ANALYSIS OF GENETIC VARIABILITY IN EARLY GENERATION POPULATION AND STABILITY OF CROSS DERIVATIVES OF GROUNDNUT (*Arachis hypogaea* L.)

BY
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TO

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P A R E N T S

CANDIDATE'S DECLARATION

I hereby declare that the dissertation or part thereof has not been previously submitted by me to any other University or Institution for a degree or diploma

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DATE 17-7-91

(V. N. MITKARI)

CERTIFICATE I

Shri Vijaykumar Narayanrao Mitkari has satisfactorily prosecuted his course of research for a period of not less than four semesters and that the dissertation entitled "ANALYSIS OF GENETIC VARIABILITY IN EARLY GENERATION POPULATION AND STABILITY OF CROSS DERIVATIVES OF GROUNDNUT (*Arachis hypogaea* L.)" submitted by him is the result of original research work and is of sufficiently high standard to warrant its presentation to the examination. I also certify that the dissertation or part thereof has not been previously submitted by him for a degree of any University.

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(Dr. V.G. Makne)
Guide

CERTIFICATE II

This is to certify that the dissertation entitled "ANALYSIS OF GENETIC VARIABILITY IN EARLY GENERATION POPULATION AND STABILITY OF CROSS DERIVATIVES OF GROUNDNUT (*Arachis hypogaea* L.)" submitted by Shri. Vijaykumar Narayanrao Mitkari to Marathwada Agricultural University in partial fultilment of the requirement for the degree of Master of Science (Agriculture) in the subject of Agricultural Botany (Genetics and Plant Breeding) has been approved by the student's advisory committee after oral examination in collaboration with the external examiner.

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CHAPTER I

INTRODUCTION

I. INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is an important oilseed crop and accounts for 60 per cent of the vegetable oil produced in India, but the average yield is as low as 850 kg/ha because of fluctuations in yield over locations and seasons. Besides, it being a legume it can fit well in intercropping, relay cropping and multiple cropping systems.

In India groundnut is cultivated on an area of 67.88 lakh hectares (Anonymous, 1989). The principal States where groundnut is grown on large area are Gujarat, Andhra Pradesh, Tamil Nadu, Karnataka and Maharashtra. These States accounts for 80 per cent of the area and 84 per cent of the production. Maharashtra accounts for 7.09 lakh hectare area under groundnut cultivation. In Marathwada region, Latur (0.3 lakh ha), Parbhani).24 lakh ha) and Osmanbad (0.16 lakh ha) are the major groundnut growing districts.

The area under summer groundnut is increasing year after year due to the availability of irrigation facilities. The production level is also almost double to that of kharif grown groundnut. Thus it is imperative to breed stable and high yielding genotypes showing resistance/tolerance to disease and pests. Because groundnut is suffering with severe damage from insect and pests. Particularly leaf miner

(*Aproaerema modicella* Dev.) the key pest of groundnut in many parts of India. The areas most affected are Tamil Nadu, Western and Central Andhra Pradesh, Karnataka, Western Maharashtra and Orissa. Reported yield increase ranged from 49 to 85 per cent when the insect was controlled with chemicals. However, groundnut is grown mostly as a rainfed crop, control of the leaf miner is aimed at through the development of resistant cultivar. Similarly, in India the foliar fungal disease commonly cause severe damage to groundnut is late leaf spot caused by *Phaeoisariopsis personata.*

The estimates of variability and its heritable components available in a material are prerequisite for any breeding programme. Whether any phenotypic variability is heritable or non heritable is difficult to judge. The studies on character association, heritability and genetic advance also will provide a reliable information in formulating a breeding strategy. Such type of studies in early generation material are limited. Similarly, these estimates in early generation material particularly for leaf spot disease and leaf miner pest which are the two serious problems of groundnut cultivation are still in a limited condition.

At the same time to step up production in this crop breeders aim at evolving strains which are capable of giving maximum mean performance for yield and yield components over environments. Experiments shows that strains with wider genetic base are more stable under adverse seasonal conditions. The crop being relatively insensetive to day length with remarkably high level of adaptability as stated by Norden (1980) and Reddi (1980) that introduction and selection of high yielding varieties and testing their performance in different years or growing them at more locations in one year is also important.

Therefore, in the present investigation efforts were made to test the genetic parameters in the early generation groundnut crosses which will help for further selection and improvement and to identify certain progenies showing tolerance to pest and disease. Similarly, the stability performance of newly developed groundnut genotypes was also judged.

The objectives of these investigations were as given below :

1. To study the extent of genetic variation in early generation of different groundnut crosses for morphological characters.
2. To observe the extent of genetic variation for late leaf spot disease and leaf miner pest in progenies of some groundnut crosses.

3. To study the extent of genetic correlations between yield and its related characters in groundnut crosses.

4. To study the adaptability of newly developed groundnut genotypes for pod yield and important components.

CHAPTER II

REVIEW OF LITERATURE

II. REVIEW OF LITERATURE

2.1 Genetic variability

Very little published work (Coeffelt and Hammons, 1974; Sandhu and Khehra, 1977) on the degree of association between morphological characters, and the pod yield in the segeragating populations of groundnut is available. With this object in view, the present investigation involving varieties belonging to different botanical species a hybridization programme was undertaken and population was developed for genetic investigation. The available literature on these aspects in early generation population of groundnut crosses is reviewed in the following pages.

Eight selections of groundnut evolved at Agricultural Research Station, Raichur were compared for their heritability and variability of certain characters by Kulkarni and Albuquarque (1967). It was found that all the characters studied showed high heritability for height, number of branches, number of developed and undeveloped pods.

Labana et al. (1980) studied variability and interrelationship among characters in F_2 progeny of groundnut. They observed that the F_2 from the cross

M 145 x U 2-47-3 in which the heritability estimates for number of fruiting nodes per primary branches followed by 100 seed weight was highest. The expected genetic advance was highest for leaflet breadth followed by the number of fruiting nodes per secondary branches. The pod yield was correlated with the number of pods, 100 seed weight and number of secondary branches.

The variation in improved groundnut varieties was also studied by Bhagat et al. (1986). In their studies the phenotypic variability was greater for underground pegs, pod weight and node numbers on primaries. For oil content, the variability was lower. Heritability and genetic advance were high for pod yield/plant, Shelling percentage and 100 seed weight. Similar results were also reported by Dixit et al. (1970); Labana et al. (1980); Nagbhushanam et al. (1982) and Hari Singh et al. (1982).

In the studies of Deshmukh et al. (1986) carried out for variability, correlation and path coefficient for twelve characters, the phenotypic coefficient of variation was higher than genotypic coefficients. Heritability estimates were highest for 100 pod weight (which also showed the highest expected genetic advance) and were also high for main stem height, 100 seed weight, shelling percentage and percentage oil content.

The variability was studied in twelve promising bunch groundnut culture in advanced stages of breeding by Kandaswami et al. (1986). The characters like plant height, number of secondary branches, pod to peg ratio and number of primary branches showed high heritability estimates ranging from 0.8 to 0.96. While in the characters like number of mature pods, number of nodes on main stem, sound mature kernels, shelling percentage, harvest index and pod yield showed moderate heritability estimates of 0.45 to 0.62. The lower heritability estimates of 0.27 to 0.36 were recorded for weight of mature pod, 100 kernel weight and 100 pod weight. The high genotypic coefficient of variation ranging from 11.55 to 41.39 was observed for number of secondary branches, plant height and pod yield. The number of secondary branches and plant height recorded high genetic gain of 82.09 and 60.57 respectively and lowest genetic gain of 1.4 was recorded by shelling percentage followed by number of nodes on main stem and weight of mature pods (2.04 and 2.44).

Phenotypic and genotypic variability of eighteen characters was studied in 6 parents and their 15 F_2's from a half diallel set of crosses by Patil and Bhapkar (1987). They reported a wide range of variation in height of main stem, lateral spread, number of secondary branches, flowering duration, pod number, pod yield, 100 kernel weight, days to maturity and seed dormancy. Phenotypic and genotypic variances were the highest for seed dormancy and lowest for pod breadth. The phenotypic and genotypic coefficient of variation ranged from 2.16 to 29.97 and 1.17 to 29.75, respectively. Broad sense heritability was more than 60 per cent for almost all the characters. Expected genetic advance was highest for the secondary branches and lowest for pod length.

Early generation selection methods for the identification of groundnut crosses with combined high yield and disease resistance in 11 crosses were investigated by Iroune and Knauft (1987). The results on narrow sense heritability for all the traits, genetic correlation among the traits and relative efficiency of indirect selection for all the traits suggested that selection among crosses would be advantagious in S_1 (h^2 = 67 to 79 per cent) as compared with individual plant selection (h^2 = 16 to 26 per cent) or within family selection (h^2 = 3 to 5 per cent). Selection of genotypes within crosses, could be the present strategy in early generation. Negative genetic correlations were noted between yield and leaf spot severity.

Reddy et al. (1987) studied variability in F_2 generation of 6 x 6 diallel set of groundnut. Height of main axis, number of primary and secondary branches, kernel yield and pod yield, exhibited high heritability and genetic advance, shelling percentage showed high heritability and moderate genetic advance. The Spanish x Virginia (and reciprocal) combinations were at highest mean values for all the yield cpmponents.

Data on pod and seed characters were tabulated for the F_2 hybrids and the parental genotype by Tsaur et al. (1989). They observed that, heritability estimates were more than 90 per cent for pod and seed length and width and also for number and weight of poorly filled seed at both the locations.

Green and Wynne (1987) estimated, genetic variability and heritability for resistance to early leaf spot in four crosses of virginia type groundnut in F_5 generation. They observed that, the heritability estimates were moderate to high for resistance ranging from 0.41 to 0.78. Estimates of realised heritability ranged from 0.45 to 0.57.

In the studies of Patil et al. (1984)a in field screening 19 varieties and in glass house screening 14 varieties were moderately resistant to cercospora leaf spot disease.

In the field screening of groundnut genotypes for resistance to late leaf spot, Waliger and McDonald (1988) observed variable response of genotypes.

The variability in growth characteristics and leaf spot resistance parameters of groundnut lines was studied by Kanuft and Gorbet (1990). Their study revealed that 14 genotypes had similar vegetative stages throughout the growing stage. The vegetative weights of disease susceptible cultivar did not exceeded 165 g/plant while many resistant lines exceeded 250 g/plant. In the susceptible cultivar the partioning coefficient generally exceeded 80 per cent while resistant lines ranged from 20 to 80 per cent.

The increased area under irrigated groundnut in recent year has led to an increase in incidence of leaf miner (Aproaeroma modicella Dev.), the groundnut germplasm was screened for this pest. Rao and Sindagi (1974) and observed less than 17 per cent infestation of leaf miner on M.S. 11, G.N. 1024 and No. 27, while Lewin et al. (1971) reported more leaf miner incidence in bunch varieties than in spreading and semispreading types. Ghule et al. (1988) reported that the infestation was ranged from 20.53 to 95.48 per cent.

Mahadevan *et al.* (1988) had screened groundnut genotypes showing resistance to leaf miner and they observed that ICGS 50 possesses resistance to leaf miner (23.3 per cent damage). Similarly, Singh (1979) reported that genotypes USA 61 and No. 243 were resistant and EC 76452, EC 76457, EC 107980, EC 106983, EC 106966, Exotic 5, Exotic 5-3, Exotic 5-4 and AL 6695 were tolerant to leaf miner. In the screening of 155 genotypes carriedout by Mahadevan *et al.* (1989), eight spanish bunch entries showed some resistance to groundnut leaf miner compared with the control varieties. In the reaction of 18 interspecific derivatives to groundnut leaf miner, Kalaimani *et al.* (1989) observed that the *Arachis cardenasii* derivatives can also probably be a source for incorporation of resistance to leaf miner. In their studies the lowest incidence (4.0 per cent) was recorded in the entry VG 101.

2.2 Phenotypic stability

Although the genetic potential of 25 to 30 quintals/ha have been demonstrated, the unit area production on national basis has remained constant at 8 to 9 quintals/ha for several years. Varietal component being the major contributer for high yields seems to be not performing consistently under fluctuating environmental conditions. It is therefore necessary to identify varieties having wide adaptability so as to obtain high yield levels. The pertinant literature so far available on adaptability of groundnut genotypes is briefly reviewed here.

In the stability analysis carried out for six groundnut genotypes by Makne et al. (1979), it was observed that selection No. 90 and selection No. 91 were found as general adapter. Whereas other two selections viz., No. 92 and 95 A were specifically adapted to poor environment.

Yadava et al. (1980) found that genotype x environment interaction was significant for all the traits with a high linear component for 100 seed weight and oil content and high non linear component for shelling percentage. The estimates of stability parameters revealed that TG 10 gave the highest 100 seed weight followed by 13-46, G 64-206, 7-1 and the standard variety C 501. These varieties except 7-1 and C-501 had a high environmental response.

Kumar et al. (1984) found significant genotypic x environment interaction for all the characters. Both the linear and non-linear components of the interactions were significant for all the characters except pod yield. The genotype GC 90 possesses high pod yield and oil content and was stable for these two characters.

In the stability analysis carriedout by Patil et al. (1984), out of six promising varieties from India and Israel tested at four sites of Western Maharashtra over three years, the M 13 had good stability and second highest yield, while TMV 10 gave the highest yield with moderate stability.

Pushkaran and Gopinathan (1985) screened a widely divergent collection of 93 groundnut varieties to select the best suited variety for the kharif of upland and summer rice fallows. The varieties exhibited wide diversity for important economic traits within and between seasons and many of them were far superior to the recommended varieties. TG 14 in upland and TG 3 in rice fallows were the top ranking varieties.

Kandaswami et al. (1986) observed that the genotype x environment interaction variance was low for the traits, plant height, secondary branches and pod to peg ratio. Similarly, the environments created by adapting different spacings for groundnut sowing may also help to identify superior genotype and accordingly Preston et al. (1986) in variety x spacing and variety x sowing date, trials in Tanzania reported that the long season spreading bunch groundnut variety, Red Mwitunde was less tolerant of delayed sowing and more tolerant of wider spacing than Natal common, a short season upright bunch variety.

Eight promising bunch genotypes were evaluated for their stability of pod yield performance over four location in Karnataka State by Habib et al. (1986). They observed that the variety Dh 8 had good stability and high level of performance for pod yield.

The essential of yield capacity of new groundnut lines carriedout by Pompeu et al. (1986), it was observed that the high yielding lines differed from the local in the morphological characters of pods and seeds and suggested that they can be used individually or in mixture as new cultivars.

Phenotypic stability of pod yield in summer groundnut was studied by Bhole et al. (1987) in which significant differences amongst environments and genotypes were observed. They concluded that the cultivars UF 70-103 and J 2 can be considered as the most desirable varieties for summer cultivation under favourable and medium environmental conditions, respectively.

Kanuft et al. (1987) assessed 5 market quality characters in four cultivars and two experimental lines for 7 years. They observed significant genotype x year interaction for five of the characters and dixie runner were less responsive to environment than early bunch and florigiant. Early bunch had the smallest deviation from regression from virginia pods and total sound mature kernels. While florigiant had a smallest deviation for extra large kernels and weight of 100 sound mature kernels.

Patra and Mohanty (1987) tested 7 cross derivitives and 3 checks in 7 different seasons. OG 35-1, OG 71-3 and Kisan and J-11 of groundnut were found to be general adapters for yield. OG 9-2 had an average stability but low yield and showed adaptation to high yielding environments as it gave high yield in the winters. OG 13-1 showed below average stability.

The combine analysis of variance for pod and seed yield in 10 newly developed lines carried out by Lu et al. (1988) indicated that the mean squares for genotypes, environments and genotypes x environment interactions were significant. The non Keigi-133 and 134 showed the best pod and seed yield abilities over all the environments in the spring.

Sometimes mixtures, blends or composite lines are more stable than a single pure line under unfavourable environments. To justify this fact Ravindranath et al. (1988) tested 7 experimental cultures derived from crosses which were blended into 3 composit lines croswise and evaluated under 2 environments i.e. irrigated and rainfed conditions. They observed that genotype x environment interaction for most of the characters were found to be significant. All the genotypes both the pure stands and in mixed stands showed better performance under irrigated conditions than in rainfed condition and the genotypic blends showed better performance over their constituents pure stands in respect of character under both the environments.

2.3 Character association and path coefficient analysis

The information on character association and path analysis particularly in early generation groundnut population will help to identify the efficient plants based on phenotypic expression for morphological characters. The reports on these aspects in early generation material have been reviewed in the following pages.

In infraspecific cross population of groundnut Coffelt and Hammons (1974) and Gopani et al. (1970) observed that number of pods and pod weight, number of seeds and seed weight were significantly and positively correlated. Similarly, Mohammed et al. (1978) in the studies of early generation variability in crosses of virginia and spanish groundnut reported that pod yield was phenotypically and genotypically correlated with mature pod and fruit size.

Labana *et al.* (1980) studied the inter-relations amongs characters in F_2 progeny of groundnut and observed that the pod yield was highly and positively associated with the number of secondary branches and the pods and the 100 kernel weights. The height of the main stem, the number of primary branches, secondary branches and pods were highly correlated with one another. The maximum contribution to the pod yield was from the number of pods followed by 100 kernel weight.

Miller and Norden (1980) confirmed that resistance to leaf spot was negatively correlated with yield and early maturity.

Arunachalum and Bandopadhaya (1984) concluded that pod yield, shelling percentage and 100 kernel weight were the main traits to explaining variations in kernel yield.

Sibale (1985) observed in F_4 generation that, genotypic correlation among the traits were generally higher than phenotypic correlations. The data indicated that the seed set improvement can best be achieved directly selecting for pod set index with indirect selection of long pods as the best alternative.

Bhagat *et al*. (1986) in improved groundnut varieties reported that genotypic correlations were higher than phenotypic correlation with similar signs indicating the strong inherent association between the characters and are governed by genetic causes. Pod weight had significant poisitive phenotypic correlations with node number of topmost pegs, last pod bearing peg on primaries, mature pods and shelling percentage. Primary branches has no significant correlation with pod weight.

Negative genetic correlation were noted between yield and leaf spot severity by Iroune and Knauft (1987).

In the character association studies in F_2 generation carried out by Reddy *et al*. (1987) it was also observed that the genotypic correlations were higher than phenotypic correlations. The height of main axis showed negative significant genotypic correlation with number of primaries and secondaries.

Tasur *et al*. (1989) in F_2 population from 2 crosses of groundnut observed that all pods and seed triats showed significant correlations except between number and weight of poorly filled seed and number and weight of well filled seed.

The path coefficient analysis conducted by Raju et al. (1981) indicated that the direct and indirect influences of number of mature pods were more pronounced on pod yield both in parents and F_1 hybrids.

Mohinder Singh et al. (1984) stated that pod width contributed most to the pod yield.

