

**STUDY OF GENETIC VARIABILITY AND
CORRELATION IN INTERSPECIFIC
DERIVATIVES OF PIGEONPEA
[*Cajanus cajan* (L.) Millsp.]**

BY

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DISSERTATION

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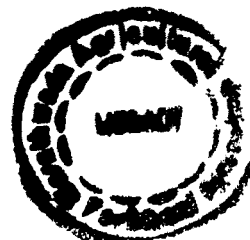
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MARATHWADA AGRICULTURAL UNIVERSITY

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2006

*To my
Mother, Father and Teachers*

CANDIDATE'S DECLARATION

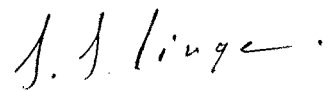
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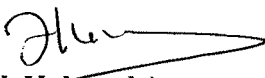
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CERTIFICATE-I

This is to certify that **Shri LINGE SHIVRAJ SHRIRANG** has satisfactorily prosecuted his course and research for a period of not less than four semesters and that the dissertation entitled "**STUDY OF GENETIC VARIABILITY AND CORRELATION IN INTERSPECIFIC DERIVATIVES OF PIGEONPEA [*Cajanus cajan* (L.) Millsp.]**" submitted by him is the result of original research work and is of sufficiently high standard to warrant its presentation to the examination.

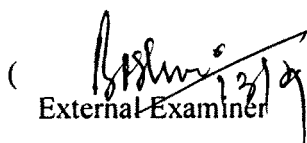
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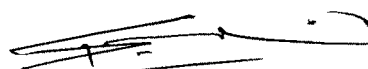
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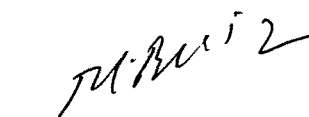
This is to certify that the dissertation entitled "**STUDY OF GENETIC VARIABILITY AND CORRELATION IN INTERSPECIFIC DERIVATIVES OF PIGEONPEA [*Cajanus cajan* (L.) Millsp.]**" submitted by **Shri LINGE SHIVRAJ SHRIRANG** to the Marathwada Agricultural University, Parbhani in partial fulfilment of the requirement for the degree of **MASTER OF SCIENCE (Agriculture)** in the subject of **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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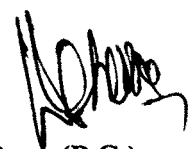
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Place : Parbhani

Date : 12/06/2006

S. S. Linge
(Linge S.S.)

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ABBREVIATIONS

Σ	=	summation
%	=	per cent
/	=	per
σ^2	=	variance
b.s.	=	broad sense
CD	=	Critical difference
cm	=	centimetre(s)
CV	=	Coefficient of variance
d.f.	=	degree of freedom
EGA	=	Expected genetic advance
EMS	=	error mean sum of square
<i>et al.</i>	=	and other
etc.	=	etceteras
Fig.	=	Figure
g	=	gram (s)
GCV	=	genotypic coefficient of variance
GM	=	General mean
h^2	=	heritability
ha	=	hectare(s)
ISD	=	Interspecific derivatives
kg	=	kilogram(s)
m	=	metre(s)
mm	=	millimetre(s)
MSS	=	mean sum of square
No.	=	number
P	=	phenotypic correlation
PCV	=	phenotypic coefficient of variance
pp	=	pages
R	=	residual effect
r	=	correlation coefficient
SE	=	Standard error
viz.,	=	videlicet (namely)



Introduction



Chapter-I

INTRODUCTION

Pigeonpea [*Cajanus cajan* (L.) Millsp.] is one of the major grain legume pulse crops of tropics and subtropics. The earliest reference to this crop in Indian literature goes back only to the third or fourth century A.D. where it has been referred as tuvarica, adhaki a synonym cited in Susruta Sanhita, the Sanskrit medical text dated around the sixth century A.D.

The pigeonpea has been a very important component of farming system in India because of its ability to fix atmospheric nitrogen. Being a deep rooted crop, it can thrive well under rainfed condition and hence serve as an important companion crop under intercropping. Its roots open up the soil and improve the soil structure. In addition, it adds organic matter to the soil in the form of dried leaves and roots. Besides its main use as *dal*, its green seeds are used as a vegetable. It has been recognized as a valuable source of protein particularly in the developing countries, where majority of the population depends on the low priced vegetarian foods for meeting its dietary requirements. Crushed dry seeds as animal feeds, green leaves as fodder and stem as fuel wood and to make huts, baskets, etc.

Being the principal centre of diversity of pigeonpea, India has a virtual monopoly on pigeonpea production in the world so far. India accounts for 78 per cent of the global output with production of 2.21 million tonnes from 3.38 million ha recording average yield of 653 kg per ha. Pigeonpea is the second most important crop in the country and

account for 14.44 per cent and 15.95 per cent of the national pulse acreage and production (Ali and Kumar, 2004). The area under *kharif* pulses in the Maharashtra State in 2004-05 was 22.7 lakh ha, less by 9.5 per cent than that in earlier year and the production is expected to be much low at 9.2 lakh tones, less by 38.1 per cent than that in the earlier year. By the preliminary forecast, area under pigeonpea in 2004-05 is estimated at 11.1 lakh ha, more by 6.4 per cent, however, the production is expected to be at 5.68 lakh tones, less by 18.0 per cent than that in the earlier year (Anonymous, 2006). It indicates the poor productivity of crop in India in general and in Maharashtra State in particular.

The history of adaptation of the different pulse crops in India is well reflected in the naturally existing plant types. The luxurious vegetative growth of the land race over production and simultaneous shedding of flowers, the indeterminate and long duration of growth, etc. are the factors that domesticated pulses for maximum survival rather than maximum production. So the yield potential of pulses has remained unrealized as stagnant. Some of the major problems like susceptibility to diseases and pests, desirable grain and *dal* qualities, adaptability to different climatic factors are still persist. No doubt breeding methods like use of male sterility, use of wild relatives has been tried.

Primitive cultivars are known to harbour many genes for variability, grain yield, adaptation, resistance to insect pests, diseases, drought and quality. The genetic potential of wild relatives in crop improvement is now also a well demonstrated fact. Even with a world germplasm collection of crop species at hand, sometimes breeders find

themselves at dead end in search of other unique characters such as disease and pest resistance in pigeonpea. Now there are evidences which showed that the wild relatives of pigeonpea can make substantial contribution to overcome these problems. About 32 species are known in the genus *cajanus*, *Cajanus cajanifolia*, *C. sericeus*, *C. scarabacoides* and *C. acutifolius* are known as valuable sources for resistance for tolerance to several biotic and abiotic stresses besides yield components and cytoplasmic male sterility (Ali and Kumar, 2004). Wild relatives are having great diversity and very valuable gene reservoirs which is helpful for improvement programme through introgression.

The pigeonpea improvement programme may find a important place in near future by incorporation of male sterility in different genetic background and crosses with the diverse genotype and throw variability in segregating generation which may in turn can be utilized in development of varieties. So it becomes necessary to find out pollen sterility and pod setting in interspecific derivatives.

Interest in this crop is growing in many countries because of its multiple uses as a source of food, feed, fuel and manure. Cropping system is a combination of crop in space and time and the objective of any system should be to provide the farmer with high and stable level of return. This depends on the inherent efficiency of the genotype. One of the important considerations in any crop improvement programme is the detailed study of genetic variability. The estimate of heritable and non-heritable variances gives a clue on improvement possible for the character under study.

Yield is a complex character, which depends upon many determining characters. Hence, the information on the correlation between yield and its component characters is pre-requisite for crop improvement.

The phenotypic correlation indicates the extent of observed relationship between the two characters while the genotypic correlation provides information about linkage for the genes controlling the pair of characters. Therefore, the correlation coefficient both at genotypic and phenotypic levels is considered. However, they do not provide the exact picture of direct and indirect causes of such association, which can be detected through path analysis (Wright, 1921).

The present investigation entitled **“Study of Genetic Variability and Correlation in Interspecific Derivatives of Pigeonpea [*Cajanus cajan* (L) Millsp.]”** was undertaken with following objectives.

1. To study pollen sterility and pod setting. ✓
2. To study the correlation and path analysis for yield and yield contributing characters. ✓
3. Identification of pod borer tolerant genotypes.



Review of Literature



Chapter-II

REVIEW OF LITERATURE

The pertinent review of literature in respect of genetic variability, correlation among important characters in pigeonpea is described in the following pages

2.1 Genetic variability

Khapre *et al.* (1993) concluded that for improving the grain yield in pigeonpea due emphasis should be placed on harvest index, pods per plant, plant height and days to 50 per cent flowering. All the traits had high heritability coupled with good genetic advance and had positive association and direct effect on grain yield which can be increased through the selection for these traits.

Aher *et al.* (1996) revealed that the variability observed in characters viz., plant height, plant spread, pods per plant, days to 50 per cent flowering, days to maturity, primary and secondary branches per plant and grain yield per plant will be very useful in further breeding programme. Appreciable amount of GCV, heritability and expected genetic advance was observed for secondary branches per plant, pods per plant, plant spread and grain yield per plant which indicated the additive gene action in the control of these characters and these characters should be improved by selection.

Aher *et al.* (1998) reported wide genetic variability for plant height, plant spread, number of secondary branches per plant and day to 50 per cent flowering. High heritability accompanied with high genetic advance was observed for number of primary and secondary branches per

plant, followed by grain yield per plant, days to 50 per cent flowering, plant spread and plant height. All the characters studied showed significant positive correlation with grain yield and also with each other.

Pansuriya *et al.* (1998) reported that the genotypic and phenotypic coefficient of variation were highest for dry matter per plant, harvest index, pods per plant and grain yield per plant. Heritability estimates were high for all the characters studied. However, high genetic advance was obtained only for dry matter per plant followed by pods per plant and plant height. High heritability coupled with high genetic advance for these traits indicated that additive gene effect was probably more important in the inheritance of these traits. Grain yield was significantly and positively correlated with pods per plant and dry matter per plant indicating that selection on the basis of these traits would be effective for yield improvement.

Patel and Patel (1998) gave information on heritability, genetic advance and phenotypic (PCV) and genetic (GCV) coefficient of variation for nine quantitative characters in four crosses of pigeonpea (*Cajanus cajan*) grown at Anand, Gujarat, during the 1993-94 rainy season. High PCV and GCV were observed for number of clusters per plant, number of pods per plant and seed yield in all crosses. Plant height and number of primary branches per plant in Anand I x Pusa 851 (A x P) and GAUT 82-90 x ICPL 84023 (G x I) pod thickness and methionine content in A x P and GAUT 82-90 x AF 100 (G x A) and days to flowering in G x I. High heritability recorded for days to 50 per cent flowering and plant spread. High heritability coupled with high genetic advance was observed

in seed yield, number of primary branches per plant, number of pods per plant and pod thickness in A x P, plant height in Anand 1 x H 76-208, number of clusters per plant in A x P and G x A.

Takalkar *et al.* (1998) estimated variability, heritability and genetic advance using 23 early genotypes of pigeonpea. The highest level of variability was observed for pods per plant followed by straw yield per plant and plant height. The high heritability estimates were observed for all the characters under study except straw yield per plant. The expected genetic advance was high for pods per plant, plant height, straw yield per plant and days to maturity. However, low genetic advance was observed for branches per plant, seeds per pod, 100-seed weight and harvest index. Singh *et al.* (1999) evaluated twelve male sterile F₁ hybrids of pigeonpea (*Cajanus cajan*) for yield and yield components at the Banaras Hindu University farm and subjected to four selection schemes. Mass selection without gridding, mass selection with gridding, selection among selfed progeny and half-sib progeny selection. For all four selection schemes, heritability and genetic advance were measured over the base population, genetic advance as a percentage of mean was greatest in the case of selection among selfed progeny with gridding. Correlation coefficient between all character pairs in all four selections as well as in the base population were significant and positive at both the genotypic and phenotypic levels. The most important yield contributing trait was number of pods per plant.

Srinivas *et al.* (1999) carried out study in a line x tester set with two male sterile and eleven pollen parents in pigeonpea. Genetic

variability was highest for number of pods and lowest for number of seeds per pod. Heritability estimates were high for all traits except seeds per pod. Genetic advance was maximum for pods per plant.

Basavarajaiah *et al.* (2000) concluded that high values of phenotypic and genotypic coefficients of variation were observed for days to 50 per cent flowering, straw weight, pods per plant, yield per plant and length of pod bearing branches. High heritability coupled with genetic advance was observed for days to 50 per cent flowering, straw weight, yield per plant, length of pod bearing branches and 100 seed weight, indicating that additive gene effects were operating for these characters. Japan super, C 11, KE 71, TTB 7, ICPL 87091, ES 90 and BDN 69 were identified as promising genotypes.

Venkateswarlu (2001) observed maximum variability for number of pods per plant followed by straw yield per plant and plant height. The high heritability estimates were observed for the characters like number of secondaries per plant, grain yield per plant, days to maturity, straw yield per plant and number of primaries per plant. The expected genetic advance was high for straw yield per plant, plant height, number of pods per plant, grain yield per plant and days to maturity.

Yadav and Padmaja (2002) obtained F₁ hybrids between *C. cajan* x *C. cajanifolius* and *C. sericeus* x *C. cajan* were characterized. *C. cajan* x *C. Platycarpus* and *C. cajan* x *C. scarabaeoides* crosses yielded hybrid pods containing shrivelled, non-viable seed. Based on data, crossability relationships and phylogenetic affinities among *C. cajan* and four wild species were elucidate.

Bajpai *et al.* (2003) reviewed wide species of *cajanus* group and their role in genetic improvement in pigeonpea. Meiotic behavior of chromosomes, fertility level and phylogenetic implications in hybrids developed from *C. sericeus*, *C. platycarpus*, *C. cajanifolius*, *C. scarabaeoides*, *C. volubilis*, *C. trinervius*, *C. pluriflora*, *C. lineatus*, *C. albicans* and *C. acutifolius* are covered.

Radhakrishna *et al.* (2003) observed high genetic variability for plant height followed by pods per plant and low for shelling percentage. Heritability estimates were high for all the traits under study. Genetic advance was high for plant height, primary branches, secondary branches, pods per plant, harvest index, and seed yield. Seed yield showed significant positive relationship with all the characters except 100 seed weight and shelling per cent. Path analysis revealed plant height, primary branches, and pods per plant to be major contributors for seed yield.

Chattopadhyay and Dhiman (2005) reported that plant height and seeds per pod contributed positively and directly, whereas contribution of 100 seed weight was negative to seed yield. While measuring their diversity, genotypes were grouped under three clusters, cluster I was the biggest and cluster II contained two germplasm which gave around 3500 kg/ha seed yield in around 270 days. Very high inter and intra cluster distances suggested huge range of variability among those germplasm belonging to North-Eastern states.

Baskara nanda and Muthiah (2006) studied genetic parameters on 18 hybrid populations synthesized from six female and three male parents in pigeonpea. Genetic variability was found to be highest for

number of clusters per plant and number of pods per plant. The characters like number of clusters per plant, plant height, number of branches per plant, number of pods per plant and seed yield per plant had high heritability and genetic advance suggesting that improvement could be brought about by direct selection. Days to 50 per cent flowering, days to maturity and seed protein content exhibited high heritability but low genetic advance and selection for these traits must be taken up in advance generation.

2.2 Correlation of characters and path coefficient analysis

The review on these aspects in pigeonpea is described as below.

Angadi *et al.* (1988) evaluated eleven hybrids and nine varieties during the monsoon season; varietal differences were significant for the nine quantitative characters studied. Pod yield was significantly correlated with seed yield, pod per plant, days to flowering and plant height. Pod yield was the only characters with a direct effect on seed yield.

Dahiya and Singh (1994) recorded information on the direct and indirect effects of five traits on yield derived from path analysis in 30 pigeonpea genotypes selected from the F_8 generation of an eight parent composite cross. The material was grown under two sowing dates at Hissar in 1991 and one sowing date at Kaul on 1991. Number of pods per plant had the highest direct effect on plot yield followed by 100 seed weight.

Dhameliya and Pathak (1994) observed that genotypic correlation coefficient were in general higher than phenotypic correlations. Yield contributing traits such as branches per plant, pods per plant and

plant height showed positive association with each other. Seed yield showed the highest positive association with number of pods per plant and number of branches per plant. Correlation of 100 seed mass was significant and positive with pod length and seeds per pod and significant and negative with pods per plant. Branches per plant exhibited significant and positive association with pods per plant, days to 50 per cent flowering and plant height. Pods per plant was negatively correlated with seeds per pod and seed mass. Days to flowering and days to maturity were positively and significantly associated with each other and with plant height.

Sarma *et al.* (1994) studied that grain yield was positively correlated with plant height and number of pods per plant and negatively correlated with number of days to maturity and 100 seed weight. Number of days to maturity was positively correlated with number of days to flowering and 100 seed weight was negatively correlated with number of pods per plant. Path coefficient analysis indicted that in decreasing order number of days to maturity, number of pods per plant, seed weight, number of seeds per pod and plant height showed the maximum direct positive effect on grain yield.

Viramgama and Goyal (1994) observed that path analysis for number of pods per plant had the highest direct and indirect positive effect on seed yield and plant height, primary branches number and test weight had indirect effects through pod number which were greater than their individual direct effect. Selection for improved yield through these traits appeared promising.

Dhameliya and Pathak (1995) concluded that pods per plant had the highest direct positive effect on yield, followed by seeds per pod, days to flowering, branches per plant and 100 seed weight.

Mahajan *et al.* (1995) gave the information on yield correlation derived from data on nine characters in 23 pigeonpea (*Cajanus cajan*) genotypes grown in three environment (rainfed at Parbhani, irrigated at Parbhani and rainfed at Badnapur) in Maharashtra during *kharif* 1992. A pod per plant was significantly positively correlated with yield in all three environments.

Salunke *et al.* (1995) observed significant and positive association of seed yield with pods per plant, primary and secondary branches, plant height and 100 seed weight. It had strong negative association with seeds per pod. The yield components viz., days to 50 per cent flowering, days to maturity, plant height, plant spread, primary branches, secondary branches and 100 seed weight were positive and significantly associated with each other. A pod per plant was positive and significantly associated with primary branches, secondary branches, plant height and plant spread. Path coefficient analysis revealed that pods per plant, seeds per pod and 100 seed weight had direct positive effects on seed yield. Pods per plant and 100 seed weight also exhibited high positive indirect effects on grain yield through most of the other characters.

Paul *et al.* (1996) reported that number of pods per plant, dry mater at maturity and number of secondary branches had positive and significant correlation with seed yield. Path coefficient analysis revealed

that highest direct effect of pods per plant on seed yield followed by dry matter at maturity and 100 seed weight.

Kingshlin and Subbaraman (1997) revealed information on yield correlation derived from data on ten yield related traits in F_3 and biparantal progeny from the cross MS Prabhat DT x ICPL 151 grown at Madurai during *rabi* 1993. The results indicated that branches per plant, clusters per plant, pods per plant, pod length, seeds per pod and 100 seed weight were strongly associated with seed yield. Path coefficient analysis revealed that pod length, seeds per pod and 100 seed weight made the highest contribution towards seed yield, both directly and indirectly.

Vanniarajan *et al.* (1997) observed that yield showed a significant and positive association with days to 50 per cent flowering, days to maturity, plant height, branches per plant, clusters per plant, pods per plant, pods length and 100 seed weight. Association of pod length with seeds per pod and 100 seed weight was significant and positive. Path analysis revealed that pods per plant and 100 seed weight had high positive and direct effects on seed yield.

