height was moderate (31.467 - 54.867) with general mean 42.837. The maximum height of plant was recorded for JVB - 262 (54.867) followed by JVB - 230 (50.667), JVB - 194 (48.200), JSSP - 17 (47.933), JSSP - 16 (47.867) and JVB - 345 (47.400). The minimum height of plant was recorded for JVB - 134 (31.467), JSSP - 9 (31.667), JSSP - 14(32.467) and JVB - 148 (32.867).

TABLE - 4.2.

Range of variation, Mean ± SE and Components of Variance of 13 characters of groundnut genotypes

Sr No	Characters	Range	Mean ±SE	Genotypic vg	Phenotypic vp	Environmental ve
1	Pod yield / plant (gm)	14.600 - 33.067	21.886 ± 1.561	17.334	24.645	7.310
2	Days to 50% flowering	24.667 - 31.333	28.459 ± 0.416	02.818	03.338	0.520
3	Plant height (cm)	31.467 - 54.867	42.837 ± 1.431	22.405	28.550	6.145
4	No. of primary branches/plant	04.733 - 08.333	06.603 ± 0.304	00.682	00.960	0.278
5	No. of mature pods / plant	11.333 - 28.000	20.727 ± 1.145	12.898	16.831	3.932
6	Days to maturity	95.667 - 112.333	106.556 ± 0.957	18.231	20.977	2.746
7	Kernel yield / plant(gm)	07.867 - 21.533	13.876 ± 1.023	11.116	14.255	3.139
8	100 pods weight.(gm)	71.723 - 122.333	105.513 ± 1.273	116.764	121.624	4.860
9	100 kernels weight.(gm)	31.000 - 54.667	45.719 ± 1.072	33.114	36.560	3.446
10	Shelling (%)	50.819 - 74.517	62.903 ± 1.039	33.704	36.944	3.240
10	Harvest Index (%)	11.267 - 34.885	24.537 ± 0.782	23.073	24.905	1.833
12	Oil content (%)	41.137 - 53.207	46.540 ± 0.460	11.564	12.200	0.636
13	Protein content (%)	20.303 - 31.137	26.348 ± 0423	08.205	08.743	0.538

4.2.3 Number of primary branches per plant

The maximum number of primary branches per plant was recorded for JVB - 134 (8.333) followed by JVB - 161 (8.133), JVB - 148 (8.000) and JVB - 348 (7.933). The minimum number of primary branches per plant was recorded for JVB - 194 (4.733) followed by JVB - 262 (5.200), JSSP - 5 (5.400), JVB - 347 (5.533) and JVB - 357 (5.533). This character exhibited narrow range of phenotypic variability (4.733 - 8.333) with general mean 6.603.

4.2.4 Number of mature pods per plant

The range of phenotypic variability for number of mature pods per plant was moderate (11.333 - 28.000) with general mean 20.727. The maximum number of mature pods per plant was recorded for JSSP - 6 (28.000) followed by JVB - 359 (27.533), JVB - 354 (27.200), JVB - 352 (26.533) and JVB - 263 (26.400). The minimum number of mature pods per plant was recorded for JVB - 343 (11.333) followed by JVB - 244 (13.000), JVB - 342 (14.667), JSSP - 14 (15.733) and JVB - 194 (16.267).

4.2.5 Days to maturity

The range of phenotypic variability for days to maturity was moderate (95.667 - 112.333) with general mean 106.556. The maximum days to maturity was recorded for JSSP - 13 (112.333) followed by JVB - 244 (112.000), JVB - 331 (111.333), JSSP - 14 (111.000) and JVB - 153 (111.000) and JVB - 354 (111.000). The minimum days to maturity was recorded for JVB - 262 (95.667) followed by JVB - 347 (96.000), JVB - 359 (97.000) and JVB - 170 (99.667).

4.2.6 Kernel yield per plant

The range of phenotypic variability for kernel yield per plant was moderate (07.867 - 21.533) with general mean 13.876. The maximum kernel yield per plant was recorded for JVB - 359 (21.533) followed by JSSP - 6 (20.000), JVB - 352 (19.067), JVB - 347 (18.933) and JVB - 361 (18.733). The minimum kernel yield per plant was recorded for KADIRI - 3 (7.867) followed by JVB - 343 (8.200), JVB - 265 (9.067), JVB - 342 (9.267), JVB - 153 (9.467) and JVB - 194 (9.600).

4.2.7 100 pods weight

High range of phenotypic variability was observed for 100 pods weight (71.723 - 122.333) with general mean 105.513. The maximum 100 pod weight was recorded for JVB - 343 (122.333) followed by JVB - 363 (122.246), JVB - 354 (119.667) and JVB - 244 (116.954). The minimum 100 pod weight was recorded for KADIRI - 3 (71.723) followed by JVB - 265 (74.090), JVB - 331 (83.927) and JVB - 153 (88.408).

4.2.8 100 kernels weight

The range of phenotypic variability for 100 kernels weight was moderate (31.000 - 54.667) with general mean 45.719. The maximum 100 kernels weight was recorded for JVB - 353 (54.667) followed by JVB - 356 (53.333), JVB - 244 (52.667), JVB - 345 (51.333) and JVB - 354 (51.333). The minimum 100 kernel weight was recorded for JVB - 265 (31.000) followed by JVB - 263 (35.000), JVB - 194 (35.333), JVB - 153 (35.333), JVB - 134 (36.000), KADIRI - 3 (36.000) and JSSP - 10' (36.667).

4.2.9 Shelling percentage

The range of phenotypic variability for shelling percentage was moderate (50.819 - 74.517) with general mean 62.903. The maximum shelling percentage was recorded for JVB - 361 (74.517) followed by JSSP - 17 (70.848), JVB - 347 (70.522) and JVB - 356 (70.106). The minimum shelling percentage was recorded for JVB - 263 (50.819) followed by JVB - 354 (52.491), KADIRI - 3 (52.530), JVB - 137 (53.546) and JVB - 153 (53.710).

4.2.10 Harvest index

The range of phenotypic variability for harvest index was moderate (11.267 - 34.885) with general mean 24.537. The maximum harvest index was recorded for JVB - 347 (34.885) followed by JVB - 359 (32.025) and JVB - 348 (30.260). The minimum harvest index was recorded for JVB - 343 (11.267) followed by JVB - 342 (12.410) and JVB - 194 (16.292).

4.2.11 oil content

The maximum oil content was recorded for JVB - 345 (53.207) followed by JSSP - 16 (52.790), JSSP - 17 (51.977), JVB - 352 (51.893), JVB - 354 (51.407) and JVB - 353 (51.363). The minimum oil content was recorded for JVB - 170 (41.137) followed by JVB - 244 (41.193), JVB - 134 (41.450), JSSP - 8 (41.560) and

JSSP - 13 (41.597). This character exhibited narrow range of phenotypic variability (41.137 - 53.207) with general mean 46.540.

4.2.12 Protein content

The maximum protein content was recorded for JVB - 170 (31.137) followed by JSSP - 8 (30.603), JVB - 230 (30.477), JSSP - 13 (30.400) and JVB - 331 (30.347). The minimum protein content was recorded for JVB - 194 (20.303) followed by JVB - 262 (20.610), JVB - 260 (21.157), JVB - 343 (21.353) and JSSP - 17 (21.357). This character exhibited narrow range of phenotypic variability (20.303 - 31.137) with general mean 26.348.

4.3 VARIANCE COMPONENTS

The phenotypic, genotypic and environmental variances calculated for all the characters presented in Table 4.2.