The path analysis studies of Bhagat et al. (1986) revealed that only the mature pods maintained a strong positive direct effect with pod weight. The direct effects of primary branches, fresh plant weight, node number of last pod,bearing pegs and shelling percentage were also substantial and high.

Makne (1986) reported that in parents and F_1 population, the pod yield was significantly and positively correlated with important yield components like number of developed pods and kernel yield. In the path coefficient analysis, the secondary branches and kernel yield were the major contributor for pod yield in both parental and F_1 population.

Deshmukh et al. (1987) observed high positive direct effect of number of secondary branches, number of mature pods, 100 pod weight and 100 kernel weight on pod yield.

CHAPTER III

MATERIALS AND METHODS

III. MATERIALS AND METHODS

The present experiment was undertaken in groundnut to study the extent of genetic variability in early generation population of different groundnut crosses. The study was also included with the stability analysis of newly developed cross derivatives alongwith checks. The correlation coefficient and path analysis of yield and yield components at genetic level was also studied.

3.1 Experimental material

The experimental material included for the present study was as given below :

3.1.1 Early generation population in F_3 generation

A hybridization programme between Robut 33-1 and S.B. XI as female parents and No. 75-12 (leaf miner tolerant, P.I. 405132 and NCAC 17133 (late leaf spot resistant parent) as male parents was carried out in the Department of Genetics and Plant Breeding during kharif 1988. Five F_1's were grown and harvested for F_2 in Summer 1988. The five crosses in single individual F_2 generations were sown in kharif 1989. Based on plant type and pod yield potential the individual F_2 plants were selected and harvested separately for planting in F_3 generation during kharif 1990. The details of the crosses and their progenies selected for growing in F_3 generation are as given below :

Sr. No.	Cross	F_2/F_3 selected progenies
1.	Robut 33-1 x NCAC 17133	12
2.	Robut 33-1 x P.I. 405132	11
3.	Robut 33-1 x No. 75-12	51
4.	Robut 33-1 x Local	57
5.	S.B. XI x NCAC 17133	7
	Total	138

3.1.2 Parental genotypes

Fourteen parental genotypes were also selected for studying the variability and variability parameters for certain characters.

3.1.3 Cross derivatives of groundnut

Out of ten, four genetically fixed cross derivatives which were found promising during last 3 to 4 summer testings alongwith four standard checks were used for stability analysis. The details of the cross derivatives and checks included for the study are as given below :

Sr. No.	Genotype	Pedigree
1.	PBNG 8	M 13 x Jyoti
2.	PBNG 17	JL 24 x MH_2
3.	PBNG 18	S.B. XI x Robut 33-1
4.	PBNG 26	Robut 33-1 x Shulmit
5.	CGC 4018	Check
6.	JL 24	Check
7.	ICGS 11	Check
8.	S.B. XI	Check

3.2 Experimental methods

3.2.1 Experimental details

3.2.1.1 Variability analysis in early generation population

One thirty eight progenies in F_3 generation of five crosses were planted during kharif 1990 in randomised block design in a single row of 4 m length replicated three times. The rows were spaced at 50 cm from each other and plants in a row were dibbled at 20 cm distance

3.2.1.2 Variability analysis in parentla genotypes

A set of fourteen parental lines was also sown in separate experiment in randomised block design in a three row plot of 3 m length in three replications during kharif 1990. The row to row and plant to plant distance of 45 and 15 cm respectively was kept. The recommended uniform cultivation practices with plant protection measures were followed.

3.2.1.3 Stability analysis

The eight genotypes (4 cross derivatives and four standard checks) were planted during summer 1990 at five locations like Parbhani, Basmath, Ambajogai, Latur and Aurangabad. The experiment at each location was sown in a plot size of 5.10 x 3.00 m. following a spacing of 30 x 15 cm. Recommended cultural practices and plant protection measures were undertaken at each location as and when required. The crop was irrigated at an interval of 8 to 10 days till harvest.

3.3 Field observations

3.3.1 Variability analysis in early generation population

Ten plants were randomly selected in each progeny of each cross at the time of harvest for recording the following observations.

3.3.1.1 Days to 50 per cent flowering

Days required for sowing to 50 per cent flowering of the plants in each progeny were recorded.

3.3.1.2 Main stem height (cm)

Height was measured from the ground level to the tip of the main shoot at maturity.

3.3.1.3 Number of nodes on main stem

The nodes on main stem of each selected plant were counted.

3.3.1.4 Number of primary branches

The primary branches arising on main shoot were counted on each selected plant.

3.3.1.5 Number of secondary branches

Number of secondary branches on primary were counted on each plant.

3.3.1.6 Number of aerial pegs

On each selected plant the number of pegs which were not effected in to pods were counted on each selected plant.

3.3.1.7 Number of undeveloped pods

Total undeveloped pods were counted on each plant.

3.3.1.8 Number of developed pods

The sound mature pods were counted on each plant at the time of harvest.

3.3.1.9 Weight of developed pods in (g)

The developed dry pods were weighed from each plant and was recorded as pod yield per plant.

3.3.1.10 Shelling percentage

The pods from selected plants were shelled and shelling percentage was calculated.

3.3.1.11 100 kernel weight (g)

Well developed 100 kernels from each progeny were weighed in grams.

3.3.1.12 Harvest index

The ratio of economic yield to biological yield was taken as harvest index and was expressed in percentage.

$$\text{Harvest index} = \frac{\text{Pod yield per plant}}{\text{Biological yield}} \times 100$$

3.3.1.13 Disease and pest intensity

Per cent infestation of leaf miner pest

In 57 progenies of the cross of Robut 33-1 x No. 75-12 on selected ten plants, the healthy leaves and affected leaves by leaf miner were counted at the time of pod development stage and at harvest. The per cent infestation was estimated and angular transformation were made.

3.3.1.14 Leaf spot disease intensity

In eleven progenies each of crosses like Robut 33-1 x NCAC 17133 and Robut 33-1 x P.I. 405132 at the time of pod development stage and at harvest the healthy leaves and diseased leaves were counted. The disease intensity per cent was estimated and the values were angularly transformed.

3.3.2 Variability analysis in parents

In a set of parents in the central row five plants in each genotype were randomly selected for recording morphological observation on 12 characters as listed below :

3.3.2.1 Main stem height (cm)

The height was measured from the ground level to the tip of the main shoot.

3.3.2.2 Number of nodes on main stem

The nodes on main stem of each selected plant were counted.

3.3.2.3 Number of primary branches

The primary branches arising on main shoot were counted on each selected plants.

3.3.2.4 Number of secondary branches

The number of secondary branches arising on primary were counted on each plant.

3.3.2.5 Number of aerial pegs

On each selected plants the number of pegs which were not effected in pods were counted.

3.3.2.6 Number of undeveloped pods

Total undeveloped pods were counted on each plant.

3.3.2.7 Number of developed pods

The sound mature pods were counted on each plant at the time of harvest.

3.3.2.8 Weight of developed pods (g)

The developed dry pods were weighed from each plant and was recorded as pod yield per plant.

3.3.2.9 Weight of kernels per plant (g)

The dried pods were selled and weight of kernels was recorded as kernel yield per plant.

3.3.2.10 Harvest index

The ratio of economic yield was taken as harvest index and was expressed in percentage.

$$\text{Harvest index} = \frac{\text{Pod yield per plant}}{\text{Biological yield}} \times 100$$

3.3.3 Stability analysis

At each location by selecting randomly five plants in each of the eight genotypes the following observations were recorded.

3.3.3.1 Main stem height (cm)

The height was measured from the ground level to the tip of the main shoot at the maturity.

3.3.3.2 Number of nodes on main stem

The nodes on main stem of each selected plant were counted.

3.3.3.3 Number of primary branches

The primary braeches arising on main shoot were counted on each selected plant.

3.3.3.4 Number of secondary branches

The number of secondary branches arising on primary were counted on each plant.

3.3.3.5 Number of aerial pegs

On each selected plant the number of pegs which were not effective into pod were counted.

3.3.3.6 Number of undeveloped pods

Total undeveloped pods were counted on each plant.

3.3.3.7 Number of developed pods

The sound mature pods were counted on each plant at the time of harvest.

3.3.3.8 Weight of developed pods (g)

The developed dry pods were weighed from each plant and was recorded as pod yield per plant.

3.3.3.9 Shelling percentage

The pods from selected plants were shelled and shelling percentage was calculated.

3.3.3.10 100 kernel weight (g)

Well developed 100 kernels from each plant were weighed in grams. These observations were made in the group of 3, 4, and 4 at 3-4 locations for statistical analysis.

3.3.3.11 Days to maturity

The days were counted from sowing to maturity of crop in each genotype.

3.4 Statistical analysis

3.4.1 Variability analysis in early generation population

The replication means based on ten randomly selected plants in each progeny of the crosses for different characters in early generation crosses and characters in parents were used for analysis of variance as per the model suggested by Cockerhan and Cocks (1957). The phenotypic and genotypic coefficient of variations were worked out as per the formula of Burton (1952). The heritability in broad sense was estimated according to Lush (1940). The genetic advance expressed as per cent of mean was worked out as per the formula of Johanson *et al.* (1955). The remaining characters in early generation crosses and 3 characters in parental populations were analysed for variance, standard deviation and coefficient of variation as measures of dispersion using standard procedure described in a hand book of Agricultural Statistics written by Chandel (1975).

3.4.2 Stability analysis

The analysis of phenotypic stability for each genotype for the characters under study was carried out as per the procedure of Eberhart and Russel (1966).

3.4.3 Correlation and path coefficient

In the early generation population of five crosses the genotypic correlation between yield and different characters were estimated as per the formula of Falconer (1964). The path coefficient effects were worked out according to Dewey and Lu (1959).

CHAPTER IV

EXPERIMENTAL RESULTS

IV EXPERIMENTAL RESULTS T 1931.

4.1 Variability analysis in early generation population

4.1.1 Mean performance

The mean performance of progenies of different crosses for ten characters in F_3 generation is presented in Table 1. The progeny means were statistically significant for all the characters in the crosses. In cross Robut 33-1 x NCAC 17133 almost 3-4 progenies showed superior performance for all the characters than the general mean. In general the progenies 7 and 9 were found superior in performance for most of the characters. The progeny number 5 (3.33) followed by 1 (3.52) had least number of aerial pegs. The per cent incidence of late leaf spot in the progenies like 2 (26.41), 3 (27.14), 5 (27.45) and 9 (28.93) was comparatively low at pod development stage. It was found increased in almost all the progenies at harvest however, and was lowest in the progeny No. 8 (41.85). Excess raining during the crop growth period affected pod yield performance.

The progeny mean performance for all the characters in the cross Robut 33-1 x P.I. 405132 was also significant for all the characters. The progeny numbers like 2 (6.63), 5 (6.77) and 9 (6.25) had recorded lowest number of aerial pegs. Out of 11

Table 1. Mean performance of progenies of different crosses for different characters in F_3 generation.

Cross : Robut 33-1 x NCAC 17133

Progenies	Mean performance									
	Main stem height (cm)	Nodes on main stem	Primary branches/ plant	Secondary branches/ plant	Aerial pegs/ plant	Undeveloped pods/ plant	Developed pods/ plant	Pod yield/ plant (g)	Disease incidence at pod development stage (%)	Disease incidence at harvest (%)
1	2	3	4	5	6	7	8	9	10	11
1.	22.88	14.94	4.05	0.60	3.52	5.33	1.16	0.98	32.40	54.06
2.	18.60	14.16	4.16	2.24	4.36	5.77	3.33	1.88	26.41	52.63
3.	21.44	15.52	3.41	2.36	4.10	3.49	1.72	1.10	27.14	40.82
4.	20.91	13.52	3.77	4.44	5.77	3.44	2.66	2.66	33.55	44.33
5.	25.11	15.83	4.33	4.00	3.33	3.33	2.72	2.25	27.45	58.20
6.	27.49	13.72	3.88	2.58	5.66	2.08	1.91	1.41	30.44	53.91
7.	29.44	17.19	4.08	6.33	5.69	2.97	2.77	3.11	29.53	45.69
8.	20.19	13.91	4.11	4.02	4.80	1.61	2.66	1.33	30.79	41.85
9.	25.38	16.99	4.30	5.08	4.85	5.49	3.16	3.25	28.93	42.94
10.	34.16	22.08	3.52	2.05	4.94	2.05	2.75	2.00	29.78	42.58
Mean	24.56	15.78	3.96	3.37	4.70	3.55	2.48	2.00	29.63	47.70
SE±	0.83	0.49	0.24	0.49	0.38	0.45	0.47	0.32	1.67	3.55
CD at 5%	2.49	1.48	0.73	1.45	1.14	1.34	1.42	0.95	4.97	10.55

Contd

Cross : Robut 33-1 x P.I. 405132

1	2	3	4	5	6	7	8	9	10	11
1	26.16	20.30	4.00	4.58	8.25	4.16	3.69	2.54	26.66	50.72
2	25.25	18.47	4.08	4.77	6.63	3.72	6.11	4.76	25.77	41.59
3	32.27	22.49	3.97	6.52	7.13	6.35	4.00	2.91	23.81	33.76
4	23.72	17.44	3.91	7.88	7.52	4.69	3.75	2.79	27.94	53.10
5	22.88	20.02	4.00	4.58	6.77	4.33	4.22	3.16	31.34	32.41
6	22.38	18.41	3.91	8.05	8.80	5.44	3.72	2.97	25.13	48.28
7	23.63	19.30	4.11	6.55	8.41	3.19	3.69	2.94	24.52	61.02
8	33.49	22.13	4.02	2.94	13.05	7.80	6.69	4.54	21.57	57.24
9	27.74	19.63	4.00	2.50	6.25	2.47	4.27	3.97	21.21	54.11
10	28.66	22.69	4.00	10.00	17.27	5.80	5.66	4.44	21.93	70.23
11	29.05	22. 16	3.88	7.30	11.05	5.69	5.24	4.52	26.54	56.88
Mean	26.84	20.28	3.99	5.97	9.19	4.87	4.64	3.59	25.13	50.85
SE±	0.99	0.70	0.11	0.51	0.53	0.34	0.41	0.34	2.05	5.07
CD at 5%	2.92	2.08	0.34	1.50	1.57	1.00	1.22	1.01	6.03	14.97

Contd....

Cross : Robut 33-1 x No.75-12

1	2	3	4	5	6	7	8	9	10	11
1	21.13	18.27	4.00	11.77	8.99	4.25	7.10	5.11	10.76	15.08
2	22.27	18.52	4.00	7.27	8.30	3.02	4.80	2.70	23.60	19.09
3	27.47	21.99	4.00	13.13	9.33	2.88	3.49	2.39	8.42	13.75
4	21.49	18.22	3.60	8.72	9.50	2.50	4.25	2.06	12.08	18.81
5	20.91	18.41	4.08	9.33	9.83	2.97	4.58	3.20	12.77	12.62
6	22.63	19.63	4.13	8.77	9.82	4.24	5.91	3.37	12.71	15.35
7	21.91	18.77	4.22	8.38	10.63	3.44	5.22	3.88	11.54	14.94
8	22.75	17.36	3.91	5.66	4.11	3.47	4.27	2.58	11.23	13.96
9	19.38	15.25	3.74	9.60	3.61	3.69	4.77	2.88	12.65	14.97
10	20.36	17.83	4.02	9.97	2.99	3.32	5.63	3.76	12.33	15.06
11	22.94	18.38	4.02	10.11	3.75	4.05	5.30	3.45	10.89	11.54
12	22.80	17.94	3.80	15.89	3.00	3.44	5.75	3.53	10.51	13.29
13	21.38	17. 33	3.58	8.02	2.80	2.55	4.10	2.28	11.06	14.99
14	22.97	18.44	3.80	14.02	3.55	4.36	5.77	3.73	11.95	15.36
15	22.75	18.19	3.72	14.44	3.47	2.85	6.50	3.30	11.68	11.49

Contd...

1	2	3	4	5	6	7	8	9	10	11
16	20.94	17.47	4.00	13.97	9.27	5.27	7.22	3.52	13.23	12.64
17	21.38	17.94	4.00	9.74	12.97	4.49	6.25	3.92	15.87	15.19
18	26.27	18.52	4.00	11.33	12.50	4.22	6.44	4.91	8.55	12.98
19	24.41	18.55	4.11	12.22	8.58	4.72	8.22	5.61	11.11	13.92
20	26.60	18.94	4.13	16.44	12.33	5.55	6.69	4.87	8.60	12.15
21	32.35	22.47	4.41	19. 69	14.16	5.16	6.44	5.05	9.48	9.77
22	23.33	18.08	3.36	3.94	7.55	2.52	4.52	2.95	10.62	14.78
23	22.44	17.86	3.77	7.47	3.33	4.13	4.77	2.55	11.57	12.39
24	23.02	18.41	3.77	13.08	9.47	3.94	5.44	3.49	13.58	12.91
25	21.58	17.66	3.80	7.02	11.30	3.94	7.58	5.33	15.32	13.54
26	22.24	18.10	3.69	10.88	9.44	4.16	5.16	3.53	14.98	14.55
27	22.02	18.38	3.41	9.24	9.13	4.02	4.58	3.59	16.37	16.18
28	21.50	17.97	3.55	9.88	11.19	4.58	4.58	13.63	14.23	13.16
29	21.08	17.63	4.00	6.80	8.36	3.75	6.27	4.36	12.74	14.21
30	21.85	18.52	3.91	12.99	10.72	4.19	5.72	4.70	15.43	13.88

Contd...

1	2	3	4	5	6	7	8	9	10	11
31	21.52	18.05	4.02	13.24	11.47	5.88	7.80	6.91	12.99	14.67
32	22.13	18.24	3.88	9.44	11.55	5.05	5.94	3.74	13.73	12.51
33	22.33	17.97	4.44	18.50	17.08	6.11	8.00	5.74	11.99	12.34
34	22.30	17.88	4.22	14.97	15.88	5.38	5.41	3.67	13.13	12.08
35	21.60	18.27	4.41	10.02	11.36	5.30	8.11	6.47	12.14	13.60
36	22.27	18.50	4.00	9.36	8.66	5.16	6.47	4.40	14.25	11.51
37	21.33	17.80	4.02	6.66	7.22	5.55	4.99	2.58	8.73	12.49
38	22. 16	18.13	3.83	5.33	5.33	3.60	5.32	2.71	7.85	13.21
39	21.33	21.25	4.63	7.00	7.02	3.27	4.33	3.58	6.84	13.78
40	21.55	17.19	4.36	4.08	5.86	3.66	4.66	2.66	9.01	13.76
41	20.91	17.97	4.11	4.55	6.80	3.83	5.05	2.70	8.51	13.27
42	24.58	19.33	4.33	5.77	7.74	5.74	5.61	3.36	7.64	13.47
43	21.66	16.74	4.10	3.74	6.63	3.41	3.80	1.88	8.37	11.24
44	22.25	18.52	4.97	5.10	7.41	5.58	5.51	3.63	8.85	14.27
45	22.13	18.27	4.16	7.63	8.13	5.80	6.02	3.76	8.46	15.47

Contd...