Chandirakala and Raveendran (1998) reported that high phenotypic and genotypic coefficient of variation were observed for number of branches per plant, number of pods per plant, number of clusters per plant and 100 seed weight. Seed yield was significantly and positively correlated with number of branches per plant, number of pods per plant, number of clusters per plant, number of seeds per pod and 100 seed weight. Path analysis revealed that 100 seed weight had the highest positive direct effect on grain yield followed by number of pods per plant

and number of clusters per plant. Number of branches per plant, number of pods per plant, number of clusters per plant, number of seeds per pod and 100 seed weight showed high positive indirect effect on grain yield, indicating the potential of the component selection method to improve yield in pigeonpea. The importance of 100 seed weight in selection programme was also noted.

Musaana and Nahdy (1998) observed the parents, F_1 and F_2 populations which were used to record yield and some of yield components. Phenotypic and genotypic correlations were calculated from data and later a path coefficient analysis carried out using the genotypic correlation. Both the phenotypic and genotypic correlations showed that plant height, pods per plant, seeds per pods, seed weight and number of primary branches were primary components of yield in pigeonpea. Plant height and seeds per pod were also negatively and significantly correlated. Seed per pod and seed weight were negatively correlated with branch number, cluster number and pods per plant. Seeds per pod was also negatively correlated with seed weight. However, plant height and seed weight were positive and significantly correlated. A path coefficient analysis, however, indicated that pod clusters per plant, pods per plant, seeds per pod and seed weight were main yield component having maximum direct effect on yield.

Pandey and Singh (1998) derived information on correlation coefficient from data on eleven yield related traits in eight short duration pigeonpea (*Cajanus cajan*) hybrids and four controls. The data obtained indicated that number of primary branches per plant and pods per plant are the prime contributing characters to seed yield.

Jagdish Singh (1999) studied correlation coefficient, correlated response and relative selection efficiency for seed yield and its components in pigeonpea (*Cajanus cajan*). Parents and hybrids differed significantly for seed yield and the majority of its components. Seed yield per plant showed significant positive association with plant height, branches per plant, pods per plant, seeds per pod, biological yield per plant and harvest index. Maximum correlated response was recorded for biological yield per plant followed by pods per plant, branches per plant, harvest index and seeds per pod. The results suggested that direct selection for biological yield per plant and pods per plant would be more effective than selection for seed yield itself.

Kingshlin and Subbaraman (1999) observed yield correlation derived from path analysis of data on ten yield related traits in F_3 and biparental progeny of pigeonpea (*Cajanus cajan*) cross MS T 21 x ICPL 151 grown at Madurai during *rabi* 1993. Branches per plant, clusters per plant, pods per plant, seeds per pod and 100 seed weight was strongly associated with seed yield. Path coefficient analysis indicated that in the biparental progeny, plant height had the highest direct effect on yield, followed by branches per plant. In F_3 progeny, days to maturity had the highest direct effect.

Srinivas *et al.* (1999) reported significant positive relationship of seed yield with plant height, number of primary branches, secondary branches and pods per plant. Path analysis also revealed pods per plant, plant height and secondary branches to be the major contributors for seed yield.

Pandey and Singh (2002a) reported that during the *kharif* season seed yield was significantly correlated with the number of pods and seed yield per plant at the genotypic level. No character was significantly associated with seed yield at the phenotypic level. During the pre-*rabi* season, seed yield per plot was highly correlated with seed yield per plant and harvest index at genotypic and phenotypic levels. Significant and positive association were observed between seed yield per plant and the number of primary branches and between the number of pods per plant and number of seeds per pod at genotypic level. Significant negative association was observed between plant height at initial flowering and at maturity (genotypic level) and between harvest index and plant height at maturity (phenotypic level). The number of primary and secondary branches per plant, number of pods per plant, and number of seeds per pod were the major yield contributing characters; however the best index of high yield was the number of pods per plant.

Pandey and Singh (2002b) reported that significant variation among pigeonpea hybrids for all traits except for seeds per pod. Significant genotypic correlations were observed between seed yield per plot and days to initial flowering and maturity, plant height at initial flowering and maturity, primary branches and pods per plant and seeds per pod. The phenotypic correlation between seed yield per plot and days to maturity was significant in the first year. In second year, seed yield per plot showed significant genotypic correlations with days to initial flowering, plant height at maturity and primary branches and pods per plant. The major yield contributing characters were primary branches and pods per plant and

seeds per pod, however, the best index of high yield were primary branches and pods per plant.

Lal and Rajni Raina (2002) observed that number of primary and secondary branches, harvest index, dry matter at maturity and pods per plant exhibited positive correlation with yield. The main contribution of direct effects towards yield was observed for harvest index, dry matter at maturity, number of primary branches and pods per plant. Negative direct effects were observed for traits like secondary branches, 100 seed weight, seed per pod and plant height.

Li *et al.* (2004) showed that grain yield per plant showed a high degree of positive correlation with number of pods per plant, but exhibited a low positive correlation with plant height and stem diameter. Grain yield per plant was not significantly correlated with the other characters. The number of pods per plant, number of pods damaged by pests and 100 seed weight had the greatest effect on seed yield per plant. Thus, the utilization of plants with higher number of pods per plant, larger seeds and lower number of seeds damaged by pests in breeding programmes would most likely generate new cultivars with increased grain yield and pest resistance.

Ramdhari *et al.* (2004) utilized forty nine early pigeonpea genotypes were used to study the relationships among the seed yield and its component traits. The range of means for the traits indicated wide variation, therefore, desirable genotypes could be selected for using them in hybridization programme. The genotypes H 2000-9 and H 2000-25 had high number of both fruiting branches and pods per plant. Correlation and

path analysis showed that the selection for pods per plant and fruiting branches per plant could enhance the seed yield potential in pigeonpea.

Gupta (2005) revealed that correlation between grain yield and its component characters viz., pod per plant, damaged pods per plant, length of pod, number of seeds per pod, were significant and positive at genotypic and phenotypic level. However, distance of first branch from ground level and number of nodes upto first branch were negatively significant correlation with grain yield also reported positive and significant correlation of days to 50 per cent flowering with days to maturity both at genotypic and phenotypic levels. Path analysis indicated that pods/plant, distance of first branch from ground level, plant height, number of primary branches, number of secondary branches, pod damage, pod length and days to 50 per cent flowering had direct effect on grain yield.

2.3 Pod borer infestation

Levin (1973) described the role of trichomes in plant defense and pointed out that in numerous species there was negative correlation between trichome density and insect feeding and oviposition responses and nutrition of larvae.

Tripathi and Purohit (1984) studied pod damage by *H. armigera* in relation to pod size and colour among the varieties with small pods. Pod damage ranged between 33 per cent (green pod with streaks) and 61 per cent (green pods), with large pods, pod damage ranged between 25.1 per cent streaky pods and 33.8 per cent (in green pods). Thus, green pods were more susceptible to pod borer attack.

Pundir and Singh (1987) studied various wild relatives of pigeonpea (*Cajanus cajan*) namely some species of *Atylosia* and *Rhynchosia*, which possess desirable characteristics that could be utilized for effecting genetic improvement of this crop in total 73 cross combinations. Among two cultivar of *C. cajan* and one accession of eight *Atylosia* sp. and one of *Rhynchosia* were attempted. Twelve hybrids were obtained. Seven of these were analysis for F₁ fertility and their utility for agronomic improvement of the *C. cajan* fertility behaviour of different F₁ hybrids varied and indicated that potential of gene transfer between the two genera. *Atylosia* and *cajanus* were as good as within the genus *Atylosia* from F₂ and F₃ families of *C. cajan* x *A. scorabaeoides* and *C. cajan* or *A. albicans*. Plants were selected with greater physiological efficiency and agronomic superiority. The prospects of transferring pod borer resistance and higher seed protein from some *Atylosia* species to pigeonpea were discussed.

Pathanik *et al.* (1995) reported that PRG 100 and HTH 15 were tolerant (< 10 per cent damage). The grain yield was highest in 1991 (2.9 – 4.8 t/ha) than in 1989 and 1990. Yield and pest damage data showed that PRG 100 and HTH 15 were superior over UPAS 120.

Peter *et al.* (1995) reviewed the role of plant trichomes in insect resistance and suggested that trichomes can act as an insect resistance mechanism in one of three way like acting as a physical barrier, limiting an insects contact and movement on the plant surfaces, which is precisely the mechanism acting in case of sorghum shoot fly.

Verulakar and Singh (1998) reported that the wild relative *Cajanus scarabaeoides* exhibited high number of seeds per pod and high level of resistance to pod borer and also interspecific hybrids showed minimum percentage of pod borer damage as compared to cultivated genotypes.

Khandwe *et al.* (1998) conducted an experiment during 1992-93 in Madhya Pradesh, India, to determine the correlation between *Heliothis armigera* (*Helicoverpa armigera*) larval densities and yield attributing parameters of pigeonpea. There was negative correlation between larval intensity and number of pods, grains and their weight, while there was positive correlation with pod damage at green and dry stage. With an increase of one larva per plant, there was a decrease of 4.95 green pods, 7.05 dry pods, 18.01 grains, 3.79 g pod and 2.05 g grain weight per plant, whereas pod damage increased by 2.61 and 4.93 per cent at green and dry stages respectively.

Romeis *et al.* (1999) reported that trichomes have been modified in a number of crops to develop insect tolerant genotypes. Pigeonpea [*Cajanus cajan* (L.) Millsp.] is often heavily damaged by insect pests and trichomes provide a potential insect resistance mechanism. They conducted a study to identify and characterize the distribution of trichomes on pigeonpea and two wild species. *C. platycarpus* (Bentham) Van der massen and *C. scarabaeoides* (L.) Thours. glandular (type A, B and E) and two nonglandular (type C and D) trichome types were identified with light and electron microscopy.

Reddy *et al.* (2001) observed that there was a strong negative correlation between larval density and grain yield. On the average, one larvae per plant resulted in 6.57 and 6.08 per cent loss in grain yield during 1996 and 1997, respectively.

Pournami *et al.* (2002) revealed significant variation in pod damage by legume pod borer among the cultivars of yard long bean. There was significant negative correlation between density of non glandular trichomes on pod wall and severity of pod damage. The correlation of pod width, pod infestation and pod damage severity were positive and significant. It is concluded that high density of non glandular, Trichomes on pods and low pod width tend to reduce the attack of yard long bean pods by Legume pod borer .

Sahoo and Senapati (2002) revealed that trichome density and pod length had adverse effect on pod borer incidence and the adverse effects of trichome density was more pronounced than that of trichome length.

Gangwar and Bajpai (2005) studied seventy two interspecific plant peogenies derived between wild species viz., *Cajanus cajanifolius*, *C. acutifolius* and *C. scarabaeoides* and cultivated lines viz., UPAS 120, Pant A 134 and ICPL 84023 were taken up for identification of pod borer resistant lines. In progenies involving *C. Cajanifolius*, the pod damage ranged between 1.1 and 6.5 per cent in protective, and 1.6 and 7.1.1 in unprotective condition. In progenies of *C. acutifolius* pod and seed damage ranged between 0.9 and 9.3 per cent and 0.5 and 8.0 per cent respectively in protective and unprotective conditions. Six F3 progenies of UPAS 120 x *C.*

scarabaeoides, seven in Pant A 134 x *C. scarabaeoides* and eight in ICPL 84023 x *C. scarabaeoides* where marked as highly resistant in protective as well as unproductive conditions.

2.4 Pollen sterility and pod setting

Sexena *et al.* (1981) recorded that the pollen fertility as indicated by stainability with acetocarmine, ranged from 20 per cent to 60 per cent, depending on the plant, whereas normal fertile plants generally revealed more than 90 per cent stainability. Pod set on plants revealing low pollen production and low stainability of pollen varied from apparently of normal to virtually zero. Thus pod set was associated with degree of sparseness of pollen production.

Ariyanagam *et al.* (1993) developed gene cytoplasmic male sterility system through wide hybridization. Also indicated the prevalence of differences among species, and among accessions within species for the occurrence of male sterility as well as the level of male sterility of successive generation.

Nageshwar Rao *et al.* (1996) reported that insect aided pod set on male sterile plants under open pollination was also good and on an average each male sterile plant produced 45 hybrid pods with 1.8 seeds per pod. Among pollen parents used natural cross pollination, ICPL 151 was best with 79 pods per plant followed by ICPL 88009 with 75 pods per plant. ICPL 87 on contrary produced the fewest (28 pods per plant) number of hybrid pods when used as pollen parent.

Verulkar and Singh (1997) observed a male sterile plant in the UPAS 120 cultivar of pigeonpea (*C. cajan*). The plant was about 5-7

day late flowering and had white translucent anthers with complete pollen sterility. The inheritance of this spontaneous male sterility was studied in cross involving the mutant and fertile UPAS 120 including their F_1 , F_2 , BC_1 and BC_2 generation. The results suggested that the male sterility was genetic and due to recessive gene.

Bhattacharya and Sharma (2001) observed that flower drop was positively correlated with dry matter allocation to stem root and leaf under normal sowing conditions. Correlation and path analysis showed that during early flowering, leaf area and specific leaf weight restricted flower drop. Flower drop was higher under late than normal sowing conditions.

Yadav *et al.* (2001) conducted an experiment during October-November (wet season) and March-April (dry season) 1996-97 and October-November 1997-98 to study pod set in pigeonpea hybridization using genetic male sterile line MS UPAS 120. A mean pod set of 20.1 per cent with a range of 5.0 – 66.7 per cent was observed in pollinations made during March-April 1996-97. The lowest pod set of 13.2 per cent with a range of 5.7 – 24.2 per cent was observed in October-November 1997-98 pollinations.

Pandey (2004) observed maximum bud blooming and pod setting when the minimum and maximum day temperature ranged between 13 and 25°C, respectively. Maximum floral bud drop was recorded at lower temperature regimes i.e. 6-4 °C and 12-14 °C with 100 per cent relative humidity, while maximum, pod drop was recorded at higher temperature regimes i.e. 22-24 °C (minimum) and 38-42 °C (maximum). The genotypes DA 32, DA 34, DA 36 and DA 45 exhibited highly

significant positive correlation among the characters like pods per plant and floral bud drop per plant. Highly significant negative correlation among the traits like pods per plant and floral bud drop and flower drop per plant were exhibited by the genotype Bahar, Pusa 9, Sharad, DA 35 and DA 46.

Singh and Bajpai (2005) reported relative less pollen fertility and morphology in interspecific crosses of pigeonpea *C. cajan* x *C. acutifolius* hybrid showed low pollen fertility in F1 generation, whereas high pollen fertility was found in crosses utilizing *C. cajanifolius* and *C. scarabaeoides*.



Material and Methods



Chapter-III

MATERIAL AND METHODS

The details of the material used and methods adopted for conducting the present investigation are described in this chapter under appropriate heads. The experiment was conducted at experimental farm of the Department of Agricultural Botany, Marathwada Agricultural University, Parbhani during *kharif* 2005.

3.1 Experimental materials

The experimental material consists of forty interspecific derivatives (ISD) of pigeonpea along with five national checks derived from ICRISAT, Patancheru, Hyderabad and one local check.

Table 3.1. List of genotypes

Sr. No	Genotype	Sr. No	Genotype
1	(UPAS 120 x <i>C. trinervius</i>)-3-1	24	(Pant A-2 x <i>C. scarabaeoides</i>)-20-1
2	(Pant A-2 x <i>C. albicans</i>)-14-1	25	(Pant A-2 x <i>C. albicans</i>)-24-1
3	(Prabhat x <i>C. scarabaeoides</i>)-3-1	26	(Pant A-2 x <i>C. albicans</i>)-24-2
4	(Prabhat x <i>C. scarabaeoides</i>)-3-2	27	(UPAS 120 x <i>C. trinervius</i>)-4-1
5	(Prabhat x <i>C. scarabaeoides</i>)-3-3	28	(Pant A-2 x <i>C. scarabaeoides</i>)-12-1
6	(Pant A-2 x <i>C. albicans</i>)-9-1	29	(Pant A-2 x <i>C. scarabaeoides</i>)-12-2
7	(Pant A-2 x <i>C. albicans</i>)-9-2	30	(Pant A-2 x <i>C. albicans</i>)-6-2-1
8	(Pant A-2 x <i>C. albicans</i>)-11-1	31	(Pant A-2 x <i>C. albicans</i>)-6-2-2
9	(Pant A-2 x <i>C. lanceolatus</i>)-1	32	(<i>C. sericeus</i> x <i>C. scarabaeoides</i>)-2-1
10	(Prabhat x <i>C. scarabaeoides</i>)-3-2-1	33	(Pant A-2 x <i>C. albicans</i>)-28-1
11	(Prabhat x <i>C. scarabaeoides</i>)-3-2-2	34	(Pant A-2 x <i>C. albicans</i>)-10-1
12	(Pant A-2 x <i>C. scarabaeoides</i>)-14-1	35	(Pant A-2 x <i>C. albicans</i>)-6-3-1
13	(Pant A-2 x <i>C. scarabaeoides</i>)-14-2	36	(Pant A-2 x <i>C. scarabaeoides</i>)-5-1
14	(UPAS 120 x <i>C. trinervius</i>)-5-1	37	(UPAS 120 x <i>C. trinervius</i>)-1-1
15	(Pant A-2 x <i>C. scarabaeoides</i>)-16-1	38	(Pant A-2 x <i>C. scarabaeoides</i>)-3-1
16	(Pant A-2 x <i>C. scarabaeoides</i>)-16-2	39	(Pant A-2x <i>C. scarabaeoides</i>)-27-2-1
17	(Pant A-2 x <i>C. albicans</i>)-29-1	40	(Pant A-2x <i>C. scarabaeoides</i>)-27-2-2
18	(Pant A-2 x <i>C. albicans</i>)-29-2	41	ICPL 87119 (<i>Asha</i>)
19	(Prabhat x <i>C. scarabaeoides</i>) 3-3-1	42	ICPL 332
20	(Prabhat x <i>C. scarabaeoides</i>) 3-3-2	43	ICPL 87 (<i>pragati</i>)
21	(Prabhat x <i>C. scarabaeoides</i>) 3-1-1	44	ICP 7035
22	(Pant A-2 x <i>C. albicans</i>)-23-1	45	ICPL 88039
23	(Pant A-2 x <i>C. albicans</i>)-23-2	46	BSMR 736

The genotype are mentioned as per their serial number in subsequent chapters

3.2 Experimental method

3.2.1 Design and layout

The field trial comprising of forty ISD, five national released checks and one local check of pigeonpea was undertaken in randomized block design with two replications.

3.2.2 Sowing

The experimental material was sown on 16th July, 2005, two seeds of each entry were dibbled at a place.

3.2.3 Cultural practices

All recommended package of practices were applied.

3.3 Observations

Observations were recorded on twenty randomly selected plants in different genotypes in each replication.

Data on following characters were recorded.

3.3.1 Days to flower initiation:

Days required from sowing to the flower initiation in each line.

3.3.2 Days to 50 per cent flowering:

Days required from sowing to the flowering of 50 per cent plant in each line.

3.3.3 Days to maturity:

Days required from sowing to physical maturity of the crop.

3.3.4 Plant height (cm) :

At maturity, plant height was measured from ground level of the plant to tip of the main stem.

3.3.5 Number of primary branches:

Total effective pod bearing branches per plant on the main stem were recorded.

3.3.6 Number of secondary branches:

Total effective pod bearing branches per plant on primary branches were noted.

3.3.7 Height of first branch from ground level (cm)

The distance was measured from ground level to where the first branching was started.

3.3.8 Number of pods per plant

Total numbers of pods bearing seeds were counted per plant at maturity.

3.3.9 Number of seeds per pod

The numbers of seeds in each of twenty representative pods were recorded and average was worked out as number of seeds per pod.

3.3.10 Per cent pod damage

The ratio of infected pods by pod borer (*Helicoverpa armigera*) to total number of pods per plant was measured.

$$\text{Per cent pod borer damage} = \frac{\text{Number of infected pods by pod borer}}{\text{Total number of pods per plant}} \times 100$$

The per cent values were converted into arcsine values for statistical analysis.

3.3.11 100 seed weight (g) :

Healthy 100 seeds were counted and weighed.

