YIELD POTENTIAL AND ADAPTABILITY OF BLACK GRAM GENOTYPES FOR RICE FALLOWS

By

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THESIS

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DECLARATION

I hereby declare that this thesis entitled **"Yield Potential and Adaptability of Black gram Genotypes for Rice Fallows"** is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award of any degree, diploma, associateship, fellowship or other similar title of any other University or Society.

Vellayani,
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CERTIFICATE

Certified that this thesis entitled **"Yield Potential and Adaptability of Black gram Genotypes for Rice Fallows"** is a record of research work done independently by Sri. Sajikumar, K. R. under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to him.

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INTRODUCTION

INTRODUCTION

Pulses form an important source of dietary protein for majority of the population in India. The amino acid composition of pulse protein is such that a mixed diet of cereal and pulse has greater biological value than either of the component alone. Pulses in India are at present grown in about 27.14 lakh hectares with an annual production of about 12.97 lakh tonnes (Chopra, 1989). Ninety per cent of our pulse crops come from dry farming areas which are characteristic of moisture stress. So pulses have the capacity of utilising residual moisture available in the field (Srivastava et al., 1984). Another unique property of pulses is the capacity of maintaining and restoring soil fertility through nitrogen fixation as well as by converting and improving the physical property of soil by virtue of their tap root system (Nambiar et al., 1988).

Black gram or Urd (*Vigna mungo* (L.) Hepper) is one of the most important and highly nutritious pulse crops. In India, black gram is grown in about 3.07 lakh hectares with a total production of 1.2 lakh tonnes (Lal, 1987). In Kerala it occupies an area of 3400 hectares (Anon., 1985). The production and productivity of this crop at national and State level is considerably low. The availability of grain legume is only 60g/head/day (Jeswani, 1986) as against 80 g/head/day recommended by FAO and WHO. Poor production and availability clearly indicates the low productivity of pulses in general and black gram in particular. This calls for special efforts to achieve increased production of black gram through enhancing the productivity.

Summer rice fallows and interspaces of coconut garden are the two potential areas available for effective utilisation in Kerala. Genetic analysis of black gram has been attempted previously and proved that a lot of variation has crept in. All these variations, both desirable and undesirable are scattered over and it is the duty of plant breeder to select the most suitable one. The present work was undertaken with the objective of identifying the important yield components that would help in the selection of superior black gram genotypes for yield and adaptability in summer rice fallows.

The major objectives of the study are:

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

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

To select adaptable and high yielding varieties for summer rice fallows based on the selection index prepared using major characters.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Among grain pulses, black gram (*Vigna mungo* (L.) Hepper) is an important crop in India. Exploration and evaluation has shown a large diversity and this provides ample evidence for black gram improvement (Singh et al., 1974). Selection of genotypes suited to a particular soil and climatic condition from this diverse population forms the basic step in any breeding programme for getting.appreciable grain yield and improving adaptability. The estimation of genetic variability, heritability of each character, genetic advance, correlated response of these characters and discriminant function analysis based on yield and major yield contributing characters help in the selection of superior genotypes from genetically diverse population. A brief account of work done on these aspects which forms the basis for a critical evaluation and planning of future strategies in black gram breeding is reviewed here.

2.1 Variability

a. Black gram

Sagar *et al*. (1976) studied 27 lines of black gram and reported maximum variability for yield per plant, pods per plant, days to 50 per cent flowering and branches per plant. Environmental influence was found to be high in all these characters.

Sandhu et al. (1978) evaluated 268 varieties and reported highest genotypic coefficient of variation for number of pods per plant (28.3%) followed by number of branches per plant (26.4%), grain yield per plant (24.9%), height of the plant (24.8%) and number of pod clusters per plant (22.1%). Length of pod recorded minimum value of 5.6%.

Pillai (1980) recorded high genotypic coefficient of variation for height of the plant (31.4%) and number of branches per plant (25.8%). The lowest value of 5.2% was exhibited by the number of days to maturity.

Based on the variability study on 20 varieties, Patel and Shah (1982) reported maximum genotypic coefficient of variation for length of pod (40.5%) followed by height of the plant (35.8%).

Singh and Misra (1985) studied 30 varieties and observed high genotypic and phenotypic variances for plant height and number of pods per plant.

Philip (1987) evaluated 20 genotypes and reported that genotypic coefficient of variation was maximum for cercospora leafspot and minimum for days to pod harvest initiation.

From a study on variability, Saji (1988) reported significant differences among the varieties for number of days to pod harvest initiation, height of the plant, number of branches per plant and leaf area index.

In a varietal evaluation trial with 20 varieties of black gram, Sudha Rani (1989) reported significant difference for days to maturity, root spread, number of seeds per pod and 100 seed weight.

Kavitha and Viswanathan (1991) evaluated 20 blackgram genotypes under moisture stress condition and reported significant difference among varieties for seed yield and its components viz., pod length, number of seeds per pod and 100 seed weight.

Siby (1994) reported wide range of variability for length of root, days taken for 50 per cent flowering, plant height, grain yield and biological yield among the 33 varieties evaluated.

b. Green gram

Sreekumar and Abraham (1979) reported high value for genotypic coefficient of variation for height of the plant (14.97%), grain yield per plant (12.83%) and number of pods per plant (9.95%). The minimum value was for number of branches per plant (0.38%).

In 90 selected varieties of green gram Paramasivan and Rajasekaran (1980) noticed wide range of variability for plant height and number of pods per plant.

Liu *et al*. (1984) reported high genotypic coefficient of variation for seed yield per plant and number of pods per plant among nine quantitative characters studied.

Ali and Shaikh (1987) noticed high genotypic and phenotypic coefficients of variation for seed yield per plant. Least phenotypic variation was observed for days to maturity and genotypic variation for number of seeds per pod.

Number of pods per plant and number of pod clusters per plant were reported to have high genotypic coefficient of variation by Ramana and Singh (1987) in a varietal trial.

Anitha (1989) evaluated 20 varieties under open condition and analysis of variance revealed significant difference among the varieties for plant height, pod length, number of seeds per pod, 100 seed weight, seed yield per plot, stomatal distribution, leaf area index, root length, root spread, days to maturity and days taken for completion of harvest.

C. Cowpea

Lakshmi and Goud (1977) noticed high genotypic coefficient of variation for plant height, grain yield, number of pods per plant and 100 seed weight in 12 varieties.

Ramachandran *et al.* (1980) reported highest genotypic coefficient of variation for grain yield per plot (57.12%) followed by number of pods per plant (56.56%) and minimum for length of pod (6.44%).

Radhakrishnan and Jebaraj (1982) observed maximum genotypic coefficient of variation (48.2%) for number of pods per plant followed by number of pod clusters per plant (36.6%) and number of branches per plant (27.5%). The minimum value was for days to maturity (4.7%).

Dharmalingam and Kadambavanasundaram (1984) reported high genotypic coefficient of variation for number of pods per plant (29.92%) and grain yield per plant (24.16%). Number of seeds per pod had the minimum value (12.88%).

d. Red gram

Godawat (1980) reported that genotypic coefficient of variation was highest for grain yield per plant and number of primary branches in a study with 26 genotypes.

Bainiwal et al. (1981) reported maximum variability for number of branches per plant and seed yield on the basis of high genotypic coefficient of variation in 29 varieties.

Estimates of variability were worked out in 100 genotypes of red gram and revealed high genotypic coefficient of variation for pods per plant, days to maturity, plant height and days to 50 per cent flowering by Shoram (1983).

Patil et al. (1990) in their genetic variability analysis recorded high genotypic coefficient of variation for seed yield, number of pods per plant and number of branches per plant.

e. Other pulses

Thirty varieties of pea were evaluated by Singh (1985) and reported high degree of genetic variability for grain yield, plant height, number of pods per plant and number of branches per plant.

Suraiya _et al_. (1988) reported highest genotypic variance for number of pods per plant, plant height, days to 50 per cent flowering and day to maturity in horse gram.

Sadhu and Madan (1989) in their genetic variability study on chickpea revealed considerable variability for plant height, pod number, seed number and seed yield.

Sharma _et al_. (1990) recorded high genotypic and phenotypic variation for number of branches per plant and 100 seed weight in chickpea.

Arora (1991) from a variability study on chickpea reported high genotypic and phenotypic coefficient values for pods per plant, 100 seed weight and seed yield per plant and moderately high for plant height, number of branches per plant and number of seeds per pod.

Elizabeth (1991) evaluated the performance of 48 horse gram varieties and reported significant differences among the varieties for height of the plant, number of branches per plant, number of pods per plant, number of seeds per pod, seed yield per plant, length of pod and 100 seed weight.

2.2 Heritability and genetic advance

a. Black gram

Patel and Shah (1982) estimated heritability and genetic advance in 20 varieties and reported high heritability coupled with high genetic advance for plant height (86.2% and 68.5%) and length of pod (46.9% and 57.2%). High heritability coupled with low genetic advance was observed for number of seeds per pod (42.7% and 6.6%).

Number of pods per plant and 100 seed weight showed appreciable heritability and genetic advance in a variability study by Sarkar et al. (1984).

Patil and Narkhede (1987) observed high heritability and high expected genetic gain for yield per plant, pod length and plant height. Medium heritability was showed by 100 seed weight.

seeds per pod (10.7%), grain yield per plant (28%) and biological yield per plant (27%). Grain yield per plant (20.3%) and biological yield (19.5%) had comparatively high genetic advance.

b. **Green gram**

A hundred percentage heritability was observed for 100 seed weight by Paramasivan and Rajasekaran (1980). Pod length (97.18%), number of pod clusters per plant (92.56%) and seed yield (89.45%) also had high heritability. The genetic advance was also found to be high for these characters.

Ramana and Singh (1987) recorded high heritability for number of pods per plant and pod clusters per plant.

Anitha (1989) estimated heritability and genetic advance for yield components and recorded moderate to high values for pod length, number of seeds per pod and 100 seed weight.

c. Cowpea

Radhakrishnan and Jebaraj (1982) reported high heritability and genetic advance for number of pods per plant and number of pod clusters per plant. Number of days to maturity and plant height registered high heritability with low genetic advance.

Heritability estimate was found to be maximum for length of pod (87.37%) by Dharmalingam and Kadambavanasundaram (1984).

Thiagarajan et al. (1989) in Nigerian cowpea reported high heritability and genetic advance for height of the plant, number of clusters per plant, number of pods per plant, number of seeds per pod and seed yield per plant.

Roquib and Patnaik (1990) observed high heritability estimates for plant height, number of seeds per pod, pod length, days to 50 per cent flowering, days to maturity and seed yield. Genetic advance of these traits were also found high.

d. Pigeon pea

Godawat (1980) reported that the traits, grain yield per plant and number of primary branches per plant had high heritability combined with high genetic advance.

Bainiwal *et al*. (1981) observed high heritability for days to maturity and moderate for height of the plant, number of branches per plant and number of seeds per pod. All these showed low genetic advance. Seed yield per plant, number of primary branches per plant and plant height showed high genetic advance.

Shoram (1983) reported high estimates for heritability and genetic advance for number of pods per plant, days taken for maturity and number of days to flowering.

Patil *et al*. (1990) recorded high heritability estimate and genetic advance for seed yield per plant, number of pods per plant and biological yield.