1	2	3	4	5	6	7	8	9	10	11
46	22.88	18.38	4.02	7.44	8.66	5.99	5.49	2.94	7.81	16.76
47	23.36	18.00	3.91	7.80	9.43	5.55	5.22	3.03	7.38	15.81
48	22.08	17.72	4.00	7.22	7.66	5.97	7.13	3.70	10.25	12.94
49	22.50	17.91	4.00	7.74	9.99	6.88	7.27	4.91	13.03	11.71
50	21.94	17.77	3.99	9.77	8.91	5.60	5.83	3.66	9.45	13.54
51	21.72	17.83	4.00	10.58	9.94	5.66	7.16	4.56	8.44	10.12
52	22.61	18.41	3.91	3.66	8.83	5.00	6.47	4.23	8.12	11.88
Mean	22.52	18.29	4.00	9.60	8.58	4.41	5.61	3.74	11.40	13.69
SE±	0.71	0.48	0.66	0.64	0.96	0.71	0.61	0.53	2.00	1.04
CD at 5%	2.01	1.37	0.47	1.83	2.72	2.01	1.73	1.51	5.67	2.95

Cross : <u>Robut 33-1 x Local</u>

1	2	3	4	5	6	7	8	9	10	11
1	24.22	14.63	4.00	3.99	6.44	4.83	3.99	2.52		
2	22.66	16.58	4.00	4.58	8.58	5.11	5.11	3.22		
3	19.88	14.91	4.00	4.30	12.38	3.86	2.30	1.66		
4	20.50	15.69	4.00	2.47	12.69	6.94	8.74	5.17		
5	20.13	14.77	4.00	1.88	8.11	8.11	3.91	3.54		
6	19.94	15.69	4.00	4.10	13.86	6.02	2.55	2.67		
7	22.27	15.19	4.00	4.52	10.85	3.80	7.11	4.66		
8	20.83	16.05	4.00	2.77	6.27	4.08	3.44	3.08		
9	25.69	16.77	4.00	4.66	11.63	5.55	4.16	3.34		
10	22. 38	15.74	4.00	4.72	8.27	0.86	5.94	5.37		
11	22.96	15.99	4.00	2.36	7.41	4.16	3.22	2.58		
12	24.33	16.52	4.00	1.44	6.16	2.88	3.05	2.63		
13	29.50	18.02	3.91	2.11	11.72	5.08	5.63	2.77		
14	22.47	17.38	4.00	3.25	10.49	6.33	7.41	4.04		
15	20.88	16.10	3.88	2.33	6.10	2.44	3.22	2.55		

Contd...

1	2	3	4	5	6	7	8	9
16	22.66	16.77	4.00	6.16	8.72	3.61	4.33	2.99
17	24.99	18.08	4.00	1.47	8.19	4.44	2.97	2.67
18	28.33	16.99	4.00	5.38	6.49	4.30	3.50	2.51
19	18.97	15.22	3.91	3.88	7.99	4.99	3.77	3.30
20	15.69	12.63	4.00	2.08	6.36	3.55	2.22	1.49
21	23.30	17.52	4.00	8.02	12.77	5.91	6.44	5.73
22	19.83	16.24	4.00	3.13	9.58	5.72	5.16	3.83
23	23.13	15.27	4.00	2.52	10.22	5.94	3.24	2.34
24	32.97	17.38	4.00	4.58	19.19	5.49	8.96	6.72
25	33.08	20.38	4.00	3.66	9.41	3.94	2.72	2.45
26	24.02	17.97	4.00	1.22	10.47	4.88	5.33	4.40
27	26.22	17.19	3.58	1.44	10.86	5.99	6.05	3.10
28	23.00	15.55	4.00	3.24	9.19	4.69	2.66	1.34
29	23.69	15.49	4.00	1.86	9.61	4.00	2.91	2.22
30	15.16	15.16	4.00	1.33	6.35	4.30	3.94	3.09
31	20.44	16.13	4.00	2.63	8.41	4.11	4.13	2.33
32	19.52	14.38	4.00	4.30	7.85	5.16	3.61	2.99

Contd...

1	2	3	4	5	6	7	8	9
33	18.58	15.63	3.66	2.44	7.80	6.30	5.77	4.45
34	24.33	18.52	3.91	1.16	7.47	5.83	4.36	2.58
35	12.61	11.19	3.91	1.33	7.91	4.97	3.74	2.14
36	25.77	19.52	4.00	2.33	10.11	4.41	7.22	4.94
37	23.1 3	16.68	4.00	3.08	9.08	4.10	4.30	2.41
38	25.05	15.33	4.00	5.13	7.66	4.77	3.22	1.86
39	21.94	14.52	4.00	1.33	11.19	9.47	4.16	3.38
40	26.86	17.41	4.00	3.13	15.91	6.24	7.33	6.61
41	29.58	18.83	4.00	1.41	7.86	5.94	3.27	2.97
42	20.91	16.88	4.00	4.05	13.05	8.08	6.85	4.16
43	24.13	17.41	4.00	1.66	7.66	5.63	5.22	5.21
44	19.58	16.49	4.00	2.10	7.08	5.80	3.38	2.16
45	28.94	19.47	4.00	4.63	9.05	4.69	4.33	2.05
46	27.27	18.50	4.00	3.44	7.75	3.30	5.36	3.16
Mean	23.09	16.40	3.97	3.12	9.39	5.14	4.57	3.29
SE ±	1.34	0.89	0.07	0.59	1.10	0.81	0.55	0.60
CD at 5%	3.80	2.56	0.20	1.69	3.13	2.31	1.57	1.70

Cross ; S.B. XI x NCAC 17133

Progenies	Main stem height (cm)	Nodes on main stem	Secondary branches/ plant	Aerial pegs/ plant	Undeveloped pods/ plant	Developed pods/ plant	Pod yield/ plant (g)
1	21.30	14.80	1.91	8.97	5.13	4.91	3.36
2	19.63	15.35	1.00	5.77	3.88	1.66	1.33
3	26.25	15.72	1.88	5.66	1.88	2.75	2.92
4	22.88	15.55	1.11	6.66	5.66	4.16	4.55
5	18.66	14.74	1.72	8.72	6.61	6.80	4.94
6	20.11	14.30	4.35	20.97	9.35	7.80	5.15
Mean	21.47	15.08	1.99	9.46	5.42	4.68	3.71
SE ±	1.18	0.57	0.58	0.98	1.01	0.80	0.49
CD at 5%	3.72	1.80	1.83	3.11	3.18	2.54	1.55

progenies 4 progenies had given superior performance for pod yield. The late leaf spot disease incidence was comparatively less at pod development stage in all the progenies in this cross.

Fifty two progenies of the cross Robut 33-1 x No.75-12 were evaluated for 10 characters. The progenies numbers like 14 (14.02), 15 (14.44), 20 (16.44), 21 (19.69), 33 (18.50) and 34 (14.97) had shown quite high number of secondary branches/plant. The number of aerial pegs were quite less in the progeny numbers 9 (3.61, 10 (2.99), 11 (3.75), 12 (3.00), 13 (2.83), 14(3.55), 15 (3.47) and 23 (3.33). The progeny numbers 19 (8.22), 33 (8.00) and 35 (8.11) also showed highest number of developed pods. The per cent incidence of leaf miner at pod development stage was quite low in the progenies like numbers 38 (7.85), 39 (6.84), 42 (7.64), 46 (7.81) and 47 (7.38). Whereas at harvest, the incidence of this pest was less in progeny numbers 11 (11.54), 19 (11.49), 21 (9.77), 36 (11.51), 43 (11.24), 49 (11.71) and 52 (11.88). The progeny number 21 was found with desirable mean pod yield, high number of primaries and secondaries and with lowest incidence of leaf miner incidence at both the stages.

The progenies in the cross Robut 33-1 x local showed less differences for the characters main stem height, nodes on main stem and primary branches.

However, the progeny differences were greater for secondary branches, aerial pegs, developed pods and pod yield. The progenies like 16 (6.16) and 21 (8.02) had showed highest number of secondary branches. The aerial pegs were minimum in progeny numbers 1 (6.44), 8 (6.27), 12 (6.16), 15 (6.10), 18 (6.49) and 20 (6.36). The highest number of developed pods were recorded by the progeny numbers like 4 (8.74), 24 (6.72) and 40 (6.61) and were found superior.

Six progenies of the cross S.B. XI x NCAC 17133 were evaluated for 7 characters. The progeny number 6 was having highest number of developed pods (7.80) and pod yield/plant (5.15). However, aerial pegs (20.97) in this progeny were highest of all.

4.1.2 Analysis of variance

The observations for five crosses are grouped in to two tables. The analysis of variance for 10 characters in three crosses (Table 2) revealed that the progeny differences in all the crosses were highly significant except for the number of primary branches/plant, developed pods/plant and late leaf spot incidence at pod development stage in the cross Robut 33-1 x P.I. 405132, and for undeveloped pods/plant in the cross Robut 33-1 x No. 75-12. This indicated that there was sufficient variability in the progenies of these three crosses.

Table 2. Analysis of variance (RBD) for progenies of three crosses for 10 characters in F_3 generation.

Characters	Mean sum of squares			Mean sum of squares			Mean sum of squares		
	Replication (2 d.f.)	Progeny (9 d.f.)	Error (18 d.f.)	Replication (2 d.f.)	Progeny (10 d.f.)	Error (20 d.f.)	Replication (2 d.f.)	Progeny (51 d.f.)	Error (102 d.f.)
	Robut 33-1 x NCAC 17133			Robut 33-1 x P.I.405132			Robut 33-1 x No.75-12		
Main stem height (cm)	2.03	68.69**	2.11	0.26	42.40**	2.94	0.11	13.79**	1.52
Nodes on main stem	0.16	19.78**	0.74	1.56	10.19**	1.50	0.68	3.68**	0.71
Primary branches/plant	0.27	0.29	0.18	0.01	0.01	0.04	0.29	0.24*	0.08
Secondary branches/plant	0.11	8.64**	0.72	0.21	15.94**	0.78	0.24	42.09**	1.25
Aerial pegs/plant	1.80	2.29**	0.44	0.66	34.00**	0.85	1.15	30.58**	2.78
Undeveloped pods/plant	0.51	6.82**	0.61	0.28	7.02**	0.35	0.28	3.63	1.52
Developed pods/plant	0.15	1.36	0.68	0.49	3.58**	3.58**	0.51	4.05*	1.13
Pod yield/plant (g)	0.09	1.97**	0.31	0.68	2.15**	0.35	0.24	3.55**	0.85
Disease and pest incidence at pod developed stage (%)	15.40	15.61	8.39	0.22	27.51	12.55	43.50	27.23*	12.06
Disease and pest incidence at harvest (%)	60.60	119.81**	37.88	95.65	388.95**	77.34	1.56	9.94*	3.27

* and ** significant at 5 % and 1 % level, respectively.

The analysis of variance for seven characters in two crosses (Table 2a) indicated that the progeny differences were statistically significant except for nodes on main stem in the cross S.B. XI x NCAC 17133.

4.1.3 Genotypic and phenotypic variability and mean

4.1.3.1 Range and mean

The range, mean, genotypic, phenotypic and environmental variances for 10 characters in three crosses are furnished in Table 3. All these characters showed a wide range of variation. The maximum extent of variability was noticed for late leaf spot disease incidence at harvest in the cross Robut 33-1 x P.I. 405132 (32.41 - 70.23) followed by secondary branches (3.66 - 19.69) and aerial pegs (2.80 - 17.08) in the cross Robut 33-1 x No.75-12. Main stem height in the cross Robut 33-1 x NCAC 17133 and aerial pegs in the cross Robut 33-1 x No. 75-12. The least range of variation was observed for primary branches in all the three crosses. The phenotypic variation in all the three crosses was observed to be high for disease and pest incidence.

The range of phenotypic variability and their variances for 8 characters in two crosses (Table 3a) indicated that the character aerial pegs in both the crosses varied with high range.

Table 2a. Analysis of variance for seven characters in two crosses of F_3 generation.

Characters	Mean sum of squares			Mean sum of squares		
	Replication (2 d.f.)	Progeny (45 d.f.)	Error (90 d.f.)	Replication (2 d.f.)	Progeny (- d.f.)	Error (- d.f.)
	Robut 33-1 x Local			S.B. XI x NCAC 17133		
Main stem height (cm)	1.65	51.52**	5.41	8.34	22.78**	4.20
Nodes on main stem	4.93	8.81**	2.40	5.51	0.90	0.98
Secondary branches/plant	0.07	6.83**	1.07	0.96	4.46*	1.01
Aerial pegs/ plant	7.85	22.09**	3.69	6.39	101.44**	2.93
Undeveloped pods/plant	2.27	5.71*	2.00	0.09	19.13**	3.06
Developed pods/plant	1.10	8.67**	0.92	2.41	16.43**	1.96
Pod yield/ plant (g)	1.11	4.93	1.09	0.65	6.41**	0.73

* and ** indicates significance at 5 and 1 per cent level, respectively.

Table 3. Range, mean and estimates of genotypic, phenotypic and environmental variances for 10 characters in three different crosses in F_3 generation.

Character		Range	Mean	$\sigma^2 g$	$\sigma^2 p$	$\sigma^2 e$
Main stem height (cm)	A	18.606-34.166	24.563	22.196	24.30	2.11
	B	22.38-33.49	26.84	13.15	16.09	2.94
	C	20.91-32.35	22.52	4.09	5.61	1.52
Nodes on main stem	A	13.52-22.08	15.78	6.34	7.09	0.74
	B	17.44-22.69	20.28	2.89	4.39	1.50
	C	16.74-22.47	18.29	0.99	1.70	0.71
Primary branches/ plant	A	3.41- 4.33	3.96	0.03	0.21	0.18
	B	3.91- 4.11	3.99	-0.00	0.03	0.04
	C	3.41- 4.97	4.00	0.05	0.13	0.08
Secondary branches/ plant	A	0.60- 6.33	3.37	28.57	29.29	0.72
	B	2.50-10.00	5.97	5.05	5.83	0.78
	C	3.66-19.69	9.60	13.61	14.87	1.25
Aerial pegs/ plant	A	3.33- 5.77	4.70	0.61	1.06	0.44
	B	6.25-17.27	9.19	11.04	11.90	0.85
	C	2.80-17.08	8.58	9.26	12.05	2.78
Undeveloped pods/ plant	A	1.61- 5.77	3.55	2.07	2.68	0.61
	B	2.47- 7.80	4.87	2.22	2.57	0.35
	C	2.50- 6.88	4.41	0.70	2.29	1.52
Pod yield/ plant (g)	A	0.98- 3.25	2.00	0.55	0.86	0.31
	B	2.54- 4.76	3.59	1.80	2.15	0.35
	C	1.88- 6.91	3.74	0.89	1.75	0.85
Disease and pest incidence at pod development stage (%)	A	26.41-33.55	29.64	2.40	10.80	8.39
	B	21.21-31.34	25.13	4.85	17.41	12.55
	C	6.84-16.37	11.40	5.05	17.12	12.06
Disease and pest incidenece at harvest (%)	A	40.87-58.20	47.70	27.30	65.19	37.88
	B	32.41-70.23	50.85	103.86	181.21	77.34
	C	9.77-19.09	13.69	2.22	5.49	3.27

A = Robut 33-1 x NCAC 17133, B = Robut 33-1 x PI 405132
C = Robut 33-1 x No. 75-12

Table 3a. Range, mean and genotypic, phenotypic and environmental variances for 8 characters in two crosses in F_3 generation.

Characters		Range	Mean	6^2g	6^2p	6^2e
Main stem height (cm)	D	12.61 - 33.08	23.09	15.36	20.78	5.41
	E	18.66 - 26.26	21.47	6.19	10.39	4.20
Nodes on main stem	D	11.19 - 20.38	16.40	2.13	4.54	2.40
	E	14.30 - 15.72	15.08	-0.02	0.96	0.98
Primary brnaches/ plant	D	3.58 - 4.00	3.97	0.00	0.01	0.01
	E	-- --	--	--	--	--
Secondary branches/ plant	D	1.22 - 8.02	3.12	1.91	2.99	1.07
	E	1.00 - 4.35	1.99	1.15	2.16	1.01
Aerial pegs /plant	D	6.16 - 19.19	9.39	6.13	9.82	3.69
	E	5.66 - 20.97	9.46	32.83	35.77	2.93
Undeveloped pods/plant	D	2.88 - 9.47	5.14	1.23	3.24	2.00
	E	1.88 - 9.35	5.42	5.35	8.42	3.06
Developed pods/plant	D	2.30 - 8.99	4.57	2.58	3.50	0.92
	E	1.66 - 7.80	4.68	4.82	6.78	1.96
Pod yield/ plant (g)	D	1.34 - 6.72	3.29	1.28	2.37	1.09
	E	1.33 - 5.15	3.10	1.89	2.62	0.73

D = Robut 33-1 x Local, E = S.B. XI x RCAC 17133

4.1.3.2 Variance components

The genotypic and phenotypic variances (Table 3) indicated that these were highest for late leaf spot disease incidence at harvest in the cross Robut 33-1 x P.I. 405132 (σ^2g = 103.86, σ^2g = 181.21) and Robut 33-1 x NCAC 17133 (σ^2g = 27.30 , σ^2g = 65.19) followed by secondary branches.in the cross Robut 33-1 x NCAC 17133 (σ^2g = 28.57, σ^2p = 29.29). These variances were low for primary branches in all the three crosses and for nodes on main stem in the cross Robut 33-1 x No.75-12 and pod yield in the cross Robut 33-1 x NCAC 17133. The environmental variance was quite high for late leaf spot disease in the two crosses like Robut 33-1 x NCAC 17133 (σ^2e = 37.88) and Robut 33-1 x P.I. 405132 (σ^2e = 77.34) at harvest.

Similarly the variance components for 8 characters in two crosses shown in Table 3a indicated that the maximum genotypic and phenotypic variance were observed for aerial pegs in the cross S.B. XI x NCAC 17133 (σ^2g = 32.33, σ^2p = 35.77) followed by main stem height in both the crosses. The environmental variance in these crosses for main stem height were also high.

4.1.4 Estimates of variability parameters

The estimates of variability parameters for 10 characters in three crosses are presented in Table 4.

Table 4. Genotypic, phenotypic and environmental coefficients of variation (GCV, PCV and ECV), heritability in broad sense (h^2 (BS)) and genetic advance (GA) for 10 characters in three crosses in F_3 generation.