3.3.12 Pod length (cm):

The length of pod was measured from pod tip to down.

3.3.13 Grain yield per plant (g) :

Grain of the randomly selected plants were harvested and threshed separately. Grain weight was taken after thorough drying in the sun.

The total harvested grains from plant were weighted in gram.

3.3.14 Per cent pod setting

Plants inflorescence were selfed with butter paper bag with providing proper aeration. Then record the pod set by counting pod to be set and dropped flowers, and per cent pod setting was calculated as follows.

$$\text{Per cent pod setting} = \frac{\text{Number of pods}}{\text{Total number of flower (Dropped flowers + Number of pods)}} \times 100$$

The per cent values were converted into arcsine values for statistical analysis.

3.3.15 Per cent pollen sterility

By using 2 % acetocarmine stain, test the pollen grains of flower were carried out under compound microscope. By counting the presence of sterile pollens and fertile pollen and per cent pollen sterility was calculated as follows.

$$\text{Per cent pollen sterility} = \frac{\text{Number of sterile pollens}}{\text{Total number of pollens (sterile pollens + fertile pollens)}} \times 100$$

The per cent values were converted into arcsine values for statistical analysis.

3.3.16 Number of Trichomes per microscopic field

Take 12 to 14 days old ^{Pods} and leave them for 24 hrs in 20 ml acetic acid : alcohol (2:1) in small stoppered glass vials. Then transfer the pod samples to 90 % lactic acid in stoppered vials. The cleared leaf samples can be stored for examination. Mount the pod samples on a slide in a drop of lactic acid and observe under a microscope at 40x. Count the number of trichomes in field's selected at random and express the trichomes per microscopic field (Sharma and Nwanze 1997).

Types

Five morphologically distinct types of trichomes (Type A-E) were identified from pods of *Cajanus* spp. by light / compound microscope.

Type-A has a long tubular neck from which a clear viscous fluid is secreted. It is longer than all other trichomes except type D. The base is enlarged and appears to consist of 6 to 10 cell. The neck is comprised of 4 to 8 cells.

Type-B is yellowish, unsegmented, globular Sac. Its contents are only released after the cell wall is ruptured.

Unsegmented nonglandular trichomes were separated into short (type-C) and long (type-D) trihcomes.

Type-D is 4 to 11 times longer than type-C.

Type-E trichomes are shorter than all other trichomes type.

Because of their small size and rarity, type-E trichomes were not considered in this study (Romies *et al.* 1999).

Qualitative observations

3.3.17 Stem colour

Royal Horticultural Society (RHS) colour cods are given in parenthesis besides descriptor states.

1. Green (yellow – green group 144B)
2. Sun-red (grayed red group 178 B)
3. Purple (grayed purple group 183 A)
4. Dark purple (grayed purple group 187 A)

3.3.18 Standard petal colour

Standard petal colour (dorsal side) is grouped into four colours as:

1. Ivory
2. Light yellow
3. Orange yellow
4. Red

3.3.19 Pattern of streaks on standard petals

These were categorized into five categories on the basis of pattern and density of streaks on standard petal, which can be observed by necked eyes on dorsal side of standard petal.

1. Dense streaks
2. medium amount of streaks
3. Sparse streaks
4. Uniform coverage
5. No streaks.

3.3.20 Pod colour

For main colour of the pod, Royal Horticultural Society (RHS) colour codes are given in parenthesis, besides descriptor states.

1. Green (yellow green group 144 A)
2. Purple (grayed purple group 183 A)
3. Mixed green and purple
4. Dark purple (grayed – purple group 187 A).

3.3.21 Growth habit

This refers to pattern of growth and plant habit. The growth habit depends mainly upon the number of primary branches and secondary branches and angle of branches on the stem on which they are born resulting in a continuous variety of forms from upright compact to spreading types.

Growth habit is categorized into three categories.

3.3.21.1 Compact / erect

Having relatively thick branches, which are borne at narrow angles to stem.

3.3.21.2 Spreading

The branches resulting in a broad plant canopy.

3.3.21.3 Semi-spreading

Being intermediate between the compact and spreading type.

3.3.22 Flowering pattern

1. Determinate
2. Semi-determinate

T 5040



3. Indeterminate

1. Determinate

In the determinate types flowering duration is short, the flowers occurs more or less in the same plane, and apical buds of main shoots develop into inflorescences.

2. Indeterminate

Flowering duration is longer and flowers occur in axillary racemes spread over considerable lengths of stem.

3. Semi determinate

Where flowering starts at nodes below the apex and proceeds both acropetally and basipetally.

3.3.23 Seed coat colour or base seed colour

Royal Horticultural Society (RHS) colour codes are given in parenthesis besides descriptor states.

1. White (yellow –white group 158 C)
2. Cream (grayed – white group – 156 C)
3. Orange (grayed – orange group 163 B)
4. Light brown (yellow orange group 22 C)
5. Reddish – brown (reddish – brown group 200 D)
6. Light gray (gray brown group 199 B)
7. Gray (grayed green group 197 A)
8. Purple (grayed – purple group 187 A)
9. Dark purple (black group 202 A)
10. Dark gray (black group 202 B)

3.4 Statistical methods

3.4.1 Analysis of variance

For testing significance of results, the data were subjected to analysis of variance method. Mean values of the plants selected in each replication were used for statistical analysis. The analysis of variance is set out under ANOVA Table :

Sr. No.	Source of variation	d.f.	MSS	Variance ratio 'F' observed	Table 'F'
1.	Replication	(r-1)	$\sigma^2_e + r\sigma^2_g$		
2.	Treatment	(t-1)	$\sigma^2_e + r\sigma^2_g$		
3.	Error	(r-1) (t-1)	σ^2_e		
	Total	(rt-1)			

$$\text{Standard error (SE)} = \sqrt{\text{EMSS}/r}$$

Where,

EMSS = error mean sum of squares

r = number of replications

$$\text{Critical difference (CD)} = \text{S.E.} \times \sqrt{2} \times 't'$$

Where

t = table value of 't' at error d.f.

3.4.2 Genetic variability

Various parameters of genetic variability were calculated by using appropriate formulae.

1. Genotypic variance (σ^2_g)

$$\sigma^2_g = \frac{\text{TRMSS} - \text{EMSS}}{r}$$

2. Phenotypic variance (σ^2_p)

$$\sigma^2_p = \sigma^2_g + \text{error variance } (\sigma^2_e)$$

Where,

$$\sigma^2_e = \text{MSS due to error}$$

3. Phenotypic coefficient of variation (PCV)

$$\text{PCV} = \frac{\sqrt{\sigma^2_p}}{\bar{x}} \times 100$$

4. Genotypic coefficient of variation (GCV)

$$\text{GCV} = \frac{\sqrt{\sigma^2_g}}{\bar{x}} \times 100$$

Where,

$$\sigma^2_g = \text{genotypic variance}$$

$$\sigma^2_p = \text{phenotypic variance}$$

$$\bar{x} = \text{general or grand mean of character}$$

5. Heritability (Broad sense) was calculated according to the method suggested by Hanson *et al.* (1956) for each character as :

$$\text{Heritability (h}^2\text{) (bs)} = \frac{\sigma^2_g}{\sigma^2_p} \times 100$$

Where,

$$\sigma^2_g = \text{genotypic variance}$$

$$\sigma^2_p = \text{phenotypic variance}$$

$$\text{Genetic advance} = h^2 \times K \times \sqrt{\sigma_p^2}$$

Where,

$$h^2 \text{ (b.s.)} = \text{heritability}$$

$$K = \text{selection difference at 5 per cent selection intensity, it is 2.06}$$

$$\sqrt{\sigma_p^2} = \text{phenotypic standard deviation}$$

Genetic advance in percentage (EGA) expressed in terms of mean is calculated as,

$$EGA = \frac{GA}{\bar{x}} \times 100$$

Where,

GA = Genetic advance

$\bar{x}$ = general or grand mean of character

3.4.3 Correlation

Covariance were calculated for all characters to find out correlations among the characters. The inter relationship of different yield contributing characters at genotypic and phenotypic level was worked out according to Johnson *et al.* (1955).

Genotypic correlation coefficient rg_{xy}

$$rg_{xy} = \frac{\text{Cov} (g_x \cdot g_y)}{\sqrt{\sigma^2_{g_x} \cdot \sigma^2_{g_y}}}$$

Where,

$\text{Cov} (g_x g_y)$ = Genotypic covariance between character x and y.

$\sigma^2_{g_x}$ and $\sigma^2_{g_y}$ = genotype variance of character x and y respectively.

Similarly,

Phenotypic correlation coefficient (rP_{xy})

$$rP_{xy} = \frac{\text{Cov} (P_x \cdot P_y)}{\sqrt{\sigma^2_{P_x} \cdot \sigma^2_{P_y}}}$$

where,

$\text{Cov} (P_x \cdot P_y)$ = phenotypic covariance between characters x and y.

$\sigma^2_{p_x}$ and $\sigma^2_{p_y}$ = phenotypic variance of characters x and y.

3.4.4 Path analysis

Correlation does not provide an exact picture of the relative importance of direct and indirect influence of each of the component characters. The path coefficient analysis, a cause of and effect relationship

provide knowledge of relative importance of each of the component character.

The path coefficient analysis was carried out according to Dewey and Lu (1959). The direct path coefficients were calculated by solving the following set of 'p' simultaneous equation by the abbreviated Doolittle technique.

$$P_{01} + P_{02} + r_{12} + \dots P_{op} r_{ip} = r_{01}$$

$$P_{01} r_{12} + P_{02} + \dots P_{op} r_{2p} = r_{02}$$

$$P_{01} r_{10} + P_{02} r_{2p} + \dots P_{op} = r_{op}$$

$P_{01}, P_{02} \dots P_{op}$ are the path effects of 1, 2 p variables, on 'o' variable.

$r_{12}, r_{13} \dots r_{1p} \dots r_{op} (p-1)$ are the possible correlation coefficient between various independent variable and $r_{01}, r_{02} \dots r_{op}$ were the correlation of independent variables with dependant variable.

The direct effect of i^{th} variable via j^{th} variable was worked out as $(P_{0j} \times P_{ij})$

From the simultaneous equations, it is clear that the correlation coefficient is the sum of direct and indirect path coefficients.

Residual effect was calculated as under.

$$P^2_{ox} = 1 - (P^2_{01} + 2P_{01}P_{02}r_{12} + 2P_{01}P_{03}r_{13} + P^2_{02} + 2P_{02}P_{03}r_{23} + \dots P^2_{op}).$$

$$\text{Residual factor} = \sqrt{P^2_{ox}}$$



Results

Chapter-IV

RESULTS

The mean data on genotypes was analysed as per standard procedure and are presented under the following major headings.

- 4.1 Analysis of variance
- 4.2 Mean performance
- 4.3 Genetic parameters
- 4.4 Correlation
- 4.5 Path coefficient analyses for yield and yield contributing characters.
- 4.6 Qualitative characters

4.1 Analysis of variance

Analysis of variance was worked out to assess the variation in ISD of pigeonpea for nineteen characters (Table 4.1)

Analysis of variance showed that differences among the genotype in respect of all characters were significant both at 5 per cent and 1 per cent level. This indicates wide range of variability in ISD.

4.2 Mean performance

The mean performance of the genotypes studied is given in the Table 4.2

4.2.1 Yield and yield components

4.2.1.1 Days to flowering initiation

The variation in days to flower initiation ranged between 78 days (ICPL 88039) to 130 days (Prabhat x *C. scarabaeoides*)-3-3-2. The mean of days to flower initiation was 115 days. The genotypes ICPL 88039

Table 4.1. Analysis of variance of different characters in ISD of pigeonpea.

Characters	Mean sum of squares		
	Replication (1)	Treatment (45)	Error (45)
Days to flower initiation	8.50	209.65**	9.10
Days to 50% flowering	7.95	280.94**	9.123
Days to maturity	50.26	440.60**	23.21
Plant height	25.78	334.01**	19.35
No. of primary branches	4.38	7.00**	1.69
No. of secondary branches	10.70	62.18**	2.40
Height of primary branch from G.L.	4.37	22.57**	2.93
No. of pods/plant	4.17	5569.61**	195.53
No. of seeds/pod	0.143	0.4098**	0.029
Per cent pod damage	4.38	19.47**	4.52
100 seed wt. (g)	0.037	2.256**	0.238
Pod length (cm)	0.015	0.260**	0.1024
Pod setting (%)	-0.004	43.67**	2.350
Pollen sterility (%)	45.42	21.32**	2.18
Trichome-A	0.111	16.286**	1.91
Trichome-B	41.50	19.48**	0.783
Trichome-C	148.65	4355.37**	100.15
Trichome-D	36.61	58.79**	2.13
Grain yield (g)	18.65	241.54**	39.43

*, ** significant at 5 and 1 per cent level, respectively.

Table 4.2. Mean performance of ISD of pigeonpea for different yield contributing characters .

Genotypes Sr. No.	Days to flower initiation	Days to 50% flowering	Days to maturity	Plant height	No. of primary branches	No. of secondary branches	Height of primary branch from G.L.	No. of pods/plant	No. of seeds/pod	Per cent pod damage	100 seed wt. (g)	Pod length (cm)	Pod setting (%)	Pollen sterility (%)	Trichome-A	Trichome-B	Trichome-C	Trichome-D	Grain yield (g)
1	113.00	135.50	191.50	130.30	9.80	18.50	9.80	136.90	3.75	10.56 (18.95)	8.16	5.24	24.91 (29.83)	9.04 (17.43)	0.50	6.83	117.83	15.50	23.53
2	124.00	147.00	199.50	114.50	9.80	11.70	21.10	151.40	3.74	8.79 (17.11)	7.55	5.06	14.13 (22.06)	5.74 (13.82)	1.83	4.17	178.33	11.17	31.42
3	112.50	132.00	190.00	145.80	10.29	12.40	30.60	116.50	3.62	12.39 (20.53)	7.51	5.32	23.18 (28.76)	5.73 (13.80)	1.17	4.50	162.33	10.07	24.70
4	113.00	144.00	190.00	155.70	13.10	21.70	22.40	285.00	4.02	7.30 (15.68)	9.00	5.51	20.18 (26.57)	9.81 (18.33)	0.67	4.50	201.97	10.97	57.21
5	116.00	132.00	189.50	118.30	7.30	8.90	26.20	82.80	3.88	10.58 (18.85)	7.62	4.92	39.41 (38.85)	5.43 (13.33)	1.17	5.67	123.83	11.33	17.17
6	115.00	128.00	185.50	137.70	11.20	14.00	27.90	190.00	3.52	8.02 (16.43)	7.62	4.94	15.94 (23.50)	6.90 (23.50)	2.33	6.00	171.00	13.66	35.37
7	112.00	135.50	180.50	135.70	12.60	11.60	26.20	166.70	3.90	6.73 (15.00)	7.96	5.40	21.94 (27.89)	8.88 (21.89)	1.67	9.67	211.17	14.17	36.62
8	118.00	159.00	210.50	134.20	10.90	9.50	22.80	95.50	3.66	12.31 (20.50)	7.13	5.11	8.58 (16.92)	16.75 (17.02)	5.50	5.66	151.00	17.67	19.07
9	119.50	148.50	191.00	138.70	10.40	5.60	23.70	127.60	3.96	9.96 (18.34)	6.62	5.66	21.62 (27.66)	8.25 (16.62)	4.33	8.16	132.00	10.17	21.96
10	118.00	148.00	193.50	132.30	12.20	12.20	27.20	121.20	3.90	9.40 (17.86)	8.47	5.11	20.94 (24.20)	8.65 (17.10)	1.33	8.17	142.16	12.16	28.22
11	116.00	144.00	193.00	133.30	11.65	7.90	24.20	92.50	5.00	7.34 (15.67)	7.39	4.97	23.35 (28.65)	10.66 (19.00)	0.67	8.50	188.83	14.67	18.19
12	119.00	138.00	190.00	139.60	11.60	15.00	27.10	210.60	3.94	4.88 (12.59)	6.25	5.43	25.07 (29.97)	6.28 (14.13)	0.50	4.47	231.17	12.67	33.05
13	116.00	139.00	201.00	138.90	11.60	8.50	24.70	144.80	3.70	10.81 (19.12)	7.57	5.57	14.76 (22.53)	8.23 (16.65)	1.83	8.83	110.83	8.00	25.78
14	113.00	134.50	184.00	137.90	13.80	16.85	25.30	232.90	3.82	7.13 (22.06)	7.30	5.62	14.76 (22.56)	8.57 (16.94)	5.00	7.82	199.00	11.33	53.53

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
15	123.00	140.00	189.50	127.80	9.50	5.60	27.00	123.70	3.82	5.86 (14.37)	7.57	5.58	14.74 (22.54)	9.01 (17.43)	0.67	12.5 0	228.00	9.50	25.53
16	123.00	140.00	181.50	117.40	9.50	5.90	22.50	116.80	3.78	6.43 (14.45)	6.65	5.41	14.10 (21.97)	12.34 (20.53)	9.50	5.33	211.50	13.33	19.40
17	118.00	140.50	186.50	135.80	12.00	13.80	25.00	177.50	3.68	2.41 (10.83)	5.59	4.66	23.53 (29.00)	9.26 (17.66)	2.00	2.50	244.50	16.27	26.92
18	113.00	130.50	186.00	137.10	12.90	13.80	25.40	186.50	5.00	4.28 (11.90)	7.07	5.29	33.65 (35.45)	10.26 (18.66)	9.33	7.00	211.50	9.17	33.87
19	113.00	135.00	185.50	138.60	10.20	10.20	30.10	164.55	3.68	4.68 (18.10)	7.39	5.85	4.93 (12.71)	20.53 (26.92)	0.17	11.0 0	150.00	24.19	32.15
20	130.00	159.00	212.00	142.20	15.10	9.40	26.60	116.70	3.54	6.36 (14.49)	6.60	5.39	12.53 (20.75)	19.15 (25.96)	3.50	6.30	209.17	20.33	15.66
21	118.00	136.00	185.00	131.20	13.30	9.00	23.90	156.30	3.66	6.83 (15.12)	7.27	5.52	18.77 (25.64)	6.02 (14.17)	1.00	10.1 6	200.33	29.17	31.68
22	96.00	126.00	182.50	147.20	11.20	11.70	27.00	165.10	3.84	6.21 (14.24)	7.21	5.50	15.72 (23.33)	8.91 (17.30)	2.00	9.32	209.50	15.00	34.42
23	116.00	138.00	191.50	134.80	12.00	14.40	28.06	148.30	3.90	6.04 (17.46)	7.11	5.20	22.31 (28.16)	12.33 (20.51)	4.00	8.67	170.50	14.67	30.83
24	104.50	137.00	182.00	135.30	11.60	11.40	27.70	126.50	3.68	6.37 (14.41)	7.28	5.45	23.37 (28.85)	7.35 (15.58)	11.4 8	8.66	185.00	9.13	22.76
25	116.00	141.50	189.00	135.90	11.00	21.00	24.80	174.00	3.64	9.88 (18.23)	7.65	5.45	16.80 (24.16)	12.36 (20.61)	2.67	5.63	144.16	11.33	39.34
26	113.00	132.00	197.00	130.40	9.10	7.00	27.50	150.50	4.08	7.71 (13.74)	7.27	5.99	24.81 (29.86)	6.98 (15.34)	2.67	9.33	226.82	12.16	29.60
27	125.50	159.50	220.50	101.70	8.70	5.50	26.30	88.90	3.56	9.55 (17.94)	7.42	5.82	22.12 (28.04)	13.24 (21.31)	4.66	7.48	156.50	20.67	17.72
28	113.00	140.50	203.00	126.90	11.70	11.60	27.70	164.10	5.00	17.13 (24.32)	7.96	5.82	11.37 (25.35)	11.47 (19.82)	1.67	5.17	71.16	11.00	33.95
29	128.50	139.00	194.50	127.70	9.20	8.50	26.00	108.20	3.94	11.03 (19.40)	9.31	5.93	15.88 (23.44)	8.77 (17.16)	5.17	5.72	126.33	13.00	25.10
30	121.50	145.50	188.50	121.80	9.30	12.30	26.20	156.55	3.62	7.94 (16.33)	7.62	5.55	19.19 (26.01)	10.62 (19.00)	2.00	6.00	185.33	12.50	29.48
31	118.50	141.00	199.00	126.70	11.20	24.20	24.30	160.20	3.92	7.49 (15.53)	7.80	5.48	13.36 (21.36)	11.15 (19.47)	4.83	8.00	190.83	22.00	35.44
32	119.00	148.00	195.00	121.50	10.20	13.50	27.70	131.30	3.54	7.95 (16.32)	7.53	5.36	15.33 (22.99)	7.88 (16.30)	3.17	5.00	187.50	10.00	19.71

Contd...