Paul and Upadhaya (1991) evaluated 8 varieties and indicated high heritability values for number of pods per plant and seed yield per plant.

Patel and Patel (1992) reported moderate to high heritability and genetic advance for plant height and number of pods per plant.

e. Other pulses

Jivani and Yadavendra (1988) in chickpea reported high heritability estimate for plant height, days to maturity, number of pods per plant and 100 seed weight. The greatest genetic gain was expected for 100 seed weight and number of pods per plant.

Sharma _et al_. (1990) studied heritability and genetic advance of eleven characters in 70 chickpea genotypes and observed highest heritability for 100 seed weight, days to maturity and plant height.

Eighteen varieties of chickpea were evaluated by Misra (1991) and high heritability estimate was recorded for days to 50 per cent flowering, days to maturity, plant height, number of pods per plant and 100 seed weight. Number of pods per plant, number of branches per plant, number of seeds per pod and 100 seed weight had moderate to high genetic advance.

Singh *et al*. (1992) reported high heritability estimates for 100 seed weight, days to flower, days to maturity and plant height in rice bean.

2.3 Correlation

2.3.1 Association between yield and its components

a. Black gram

Waldia *et al*. (1980) indicated significant correlation of the characters, number of branches per plant, number of pod clusters per plant and number of pods per plant with seed yield.

Pillai (1980) in his study with six varieties of black gram found days to flowering, days to maturity, height of the plant, number of primary branches per plant, number of pod clusters per plant, number of pods per plant, length of pod and number of seeds per pod had high and significant positive genotypic and phenotypic correlation with grain yield per plant.

Muthiah and Sivasubramanian (1981) reported significant positive correlation of seed yield with plant height, number of branches per plant, number of pod clusters per plant, number of pods per plant, pod length and number of seeds per pod.

Significant positive genotypic correlation of seed yield with plant height, number of clusters per plant, number of pods per plant, length of pod and number of seeds per pod were recorded by Usha and Sakharam (1981).

Number of pods per plant and 100 seed weight had significant positive correlation with yield as reported by Sarkar _et al_. (1984).

Patil and Narkhede (1987) evaluated 28 strains and found significant correlation of seed yield with number of pods per plant, 100 seed weight, pod length and number of seeds per pod.

Philip (1987) observed that at the genotypic level seed yield showed high positive correlation with days to 50 per cent flowering, days to pod harvest initiation, number of nodes per plant, number of pod clusters per plant, number of pods per plant and number of seeds per pod.

Saji (1988) reported high positive correlation of number of branches per plant, number of pod clusters per plant, number of pods per plant, length of pod, number of seeds per pod and leaf area index with seed yield.

Waryari (1988) observed that number of pods, pod length, number of pod clusters per plant and 100 seed weight had positive association with yield.

Sudha Rani (1989) studied 20 varieties and inferred that yield per plant was positively correlated with leaf area, root spread, number of pods per plant, number of grains per pod and 100 seed weight.

Kavitha and Viswanathan (1991) reported positive correlation of root length with seed yield.

Verma (1992) reported significant positive correlation of seed yield with 100 seed weight, days to maturity, number of primary branches per plant and plant height.

Renganayaki and Sreerangasamy (1992) observed that grain yield per plant showed significant correlation with leaf area index, pod length, number of seeds per pod and 100 seed weight.

Siby (1994) reported high positive correlation of number of pods per plant, length of primary root, plant height, number of seeds per pod and biological yield with grain yield.

b. Green gram

Upadhaya et al. (1980) observed significant positive genotypic correlation of number of branches per plant, number of pods per plant and number of seeds per pod with seed yield.

Studies on 8 yield characters in 49 lines, Boomikumaran and Rathinam (1981) showed that height of the plant, number of branches per plant and number of seeds per pod had positive genotypic correlation with seed yield.

Gupta et al. (1982) reported high positive correlation of yield with number of days to maturity, number of pod clusters per plant, number of pods per plant and number of seeds per pod.

Malik et al. (1987) in their studies revealed that yield was positively and significantly associated with plant height, primary branches per plant, pods per plant, pod clusters per plant and biological yield.

Correlation studies by Râut et al. (1988) revealed positive correlation of seed yield with number of seeds per pod, number of branches per plant and pod clusters per plant at the genotypic level.

Patil and Deshmukh (1988) identified significant positive correlation of seed yield with 100 seed weight, seeds per pod and pods per plant.

Satyan et al. (1989) reported that seed yield was positively and significantly correlated with plant height, number of branches per plant, number of clusters per plant, number of pods per plant, number of pods per cluster, number of seeds per pod, pod length and days to maturity.

Anitha (1989) recorded significant correlation of yield with number of pods per plant and 100 seed weight at the genotypic level. Negative correlation was observed with plant height, pod length, number of seeds per pod and leaf area index.

Pundir _et al_. (1992) observed positive correlation of yield with branches per plant, pod clusters per plant, pods per plant, pod length, seeds per pod and 100 seed weight.

c. **Cowpea**

Significant positive correlation of seed yield with height of the plant, number of pods per plant and number of seeds per pod was reported by Singh _et al_. (1982).

Seed yield showed significant positive association with plant height, pods per plant, pod length and number of seeds per pod as reported by Jindal and Gupta (1984).

Singh and Dabas (1985) observed significant positive correlation of grain yield with plant height, pods per plant, pod length and grain per pod.

Patil and Bhapkar (1987) revealed that number of pods per plant and seeds per pod had significant positive association with grain yield per plant.

Tyagi and Koranne (1988) reported positive and significant correlation of seed yield with number of branches per plant and number of seeds per pod.

Patil *et al*. (1989) reported high positive correlation between grain yield and pods per plant, 100 grain weight, number of pod clusters per plant, pod length and days to 50 per cent flowering.

Siddique and Gupta (1991) reported that seed yield per plant was significantly correlated with days to 50 per cent flowering, days to maturity, number of pod clusters per plant and number of pods per plant.

d. Pigeon pea

Positive and significant association of seed yield with number of primary branches per plant, 100 seed weight, number of pods per plant and pod length was reported by Godawat (1980).

A significant and positive correlation of seed yield with plant height, number of days to flowering and number of days to maturity at the genotypic level was reported by Bainiwal et al. (1981).

Ganesamurthy and Dorairaj (1990) observed positive and significant association of seed yield with number of pods per plant, clusters per plant, number of branches per plant, plant height and leaf area index.

Patel and Patel (1992) reported that the characters important for yield selection were days to 50 per cent flowering, days to pod maturity, plant height, number of primary branches and pods per plant as they were positively correlated with yield.

e. Other pulses

Naidu et al. (1985) based on their study in broad been reported significant and positive correlation of seed yield with number of branches per plant, number of clusters per plant, number of pods per plant and number of seeds per pod at the genotypic level.

Singh (1985) reported positive association of the characters days to 50 per cent flowering, days to maturity, plant height, number of pods per plant and number of primary branches per plant with grain yield in peas.

Sharma and Maloo (1988) observed that seed yield was significantly correlated with number of pods per plant, number of primary branches per plant and 100 seed weight in chickpea.

In soya bean, Amaranatha et al. (1990) noticed strong association of seed yield with number of seeds, pods and branches per plant, 100 seed weight, days to maturity, days to 50 per cent flowering and plant height.

Kumar and Arora (1991) found that correlation with seed yield was significant for biological yield, pods per plant, 100 seed weight and plant height in chickpea.

Singh et al. (1992) reported positive and significant correlation of seed yield with number of pods per plant, number of seeds per pod and total biological yield in rice bean.

2.3.2 Inter-correlation among yield components

a. Black gram

Sandhu et al. (1980) reported significant positive correlation among the characters, number of pod clusters per plant, number of pods per plant, length of pod and number of seeds per pod at the genotypic level.

Number of branches per plant, number of pod clusters per plant and number of pods per plant had significant inter se correlation as reported by Waldia et al. (1980).

Muthiah and Sivasubramanian (1981) observed positive genotypic correlation among the characters, height of the plant, number of branches per plant, number of pod clusters per plant, number of pods per plant, length of pod and number of seeds per pod.

Philip (1987) reported that number of pod clusters per plant, number of pods per plant, number of days to pod harvest initiation, height of the plant, days to 50 per cent flowering, number of pods per plant, mean length of pod and 100 seed weight were positively correlated with each other at the genotypic level.

Siby (1994) reported positive inter se correlation of plant height, number of seeds per pod, biological yield and length of root.

b. Green gram

A negative genotypic correlation was observed between number of pods per plant and length of pod by Ratnaswamy et al. (1978).

Upadhaya et al. (1980) reported significant positive genotypic correlation between number of seeds per pod, number of days to maturity, height of plant, number of pods per plant, number of branches per plant and length of pod.

Boomikumaran and Rathinam (1981) observed that the characters, plant height, number of branches per plant, number of clusters per plant, number of pods per plant and number of seeds per pod had significant positive correlation with each other at the genotypic level.

Liu et al. (1984) reported negative correlation of 100 seed weight with pod number per plant.

Anitha (1989) evaluated 20 varieties and recorded positive correlation between root spread, leaf area index, root length, 100 seed weight and number of pods per plant.

C. **Cowpea**

Angadi (1976) reported positive correlation of seeds per pod with plant height and pod length and also between pod clusters per plant and number of branches per plant. The correlation between branches per plant and plant height, pod length and branches per plant, pod length and clusters per plant, pod length and number of pods per plant, seeds per pod and number of branches were found negative.

The correlation between length of pod and number of seeds per pod were found to be significantly positive by Natarajaratnam et al. (1985).

Patil and Bhapkar (1987) reported negative correlation between number of pods per plant and number of seeds per pod.

d. Pigeon pea

Joshi and Kabaria (1973) observed that inter-correlation between number of branches per plant and number of pods per plant were significantly positive and that between pod number and number of seeds per pod were negative at the genotypic level.

Veeraswamy et al. (1973) reported positive correlation of plant height with number of days to flowering, number of branches per plant, number of pod clusters per plant and number of pods per plant.

Singh et al. (1977) from their correlation study inferred that leaf area index was positively correlated with 100 seed weight.

2.4 Selection index

The aim of most breeding programme is simultaneous improvement of several characters. The importance of reliable screening technique as an integral component of any crop improvement programme has been stressed by Levitt (1964) and Cooper (1974).

Richards and Thurling (1979) suggested a joint selection for yield, harvest index, 100 seed weight and number of seeds per pod which was 20 per cent more effective than direct selection for yield under drought.

Sharma (1979) emphasised the importance of selection criteria based on root characters, grain filling period, earliness, yield and yield components in improving the drought resistance.

Gupta et al. (1982) concluded that while constructing selection indices emphasis should be placed on number of clusters, pods per plant, seeds pod and days to maturity in addition to yield per plant.

Malik et al. (1982) repoyled that simultaneous selection for pods per plant, seeds per pod and seed weight was superior to selection for yield alone and also resulted in the greatest genetic advance.

A selection index consisting of the traits, pod length, seed number per pod and seed yield per plant was prepared by Murthy (1982) in three F2 population of cowpea.

Sudha Rani (1989) prepared a selection index based on yield, yield component and drought tolerant parameters and inferred that selection based on this method was more effective than direct selection for yield.