Characters		GCV (%)	PCV (%)	ECV (%)	h^2(BS) (%)	GA	GA as % of mean
Main stem height (cm)	A	19.18	20.07	5.91	91.31	9.27	37.74
	B	13.51	14.94	6.39	81.70	6.75	25.15
	C	8.97	10.51	5.45	72.86	3.55	15.77
Nodes on main stem	A	15.95	16.86	5.47	89.46	4.90	31.05
	B	8.39	10.33	6.03	65.88	2.84	14.00
	C	5.43	7.1 3	4.61	58.16	1.56	8.53
Primary branches/ plant	A	4.72	11.80	10.82	15.98	0.15	3.83
	B	-2.37	0.82	5.13	-27.27	-0.10	-2.53
	C	5.75	9.21	7.20	38.97	0.29	7.37
Secondary branches/ plant	A	158.52	160.46	25.19	97.53	10.87	322.36
	B	37.63	40.44	14.80	86.60	4.30	73.82
	C	38.40	40.14	11.68	91.53	7.26	75.66
Aerial pegs/ plant	A	16.70	21.89	14.14	58.24	1.23	26.22
	B	36.14	37.51	10.05	92.80	6.56	71.38
	C	35.46	40.45	19.45	76.87	5.49	63.98
Undeveloped pods/ plant	A	40.42	46.03	22.01	77.12	2.60	73.05
	B	30.57	32.88	12.12	86.40	2.85	58.50
	C	18.93	33.78	27.98	31.40	0.96	21.83
Developed pods/ plant	A	19.11	38.44	33.35	24.72	0.48	19.54
	B	21.77	26.70	15.45	66.49	1.69	36.50
	C	17.55	25.81	18.92	46.24	1.37	24.56
Pod yield/ plant (g)	A	37.21	46.52	27.92	63.97	1.22	61.20
	B	37.30	40.85	16.63	83.41	2.52	70.16
	C	25.31	35.38	22.88	51.16	1.39	37.22
Disease and pest incidence at pod developmentstage (%)	A	5.23	11.08	9.77	22.26	1.50	5.06
	B	8.77	16.67	14.09	27.90	2.39	9.53
	C	19.71	36.28	30.46	29.52	2.51	22.04
Disease and pest incidence at harvest(%)	A	10.95	16.92	12.90	41.89	6.95	14.57
	B	20.04	26.47	17.29	57.31	15.88	31.24
	C	10.88	17.11	13.21	40.42	1.95	14.24

A = Robut 33-1xNCAC 17133, B = Robut 33-1xP.I. 405132
C = Robut 33-1xNo. 75-12

4.1.4.1 Genotypic coefficient of variation

The genotypic coefficient of variation was maximum for secondary branches/plant (158.52%) in the cross Robut 33-1 x NCAC 17133 followed by undeveloped pods (40.42%.) The pod yield/plant also exhibited substantially high genotypic coefficient of variation in all the 3 crosses like Robut 33-1 x NCAC 17133 (37.21%,) Robut 33-1 x P.I. 405132 (37.30%,) Robut 33-1 x No.75-12 (25.31%.) The least estimates of genotypic coefficient of variation were recorded for primary branches/plant in all the three crosses (-4.72% -2.37% and 5.75%.) The genotypic coefficient of variation was moderate for leaf miner pest incidence in the cross Robut 33-1 x No.75-12 (19.71%) at pod development stage and the late leaf spot disease incidence at harvest in the cross Robut 33-1 x P.I. 405132 (20.04%) compared to other two crosses.

4.1.4.2 Phenotypic coefficient of variation

The estimates of phenotypic coefficient of variation were slightly higher than the genotypic coefficient of variation in all the crosses for all the characters. The maximum estimates in all the three crosses were observed for secondary branches (160.46%) in the cross Robut 33-1 x NCAC 17133. The three crosses viz., Robut 33-1 x NCAC 17133 (46.92%), Robut 33-1 x P.I. 405132 (40.85%) and Robut 33-1 x No. 75-12 (35.38%) also recorded high estimates of phenotypic coefficient of variation for pod yield/plant. Similar high values for developed pods/plant (38.44%, 26.70% and 25.81%) and aerial pegs/plant (21.89%, 37.51% and 40.45%) were also observed in all the three crosses. The highest coefficient of phenotypic variation to the extent of 36.28% in the cross Robut 33-1 x No.75-12 and 26.47% in the cross Robut 33-1 x P.I. 405132 was observed, respectively for leaf miner pest incidence at pod development stage and late leaf spot disease incidence at harvest. The lowest values of phenotypic coefficient of variation were associated with primary branches/plant (11.80%, 0.82% and 9.21%) in all the three crosses.

4.1.4.3 Environmental coefficient of variation

The environmental coefficient of variation was observed to be high for developed pods (33.35%) in the cross Robut 33-1 x NCAC 17133 followed by leaf miner pest and for undeveloped pods (27.98%) in the cross Robut 33-1 x No. 75-12. Very less estimates for this parameter in all the three crosses were recorded by the primary branches followed by main stem weight.

The genotypic, phenotypic and environmental coefficient of variability parameters for 8 characters in two crosses are presented in Table 4a. The maximum genotypic coefficient of variation was observed for

Table 4a. Genotypic, phenotypic and environmental coefficients of variation (GCV, PCV and ECV), heritability in broad sense (h^2(BS)) and genetic advance (GA) for 10 characters in three crosses in F_3 generation.

Charecter		GCV (%)	PCV (%)	ECV (%)	h^2(BS) (%)	GA	GA as % mean
Main stem height (cm)	D	16.97	19.73	10.07	73.94	6.93	30.04
	E	11.58	15.01	9.54	59.57	3.95	18.39
Nodes on main stem	D	8.91	12.98	9.44	47.08	2.06	12.56
	E	-1.12	6.49	6.28	-3.02	-0.06	-0.40
Secondary branches/ plant	D	44.32	55.37	33.19	64.08	2.28	72.98
	E	53.69	73.70	50.34	53.21	1.61	80.63
Aerial pegs/plant	D	26.36	33.37	20.46	62.39	4.02	42.82
	E	60.57	63.22	18.11	91.78	11.29	119.40
Undeveloped pods/plant	D	21.60	34.99	27.52	38.13	1.41	27.45
	E	42.60	53.42	32.24	63.57	3.79	69.88
Developed pods/plant	D	35.14	40.96	21.04	73.61	2.83	62.09
	E	46.88	55.61	29.91	71.06	3.81	81.34
Pod yield/ plant (g)	D	34.35	46.78	31.75	53.93	1.71	51.94
	E	44.26	52.14	27.56	72.05	2.40	77.30

D = Robut 33-1 x Local. E = S.B.XI x NCAC 17133 aerial pegs (60.57%) followed by secondary branches (53.69%) in the cross S.B. XI x NCAC 17133. Except nodes on main stem and main stem height for rest of the characters the values were moderately high. The estimates of phenotypic coefficient of variation were also high for secondary branches (73.60%) aerial pegs (63.22%) and developed pods (55.61%) in the cross S.B. XI x NCAC 17133. The highest estimates of environment coefficient of variation to the extent of 50.34% (S.B. XI x NCAC 17133) and 33.19% (Robut 33-1 x local) were observed for secondary branches. For nodes on main stem, it was lowest in both the crosses (9.44% and 6.28%).

4.1.5 Heritability and genetic advance

4.1.5.1 Heritability (Broad sense)

The broad sense heritability in all the three crosses was high for main stem height (91.31%, 81.70% and 72.86%) and secondary branches (97.53%, 86.60% and 91.53%) (Table 4). The estimate were also high for nodes on main stem (89.46%) in Robut 33-1 x NCAC 17133, for aerial pegs (92.80%) in Robut 33-1 x P.I. 405132 and Robut 33-1 x No.75-12 (76.87%) for undeveloped pods (86.40%) in the cross Robut 33-1 x P.I. 405132 and for pod yield (83.41%) in Robut 33-1 x P.I. 405132. The medium heritability estimates were associated with the characters nodes on main stem in the cross Robut 33-1 x P.I. 405132 (65.88%) and Robut 33-1 x No.75-12 (58.61%) aerial pegs (58.24%) in

Robut 33-1 x NCAC 17133, Developed pods (66.49%) in Robut 33-1 x P.I. 405132, and pod yield in the cross Robut 33-1 x NCAC 17133 (63.97%) and in Robut 33-1 x No. 75-12 (51.16%). As far as disease and pest incidence at both the stages is concerned the heritability estimates were low to medium in all the three crosses.

4.1.5.2 Genetic advance (GA)

The maximum genetic advance to the extent of 15.88 for late leaf spot disease incidence at harvest was observed in the cross Robut 33-1 x P.I. 405132. The values to the magnitude of 10.87 and 9.27, respectively for secondary branches and main stem height were recorded in the cross Robut 33-1 x NCAC 17133. For rest of the characters in all the 3 crosses the characters in all the 3 crosses the genetic advance was found in the range from 0.10 to 7.26.

4.1.5.3 Genetic advance as per cent of mean

The maximum genetic advance as expressed in per cent of mean in all the three crosses was recorded by secondary branches (322.36%, 73.82% and 75.66%). The aerial pegs, undeveloped pods, developed pods and pod yield in all the three crosses also recorded moderate to high genetic advance as expressed in per cent of mean. As far as disease and pest incidence is concerned the high genetic gain as per cent of mean was observed for late leaf spot incidence at harvest (31.24%) in the cross Robut 33-1 x P.I. 405132 and for leaf miner pest incidence at pod development stage (22.04%)in the cross Robut 33-1 x No. 75-12).

The heritability, genetic advance and genetic advance as per cent of mean for 8 characters in two crosses are shown in Table 4a. The estimates of broad sense heritability were high for main stem height (73.94%)in Robut 33-1 x local, aerial pegs (91.78%) in S.B. XI x NCAC 17133 for developed pods in the cross Robut 33-1 x local (73.16%)and in the cross S.B. XI x NCAC 17133 (71.06%)andfor pod yield in the cross S.B. XI x NCAC 17133 (72.05). The maximum genetic advance to the extent of 11.29 was observed for aerial pegs in the cross S.B. XI x NCAC 17133. The genetic advance as expressed in per cent mean was maximum to the tune of 119.40% 81.34% 80.63%and 77.30%for aerial pegs, developed pods, secondary branches and pod yield, respectively in the cross S.B. XI x NCAC 17133.

4.1.6 Mean, variance, standard deviation and coefficient of variation

The parameters of variability like variance, standard deviation and coefficient of variation for four characters in five crosses of F_3 generation is shown in Table 5. The results indicated that the progeny means were slightly different for all the four characters like shelling percentage, test weight, harvest index and

Table 5. Mean, variance, standard deviation and coefficient of variation for four characters in five crosses in F_3 generation.

Progenies	Shelling (%)	Test weight (g)	Harvest index (%)	Days to 50 % flowering
1	2	3	4	5
Cross : Robut 33-1 x NCAC 17133				
1	40.00	20.00	8.77	46
2	45.00	15.50	15.25	45
3	48.86	19.50	9.09	44
4	43.5	30.00	20.76	47
5	55.27	25.30	13.92	44
6	80.00	32.30	15.55	46
7	64.56	34.40	24.07	47
8	62.00	20.60	11.59	46
9	55.38	27.00	21.31	45
10	47.53	25.60	11.39	46
Mean	54.21	25.02	16.17	45.60
Variance	145.56	37.31	50.73	1.15
S.D.	12.06	6.10	7.12	1.07
C.V.	22.25	24.41	44.05	2.35

Contd....

Table 5. Contd...

1	2	3	4	5
Cross : Robut 33-1 x P.I. 405132				
1	62.90	29.43	15.04	47
2	56.25	27.27	26.96	46
3	50.66	21.70	13.04	45
4	56.46	29.77	22.48	44
5	50.63	29.62	24.01	46
6	54.64	24.19	16.89	46
7	52.94	32.19	16.51	45
8	56.08	19.54	20.35	48
9	58.48	39.15	13.64	47
10	60.06	31.16	30.74	44
11	60.86	34.56	17.96	45
Mean	56.36	28.96	19.79	45.72
Variance	16.12	31.87	32.51	1.61
S.D.	4.01	5.64	5.70	1.27
C.V.	7.12	19.49	28.82	2.78

Table 5. Contd....

1	2	3	4	5
1	62.06	31.27	29.13	44
2	74.61	29.39	17.21	45
3	63.67	31.83	14.05	47
4	77.14	33.75	20.00	46
5	62.85	35.35	28.25	45
6	75.07	33.88	24.52	47
7	58.18	30.68	27.79	46
8	73.58	31.96	24.88	45
9	72.60	29.04	25.92	47
10	67.57	29.73	20.24	47
11	65.88	33.43	27.41	46
12	67.24	34.11	30.13	45
13	73.47	33.13	22.33	44
14	60.00	27.77	23.80	45
15	78.52	28.92	25.37	46
16	68.85	26.48	24.13	47
17	58.20	32.89	15.66	46
18	67.29	29.09	31.37	47
19	57.19	31.90	32.20	45
20	56.31	24.89	19.52	47
21	65.34	31.59	41.90	45
22	63.87	31.42	9.36	46
23	66.53	29.12	22.41	45
24	63.18	29.06	25.65	44
25	60.94	30.76	39.84	45
26	73.14	30.84	25.93	47
27	63.88	32.85	25. 47	46
28	63.87	33.23	27.16	44
29	77.34	31.16	25.92	45
30	54.04	29.19	23.85	44

Contd...

Table 5. Contd..

1	2	3	4	5
31	52.29	39.88	38.02	46
32	61.31	23.53	27.53	47
33	52.63	25.86	18.56	48
34	61.19	26.32	15.29	47
35	68.00	33.23	33.33	46
36	64.41	29.28	26.21	48
37	65.66	25.08	20.56	46
38	63.93	26.00	23.37	48
39	73.77	30.50	13.23	47
40	74.70	32.24	22.70	45
41	58.27	25.60	26.60	46
42	60.86	31.81	25.65	46
43	79.48	27.19	20.63	45
44	68.88	27.86	31.03	47
45	71.42	30.58	22.55	46
46	80.61	34.85	21.09	44
47	65.42	27.97	22.77	45
48	55.46	25.32	26.52	47
49	59.89	30.53	31.37	46
50	62.85	37.81	27.79	46
51	58.57	29.58	32.88	48
52	61.16	32.87	32.33	47
Mean	65.05	30.43	25.21	45.94
Variance	77.98	11.04	40.75	1.30
S.D.	8.83	3.32	6.38	1.14
C.V.	13.57	10.92	25.31	2.49

Contd....

Table 5. Contd...

1	2	3	4	5
Cross : Robut 33-1 x Local				
1	61.92	27.35	20.63	47
2	40.42	27.94	18.84	47
3	50.00	38.07	9.34	48
4	57.52	35.52	28.76	47
5	42.66	45.71	31.04	46
6	62.50	34.37	14.16	45
7	50.87	28.06	18.56	45
8	66.82	32.32	14.77	48
9	48.88	31.84	35.48	48
10	63.22	30.15	17.12	47
11	70.41	32.40	30.13	46
12	64.41	33.50	32.87	45
13	57.90	38.21	26.98	45
14	66.26	51.90	25.13	47
15	67.52	32.91	17.80	46
16	72.22	31.96	16.16	46
17	61.00	22.38	32.00	45
18	57.04	29.21	21.75	46
19	71.33	35.08	17.64	45
20	62.64	33.20	13.48	46
21	59.46	31.66	6.00	47
22	71.42	32.05	16.66	48
23	55.96	24.72	15.25	47
24	53.19	20.16	22.70	47
25	54.28	34.20	21.21	46
26	65.18	24.44	15.66	45
27	61.40	33.33	28.93	45
28	63.59	29.00	21.34	47
29	74.89	40.00	19.02	46
30	57.14	24.69	21.87	46

Contd...

Table 5. Contd....

1	2	3	4	5
31	67.17	34.50	13.35	48
32	65.83	37.61	17.91	47
33	80.00	32.72	27.27	46
34	49.15	31. 62	18.47	48
35	51.41	41.42	8.59	45
36	20.51	50.00	11. 50	45
37	52.96	25.51	13.43	47
38	66.08	20.00	12.56	48
39	65.25	34.11	19.65	48
40	42.02	34.11	29.48	47
41	69.84	25.88	25.23	46
42	66.19	23.55	20.79	47
43	60.10	24.83	21.65	46
44	65.90	34.52	12.79	46
45	63.49	36.36	10.71	45
46	52.59	35.55	17.44	46
47	38.69	20.96	16.27	46
48	47.59	25.44	30.00	47
49	69.33	30.58	23.14	45
50	32.98	32.75	24.24	47
51	49.65	31.28	14.04	46
52	70.58	42.32	10.69	46
53	42.73	27.77	32.09	48
54	77.47	29.65	5.99	47
55	14.55	27.14	34.29	48
56	69.94	29.09	23.37	48
Mean	58.34	31.88	20.11	46.41
Variance	168.55	43.74	54.83	1.08
S.D.	12.98	6.61	7.40	1.04
C.V.	22.25	20.74	36.82	2.24

Table 5. Contd....

1	2	3	4	5
1	66.06	25.05	18.03	47
2	70.00	38.88	11.11	45
3	65.95	46.66	23.92	46
4	54.10	34.46	33.82	47
5	61.81	41.35	24.81	48
6	62.85	36.66	26.60	47
7	81.50	35.86	36.17	45
Mean	66.04	36.98	24.92	46.42
Variance	71.18	44.39	74.63	1.28
S.D.	8.43	6.66	8.63	1.13
C.V.	12.77	18.01	34.66	2.44

days to 50 per cent flowering in the cross Robut 33-1 x NCAC 17133 compared to population means. The variance was maximum for shelling percentage (145.56) followed by harvest index 50.73. The standard deviation was also high for these two characters (12.06 and 7.12). The progeny number 6 for shelling percentage (80.00) and progeny number 7 for test weight (34.40) and harvest index (24.07) were found superior when evaluated with population mean and one standard deviation. The coefficient of variability was maximum for harvest index 44.05 which indicated the high amount of variability in the progenies compared to other 3 characters.

In the cross Robut 33-1 x P.I. 405132 the maximum variance was recorded for harvest index (32.51) and test weight (31.87). The evaluation of progenies with population mean and one standard deviation, it was observed that progenies like 1 (62.9) and 11 (60.86) were superior for shelling percentage, whereas progenies 7 (31.19) and 9 (39.15) were superior for test weight. For harvest index the progenies 2 (26.96) and 10 (30.74) were superior one, whereas progenies 4 (44) and 10 (44) were superior for days to 50 per cent flowering. The variability among the progenies was highest for harvest index followed by test weight as indicated by the high estimates of coefficient of variation.