The phenotypic variances were higher than corresponding genotypic variances. The highest genotypic and phenotypic variance were observed for 100 pods weight (121.624 and 116.764), While it was high for shelling percentage (36.944 and 33.704), 100-kernels weight (36.560 and 33.114), harvest index (24.905 and 23.073), plant height (28.550 and 22.405), pod yield (24.645 and 17.334) days to maturity (20.977 and 18.231).

TABLE - 4.3

The estimates of genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability (h), expected genetic advance and expected genetic advance as percentage of mean for 13 characters of groundnut genotypes

Sr No	Characters	GCV %	PCV %	H %	G A	G A M
1	Pod yield / plant(gm)	19.023	22.683	70.339	06.033	27.564
2	Days to 50% flowering	05.899	06.420	84.421	02.919	10.258
3	Plant height (cm)	11.050	12.473	78.476	07.652	17.863
4	No. of primary branches/plant	12.509	14.837	71.082	01.209	18.317
5	No. of mature pods / plant	17.327	19.793	76.636	05.670	27.354
6	Days to maturity	04.007	04.298	86.908	07.644	07.174
7	Kernel yield / plant(gm)	24.028	27.209	77.983	05.356	38.600
8	100 podsweight.(gm)	10.241	10.452	96.004	21.370	20.254
9	100 kernelsweight.(gm)	12.587	13.225	90.574	10.737	23.484
10	Shelling (%)	09.229	09.663	91.230	10.911	17.345
10	Harvest Index (%)	19.576	20.339	92.642	09.167	37.360
12	Oil content (%)	07.307	07.505	94.787	06.640	14.267
13	Protein content (%)	10.871	11.222	93.848	05.538	21.017

Both values were moderate for number of pods per plant (16.831 and 12.898), oil content (12.200 and 11.564) and kernel yield (14.255 and 11.116).

The low values of phenotypic and genotypic variance observed for protein content (8.743 and 8.205), days to 50% flowering (3.338 and 2.818) and number of primary branches per plant (0.960 and 0.682).

The highest environmental variance was observed for pod yield per plant (7.310) followed by plant height (6.145), 100 pod weight (4.860), number of mature pods per plant (3.932), 100 kernel weight (3.446), shelling percentage (3.240), kernel yield per plant (3.139), days to maturity (2.746) and harvest index (1.833), while it was low for number of primary branches per plant (0.278).

4.4 GENOTYPIC AND PHENOTYPIC COEFFICIENTS OF VARIATION

The genotypic and phenotypic coefficients of variation for all characters are presented in Table 4.3

4.4.1 Genotypic coefficient of variation (GCV %)

The estimates of genotypic coefficient of variation ranged from 4.007 (days to maturity) to 24.028 (kernel yield per plant).

The maximum genotypic coefficient of variation (GCV) observed for kernel yield per plant (24.028). High GCV also observed for harvest index (19.576), pod yield (19.023), number of mature pods per plant (17.327), 100 kernels weight (12.587) and number of primary branches per plant (12.509). While plant height (11.050), protein content (10.871), 100 pods weight (10.241) exhibited moderate GCV. It was the lowest for days to maturity (4.007), days to 50% flowering (5.899), oil content (7.307) and shelling percentage (9.229).

4.4.2 Phenotypic coefficient of variation (PCV %)

The estimates of phenotypic coefficient of variation ranged from 4.298 (days to maturity) to 27.209 (kernel yield per plant). Characters such as days to maturity (4.298), days to 50% flowering (6.420), oil content (7.505), shelling percentage (9.663), 100 pods weight (10.452), protein content (11.222), plant height (12.473) and 100 kernels weight (13.225) exhibited low PCV, where as number of pods per plant (19.793), harvest index (20.339), pod yield per plant (22.683) and kernel yield per plant (27.209) exhibited moderate PCV.

4.5 HERITABILITY

The broad sense heritability estimates for different characters presented in Table 4.3.

High heritability estimates found for 100 pods weight (96.004), oil content (94.787), protein content (93.848), harvest index (92.642), shelling percentage (91.230),100 kernels weight (90.514),days to maturity (86.908) and days to 50% flowering (84.421). While moderate values observed for plant height (78.476), kernel yield per plant (77.983), number of primary branches per plant (71.082) and pod yield per plant (70.339).

4.6 GENETIC ADVANCE AND GENETIC ADVANCE EXPRESSED AS PERCENTAGE OF MEAN

Genetic advance at five per cent selection intensity (k=2.06) was estimated for different characters. The estimates are summarised in Table 4.3.

The highest genetic advance (GA) observed for 100-pods weight (21.370). While it was high for shelling percentage (10.911), 100-kernels weight (10.737) and harvest index (9.167). It was moderate for days to maturity (7.644), plant height (7.652), oil content (6.640), pod yield per plant (6.033), number of mature pods per plant (5.670), protein content (5.538) and kernel yield (5.356). The low genetic advance observed for days to 50% flowering (2.919) and number of primary branches per plant (1.209).

High genetic advance expressed as percentage of mean (GAM) was found for kernel yield per plant (38.600), harvest index (37.36[illegible]), pod yield per plant (27.564) and number of mature pods per plant (27.354). While it was moderate for 100-kernels weight (23.484), 100 pods weight (20.254), protein content (21.017), number of primary branches per plant (18.317), plant height (17.863), shelling percentage (17.345) and oil content (14.267). It was low for days to 50 % flowering (10.258) and days to maturity (7.174).

low for days to 50 % flowering (10.258) and days to maturity (7.174).

4.7 CORRELATION COEFFICIENTS

The correlation coefficients estimated among thirteen characters to find out correlation of pod yield per plant and its components at genotypic (rg) and phenotypic (rp) levels. The data given in Table 4.4 reveals that there is not much difference in the magnitude of genotypic and phenotypic correlation coefficients. In general, the genotypic values were relatively higher than their corresponding phenotypic values.

The results of correlation between different pairs of characters are described below.

4.7.1 Pod yield per plant

Pod yield per plant was positively and significantly correlated with plant height (rg= 0.1794, rp= 0.1438), shelling percentage (rg= 0.4111, rp= 0.3343), oil content (rg= 0.4219, rp= 0.3435), 100 pods weight (rg= 0.4996 , rp= 0.4173), 100-kernels weight (rg= 0.5790, rp= 0.4737), harvest index (rg= 0.7578, rp= 0.6753), number of pods per plant (rg= 0.9816, rp= 0.8010) and kernel yield (rg= 0.9142, rp= 0.9264) at genotypic and phenotypic levels. While it was negatively associated with number of branches per plant (rg= -0.0559, rp= -0.0129), days to 50% flowering (rg= -0.2661, rp=-0.1698) and days to maturity (rg= -0.0452, rp= 0.0595).