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
33	95.00	113.50	143.50	124.10	12.00	16.80	25.80	142.70	3.68	12.25 (20.47)	6.00	4.41	11.03 (19.37)	10.52 (18.90)	3.17	8.83	146.50	20.50	29.33
34	112.50	134.50	179.50	144.80	13.50	9.10	29.20	142.10	3.78	6.78 (15.34)	7.39	5.40	11.55 (19.78)	9.11 (17.48)	2.17	7.00	175.50	13.33	31.98
35	113.00	140.00	189.50	114.90	9.60	11.20	25.20	137.90	5.00	7.47 (15.63)	8.17	5.57	14.90 (22.64)	7.36 (15.72)	3.67	3.33	150.17	22.33	32.00
36	119.50	139.00	192.00	152.00	12.40	19.80	29.80	193.40	3.58	9.59 (17.99)	7.79	5.66	22.51 (28.30)	11.02 (19.47)	10.1 7	9.97	148.50	25.67	38.66
37	124.00	146.00	208.00	151.20	12.40	12.70	23.80	181.90	3.80	6.80 (15.11)	7.52	5.69	20.34 (26.78)	11.65 (19.96)	5.33	10.1 7	200.17	12.17	33.59
38	124.50	146.50	192.00	114.90	13.90	10.40	24.50	155.20	3.48	5.74 (13.88)	7.69	4.97	12.57 (20.73)	10.05 (18.48)	4.50	9.00	222.66	8.83	30.01
39	126.50	144.50	203.50	132.90	13.80	25.60	23.70	252.60	3.98	5.03 (12.83)	6.56	5.47	12.17 (20.40)	12.67 (20.77)	3.33	12.8 3	226.33	15.33	40.65
40	119.00	136.50	190.00	139.10	11.20	17.90	27.80	237.90	5.00	5.14 (13.12)	7.01	5.81	16.94 (24.27)	14.97 (22.70)	1.50	14.3 3	225.17	12.00	55.38
41	118.00	123.00	181.50	124.20	12.90	18.40	23.30	166.40	3.52	7.36 (15.68)	9.25	5.87	16.97 (26.60)	10.71 (19.06)	4.17	6.17	198.50	7.66	53.85
42	115.00	139.00	182.00	153.80	13.70	23.80	27.50	280.30	3.60	4.42 (12.10)	8.68	5.71	21.79 (27.76)	8.70 (17.10)	6.67	3.33	240.00	8.50	68.47
43	81.00	99.50	135.00	100.80	10.40	3.90	21.60	65.90	3.46	14.13 (22.00)	8.39	5.64	25.65 (30.39)	6.65 (14.76)	3.17	0.17	85.33	2.50	18.33
44	121.50	152.00	199.50	104.80	5.30	2.30	31.00	18.60	3.91	16.76 (24.11)	12.6	6.35	16.26 (23.77)	9.14 (17.55)	7.00	0.33	81.83	7.16	5.74
45	78.00	104.50	158.00	116.60	10.00	3.90	22.50	76.00	5.00	13.70 (21.48)	7.56	5.86	22.70 (28.39)	6.64 (14.81)	5.00	2.83	92.00	5.00	20.06
46	117.00	126.00	182.00	124.60	10.00	14.70	23.00	158.70	3.85	10.64 (19.03)	8.26	5.34	28.84 (32.45)	10.30 (18.66)	10.1 5	1.33	89.17	11.33	37.43
Mean	115.20	137.79	189.00	131.12	11.20	12.47	25.47	151.73	3.91	8.50 (16.83)	7.64	5.45	18.38 (25.46)	9.91 (18.36)	3.67	6.88	169.81	13.46	30.32
SE ±	3.017	3.020	4.818	4.399	1.30	1.55	1.71	13.98	0.17	2.12 (16.83)	0.48	0.32	1.66 (25.46)	1.478 (18.36)	1.38	0.88	10.00	1.46	6.28
CD at 5%	6.076	6.084	9.705	8.86	2.62	3.12	3.44	28.16	0.34	4.28 (16.83)	0.98	0.64	3.35 (25.46)	2.97 (18.36)	2.78	1.78	20.15	2.94	12.64

Note: 1. The genotype serial number represent the genotypes mentioned in Table 3.1.
2. Figure sin parentheses indicate arcsine values.

(78) followed by ICPL 87 (81) and (Pant A-2 x *C. albicans*)-28-1 (95) were observed earlier in days to flower initiation than other genotypes. The genotypes (Prabhat x *C. scarabaeoides*)-3-3-2 (130) followed by (Pant A-2 x *C. scarabaeoides*)-12-2 (128) and (Pant A-2 x *C. scarabaeoides*)-27-2-1 (126) were observed to be late for flower initiation.

4.2.1.2 Days to 50 per cent flowering

Days to 50 per cent flowering ranged from 99 (ICPL 87) to 159.50 days (UPAS 120 x *C. trinervius*)-4-1 with a mean of 137 days (Table 4.2). The genotypes ICPL 87 (99) followed by ICPL 88039 (104) and (Pant A-2 x *C. albicans*)-28-1 (113) were observed earlier in days to 50 per cent flowering. The genotypes (UPAS 120 x *C. trinervius*)-4-1 (159.50) followed by (Pant A-2 x *C. albicans*)-11-1 (159), (Prabhat x *C. scarabaeoides*)-3-3-2 (159) and (ICP 7035) (152) were observed to be late for days to 50 per cent flowering.

4.2.1.3 Days to maturity

The range of variation in days to maturity observed between 135 days (ICPL 87) to 220.5 days (UPAS 120 x *C. trinervius*)-4-1. Mean for days to maturity was 189 days. The genotypes ICPL 87 (135) followed by (Pant A-2 x *C. albicans*)-28-1 (143) and ICPL 88039 (158) were found to mature earlier than other genotypes. It is observed that (UPAS 120 x *C. trinervius*)-4-1 (220) followed by (Prabhat x *C. scarabaeoides*)-3-3-2 (212) and (Pant A-2 x *C. albicans*)-11-1 exhibited late maturity.

4.2.1.4 Plant height (cm)

The plant height was maximum (155.70cm) in case of (Prabhat x *C. scarabaeoides*)-3-2 while it was minimum (100.80cm) in case

of ICPL 87. The mean for plant height was 131.12 cm. The tallest genotype was (Prabhat x *C. scarabaeoides*)-3-2 (155.70) followed by ICPL 332 (153.80) and (Pant A-2 x *C. scarabaeoides*)-5-1 (152.00). The genotypes ICPL 87 (100.80) followed by (UPAS 120 x *C. trinervius*)-4-1 (101.70) and ICP 7035 (104.80) recorded less height.

4.2.1.5. Number of primary branches

The character number of primary branches per plant ranged between 5.30 (ICP 7035) to 15.10 (Prabhat x *C. scarabaeoides*)-3-3-2. The mean for number of primary branches per plant was 11.20. The maximum number of primary branches per plant observed for (Prabhat x *C. scarabaeoides*)-3-3-2 (15.10) followed by (Pant A-2 x *C. scarabaeoides*)-3-1 (13.90) and (Pant A-2 x *C. scarabaeoides*)-27-2-1 (13.80). The genotype ICP 7035 (5.3) followed by (prabhat x *C. scarabaeoides*)-3-3 (7.3) and (UPAS 120 x *C. trinervius*)-4-1 had less number of primary branches (8.7).

4.2.2.6 Number of secondary branches

the mean value for number of secondary branches ranged from 2.30 (ICP 7035) to 25.6 (Pant A-2 x *C. scarabaeoides*)-27-2-1 with a general mean of 12.47. However, the highest number of secondary branches per plant was observed for (Pant A-2 x *C. scarabaeoides*)-27-2-1 (25.60) followed by (Pant A-2 x *C. albicans*)-6-2-2 (24.20), ICPL 332 (23.80). Lowest of secondary branches per plant was recorded for ICP 7035 (2.3) followed by ICPL 87 (3.9), ICPL 88039 (3.9) and (UPAS-120 x *C. trinervius*)-4-1 (5.5).

4.2.2.7 Height of first primary branch from ground level (cm)

Range of height of first primary branch from ground level was from 9.8 cm (UPAS 120 x x *C. trinervius*)-3-1 to 31.00 cm ICP 7035 with average mean value of 25.47 cm. Maximum was recorded ICP 7035 (31.00) followed by (Prabhat x *C. scarabaeoides*)-3-1 (30.60) and (Prabhat x *C. scarabaeoides*)-3-3-1 (30.10), whereas (UPAS 120 x x *C. trinervius*)-3-1 (9.8), (Pant A-2 x *C. albicans*)-14-1 (21.10) and ICPL 87 (21.60) had minimum height of first primary branch from ground level.

4.2.1.8. Number of pods per plant

The mean number of pods per plant was observed from 18.60 (ICP 7035) to 285.00 (Prabhat x *C. scarabaeoides*)-3-2, with a mean of 151.73. The maximum number of pods per plant was recorded in the genotype (Prabhat x *C. scarabaeoides*)-3-2 (285.00) followed by ICPL 332 (280.00) and (Pant A-2 x *C. scarabaeoides*)-27-2-1 (252.60). The minimum number of pods per plant was recorded for ICP 7035 (18.60), ICPL 87 (65.90) and ICPL 88039 (76.00).

4.2.1.9. Number of seeds per pod

The variation in number of seeds per pod recorded between 5.00 to 3.46 with general mean value 3.91. The genotypes (Prabhat x *C. scarabaeoides*)-3-2-2(5.00), (Pant A-2 x *C. scarabaeoides*)-12-1(5.00), (Pant A-2 x *C. albicans*)-6-3-1(5.00), (Pant A-2 x *C. scarabaeoides*)-27-2-2 (5.00), ICPL 88039 (5.00), (Pant A-2 x *C. albicans*)-24-2 (4.08) and (Prabhat x *C. scarabaeoides*) (4.02) exhibited highest seeds per pod. Whereas ICPL 87 (3.46), (Pant A-2 x *C. scarabaeoides*)-3-1 (4.80), ICPL 332 (3.60) were recorded less number of seeds per pod.

4.2.1.10. Per cent pod damage

The per cent pod damage was maximum (17.13) in case of (Pant A-2 x *C. scarabaeoides*)-12-1, while it was minimum (2.41) in case of (Pant A-2 x *C. albicans*)-29-1. The mean of per cent pod damage was 8.59 per cent. The highest per cent pod damage was observed in (Pant A-2 x *C. scarabaeoides*)-12-1 (17.13) followed by ICP 7035 (16.76) and ICPL 87 (14.13). The genotypes (Pant A-2 x *C. albicans*)-29-1 (2.41), (Pant A-2 x *C. albicans*)-29-2 (4.28) and ICPL 332 (4.42) recorded less per cent pod damage.

4.2.1.11. 100 seed weight (g)

The variation in 100 seed weight was observed between 5.59 g (Pant A-2 x *C. albicans*)-29-1 to 12.60 g (ICP 7035). The mean of 100 seed weight was 7.64 g. 100 seed weight were recorded highest for the genotypes viz., ICP 7035 (12.60), (Pant A-2 x *C. scarabaeoides*)-12-2 (9.31) and ICPL 87119 (9.25). Whereas genotypes (Pant A-2 x *C. albicans*)-29-1 (5.59), (Pant A-2 x *C. albicans*)-28-1 (6) and Pant-A-2 x *C. scarabaeoides*)-14-1 (6.24) were found lowest for 100 seed weight than all other 46 genotypes studied in this experiment.

4.2.1.12. Pod length (cm)

The mean pod length ranged from 4.41cm (Pant A-2 x *C. albicans*)-28-1 to 6.35 cm (ICP 7035). The mean pod length was 5.45 cm. The maximum pod length was recorded in the genotype ICP 7035 (6.35), (Pant A-2 x *C. albicans*)-24-2 (5.99) and (Pant A-2 x *C. scarabaeoides*)-12-2 (5.92). The minimum pod length was recorded for (Pant A-2 x *C.*

albicans)-28-1 (4.41) (Pant A-2 x *C. albicans*)-29-1 (4.66) and (Prabhat x *C. scarabaeoides*)-3-3 (4.92)

4.2.1.13 Per cent pod setting

The mean per cent pod setting per plant was ranged from 4.93 (Prabhat x *C. scarabaeoides*)-3-3-1 to 39.41 (Prabhat x *C. scarabaeoides*)-3-3 per cent with average mean value of 18.38 per cent.

However, maximum per cent pod setting was recorded for (Prabhat x *C. scarabaeoides*)-3-3 (39.41) followed by (Pant A-2 x *C. albicans*)-29-2 (33.65) and BSMR 736 (28.84). The minimum pod setting was observed in (Prabhat x *C. scarabaeoides*)-3-3-1 (4.93), (Pant A-2 x *C. albicans*)-11-1 (8.58) and (Pant A-2 x *C. albicans*)-28-1 (11.03).

4.2.1.14 Per cent pollen sterility

The variation in per cent pollen sterility was observed between 5.43 (Prabhat x *C. scarabaeoides*)-3-3 to 20.53 (Prabhat x *C. scarabaeoides*)-3-3-1.

The mean of per cent pollen sterility was 9.91 per cent. The maximum per cent pollen sterility was observed in (Prabhat x *C. scarabaeoides*)-3-3-1 (20.53) followed by (Prabhat x *C. scarabaeoides*)-3-3-2 (19.15) and (Pant A-2 x *C. scarabaeoides*)-27-2-2 (14.97). The genotypes (Pant A-2 x *C. scarabaeoides*)-3-3 (5.43), (Prabhat x *C. scarabaeoides*)-3-1 (5.73) and (Plant A 2 x *C. albicans*)-14-1 (5.73) exhibited minimum per cent pollen sterility.

4.2.1.15 Number of trichomes per microscopic field

4.2.1.15.1 Trichome type A

The variation in trichome type-A was ranged from 0.165 (Prabhat x *C. scarabaeoides*)-3-3-1 to 11.48 (Pant A-2 x *C. scarabaeoides*)-20-1. The mean of trichome type-A was 3.67. Among 46 genotypes, (Pant A-2 x *C. scarabaeoides*)-20-1 (11.48) followed by (Pant A-2 x *C. scarabaeoides*)-5-1 (10.16) and BSMR 736 exhibited maximum number of trichome type-A. The genotypes (Prabhat x *C. scarabaeoides*)-3-3-1 (0.165) followed by (UPAS 120 x *C. trinervius*)-3-1 (0.500), (Pant A-2 x *C. scarabaeoides*)-14-1 (0.500) and (Prabhat x *C. scarabaeoides*)-3-2-2 (0.665) had less number of trichome type-A.

4.2.1.15.2 Trichome type B

The mean number of trichome type B per microscopic field was ranged from 0.16 to 14.33 with general mean value of 6.88. The genotype ICPL 87 showed less number of trichomes per microscopic field was ICPL-87 (0.16), where as (Pant A-2 x *C. scarabaeoides*)-27-2-2 (14.33) recorded more number of trichome-B.

Highest number of Trichome type B per microscopic field were observed by (Pant A-2 x *C. scarabaeoides*)-27-2-2 (14.33) followed by (Pant A-2 x *C. scarabaeoides*)-27-2-1 (12.83) and (Pant A-2 x *C. scarabaeoides*)-16-1 (12.50). The genotypes ICPL 87 (0.165), ICP 7035 (0.330) and BSMR 736 (1.33) exhibited minimum number of trichome type B.

4.2.1.15.3 Trichome type C

The mean number of trichome type C per microscopic field was ranged between 71.16 to 244.50 with a general mean value of 169.80. The genotype had shown less number of trichomes per microscopic field where (Pant A-2 x *C. scarabaeoides*)-12-1 (71.16) and highest number of trichomes per microscopic field was shown by (Pant A-2 x *C. albicans*)-29-1 (244.50).

Highest number of Trichome type C per microscopic field was recorded for (Pant A-2 x *C. albicans*)-29-1 (244.50) followed by ICPL 332 (240), (Pant A-2 x *C. scarabaeoides*)-14-1 (231.16). The genotypes (Pant A-2 x *C. scarabaeoides*)-12-1 (71.16), ICP 7035 (81.30) and ICPL 87 (85.3) had less number of trichome type C per microscopic field.

4.2.1.15.4 Trichome type D

Number of trichomes per microscopic field was ranged from 2.50 (ICPL 87) to 29.16 (Prabhat x *C. scarabaeoides*)-3-1-1 with general mean values of 13.46. The maximum number of trichomes type D were observed for (Prabhat x *C. scarabaeoides*)-3-1-1 (29.16), followed by (Pant A-2 x *C. scarabaeoides*)-5-1 (25.66), (Prabhat x *C. scarabaeoides*)-3-3-1 (24.19). Minimum number of trichome type D was recorded for ICPL 87 (2.50) followed by ICPL 88039 (5.00) and ICP 7035 (7.16).

4.2.1.16 Grain yield per plant (g)

Grain yield per plant was ranged between 5.74 ICP 7035 to 68.47 ICP 332 with general mean value of 30.32 g.

Maximum grain yield was recorded ICPL 332 (68.47) followed by (Prabhat x *C. scarabaeoides*)-3-2 (57.21) and (Pant A-2 x *C.*

scarabaeoides)-27-2-2 (55.85) .The genotypes ICP 7035 (5.74), (Prabhat x *C. scarabaeoides*)-3-3-2 (15.66) and (UPAS 120 x *C. trinervius*)-4-1 (17.71) had less grain yield per plant.

4.3 Genetic parameters

The characters under investigation were analysed for genotypic variance (σ^2_g), phenotypic variance (σ^2_p), and genotypic coefficient of variance (GCV), phenotypic coefficient variance (PCV), heritability (bs), genetic advance (GA) and the expected genetic advance (EGA). The results are presented in Table 4.3.

In general σ^2_p was found to be higher than σ^2_g for all characters studied. The magnitude of genotypic variance was the highest for number of pods per plant (2687.03) followed by trichome type C (2127.61) and days to maturity (208.69). The genotypic variance was ranged between 0.07 to 2687.03. While phenotypic variance however ranged between 0.18 to 2882.57. The highest estimate of phenotypic was observed for number of pods per plant (2882.57) followed by trichome type C (2227.76) and days to maturity (231.90).

4.3.1 Estimates of variability parameters

4.3.1.1 The genotypic coefficient of variance (GCV)

The estimates of genotypic and phenotypic coefficient of variance are presented in Table 4.3. Highest genotypic coefficient of variance was observed to be high for trichome type A (73.02) followed by trichome type B (44.47), number of secondary branches (43.84), trichome type D (39.54) and pods per plant (34.16). For rest of characters, genotypic coefficient variance was ranged from 8.46 to 33.15.

Table 4.3. Parameters of genetic variability for yield and yield contributing characters in ISD of pigeonpea.