Quite large number of progenies were found with high mean than the population mean for all the four characters in the cross Robut 33-1 x No.75-12. The variance was highest for shelling percentage (77.88) and harvest index (40.75). The progenies like numbers 2 (74.61), 4 (77.14), 6 (75.07), 15 (78.52), 29 (77.34), 40 (74.70) and 46 (80.61) were found with high mean performance for shelling percentage when compared with population mean and one standard deviation. For test weight progeny number 4 (33.75), 5 (35.35), 12 (34.11), 31 (39.87) and 46 (34.85) were superior one whereas, for harvest index the progenies like 21 (41.90). 25 (39.84), 31 (38.02), 51 (32.88) and 52 (32.33) were superior one. The differences in progenies for days to 50 per cent flowering were more or less equal. The highest variability as indicated by coefficient of variation was observed for harvest index (25.31) in the population.

The population mean for test weight was desirable in the cross Robut 33-1 x local. The variance was maximum for shelling percentage (168.55) followed by harvest index (54.83). The progenies like Nos. 16 (72.22), 19 (71.33), 22 (71.42), 29 (74.39), 33 (80.00) and 54 (77.47) showed superior shelling percentage, when measured with population mean and one standard deviation. In respect of test weight, progenies like

5 (45.71), 14 (51.90), 29 (40.00), 36 (50.00) and 52 (43.32) were the superior one. Out of 56 progenies 11 progenies like Nos. 4 (28.76), 5 (31.04), 9 (35.48), 11 (30.13), 12 (32.87), 17 (32.00), 27 (28.93), 40 (29.48), 48 (30.00), 53 (32.09) and 55 (34.29) had shown highest harvest index beyond population mean and one standard deviation. The maximum coefficient of variation to the extent of 36.82 was observed for harvest index in this cross.

In the cross S.B. XI x NCAC 17133 a desirable mean for test weight (36.98) and harvest index (24.92) was noticed. The variance to the magnitude of 74.6 and 71.1 was observed for harvest index and shelling percentage, respectively. Only progeny 7 (81.50) for shelling percentage progeny 3 for test weight (46.66) and progenies 4 (33.82) and 7 (36.17) for harvest index were superior in mean performance.

The evaluation of progenies for four different characters indicated that the progeny No. 7 in the cross Robut 33-1 x NCAC 17133 for test weight and harvest index, progeny No. 10 for harvest index and days to 50 per cent flowering in the cross Robut 33-1 x P.I. 405132, progeny No. 31 for test weight and harvest index and 46 for shelling percentage, test weight and days to 50 per cent flowering in the cross Robut 33-1 x No.75-12, progeny No. 29 for shelling percentage and test weight, No. 5 for test weight and harvest index in the cross Robut 33-1 x local and progeny No.7 for shelling percentage and harvest index in the cross S.B. XI x NCAC 17133 were found superior in performance.

4.1.7 Genotypic correlations

The genotypic correlations of the characters with pod yield in three crosses alongwith their direct and indirect effects on pod yield are presented in Table 6. The correlation studies indicated that in all the 3 crosses the developed pods (0.651**, 0.819** and 0.770**) were found to be highly and significantly correlated with pod yield. The correlation of nodes on main stem (0.163*) and aerial pegs/plant (0.505**) with pod yield in the cross Robutm 33-1 x No. 75-12 was also positive and significant. In the cross Robut 33-1 x NCAC 17133 the number of secondary branches (0.729**) had also positive and highly significant correlation with pod yield. The association between disease and pest incidence at both the stages with pod yield in all the three crosses were either weak positive or negative. The path analysis revealed that the developed pods in the cross Robut 33-1 x P.I. 405132 (1.005) and Robut 33-1 x No. 75-12 (0.664) and secondary

Table 6. Genotypic correlation coefficient of different characters with pod yield and their direct and indirect effects on pod yield in three crosses in F_3 generation.

Characters		Correlation with pod yield	Direct effect on pod yield	Indirect effect on pod yield through
Main stem height (cm)	A	0.220	0.264	0.069 (SB)
	B	0.439	-0.063	0.458 (DP)
	C	0.142	-0.002	0.058 (AP)
Nodes on main stem	A	0.237	0.005	0.207 (H)
	B	0.405	0.390	0.338 (DP)
	C	0.163**	0.051	0.066 (AP)
P rimary branches/ plant	A	0.242	-0.106	0.138 (SB)
	B	0.100	-0.085	0.119 (DP)
	C	0.261	0.052	0.142 (DP)
Secondary branches/ plant	A	0.729**	0.590	0.157 (DP)
	B	-0.156	0.106	0.062 (DI)
	C	0.368	0.045	0.224 (DP)
Aerial pegs/ plant	A	0.409	0.008	0.260 (SB)
	B	0.385	-0.317	0.510 (DP)
	C	0.505**	0.216	0.247 (DP)
Undeveloped pods/plant	A	0.214	0.385	0.049 (DP)
	B	0.194	-0.275	0.444 (DP)
	C	0.434	-0.010	0.117 (DP)
Developed pods/plant	A	0.651**	0.361	0.256 (SB)
	B	0.819**	1.005	0.131 (Nodes)
	C	0.770**	0.664	0.080 (AP)
Disease and pest incide-nce at pod development stage (%)	A	0.017	0.024	0.014 (DI)
	B	-0.155	-0.024	0.094 (AP)
	C	0.015	0.004	0.027 (AP)
Disease and pest incide-nce at har-vest (%)	A	-0.156	-0.098	0.093 (UDP)
	B	0.211	0.223	0.088 (DP)
	C	-0.146	-0.028	0.001 (DI)

A = Robut 33-1 x NCAC 17133, B = Robut 33-1 x P.I. 405132

C = Robut 33-1 x No. 75-12

* and ** indicates significance at 5 and 1 per cent level, respectively.

branches in the cross Robut 33-1 x NCAC 17133 (0.590) had maximum direct effect on pod yield. The nodes on main stem in the cross Robut 33-1 x P.I. 405132 also influenced pod yield directly. The rest of the characters had very least direct influence on pod yield. The disease and pest incidence except late leaf spot disease at harvest did not influenced pod yield directly. The studies further indicated that the developed pods/plant through secondary branches, number of nodes and aerial pegs affected pod yield indirectly. The developed pods in all the crosses was found very influencing in affecting pod yield directly as well as indirectly through most of the characters.

The genotypic correlations and path coefficient for 6 characters in two crosses are shown in The Table 6a. The correlations indicated that all the 6 characters like main stem height (0.226**), nodes on main stem, (0.223**), secondary branches (0.175**), aerial pegs (0.500**), undeveloped pods (0.266**) and developed pods (0.758) had significant positive correlation with pod yield in the cross Robut 33-1 x local. The magnitude of association between developed pod and pod yield in both the crosses was very strong. The developed pod in both the crosses had maximum direct effect (0.679, and 0.967) on pod yield. The indirect contribution of

Table 6a. Genotypic correlation coefficient of different characters with pod yield and their direct and indirect effects on pod yield in two crosses in F_3 generation.

Characters		Correlation with pod yield	Direct effect on pod yield	Indirect effect on pod yield through
Main stem height (cm)	D	0.226**	0.036	0.157 (DP)
	E	-0.192	0.175	0.038 (Nodes)
Nodes on main stem	D	0.233**	0.002	0.184 (DP)
	E	-0.324	0.064	0.104 (Ht)
Secondary branches/ plant	D	0.175*	0.027	0.121 (DP)
	E	0.295	-0.178	0.434 (DP)
Aerial pegs/ plant	D	0.500**	0.092	0.367 (DP)
	E	0.562	0.020	0.679 (DP)
Undeveloped pods/ plant	D	0.266**	0.062	0.170 (DP)
	E	0.451	0.080	0.563 (DP)
Developed pods/ plant	D	0.758**	0.679	0.050 (AP)
	E	0.849**	0.960	0.967 (Ht)

D = Robut 33-1 x Local, E = S.B. XI x NCAC 17133 developed pods on pod yield through aerial pegs and height of main stem was also positive. The secondary branches (0.121, and 0.434) aerial pegs and undeveloped pods were found responsible in affecting pod yield indirectly through developed pods in both the crosses.

In general correlation and path coefficient studies indicated that the developed pods, secondary branches, aerial pegs and nodes on main stem were the chief yield contributing characters.

4.2 Variability analysis in parents

4.2.1 Analysis of variance

The analysis of variance for 9 characters shown in Table 7 indicated that the genotypic differences for all the characters except primary branches were highly significant.

4.2.2 Range, mean and variability parameters

The range, genotypic, phenotypic and environmental coefficient of variation heritability and genetic advance for 9 characterns in the parental genotype is shown in Table 8. The result indicated that the range for nodes on main stem (15.50 - 61.75) was maximum followed by aerial pegs (6.06 - 17.16). The phenotypic and genotypic coefficient of variations were highest for secondary branches (PCV = 71.61 and GCV 69 = 69.17), kernel yield (PCV 38.15 and

Table 7. Analysis of variance (RBD) for 9 characters in parental genotypes.

Characters	Mean sum of squares		
	Replication (2 d.f.)	Genotype (13 d.f.)	Error (26 d.f.)
Main stem height (cm)	16.667	53.309**	2.540
Nodes on main stem	5.786	8.209**	1.699
primary branches/ plant	0.041	0.031	0.028
Secondary branches/ plant	0.364	63.605**	1.490
Aerial pegs/plant	1.664	31.790**	3.166
Undeveloped pods/ plant	1.037	7.014**	1.026
Developed pods/ plant	0.639	18.504**	1.251
Pod yield/plant (g)	2.771	11.190**	0.882
Kernel yield/plant (g)	0.287	2.375**	0.358

** indicate significance at 1 per cent level.

Table 8. Range and mean, genotypic, phenotypic and environmental coefficient of variation, heritability in broad sense h^2(BS) and genetic advance (GA), genetic advance as % mean in parental genotypes.

Character	Range mean	GCV (%)	PCV (%)	ECV (%)	h^2(BS) (%)	GA	GA as % of mean
Plant height (cm)	17.08 - 31.66 (25.18)	16.33	17.51	6.32	86.94	7.89	31.34
Nodes on main stem	15.50 - 61.75 (17.68)	8.32	11.12	7.36	56.08	2.26	12.82
Primary branches/plant	3.91 - 4.33 (4.29)	0.73	3.96	3.87	3.44	0.01	0.27
Secondary branches/plant	2.24 - 17.16 (6.57)	69.17	71.61	18.55	93.28	9.02	137.16
Aerial pegs/ plant	6.66 - 17.16 (10.85)	28.89	32.83	16.39	75.08	5.50	50.72
Undeveloped pods/plant	4.08 - 9.50 (6.56)	21.52	26.48	15.43	66.04	2.36	35.99
Developed pods/plant	3.05 - 11.91 (8.14)	29.44	32.49	13.73	82.13	4.47	54.94
Pod yield (g)	1.84 - 10.19 (5.97)	9.07	18.14	15.71	25.00	0.55	9.34
Kernel yield/ plant (g)	1.31 - 4.49	30.81	38.15	22.49	65.24	1.36	51.20

GCV=30.81) and developed pods/plant (PCV=32.49 and GCV=29.41). The value of these two variability parameters were low for primary branches. The environmental coefficient of variation was maximum for kernel yield (ECV=22.49) followed by secondary branches (ECV = 18.55). The estimates of heritability in broad sense were high for plant height (86.94), secondary branches (93.28), aerial pegs (75.08) and developed pods (82.13) whereas medium heritability was observed for nodes on main stem (56.08), undeveloped pods (66.04), and kernel yield (65.24). It was low for primary branches (3.44) and pod yield (25.00). The genetic advance to the extent of 9.02 was maximum for secondary branches followed by main stem height (7.89). The genetic advance as per cent of mean was quite high for secondary branches (137.16) followed by aerial pegs (50.72), developed pods (54.94) and kernel yield (51.20). It was very low for primary branches (0.27).

4.2.3 Mean, variance and standard deviation and coefficient of variation

The measure of dispersion like variance, standard deviation and coefficient of variation for three important characters in 14 parents are presented in Table 9. The analysis indicated that the mean for

Table 9. Mean, variance, standard deviation and coefficient of variation for four characters in groundnut genotypes.

Genotypes	Developed pods/plant	Pod yield/ plant (g)	Harvest index (%)
PBNG 6	6.66	6.43	30.79
PBNG 18	10.16	7.44	32.58
PBNG 26	7.58	6.85	28.39
PBNG 27	5.50	4.77	24.75
LG 19	8.00	5.22	29.28
CGC 4018	7.98	6.83	29.57
ICGS 76	6.91	5.35	44.85
ICGS 11	11.41	5.24	27.81
M 13	10.41	10.19	17.28
JL 24	11.91	7.51	28.79
S.B. XI	7.08	4.26	33.333
Robut 33-1	10.58	6.74	35.56
No. 75-12	3.05	1.84	8.45
Local	6.74	4.95	30.59
Mean	8.14	5.97	28.72
Variance	6.16	3.73	70.03
S.D.	2.48	1.93	8.36
C.V.	20.49	34.10	29.13

harvest index (28.72) was desirable. The maximum variance to the extent of 70.03 was observed for harvest index. The mean performance measured as against population mean and one standard deviation for 14 parents indicated that ICGS 11 (11.41) and JL 24 (11.91) were the superior for developed pod whereas for pod yield, M 13 (10.19) was the only superior one. In respect of harvest index, ICGS 76 (44.85) was the only superior one. There was high coefficient of variation for pod yield/plant (34.10) as compared to other two characters.

4.3 Phenotypic stability

4.3.1 Mean performance

The mean performance for four characters in 8 groundnut genotypes tested at 3 locations is presented in Table 10. The genotypic differences for all the 4 characters were found significant at all the three locations. The main stem height, nodes on main stem and primary branches were found to be increased at Latur in all the genotypes, whereas the mean performance for secondary branches for almost all genotypes was higher at Parbhani. The maximum number of primaries and secondaries were observed in PBNG 18 to the extent of 7.66 and 20.40 at Latur and Parbhani, respectively.

Table 10. Mean performance for four characters of groundnut genotypes tested at three locations.

Sr. No.	Genotypes	Main stem height (cm)				Nodes on main stem			
		PBN	AMB	LTR	Mean	PBN	AMB	LTR	Mean
1.	PBNG 8	17.66	23.86	28.00	23.17	15.53	17.93	19.66	17.70
2.	PBNG 17	22.60	35.30	32.00	22.43	15.66	15.66	18.00	16.44
3.	PBNG 18	23.86	24.73	23.33	23.97	17.00	15.66	18.33	16.99
4.	PBNG 26	23.53	25.46	33.66	27.55	15.33	17.13	21.00	17.82
5.	CGC 4018	14.41	20.00	26.33	20.24	14.06	13.73	16.33	14.70
6.	JL 24	28.86	33.13	38.00	33.33	15.13	17.13	22.00	18.08
7.	ICGS 11	19.60	17.26	23.66	20.17	15.66	11.73	16.00	14.46
8.	S.B. XI	25.26	39.20	45.66	36.70	15.73	17.53	20. 33	17.86
	Mean	21.97	27.37	32.45		15.51	15.81	18.95	
	SE ±	0.92	1.27	1.11		0.43	0.63	0.63	
	CD at 5%	2.85	3.91	3.42		1.35	1.95	1.96	

Contd....

Table 10 Contd....

Sr. No.	Characters	Primary branches/plant				Secondary branches/plant			
		PBN	AMB	LTR	Mean	PBN	AMB	LTR	Mean
1.	PBNG 8	4.46	6.06	7.33	5.95	8.46	6.20	10.66	8.44
2.	PBNG 17	4.60	7.20	7.66	6.48	16.26	8.10	13.33	12.56
3.	PBNG 18	4.33	7.50	7.66	6.49	20.40	15.51	14.00	16.63
4.	PBNG 26	4.40	6.80	7.33	6.17	11.26	11.30	12.33	11.63
5.	CGC 4018	4.06	5.60	5.33	4.99	7.53	7.90	4.66	6.69
6.	JL 24	4.46	6.00	6.33	5.59	15.40	9.26	8.00	10.88
7.	ICGS 11	4.33	6.46	6.66	5.81	11.33	3.83	8.66	7.94
8.	S.B. XI	4.46	6.66	6.66	5.92	14.26	5.66	13.66	11.19
	Mean	4.39	6.55	6.87		13.11	8.47	10.66	
	SE ±	0.20	0.28	0.32		0.63	0.50	0.54	
	CD at 5 %	0.62	0.88	0.99		1.94	1.54	1.69	

The PBNG 17 was next genotype recording higher number of primaries and secondaries at these locations. In general PBNG 18 was the higher recorder of primary and secondaries.

The mean performance for 4 characters in 8 genotypes tested at 4 locations is presented in Table 10a. The two characters viz., aerial pegs and developed pods showed significant differences. Except JL 24, all the genotypes recorded maximum number of aerial pegs at Ambajogai. PBNG 26 (36.41) followed by PBNG 18 (23.03) were the highest mean aerial pegs recording genotypes. The variable performance of developed pods was observed at all the 4 locations for all the genotypes. The PBNG 17 (38.19) and PBNG 18 (40.46) were the maximum recorder for mean developed pods. There were more number of undeveloped pods in 4 newly developed genotypes at Parbhani followed by at Latur. At Basmath all the genotypes recorded least number of undeveloped pods. The maximum mean undeveloped pods (21.16) were observed in ICGS 11. The pod yield potential of the genotypes was maximum at Parbhani and Ambajogai. The maximum pods to the extent of 24.13 and 21.06 were recorded by the genotypes PBNG 26 and ICGS 11, respectively at Parbhani. On overall basis PBNG 26 was the highest one in recording developed pods (13.98).

Table 10a. Mean performance of groundnut genotypes for four characters tested at four locations.

Sr. No.	Genotypes	Aerial pegs/plant					Developed pods/plant				
		PBN	AMB	LTR	BSMT	Mean	PBN	AMB	LTR	BSMT	Mean
1.	PBNG 8	17.73	30.20	19.66	31.26	24.71	25.80	40.60	43.33	17.46	31.79
2.	PBNG 17	17.80	29.73	16.00	21.26	21.19	23.53	63.60	49.00	16.66	38.18
3.	PBNG 18	22.53	36.73	17.00	15.86	23.03	34.73	55.80	53.00	18.33	40.46
4.	PBNG 26	18.13	65.00	21.66	40.86	36.41	28.93	36.66	39.33	21.60	31.63
5.	CGC 4018	17.40	25.06	13.33	18.46	18.56	33.06	27.60	37.33	16.00	28.49
6.	JL 24	15.20	7.93	10.00	8.40	10.38	19.66	25.86	24.66	17.46	21.91
7.	ICGS 11	17.73	20.60	16.33	14.00	17.16	23.80	35.60	45.00	18.73	30.78
8.	S.B. XI	19.00	16.40	24.66	14.66	18.68	28.60	30.66	35.33	20.53	28.78
	Mean	18.19	28.95	17.33	20.66		27.27	39.55	30.87	18.35	
	SE ±	0.86	1.19	1.40	0.74		0.97	1.08	0.86	0.87	
	CD at 5 %	2.62	3.61	4.26	2.25		2.94	3.29	2.61	2.63	

Contd....