TABLE - 4.4

Genotypic and phenotypic correlation coefficient for Virginia bunch groundnut genotypes

Sr No	Characters	Days to 50% flowering		Plant height (cm)		No. of primary branches/ plant		No. of mature pods / plant		Days to maturity		Kernel yield / plant (gm)	
		rg	rp	rg	rp	rg	rp	rg	rp	rg	rp	rg	rp
1	Pod yield /plant (gm)	- 0.2661*	- 0.1698	0.1794*	0.1438	- 0.0559	- 0.0129	0.8916**	0.8010**	-0.0452	-0.0595	0.9142**	0.9264**
2	Days to 50% flowering	1.000	1.000	- 0.5061**	-0.4147**	0.4846**	0.4083**	-0.1389	-0.1013	0.3930**	0.3531**	-0.2379**	-0.1679
3	Plant height (cm)			1.000	1.000	-0.3480**	-0.2390**	0.0768	0.0638	-0.4027**	-0.2937**	0.2301**	0.1959*
4	No. of primary branches / plant					1.000	1.000	-0.0544	-0.0107	0.2267	0.1591	-0.0698	-0.0001
5	No. of mature pods /plant							1.000	1.000	-0.0208	-0.0458	0.7966**	0.7402**
6	Days to maturity									1.000	1.000	-0.1673	-0.1695*
7	Kernel yield / plant (gm)											1.000	1.000
8	100 pods weight. (gm)												
9	100-kernels weight. (gm)												
10	Shelling %												
11	Harvest index %												
12	Oil content %												

*, ** significant at 5% and 1% levels respectively

rg : genotypic correlation

rp : phenotypic correlation

TABLE - 4.4 CONTINUE...

Sr No	Characters	100 pod weight (gm)		10 0 kernel weight (gm)		Shelling %		Harvest index %		Oil content %		Protein content %	
		rg	rp	rg	rp	rg	rp	rg	rp	rg	rp	rg	rp
1	Pod yield /plant (gm)	0.4996**	0.4137**	0.5790**	0.4737**	0.4111**	0.3343**	0.7578**	0.6753**	0.4219**	0.3435**	0.0778	0.0467
2	Days to 50% flowering	-0.2120*	-0.1926*	-0.1704*	-0.1516	-0.1685	-0.1378	-0.1564	-0.1272	-0.1679	-0.1511	0.3733**	0.3291**
3	Plant height (cm)	0.2192*	0.1697*	0.2939**	0.2434**	0.2823**	0.2457**	-0.1288	-0.0933	0.2144**	0.1794*	-0.2950**	-0.2563**
4	No. of primary branches / plant	0.1397	0.1228	0.1033	0.0948	-0.1034	-0.0867	-0.0976	-0.0544	-0.0843	-0.0611	02075*	0.1278
5	No. of mature pods /plant	0.0159	-0.0009	0.1960*	0.1841*	0.3098**	0.2535**	0.7340**	0.6385**	0.3113**	0.2760**	0.1934*	0.1416
6	Days to maturity	-0.1273	-0.1150	-0.1079	-0.1137	-0.3507**	-0.3202**	-0.0427	-0.0231	-0.1695	-0.1566	0.3942**	0.3661**
7	Kernel yield / plant (gm)	0.4752**	0.4156**	0.6902**	0.5839**	0.7421***	0.6376**	0.7562**	0.6939**	0.5183**	0.4480**	0.0154	-0.0019
8	100 pods weight. (gm)	1.000	1.000	0.6938**	0.6535**	0.2386**	0.2329**	0.2575**	0.2424**	0.2697**	0.2608**	-0.2213**	-0.2111
9	100-kernels weight. (gm)			1.000	1.000	0.6290***	0.5637**	0.3750**	0.3476**	0.4814**	0.4507**	-0.1123	-0.1053
10	Shelling %					1.000	1.000	0.4335**	0.3907**	0.5247**	0.4848**	-0.0835	-0.0894
11	Harvest index %							1.000	1.000	0.2822**	0.2680**	0.1094	0.1097
12	Oil content %									1.000	1.000	-0.1694	-0.1659

*, ** significant at 5% and 1% levels respectively

rg : genotypic correlation

rp : phenotypic correlation

4.7.2 Days to 50% flowering

Days to 50% flowering was positively and significantly correlated with number of primary branches per plant(rg= 0.4846, rp= 0.4083), days to maturity(rg= 0.3930, rp= 0.3531) and protein content(rg= 0.3733, rp= 0.3291) at both genotypic and phenotypic level, but negatively and significantly correlated with plant height(rg= -0.5061, rp= -0.4147) and 100 pods weight(rg= -0.2120, rp= -0.1926) at both genotypic and phenotypic level. Number of mature pods per plant (rg= -0.1389, rp= -0.1013), 100 kernels weight (rg= -0.1704, rp= -0.1516), shelling percentage (rg= -0.1685, rp= -0.1378), harvest index (rg= -0.1564, rp= -0.1272) and oil content (rg= -0.1679, rp= -0.1511) had negatively and non significant correlation with days to 50% flowering.

4.7.3 Plant height

Plant height was positively and significantly correlated with kernel yield per plant(rg= 0.2301, rp= 0.1959), 100 pods weight(rg= 0.2192, rp= 0.1697), 100 kernels weight(rg= 0.2939, rp= 0.2434), shelling percentage(rg= 0.2823, rp= 0.2457) and oil content(rg= 0.2144, rp= 0.1794), while negatively and significantly correlated with number of primary branches per plant(rg= -0.3480, rp= -0.2390), days to maturity(rg= -0.4027, rp= -0.2937) and protein content(rg= -0.2950, rp= -0.2563). Number of mature pods per plant (rg= 0.0768, rp= 0.0638) had positive and non significant and harvest index (rg= -0.1288, rp= -0.0933) had negative and non significant correlation with plant height.

4.7.4 Days to maturity

Days to maturity was positively and significantly correlated with protein content (rg= 0.3942,rp= 0.3661), but negatively and significantly correlated with shelling percentage(rg= -0.3507,rp= -0.3202. Remaining characters showed negative correlation with days to maturity.

4.7.5 Kernel yield per plant

Kernel yield per plant was positively and significantly correlated with number of pods per plant(rg= 0.7966,rp= 0.7402) harvest index(rg= 0.7562,rp= 0.6939), shelling percentage(rg= 0.7421,rp= 0.6376), 100-kernel weight(rg= 0.6902, rp= 0.5839), oil content(rg= 0.5183,rp= 0.4480), 100 pods weight (rg = 0.4752, rp= 0.4156), plant height(rg= 0.2301,rp = 0.1959) and protein content(rg= 0.0154, rp= 0.0019) at genotypic and phenotypic levels. While it was negatively associated with number of primary braches per plant (rg= -0.0698, rp= -0.0001), days to maturity (rg= -0.1673, rp= -0.1695) and days to 50% flowering (rg= -0.2379, rp= -0.1679).

4.7.6 Number of mature pods per plant

Number of mature pods per plant was strongly associated with harvest index (rg= 0.7340, rp= 0.6385), shelling percentage (rg= 0.3098, rp= 0.2535) and kernel yield (rg= 0.7966, rp= 0.7402). It was negatively correlated with days to 50% flowering (rg= -0.1389, rp= -0.1013), number of primary branches per plant (rg= -0.0544, rp= -0.0107) and days to maturity. (rg= -0.0208, rp= -0.0458) at genotypic and phenotypic level.

4.7.7 Number of primary branches per plant

Number of primary branches per plant was positively correlated with days to 50% flowering (rg= 0.4846, rp= 0.4083), but negatively correlated with plant height (rg= -0.3480, rp= -0.2390) at genotypic and phenotypic level.

4.7.8 100 pods weight

100-pods weight was positively and significantly correlated with pod yield (rg= 0.4996, rp= 0.4137), kernel yield (rg= 0.4752, rp= 0.4156) at genotypic and phenotypic level, but it was negatively correlated with days to 50% flowering (rg= -0.2120, rp= -0.1926) and days to maturity (rg= -0.1273, rp= -0.1150).