Sr. No.	Parameters	Range	General mean	Genotypic variance (σ^2_g)	Phenotypic variance (σ^2_p)	GCV (%)	PCV (%)	Heritability (%)	GA (%)	EGA (%)
1.	Days to flower initiation	78 – 130	115.19	100.27	109.37	8.69	9.07	91.6	17.14	14.87
2.	Days to 50% flowering	99.5-159.5	37.79	135.91	145.03	8.46	8.73	93.7	16.87	12.24
3.	Days to maturity	135-220.5	189.00	208.69	231.90	7.64	8.05	89.9	14.93	7.89
4.	Plant height	100.80-155.70	131.12	157.33	176.68	9.56	10.13	89.0	18.59	14.17
5.	No. of primary branches	5.30-15.10	11.19	2.65	4.35	14.56	18.62	61.1	23.45	209.56
6.	No. of secondary branches	2.30-25.60	12.47	29.89	32.29	43.84	45.57	92.5	86.89	696.79
7.	Height of first primary branch from ground level	9.80-31.00	25.47	9.82	12.75	12.30	14.02	77.0	22.24	87.31
8.	No. of pods/plant	18.60-285.00	151.73	2687.03	2882.57	34.16	35.38	93.2	67.94	44.77
9.	No. of seeds/pod	3.48-5.00	3.912	0.19	0.22	11.14	11.98	86.4	21.34	545.78
10.	Per cent pod damage	2.41-17.13	16.83	7.47	12.001	16.24	20.57	62.27	26.40	156.86
11.	100 seed wt. (g)	5.59-24.31	7.63	1.00	1.24	13.15	14.62	80.8	24.36	319.26
12.	Pod length (cm)	4.41-6.35	5.45	0.07	0.18	5.15	7.81	43.5	7.00	128.44
13.	Pod setting (%)	4.93-39.41	25.45	20.45	23.22	17.76	18.92	88.0	34.34	134.49
14.	Pollen sterility (%)	5.43 – 20.53	18.36	9.57	11.75	16.85	18.67	81.4	31.32	170.58
15.	Trichome-A	0.16-11.48	3.67	7.18	9.09	73.02	82.16	78.9	133.68	3642.50
16.	Trichome-B	0.16-14.33	6.87	9.35	10.13	44.47	46.30	92.2	88.01	1281.07
17.	Trichome-C	71.16-244.0	169.80	2127.61	2227.76	27.16	27.79	95.5	54.68	32.39
18.	Trichome-D	2.50-29.16	13.46	28.32	30.46	39.54	41.00	92.9	78.54	583.50
19.	Grain yield (g)	5.74-68.47	30.32	101.05	140.49	33.15	39.08	71.9	57.91	190.99

4.3.1.2 Phenotypic coefficient of variance (PCV)

The phenotypic coefficient of variance was recorded to be high for trichome type A (82.16) followed by trichome type B (46.30), number of secondary branches (45.57), trichome type D (41.00) and grain yield (39.08). While low PCV was observed for remaining characters.

4.3.1.3 Heritability

It has been observed that the heritability estimates (broad sense) were high for trichome type C (95.5), days to 50 per cent flowering (93.7), number of pods per plant (93.2), trichome type D (92.9), number of secondary branches (92.5), trichome type B (92.2), days to flower initiation (91.6), days to maturity (89.9), plant height (89.0), per cent pod setting (88.0), per cent pollen sterility, 100 seed weight (80.8), trichome type A (78.9) height of first primary branch from ground level (77.00), whereas medium heritability were recorded for grain yield (71.9) and per cent pod damage (62.27). While low heritability estimates were observed for pod length (43.5).

4.3.1.4 Genetic advance

On the basis of mean higher estimates of genetic advance were observed in trichome type A (133.68) followed by trichome type B (88.01), number of secondary branches (86.89), trichome type D (78.54) and number of pods per plant (67.94). Lowest genetic advance were observed in pod length (7.00) followed by days to maturity (14.93), days to 50 per cent flowering (16.87), days to flower initiation (17.14) and plant height (18.59).

4.3.1.5 Genetic advance as per cent of mean (Expected genetic advance)

On the basis of mean, genetic advance as per cent of mean showed highest value for trichome type A (3642.50) followed by trichome type B (1281.07), number of secondary branches (696.79), trichome type D (588.50) and number of seeds pod (545.78) were noted. Low genetic advance as per cent of mean was observed in days to maturity (7.89) followed by days to 50 per cent flowering (12.24), plant height (14.17), days to flower initiation (14.87) and trichome type C (32.39).

4.4 Correlation

The correlation coefficient is a most important statistical constant used as a measure of the degree of association between two characters worked at the same time. The correlation studies help the breeder to compute the required genotypic make up of the ideal variety. In order to find out the association or correlation between the characters considered. In the present study genotypic and phenotypic correlation coefficient were worked out for nineteen characters, which are presented in Table 4.4 and 4.5. The only significant correlation either in positive or negative directions are described.

4.4.1 Associations of grain yield with its components

It was revealed that positive and highly significant genotypic and phenotypic correlation were observed between grain yield and its components characters namely number of pods per plant (0.953) follow by number of secondary branches (0.827), plant height (0.649) and number of primary branches (0.567), trichome type-C (0.364). While per cent pod

Table 4.4. Genotypic correlation of yield with other yield components in ISD of pigeonpea

Characters	Days to flower initiation	1																	0.827**
	Days to 50% flowering	2	0.851**																0.567**
	Days to maturity	3	0.834**	0.894**															0.169
	Plant height	4	0.128	0.134	0.036	0.034	0.123	0.042	-0.124	-0.200	0.053	0.070	-0.290	0.226	-0.005	0.190	0.293*	0.292*	0.262
	No. of primary branches	5	0.059	-0.010	0.036	0.034	0.123	0.042	-0.124	-0.200	0.053	0.070	-0.290	0.226	-0.005	0.190	0.293*	0.292*	0.262
	No. of secondary branches	6	0.162	0.069	0.034	0.034	0.123	0.042	-0.124	-0.200	0.053	0.070	-0.290	0.226	-0.005	0.190	0.293*	0.292*	0.262
	Height of 1st primary branch from gl.	7	0.130	0.114	0.123	0.042	0.130	0.170	-0.216	-0.353*	0.045	0.057	-0.196	0.269	0.042	0.267	0.340**	0.277	0.262
	No. of pods/plant	8	0.170	0.070	0.042	0.042	0.130	0.170	-0.216	-0.353*	0.045	0.057	-0.196	0.269	0.042	0.267	0.340**	0.277	0.262
	No. of seeds/pod	9	-0.216	0.001	-0.124	-0.200	-0.353*	-0.216	-0.353*	-0.353*	0.045	0.057	-0.196	0.269	0.042	0.267	0.340**	0.277	0.262
	Per cent pod damage	10	-0.353*	-0.160	-0.200	-0.353*	-0.353*	-0.353*	-0.353*	-0.353*	0.045	0.057	-0.196	0.269	0.042	0.267	0.340**	0.277	0.262
	100 seed wt. (g)	11	0.045	0.064	0.053	0.045	0.057	0.045	0.057	0.045	0.045	0.057	-0.196	0.269	0.042	0.267	0.340**	0.277	0.262
	Pod length (cm)	12	0.057	0.250	0.070	0.070	0.130	0.170	-0.216	-0.353*	0.045	0.057	-0.196	0.269	0.042	0.267	0.340**	0.277	0.262
	Pod setting (%)	13	-0.196	-0.158	-0.290	-0.290	-0.353*	-0.353*	-0.353*	-0.353*	0.045	0.057	-0.196	0.269	0.042	0.267	0.340**	0.277	0.262
	Pollen sterility (%)	14	0.269	0.205	0.226	0.226	0.130	0.170	-0.216	-0.353*	0.045	0.057	-0.196	0.269	0.042	0.267	0.340**	0.277	0.262
	Trichome-A	15	0.042	-0.051	-0.005	-0.005	0.130	0.170	-0.216	-0.353*	0.045	0.057	-0.196	0.269	0.042	0.267	0.340**	0.277	0.262
	Trichome-B	16	0.267	0.241	0.190	0.190	0.130	0.170	-0.216	-0.353*	0.045	0.057	-0.196	0.269	0.042	0.267	0.340**	0.277	0.262
	Trichome-C	17	0.340**	0.194	0.293*	0.293*	0.130	0.170	-0.216	-0.353*	0.045	0.057	-0.196	0.269	0.042	0.267	0.340**	0.277	0.262
	Trichome-D	18	0.277	0.262	0.292*	0.292*	0.130	0.170	-0.216	-0.353*	0.045	0.057	-0.196	0.269	0.042	0.267	0.340**	0.277	0.262
	Grain yield (g)	19	0.037	-0.088	-0.106	-0.106	0.130	0.170	-0.216	-0.353*	0.045	0.057	-0.196	0.269	0.042	0.267	0.340**	0.277	0.262

Height of primary branche from G.L.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Pod setting (%)														-0.392**	0.176	-0.298*	-0.114	-0.359*	-0.055
Pod length (cm)												0.734**	0.064	-0.088	0.174	-0.415**	-0.536**	-0.330*	-0.059
100 seed wt. (g)											0.610**	0.491**	-0.008	-0.146	-0.041	-0.468**	-1.078**	-0.201	-0.392**
Per cent pod damage										0.020	-0.027	0.220	0.213	-0.015	-0.021	0.045	-0.082	-0.112	-0.011
No. of seeds/pod																			
No. of pods/plant									0.013	-0.604**	-0.288*	-0.075	-0.066	0.237	-0.064	0.319*	0.537**	0.104	0.953**
Height of primary branche from G.L.								0.018	0.012	-0.079	0.104	0.278	-0.130	0.167	0.075	0.164	0.180	0.092	0.074

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Trichome-D																			0.031
Trichome-C																		0.207	0.364*
Trichome-B																	0.456**	0.377**	0.165
Trichome-A																-0.201	-0.095	-0.109	-0.010
Pollen sterility (%)															-0.003	0.428**	0.182	0.330*	0.208

* and ** significant at 5 and 1 per cent level, respectively.

Table 4.5. Phenotypic correlation of yield with other yield components in pigeonpea

[illegible]

[illegible]

				0.020	0.316*	0.198	-0.020	19
					0.196	0.344*	-0.067	18
						0.433**	-0.078	17
							-0.179	16
								15
								14
								13
								12
								11
								10
								9
								8
								7
								6
								5
								4
								3
								2
								1
Trichome-A								
Trichome-B								
Trichome-C								
Trichome-D								

* and ** significant at 5 and 1 per cent level, respectively.

damage was negative and significant correlation at both genotypic and phenotypic levels with grain yield.

4.4.2 Interrelationship of yield components

4.4.2.1 Days to flower initiation

It is evident that high positive correlation at genotypic and phenotypic correlation were noted for days to 50 per cent flowering, days to maturity and trichome type C with days to flower initiation, trichome type C. However negative and significant genotypic association was observed with per cent pod damage.

4.4.2.2 Days to 50 per cent flowering

This trait exhibited positive and highly significant phenotypic and genotypic correlation with days to maturity. While it showed positive significant genotypic correlation with trichome type C and D.

4.4.2.3 Plant height

Plant height exhibited positive and highly significant correlation at both genotypic and phenotypic levels for number of pods per plant, number of primary branches, number of secondary branches, trichome type C, and trichome type B. Further it shown highly significant and negative association with per cent pod damage.

4.4.2.4 Number of primary branches

The correlation of number of primary branches with number of pods per plant, number of secondary branches, trichome type C, B and per cent pollen sterility were positive and highly significant correlation both at the genotypic and phenotypic levels. It also showed strong negative correlation with pod length. 100 seed weight and per cent pod damage.

4.4.2.5 Number of secondary branches

The strong positive and significant correlation was observed between number of secondary branches with number of pods per plant at both the genotypic and phenotypic levels. While it was negative and significantly correlated with per cent pod damage at genotypic level only.

4.4.2.6 Number of pods per plant

It is revealed that from Table 4.4 and 4.5 that the correlation between number of pods per plant and trichome type C and B were strong and positive at both genotypic and phenotypic levels. Number of pod per plant was shown negative and significant correlation with per cent pod damage at both levels, where as it exhibited negative significant correlation with 100 seed weight at genotypic level only.

4.4.2.7 Per cent pod damage

The correlation of per cent pod damage with 100 seed weight was positive and highly significant both at genotypic and phenotypic levels. It also showed high positive significant association with pod length at genotypic level only. This trait showed negative correlation with trichome type B and C at both the genotypic and phenotypic levels.

4.4.2.8 100 seed weight

100 seed weight exhibited high positive and significant association at both genotypic and phenotypic with pod length. Whereas it exhibited strong negative and significant genotypic and phenotypic correlation between trichome type D, B and C

4.4.2.9 Pod length

Pod length showed strong negative and significant correlation with trichome type C at genotypic level only.

4.4.2.10 Percent pod setting

The correlation of per cent pod setting with per cent pollen sterility and trichome type D were negative and highly significant at genotypic and phenotypic levels. It also had negative significant association with trichome type B at genotypic level only.

4.4.2.11 Percent pollen sterility

Per cent pollen sterility showed positive and highly significant correlation with trichome type B and D at both genotypic and phenotypic levels.

4.4.2.12 Trichome type B

Trichome type B exhibited strong positive correlation with trichome type C and D at both genotypic and phenotypic levels.

4. 5 Genotypic path coefficient analysis.

4.5.1 Grain yield Vs days to flower initiation.

Days to flower initiation exhibited positive direct effect (0.168) on grain yield per plant. The indirect effects of this trait *via.*, days to 50 per cent flowering (0.481), number of pods per plant (0.112), number of secondary branches (0.055), Trichome type C (0.035), plant height (0.016), pod length (0.013), per cent pollen sterility (0.011), height of first primary branch from ground level (0.005) and trichome type D (0.005) were positive. However indirect effect mainly via days to maturity (-0.344) was negative and indirect effect, while indirect effects *via.*, all other remaining characters were negative. The total correlation of days to flower initiation with grain yield was positive and non significant (0.037).

Table 4.6. Direct and indirect effects (genotypic) of yield and yield components in ISD of pigeonpea

Characters	Days to flower initiation	Days to 50% flowering	Days to maturity	Plant height	No. of primary branches	0.010	0.022	- 0.140	0.143	0.168	1	Days to flower initiation	0.002	0.008	0.051	0.057	-0.369	0.017	0.000	0.011	0.005	0.055	No. of secondary branches	0.000	0.008	0.005	0.112	8	No. of pods/plant	-0.001	0.000	-0.017	-0.022	-0.001	0.016	-0.007	0.009	0.000	-0.028	-0.040	0.030	0.006	-0.106	0.037	19	Grain yield (g)
						0.002	0.008	0.051	0.057	-0.369	0.017	0.000	0.011	0.005	0.055	No. of secondary branches	0.000	0.008	0.005	0.112	8	No. of pods/plant	-0.001	0.000	-0.017	-0.022	-0.001	0.016	-0.007	0.009	0.000	-0.028	-0.040	0.030	0.006	-0.106	0.037	19	Grain yield (g)							
						0.004	-0.075	-0.412	0.023	0.005	0.023	0.011	0.005	0.028	-0.001	-0.022	-0.001	0.059	-0.004	0.008	0.003	-0.036	0.020	0.005	-0.088	-0.106	0.037	19	Grain yield (g)																	
						0.085	0.126	0.023	0.017	0.000	0.011	0.005	0.028	-0.001	-0.022	-0.001	0.059	-0.004	0.008	0.003	-0.036	0.020	0.005	-0.088	-0.106	0.037	19	Grain yield (g)																		
						-0.004	-0.003	0.000	0.000	0.011	0.005	0.028	-0.001	-0.022	-0.001	0.059	-0.004	0.008	0.003	-0.036	0.020	0.005	-0.088	-0.106	0.037	19	Grain yield (g)																			
						0.185	0.172	0.023	0.011	0.005	0.028	-0.001	-0.022	-0.001	0.059	-0.004	0.008	0.003	-0.036	0.020	0.005	-0.088	-0.106	0.037	19	Grain yield (g)																				
						0.000	0.008	0.005	0.028	-0.001	-0.022	-0.001	0.059	-0.004	0.008	0.003	-0.036	0.020	0.005	-0.088	-0.106	0.037	19	Grain yield (g)																						
						0.439	0.447	0.046	0.028	-0.001	-0.022	-0.001	0.059	-0.004	0.008	0.003	-0.036	0.020	0.005	-0.088	-0.106	0.037	19	Grain yield (g)																						
						-0.001	0.000	0.000	-0.001	-0.022	-0.001	0.059	-0.004	0.008	0.003	-0.036	0.020	0.005	-0.088	-0.106	0.037	19	Grain yield (g)																							
						-0.061	-0.046	-0.017	-0.022	-0.001	0.059	-0.004	0.008	0.003	-0.036	0.020	0.005	-0.088	-0.106	0.037	19	Grain yield (g)																								
						0.006	0.003	-0.001	0.059	-0.004	0.008	0.003	-0.036	0.020	0.005	-0.088	-0.106	0.037	19	Grain yield (g)																										
						-0.109	-0.013	0.059	0.016	-0.007	0.009	0.000	-0.028	-0.040	0.030	0.006	-0.106	0.037	19	Grain yield (g)																										
						-0.005	-0.001	-0.004	-0.007	-0.005	0.011	-0.002	-0.040	0.030	0.006	-0.106	0.037	19	Grain yield (g)																											
						0.014	0.009	0.008	0.009	0.000	-0.028	-0.040	0.030	0.006	-0.106	0.037	19	Grain yield (g)																												
						0.001	0.005	0.003	0.000	-0.028	-0.040	0.030	0.006	-0.106	0.037	19	Grain yield (g)																													
						-0.054	-0.058	-0.036	-0.028	-0.040	0.030	0.006	-0.106	0.037	19	Grain yield (g)																														
						0.052	0.043	0.020	0.030	0.006	-0.106	0.037	19	Grain yield (g)																																
						0.003	0.003	0.005	0.006	-0.106	0.037	19	Grain yield (g)																																	
						0.567	0.649	-0.088	-0.106	0.037	19	Grain yield (g)																																		

Pod length (cm)	0.010	0.008	-0.059	-0.036	0.029	0.022	0.027	1
100 seed wt. (g)	0.004	0.003	-0.011	-0.007	0.002	0.007	0.002	2
Per cent pod damage	0.066	0.026	0.066	0.000	-0.029	-0.047	-0.028	3
No. of seeds/pod	-0.003	-0.053	-0.003	0.000	0.086	0.026	0.064	4
No. of pods/plant	-0.003	-0.003	-0.003	0.000	0.000	0.000	-0.002	5
Height of first primary branch from ground level	-0.042	-0.106	-0.027	0.272	-0.038	0.339	0.005	6
No. of secondary branches	0.011	0.004	-0.003	0.000	0.008	0.010	0.001	7
	-0.049	-0.189	-0.396	0.008	0.655	0.012	0.525	8
	0.002	0.000	0.000	0.010	0.000	0.000	-0.001	9
	0.053	0.066	0.109	0.002	-0.066	-0.009	-0.034	10
	-0.009	-0.012	-0.007	0.000	0.003	-0.001	0.001	11
	0.236	0.173	0.116	0.052	-0.018	0.065	-0.071	12
	-0.003	0.002	0.000	0.005	-0.002	-0.003	-0.002	13
	0.000	-0.004	-0.006	0.001	0.010	0.007	0.008	14
	-0.009	-0.009	0.002	0.001	0.003	-0.004	-0.001	15
	0.000	0.062	0.070	-0.007	-0.048	-0.024	-0.029	16
	-0.031	-0.055	-0.110	-0.008	0.055	0.018	0.029	17
	-0.005	-0.006	-0.004	-0.002	0.002	0.002	0.004	18
	0.001	-0.059	-0.392	-0.011	0.953	0.074	0.827	19

Trichome-D	0.047	0.057	0.045	0.007	0.045	-0.033	1
Trichome-C	0.017	0.017	0.011	0.000	0.013	-0.016	2
Trichome-B	-0.108	-0.080	-0.099	0.021	-0.085	0.065	3
Trichome-A	0.022	0.053	0.049	-0.011	0.027	-0.004	4
Pollen sterility (%)	-0.001	-0.002	-0.002	0.000	-0.001	0.001	5
Pod setting (%)	0.065	0.097	0.066	0.007	0.069	-0.020	6
	0.004	0.007	0.007	0.003	0.007	-0.005	7
	0.068	0.352	0.209	-0.042	0.156	-0.043	8
	-0.001	-0.001	0.000	0.000	0.000	0.002	9
	-0.022	-0.117	-0.051	-0.004	-0.016	-0.001	10
	0.004	0.006	0.005	-0.002	0.001	-0.001	11
	-0.058	-0.072	0.000	0.041	0.000	-0.026	12
	-0.009	-0.003	-0.008	0.005	-0.010	0.026	13
	0.014	0.007	0.018	0.000	0.041	-0.016	14
	0.006	0.005	0.010	-0.050	0.000	-0.009	15
	-0.056	-0.068	-0.150	0.030	-0.064	0.045	16
	0.021	0.102	0.047	-0.010	0.019	-0.012	17
	0.020	0.004	0.007	-0.002	0.006	-0.007	18
	0.031	0.364	0.165	-0.010	0.208	-0.055	19

Residual effect = 0.0506.