Table 10a. Contd....

Sr. No.	Genotypes	Undeveloped pods/plant					Pod yield/plant (g)				
		PBN	BSMT	LTR	AMB	Mean	PBN	BSMT	LTR	AMB	Mean
1.	PBNG 8	25.93	8.00	12.33	15.33	15.39	17.46	8.66	7.41	13.29	11.70
2.	PBNG 17	15.00	4.13	12.33	17.20	12.16	15.33	8.66	6.13	14.26	11.09
3.	PBNG 18	21.00	8.06	19.66	23.53	18.04	17.00	9.33	9.39	15.00	12.68
4	PBNG 26	19.46	12.00	19.33	20.13	17.73	24.13	10.66	8.43	12.73	13.98
5.	CGC 4018	21.46	9.73	8.00	13.73	13.23	19.66	9.13	9.34	7.82	11.48
6.	JL 24	15.33	2.86	13.00	10.71	10.47	11.80	8.80	8.25	7.83	9.17
7.	ICGS 11	24.60	8.40	28.33	23.33	21.16	21.06	12.13	6.42	8.06	11.91
8.	S.B. XI	23.06	6.93	19.00	12.86	15.46	13.76	5.40	4.65	8.09	7.97
	Mean	20.73	7.51	16.50	17.10		17.52	9.10	7.50	10.88	
	SE ±	0.75	0.48	0.82	0.77		0.76	0.25	0.54	0.15	
	CD at 5%	2.28	1.46	2.48	2.36		2.32	0.76	1.64	0.47	

The mean performance for days to maturity, shelling percentage and test weight in 8 genotypes tested at 3 locations is showed in Table 10b. Compare to Parbhani and Aurangabad less number of days were recorded for maturity by genotypes grown at Latur. The CGC 4018 was the earliest one in maturity (114.00). The highest shelling percentage to the tune of 73.50 in CGC 4018 and 73.00 in PBNG 17 at Latur and Parbhani, respectively was observed. But on overall basis PBNG 17 was found at the top rank in shelling percentage. The test weight differences as observed at 3 locations were different from each other in all the genotypes. Except CGC 4018, all the genotypes at Aurangabad recorded higher test weight. PBNG 26 (48.05) followed by PBNG 8 (43.67) were found bold seeded on overall basis.

4.3.2 Analysis of variance

The analysis of variance for 4 characters tested at 3 locations (Table 11) indicated that the genotypic differences at all the locations were highly significant except for number of nodes on main stem at Latur and primary branches at Parbhani.

The differences for 4 characters like aerial pegs, undeveloped pods, developed pods and pod yield were also found highly significant at all the 4 locations (Table 11a).

Table 10b. Mean performance for three characters of groundnut genotypes tested at three locations.

Sr. No.	Genotypes	Days to maturity				Shelling percentage				Test weight (g)			
		PBN	LTR	A'BAD	Mean	PBN	LTR	A'BAD	Mean	PBN	LTR	A'BAD	Mean
1.	PBNG 8	115.66	114.33	119.66	116.55	66.20	64.73	65.41	65.44	34.75	47.20	49.06	43.67
2.	PBNG 17	121.66	119.33	122.33	121.10	73.00	70.66	65.83	969.84	29.03	35.76	38.76	34.51
3.	PBNG 18	121.66	116.33	127.00	121.66	63.66	62.50	65.41	63.85	39.00	38.48	50.46	42.64
4.	PBNG 26	122.33	11 9.00	120.00	120.44	56.00	69.66	63.75	63.13	42.33	50.76	51.06	48.05
5.	CGC 4018	120.00	11 0.86	112.00	114.00	55.33	73.50	61.00	63.27	20.74	34.00	29.29	28.01
6.	JL 24	119.33	116.66	124.33	120.10	64.50	70.50	64.58	66.52	31.97	41.00	48.03	40.33
7.	ICGS 11	122.33	117.33	130.00	123.22	63.00	65.53	67.00	65.17	35.84	34.00	46.23	38.69
8.	S.B. XI	120.33	109.66	115.33	115.16	57.50	71.16	66.41	65.02	36.45	31.40	34.28	33.71
	Mean	120.41	115.41	121.33		62.40	68.53	64.92		33.64	39.07	43.40	
	SE ±	1.86	1.29	1.13		1.83	1.07	0.74		0.80	0.56	0.82	
	CD at 5%	5.65	3.91	3.44		5.54	3.26	2.24		2.44	1.70	2.49	

Locations : PBN = Parbhani, BSMT = Basmathnagar, AMB = Ambajogai, LTR = Latur, A'BAD = Aurangabad

Table 11. Analysis of variance (RBD) for four characters at three locations.

Characters	Location	Mean sum of squares		
		Replication (2 d.f.)	Genotype (7 d.f.)	Error (14 d.f.)
Main stem height (cm)	PBN	1.34	62.61**	2.58
	AMB	1.63	177.98**	4.84
	LTR	5.79	146.38**	3.69
Nodes on main stem	PBN	2.28	1.96**	0.57
	AMB	0.22	13.69**	1.20
	LTR	3.79	14.04	1.22
Primary branches/ plant	PBN	0.04	0.07	0.12
	AMB	0.25	1.24**	0.24
	LTR	0.50	1.89**	0.30
Secondary branches/ plant	PBN	1.36	55.24**	1.19
	AMB	0.17	39.97**	0.75
	LTR	0.66	33.04*	0.90

* and ** indicates significance level at 5 and 1 per cent, respectively.

Table 11a. Analysis of variance for four characters of groundnut genotypes of four locations.

Characters	Location	Mean sum of squares		
		Replication (2 d.f.)	Genotypes (7 d.f.)	Error (14 d.f.)
Aerial pegs/ plant	PBN	3.27	12.71**	2.26
	BSMT	0.33	334.08**	1.66
	AMB	4.40	877.01**	4.28
	LTR	5.04	64.57**	5.94
Undeveloped pods/plant	PBN	0.80	47.86**	1.71
	BSMT	3.16	25.60**	00.70
	AMB	3.27	69.67**	1.82
	LTR	0.50	121.52**	2.02
Developed pods/plant	PBN	4.86	77.14**	2.83
	BSMT	0.33	10.88**	2.27
	AMB	3.87	547.04**	3.54
	LTR	2.00	233.33**	2.23
Pod yield/ plant (g)	PBN	0.45	48.33**	1.76
	BSMT	0.005	11.08**	0.19
	AMB	0.16	30.85**	0.07
	LTR	0.72	8.38**	0.88

* and ** indicates significance at 5 and 1 per cent, respectively.

The analysis of variance for days to maturity, shelling percentage and test weight at 3 locations (Table 11b) indicated that the genotypic differences were highly significant except for days to maturity at Parbhani.

4.3.3 Pooled analysis

The pooled analysis of variance for main stem height, nodes on main stem, primary branches and secondary branches (Table 12) revealed that the variance for genotypes and environment were highly significant for all the characters except for primary branches for genotypes. The GxE interaction variances except primary branches were also highly significant. All the 4 characters showed significant mean squares due to environment plus G x E. The G x E (linear) was found significant for main stem height only. The another component of variation for stability variance due to pooled deviation was highly significant for main stem height and secondary branches.

The pooled analysis for 4 characters like aerial pegs, undeveloped pods, developed pods and pod yield tested at 4 locations (Table 12a) showed that the mean square were highly significant for environment, G x E, E + (G x E) and environment linear and pooled

Table 11b. Analysis of variance (RBD) for three characters of groundnut genotypes at the locations.

Characters	Location	Mean sum of squares		
		Replications (2 d.f.)	Genotypes (7 d.f.)	Error (14 d.f.)
Days to maturity	PBN	10.04	14.73	10.47
	LTR	28.16	39.02**	5.02
	A'BAD	10.16	104.95**	3.88
Shelling percnetage	PBN	6.61	106.32**	10.05
	LTR	0.01	43.34**	3.49
	A'BAD	1.54	10.64**	1.65
Test weight (g)	PBN	9.26	130.35**	1.96
	LTR	0.32	140.63**	0.94
	A'BAD	1.29	203.13**	2.03

** indicate significance at 1 per cent, respectively.

Table 12. Pooled analysis of variance for four characters of groundnut genotypes tested at three locations.

Source of variation	d.f.	Mean sum of squares			
		Main stem height (cm)	Nodes on main stem	Primary branches/ plant	Secondary branches/ plant
Genotype	7	107.01**	6.273*	0.722	29.387**
Environment	2	219.79**	29.07**	14.595**	43.173**
G x E	14	10.993**	1.812**	0.174	6.683**
E + (G x E)	16	37.092**	5.219**	1.976**	11.869**
E (linear)	1	439.61**	58.126**	29.199**	86.354**
G x E (linear)	7	10.80**	1.460	0.243	6.417
Pooled deviation	8	9.78**	1.895	0.901	6.078**
Pooled error	48	1.23	0.333	0.075	0.317

* and ** indicates significance at 5 and 1 per cent level, respectively.

Table 12a. Poo led analysis of variance for four characters of groundnut genotypes tested at four locations

Source of variation	d.f.	Mean sum of squares			
		Aerial pegs/plant	Undeveloped pods/plant	Developed pods/plant	Pod yield/ plant (g)
Genotype	7	225.010**	48.650**	133.740**	14.454
Environment	3	22.545**	252.520**	915.910**	155.210**
G x E	21	68.154**	13.189**	51.909**	6.134**
E + (G x E)	24	62.468**	43.105**	159.909**	25.189**
E (linear)	1	676.161**	757.493**	2747.243**	465.627**
G x E (linear)	7	74.142**	5.876	98.882**	7.983
Pooled deviation	16	18.975**	4.618**	24.900**	4.558**
Pooled error	64	1.179	0.527	0.407	0.242

* and ** indicates significance at 5 and 1 per cent level, respectively.

deviation for all the four characters. But the genotype and G x E (linear) component of variation were non significant for pod yield.

The results of pooled analysis of variance for days to maturity, shelling percentage and test weight (Table 12b) indicated that the mean sum of square for environment, environment + (G x E), E (linear) and pooled deviation were highly significant for all the three characters. The variances for G x E interaction was only significant for days to maturity. Similarly, G x E (linear) mean sum of square was highly significant for shelling percentage only.

4.3.4 Environmental indices and mean performance

The environmental indices and mean percentage for four characters of groundnut genotypes tested at 3 locations (Table 13) showed that the environment at Latur was found to be favourable one for recording high performance for main stem height, nodes on main stem and primary branches per plant. Whereas for secondary branches per plant, Parbhani was the favourable environment for recording highest number of secondary branches.

In respect of aerial pegs, developed pods, undeveloped pods and pod yield, Ambajogai, Latur, Parbhani and Parbhani, respectively were found the favourable

Table 12b. Pooled analysis of variance for three characters of groundnut genotypes tested at three locations.

Source of variation	d.f.	Mean sum of squares		
		Days to maturity	Shelling (%)	Test weight (g)
Genotype	7	32.836	14.142**	123.040*
Environment	2	81.130**	76.012**	191.248**
G x E	14	10.034**	1.964	17.499
E + (G x E)	16	18.921**	26.687**	39.219**
E (linear)	1	162.271**	152.057**	382.517**
G x E (linear)	7	5.366	32.061**	13.735
Pooled deviation	8	12.862**	6.313*	18.600**
Pooled error	48	2.152	1.688	0.549

* and ** indicates significance at 5 and 1 per cent level, respectively.

Table 13. Environmental indices (IJ) and mean performance ($\bar{X}$) for four characters of groundnut genotypes tested at three locations.

Characters		Locations		
		PBN	AMB	LTR
Main stem height (cm)	IJ	-5.292	0.102	5.190
	$\bar{X}$	21.97	27.37	32.45
Nodes on main stem	IJ	-1.247	-0.947	2.194
	$\bar{X}$	15.51	15.81	18.95
Primary branches/ plant	IJ	-1.549	0.613	0.934
	$\bar{X}$	4.39	6.55	6.87
Secondary branches/ plant	IJ	2.365	-2.279	-0.085
	$\bar{X}$	13.11	8.47	10.66

environments as indicated by recording high mean performance and high positive value for environmental indices (Table 13a).

The desirable values of environmental indices and mean performance for days to maturity, shelling percentage and test weight were recorded in the genotype grown at Latur, Latur and Aurangabad, respectively and were considered as favourable environments for these characters (Table 13b).

In general Latur was considered as most favourable environment for about six characters.

4.3.5 Stability parameters

The estimates of stability parameters for main stem height, nodes on main stem, primary branches and secondary branches are given in Table 14. The results indicated that the regression coefficient (bi) for all the genotypes except CGC 4018 for primary branches was found non significant for all the 4 characters. The values for deviation from regression (S^2di) were however found significant for some of the genotypes for all the 4 characters. The genotypes PBNG 8 (bi = 9.87, S^2di = -7.36) and ICGS 11 (bi = 1.60, S^2di = 0.79) were found highly stable for main stem height and secondary branches respectively as they recorded

Table 13a. Environmental indices (IJ) and mean performance ($\bar{X}$) of four groundnut genotypes tested at four locations.

Characters		Locations			
		PBN	AMB	LTR	BSMT
Aerial pegs/ plant	IJ	-3.079	7.687	-3.937	-0.670
	$\bar{X}$	18.19	28.95	17.33	20.60
Developed pods/plant	IJ	-4.238	8.037	9.363	-0.131
	$\bar{X}$	27.27	39.55	40.87	18.35
Undeveloped pods/plant	IJ	5.269	1.642	1.036	-7.947
	$\bar{X}$	20.73	17.10	16.50	7.51
Pod yield/ plant (g)	IJ	6.273	-0.366	-3.751	-2.156
	$\bar{X}$	17.52	10.88	7.50	9.10

Table 13b. Environmental indices (IJ) and mean performance ($\bar{X}$) of three characters of groundnut genotypes tested at three locations.

Characters		Locations PBN	LTR	A'BAD
Days to maturity	IJ	1.361	-3.639	2.278
	$\bar{X}$	120.41	115.41	121.33
Shelling percentage	IJ	-2.887	3.247	-0.359
	$\bar{X}$	62.40	68.53	64.92
Test weight (g)	IJ	-5.064	0.370	4.694
	$\bar{X}$	33.64	39.07	43.40

Locations : PBN = Parbhani, AMB = Ambajogai, LTR = Latur BSMT = Basmat, and A'BAD = Aurangabad.

Table 14. Mean and estimates of stability parameters for four characters in eight groundnut genotypes tested at three locations.

Genotypes	Main stem height (cm)			Nodes on main stem			Primary branches/ plant			Secondary branches /plant		
	Mean	bi	S^2di	Mean	bi	S^2di	Mean	bi	S^2di	Mean	bi	S^2di
PBNG 8	23.17	0.987	-0.71	17.71	0.935	1.92**	5.95	1.00	0.37*	8.44	0.46	7.36**
PBNG 17	29.96	0.911	39.97**	16.44	0.704	-0.31	6.48	1.22	-0.07	12.56	1.74	0.94
PBNG 18	26.97	0.801	6.88**	17.00	0.576	0.808	6.50	1.38	-0.03	16.63	1.08	9.41**
PBNG 26	27.55	0.960	5.94**	17.82	1.476	0.593	6.17	1.16	-0.06	11.63	0.01	0.41
CGC 4018	20.24	1.136	-1.03	14.71	0.727	-0.180	5.00	0.58**	0.02	6.70	0.05	5.91**
JL 24	33.33	0.870	-1.11	18.08	1.813	0.733	5.82	0.73	-0.07	10.88	1.35	11.23**
ICGS 11	20.17	0.379	11.82**	14.46	1.613	8.19**	5.97*	0.95	-0.07	7.94	1.60	0.79
S.B.XI	36.71	1.953	6.62*	17.86	1.154	0.72	5.94	0.95	0.02	11.20	1.82	10.01**
SE ±	2.21	0.421		0.973	0.510		0.21	0.15		1.74	0.75	
CD at 5%	5.41	1.030		2.136	1.247		0.51	0.38		4.26	1.83	

* and ** indicates significance at 5 and 1 per cent level, respectively.

unit regression (non significant bi) and least deviation from regression (S^2di) with desirable mean. The genotype PBNG 18 recorded high number of secondary branches (16.63) but the regression coefficient (bi = 1.082) which is non significantly deviating from unity was also found as stable one.

The stability parameters for 8 genotypes tested at 4 locations with regards to aerial pegs, developed pods, undeveloped pods and pod yield are presented in Table 14a. The results indicated that PBNG 8 was found stable one for aerial pegs because it had regression coefficient (bi = 0.93), high mean (24.71) and low deviation from regression (S^2di = 0.35). The genotype JL 24 was found with low aerial pegs (10.83) but it was found specifically adopted to above average stability. For developed pods, undeveloped pods and pod yield almost all the genotypes showed instability because the stability parameter S^2di was significant. However, the genotypes PBNG 17 (38.20) and PBNG 18 (40.46) recorded maximum developed pods but the regression coefficient (bi = 1.89** and 1.61*) were significantly different indicated their below average stability. The character undeveloped pods was found as highly unstable. Least number of undeveloped pods were recorded by the genotypes JL 24 (10.43). The

Table 14a. Mean and estimates of stability parameters for four characters in eight groundnut genotypes tested at four locations.

Genotypes	Aerial pegs/plant			Developed pods/plant			Undeveloped pods/ plant			Pod yield/plant (g)		
	Mean	bi	S^2di	Mean	bi	S^2di	Mean	bi	S^2di	Mean	bi	S^2di
PBNG 8	24.71	0.93	0.35	31.80	1.14	0.43*	15.40	1.17	21.95**	11.71	0.94	2.33**
PBNG 17	21.20	1.14	0.54	38.20	1.89**	102.72**	12.16	0.92	8.28**	11.10	0.84	8.16**
PBNG 18	23.03	1.60	2.20**	40.46	1.61*	6.20**	18.06	1.11	11.16**	12.68	0.78	4.76**
PBNG 26	36.41	3.91**	44.62**	31.63	0.74	-0.005	17.73	0.63	2.37**	13.99	1.58	0.008
CGC 4018	18.56	0.87	1.73*	28.50	0.64	56.19**	13.23	0.70	29.90**	11.49	1.13	7.81**
JL 24	10.83	0.36*	9.84**	21.91	0.36**	0.14	10.47	0.94	1.54**	9.17	0.36	0.72**
ICGS 11	17.61	0.35	4.89**	30.78	1.04	20.00**	21.16	1.37	24.92**	11.92	1.35	10.60**
S.B.XI	18.68	0.46*	18.27**	28.80	0.54	6.23**	15.46	1.13	13.65**	7.97	0.93	0.003
SE ±	2.51	0.47		2.88	0.26		2.21	0.39		1.23	0.27	
CD at 5%	6.15	1.15		7.04	0.65		5.42	0.96		3.01	0.68	

* and ** indicates significance at 5 and 1 per cent level, respectively.

genotype PBNG 8 was considered as average stable for pod yield as it recorded desirable mean (11.71), unit regression coefficient (0.94) and comparatively low S^2di (2.33**). PBNG 18 was also found as specifically adopted to above average stability (mean = 12.68, bi = 0.78, S^2di = 4.76**) for podyield. The two genotypes viz., PBNG 26 and ICGS 11 were again categorized as below average stable because though their regression coefficients was non significant, it was more than unity. These genotypes seens to be specifically adapted to favourable environment.