4.7.9 100 Kernels weight

100-kernels weight was positively and significantly correlated with 100-pods weight (rg= 0.6938, rp= 0.6535),shelling percentage(rg= 0.6290,rp= 0.5637),harvest index(rg= 0.3750,rp= 0.3476)oil content(rg= 0.4814,rp= 0.4507),but it was negatively correlated with protein content(rg= -0.1123,rp= -0.1053) at genotypic and phenotypic level.

4.7.10 Shelling percentage

Shelling percentage was positively and significantly correlated with kernel yield per plant (rg= 0.7421, rp= 0.6376),100 kernels weight (0.6290, rp= 0.5637), pod yield per plant (rg= 0.4111, rp= 0.3343), number of mature pods per plant (rg= 0.3098, rp= 0.2535) and plant height (rg= 0.2823, rp= 0.2457) at genotypic and phenotypic level, but it was negatively correlated with days to 50% flowering(rg= -0.1685,rp= -0.1378),number of primary branches per plant(rg= -0.1034,rp= -0.0867) and protein content(rg= -0.0835,rp= -0.0854).

4.7.11 Harvest index

Harvest index was positively and significantly correlated with pod yield per plant (rg= 0.7578,rp= 0.6753), kernel yield per plant (rg= 0.7562,rp= 0.6939), number of mature pods per plant (rg= 0.7340,rp= 0.6385), shelling percentage (rg = 0.4335,rp= 0.3907), 100-kernels weight (rg= 0.3750,rp= 0.3476),100 pods weight (rg= 0.2575,rp= 0.2424) and oil content (rg= 0.2822,rp= 0.2680),but it was negatively correlated with days to 50% flowering(rg= -0.1564,rp= -0.1272),plant height(rg= -0.1288,rp= -0.0933),number of primary branches per plant(rg= -0.0976,rp= -0.0544)and days to maturity(rg= -0.0427,rp= -0.0231) at genotypic and phenotypic level.

4.7.12 Oil content

Oil content was positively and significantly correlated with shelling percentage (rg= 0.5247, rp= 0.4848), 100 kernels weight (rg= 0.4814, rp= 0.4507), number of mature pods per plant (rg= 0.3113, rp= 0.2760) and100 pods weight (rg= 0.2697, rp= 0.2608), but it was negatively correlated with days to 50% flowering (rg= -0.1679, rp= -0.1511), number of primary branches per plant(rg= -0.0843, rp= -0.0611), days to maturity(rg= -0.1695, rp= -0.1566) and protein content(rg= -0.1694, rp= -0.1699)at genotypic and phenotypic level.

4.7.13 Protein content

Protein content was positively and significantly correlated with days to maturity (rg= 0.3942, rp= 0.3661) and days to 50% flowering (rg= 0.3733, rp= 0.3291) at genotypic and phenotypic level, but it was negatively correlated with plant height (rg= -0.2950, rp= -0.2563) at genotypic and phenotypic level.

4.8 PATH COEFFICIENT ANALYSIS

Pod yield per plant is the result of direct and indirect effects of several yields contributing characters. To know the contribution of various characters towards pod yield, the significant genotypic correlation of different traits with pod yield per plant were partitioned into their direct and indirect effects. This will provide more precise information for the selection of important traits which may more contribute towards pod yield. Direct and indirect effects of twelve causal variables on pod yield per plant are presented in Table 4.5

4.8.1 Days to 50 % flowering Vs pod yield per plant

The genotypic correlation between days to 50 % flowering and pod yield per plant was negative (rg= - 0.2661). The direct effect of days to 50 % flowering was negative and moderate (-0.0462). The indirect effect of this trait on pod yield per plant through plant height and kernel yield was positive and of high magnitude. Its indirect effect through number of primary branches, days to maturity and protein content were negative and low.

4.8.2 Days to maturity Vs pod yield per plant

The correlation between days to maturity and pod yield per plant was negative (rg= -0.0452). The direct effect of this trait on pod yield per plant was negative and high magnitude (-0.0323). The indirect effect of this trait on pod yield per plant through days to 50% flowering, number of primary branches per plant and protein content was negative and low magnitude. Its indirect effect through remaining traits was positive and low.

4.8.3 Plant height Vs pod yield per plant

Plant height showed positive association with pod yield per plant (rg= 0.1794). Its direct effect on pod yield per plant was positive and low magnitude

TABLE - 4.5

Path coefficient showing direct and indirect effects on causal variable on pod yield per plant in groundnut

Sr No	Character	Days to 50% flowering	Plant height (cm)	No. of primary branches / plant	No. of mature pods / plant	Days to maturity	Kernel yield / plant (gm)	100 pod weight (gm)	100 kernel weight (gm)	Shelling %	Harvest index %	Oil content %	Protein content %	Genotypic correlation coefficient with pod yield
2	Days to 50% flowering	**-0.0462**	0.0234	-0.0224	0.0064	-0.0182	0.0110	0.0098	0.0079	0.0078	0.0072	0.0078	-0.0172	-0.2661
3	Plant height (cm)	-0.0018	**0.0036**	-0.0012	0.0003	-0.0014	0.0008	0.0008	0.0011	0.0010	-0.0005	0.0008	-0.0011	0.1794
4	No. of primary branches / plant	-0.0060	0.0043	**-0.0123**	0.0007	-0.0028	0.0009	-0.0017	-0.0013	0.0013	0.0012	0.0010	-0.0026	-0.0559
5	No. of mature pods /plant	-0.0080	0.0044	-0.0031	**0.0573**	-0.0012	0.0456	0.0009	0.0112	0.0177	0.0420	0.0178	0.0111	0.8916
6	Days to maturity	-0.0127	0.0130	-0.0073	0.0007	**-0.0323**	0.0054	0.0041	0.0035	0.0113	0.0014	0.0055	-0.0127	-0.0452
7	Kernel yield / plant	-0.2933	0.2836	-0.0860	0.9818	-0.2062	**0.9936**	0.5857	0.8507	0.9148	0.9321	0.6388	0.0190	0.9142
8	100 pod wt. (gm)	0.0030	-0.0031	-0.0020	-0.0002	0.0018	-0.0067	**-0.0142**	-0.0099	-0.0034	-0.0037	-0.0038	0.0031	0.4996
9	100-kernel wt. (gm)	-0.0147	0.0254	0.0089	0.0170	-0.0093	0.0597	0.0600	**0.0865**	0.0544	0.0324	0.0416	-0.0097	0.5790
10	Shelling %	0.1026	-0.1718	0.0629	-0.1885	0.2134	-0.4517	-0.1452	-0.3829	**-0.6087**	-0.2638	-0.3194	0.0508	0.4111
11	Harvest index %	0.0011	0.0009	0.0007	-0.0053	0.0003	-0.0055	-0.0019	-0.0027	-0.0031	**-0.0072**	-0.0020	-0.0008	0.7578
12	Oil content %	-0.0070	0.0089	-0.0035	0.0129	-0.0070	0.0215	0.0112	0.0199	0.0217	0.0117	**0.0414**	-0.0070	0.4219
13	Protein content %	0.0167	-0.0132	0.0093	0.0087	0.0177	0.0007	-0.0099	-0.5050	-0.0037	0.0049	-0.0076	**0.0449**	0.0778

Residual effect = 0.1618

Bold figures denotes direct effect

(0.0036). The indirect effect of this trait on pod yield per plant through number of primary branches, days to maturity, days to 50% flowering, harvest index and protein content were negative and low magnitude. Its indirect effect on pod yield per plant via remaining traits was positive and low.