MATERIALS AND METHODS

MATERIALS AND METHODS

The present study was carried out in the Department of Plant Breeding and Genetics, College of Agriculture, Vellayani, Trivandrum during summer 1995.

3.1 Materials

The experimental material consisted of thirty varieties of black gram (*Vigna mungo* (L.) Hepper) collected from the germplasm conserved at the Rice Research Station, Kayamkulam and the School of Genetics, TNAU, Coimbatore. The details of the varieties are furnished in Table. 1.

3.2. Methods

A field experiment was laid out during summer 1995 with thirty varieties in a randomised complete block design with three replications. Hundred plants were maintained in a plot size of 2.5 x 1.5m. The crop was raised adopting Package of Practices Recommendations (Crops 1993) of the Kerala Agricultural University. Ten plants were selected at random from each plot and the data on the following characters were recorded and the corresponding means were subjected to statistical analysis.

Table 1. Particulars of thirty genotypes of black gram (*Vigna mungo* (L.) Hepper).

Sl. No.	Name	Source
1	Co-Bg-303	R R S, Kayamkulam
2	Co-Bg-282	R R S, Kayamkulam
3	Co-Bg-305	R R S, Kayamkulam
4	Co-Bg-301	R R S, Kayamkulam
5	Co-Bg-9	R R S, Kayamkulam
6	Co-Bg-10	R R S, Kayamkulam
7	Co-2	R R S, Kayamkulam
8	Co-3	R R S, Kayamkulam
9	Co-4	R R S, Kayamkulam
10	TMV-1	R R S, Kayamkulam
11	Vamban-1	R R S, Kayamkulam
12	KM-2	R R S, Kayamkulam
13	PDU-6	R R S, Kayamkulam
14	UPU-9-40-4	R R S, Kayamkulam
15	PU-19	R R S, Kayamkulam
16	PU-30	R R S, Kayamkulam
17	Co-Bg-307	R R S, Kayamkulam
18	SSRC-1	R R S, Kayamkulam
19	B-3-8-8-1	R R S, Kayamkulam
20	T-9	R R S, Kayamkulam
21	JU-77-41	R R S, Kayamkulam
22	TAU-1	R R S, Kayamkulam
23	UH-87-11	R R S, Kayamkulam
24	KBg-368	School of Genetics, Coimbatore
25	Co-Bg-544	School of Genetics, Coimbatore
26	VB-11	School of Genetics, Coimbatore
27	WBG-67	School of Genetics, Coimbatore
28	Co-Bg-309	School of Genetics, Coimbatore
29	TU-94-2	School of Genetics, Coimbatore
30	BD-23-14	School of Genetics, Coimbatore

1. Days taken for fifty per cent flowering

Number of days taken from the date of sowing of the seeds to fifty per cent flowering of the crop was recorded.

2. Days taken for pod harvest initiation.

Number of days taken from the date of sowing of the seeds to the first harvest of the pods was recorded.

3. Days taken for completion of harvest

Number of days taken from the first pod harvest to the final harvest of the crop from the field was recorded.

4. Number of pickings

Total number of pickings of pods from each observational plant was recorded.

5. Leaf area index (LAI)

Leaf area index was measured from each plot, when the crop was at its active vegetative phase using a leaf area meter. All the leaves were separated from the uprooted plants from each plot and fed to the leaf area meter and total leaf area of each plant was recorded. From this leaf area index was calculated by the formula suggested by William (1946).

$$\text{Leaf area index} = \frac{\text{Total leaf area of the plant}}{\text{Ground area occupied}}$$

6. **Height of the plant**

The plant height was measured from the ground level to the top of the main stem.

7. **Number of branches per plant**

Total number of primary branches was recorded from each observational plant.

8. **Number of nodes per plant**

Number of nodes per plant after the last harvest was counted and recorded.

9. **Number of pod clusters per plant.**

Number of pod clusters at each harvest was recorded.

10. Number of pods per plant

The total number of pods harvested from each plant till the last harvest was counted and recorded.

11. Length of pod

The length of ten pods selected at random from each plant was measured and recorded.

12. Weight of pods

Total weight of pods from each observational plant was computed and recorded in g.

13. Number of seeds per pod

Number of seeds in the pods selected at random was counted and recorded.

14. Seed yield per plant

Grain yield obtained from the observational plants was recorded and the mean expressed in g.

15. 100 seed weight

Random samples of 100 seeds taken from the total seeds collected from each plant was weighed on a sensitive electronic balance and expressed in g.

16. Length of root

The length of root was measured at harvest time. The sample plants were uprooted carefully and length of tap root was measured in cm.

17. Spread of root

Root spread was measured at harvest time by placing the root system on a graph paper and measuring the spread of the root system at its broadest part. The root spread was expressed in cm.

18. Duration of the crop

Mean number of days from the date of sowing to the final harvest was counted.

19. Stomatal distribution

For estimating number of stomates per microscopic field (40 x 10) fully opened and mature leaves were selected from the sample plants and leaf impressions were taken by applying a thin coat of nail polish on the lower surface and peeled off on drying. From these ten microscopic fields were scored and mean worked out.

20. Biological yield

Total dry weight of the sample plants were recorded and the mean expressed in g.

21. Reaction of pest and diseases.

Mild incidence of rust disease was noticed in the experimental field at a very late stage. The infestation was expressed in percentage after counting the infested and non-infested plants.

3.2.1 Statistical technique

1. Analysis of variance and covariance were done

i. to test for varietal effect with respect to the various traits

ii. to estimate the variance components and other genetic parameters like correlation coefficients, heritability, genetic advance etc. (Singh and Choudhary, 1979).

Table 2 represents the analysis of variance and covariance.

From this table other genetic parameters are estimated as follows:

	X	Y
Environmental variance	$(\sigma e^2) = \sigma e^2 x = E_{xx}$	$(\sigma e^2) = \sigma e^2 y = E_{yy}$
Genotypic variance	$(\sigma g^2) = \sigma^2 gx = \dfrac{G_{xx} - E_{xx}}{r}$	$\sigma^2 gy = \dfrac{G_{yy} - E_{yy}}{r}$
Phenotypic variance	$(\sigma^2 p) = \sigma^2 px = \sigma^2 gx + \sigma^2 ex$	$\sigma^2 gy + \sigma^2 ey$

Heritability (broad sense) $H^2 = \dfrac{\sigma^2 gx}{\sigma^2 px}$

(Jain, 1982)

Genetic advance as percengate of mean $= \dfrac{KH^2 \sigma p_x}{\bar{x}} \times 100$

[where K = selection differential = 2.06 at 5 per cent selection]

(Miller *et al.,* 1958)

Table 2. Analysis of variance / covariance

Source	df	Observed mean square XX	Expected mean square XX	Observed mean sum of products XY	Expected mean sum of products XY	Observed mean square YY	Expected mean square YY
Block	(r - 1)	Bxx		Bxy		Byy	
Genotype	(v - 1)	Gxx	$\sigma^2ex + r\sigma^2gx$	Gxy	$\sigma\ exy + r\sigma\ gxy$	Gyy	$\sigma^2ex + r\sigma^2gx$
Eroor	(v - 1) (r - 1)	Exx	σ^2x	Exy	$\sigma e\ xy$	Eyy	$\sigma^2e\ y$
Total	rv - 1	T_{xx}		T_{xy}		T_{yy}	

Hence we have the following estimate

$\sigma^2g(x) = (G_{xx} - E_{xx})/r$ $\qquad$ $\sigma^2ex = E_{xx}$

$\sigma^2g(y) = (G_{yy} - E_{yy})/r$ $\qquad$ $\sigma^2ey = E_{yy}$

$\sigma\ g(xy) = (G_{xy} - E_{xy})/r$ $\qquad$ $\sigma\ e(xy) = E_{xy}$

Genotypic correlation (r_{gxy}) = $\frac{\sigma_{gxy}}{\sigma_{gx} \times \sigma_{gy}}$

Phenotypic correlation (r_{pxy}) = $\frac{\sigma pxy}{\sigma px \times \sigma py}$

Genotypic coefficient of variation (GCV) = $\frac{\sigma gx}{\bar{x}} \times 100$

Phenotypic coefficient of variation (PCV) = $\frac{\sigma px}{\bar{x}} \times 100$

2. Selection index

The character index developed by Smith (1937) using discriminant function of Fisher (1936), was used to discriminate the genotypes based on six characters viz. leaf area index, number of pods per plant, weight of pods, number of seeds per pod, seed yield per plant and 100 seed weight under study. The selection index is described by the function

$$I = b_1x_1 + b_2x_2 + ... + b_6x_6$$

and the merit of a plant is described by the function

$$H = a_1G_1 + a_2G_2 + ... + a_6G_6$$

where $x_1, x_2, ..., x_6$ are the phenotypic values and $G_1, G_2, ..., G_6$ are the the genotypic worth of a plant with respect to characters $x_1, x_2, ..., x_6$

The b coefficients are determined such that the correlation between H and I is maximum. It is also assumed that the economic weight assigned to each character are equal to unity

i.e., $a_1, a_2, ..., a_6 = 1$

The expected genetic advance was also estimated at a given intensity of selection.

RESULTS

RESULTS

The data collected from the experiment were analysed and results are presented.

4.1 Analysis of variance

Analysis of variance on twenty one characters revealed the significance of all the characters except number of pickings. The mean value of these characters along with their standard error and critical difference are presented in Table 3.

4.1.1 Variability

The days taken for fifty per cent flowering of the crop ranged between 25.67 (PU-19) and 40 (Co-Bg- 9).

Days taken for pod harvest initiation ranged from 58 to 72.67. The maximum value was recorded by the varieties WBG-67 and Co-Bg-305 and minimum value by the variety PU-30.