The mean and estimates of stability parameters for days to maturity, shelling percentage and test weight for 8 genotypes are shown in Table 14b. The results indicated that the maturity was found to be a unstable character. JL 24 was considered as average stable for maturity as it recorded desirable mean (120.11) and unit regression coefficient (1.04) with least deviation from regression (S^2di = 6.20). The genotype CGC 4018 was found to be highly response to environmental condition as it records less shelling percentage (63.27) and significantly regression coefficient (bi = 2.99**). This genotype is specifically adapted to favourable environment. Though the shelling percentage in PBN 17 was high it was found most unstable as it recorded high significant deviation from regression (S^2di = 23.72**).

Table 14b. Mean and estimates of stability parameters for three characters in eight groundnut genotypes tested at three locations.

Genotypes	Days to maturity			Shelling percentage			Test weight (g)		
	Mean	bi	S^2di	Mean	bi	S^2di	Mean	bi	S^2di
PBNG 8	116.55	0.68	3.64	65.45	0.23	-1.66	43.67	1.50	1.27
PBNG 17	121.11	0.49	-2.12	69.83	0.26	23.72**	34.52	1.00	1.59
PBNG 18	121.66	1.55	5.64	64.86	0.23	1.59	42.65	1.12	31.07**
PBNG 26	120.44	0.33	1.40	63.13	2.18	1.27	48.05	0.92	7.91**
CGC 4018	114.22	0.77	36.59**	63.27	2.99**	0.49	28.01	0.94	47.37**
JL 24	120.11	1.04	6.20	66.52	1.02	2.07	40.33	1.64	-0.54
ICGS 11	123.22	1.75	16.57**	65.17	0.35	4.07	38.69	1.00	38.10**
S.B. XI	115.11	1.35	17.72**	65.02	2.16	5.43*	33.71	-0.14	7.15**
SE ±	2.53	0.79		1.77	0.57		3.05	0.62	
CD at 5%	6.20	1.93		4.34	1.40		7.46	1.52	

* and ** indicates significance at 5 and 1 per cent level, respectively.

As far as test weight is concern PBNG 17 was found stable (mean = 34.52, bi = 1.00, S^2di = 1.59), PBNG 26 (mean = 48.05, bi = 0.92, S^2di = 7.91**) and CGC 4018 (mean = 28.01, bi = 0.94, S^2di = 47.37**) as above average stable, whereas PBNG 18 (mean = 42.65, bi = 1.12 and S^2di = 31.07**) and JL 24 (mean = 40.33, bi = 1.64 and S^2di = -0.54) were as below average stable.

The overall results on stability analysis indicated that the newly developed genotypes like PBNG 18 for secondary branches, PBNG 17 and PBNG 18 for developed pods and PBNG 26 for pod yield were found specifically adapted to favourable environments. But PBNG 8 was found as average stable for pod yield.

CHAPTER V

DISCUSSION

V. DISCUSSION

Since groundnut (*Arachis hypogaea* L.) is grown on a vast area in the country a little increase in its yield potential would make a tremandous impact on the total production. To get the best picture of the amount of advance to be expected by selection, genotypic coefficient of variation should be studied together with heritability estimates (Burton, 1952). All these parameters should be considered in conection so as to bring effective improvement in yield and other complex characters. The present study was undertaken to findout, variability, heritability and genetic advance in five crosses of groundnut in F_3 generation with respect to yield and various attributes of yield with disease and pest incidence. The results obtained are discussed here.

5.1 Variability analysis in early generation population

5.1.1 Mean performance

In general the mean values of the progenies in three crosses for all the ten characters indicated that the mean performance for almost all the characters was higher in the cross Robut 33-1 x P.I. 405132. However, these values were less in cross Robut 33-1 x NCAC 17133. Considering, secondary branches, developed pod and pod yield as important characters (Reddy, 1985).

The progeny numbers like 20, 21 and 33; 19, 33 and 35 and 19, 31 and 35 in the cross Robut 33-1 x No.75-12 recorded highest mean performance, respectively for these characters. The spectrum of variation of morphological characters in the progenies of this cross was high.

Pest and disease taken a heavy toll on the yield of groundnut in India. If the different measures taken to control these pests and diseases, cultivation of resistant varieties has been realised to be the most effective, ideal and economic method of reducing crop losses (Stakman and Harrar, 1957), evaluation of pest and disease resistant varieties is one extreme in plant breeding. The genotypes developed in this regard and tested for the incidence of late leaf spot disease and leaf miner pest which are the two serious problems of groundnut cultivation revealed that the progeny number 3 in the cross Robut 33-1 x P.I. 405132 and progeny No. like 38, 39, 42 in the cross Robut 33-1 x No.75-12 had least per cent incidence of late leaf spot disease and leaf miner pest respectively at both, pod development stage and at harvest. The research workers like Waligar and McDonald (1988) in a field screening also found a variable response of genotypes for resistance to late leaf spot disease. In respect of leaf miner resistance screening as reported by Singh (1979), Mahadevan et al. (1988 and 1989) good number of genotypes had shown resistance to this pest. Therefore, these progenies offer a good promise for the development of desirable genotypes. In view of combining high yield potential of Robut 33-1 and good pod and kernel characters of a local genotype. Out of forty six progenies developed from these two parental cross, progeny numbers 21 and 24 showed desirable mean performance for secondary branches, developed pods and pod yield. The progeny No. 6 was the highest scorer for these characters in the cross S.B. XI x NCAC 17133.

Significant differences were observed for all the 14 characters including late leaf spot disease and leaf miner pest incidence in all the five crosses except primary branches, nodes on main stem and late leaf spot disease in some crosses. Similar to the present observations, Rao and Sindagi (1974) had noticed highly significant differences among the varieties for susceptibility to the leaf miner pest.

5.1.2 Genotypic and phenotypic variances and coefficients of variability

All the characters studied showed wide range of variation except nodes on main stem and primary branches. The maximum variability for late leaf spot disease incidence in the cross Ronut 33-1 x P.I. 405132 was noticed followed by secondary branches and aerial pegs in the cross Robut 33-1 x No. 75-12. Green and Wynne (1987) for early leaf spot disease also observed variation in the cross of virginia type groundnut in F_5 generation. However, a narrow range of variability of aerial pegs was reported by Bhagat et al. (1986). But the range of variability for pod yield in all the three crosses was low similar to Bhagat et al. (1986). But in the cross Robut 33-1 x local high range for developed pod was observed. The minimum range of variation for primary branches and undeveloped pods in all the five corsses was observed.

The leaf miner pest which causes a severe damage to rainfed and irrigated groundnut crop. The variability studied for the incidence of this pest indicated that the range of incidence was from 6.84 to 16.37 at pod development stage and from 9.77 to 19.09 per cent at harvest in the cross Robut 33-1 x No. 75-12. Similar wide range of incidence for this pest on groundnut genotypes was also reported by Rao and Sindagi (1974) and Ghule et al. (1980).

The genotypic and phenotypic vairances for incidence of late leaf spot disease and leaf miner pest were quite high in all the three crosses followed by secondary branches and main stem height in two crosses viz., Robut 33-1 x NCAC 17133 and Robut 33-1 x P.I. 405132. Such a high variances reported by Patil and Bhapkar (1987) for main stem height agrees to the present investigation. The high estimate of environmental variances for disease and pest incidence in all the three crosses indicated that the environment was found as a responsible factor. These results were similar to those of Reddy _et al_. (1980) and Lewin _et al_. (1971).

The genotypic coefficient of variation helps to measure the range of genotypic variability in a character and provide a measure to compare the genetic variability present in various quantitative characters (Mujumdar _et al_. 1969). The genotypic and phenotypic coefficients of variance were maximum for secondary branches, followed by undeveloped pods and pod yield in the cross Robut 33-1 x NCAC 17133. This indicated that variability at both the level in the material was high. Such high phenotypic variability for secondary branches was also reported by Labana _et al_. (1980), Kandaswamy _et al_. (1986) and Deshmukh _et al_. (1986) which agrees to the present reports. The genotypic and phenotypic coefficient of variations were comparable in magnitude for main stem height and nodes on main stem in all the five crosses indicated a high heritability of these characters. Similar results in respect of plant height were also reported by Patil et al. (1982). The values for incidence of pest and diseases in the cross Robut 33-1 x No.75-12 and Robut 33-1 x P.I. 405132 were moderate.

5.1.3 Heritability and genetic advance

The difference between phenotypic and genotypic coefficient of variations for main stem height, nodes on main stem and secondary branches were very high. But it is necessary to have high genetic coefficient of variation and high heritability associated with high genetic gain. Burton (1952) suggested that heritable variation could not be estimated with the help of genotypic variation alone. Hence, the heritability estimate is also essential in order to get the clear picture of the genetic gain to be expected from selection. This is important particularly in the segregating generation. In the present study broad sense heritability was higher for main stem height and secondary branches in all the five crosses. These estimates were also high for nodes on main stem, aerial pegs, undeveloped pods and pod yield in one or the two crosses. Kulkarni and Albuquerque (1967) and Patra (1975) reported high heritability for different characters which is in agreement with the present findings. Similarly, Reddy _et al._ (1987) also reported high heritability for these traits. In case of disease and pest incidence at both the stages the heritability estimates were low to moderate. However, Green and Wynne (1987) observed moderate to high heritability estimates for resistance to early leaf spot in F_5 generation. This indicated that there is little scope for selection of genotypes combined with yield and disease resistance. However, Irone and Knauft (1987) stated that the selection among the crosses would be advantageus as the heritability estimates were more than 65 per cent compared to individual plant selection.

Johnson _et al._ (1955) reported that heritability estimates along with genetic gain were more useful than the former alone in predicting the effect of selecting the best individual. If heritability is mainly owing to the non additive gene effects expected genetic gain would be low but if it is due to additive gene effect high genetic advance may be expected. In many of the characters studied in the present investigation, it was observed that high genotypic coefficient of variation and high heritability was not accompanied by high genetic advance. The genetic advance was low and comparatively heritability estimates were high. Therefore mostly non additive gene effect were more important for some morphological characters like primary branches, aerial pegs and undeveloped pods and also for disease and pest incidence characters. But the results reported by Reddy et al. (1987) and Sivasubramaniam et al. (1977) in F_2 generation are contradictory to the present findings. Thus simple selection for improvement of these characters in early generation crosses seems difficult.

The estimates of genetic gain as per cent of mean revealed large differences among the characters studied. Secondary branches, undeveloped pods and pod yield had high genetic gain. Similar results were reported by Dixit et al. (1970) and Patil and Bhapkar (1987). The genetic gain for primary branches, late leaf spot disease and leaf miner pest incidence at both the stages was low which is in confirmity with those results reported by Badwal et al. (1967) and Patra (1975). The genetic gain for secondary branches, aerial pegs, developed pods and pod yield in the cross like Robut 33-1 x local and S.B. XI x NCAC 17133 was also high.

5.1.4 Mean, variance, standard deviation and coefficient of variation

Crop improvement can be achieved by creating variability and selection in the early generation material.

The scope of such work depends on the magnitude of variability in the material for desirable characters. The progenies in five crosses in F_3 generation assessed for four characters with the help of simple measures of variability. From the comparison of the coefficient of variation for four characters in five crosses it was observed that there was maximum variation for harvest index and test weight in the crosses viz., Robut 33-1 x NCAC 17133, Robut 33-1 x P.I. 405132, Robut 33-1 x No.75-12 and S.B. XI x NCAC 17133, whereas for harvest index and shelling percentage it was maximum in the cross Robut 33-1 x local. This indicate that the progenies of these crosses were possessed with greater genetic diversity for these characters. This is but natural because the two parents involved in all these characters were genetically and geographically diverse from each other. Therefore, the progenies in these crosses may be easily amenable to further selection for these characters. The utility of such results was also made for studying variation in some quantitative characters in groundnut strains by Kulkarni and Albuquerque (1987). Thus progenies like No. 7 in Robut 33-1 x NCAC 17133; 10 in Robut 33.1 x P.I. 405132; 31 and 46 in Robut 33-1 x No. 75-12; 5 and 29 in Robut 33-1 x local and 7 in S.B. XI x NCAC 17133 were found potential for test weight, shelling percentage and harvest index. The improvement for these desirable characters is expected from these progenies in subsequent generation.

5.1.5 Genetic correlation and path coefficient analysis

An understanding of the association of yield components with yield is of paramount importance in the breeding programmes. The study of the character association in the segregating generations from which the actual selection is made may be more useful to the breeders. In groundnut such studies particularly in early generation are limited. In the present study it was observed that the number of developed pods exhibited strong positive correlations with pod yield in all the three crosses indicating that any increase in the number of mature pods would result in the increase of pod yield. The other characters like number of secondaries, nodes on main stem and aerial pegs also showed significant positive correlation with pod yield in either of the five crosses. Reddy _et al_. (1987) also reported strong positive correlation between mature pods and pod yield. The correlations of disease and pest incidence with pod yield were negative, which corresponds to the observations of Iroune and Knauft (1987).

The path analysis revealed that developed pods followed by secondary branches maintained a strong positive direct effects on pod yield. Similarly, it was observed that through developed pods most of the characters affected pod yield indirectly. Bhagat *et al.* (1986) also found such strong direct influence of number of mature pods on pod yield. Thus the studies indicated that developed pods, secondary branches, aerial pegs and nodes on main stem were the chief pod yield determinants in early generation population of groundnut. Therefore, selection based on these characters would bring out improvement of pod yield.

The variability analysis in F_3 generation of different five crosses for pod yield and its related components including disease and pest incidence indicated that sufficient variability among the different progenies of all the crosses for most of the characters was observed. The maximum range of phenotypic variability for late leaf spot disease incidence, secondary branches and aerial pegs was observed. The range of variation for leaf miner pest incidence in the cross Robut 33-1 x No. 75-12 was also high. The genotypic and phenotypic coefficient of variation for secondary branches, undeveloped pods and pod yield was also high. The heritability estimates and genetic gain were also more for these characters. Further the association and path coefficient studies also indicated that developed pods, secondary branches and aerial pegs had strong positive correlation with pod yield. Similarly, the coefficient of variability for harvest index and test weight was high in all the five crosses.

Such a wide spectrum of variation was expected because the female parent in all crosses was high yielding ability with good morphological characters and the male parents used in these crosses were superior for specific characters but were agronomically inferior. The involvement of these parents in crossing resulted number of desirable recombinants in segregating generation. This has resulted in to the identification of the progenies like No. 7 for test weight and harvest index (Robut 33-1 x NCAC 17133), No. 46 for shelling percentage and test weight (Robut 33-1 x No. 75-12), No. 5 and 29 for shelling percentage and test weight (Robut 33-1 x local), No. 2 for least incidence of late leaf spot disease (Robut 33-1 x NCAC 17133), No. 21 for least incidence of leaf miner pest (Robut 33-1 x No. 75-12) and No. 4, 24 and 40 for developed pods and pod yield (Robut 33-1 x local). These are the potential progenies worth for development of new superior genotypes.

At the same time, in segregating population it is felt that more concentration should be exercised on secondary branches, aerial pegs, developed pods, test weight and harvest index while carrying out actual selection for development of new genotype.

5.2 Variability analysis in parents

Except primary branches all the 8 characters showed significant differences. The comparison of variances and variability parameters estimated in early generation population and parental genotypes indicated that the magnitude was greater in early generation population for all the characters studied indicating availability of high amount of variability. High genetic coefficient of variation for secondary branches, kernel yield, developed pods and aerial pegs indicated that these traits were least affected by environment. These results were in agreement with the results of Nagbhushanum *et al.* (1982) and Kandaswami *et al.* (1986). The high heritability recorded for the traits, plant height, secondary branches, aerial pegs and developed pods in the present study showed that these triats might lend themselves genetic manipulation by adapting mass selection for their improvement. These results were in conformity with the findings of Quadri and Kunti (1982) and Kandaswami *et al*. (1986). In order to improve any character, high genetic variability and high variability coupled with high genetic advance. Thus the secondary branches and aerial pegs showing high heritability and high genetic advance as per cent of mean might point to the predominance of additive gene effects (Panse, 1957). The selection excercised for these traits will bring out more genetic grain. But high heritability coupled with low genetic advance was observed for plant height. Johanson *et al*. (1955) reported that genetic gain will be low where there is non additive gene effects.

The results indicated that secondary branches, aerial pegs and mature pods shouldbe given due importance in selection programme as considerable improvement can be made by genetic manipulation of these traits.

Pod yield followed by developed pods, showed high amount of variability exhisted among the parental genotypes.

5.3 Phenotypic stability

5.3.1 Mean performance over locations

To step up production in groundnut, breeders aim at evolving strains which are capable for giving maximum mean economic yield over environments. The overall mean performance of genotypes over locations for different characters indicated that the newly developed genotypes like PBNG 17 for shelling percentage, PBNG 18 for secondary branches, develpped pods and pod yield and PBNG 26 for days to maturity and test weight had shown their superiority compared to other genotypes. The genotypic differences tested at all the locations were statistically highly significant for all the characters for one or the other characters excep at one or the other location indicating thereby that they were genotypically different from each other. Pushkaran and Gopinathan (1985) also noticed wide diversity in the screening of varieties for important economic characters.

5.3.2 Pooled analysis

The pooled analysis of variance showed that there were significant differences amongst environment and genotypes similar to Lu *et al.* (1988) for most of the characters except for primary branches, pod yield and days to maturity (genotypes). The significant G x E interaction for most of the characters including pod yield except primary branches and shelling percentage indicated that the genotypes responded differently, related to each other to a change in environments. The results of Habib et al. (1986) in respect of pod yield and Knauft et al. (1987) for five characters were similar to the present findings. However, except pod yield for all the characters, Kumar et al. (1987) reported significant G x E interaction. Significant mean squares due to E + (G x E) interaction for all the characters revealed that the genotypes interacted with environmental conditions that existed at different locations. Performance of non linear component (G x E) was not significant only for a aerial pegs and undeveloped pods particularly when tested against the pooled deviation revealing thereby the fact that the prediction of performance in different environments was not possible for most of the characters. Similar observations in case of pod yield were also reported by Bhole et al. (1987). Further the significant G x E (linear) interaction for main stem height, aerial pegs, developed pods and shelling percentage indicated that the stability parameters, regression coefficient (bi) estimated by the linear component of the responce to a change in environment was different for various genotypes under study. The pooled deviation was also highly significant for main stem height, secondary branches, aerial pegs, undeveloped pods, developed pods, pod yield, days to maturity and test weight indicated that differences in stability for these characters among the genotypes were due to both linear and deviations from the linear function. The results of Habib et al. (1986) in case of pod yield, correspondance to the present findings.