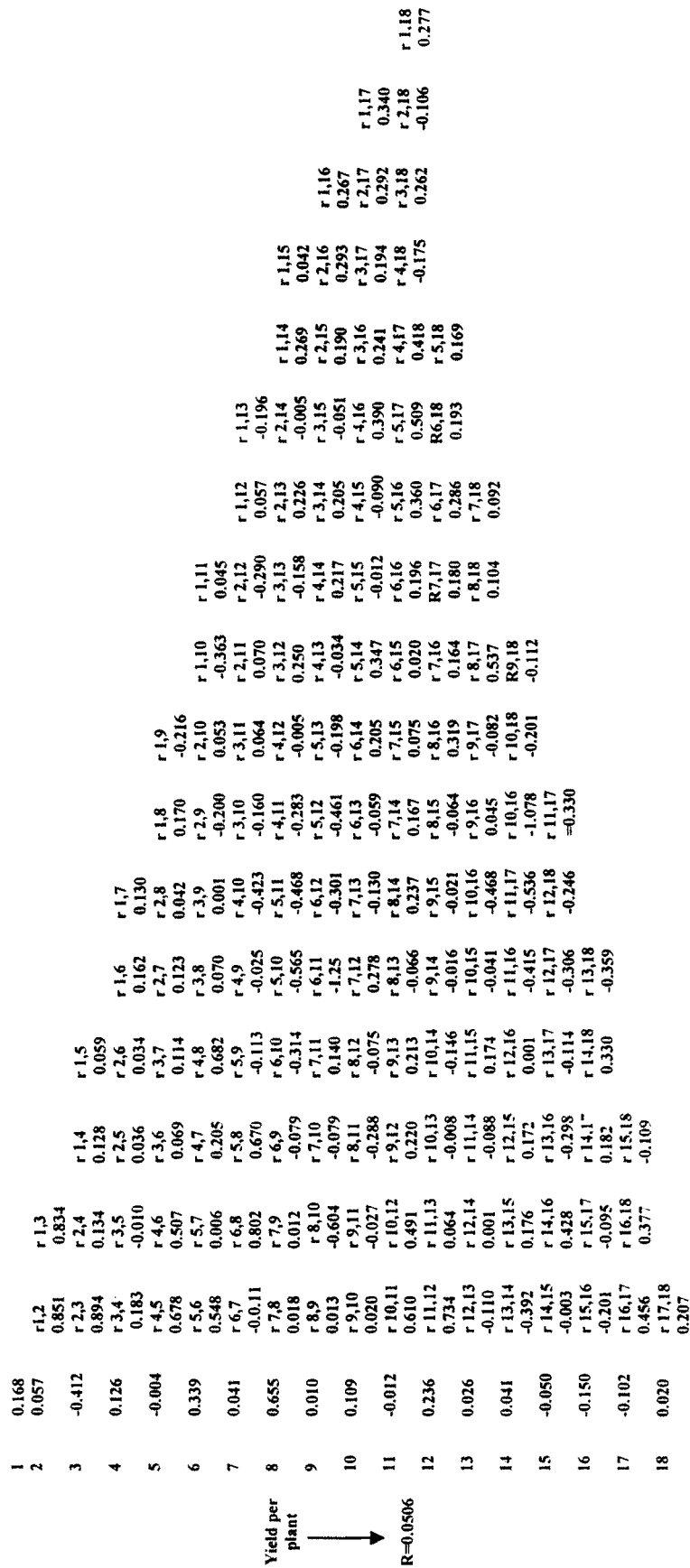


Fig.5.1. Path diagram showing the factors influencing grain yield per plant.

4.5.2 Grain yield Vs days to 50 per cent flowering

Days to 50 per cent flowering had medium positive direct effect (0.057) on grain yield. Its indirect effects *via* days to flower initiation (0.143), trichome-C (0.030), number of pods per plant (0.028), plant height (0.017), pod length (0.016) and number of secondary branches (0.011) were positive. The negative indirect effect mainly *via* days to maturity (-0.369) followed by trichome type B (-0.028) and per cent pod damage (-0.022), while rest of characters were negative leading to negatively non-significant correlation (-0.106).

4.5.3 Grain yield Vs days to maturity

Days to maturity had negative direct effect (-0.412) on grain yield. It had negative indirect effects *via* trichome type B (-0.036) per cent pod damage (-0.017), per cent pod setting (-0.004) and 100 seed weight (0.001). The ~~negative~~^{positive} direct effect *via* days to flower initiation (0.140), pod length (0.059), days to 50 per cent flowering (0.051) and number of pods per plant (0.046), indirect effects. The correlation of days to maturity with grain yield was non-significant negative (-0.088).

4.5.4 Grain yield Vs plant height

The direct effect of plant height on grain yield was positive (0.126). Its indirect effects *via* number of pods per plant (0.447), number of secondary branches (0.172), trichome type C (0.043), days to flower initiation (0.022), per cent pollen sterility (0.009), height of first primary branch from ground level (0.008), trichome type-A (0.005), 100 seed weight (0.003) and trichome type-D (0.003) were positive. Indirect effects

via rest of the characters were negative. The total correlation of plant height with grain yield was significantly positive (0.649).

4.5.5 Grain yield Vs number of primary branches

Number of primary branches had negative direct effect (0.004) on grain yield. It had negative indirect effects *via* pod length (-0.109), per cent pod damage (-0.061), trichome-B (-0.054) and number of seeds/pod (-0.001). the character number of primary branches had positive indirect effect *via* number of pods per plant (0.439), number of secondary branches (0.185), plant height (0.085) and trichome type C (0.052). While with rest of the characters they were positive indirect effects leading to positive significant correlation (0.567).

4.5.6 Grain yield Vs number of secondary branches

Number of secondary branches exhibited high positive direct effect (0.339) on grain yield. Whereas indirect effects *via* number of pods per plant (0.525), plant height (0.064), trichome type-C (0.029), days to flower initiation (0.027), trichome type-D (0.004), days to 50per cent flowering (0.002) and 100 seed weight (0.001) were positive. Its indirect effects on grain yield *via* rest of characters were negative. The total correlation of grain yield with this character was positive and highly significant (0.827).

4.5.7 Grain yield Vs height of first primary branch from ground level

The direct effect of height of first primary branch from ground level on grain yield was positive and negligible (0.041) and indirect effects *via* pod length (0.065), plant height (0.026), days to flower

initiation (0.027), per pollen sterility (0.008), trichome type-D (0.004) and days to 50 per cent flowering (0.002) were positive, while with rest of the characters they were negative and mostly negligible. The total correlation of grain yield with this character was positive and non significant (0.074) .

4.5.8 Grain yield Vs number of pods per plant

The number of pods per plant had highly positive direct effect (0.655) on grain yield and indirect effects *via* number of secondary branches (0.272), plant height (0.086), trichome type-C (0.055), days to flower initiation (0.029), per cent pollen sterility (0.010), 100 seed weight (0.003), trichome type-A (0.003), days to 50 per cent flowering (0.002), trichome type-D (0.002) and height of first primary branch from ground level (0.001) were positive. Its indirect effects on grain yield *via* rest of characters were negative. The total correlation with grain yield was significantly positive (0.953).

4.5.9 Grain yield Vs number of seeds per pod

The direct effect of seeds per pod was positive (0.010) with grain yield. Its indirect effects *via* pod length (0.052), pods per plant (0.008), per cent pod setting (0.005), per cent pod damage (0.002) and trichome type-A (0.001) were positive. The negative indirect effect *via* days to flower initiation (-0.036), number of secondary branches (-0.027), trichome type C (-0.008) and days to 50 per cent flowering (-0.007). All remaining characters expressed negative indirect effects. The total correlation with grain yield was negative (-0.011).

4.5.10 Grain yield Vs per cent pod damage

Per cent pod damage exhibited positive direct effect (0.109) on grain yield. The indirect effects of this character *via* pod length (0.116), trichome type-B (0.070), days to maturity (0.066), number of primary branches (0.002) and trichome type-A (0.002) were positive. While, rest of characters had negative indirect effects. The correlation per pod damage with grain yield was significantly negative (-0.392).

4.5.11 Grain yield Vs 100 seed weight

The direct effect of this trait on grain yield was negative (-0.012). It had positive indirect effects *via* pod length (0.173), per cent pod damage (0.066), trichome type-B (0.062), days to flower initiation (0.008), days to 50 per cent flowering (0.003), number of primary branches (0.002), per cent pod setting (0.002), negative indirect effect via pods per plant (-0.189), trichome type C (-0.055), number of secondary branches (-0.042), plant height (-0.036), days to maturity (-0.026) whereas it had negative indirect effects *via* all the remaining characters. The total correlation of 100 seed weight with grain yield was negatively non significant (-0.059).

4.5.12 Grain yield Vs pod length

Pod length had positive direct effect (0.236) on grain yield. Its indirect effects on grain yield *via* per cent pod damage (0.053), height of first primary branch from ground level (0.011), days to flower initiation (0.010), days to 50 per cent flowering (0.004), number of primary branches (0.002) and number of seeds per pod (0.002) were positive. Pod length had negative indirect effect *via* days to maturity (-0.103), number of secondary branches (0.011), pods per plant (-0.049) and trichome type C (-

0.031). Its indirect effects on grain yield *via* rest of character were negative resulted in positive non-significant correlation with grain yield (0.001).

4.5.13 Grain yield Vs per cent pod setting

Per cent pod setting exhibited positive negligible direct effect (0.026) on grain yield. Positive indirect effects was recorded *via* days to maturity (0.065), trichome type-B (0.045), number of seeds per pod (0.002) and number of primary branches (0.001). It had negative indirect effect *via* pod per plant (-0.043), days to flower initiation (-0.033), pod length (-0.026) and number of secondary branches (-0.020), while remaining characters had negative indirect effects resulting into negatively non-significant correlation with grain yield (-0.055).

4.5.14 Grain yield Vs per cent pollen sterility

Per cent pollen sterility exhibited positive negligible direct effect (0.041) on grain yield. Its indirect effects on grain yield *via* days to maturity (-0.085), trichome type-B (-0.064), per cent pod damage (-0.016), per cent pod setting (-0.010), number of primary branches (-0.0010) were negative. While its indirect effects to rest of characters were positive resulting into significant positive correlation with grain yield (0.208).

4.5.15 Grain yield Vs trichome-A

The direct effect of trichome-A on grain yield was negative (-0.050). Its indirect effects on grain yield *via* number of pods per plant (-0.042), plant height (-0.011), trichome type-C (-0.010), per cent pod damage (-0.004), 100 seed weight (-0.002) were low and negative. Positive indirect effect *via* pod length (0.041), trichome type B (0.030) and days to maturity (0.021) and the remaining characters expressed positive indirect

effects leading to negative non-significant correlation with grain yield (-0.010).

4.5.16 Grain yield Vs trichome type-B

Trichome type-B had negative direct effect (-0.150) on grain yield and indirect effects *via* days to maturity (-0.099), per cent pod damage (-0.051), per cent pod setting (-0.008), number of primary branches (-0.002) were negative. Positive indirect effect *via* pods per plant (0.209), number of secondary branches (0.066), plant height (0.049) and trichome type C (0.047). Its indirect effects on grain yield *via* rest of characters were however, positive. The correlation with grain yield was positive and non-significant (0.165).

4.5.17 Grain yield Vs trichome type-C

Trichome type-C exhibited medium positive direct effect (0.102). Among all the indirect effects, maximum influence was due to number of pods per plant (0.352) followed by number of secondary branches (0.097), days to flower initiation (0.057), plant height (0.053), days to 50 per cent flowering (0.017), height of first primary branch from ground level (0.007), per cent pollen sterility (0.007), trichome type-A (0.005) and trichome type-D(0.004) were positive. Whereas negative indirect effects *via* all the remaining characters were noted. The total correlation with grain yield was positive and highly significant (0.364).

4.5.18 Grain yield Vs trichome type-D

The direct effect of trichome type-D on grain yield was negligibly positive (0.020). The indirect effects *via* days to maturity (-0.108), pod length (-0.058), trichome type-B (-0.056), per cent pod damage

(-0.022), per cent pod setting (-0.009), number of seed per pod (-0.001) were negative. Its indirect effects on grain yield *via* rest of characters were however, positive leading to positive non-significant correlation (0.031) with grain yield.

4.6 Qualitative characters

Observations were recorded on various qualitative characters *viz.*, stem colour, standard petal colour, pattern of streaks on standard petal pod colour, growth habit, flowering pattern and seed coat colour (Table 4.7). Variation in these characters is shown in plates 1 to 6B.

Table 4.7. Qualitative characters in ISD of pigeonpea.

Sr. No	Genotypes	Stem colour	Standard petal colour	Pattern of streak on std. petal	Pod colour	Growth habit	Flowering pattern	Seed coat colour
		1	2	3	4	5	6	7
1	(UPAS 120 x <i>C. trinervius</i>)-3-1	Sunred	Light yellow	No streak	Mixed	Semi spreading	Indeterminate	Creamy white
2	(Pant A-2 x <i>C. albicans</i>)-14-1	Green	Light yellow	Medium streak	Mixed	Erect	Determinate	Grey
3	(Prabhat x <i>C. scarabaeoides</i>)-3-1	Sunred	Light yellow	Sparse streak	Purple	Semi spreading	Indeterminate	Cream white
4	(Prabhat x <i>C. scarabaeoides</i>)-3-2	Sunred	Yellow	No streak	Dark purple	Spreading	Determinate	Light brown
5	(Prabhat x <i>C. scarabaeoides</i>)-3-3	Sunred	Yellow	Dark streak	Purple	Spreading	Determinate	Light brown
6	(Pant A-2 x <i>C. albicans</i>)-9-1	Sunred	Orange yellow	No streak	Mixed	Spreading	Indeterminate	Light grey
7	(Pant A-2 x <i>C. albicans</i>)-9-2	Sunred	Orange yellow	No streak	Mixed	Spreading	Indeterminate	Light grey
8	(Pant A-2 x <i>C. albicans</i>)-11-1	Green	Orange yellow	No streak	Mixed	Erect	Indeterminate	Orange
9	(Pant A-2 x <i>C. lanceolatus</i>)-1	Green	Light yellow	No streak	Mixed	Spreading	Determinate	Creamy white
10	(Prabhat x <i>C. scarabaeoides</i>)-3-2-1	Green	Light yellow	No streak	Mixed	Erect	Indeterminate	Light brown
11	(Prabhat x <i>C. scarabaeoides</i>)-3-2-2	Sunred	Light yellow	No streak	Mixed	Spreading	Determinate	Light brown
12	(Pant A-2 x <i>C. scarabaeoides</i>)-14-1	Green	Light yellow	No streak	Mixed	Spreading	Determinate	Light brown
13	(Pant A-2 x <i>C. scarabaeoides</i>)-14-2	Green	Orange yellow	No streak	Mixed	Spreading	Indeterminate	Orange
14	(UPAS 120 x <i>C. trinervius</i>)-5-1	Sunred	Light yellow	No streak	Purple	Spreading	Determinate	Creamy white
15	(Pant A-2 x <i>C. scarabaeoides</i>)-16-1	Sunred	Yellow	No streak	Purple	Erect	Indeterminate	Creamy white

Contd...

	1	2	3	4	5	6	7
16	(Pant A-2 x <i>C. scarabaeoides</i>)-16-2	Yellow	Sparse streak	Dark purple	Semi spreading	Indeterminate	Light brown
17	(Pant A-2 x <i>C. albicans</i>)-29-1	Yellow	No streaks	Mixed	Spreading	Indeterminate	Reddish brown
18	(Pant A-2 x <i>C. albicans</i>)-29-2	Light yellow	No streak	Mixed	Spreading	Indeterminate	Light brown
19	(Prabhat x <i>C. scarabaeoides</i>)-3-3-1	Yellow	Complete cover	Green	Semi spreading	Indeterminate	Brown
20	(Prabhat x <i>C. scarabaeoides</i>)-3-3-2	Yellow	No streak	Green	Semi spreading	Indeterminate	Grey
21	(Prabhat x <i>C. scarabaeoides</i>)-3-1-1	Dark purple	No streak	Mixed	Semi spreading	Determinate	Creamy white
22	(Pant A-2 x <i>C. albicans</i>)-23-1	Green	No streak	Mixed	Spreading	Determinate	Creamy white
23	(Pant A-2 x <i>C. albicans</i>)-23-2	Green	Sparse streak	Mixed	Spreading	Indeterminate	Creamy white
24	(Pant A-2 x <i>C. scarabaeoides</i>)-20-1	Orange yellow	Sparse streak	Mixed	Spreading	Indeterminate	Brown
25	(Pant A-2 x <i>C. albicans</i>)-24-1	Light yellow	Medium streak	Mixed	Semi spreading	Indeterminate	Light brown
26	(Pant A-2 x <i>C. albicans</i>)-24-2	Orange yellow	Dark streak	Purple	Erect	Determinate	Reddish brown
27	(UPAS 120 x <i>C. trinervius</i>)-4-1	Light yellow	Medium streak	Purple	Spreading	Indeterminate	Grey
28	(Pant A-2 x <i>C. scarabaeoides</i>)-12-1	Green	No streaks	Purple	Spreading	Indeterminate	Reddish brown
29	(Pant A-2 x <i>C. scarabaeoides</i>)-12-2	Green	Dark red streak	Dark purple	Semi spreading	Determinate	Orange
30	(Pant A-2 x <i>C. albicans</i>)-6-2-1	Green	Medium streak	Purple	Semi spreading	Indeterminate	Grey
31	(Pant A-2 x <i>C. albicans</i>)-6-2-2	Green	Medium streak	Mixed	Erect	Determinate	Grey
32	(<i>C. sericeus</i> x <i>C. scarabaeoides</i>)-2-1	Green	Medium streak	Mixed	Erect	Indeterminate	Creamy white

Contd...