Table 3. Mean value of twenty one characters in black gram

Genotype	Days taken for 50% flowering	Days taken for pod harvest initiation	Duration of the crop	No. of pickings	LAI	Height of the plant (cm)	No. of branches per plant	No. of nodes per plant	No. of pod clusters per plant	No. of pods per plant	Length of pod (cm)	Weight of pods (g)	No. of seeds per pod	Seed yield per plant (g)	100 seed weight (g)	Length of root (cm)	Spread of root (cm)	Days taken for completion of harvest	Stomatal distribution	Biological yield (g)	Reaction to disease (Rust %)
Co-Bg-303	34.00	61.67	89.33	3.33	3.50	40.45	2.56	10.67	16.56	56.32	4.60	25.00	6.17	19.17	5.23	19.67	23.45	27.67	12.33	5.11	0.95
Co-Bg-282	37.00	68.67	98.33	3.33	3.54	56.44	2.78	11.00	18.89	52.89	4.88	20.77	5.77	11.45	5.63	13.22	21.50	29.67	23.83	6.61	4.04
Co-Bg-305	39.67	72.67	100.33	2.67	5.63	64.34	3.33	10.56	12.78	28.89	4.20	12.45	6.10	7.94	5.04	14.01	19.28	27.67	26.33	5.72	5.96
UPU-9-40-4	36.33	63.67	95.33	3.00	4.40	50.67	3.33	12.33	17.11	48.67	4.33	17.06	6.08	13.17	5.88	14.39	27.67	31.67	18.77	7.83	4.26
PU-30	32.67	58.00	86.67	3.00	2.52	42.67	2.56	11.67	15.11	54.56	4.29	20.95	6.12	13.89	5.23	13.93	22.95	28.67	19.33	4.56	4.30
Co-Bg-307	36.67	63.33	82.00	3.00	1.95	24.78	2.33	11.67	12.56	29.89	3.74	11.95	6.24	9.61	3.47	16.17	20.22	18.67	16.22	2.69	1.23
SSRC-1	36.00	60.00	61.33	2.67	4.52	37.00	3.00	10.44	14.56	32.78	4.55	15.50	6.52	9.11	4.94	15.61	17.83	28.33	24.33	7.22	0.00
B-3-8-8-1	35.00	70.67	98.33	3.00	4.52	42.56	2.67	11.78	22.22	61.89	4.16	22.03	5.62	17.67	4.36	15.61	29.33	27.67	17.67	11.45	5.49
Co-3	38.33	70.67	97.33	3.00	2.35	53.00	2.78	10.89	13.11	31.67	4.51	16.56	6.36	12.72	5.25	18.78	18.45	26.67	16.33	6.45	4.44
Co-Bg-301	37.67	69.33	97.67	2.67	5.62	56.22	2.56	12.22	16.67	44.11	4.95	16.61	6.60	11.67	4.77	18.11	21.73	28.33	20.00	7.28	4.59
T-9	37.67	70.67	97.00	3.00	4.38	52.45	4.78	12.89	19.22	58.11	4.58	18.29	6.18	12.39	5.49	14.89	24.22	26.33	16.67	9.61	3.53
Co2	36.00	70.67	98.33	3.00	4.32	45.56	3.00	12.11	14.00	35.34	4.37	13.39	6.04	10.39	4.77	15.39	27.89	27.67	2.33	6.39	2.99
PDU-6	38.67	69.67	98.67	3.00	5.85	61.34	3.45	12.44	14.89	30.11	3.80	18.39	5.25	13.22	6.31	20.39	20.00	29.00	15.67	11.28	5.38
Co-Bg-9	40.00	70.00	99.00	3.00	8.19	80.00	4.33	12.33	23.22	69.44	4.56	22.28	5.76	15.8	5.37	14.22	33.00	29.00	21.67	10.16	19.09
Co-Bg-10	36.67	69.33	99.67	3.00	4.57	45.44	3.56	11.11	14.22	38.44	4.79	18.39	6.73	10.39	5.95	18.50	22.17	30.33	18.87	6.50	0.95
Vamban-1	31.33	59.33	78.33	3.33	2.21	41.22	3.55	12.00	15.56	49.89	4.22	20.67	5.00	14.39	4.75	17.06	21.67	19.00	19.33	6.33	0.00
Ju - 77 - 41	35.67	69.33	89.00	3.00	5.45	59.00	4.11	13.22	19.67	48.11	5.17	22.39	5.65	13.61	5.63	16.17	28.83	19.67	19.00	11.08	3.25
UH - 87 - 11	36.00	71.33	101.33	2.33	3.98	55.22	2.89	11.56	12.33	23.89	4.50	13.39	6.54	7.89	4.64	17.39	20.11	30.00	24.00	6.00	3.76
PU - 19	25.67	72.00	100.33	3.00	5.50	72.67	2.67	13.78	17.33	49.78	3.90	17.89	4.75	12.95	4.92	19.78	23.17	28.33	22.33	11.00	5.31
Co - 4	35.00	71.67	100.00	3.00	6.53	62.44	3.11	10.33	20.00	58.78	5.04	18.50	7.19	11.39	5.13	18.39	28.11	28.33	17.00	10.67	4.69
TAU - 1	36.00	72.00	99.33	3.00	5.52	49.78	2.67	12.78	17.00	52.67	4.50	19.45	7.10	14.11	5.04	12.72	22.95	27.33	10.00	8.00	8.79
TMV - 1	31.00	59.67	97.67	3.33	4.11	35.33	2.33	12.44	15.56	40.55	4.61	18.45	6.48	11.72	4.98	13.61	21.56	38.00	20.67	4.97	6.60
KM -2	36.00	71.33	100.67	2.33	2.74	42.11	3.33	12.44	14.22	38.00	4.55	17.00	6.11	14.56	4.87	17.78	22.33	29.33	13.33	4.89	2.95
KBg-368	38.33	70.33	69.00	3.00	2.22	45.67	3.78	11.33	21.78	46.22	4.09	22.95	6.41	15.89	6.04	24.06	24.56	28.67	19.19	8.97	7.95
Co-Bg - 544	35.67	69.33	99.67	2.33	5.11	53.33	3.50	11.67	12.33	46.78	3.80	17.56	4.79	14.50	6.42	17.46	22.06	30.33	21.33	5.89	3.57
VB - 11	32.00	59.33	88.67	3.33	2.19	35.78	3.33	11.33	12.78	19.78	4.35	20.78	6.05	16.17	5.53	9.61	21.72	29.33	20.33	4.11	0.96
WBG - 67	34.00	72.67	100.33	3.33	2.68	28.67	3.11	10.89	16.89	55.78	4.48	30.11	6.10	22.95	4.81	14.95	28.28	26.33	24.00	6.94	0.56
Co-Bg-309	35.00	69.00	97.67	3.00	4.20	42.56	2.78	12.67	26.34	78.78	3.67	16.67	5.79	10.95	5.00	19.67	29.33	28.67	19.00	5.94	5.34
TU -94- 2	32.33	59.33	78.67	3.67	2.61	32.44	4.22	10.33	14.78	38.11	3.67	13.86	5.66	9.61	4.45	20.5	20.17	19.33	16.33	3.78	0.00
BD -23- 11	34.00	59.67	79.00	2.00	2.59	72.22	5.22	10.34	19.00	50.56	4.44	27.69	6.65	16.78	4.90	20.17	17.78	19.33	14.00	7.22	3.01
F Values	1.73*	15.05**	1.97*	1.37	51.3**	17.7**	2.7**	1.56*	5.54**	81.94**	14.27**	4.11**	24.57**	5.22**	91.02**	3.03**	3.70**	10.98**	31.11**	5.44**	7.52**
SE	2.24	1.31	7.42	-.-	0.21	3.13	0.43	0.74	1.50	1.49	0.11	2.09	0.12	1.46	0.06	1.72	2.04	1.28	0.68	1.03	1.33
CD	6.333	3.705	20.999	-.-	0.604	8.864	1.230	2.106	4.255	4.226	0.298	5.903	0.339	4.136	0.181	4.875	5.765	3.615	1.937	2.919	3.757
Range	25.67-40.00	58.00-72.67	61.33-101.33	2.00-3.67	1.95-8.19	24.78-80.00	2.33-5.22	10.33-13.78	12.33-26.34	19.78-78.78	3.67-5.17	11.95-30.11	4.75-7.91	7.89-22.95	3.47-6.42	9.61-24.06	17.78-33.00	18.67-38.00	10.00-26.33	2.69-11.45	0.00-19.09

The variety UH-87-11 was identified as the variety with maximum crop growth period (101.33 days) and SSRC-1 with minimum growth period (61.33 days).

Eventhough number of pickings were found insignificant among the varieties, it ranged from 2 to 3.67. Maximum value was exhibited by TU-94-2 and minimum by BD-23-11.

Maximum leaf area index was recorded by the variety Co-Bg-9 (8.19) and none of the varieties was found to be on par with this variety. The minimum value was recorded by Co-Bg-307 (1.95).

Plant height ranged from 24.78 cm to 80 cm. The maximum height was observed for the variety Co-Bg-9 and the varieties PU-19 and BD-23-11 were found to be on par with Co-Bg-9. The minimum height was exibited by the variety Co-Bg-307.

Number of branches per plant ranged between 2.33 and 5.22. The maximum number of branches was noticed in the variety BD-23.14. The varieties on par with this were T-9, Co-Bg-9, TU-94-2 and JU-77-41. The varieties Co-Bg-307 and TMV-1 showed minimum value for this character.

The maximum number of nodes per plant observed was 13.78 in the variety PU-19 and the minimum of 10.33 in BD-23-11 and TU-94-2.

Number of pod clusters per plant ranged from 12.33 to 26.34. The maximum value reported was from the variety Co-Bg-309. The varieties Co-Bg-9 and B-3-8-8-1 were found to be on par with Co-Bg- 309. Minimum value was reported from UH-87-11 and Co-Bg-544.

Number of pods per plant ranged between 19.78 and 78.78. The highest value was reported from Co-Bg-309 and the lowest from VB-11. None of the varieties were found to be on par with Co-Bg-309.

The variety JU-77-41 exhibited maximum value for length of pods (5.17 cm) and minimum value by Co-Bg-309 and TU-94-2 (3.67cm). The varieties Co-4, Co-Bg-301 and Co-Bg-282 were found to be on par with JU-77-41.

Weight of pods ranged from 11.95 g (Co-Bg-307) to 30.11g (WBG-67). The varieties found to be on par with WBG-67 were BD-23-11 and Co-Bg-303.

Number of seeds per pod ranged between 4.75 and 7.91. The highest seed count per pod was observed in Co-4. The variety TAU-1 was found to be on par with Co-4. The lowest count was given by PU-19.

The highest seed yield per plant was 22.95 g in the variety WBG-67 and the variety Co-Bg-303 was found to be on par with WBG-67. The minimum value observed was 7.89 g (UH-87-11).

Hundred seed weight ranged between 3.47g. (Co-Bg-307) and 6.42 g. (Co-Bg-544). The variety PDU-6 was found to be on par with Co-Bg-544.

The variety KBg-368 was identified as the genotype with maximum tap root length (24.06 cm.). The varieties TU-94-2, PDU-6, BD-23-11, PU-19, Co-Bg-303 and Co-Bg-309 were found to be on par with KBg-368. The minimum value (9.61 cm.) was recorded by VB-11.

Root spread ranged from 17.78 cm. (BD-23-11) to 33 cm. (CO-Bg-9). The varieties B-3-8-8-1, Co-Bg-309, JU-77-41, WBG-67, Co-4, Co-2, and UPU-9-40-4 were found to be on par with Co-Bg-9.

The highest value for completion of harvest was recorded by the variety TMV-1 (38 days). None of the varieties was found to be on par with TMV-1. The lowest value reported was 18.67 days by the variety Co-Bg-307.

The highest stomatal count per microscopic field was recorded in the variety Co-Bg-305 (26.33) and the lowest in TAU-1 (10).

The biological yield per plant ranged from 2.69 g.(Co-Bg-307) to 11.45 g. (B-3-8-8-1). The varieties PDU-6, JU-77-41, PU-19, Co-4, Co-Bg-9, T-9, and KBg- 368 were found to be on par with B-3-8-8-1.

Percentage of rust incidence ranged between zero and 19.09. The highest incidence was observed from the variety Co-Bg-9 and none of the varieties were found to be as susceptable as Co-Bg-9. The lowest incidence was noticed in varieties SSRC-1, TU-94-2 and Vamban-1.

4.1.2 Genetic parameters

Genetic parameters were estimated for all the twenty one characters. Table 4 and Figure 1 indicate phenotypic and genotypic variances and coefficient of variation. Heritability and genetic advance are presented in Table 5 and Figure-2.