The assessment of the performance of genotypes tested at different locations by using environmental indices (ij) and mean performance indicated that out of five locations, Latur was found the favourable environment for main stem height, nodes on main stem, primary branches, days to maturity and shelling percentage; Parbhani for secondary branches, undeveloped pods and pod yield; Ambajogai for aerial pegs and Aurangabad for test weight. Thus the environments classified as suitable for expression of characters revealed that Latur was the best environment for most of the characters.

5.3.4 Stability parameters

Yield stability has been defined as the value of unity for the regression of gebotype on the environmental index with a small mean square deviation from regression. Thus the stable genotype should have the ability to show minimum interaction with the environments in which they are grown (Eberhart and Russel, 1966). Paroda and Hays (1971) suggested that the linear regression should simply be considered as a measure of responce of genotype, whereas the deviation around the regression line is a measurement of stability. Accordingly, in groundnut genotype x environmental interactions and stability parameters for yield and yield components have been reported by several workers (Singh et al.1975; Yadava and Kumar, 1978 and 1979; Shorter and Norman, 1983) to determine the consistancy of various genotypes across the locations and years. In the present study, an attempt was made to investigate the stability of pod yield and its components for 11 morphological characters in four promising newly developed genotypes alongwith four standard checks.

The estimates of regression coefficient and the deviation mean squares for characters like main stem height, nodes on main stem, primary and secondary branches showed a wide range of values. The PBNG 18 was found as of general adaptability. The estimates of regression and deviation from regression for aerial pegs, developed pods, undeveloped pods and pod yield were also varied with a high range. The genotype JL 24 had least number of aerial pegs and undeveloped pods but was unstable. It was evident that PBNG 8 was the most ideal genotype for developed pods and pod yield performance with linear regression value non significant and around unity and comparatively low means square deviation. Similar to the present findings Makne et al. (1979) and Habib et al. (1986) also reported that Sel.No.91 and 92 and the genotypes Dh 8 respectively were the desirable ones for their stability performance. Similarly, Patil et al. (1984) reported that out of six promising varieties from India and Israel, M 3 had good stability and second highest yield. But the other two genotypes like PBNG 18 and PBNG 26 for developed pods were found as specifically adapted to high and low yielding environments, respectively. But their stability for pod yield was reverse to that of developed pods. Patra and Mohanty (1987) also reported that the variety OG 9-2 had shown adaptation to high yielding environment. Thus by growing these genotypes in specific environmental conditions, the high returns may be obtained. Fig.1 provides a generalized version of adaptability of eight genotypes for pod yield. From the figure, it is seen that though the mean pod yield of PBNG 18 and 26 was high, they were specifically adapted but PBNG 8 had the position nearer the unit regression line with acceptable mean pod yield which showed its average stability and resistance to environmental conditions.

But recently Breese (1969), Samuel *et al.* (1970) and Paroda and Hays (1 971) emphasized that the varieties with lowest deviation from regression (S^2di) being the most stable and vice-versa. In view of this PBNG 8 for maturity, shelling percentage and test weight and PBNG 17 for maturity were the stable genotypes. The highest bold seeded genotype like PBNG 26 was also found as average stable with comparatively less S^2di value. The mean performance for all these characters was desirable. In support of this Yadava *et al.* (1980), stated that TG 10 was stable variety for test weight. The graphical representation of the genotypes (Fig22) also clearly indicated that PBNG 26 and PBNG 8 which have attained the position within the limit of the regression coefficient with high mean test weight are superior genotypes.

In general the newly developed genotypes though had shown differential stability but their mean performance for important characters like developed pod, pod yield, secondary branches and test weight was superior to other genotypes. Their yield potential can be manipulated by growing them in specific environmental conditions. The genotypes like PBNG 8, PBNG 18 and PBNG 26 were found worth for exploitation in such environmental conditions.

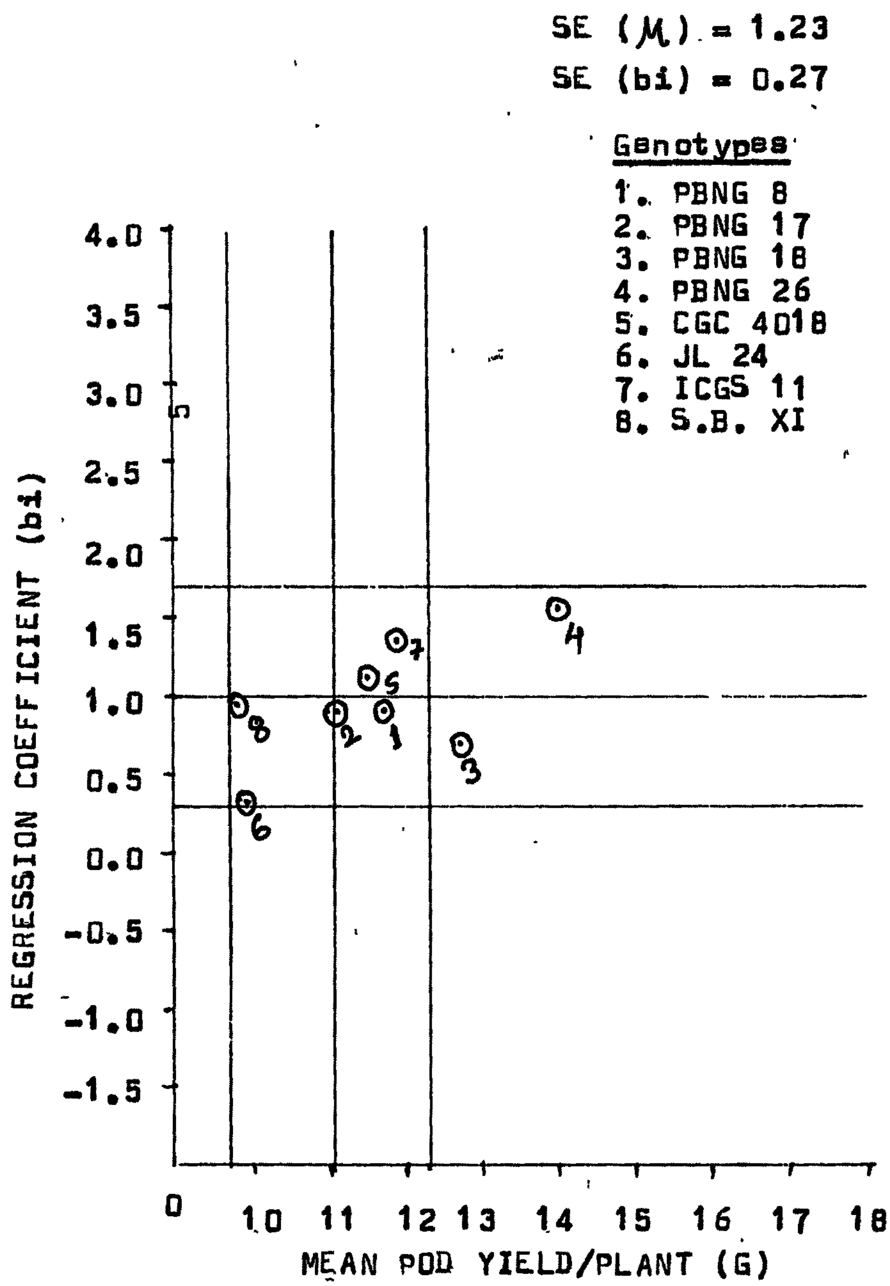

Fig. 1. RELATIVE ADAPTABILITY OF GROUNDNUT GENOTYPES FOR POD YIELD.

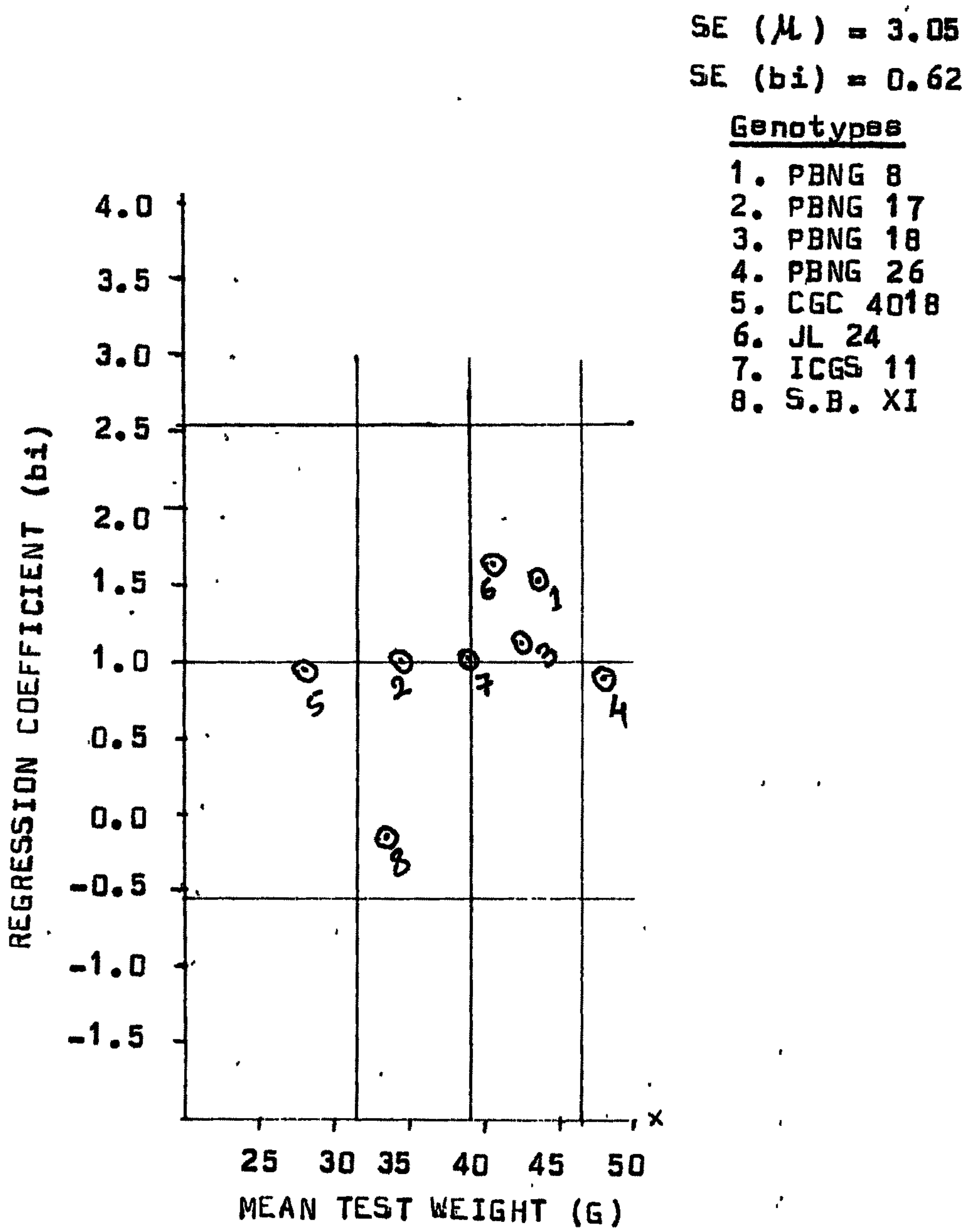

Fig. 2. RELATIVE ADAPTABILITY OF GROUNDNUT GENOTYPES FOR TEST WEIGHT.

CHAPTER VI

SUMMARY

VI. SUMMARY

An experiment consisting of 138 progenies of five crosses in F_3 generation was planned to study the genetic variability for 14 morphological characters including per cent incidence of disease and pest. The experiment was sown in a single row of 4 m length during kharif 1990 in Randomised block design with three replications following a spacing of 50 and 20 cm between and within rows, respectively. Another experiment with 14 promising genotypes was separately laidout to see the genetic variability. In a third experiment four newly evolved promising genotypes and four standard checks were sown in RBD during summer 1990 at five locations for knowing the phenotypic stability for 11 morphological characters. The results so obtained from these experiments are narrated in the following lines.

6.1 Variability analysis in early generation population

The mean per cent incidence of late leaf spot disease in the progenies like 2 (26.41), 3 (27.14), 5 (27.5), and 9 (28.93) was low at pod development stage in the cross Robut 33-1 x NCAC 17133. In the cross Robut 33-1 x No. 75-12 the progeny Nos. 19 (8.22), 33 (8.00) and 35 (8.11) recorded highest developed pods.

The per cent incidence of leaf miner pest at pod development stage in this cross was found low in the progenies like 38 (7.85), 39 (6.84), 42 (7.64), 46 (7.81) and 47 (7.38). The progeny number 21 was found with desirable mean pod yield, high number of primaries and secondaries and with lowest incidence of leaf miner pest. Similarly, the highest number of developed pods and pod yield was recorded by the progenies like No.4, 26 and 40 in the cross Robut 33-1 x local. All these progenies may yield desirable segregants in next generations.

Analysis of variance showed significant differences among the progenies for most of the characters in each cross except for primary branches and undeveloped pods in one or the other cross. This indicated that sufficient variability in the progenies was available.

The maximum range of phenotypic variability was noticed for per cent incidence of late leaf spot disease (32.41 to 70.23) at harvest in the cross Robut 33-1 x P.I. 405132 followed by secondary branches (3.66 to 19.69) and aerial pegs (2.80 to 17.08) in the cross Robut 33-1 x No. 75-12. This range was very low for primary branches in all the five crosses.

The genotypic and phenotypic variances were highest for late leaf spot disease incidence at harvest in the cross Robut 33-1 x P.I. 405132 (6^2g = 103.8, 6^2p = 181.21) and for secondary branches in the cross Robut 33-1 x NCAC 17133 (6^2g = 28.57, 6^2p = 29.29). The environmental variances was quite high for late leaf spot disease in Robut 33-1 x NCAC 17133 (6^2e = 77.34) at harvest.

The genotypic and phenotypic coefficient of variation was maximum for secondary branches (GCV = 158.32, PCV = 160.46) in the cross Robut 33-1 x NCAC 17133. Similarly, the pod yield also recorded high values in the cross Robut 33-1 x NCAC 17133 (GCV = 37.21, PCV = 46.52), Robut 33-1 x P.I. 405132 (GCV = 37.30, PCV = 40.85) and Robut 33-1 x No. 75-12 (GCV = 25.31, PCV = 35.38). The moderate values of these coefficient of variation were observed for late leaf spot disease incidence and leaf miner pest in all the three crosses. This indicated that the progenies were having good amount of variation at genotypic and phenotypic level.

The broad sense heritability estimates for main stem height and secondary branches were high in all the three crosses. For pod yield in the cross Robut 33-1 x P.I. 405132 the heritability was also high (83.41). As for as disease and pest concerned the heritability estimates were low to medium.

The maximum genetic advance to the extent of 15.88 for late leaf spot disease incidence at harvest in the cross Robut 33-1 x P.I. 405132 was observed. The high genetic advance as per cent of mean was recorded by secondary branches in all three crosses like Robut 33-1 x NCAC 17132 (322.36), Robut 33-1 x P.I. 405132 (73.82) and Robut 33-1 x No.75-12 (76.66). It was to the extent of 31.24 in the cross Robut 33-1 x P.I. 405132 and 22.04 in the cross Robut 33-1 x No.75-12 for late leaf spot disease and leaf miner pest incidence, respectively. The high heritability and high genetic advance was noticed for the characters like secondary branches and aerial pegs indicated that these characters governed by additive genetic control may be improved by selection.

The evaluation of the progenies in all the five crosses for shelling percentage, test weight, harvest index and days to 50 % flowering with the help of population mean and one standard deviation indicated that progeny Nos. 7 (Robut 33-1 x NCAC 171331), No. 10 (Robut 33-1 x P.I. 405132), No. 31 and 46 (Robut 33-1 x No. 75-12). No.5 and 29 (Robut 33-1 x local) and No.7 (S.B. XI x NCAC 17133) were the superior one.

The character association and path coefficient analysis indicated that number of developed pods, in all the five crosses, secondary branches and aerial pegs in one or the other crosses showed strong positive correlation with pod yield. Similarly developed pods had high direct and indirect effect on pod yield in all the cross. Thus secondary branches, aerial pegs, developed pods, test weight and harvest index showing high amount of variability and positive association with pod yield are important characters needs to concentration at the time of selection in early generation population.

6.2 Variability analysis in parental genotypes

In general the magnitude of variability parameters for almost all the characters was less as compared to the magnitude in segregating population. The maximum range of phenotypic variability was observed for nods on main stem (15.50 to 61.75) followed by aerial pegs (6.66 to 17.66). The genotypic and phenotypic coefficient of variation was highest for secondary branches (GCV = 69.17, PCV = 71.61), kernel yield (GCV = 30.81, PCV = 38.15) and developed pods (GCV = 29.41, PCV = 32.49). The heritability estimates were high for secondary branches (93.28), aerial pegs (75.08) and developed pods (82.13). The genetic advances as per cent of mean was quite high for secondary branches (137.16) followed by aerial pegs (50.72).

6.3 Phenotypic stability

The analysis of variance showed significant differences for almost all the characters at all the locations with exceptions of number of nodes on main stem at Latur. In general, Latur was considered as the most favraouble environment for groundnut characters experession as indicated by high mean and high environmental index.

The pooled analysis of variance showed that there were significant differences amongst environment and genotypes for most of the characters except pod yield primary branches and days to maturity (Genotypes). The significant G x E interaction for most of the characters including pod yield except primary branches and shelling percentage indicated that the genotypes responded differently, relative to each other to a change in environments. Performance of non linear component (G x E) was not significant only for aerial pegs and undeveloped pods particularly when tested against the pooled deviation revealed that the prediction of performance for most of the characters in different environments was not possible. The significance of pooled deviation for main stem height, secondary branches, aerial pegs, undeveloped pods, developed pods, pod yield, days to maturity and test weight indicated that differences in stability for these characters among the genotypes were due to both linear and deviations from the linear function.

In general the newly developed genotypes like PBNG 8, PBNG 18 and PBNG 26 had shown stability for two to three characters, their yield potential can be exploited by growing in specific environmental conditions as they have shown specific adaptation. All these genotypes had shown superior mean and are bold seeded.

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