		1	2	3	4	5	6	7
33	(Pant A-2 x <i>C. albicans</i>)-28-1	Green	Light yellow	Sparse streak	Mixed	Spreading	Determinate	Reddish brown
34	(Pant A-2 x <i>C. albicans</i>)-10-1	Dark purple	Light yellow	Medium streak	Purple	Semi spreading	Determinate	Dark purple
35	(Pant A-2 x <i>C. albicans</i>)-6-3-1	Sunred	Light yellow	No streak	Purple	Spreading	Indeterminate	Grey
36	(pant A-2 x <i>C. scarabaeoides</i>)-5-1	Green	Light yellow	Medium streak	Mixed	Spreading	Indeterminate	Light brown
37	(UPAS 120 x <i>C. trinervius</i>)-1-1	Sunred	Orange yellow	Dark streak	Purple	Semi spreading	Indeterminate	Brown
38	(Pant A-2 x <i>C. scarabaeoides</i>)-3-1	Green	Yellow	Sparse streak	Mixed	Erect	Determinate	Grey
39	(Pant A-2 x <i>C. scarabaeoides</i>)-27-2-1	Green	Light yellow	No streak	Green	Semi spreading	Determinate	Grey
40	(Pant A-2 x <i>C. scarabaeoides</i>)-27-2-2	Green	Light yellow	No streak	Mixed	Spreading	Indeterminate	Light grey
41	ICPL 87119	Green	Light yellow	No streak	Mixed	Spreading	Determinate	Reddish brown
42	ICPL 332	Green	Light yellow	Sparse streak	Mixed	Spreading	Determinate	Light brown
43	ICPL 87	Green	Light yellow	No streak	Mixed	Erect	Determinate	Grey brown
44	ICP 7035	Green	Red	Uniform cover	Purple	Erect	Indeterminate	Dark purple
45	ICPL 88039	Green	Light yellow	Uniform	Mixed	Semispreading	Determinite	Light brown
46	BSMR 736	Green	Light yellow	No streak	Green	Spreading	Determinate	Reddish brown

Note : The variation in some of qualitative characters are shown in plates No. 1 to 6B.

Table 4.8. Qualitative characters of low and high infestation of pod borer in ISD of pigeonpea.

Sr. No.	Genotypes	Stem colour	Standard petal colour	Pattern of streak on standard petal	Pod colour	Growth habit	Flowering pattern	Seed coat colour.	% pod borer damage	Grain yield (g)
		1	2	3	4	5	6	7	8	9
1	Pant A-2 x C. <i>albicans</i> 29-1	Green	Yellow	No streaks	Mixed	Spreading	Indeterminate	Reddish brown	2.41	26.92
2	Pant A-2 x C. <i>albicans</i> -29-2	Sunred	Light yellow	No streak	Mixed	Spreading	Indeterminate	Light brown	4.28	33.87
3	ICPL 332	Green	Light yellow	Sparse streak	Mixed	Spreading	Determinate	Light brown	4.42	68.47
4	(Prabhat x C. <i>scarabaeoides</i>) 3-3-1	Sunred	Yellow	Complete cover	Green	Semi spreading	Indeterminate	Brown	4.68	32.15
5	Pant A-2 x C. <i>scarabaeoides</i> -14-1	Green	Light yellow	No streak	Mixed	Spreading	Determinate	Light brown	4.88	33.05
6	Pant A-2 x C. <i>scarabaeoides</i> -27-2-1	Green	Light yellow	No streak	Green	Semisprea ding	Determinate	Grey	5.03	40.60
7	Pant A-2 x C. <i>albicans</i> -29-2	Green	Light yellow	No streak	Mixed	Spreading	Indeterminate	Light grey	5.14	55.38
8	Pant A-2 x C. <i>albicans</i> -24-2	Sunred	Orange yellow	Dark streak	Purple	Erect	Determinate	Reddish brown	5.71	29.6
9	Pant A-2 x C. <i>scarabaeoides</i> -3-1	Green	Yellow	Sparse streak	Mixed	Erect	Determinate	Grey	5.74	30.01
10	Pant A-2 x C. <i>scarabaeoides</i> -16-1	Sunred	Yellow	No streak	Purple	Erect	Indeterminate	Creamy white	5.86	25.5
11	Pant A-2 x C. <i>albicans</i> -23-1	Green	Orange yellow	No streak	Mixed	Spreading	Determinate	Creamy white	6.21	34.42

		1	2	3	4	5	6	7	8	9
12	Pant A-2 x C. <i>scarabaeoides</i> -12-1	Green	Light yellow	No streaks	Purple	Spreading	Indeterminate	Reddish brown	17.13	19.82
13	ICP 7035	Green	Red	Uniform cover	Purple	Erect	Indeterminate	Dark purple	16.76	17.55
14	ICPL 87	Green	Light yellow	No streak	Mixed	Erect	Determinate	Grey brown	14.13	14.75
15	ICPL 88039	Green	Light yellow	Uniform	Mixed	Semisprea ding	Determine	Light brown	13.70	14.80
16	Prabhat x C. <i>scarabaeoides</i> -3-2	Sunred	Light yellow	Sparse streak	Purple	Semisprea ding	Indeterminate	Cream white	12.39	13.79
17	Pant A-2 x C. <i>albicans</i> -11-1	Green	Orange yellow	No streak	Mixed	Erect	Indeterminate	Orange	12.31	17.01
18	Pant A-2 x C. <i>albicans</i> -28-1	Green	Light yellow	Sparse streak	Mixed	Spreading	Determinate	Reddish brown	12.25	18.90
19	BSMR 736	Green	Light yellow	No streak	Green	Spreading	Determinate	Reddish brown	10.64	37.49
20	Pant A-2 x C. <i>scarabaeoides</i> -12-1	Green	Orange yellow	Dark red streak	Dark purple	Semisprea ding	Determinate	Orange	11.03	17.15
21	Prabhat x C. <i>scarabaeoides</i> -3-3	Sunred	Yellow	Dark streak	Purple	Spreading	Determinate	Light brown	10.58	13.33
22	UPAS 120 x C. <i>trinervius</i> -3-1	Sunred	Light yellow	No streak	Mixed	Semisprea ding	Indeterminate	Creamy white	10.56	17.43



Plate 1. Flowering pattern

- a) Determinate (Prabhat x *C. scarabaeoides*)-3-2
- b) Indeterminate (Pant A-2 x *C. scarabaeoides*)-27-2-2

Plate 2. Growth habit

- a) Erect (pant A-2 x *C. albicans*)-11-1
- b) Semi-spreading (Pant A-2 x *C. scarabaeoides*)-3-3-1
- c) Spreading (BSMR 736)



Plate 3. ICPL 87 showing determinate growth



Plate 4. Pod colour

- a) Green (Prabhat x *C. scarabaeoides*)-27-2-1
- b) Dark purple (Pant A-2 x *C. scarabaeoides*)-12-2
- c) Mixed (Pant A-2 x *C. scarabaeoides*)-3-1
- d) Mixed (ICPL 87119)
- e) Purple (ICP 7035)

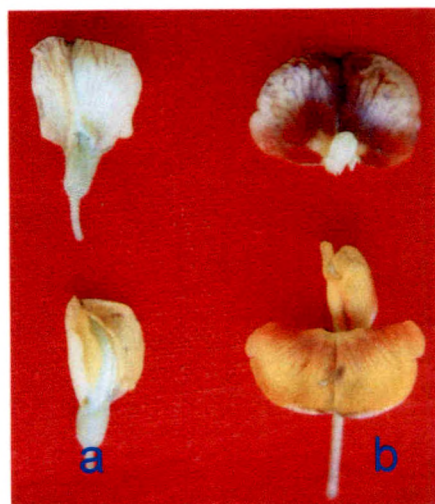


Plate 5A. Standard petal colour and pattern of streak

- a) Red and uniform cover (ICP 7035)
- b) Yellow and no streak (Pant A-2 x *C. albicans*)-29-1

Plate 5B. Standard petal colour and pattern of streak

- a) Yellow and sparse streak (Pant A-2 x *C. scarabaeoides*)-3-1
- b) Yellow and dark red streak (Pant A-2 x *C. albicans*)-24-2



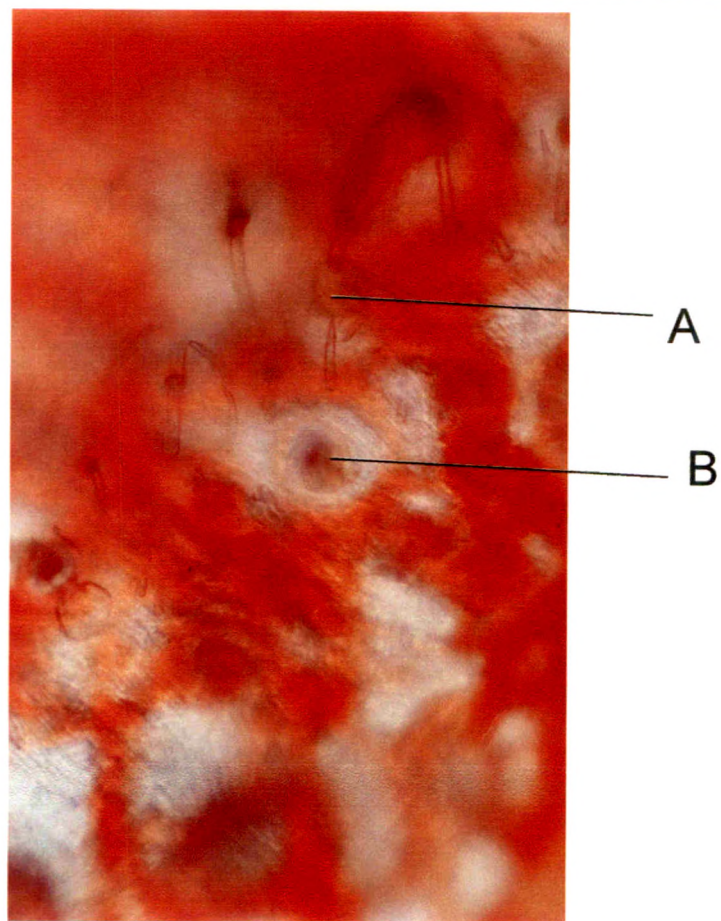


Plate 6A. Trichome type-A and B

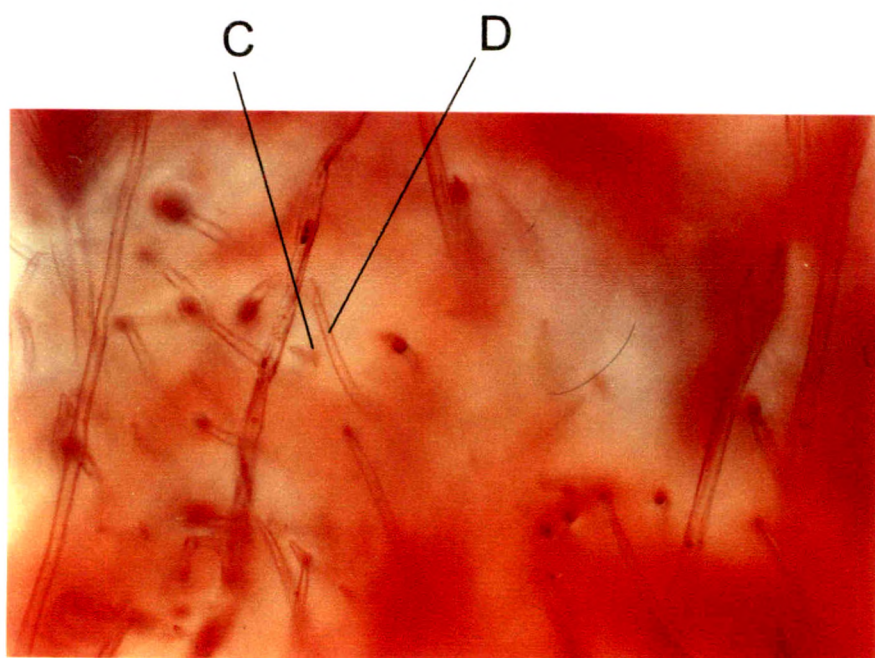


Plate 6B. Trichome type-C and D



Discussion



Chapter-V

DISCUSSION

Plant breeding deals with the management and utilization of genetic variability. Variability in the population especially in respect of the characters in which improvement is sought for, is indispensable prerequisite for successful plant selection. The genotypes under study were therefore, examined to assess the variability present among different accessions in respect of number of metrical traits. The correlation and path analysis provides information on genetic association of yield and yield contributing characters.

In addition to study of variability in pigeonpea, it is important to identify pod borer tolerant genotypes. Therefore, study between some flower characters or morphological characters with pod borer tolerance was made (Table 4.8). Along with identifying pod borer tolerant genotypes it is necessary to study pollen sterility and pod setting in ISD of pigeonpea.

In present investigation forty ISD, five national checks and one local check of pigeon were assessed to study correlation between nineteen metrical characters and direct and indirect effects of component characters on grain yield.

The results obtained on these aspects are presented in chapter four and discussed here under appropriate subheads.

5.1 Analysis of variance

Analysis of variance revealed significant differences among all the characters studied (Table 4.1). This indicates wide range of variability among the material, which is useful in crop improvement.

5.2 Mean performance

All the ISD were significantly different from each other in respect of characters studied. (Table 4.2). This indicates wide range of variability among the material, which is useful in crop improvement.

The check ICPL 88039 showed earliness in days to flower initiation (78days) as compare to all other checks.

On the basis of mean performance, earliness in 50 per cent flowering and maturity was observed in ICPL 87(99days) and (135days) respectively as compared to all other genotypes.

The ISD (Prabhat x *C. scarabaeoides*)-3-2 recorded maximum plant height (155.70cm) among all other genotypes followed by ICPL 332(153.80cm) and (Pant A-2 x *C. scarabaeoides*)-5-1 (152cm).

The genotypes (Prabhat x *C. scarabaeoides*)-3-3-2 (15.10) and (pant A-2 x *C. scarabaeoides*)-27-2-1(25.60) exhibited maximum number of primary branches and number of secondary branches respectively as compared all other ISD and checks under study.

The Lowest height of first primary branches from ground level were recorded by (UPAS 120 x *C. trinervius*)-3-1 (9.8 cm) as compare to all other ISD including checks.

Maximum numbers of pods per plant were observed in ISD (Prabhat x *C. scarabaeoides*)-3-2(285.00) as compared to all other ISD and checks.

The ISD (Prabhat x *C. scarabaeoides*)-3-2-2,(Pant A-2 x *C. scarabaeoides*)-12-1, (Pant A-2 x *C. albicans*)-6-3-1, (Pant A-2 x *C. scarabaeoides*)-27-2-2 and check ICPL 88039 had maximum number of seeds per pod as compared to all other ISD including checks.

The lowest per cent pod damage was observed in (Pant A-2 x *C. albicans*)-29-1(2.41). The Check ICP 7035 showed highest 100seed weight (12.60g) and pod length (6.35cm) as compared to all other ISD and checks.

High per cent pod setting and per cent pollen sterility were observed in (Prabhat x *C. scarabaeoides*)-3-3-1(39.41) and (Prabhat x *C. scarabaeoides*)-3-3(20.53) respectively as compared to all the genotypes.

The ISD (Pant A-2 x *C. scarabaeoides*)-20-1 (11.48) showed highest number of trichome type A as compared to all other genotypes including checks, while (Pant A-2 x *C. scarabaeoides*)-27-2-2 (14.33) recorded more number of trichome type-B.

Highest number of trichome-C per microscopic field was shown by (Pant A-2 x *C. albicans*)-29-1 (244.50) and trichome type D by (Pant A-2 x *C. scarabaeoides*)-3-1-1 (29.16) as compared to all other ISD and checks.

The Check ICP 332 (68.47) recorded more grain yield per plant followed by (Prabhat x *C. scarabaeoides*)-3-2 (57.21g) and Pant A-2 x *C. scarabaeoides*)-27-2-2 (55.85 g) as compare to all ISD and checks.

5.3 Genetic variability

Knowledge of genetic variability, heritability and genetic advance is prerequisite for initiating appropriate breeding procedure in crop improvement programme. The heritable variation is masked by non heritable variation which creates difficulty in exercising selection. Hence, it becomes necessary to split overall variability into heritable and non heritable components with the help of certain genetic parameters which may enable the breeder to plan out proper breeding programme. Since many characters of economic importance are highly influenced by environmental conditions, progress of a population mainly depends upon the magnitude of genetic variability present in the population. In the present study, efforts have been made to analyse the components of variability in the ISD with reference to future breeding programme.

5.3.1 Range of variability

Wide range of variability was observed for majority of yield contributing characters. The range of variation on the basis of mean was more for the characters number of pods per plant, trichome type C, days to maturity, grain yield, days to 50 per cent flowering, plant height, days to flowering initiation, trichome type D, per cent pod setting and number of secondary branches. Similar results were reported by several workers *Viz.*, Aher *et al.* (1996) revealed that plant height, pods per plant, days to 50 per cent flowering, days to maturity, primary branches and secondary branches per plant were showed maximum variability.

Venkateswarlu (2001) observed maximum variability for pods per plant, straw yield and plant height.

Radhakrishna *et.al.* (2003) observed high genetic variability for plant height and pods per plant.

Bhaskarnanda and Muthiah (2006) reported highest genetic variability for number of clusters per plant and pods per plant.

The values of phenotypic variance were more than genotypic variance for all the characters. High genotypic and phenotypic variances were observed for the characters pods per plant followed by trichome type C, days to maturity, plant height, days to 50 per cent flowering, grain yield, days to flower initiation, number of secondary branches, trichome type D and per cent pod setting. The lowest genotypic and phenotypic variances were observed for the characters pod length, number of seeds per pod, 100 seed weight and number of primary branches. Radhakrishana *et al* (2003) reported low genetic variability for shelling percentage.

Gupta (2005) recorded lowest genotypic and phenotypic variance for seeds per pod and length of pod.

5.3.2 Genotypic and phenotypic coefficient of variance

The selection under field condition may be strongly influenced by environmental factors affecting the progressive improvement programme. In present study the phenotypic coefficient of variance were greater than genotypic coefficient of variance. The difference between them had lower magnitude indicating small effect of environment on characters and selection may be effective. The maximum genotypic and phenotypic coefficient of variance were observed for the characters *viz.*, trichome type A, B, number of secondary branches, trichome D, number of pods per plant, grain yield, days to flower initiation and trichome type C.

Aher *et al.* (1996) reported appreciable amount of GCV for secondary branches per plant, pods per plant and grain yield per plant. Patel and Patel (1998) observed high PCV and GCV for number of pods per plant and seed yield per plant. Basvarajaiah *et al.* (2000) observed high GCV and PCV for days to 50 per cent flowering, pods per plant, yield per plant and length of pod bearing branches. Chandirakala and Reveendrum (1998) reported high PCV and GCV for number of branches per plant, number of pods per plant and 100 seed weight. Pansuriya *et al.* (1998) reported high GCV and PCV for pods per plant grain yield per plant.

Lowest genotypic and phenotypic coefficient of variance was observed for pod length and days to maturity.

5.3.3 Heritability and genetic advance

Heritability is the measure of transmission of an attribute from one generation to next generation while genetic advance is a measure of genetic gain under selection of a particular character. The high heritability coupled with high genetic advance for any particular character indicates its suitability of being selected for further improvement. However, the characters with moderate heritability coupled with high genetic advance are of paramount importance in breeding programme. While low heritability with low genetic advance are not necessary to be included in further studies as they are much influenced by non-genetic factors.

Heritability is known to be consists of two important components are resulting from purely additive action of genes and other from the presence of dominance and non-additive interactions existed in them.

Among the nineteen characters studied (Table 4.3) viz., trichome type C, days to 50 per cent flowering, trichome type D, number of secondary branches, trichome type B, days to flower initiation, days to maturity, plant height, per cent pod setting, seeds per pod, 100 seed weight, per cent pollen sterility, trichome type A and height of first primary branch from ground level exhibited high heritability (75-100 per cent). Patel and Patel (1998) recorded high heritability for days to 50 per cent flowering and plant spread. Basavarajaiah *et al.* (2000) reported for 50 per cent flowering, straw yield, yield per plant, length of pod bearing branch and 100 seed weight. While moderate heritability was recorded for number of primary branches, grain yield and per cent pod borer damage (50-75 per cent). Venkateswarlu (2001) observed high heritability for number of secondary branches, grain yield per plant, days to maturity and number of primary branches per plant. However, pod length showed low heritability estimates (< 50 per cent).