4.1.2.1 Phenotypic and genotypic variance

The maximum value for phenotypic variance was given by duration of the crop (218.07) followed by height of the plant (193.44) and number of pods per plant (187.41).

Number of pods per plant recorded maximum genotypic variance (180.71) followed by height of the plant (163.98) and duration of the crop (52.71).

4.1.2.2 Phenotypic and genotypic coefficient of variation

Maximum phenotypic coefficient of variation was recorded for incidence of rust disease on plants (89.27) followed by biological yield (39.31), leaf area index (37.91), number of pods per plant (29.96), seed yield per plant (29.76), number of branches per plant (29.03) and height of plant (28.19).

Table 4. Phenotypic and genotypic variance and coefficient of variation for 21 characters

Sl. No.	Character	Variance		Coefficient of variation	
		Phenotypic	Genotypic	Phenotypic	Genotypic
1.	Days taken for 50% flowering	18.70	3.66	12.23	5.41
2.	Days taken for pod harvest initiation	29.26	24.11	8.05	7.31
3.	Duration of the crop	218.07	52.71	15.94	7.84
4.	Number of pickings	0.313	0.033	18.90	6.14
5.	Leaf area index (LAI)	2.44	2.30	37.91	36.81
6.	Height of the plant	193.44	163.98	28.17	25.93
7.	Number of branches per plant	0.89	0.32	29.03	17.41
8.	Number of nodes per plant	1.97	0.31	11.99	4.75
9.	Number of pod clusters per plant	17.07	10.28	24.75	19.21
10.	Number of pods per plant	187.41	180.71	29.96	29.42
11.	Length of pod	0.182	0.149	9.74	8.81
12.	Weight of pods	26.61	13.54	27.29	19.47
13.	Number of seeds per pod	0.382	0.339	10.20	9.61
14.	Seed yield per plant	15.43	9.02	29.76	22.75
15.	100 seed weight	0.38	0.37	11.95	11.79
16.	Length of root	14.94	6.03	23.09	14.67
17.	Spread of root	23.69	11.23	20.79	14.31
18.	Days taken for completion of harvest	21.20	16.30	16.86	14.78
19.	Stomatal distribution	15.53	14.12	20.73	19.77
20.	Biological yield	7.92	4.73	39.31	30.38
21.	Reaction to disease (Rust %)	16.79	11.5	89.27	73.88

X1 — Days taken for fifty per cent flowering

X2 — Days taken for pod harvest initiation

X3 — Days taken for completion of harvest

X4 — Number of pickings

X5 — Leaf area index (LAI)

X6 — Height of the plant (cm.)

X7 — Number of branches per plant

X8 — Number of nodes per plant

X9 — Number of pod clusters per plant

X10 — Number of pods per plant

X11 — Length of pod (cm.)

X12 — Weight of pods (g.)

X13 — Number of seeds per pod

X14 — Seed yield per plant (g.)

X15 — 100 seed weight (g)

X16 — Length of root (cm.)

X17 — Spread of root (cm.)

X18 — Duration of the crop

X19 — Stomatal distribution

X20 — Biological yield (g.)

X21 — Reaction to disease

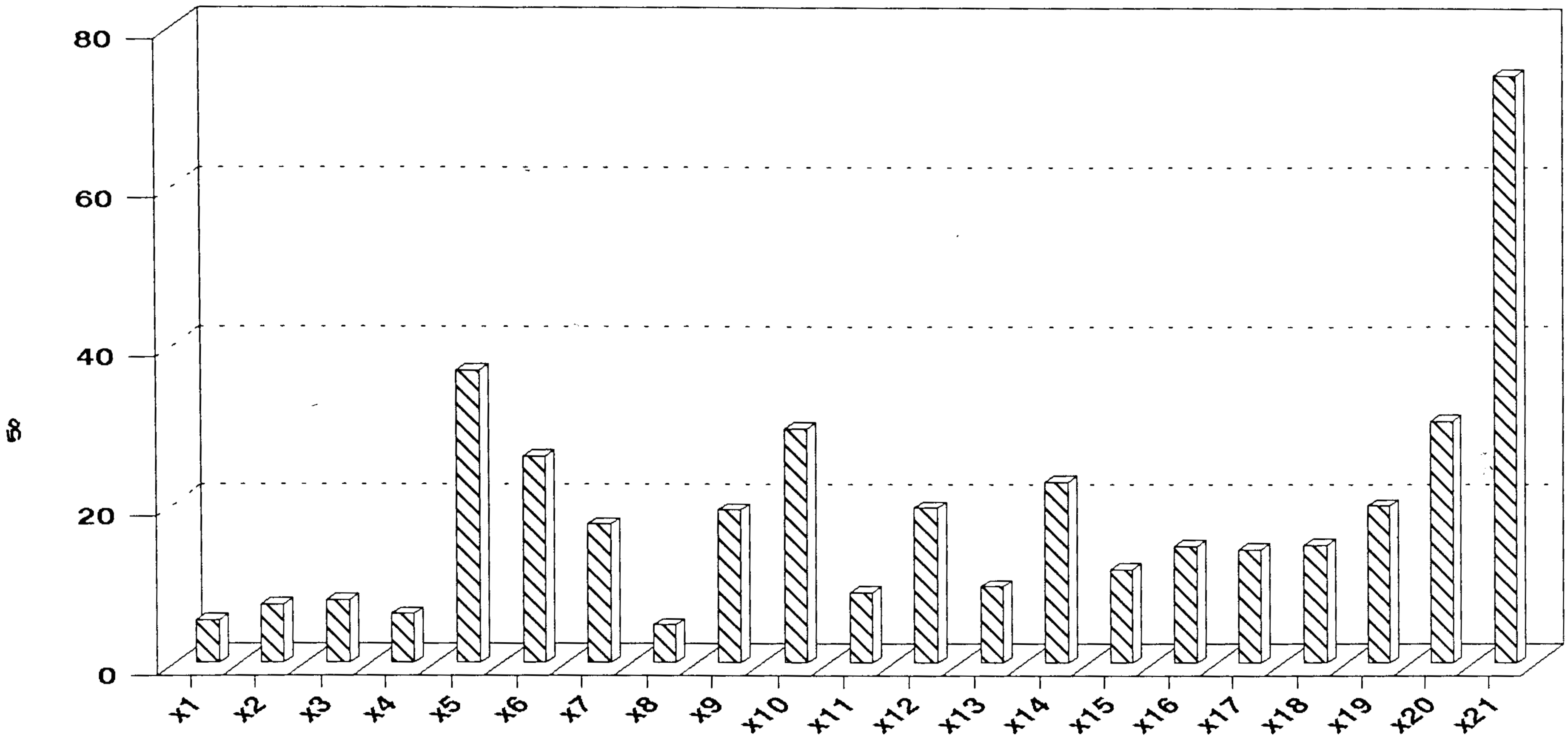

Fig. 1. Genotypic coefficient of variation for 21 characters

4.1.2.3 Heritability and genetic advance

High heritability estimates were observed for leaf area index (94.37%), height of the plant (84.77%), days taken for pod harvest initiation (82.4%), number of pods per plant (96.43%), length of pod (81.56%), number of seeds per pod (88.71%), hundred seed weight (96.78%), days taken for completion of harvest (76.89%) and stomatal distribution (90.74%). Medium estimates were obtained for number of branches per plant (36.11%), number of pod clusters per plant (60.22%), weight of pods (50.89%), seed yield per plant (58.45%), length of root (40.36%), spread of root (47.39%), biological yield (59.7%) and reaction to rust disease (68.48%). The characters, days taken for fifty per cent flowering (19.56%), duration of the crop (24.17%) number of pickings (11.07%), and number of nodes per plant (15.78%) showed comparatively low heritability estimates.

The genetic advance as percentage of mean was maximum for reaction to rust disease (75.69%) and minimum for number of nodes per plant (3.9%). Leaf area index (72.04%), height of plant (49.19%), number of pod clusters per plant (30.71%), number of pods per plant (59.52%), seed yield per

Table 5. Heritability and Genetic advance for 21 charcters

Sl. No.	Characters	Heritability percentage (H^2)	Genetic Advance (GA) %
1.	Days taen for 50% flowering	19.56	4.93
2.	Days taken for pod harvest initiation	82.41	13.67
3.	Duration of the crop	24.17	7.94
4.	Number of pickings	11.07	4.32
5.	Leaf area index (LAI)	94.37	72.04
6.	Height of the plant	84.77	49.19
7.	Number of branches per plant	36.11	21.56
8.	Number of nodes per plant	15.78	3.90
9.	Number of pod clusters per plant	60.22	30.71
10.	Number of pods per plant	96.43	59.52
11.	Length of pods	81.56	16.32
12.	Weight of pods	50.89	28.61
13.	Number seeds per pods	88.71	18.62
14.	Seed yield per plant	58.45	35.84
15.	100 seed weight	96.78	23.85
16.	Length of root	40.36	19.20
17.	Spread of root	47.39	19.95
18.	Days taken for completion of harvest	76.89	26.71
19.	Stomatal distribution	90.94	38.83
20.	Biological yield	59.70	48.35
21.	Reaction to disease (Rust %)	68.48	75.69

X1 — Days taken for fifty per cent flowering

X2 — Days taken for pod harvest initiation

X3 — Days taken for completion of harvest

X4 — Number of pickings

X5 — Leaf area index (LAI)

X6 — Height of the plant (cm.)

X7 — Number of branches per plant

X8 — Number of nodes per plant

X9 — Number of pod clusters per plant

X10 — Number of pods per plant

X11 — Length of pod (cm.)

X12 — Weight of pods (g.)

X13 — Number of seeds per pod

X14 — Seed yield per plant (g.)

X15 — 100 seed weight (g.)

X16 — Length of root (cm.)

X17 — Spread of root (cm.)

X18 — Duration of the crop

X19 — Stomatal distribution

X20 — Biological yield (g.)