4.8.4 Number of primary branches per plant Vs pod yield per plant

Number of primary branches per plant showed negative correlation with pod yield per plant (rg= -0.0559. The direct effect on pod yield per plant was negative and high. The indirect effect of this trait on pod yield per plant through number of pods per plant, kernel yield, shelling percentage, harvest index, oil content and plant height was positive and low magnitude. Its indirect effect on pod yield per plant via remaining traits was negative and low.

4.8.5 Number of pods per plant Vs pod yield per plant

Number of mature pods per plant showed strong correlation with pod yield per plant (rg= 0.8916). It exerted the highest positive direct effect on pod yield per plant (0.0573). Its indirect effect on pod yield per plant via kernel yield and harvest index was positive and high magnitude. Its indirect effect on pod yield per plant via days to maturity was negative and low. Its indirect effect via remaining characters was positive and of low magnitude.

4.8.6 Kernel yield per plant Vs pod yield per plant

Kernel yield showed positive correlation with pod yield per plant (rg= 0.9142). This trait had high positive direct effect on pod yield per plant (0.9936). Its indirect effect on pod yield per plant via shelling percentage, harvest index, 100 kernels weight, 100 pods weight, oil content and plant height was positive and high. Whereas, it's indirect effect through days to maturity, days to 50% flowering and number of primary branches per plant were negative and high. The indirect effect through remaining characters was positive and low.

4.8.7 100 pods weight Vs pod yield per plant

The correlation between 100 pods weight and pod yield per plant was positive and moderate (rg= 0.4996). This trait had moderately low negative direct effect (-0.0142) on pod yield per plant. Its indirect effect on pod yield per plant through days to maturity, days to 50% flowering and protein content was positive and low. Its indirect effect through remaining characters was negative and low magnitude.

4.8.8 100 kernels weight Vs pod yield per plant

The correlation between 100 kernels weight and pod yield per plant was positive and moderate (rg= 0.5790). This trait had moderately high positive direct effect on pod yield per plant (0.0865). Its indirect effect on pod yield per plant through kernel yield, shelling percentage, harvest index, 100 pods weight and oil content was positive and high. Its indirect effect via days to maturity, days to 50% flowering and protein content were negative and low. Its indirect effect through remaining characters was positive and low magnitude.

4.8.9 Shelling percentage Vs pod yield per plant

The correlation between shelling percentage and pod yield per plant was positive and moderate (rg= 0.4111). This trait had moderately high negative direct effect on pod yield per plant (-0.6087). Its indirect effect on pod yield per plant through kernel yield was negative and high. Its indirect effect via days to maturity and days to 50% flowering was positive and high. Its indirect effect through remaining characters was negative and high magnitude.

4.8.10 Harvest index Vs pod yield per plant

The correlation between harvest index and pod yield per plant was positive and high (rg= 0.7578). This trait had low negative direct effect on pod yield per plant (-0.0072). Its indirect effect via days to maturity, days to 50% flowering, number of primary branches per plant and plant height was positive and low. Its indirect effect through remaining characters was negative and low magnitude.

4.8.11 Oil content Vs pod yield per plant

The correlation between oil content and pod yield per plant was positive and moderate (rg= 0.4219). This trait had low positive direct effect on pod yield per plant (0.0414). Its indirect effect on pod yield per plant through days to 50% flowering, days to maturity, number of primary branches per plant and protein content was negative and low magnitude. Its indirect effect through remaining characters was positive and low magnitude.

4.8.12 Protein content Vs pod yield per plant

The correlation between protein content and pod yield per plant was positive and low (rg= 0.0778). This trait had low positive direct effect on pod yield per plant (0.0449). Its indirect effect on pod yield per plant through kernel yield, number of pods per plant, number of primary branches per plant, days to maturity and days to 50% flowering was positive and low magnitude. Its indirect effect through remaining characters was negative and low magnitude.

LEGEND

D. F.	:	DAYS TO 50% FLOWERING
P. H.	:	PLANT HEIGHT
NO. P. B.	:	NUMBER OF PRIMARY BRANCHES PER PLANT
NO. M. P.	:	NUMBER OF MATURE PODS PER PLANT
D. M.	:	DAYS TO MATURITY
K. Y.	:	KERNEL YIELD PER PLANT
100 P. W.	:	100 PODS WEIGHT
100 K. W.	:	100 KERNELS WEIGHT
S. P.	:	SHELLING PERCENTAGE
H. I.	:	HARVEST INDEX
O. C.	:	OIL CONTENT
P. C.	:	PROTEIN CONTENT
r	:	DIRECT EFFECTS
)	:	INDIRECT EFFECTS
( )	:	FIGURE IN BRACKETS INDICATES GENOTYPIC CORRELATION COEFFICIENT WITH YIELD

V. DISSCUSION

India is leading the world in area and production of groundnut, however, per hectare yield is very low. The causes for this low productivity are that of crop is grown using inadequate agronomic practices in rained area, attack of diseases and pests. Apart from the above factors, the genetic potential of a variety decides the increase or decrease in overall productivity.

Desired genotypes could be isolated after studying various characters for their variability, heritability, genetic advance, correlation and path coefficient. Attempts have been made in this study to assess several yield components in Virginia bunch group of groundnut for the above purpose.

It is also well known that the interaction of genotypes with environment decides the production potential, thus the first step in this direction to evaluate genotypes from the available germplasm to decide the breeding base of the material.

The variation present in the population under evaluation is phenotypic and genotypic. The phenotypic variation is mostly due to the effect of environment on genetic constitution of plant. The magnitude of genetic variation helps in effective selection of superior genotypes. This closeness of phenotypic variation with phenotypic values is still better as this can serve in effective selection on phenotypic basis only.

5.1 VARIABILITY, HERITABILITY AND GENETIC ADVANCE

5.1.1 VARIABILITY

Information on nature and magnitude of variability present in the population helps for effective selection of superior genotypes. Superior genotypes can only be selected if wider variability is present in a population. The heritable portion of this variability in yield components observed under a particular environment helps in selection desired genotypes. Highly significant variation was observed among all the characters studied suggesting that the material was suitable for further study.

A wide range of phenotypic variability was observed for 100 pods weight, 100 kernels weight, harvest index, plant height, pod yield per plant, number of mature pods per plant and days to maturity. Majmudar et al.(1969) obtained same results.

Oil content, protein content, days to 50% flowering and number of primary branches per plant exhibited narrow range of phenotypic variability.

The phenotypic range observed in a particular character is the result of interaction between genotype of a plant and the environment under which it is grown. For effective selection, variation due to genetic causes must be known. This information is obtained by finding the components associated with genotypic and environmental forces.

The genotypic variances were greater than the environmental variances for all the characters.

The higher estimates of genotypic variances over error variances indicate that variation owing to genetic causes was higher than that owing to non genetic factors.

According to Millar et al.(1958) for those traits were genotypic variances are greater than the environmental effects, lines may be evaluated adequately testing in only a few replicates at a minimum locations.

Genotypic coefficient of variation helps in the measurement of range of genetic diversity in a character and provides a means to compare the genetic variability in the quantitative characters (Panse, 1957). High genotypic coefficient of variation indicates high degree of genetic variability in the particular character.