High genetic advance with high heritability were observed for trichome type A, B, number of secondary branches, trichome type D, number of pods per plant, grain yield per plant, trichome type C, per cent pod setting, per cent pollen sterility, 100 seed weight, number of primary branches, height of first primary branch from ground level and seeds per pod indicating the presence of additive gene action and effective for phenotypic selection. For exploitation of genetic variability a due weightage should be given to these characters. Similar results were reported by Aher *et al.* (1996) for secondary branches, pods per plant and grain yield. Patel and Patel (1998) for seed yield, primary branches and number

of pods per plant. Pansuriya *et al.* (1998) reported for dry matter per plant, harvest index, pods per plant and grain yield per plant. Baskarananda and Muthiah (2006) reported for clusters per plant, plant height, number of branches per plant, number of pods per plant and seed yield.

Low heritability with low genetic advance was observed for pod length, indicating non-additive gene action. The selection for this trait may not reward. However, Takalkar *et al.* (1998) observed low genetic advance for branches per plant, seeds per pod and 100 seed weight.

5.4 Correlation

When a particular character is influenced by number of factors it becomes necessary to evaluate as to how and to what extent they are associated. It is also essential to find out relative contribution of each of component characters in yield so as to give weightage during selection. The correlation studies were worked out at genotypic and phenotypic levels among the characters. These studies would enable the breeders to exercise the selection programme for those characters, which are highly correlated with each other. The results were presented in Table 4.4 and 4. 5.

Among the characters the grain yield per plant was positive and significantly correlated with number of pods per plant, number of secondary branches, plant height and number of primary branches indicating that simultaneous selection for these characters might bring an improvement in grain yield plant. These results were in conformity with the results obtained by Sarma *et al.* (1994), Pandey and Singh (1998) Pandey and Singh (1998) reported that number of primary branches per plant and pods per plant were the prime contributing characters to seed

yield. Kingshin and Subbaraman (1999) revealed that branches per plant, clusters per plant, pods per plant, seeds per pod and 100 seed weight was strongly associated with seed yield. Jagdish Singh (1999) reported that seed yield per plant showed Significant positive association with plant height, branches per plant, seeds per pod, biological yield per plant and harvest index. Pandey and Singh (2002a) who stressed the importance of primary branches and pods per plant as best index of high yield. Lal and Raina (2002), Li *et al.* (2004) and RamDhari *et al.* (2004) reported similar results. However, per cent pod damage showed negative significant genotypic and phenotypic correlation with grain yield. Khandwe *et al.* (1998) and Reddy *et al.* (2001) reported strong negative correlation between larval density and grain yield.

Days to flower initiation showed positive and significant genotypic and phenotypic correlation with days to 50 per cent flowering and days to maturity, trichome type C. However, negative but significant genotypic correlation was observed with per cent pod damage. Pandey and Singh (2000 b) reported significant genotypic correlation of seed yield with days to initial flowering and plant height at maturity.

Days to 50 per cent flowering showed positive and significant genotypic and phenotypic correlations with days to maturity. Whereas trichome types C and D showed positive and significant correlation at genotypic level only. Dhamelia and Pathak (1994) reported that days to flowering and days to maturity were positively and significantly associated with each other. Salunke *et al.* (1995) and Vanniarajan *et al.* (1997) showed that significant and positive association with days to 50 per cent flowering

and days to maturity. Gupta (2005) had positive and significant correlation of days to 50 per cent flowering with days to maturity both at genotypic and phenotypic levels.

The plant height showed positive significant genotypic and phenotypic correlation with number of pods per plant, number of primary branches, number of secondary branches and trichome type C and B. Whereas, per cent pod damage showed negative and significant correlation with plant height. Dhamelia and Pathak (1994) reported positive and significant association of plant height with branches per plant. However Musaan and Nahdy (1998) reported that plant height and seeds per pod were negatively and significantly correlated. Pandey and Singh (2002 a) reported significant negative association between plant height at initial flowering and at maturity at genotypic level and between harvest index and plant height at maturity at phenotypic level.

The number of primary branches showed positive and significant correlation at both genotypic and phenotypic levels with number of pods per plant number of secondary branches, trichome type C, B and per cent pollen sterility. Dhamelia and Pathak (1994) reported positive correlation of branches per plant with pods per plant. Pandey and Singh (2002a) revealed that significant and positive association between seed yield per plant and number of primary branches.

While pod length, 100 seed weight, per cent pod damage had negative and significant correlation with number of primary branches. Khandwe *et al.* (1998) reported negative correlation between larval intensity and number of pods and grains per pod.

Positive and significant correlation of number of secondary branches with number of pods per plant Salunke *et al.* (1995) reported that pods per plant and secondary branches were positively and significantly associated. Whereas per cent pod damage had negative and significant genotypic correlation with number of secondary branches.

The characters number of pods per plant had positive and significant correlation both at level at genotypic and phenotypic with trichome type C and B. Pandey and Singh (2002 a) reported significant and positive association between the number of pods per plant and number of seeds per pod at genotypic level. Negative and significant genotypic and phenotypic correlation was observed between per cent pod damage with pods per plant. Similar results were obtained by Khandwe *et al.* (1998). While negative and significant genotypic correlation between 100 seed weight and pods per plant was observed. However, Dhameliya and Pathak (1994) recorded pods per plant was negatively correlated with seeds per pod and seed mass.

100 seed weight showed positive and significant genotypic and phenotypic correlation with pod length, while trichome-D, B and C exhibited strong negative and significant correlation. Dhamelia and Pathak (1994) reported significant and positive correlation of 100 seed weight with pod length. Vanniarajan *et al.* (1997) and Musaan and Nahdy (1998) reported that plant height and 100 seed weight were positively and significantly correlated. While seeds per pod, and 100 seed weight were significantly correlated with branch number, cluster number and pods per plant.

The pod length had negative and significant correlation with trichome type-C. Per cent pod setting had found negative and significant correlation with pollen sterility. Similar results were reported by Saxena *et al.* (1981). The character per cent pollen sterility was showed strong positive and significant association with trichome type B and D. The trichome B showed significant correlation with C and D at both genotypic and phenotypic levels.

5.5 Genotypic path coefficient analysis

The knowledge of inter-relationship between yield and its components and among the components is necessary, if selection for simultaneous improvement in these characters is to be performed. As more variables are included in the correlation study, the indirect association becomes complex. In such situation the path coefficient analysis developed by Wright (1921) provides an effective means of finding out direct and indirect causes of associations.

In present study path analysis revealed that the characters *viz.*, number of pods per plant (0.655), number of secondary branches (0.339), pod length (0.236), days to flower initiation (0.168), plant height (0.126) and per cent pod damage (0.109) had high positive direct effects on grain yield per plant and indirect effects through these characters were also high indicating improvement of these characters for increasing grain yield.

From Table 4.6 and fig. 4.1 it is observed that days to flower initiation exhibited positive direct effect on grain. It has negative indirect effects *via* days to maturity (-0.344) which resulted into positive non significant correlation of this character (0.037) with grain yield. It had

positive indirect effects *via* pods per plant (0.112) and days to 50 per cent flowering (0.048).

Days to 50 per cent flowering had positive direct effect (0.057) on grain yield (Table 4.6), though its association with yield was negatively non-significant. This might be due to its negative indirect effect *via* days to maturity followed by trichome type B and per cent pod damage. Gupta (2005) reported that days to 50 per cent flowering had positive direct effect on grain yield.

Perusal of Table 4.6 indicated that days to maturity had negative direct effect (-0.412) on grain yield with negative and non significant correlation (-0.088) due to its negative indirect effects *via* days to flower initiation, pod length, days to 50 per cent flowering and number of pods per plant. Sarma *et al.* (1994) and Kingshin and Subbaramna (1999) recorded positive direct effect of days to maturity on grain yield.)

The plant height exhibited low positive direct effect (0.126) but highly significant correlation with grain yield (0.649). This might be due to positive and high indirect effects mainly *via* number of pods per plant, number of secondary branches. The character trichomes type-C, days to flower initiation, per cent pollen sterility, height of first primary branches from ground level, trichomes Type A, 100 seed weight and trichome type-D also exhibited low positive indirect effect. (Sarma *et al.* (1994), Kingshin and Subbaraman (1999), Srinivas *et al.* (1999), Radhakrishna *et al.* (2003) and Chattopadhyay and Dhiman (2005) showed positive direct effect on grain yield of this trait.)

The character number of primary branches per plant had negative direct effect (-0.004) on grain yield. The positive significant correlation (0.562) of this trait with grain yield was mainly due to its positive indirect effects *via* number of pods per plant, secondary branches, plant height and trichome type C. Chandirakala and Raveendran (1998), Lal and Raina (2002), Radhakrishna *et al.* (2003) and Ramdhari *et al.* (2004) reported positive direct effect of primary branches on grain yield.

The character number of secondary branches exhibited high positive direct effect (0.339) on grain yield. The total correlation of grain yield with this character was positive and highly significant (0.827). It was mainly due to its positive indirect effects *via* number of pods per plant, plant height, trichome type-C, days to flower initiation, trichome type-D, days to 50 per cent flowering and 100 seed weight. Chandirakal and Raveendran (1998), Srinivas *et al.* (1999) and Ramdhari *et al.* (2004) also noted positive direct effect of this character on grain yield.)

The direct effect height of first primary branch from ground level on grain yield was positive and negligible (0.41). Total correlation of grain yield with this character was positive and non-significant (0.074). However, Gupta (2005) reported high positive direct effect of this character on grain yield.

The character number of pods per plant exhibited highly positive direct effect (0.653) on grain yield with significantly positive correlation (0.953). It resulted from very high positive indirect effects mainly *via* number of secondary branches, plant height, and trichome type-C. Several workers *viz.*, Salunke *et al.* (1995), Paul *et al.* (1996), Chandirakal

and Raveendran (1998), Mussan and Nahdy (1998), Srinivas *et al* (1999), Lal and Raini (2002), Radhakrishna *et al.* (2003) and Ramdhari *et al.* (2004) had also reported high positive direct effect.

The direct effect of seeds per pod was positive (0.010) on grain yield. Total correlation of grain yield was negative (-0.011). It might be due to indirect effect *via*. days to flower initiation, number of secondary branches, trichome type C and days to 50 per cent flowering were negative.

However, Sarma *et al.* (1994), Salunke *et al.* (1995), Vanniarajan *et al.* (1997), Musaan and Nahdy (1998) and Chattopadhyay and Dhiman (2005) reported positive direct effect of seeds per pod.

The character per cent pod damage had positive direct effect (0.109) on grain yield. But its correlation with grain yield was significantly negative (-0.392). This is due to negative indirect effect of characters *via*., pods per plant, trichome type C, number of secondary branches, days to flower initiation and plant height. However, Gupta (2005) reported positive direct effect of pod damage on grain yield.

The character 100 seed weight had negative direct effect (-0.012) on grain yield. Its total correlation with grain yield was non-significant and negative (-0.059). It had negative indirect effect *via* pods per plant, trichome type-C, number of secondary branches, plant height, days to maturity, trichome type A and D. However Dahiya and Singh (1994), Salunke *et al.* (1995), Vanniarajan *et al.* (1997), Chandirkala and Raveendran (1998) and Musaan and Nahdy (1998) reported high positive direct effect on grain yield.

Pod length had positive direct effect (0.236) on grain yield. It had positive non-significant correlation (0.001) with grain yield. This could be resulted due to negative indirect effect on grain yield *via* days to maturity, number of secondary branches, pods per plant and trichome type. C. Gupta (2005) reported that pod length had positive direct effect on grain yield. Kingshlin and subbaraman (1997) revealed that pod length had highest contribution towards seed yield directly and indirectly.

The character per cent pod setting exhibited positive direct effect (0.026) on grain yield. The correlation with grain yield was (-0.055) negative non significant. It had negative indirect effect *via* pods per plant, days to flower initiation, pod length and number of secondary branches.

The per cent pollen sterility had positive and non significant correlation (0.208) was observed. It had positive negligible direct effect (0.041) on grain yield. This might be due to positive indirect effect *via* pods per plant, number of secondary branches, days to flower initiation and plant height.

The negative indirect effects of trichome type A (-0.050) and B (-0.150) were observed, whereas trichome type-C exhibited positive direct effect (0.102) and trichome type-D showed positive direct effect (0.20) on grain yield per plant. The trichomes type B and D showed positive non significant correlation with grain yield, while trichome type – C showed positive and highly significant correlation and trichome type-A showed negative and non-significant correlation with grain yield.

5.6 Pollen sterility and pod setting

Wild species are considered as potential sources for many characters, which are not present in our cultivated species, one of them is male sterility which is important for hybrid seed production. Ariyanayagam *et al.* (1993) developed male sterility through wide hybridization.

In present investigation per cent pollen sterility range was 5.43 to 20.53 per cent. Jogendra singh and Bajpai (2005) reported that pollen sterility ranged from 81-100 per cent in cultivated species. This reduction in fertility may be due to cryptic chromosome all structural divergence and or specific genic differences between the two species, univalent formation and unequal separation of chromosome in different chromosome configurations.

Per cent pod setting had negative and significant correlation with per cent pollen sterility. Saxena *et al.* (1981) reported that pollen fertility as indicated by stainability with aceto-carmin, ranged from 20 per cent to 60 per cent depending on the plant, whereas normal fertile plants generally revealed more than 90 per cent stainability. Flowers in any given plant were relatively consistent in pollen stainability. Pod set on plants revealing low pollen production and low stainability of pollen varied from apparently of normal to virtually zero. Thus, pod set was associated with the degree of sparseness of pollen production.

5.7 Pod borer incidence and inter specific derivatives.

The qualitative observation and per cent pod damage had presented in Table 4.8. The lowest per cent of pod damage was 2.41 per cent and highest was 17.13 per cent. The genotype (Pant A-2 x C.

albicans)-29-2, ICPL 332 and Pant A -2 x *C. scarabaeoides*)-14-1 had mixed pod colour, no streaks or sparse streaks on standard petal, reddish brown seed coat colour and spreading growth habit (showed in plates 1 to 6 B) having less than 5 per cent pod damage. It gives some indication of pod borer tolerance, however further bio-chemical conformation is needed. Tripathi and Purohit (1984) observed that variety with brown colour seeds and green coloured pods were least affected by borer. It was very difficult to identify any morphological marker for pod borer tolerance.

Field screening against pod borer damage has shown some indication of relative tolerance in a few pigeonpea genotypes. However, these results are not consistent over environments, and no dependable source of resistance has been identified for incorporation into desired agronomic base. Gupta (2005) observed presence of genotypes x environment interaction for pod borer tolerance. The genotypes reported tolerant at Badnapur (*Kharif* 2004) were affected at Parbhani during *Kharif* 2005

Plant trichomes can act as an insect resistance mechanism (Peter *et al.* 1995). Trichomes have been modified in number of crop to develop insect tolerant genotype. Pigeonpea (*Cajanus cajan*) often heavily damaged by insect pests and trichomes provide potential insect resistance mechanism (Romies *et al.* 1999).

In this study five promising genotypes (shown in following Table 5.1) have been selected in the relation to grain yield per plant, per cent pod damage and non glandular trichome types C and D.

Table 5.1. Pod borer tolerance in relation to promising genotypes.

Sr. No.	Promising genotype	Grain yield/ plant	Per cent pod damage	Trichome type C per microscopic field	Trichome type D per microscopic field
1	ICPL 332	68.47 (1)	4.42 (3)	240.00 (2)	12.67 (21)
2	(Prabhat x <i>C. scarabaeoides</i>)-3-2	57.21 (2)	7.30 (20)	201.16 (13)	10.97 (33)
3	(Pant A-2 x <i>C. Scarabaeoides</i>)-27-2-2	55.85 (3)	5.14 (6)	225.17 (7)	12.00 (26)
4	ICPL 87119	53.85 (4)	7.36 (22)	198.50 (17)	7.66 (43)
5	(UPAS-120 x <i>C. trinervius</i>)-5-1	53.53 (5)	7.13 (18)	199.00 (16)	11.33 (29)

Figures in parenthesis indicated the rank of estimate of genotypes for the particular characters.

In the above highest yielding promising genotype low per cent pod damage coupled with high number of non glandular trichomes C and D was observed.

Pournami *et al.* (2002) observed that high density of non glandular trichomes on pod and low pod width tend to reduce the attacks of yard long bean pods by Legume pod borer. The trichome collectively form pubescence on pods. The hindrance to larval movement and feeding offered by non glandular trichomes might be the reason for low pod borer damage in ISD with high non glandular trichome density on pods.

Sahoo and Senapati (2002) revealed that trichome density and pod length had adverse effect on pod borer incidence.



Summary and Conclusion



Chapter-VI

SUMMARY AND CONCLUSION

The present investigation entitled “**Study of Genetic Variability and Correlation in Interspecific Derivatives of Pigeonpea [*Cajanus cajan* (L.) Mill sp.]**” was undertaken with following objectives,

- 1) To study pollen sterility and pod setting.
- 2) To study the correlation and path analysis for yield and yield contributing characters.
- 3) Identification of pod borer tolerant genotypes.

The experiment was conducted with forty six genotypes including forty ISD, ~~five~~ National checks and one local check in randomized block design with two replication during *Kharif* - 2005.

Observations were recorded on characters *viz.*, days to flower initiation, days to 50 per cent flowering, days to maturity, plant height, number of primary branches, number of secondary branches, height of first primary branch from ground level, number of pods per plant, number of seeds per pod, per cent pod damage, 100 seed weight, pod length, per cent pod setting, per cent pollen sterility, trichome types and grain yield. The qualitative characters *viz.*, stem colour, standard petal colour, pattern of streaks on standard petal, pod colour, growth habit, flowering pattern and seed coat colour were also studied. The data was collected and analysed for genotypic and phenotypic coefficient of variation, heritability, expected genetic advance, correlation and path analysis.

1. Analysis of variance showed significant differences among genotypes for all the characters indicating presence of wide genetic variability in experimental material.
2. The high genotypic and phenotypic coefficient of variation were observed for trichome type A, B, number of secondary branches, trichome-D, number of pods per plant, grain yield, days to flower initiation, days to 50% flowering, days to maturity, plant height and trichome type-C.
3. The high heritability estimates coupled with high expected genetic advance were observed for trichome type-A, B, number of secondary branches, trichome type D, number of pods per plant, grain yield per plant, trichome type C, per cent pod setting, per cent pollen sterility, 100 seed weight, number of primary branches, height of first primary branch from ground level and seeds per pod indicating the presence of additive gene action and phenotypic selection may be effective.
4. The correlation studies revealed positive and significant genotypic and phenotypic correlation of number of pods per plant, number of secondary branches, plant height, primary branches and trichome type C with grain yield; whereas per cent pod damage recorded negative significant correlation with grain yield, indicating the importance of these characters for improving grain yield per plant.

5. Path coefficient analysis revealed that the characters viz., number of pods per plant, number of secondary branches per plant. Per cent pod damage, plant height had high direct effect on grain yield.
6. The per cent pollen sterility had negative significant correlation with per cent pod setting. In present investigation per cent pollen sterility was 5.43 to 20.53.
7. More number of trichomes on pod tends to reduce pod damage as revealed by their negative correlation both at genotypic and phenotypic levels.

Conclusion

The present study revealed the importance of pods per plant, secondary branches per plant, plant height, per cent pod damage and number of trichome type C in breeding programme, since these characters showed significant desirable correlation with grain yield per plant with high positive direct effects and indirect effects. Also most of these characters exhibited high heritability coupled with high genetic advance. Hence direct selection for these characters will increase breeding efficiency. The promising genotypes viz., ICPL 332, (Prabhat x *C. scarabaeoides*)-3-2, (Pant A 2 x *C. scarabaeoides*) -27-2-2, ICPL 87119 and (UPAS -120 X *C. trinervius*)-5-1 should be evaluated for yield and other characters in future.



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