X21 — Reaction to disease

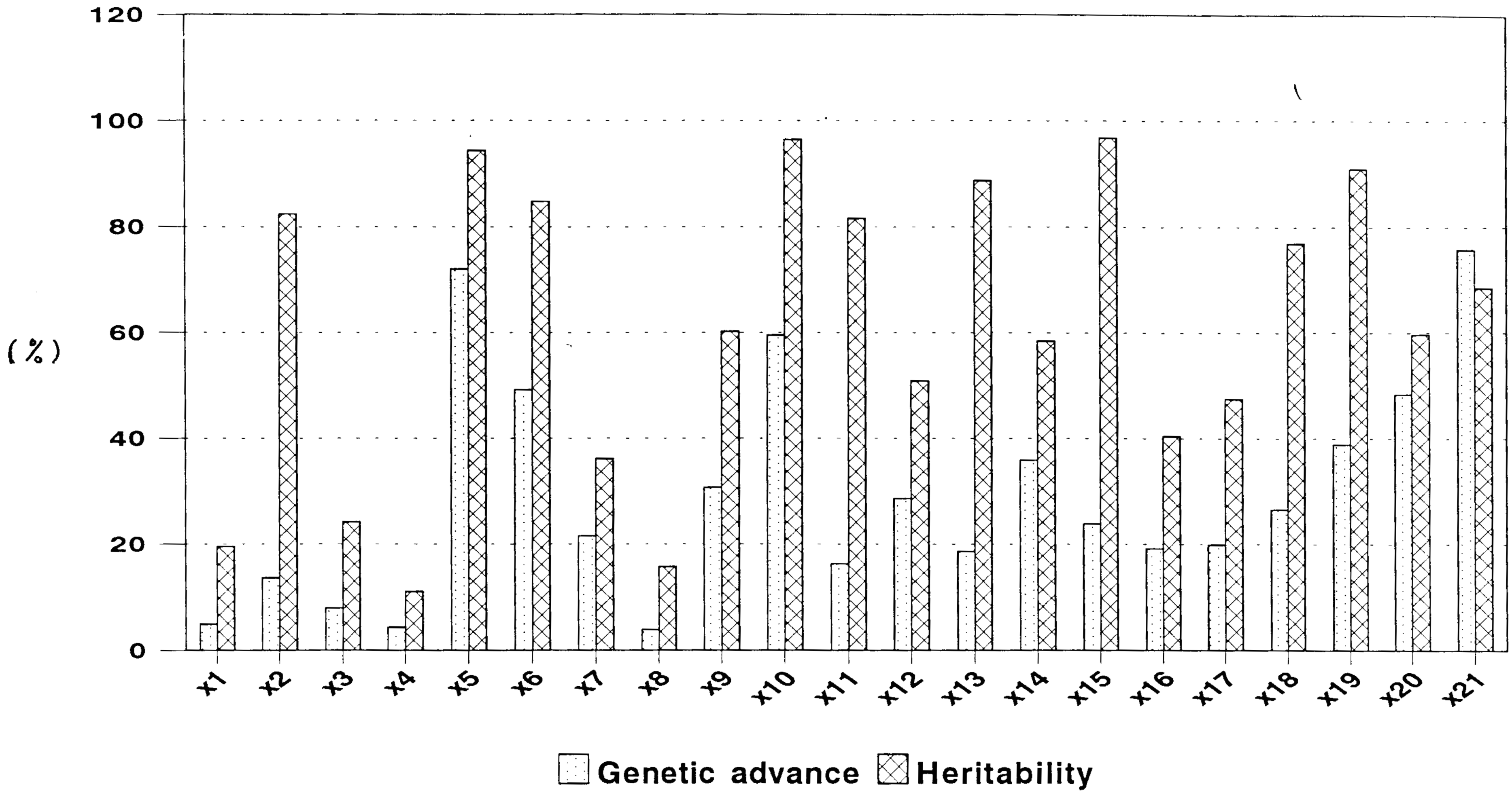

Fig. 2. Heritability and genetic advance for 21 characters

The genetic advance as percentage of mean was maximum for reaction to rust disease (75.69%) and minimum for number of nodes per plant (3.9%). Leaf area index (72.04%), height of plant (49.19%), number of pod clusters per plant (30.71%), number of pods per plant (59.52%), seed yield per plant (35.84%), stomatal distribution (38.83%) and biological yield (48.35%) recorded moderately high genetic advance while days taken for 50 per cent flowering (4.93%), days taken for pod harvest initiation (13.67%), duration of the crop (7.94%), number of pickings (4.32%), number of branches per plant (21.56%), length of pods (16.32%), weight of pods (28.61%), number of seeds per pod (18.62%), 100 seed weight (23.83%), length of root (19.2%), spread of root (19.95%) and days taken for completion of harvest (26.71) recorded comparatively lower values. Considering the parameters heritability and genetic advance, leaf area index, height of plant, number of pods per plant and stomatal distribution had higher values for both.

4.1.3 Correlations

Phenotypic and genotypic correlations between yield and other twenty characters and their *inter se* association were worked out. The data on correlations have been split up under the following categories.

i. Correlation between yield and other components

The estimate of correlation coefficient at the genotypic and phenotypic levels are given in the Table 6. All the genotypic correlations between yield and other characters were positive except for those with days taken for fifty per cent flowering, leaf area index, height of the plant, number of nodes per plant, number of seeds per pod, length of root, days taken for completion of harvest, stomatal distribution and reaction to rust disease. Weight of pods had the highest positive correlation with seed yield (0.9217) followed by number of pods per plant, spread of root, number of pod clusters per plant and number of pickings. Stomatal distribution had the highest negative influence on seed yield (-0.2983).

At the phenotypic level also weight of pods had the highest significant positive correlation with yield (0.848). Number of pods per plant, spread of root and number of pod clusters per plant also had significant positive correlation with yield followed by number of branches per plant, with positive but non-significant effect. The highest negative correlation was exhibited by stomatal distribution.

Table 6. Phenotypic and genotypic correlation coefficients of grain yield with other characters in black gram

Sl. No.	Characters	Coefficient of correlation	
		G	P
1.	Days taken for 50% flowering	-0.2722	-0.1184
2.	Days taken for pod harvest initation	0.0136	-0.0584
3.	Duration of the crop	0.1048	-0.0553
4.	No. of pickings	0.2575	0.1025
5.	LAI (leaf area index)	-0.2042	-0.1486
6.	Height of the plant	-0.0795	-0.0733
7.	No.of branches per plant	0.0509	0.2168
8.	No. of nodes per plant	-0.0678	0.0385
9.	No. of pod clusters per plant	0.2646	0.3323*
10.	No. of pods per plant	0.4362	0.3680**
11.	Length of pod	0.0494	0.0781
12.	Weight of pods	0.9217	0.8480**
13.	No. of seeds per pod	-0.1869	-0.1007
14.	100 seed weight	0.1795	0.1297
15.	Length of root	-0.0382	0.0235
16.	Spread of root	0.3538	0.3719**
17.	Days taken for completion of harvest	-0.0628	-0.0389
18.	Stomatal distribution	-0.2983	-0.2244
19.	Biological yield	0.1904	0.2152
20	Reaction to rust disease	-0.0853	-0.0435

* Significant at 0.05 level of probability
** Significant at 0.01 level of probability

ii. Correlation between pair of characters, other than those with yield.

Table 7. gives the data on correlation amongst the twenty characters in all possible combinations.

At the genotypic level days taken for fifty per cent flowering had high positive correlation with days taken for pod harvest initiation (0.6607) followed by number of branches per plant, reaction to rust disease, number of seeds per pod and 100 seed weight. Highest negative correlation was with number of pickings (-0.7305) followed by number of nodes per plant.

Days taken for pod harvest initiation showed highest positive correlation with duration of the crop (0.9381). Maximum negative influence was exhibited by number of pickings (-0.435).

Duration of the crop exhibited positive association with days taken for pod harvest initiation, leaf area index, height of plant, number of nodes per plant, spread of root,

Table 7. Phenotypic and genotypic correlation coefficients of 20 characters other than yield in black gram

		Days taken for 50% flowering	Days taken for pod harvest initiation	Duration of the crop	No. of pickings	LAI	Height of the plant (cm)	No. of branches per plant	No. of nodes per plant	No. of pod clusters plant	No. of pods per plant	Length of pod (cm)	Weight of pods (g)	No. of seeds per pod	100 seed weight (g)	Length of root (cm)	Spread of root (cm)	Days taken for completion of harvest	Stomatal distribution	Biological yield (g)	Reaction to disease (Rust %)
Days taken for 50% flowering	P	1.000	0.2702*	0.1001	-0.1431	0.1772	0.1043	-0.0323	0.0123	-0.0074	-0.0154	-0.1053	-0.1508	0.2293	0.1734	0.0987	0.0121	0.0678	-0.0342	0.0466	0.1862
	G	1.000	0.6607	0.1188	-0.7350	0.4342	0.3580	0.6367	-0.7178	0.1971	-0.1385	0.3387	-0.2091	0.4710	0.3976	-0.1597	0.1738	0.0585	0.0298	0.2562	0.6258
Days taken for pod harvest intiation	P		1.000	0.4367**	-0.1494	0.4463**	0.3631**	-0.0379	0.1489	0.1669	0.1352	0.1077	-0.1144	0.0027	0.1499	-0.1240	0.2174	0.1089	0.1274	0.3882**	0.3322*
	G		1.000	0.9381	-0.4350	0.5080	0.4300	-0.0600	0.5287	0.2438	0.1529	0.1644	-0.0707	0.0243	0.1677	0.1455	0.4798	0.2664	0.1279	0.6034	0.4025
Duration of the crop	P			1.000	0.0307	0.3302*	0.2046	-0.1753	0.1642	-0.0840	0.0945	0.1100	-0.1452	-0.0016	0.0905	-0.1876	0.1459	0.3003*	0.0026	0.0348	0.2542
	G			1.000	-0.3370	0.6567	0.4992	-0.3357	0.8726	0.1348	0.2381	0.2559	-0.0205	-0.1254	0.2003	-0.3374	0.6146	0.6732	0.1081	0.4159	0.4071
No. of pickings	P				1.000	-0.0951	-0.2890*	0.0569	-0.0793	0.2016	0.0830	-0.0638	0.1058	-0.0671	-0.0321	-0.0853	0.1039	-0.0256	-0.0331	-0.0545	-0.0501
	G				1.000	-0.2963	-0.7921	-0.9372	0.3435	0.0059	0.2812	-0.0749	0.1672	-0.3555	-0.0754	-0.4531	0.6266	-0.0419	0.0324	-0.1136	-0.1954
LAI Leaf area index	P					1.000	0.6295**	0.0526	0.2291	0.2645*	0.2785*	0.2273	-0.0843	-0.0415	0.2656*	-0.0770	0.3469**	0.2800*	0.1540	0.5420**	0.5564**
	G					1.000	0.6802	0.0722	0.5357	0.3299	0.2960	0.2615	-0.1537	-0.0306	0.2798	-0.1176	0.4868	0.3395	0.1735	0.6998	0.6650
Height of the plant (cm)	P						1.000	0.2601	0.1656	0.2520	0.1934	0.1918	0.0634	-0.1147	0.3267*	0.1414	0.1229	0.0399	0.1032	0.5686**	0.5064**
	G						1.000	0.5135	0.2954	0.3148	0.2208	0.2470	0.0991	-0.1085	0.3712	0.1472	0.1305	0.0741	0.0937	0.6503	0.6564
No. of branches per plant	P							1.000	-0.2038	0.2931*	0.0905	0.0187	0.3681**	-0.0547	0.2328	0.0905	0.0162	-0.3049*	-0.1033	0.2732*	0.1557
	G							1.000	0.1450	0.1456	0.1305	0.0628	0.1851	-0.1200	0.3872	0.3332	0.0925	-0.5288	-0.1386	0.2524	0.0363
No. of nodes per plant	P								1.000	0.1652	0.1410	-0.1020	-0.0289	-0.2304	0.0633	-0.0346	0.2557	0.1488	-0.0403	0.3332*	0.1977
	G								1.000	0.4052	0.4050	-0.0507	-0.2384	-0.6511	0.1682	-0.2875	0.6176	0.2020	-0.1705	0.4946	0.6261
No. of pod clusters per plant	P									1.000	0.7350**	0.0202	0.4233**	-0.0061	0.0723	0.1796	0.5227**	0.0012	-0.0942	0.5132**	0.3483**
	G									1.000	0.9303	0.1240	0.4474	-0.0112	0.0882	0.2229	0.8306	-0.0178	-0.1245	0.5916	0.6011
No. of pods per plant	P										1.000	0.0614	0.4137**	-0.0948	0.0491	0.0946	0.5793**	0.0009	-0.1609	0.3308*	0.3521**
	G										1.000	0.0601	0.5423	-0.1140	0.0599	0.0998	0.7737	-0.0045	-0.1686	0.4301	0.4177
Length of pod (cm)	P											1.000	0.2382	0.4794	0.1257	-0.1741	0.1703	0.1460	0.0119	0.1595	0.0290
	G											1.000	0.3127	0.5610	0.1359	-0.3921	0.1284	0.1705	0.0386	0.2779	0.0704
Weight of pods (g)	P												1.000	0.0097	0.1889	0.0927	0.2696*	-0.0597	-0.1413	0.3059*	0.0641
	G												1.000	-0.0195	0.2851	-0.0477	0.3365	-0.1164	-0.2021	0.2798	0.0951
No. of seeds per pod	P													1.000	-0.1700	-0.0515	-0.0853	0.1303	-0.2499	-0.1412	0.0263
	G													1.000	-0.1793	-0.1344	-0.1360	0.1630	-0.2449	-0.1459	0.0213
100 seed weight (g)	P														1.000	0.0421	0.0639	0.3808**	0.0514	0.2828*	0.1628
	G														1.000	0.1150	0.0990	0.4430	0.0465	0.3735	0.2221
Length of root (cm)	P															0.000	-0.0947	-0.1817	-0.2061	0.1266	-0.0988
	G															1.000	-0.1659	-0.2925	-0.3372	0.2432	-0.0811
Spread of root (cm)	P																1.000	0.0894	0.0597	0.4119**	0.3554**
	G																1.000	0.1543	0.0690	0.5162	0.5487
Days taken for completion of harvest	P																	1.000	0.2411	0.0634	0.2259
	G																	1.000	0.2964	0.0466	0.4096
Stomatal distribution	P																		1.000	-0.0081	0.0194
	G																		1.000	-0.0250	0.0452
Biological yield (g)	P																			1.000	0.3734*
	G																			1.000	0.4945
Reaction to rust disease	P																				1.000
	G																				1.000