In the present study high genotypic coefficient of variation was observed for kernel yield per plant (24.028), pod yield per plant (19.023), harvest index (19.576), and number of mature pods per plant (17.327). These traits also exhibited high phenotypic coefficient of variation indicating their genetic capacity and ability to express in the given environment, these components may form a basis for selection. Qadri and Khunti (1982) observed high genotypic coefficient of variation for pod yield, harvest index and number of mature pods per plant. Patra (1975), Sumathi and Ramanathanan (1995), Salara and Gowda (1998) recorded high genotypic coefficient of variation for pod yield and number of mature pods per plant. Dixit et al. (1970), Sangha (1973) recorded high genotypic coefficient of variation for pod yield. Ashokaraj (1969), Sangha and Sandhu (1970) recorded high genotypic coefficient of variation for number of mature pods per plant.

Oil content, shelling percentage, days to 50% flowering and days to maturity had the lowest genotypic coefficient of variation. The low genotypic coefficient of variation for oil content suggests that for this character the variation had reached a plateau.

5.1.2 HERITABILITY

Though the genotypic coefficient of variation measures the amount of variation in characters, it is not possible to determine the amount of heritable variation based on this estimate. The genotypic coefficient of variation along with heritability estimates would provide a better picture of the amount of genetic advance, expected by phenotypic selection (Burton, 1952). Thus heritable portion of variability was estimated with the help of heritability estimates. The characters having high heritability values could be improved directly through selection since they are less affected by environment.

Heritability estimation indicates the effectiveness with which selection of genotypes can be made on the basis of phenotypic performance. If heritability is cent percent, the phenotypic performance will be perfect indication of genotypic performance. In such a hypothetical situation, heritability value itself provides known indication of the amount of genetic progress that may result by selecting superior individuals. The genetic progress will increase with the availability of wide genetic variation.

In the present study high heritability estimates found for 100 pods weight (96.004), oil content (94.787), protein content (93.848), harvest index (92.642), shelling percentage (91.230), 100 kernels weight (90.574), days to maturity (86.908) and days to 50% flowering (84.421), while moderate values observed for plant height (78.476), kernel yield per plant (77.983) number of pods per plant (76.636), number of primary branches per plant (71.082) and pod yield per plant (70.339). Same result for majority of above traits were obtained by Deshmukh et al.(1986) for characters like100 pods weight,100 kernels weight, shelling percentage and oil content, by Majmudar et al.(1969) for100 kernels weight, days to maturity and days to 50% flowering, by Dixit et al.(1970) for100 pods weight and100 kernels weight, by Sangha and Sandha (1970), Dholaria (1971) for 100 kernels weight, by Khangura and Sandhu (1973) for100 kernels weight and oil content, by Singh et al.(1982) for 100 kernels weight and shelling percentage, by Qadri and Khunti (1982), Vadodaria and Patel (1990) for harvest index and100 kernels weight, by Yadav et al.(1998) for

100 pods weight, 100 kernel weights, shelling percentage, harvest index and pod yield, by Venkatramana (2001) for oil content, 100 kernels weight and shelling percentage.

5.1.3 GENETIC ADVANCE

The genetic advance expressed as percentage of mean is the product of genotypic coefficient of variation, the square root of heritability ratio and selection intensity. The high heritability estimates enable plant breeder to base the selection programme on phenotypic performance.

Johnson et al. (1955) pointed out that heritability estimates along with genetic advance was more useful than the heritability value alone in predicting the resultant effect for selecting best individuals. Heritability estimates in the broad sense will be reliable if accompanied by high genetic advance as heritability in broad sense includes both additive and epitasis gene action. Genetic advance gives an indication of expected genetic progress for particular trait under suitable selection procedure. All the above parameters should be considered in conjunction so as to bring effective improvement in yield.

High genetic advance expressed as percentage of mean was observed for kernel yield per plant (38.600), harvest index (37.360), pod yield per plant (27.564) and number of mature pods per plant (27.354), while these values are moderate for100 kernels weight, 100 pods weight, protein content, number of primary branches per plant, plant height and oil content. Days to 50% flowering and days to maturity showed low expected genetic advance. Vadodaria and Patel (1990) obtained same result for pod yield, harvest index and number of mature pods per plant, by Mishra and Yadav (1992) for pod yield and kernel yield, by Abhay et al.(2002) for pod yield and kernel yield.

High heritability, genotypic coefficient of variation and genetic advance suggests additive gene effects as such selection for these characters would prove quite effective.

High heritability, but low genetic advance suggests that high heritability was probably due to non additive (dominance and epistatic) gene action, (Panse 1957).

5.2 CORRELATION COEFFICIENTS

The association of plant characters which is statically determined by correlation coefficients, is useful as a basis for selecting desirable genotypes, genotypic correlation permits the prediction of correlated response. They further permit the evaluation of the relative influence of various characters on yield.

The correlation is the over all or net effect of the segregating genes. Some of the genes may increase both the variables causing the positive correlation while, the other may increase the one and decrease the other causing the negative correlation.

In general, the values of genotypic correlation were higher than phenotypic correlation in the present investigation. This indicated that though there was a high degree of association between two variables at genotypic level, its phenotypic expression due to the influence of environment. Such low amount of phenotypic correlation could result due to the masking or modifying effect of environment on the association of characters. Genotypic correlation provides a measure of genetic association between traits and help in identifying the importance of the traits to be considered in breeding programme. With the help of some genotypic correlations, the interpretation and conclusion drawn become more reliable.

The genotypic and phenotypic correlation coefficient for pod yield per plant with number of mature pods per plant, kernel yield per plant,100 pods weight,100 kernels weight, shelling percentage, harvest index and oil content were significant. Days to 50% flowering, days to maturity and number of primary branches per plant had negative correlation. Plant height and protein content had low association with pod yield.

From the above results it appears that number of mature pods per plant, kernel yield per plant, 100 pods weight, 100 kernels weight, shelling percentage and harvest index were the common major yield components. Chandramohan et al.(1967), Balaiah et al (1980) had noted positive significant association between pod yield and number of mature pods per plant. Sangha and Sandhu (1970), Dholaria et al. (1972), Phadnis (1973), Natarajan et al (1978), Khunti (1980) , Labana et al.(1980) and Parkashkumar and Yadav (1982), Deshmukh et al.(1986), Sumathi and Ramanathanan (1995) Singh and Singh (1999) recorded positive significant association of number of mature pods per plant and 100 kernels weight with pod yield.

The environmental correlation coefficients were non significant. The high values of genotypic and phenotypic correlation coefficient observed in this study for the above characters suggest that expression of these characters had not been appreciably influenced by environment. Reduced environment influence could be due to relative stability. Under such condition, genotypic correlations could be expected to be higher than phenotypic correlations.

No association at genotypic or phenotypic level was observed for plant height and protein content with pod yield and number of mature pods per plant, for number of primary branches per plant with days to maturity, 100 pods weight, 100 kernels weight and protein content. Harvest index with protein content. This shows that these characters are totally independent.

Days to 50% flowering showed high positive genotypic and phenotypic correlation with number of primary branches per plant, days to maturity and protein content, while, it showed negative genotypic and phenotypic correlation with plant height, kernel yield and100 pods weight.

Plant height had positive genotypic and phenotypic correlation with kernel yield, 100 pods weight, 100 kernels weight, shelling percentage and oil content; it was negatively correlated with number of primary branches per plant, days to maturity and protein content.

Number of mature pods had positive genotypic and phenotypic correlation with kernel yield, harvest index, shelling percentage and oil content.

Days to maturity had positive genotypic and phenotypic correlation with days to 50% flowering and protein content.

100 pods weight had positive genotypic and phenotypic correlation with kernel yield and plant height, thus increasing in plant height will increase in 100 pods weight.