* Significant at 0.05 level of probability

** Significant at 0.01 level of probability days taken for completion of harvest, biological yield and reaction to rust disease. Its association with days taken for pod harvest initiation showed highest positive correlation value (0.9381) while with length of root it exhibited highest negative association (-0.3374).

Number of pickings showed negative association with all characters except number of nodes per plant, number of pod clusters per plant, number of pods per plant, weight of pods, spread of root and stomatal distribution. Highest positive association was reported with spread of root (0.6266) and negative association with number of branches per plant (-0.9372).

Very high positive correlation was observed at the genotypic level between leaf area index and biological yield (0.6998) followed by height of plant, reaction to rust disease and duration of the crop. High negative influence was exhibited with number of pickings (-0.2963).

Height of the plant exhibited positive correlation with all characters except with number of pickings and number of seeds per pod at the genotypic level. Among these the highest value was reported with leaf area index (0.6802). The highest negative correlation value was -0.7921 with number of pickings.

At the genotypic level number of branches per plant showed high positive correlation with days taken for 50 per cent flowering (0.6367) followed by height of plant, 100 seed weight, length of root and biological yield. Highest negative correlation was observed with number of pickings (-0.9372).

Number of nodes per plant showed positive correlation with all characters except with days taken for 50 per cent flowering, length of pods, weight of pods, number of seeds per pod , length of root and stomatal distribution. Duration of the crop exhibited highest positive correlation with number of nodes per plant (0.872) and negative correlation with days taken for 50 per cent flowering (-0.7178).

Very high positive correlation was observed between number of pod clusters per plant and number of pods per plant (0.9303) followed by spread of root (0.8306), reaction to rust disease (0.6011) and biological yield (0.5916). Highest negative association was recorded with stomatal distribution (-0.1245).

At the genotypic level number of pods per plant exhibited positive correlation with all the characters except with days taken for 50 per cent flowering, number of seeds per pod, days taken for completion of harvest and stomatal distribution. The highest value was with number of pod clusters per plant (0.9303). Highest negative correlation was with stomatal distribution (-0.1686).

Length of pod exhibited maximum genotypic correlation with number of seeds per pod (0.561) followed by days taken for 50 per cent flowering (0.3387), weight of pods (0.3127) and biological yield (0.2779). Highest negative correlation was observed with length of root (-0.3921) at the genotypic level.

Weight of pods exhibited highest negative correlation with number of nodes per plant (-0.2384). It also showed high positive correlation with number of pods per plant (0.5423), number of pod clusters per plant (0.4474), spread of root (0.3365) and length of pods (0.3127). With all other characters it recorded low correlation values.

Number of seeds per pod showed negative correlation with all characters except with days taken for 50 per cent flowering, days taken for pod harvest initiation, length of pod, days taken for completion of harvest and reaction to rust disease. Among these, highest value was recorded with length of pods (0.561) followed by days taken for 50 per cent flowering. Highest negative correlation was found to be with number of nodes per plant (-0.6511).

Hundred seed weight was reported to be positively associated with all characters except with number of pickings and number of seeds per pod at the genotypic level. Its correlation with days taken for completion of harvest exhibited highest positive value of 0.443 followed by days taken for 50 per cent flowering (0.3976), number of branches per plant (0.3872) and height of the plant (0.3712).

Mean length of root was positively correlated with days taken for pod harvest initiation, height of the plant, number of branches per plant, number of pod clusters per plant, number of pods per plant, 100 seed weight and biological yield. The highest positive correlation was observed to be with number of branches per plant (0.3332) and negative association with number of pickings (-0.4531).

At the genotypic level spread of root was positively correlated with almost all the characters except number of seeds per pod and length of root, which recorded the highest negative value of -0. 1659 with length of root. Positive correlation value of this character is maximum with number of pod clusters per plant (0.8306) followed by number of pods per plant (0.7737), number of pickings (0.6266), number of nodes per plant (0.6176) and duration of the crop (0.6146).

The highest negative association was observed between days taken for completion of harvest and number of branches per plant (-0.5288) at the genotypic level. Duration of the crop showed highest positive correlation of 0.6732 with days taken for completion of harvest.

Y — Seed yield per plant (g.)

X1 — Days taken for fifty per cent flowering

X2 — Days taken for pod harvest initiation

X3 — Days taken for completion of harvest

X4 — Number of pickings

X5 — Leaf area index (LAI)

X6 — Height of the plant (cm.)

X7 — Number of branches per plant

X8 — Number of nodes per plant

X9 — Number of pod clusters per plant

X10 — Number of pods per plant

X11 — Length of pod (cm.)

X12 — Weight of pods (g.)

X13 — Number of seeds per pod

X14 — 100 seed weight (g.)

X15 — Length of root (cm.)

X16 — Spread of root (cm.)

X17 — Duration of the crop

X18 — Stomatal distribution

X19 — Biological yield (g.)

X20 — Reaction to rust disease

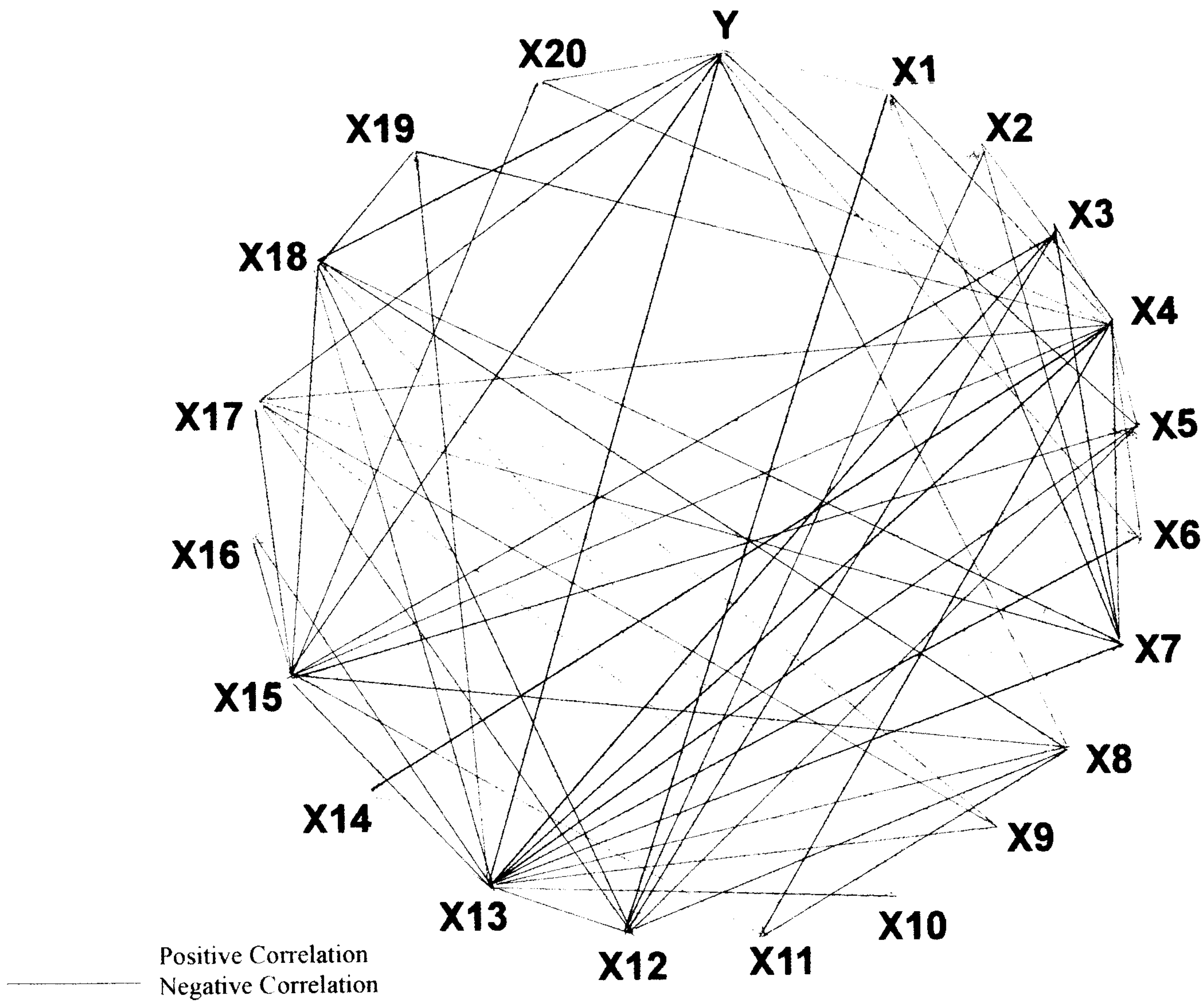

Fig. 3. Correlation Diagram

Among the genotypic correlation coefficient of stomatal distribution with other characters, days taken for completion of harvest had highest positive value (0.2964). Length of root had highest negative correlation value (-0.3372).

Biological yield of the plant had positive correlation with all the characters except with number of pickings, stomatal distribution and number of seeds per pod (-0.1459) which was the highest negative value. Leaf area index (0.6998) was found highly correlated with this character followed by height of the plant (0.6503) and days taken for pod harvest initiation (0.6034).