100 kernels weight had positive genotypic and phenotypic correlations with kernel yield, plant height and100 pods weight. This suggests that 100 kernels weight could be improved by increasing plant height.

Shelling percentage had positive genotypic and phenotypic correlation with plant height, number of mature pods per plant, kernel yield per plant, 100 pods weight and 100 kernels weight, but negative genotypic and phenotypic correlation with days to maturity. Thus improvement in these characters will increase in shelling percentage.

Harvest index had positive genotypic and phenotypic correlation with number of mature pods per plant, 100 pods weight, 100 kernels weight and shelling percentage. It was negatively associated with days to 50% flowering, plant height, number of primary branches per plant and days to maturity. Thus increase in days to 50% flowering, plant height, number of primary branches per plant and days to maturity will reduce the harvest index.

Oil content had positive genotypic and phenotypic correlation with number of mature pods per plant,100 pods weight,100 kernels weight shelling percentage , harvest index and plant height.

Protein content had positive genotypic and phenotypic correlation with days to 50% flowering and days to maturity, while negatively associated with plant height. This show increase in days to 50% flowering and days to maturity will increase in protein content and decrease in plant height will increase in protein content.

5.3 PATH COEFFICIENT ANALYSIS

The correlation simply gives the idea of the Joint variation of two characters. When more variables are included in the correlation study the interrelationship between these characters can not reveal the direct role played by these characters in enhancing yield. This correlation must therefore be partitioned into direct and indirect effects. This could be done through technique of path coefficient analysis, which is initially developed by Wright (1921) overcome this situation which partition the forces of association and examine the relative contribution of direct and indirect effects of the independent variable on the dependent variables.

In the present study, viz, days to 50% flowering, plant height, number of primary branches per plant, days to maturity, number of mature pods per plant, kernel yield per plant,100 pods weight,100 kernels weight, shelling percentage, harvest index, oil content and protein content were considered as causal variable of pod yield per plant. The genotypic correlation coefficient of these characters with pod yield per plant was partitioned into their direct and indirect effects through path coefficient analysis.

In the present investigation, number of mature pods per plant and kernel yield per plant had high positive direct effects on pod yield per plant. The direct effects of number of pods per plant on pod yield reported by Khangura and Sandhu (1972),Chandola et al (1973), Yadav et al.(1981), Prakashkumar and Yadav (1982), Deshmukh et al.(1986), Uddin et al (1995), Azad and Hamid (2000), Bera and Das (2000) .While 100 kernels weight had moderately positive direct effects on pod yield per plant. Plant height, oil content and protein content had low positive direct effects on pod yield per plant.

Days to maturity, days to 50% flowering and shelling percentage had high negative direct effects on pod yield per plant; Khunti (1980) also reported days to maturity had high negative direct effect on pod yield. While, number of primary branches per plant, 100 pods weight and harvest index had low negative direct effects on pod yield per plant.

Pod yield per plant highly and positively indirectly effected by days to 50% flowering via plant height and kernel yield, number of mature pods per plant via kernel yield and harvest index, kernel yield per plant via shelling percentage, harvest index, 100 pods weight, 100 kernels weight, oil content and plant height.

Though the study of path analysis, it was apparent that high direct effects were exerted by number of mature pods per plant, kernel yield per plant and100 kernels weight. This traits exhibited positive and significant correlations with pod yield per plant, there for these characters may be considered as the most important yield attributing characters and due emphasis should be placed on these characters while breeding for high pod yield in groundnut.

VI. SUMMARY AND CONCLUSION

Investigations were carried out on variability, heritability, genetic advance, correlation and path analysis in 45 varieties of Virginia bunch group of groundnut. The varieties were selected from the germplasm maintained at Main Groundnut Research Station, Gujarat Agricultural University, Junagadh. Thirteen characters namely days to 50% flowering, days to maturity, plant height, number of primary branches per plant, number of mature pods per plant, pod yield per plant, kernel yield per plant, 100 pods weight, 100 kernels weight, shelling percentage, harvest index, oil content and protein content were selected for the study. The experiment was conducted at Regional Oilseed Research Station, Agricultural Research Station, Gujarat Agricultural University, Talod. Dist: Sabarkantha during Kharif - 2002

The variability study revealed the presence of large magnitude of variability for most of the characters studied.

1. `The analysis of variance revealed significant differences among the genotypes for all the characters studied. This indicating the presence of sufficient variability in the experimental material.
2. A wide range of phenotypic variability was observed for 100 pods weight, shelling percentage, 100 kernels weight, harvest index, plant height, pod yield per plant, number of

mature pods per plant, days to maturity and kernel yield per plant.

While the narrow range of phenotypic variability was observed for oil content, protein content, days to maturity and number of primary branches per plant.

3. The higher magnitude of phenotypic and genotypic variance were observed for kernel yield per plant, harvest index, pod yield per plant and number of mature pods per plant. Where as genotypic variance were greater than the environmental variance for all the characters suggesting that variability was presence in various traits due to gene effect and they were less influenced by environment for pod yield and other related traits.
4. High genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were recorded for kernel yield per plant, pod yield per plant, harvest index and number of mature pods per plant.
5. High heritability estimates were observed for 100 pods weight, oil content, protein content, harvest index, shelling percentage and 100 kernels weight, indicating that these traits were less influenced by environment. The selection may be effective for all above characters.

While days to maturity, days to 50% flowering, kernel yield per plant, number of mature pods per plant and pod yield per plant had moderate heritability.

6. High values of genetic advance expressed as percentage of mean was observed for kernel yield per plant, harvest index, pod yield per plant and number of mature pods per plant.

   While the values of genetic advance for 100 kernels weight, 100 pods weight, number of primary branches per plant, shelling percentage, protein content and oil content were medium.

   Protein content and oil content exhibited low genetic advance though the heritability estimates was high and days to 50% flowering. Number of primary branches per plant also exhibited low genetic advance with medium heritability estimates. This suggests that very little improvement is possible in these characters.

7. Higher magnitude of genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability and genetic advance as percentage of mean were recorded for various characters like pod yield per plant, kernel yield per plant, harvest index, number of mature pods per plant. This indicates that additive gene action is involved in expression of these traits. There for more emphasis should be laid on these component traits. Selection method can be adopted for further improvement in pod yield.

8. Genotypic correlation coefficient was higher than phenotypic correlation coefficient in all the trait pairs, indicating strong inherent association between different characters. The

environmental correlation coefficient were non significant. The genotypic and phenotypic correlation coefficient for pod yield with number of mature pods per plant, kernel yield per plant,100 pods weight,100 kernels weight, shelling percentage, harvest index and oil content were positive and significant, where as days to 50% flowering and days to maturity was negative and non significant.

The most important finding is that protein content behaved as totally independent character. It had no genotypic and phenotypic association with the yield.

9. Path coefficient analysis revealed high positive direct effect of kernel yield per plant followed by 100 kernels weight, number of mature pods per plant, protein content, oil content and 100 pods weight. The above traits had high magnitude of genotypic correlation with pod yield.

The characters viz pod yield per plant, kernel yield per plant, harvest index and number of mature pods per plant recorded high heritability, high expected genetic advance and high positive correlation. Hence these traits may serve as important selection indices for pod improvement in groundnut.

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APPENDEX - I Mean **performances of 13 characters of Virginia bunch groundnut genotypes**

Sr No	Genotypes	Pod yield /plant (gm)	Days to 50% flowering	Plant height (cm)	No. of primary branches /plant	No. of pods /plant	Days to maturity	Kernel yield /plant (gm)	100 pod weight. (gm)	100 kernel weight. (gm)	Shelling %	Harvest index %	Oil content %	Protein content %
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	JVB - 161	21.133	30.000	35.267	8.133	20.533	110.333	11.713	107.297	44.667	56.572	22.267	45.783	28.217
2	JVB - 263	25.593	26.000	46.533	5.600	26.400	110.000	12.927	100.092	35.000	50.819	29.723	43.290	23.523
3	JSSP - 8	19.873	29.000	45.067	7.333	19.133	105.667	11.747	103.837	46.667	60.235	25.952	41.560	30.603
4	JSSP - 16	22.733	29.667	47.867	6.533	25.133	107.000	16.040	101.678	49.000	69.377	23.954	52.790	24.320
5	JVB - 349	24.600	27.667	44.133	6.800	24.067	109.67	16.887	105.915	48.000	68.173	26.633	46.697	28.447
6	JVB - 345	23.407	28.667	47.400	6.467	21.533	103.333	16.613	114.562	51.333	69.425	26.697	53.207	27.633
7	JVB - 170	22.753	27.000	42.867	6.533	22.200	099.667	13.400	108.698	44.333	60.337	26.839	41.137	31.137
8	JVB - 262	17.200	25.000	54.867	5.200	17.200	095.667	10.140	096.879	44.667	62.840	17.260	45.057	20.610
9	JVB - 134	20.133	31.333	31.467	8.333	19.733	109.333	11.333	101.909	36.000	54.951	23.855	41.450	24.433
10	JSSP - 5	23.067	28.667	38.400	5.400	19.933	108.000	15.800	105.638	48.333	69.153	26.519	47.730	26.127
11	JSSP - 13	20.533	29.000	39.933	7.333	21.133	112.333	12.867	097.221	40.000	60.849	18.667	41.597	30.400
12	JSSP - 10	18.267	29.667	43.133	5.733	17.667	110.000	10.600	103.397	36.667	57.592	25.791	46.260	29.417
13	JVB - 244	17.780	28.333	43.733	7.067	13.000	112.000	10.867	116.954	52.667	61.119	18.466	41.193	23.933
14	JVB - 265	15.200	29.000	39.467	6.800	21.533	101.667	09.067	074.090	31.000	61.014	17.905	47.637	26.543
15	JVB - 342	14.733	29.333	45.733	6.400	14.667	104.333	09.267	095.872	40.333	62.919	12.410	50.187	29.197
16	JVB - 343	15.000	30.333	46.333	7.733	11.333	105.000	08.200	122.333	47.667	54.694	11.267	43.987	21.353
17	JVB - 331	17.467	30.667	40.267	6.267	19.867	111.333	11.333	083.927	40.667	64.322	24.753	44.127	30.347
18	JVB - 368	20.800	29.667	42.267	5.933	19.667	110.667	14.400	103.671	45.000	68.748	27.042	47.013	25.827
19	JVB - 353	23.800	27.667	46.667	7.533	21.267	106.333	16.067	108.885	54.667	67.671	25.957	51.363	24.567
20	JVB - 148	21.467	30.000	32.867	8.000	23.400	110.000	11.867	096.425	39.333	56.129	25.936	45.970	28.693
21	JVB - 357	24.867	26.333	42.933	5.533	22.400	106.333	16.200	105.048	50.333	65.554	25.157	42.340	27.240
22	JVB - 302	22.533	26.000	44.467	7.667	19.400	105.667	15.267	106.971	47.000	67.203	22.225	50.350	23.160
23	GG - 20	23.800	29.333	40.533	6.133	24.600	104.000	16.267	098.105	48.000	68.296	29.322	47.187	25.097

APPENDEX - I CONTINUE...

Sr No	Genotypes	Pod yield /plant (gm)	Days to 50% flowering	Plant height (Cm)	No. of primary branches /plant	No. of pods /plant	Days to maturity	Kernel yield /plant (gm)	100 pod weight. (gm)	100 kernel weight (gm)	Shelling %	Harvest index %	Oil content %	Protein content %
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
24	**JSSP - 17**	25.133	24.667	47.933	5.267	23.133	107.667	17.800	107.763	49.333	70.848	28.058	51.977	21.357
25	**JSSP - 9**	18.667	30.000	31.667	6.800	17.733	108.000	10.800	102.310	49.667	58.225	26.551	46.263	24.580
26	**JSSP - 6**	31.067	29.000	46.333	7.733	28.000	109.000	20.0001	114.987	50.000	63.959	26.710	44.400	26.113
27	**JSSP - 14**	17.127	29.667	32.467	6.200	15.733	111.000	10.053	111.731	42.667	58.593	24.137	44.117	29.200
28	**JVB - 194**	17.267	26.000	48.200	4.733	16.267	100.333	09.600	106.066	35.333	55.540	16.292	43.500	20.303
29	**JVB - 347**	26.867	26.000	44.467	5.533	24.467	096.000	18.933	112.693	48.000	70.522	34.885	48.100	24.340
30	**JVB - 359**	31.467	30.667	43.200	7.333	27.533	097.000	21.533	117.949	50.000	68.580	32.025	48.510	25.700
31	**JVB - 356**	23.733	27.333	45.133	6.467	20.267	100.000	16.667	110.024	53.333	70.106	24.026	48.120	28.483
32	**JVB - 348**	25.600	29.000	43.400	7.933	24.000	106.000	17.333	112.273	48.667	68.386	30.260	46.473	27.367
33	**JVB - 352**	29.067	28.000	42.600	6.533	26.533	109.000	19.067	107.078	51.000	65.603	29.800	51.893	28.140
34	**JVB - 303**	23.133	27.333	44.733	6.267	20.867	106.667	16.333	114.359	51.000	67.177	29.662	47.393	24.190
35	**JVB - 361**	25.133	29.000	43.400	6.067	22.667	102.333	18.733	112.692	47.000	74.517	28.171	46.597	24.250
36	**JVB - 202**	21.533	25.667	44.400	7.333	19.333	108.333	11.933	113.649	43.333	56.641	28.072	47.133	27.737
37	**JVB - 260**	18.600	26.333	45.400	6.600	17.333	101.667	11.667	115.815	49.667	62.740	24.400	47.173	21.157
38	**JVB - 330**	21.067	30.333	43.333	7.733	18.067	107.667	13.600	112.370	50.667	64.551	24.591	50.923	24.850
39	**JVB - 369**	19.800	28.667	37.200	6.800	17.267	105.333	12.867	114.325	49.333	64.991	23.417	50.423	25.373
40	**JVB - 354**	33.067	28.000	46.600	5.533	27.200	111.000	17.067	119.667	51.333	52.491	24.917	51.407	28.507
41	**JVB - 153**	17.600	30.000	36.933	5.600	18.333	111.000	09.467	088.408	35.333	53.710	23.177	43.367	27.517
42	**JVB - 363**	27.067	26.333	40.267	6.200	23.467	109.000	17.933	122.246	50.667	66.274	27.664	48.877	29.953
43	**JVB - 137**	22.533	31.000	46.533	6.400	21.533	112.000	14.667	101.541	50.000	53.546	25.893	45.703	28.283
44	**JVB - 230**	18.000	30.000	50.667	7.000	16.000	109.667	11.533	100.000	43.667	63.090	19.464	42.457	30.477
45	**KADIRI - 3**	14.600	29.333	40.600	6.600	19.200	108.000	07.867	071.723	36.000	52.530	17.378	41.597	26.967