Number of pickings and length of root showed low negative genotypic correlation with rust disease incidence.

The genotypic relationship between yield and other characters are diagramatically represented in Figure 3.

4.1.4 Selection Index

Selection index is used for scoring varieties based on the index value prepared by using components of yield and adaptability. Leaf area index, number of pods per plant, weight of pods, number of seeds per pod and 100 seed weight were concluded to be the major characters contributing to yield and adaptability. So they were selected for the formulation of selection indices along with yield. The selection index prepared based on yield and other characters are presented in Table 8.

The b coefficients calculated for the characters were as follows.

Leaf are index = -0.0743

Number of pods per plant = 1.1390

Weight of pods = 0.1463

Number of seeds per pod = 0.7209

Grain yield per plant = 0.6382

100 seed weight = 3.4671

The highest index was recorded by the variety Co-Bg-309 (361.0716) followed by Co-Bg-9 (343.7933) B-3-8-8-1

Table 8. Selection index (Score) for thirty different varities of black gram

Sl. No.	Varieties	Selection index
1	Co-Bg-309	361.07
2	Co-Bg-9	343.79
3	B-3-8-8-1	311.44
4	WBG-67	310.37
5	Co-Bg-303	307.07
6	T-9	299.81
7	Co-4	298.25
8	PU-30	289.27
9	TAU-1	282.11
10	Co-Bg-282	281.97
11	BD-23-14	281.76
12	KBg-368	274.66
13	UPU-9-40-4	272.27
14	Co-Bg-544	271.26
15	JU-77-41	269.88
16	Vamban-1	266.86
17	PU-19	262.95
18	Co-Bg-301	242.94
19	Co-Bg-10	234.79
20	TMV-1	234.03
21	KM-2	228.43
22	TU-94-2	212.64
23	PDU-6	211.99
24	Co-2	208.19
25	Co-3	207.70
26	SSRC-1	200.68
27	Co-Bg-305	183.74
28	VB-11	177.80
29	Co-Bg-307	174.90
30	UH-87-11	164.17

(311.4375) etc. in that order. Twenty per cent selection was exercised and the varieties Co-Bg-309, Co-Bg-9, B-3-8-8-1, WBG-67, Co-Bg-303 and T-9 were identified as superior varieties.

DISCUSSION

DISCUSSION

Selection is one of the fundamental plant breeding methods employed for developing superior varieties. Selection based on yield alone is not very efficient,but based on its components as well could be more efficient (Evans,1978).Only very limited information is available on the variability and correlation among various characters in black gram under rice fallow condition. So evaluation of genetic variability on hand is indispensable. The present study was hence taken up to estimate some of the basic parameters of quantitative variability and also to prepare a selection index based on major yield contributing characters.

The results obtained in this study are discussed below.

5.1. Variability

The extent of genetic variation available for yield and its components is useful to the breeder. The naturally occuring variations in populations of self pollinated species form the primary basis for improvement of the species

(Allard, 1960). So in a self pollinated crop like black gram naturally occuring variability is of utmost importance.

Analysis of variance on twenty one characters revealed significant differences for all the characters except number of pickings. This shows the existence of high variability for majority of the characters in the thirty varieties of black gram studied. Similar trend was reported by Saji (1988) for number of days to pod harvest initiation, height of the plant, number of branches per plant and leaf area index in black gram. Anitha (1989) reported significant difference among varieties of green gram for plant height, pod length, number of seeds per pod, 100 seed weight, seed yield per plot, stomatal distribution, leaf area index, root length, root spread, days to maturity and days taken for completion of harvest in accordance with the result obtained in the present study. Same result was reported by Elizabeth (1991) for height, number of branches per plant, number of pods per plant, number of seeds per pod, seed yield per plant, length of pod and 100 seed weight in horse gram.

Phenotypic variability is the measurable variability which is the result of genetic and environmental effect. This cannot be utilised for varietal improvement. The variability present in a population can be partitioned into heritable and non-heritable components and heritable component is utilised for crop improvement.

In this study, the estimates of variance components indicated only little difference between phenotypic and genotypic variance for the characters viz. days taken for pod harvest initiation, leaf area index, length of pods, number of seeds per pod, 100 seed weight and stomatal distribution. This shows that the variation observed in these characters was mainly due to the genetic causes and the environment had only very little influence. Wider difference between the phenotypic and genotypic variances was recorded for the characters days taken for fifty per cent flowering, duration of the crop, height of the plant, weight of pods, seed yield per plant, length of root, spread of root and reaction to rust disease. Philip (1987) reported similar results in black gram. Siby (1994) reported narrow difference between the phenotypic and genotypic variance in black gram for the character days taken for fifty per cent flowering, which is contrary to the present study.

Coefficient of variation is another means of expressing the amount of variability. In the present study phenotypic and genotypic coefficients of variation were highest for incidence of rust disease, which indicate that the varieties under study showed varying degrees of susceptibility to rust. High values of phenotypic coefficient of variation with correspondingly high values of genotypic coefficient of variation were recorded for biological yield, leaf area index, number of pods per plant, seed yield per plant and height of the plant, indicating the presence of high amount of genetic variability and scope for their improvement through selection. Similar trends were reported for number of pods per plant by Singh and Misra (1985) in black gram, Liu et al. (1984) in green gram, Shoram (1983) in red gram, Singh (1985) in pea, Suraiya et al. (1988) in horse gram and Arora (1991) in chickpea. For seed yield per plant high genotypic coefficient of variation was reported by Sagar et al. (1976) in black gram, Ali and Shaikh (1987) in green and Godawat (1980) in red gram. But quite contrary to this result Singh et al. (1975) in black gram and Ratnaswamy et al. (1978) in green gram reported low values of genotypic coefficient of variation for grain yield and Khorgade et al. (1985) in bengal gram for plant height.

High values of phenotypic coefficient of variation with comparatively low value of genotypic coefficient of variation were recorded for the characters viz. number of branches per plant, number of pod clusters per plant, weight of pods, length of root and stomatal distribution which was in accordance with the finding of Philip (1987) for number of pod clusters per plant in black gram. The wide difference between these two parameters revealed the influence of environment in the expression of these characters. Contrary results have been reported for number of branches per plant in black gram by Sandhu et al. (1978) and Pillai (1980), in cowpea by Radhakrishnan and Jebaraj (1982), in red gram by Bainiwal (1981) and in chickpea by Sharma et al. (1990).

All the other characters viz. days taken for fifty per cent flowering, days taken for pod harvest initiation, duration of the crop, number of pickings, number of nodes per plant, length of pod, number of seeds per pod, 100 seed weight and days taken for completion of harvest exhibited low phenotypic and genotypic coefficient of variation. Similar results were obtained by Sandhu et al. (1978) for length of pod and Philip (1987) for all the above mentioned characters in black gram. Low genotypic coefficient of variation for number of seeds per pod was reported by Dharmalingam and Kadambavanasundaram (1984) in cowpea.

5.2 Heritability and genetic advance

Selection act on genetic difference and gains from selection for a particular character depends largely on the heritability of the character (Allard, 1960). So it is clearly evident that genotypic coefficient of variation alone is not sufficient for successful selection. According to Burton (1952) genotypic coefficient of variation along with heritability will give a clear idea about the amount of genetic advance to be expected by selection.

Hundred seed weight, number of pods per plant, leaf area index, stomatal distribution, number of seeds per pod, height of the plant, days taken for pod harvest initiation, length of pod and days taken for completion of harvest were the characters with high heritability estimates. The high value indicates highly heritable nature and minimum influence of the environment in the phenotypic expression of these characters.

Patel and Shah (1982) in black gram and Roquib and Patnaik (1990) in cowpea reported similar findings for plant height, pod length and number of seeds per pod. Patil and Narkhede (1987) reported high heritability for pod length and plant height in black gram which are in consonance with this study. Sarkar et al. (1984) in blackgram, Jivani and Yadavendra (1988) and Misra (1991) in chickpea reported same trend for 100 seed weight and number of pods per plant. For 100 seed weight a hundred per cent heritability was reported by Paramasivan and Rajasekaran (1980) in green gram.

The high heritability estimate obtained in respect of leaf area index was in agreement with the finding of Philip (1987) and Saji (1988) in black gram. Thiagarajan et al. (1989) in Nigerian cowpea observed high heritability values for height of plant, number of pods per plant and number of seeds per pod. However the findings of Siby (1994) in black gram with regard to number of pods per plant and number of seeds per pod were contrary to the present study.

Moderate heritability estimates were observed for number of branches per plant, number of pod clusters per plant, seed yield per plant, weight of pods, length of root, spread of root, biological yield and reaction to rust disease. Philip (1987) in black gram reported same results for number of branches per plant and length of root. But Paramasivan and Rajasekaran (1980) and Ramana and Singh (1987) in green gram for pod clusters per plant and seed yield, Godawat (1980) and Bainiwal (1981) in pigeon pea for number of branches per plant reported high heritability in contrary to this study. Result obtained by Patil et al. (1990) in pigeon pea for biological yield was also not in consonance with the present result.

Low heritability estimates were recorded for days to fifty per cent flowering, duration of the crop, number of pickings and number of nodes per plant. Philip (1987) reported moderate heritability for days to fifty per cent flowering in black gram. While a high heritability was reported for the same character by Roquib and Patnaik (1990) in cowpea, which is not in agreement with this result.

Eventhough heritability estimates are useful in the selection of superior genotypes on the basis of phenotypic performance of the characters, it doesnot give a clear picture on the extent of improvement that can be achieved. Hence, Johnson et al. (1955) suggested that along with the heritability estimates, the genetic advance should also be considered for identifying characters during selection programme. According to Panse (1957), the characters with high heritability and high genetic advance were controlled by additive gene action and therefore amenable to genetic improvement through selection. In the present study comparatively high heritability estimate along with high genetic advance was recorded for the characters viz. leaf area index, plant height, number of pods per plant and stomatal distribution. These characters can be considered during selection programme for the improvement of the crop. The high heritability and genetic advance estimates obtained in this study for height and number of pods per plant was in agreement with the findings of Thiagarajan et al. (1989) in cowpea, Patel and Patel (1992) in pigeon pea and Misra (1991) in chickpea. Saji (1988) in black gram reported same result for leaf area index. In the case of plant height Sarkar et al. (1984) in black gram, Raut and Patil (1975) in soya bean and Lakshmi and Goud (1977) in cowpea reported high values of genetic gain.

Genetic gain was maximum for rust disease incidence (75.69%) but had only moderate heritability. Biological yield, seed yield per plant and number of pod clusters per plant had high genetic advance estimates, which are in confirmity with the findings of Siby (1994) in black gram and Patil et al. (1990) in pigeon pea for grain yield and biological yield. For seed yield and number of pod clusters per plant Paramasivan and Rajasekaran (1980) in green gram and Thiagarajan et al. (1989) in cowpea reported same result. But these three traits had only moderate heritability.

Length of pods, number of seeds per pod and days taken for pod harvest initiation had high heritability coupled with comparatively low genetic gain. This indicates non-additive gene action which greatly limit the scope for improvement of these characters through selection (Panse, 1957). Phlip (1987) reported similar result for days taken for pod harvest initiation in black gram.

Number of branches per plant, weight of pods, 100 seed weight, length of root, spread of root and days taken for completion of harvest had only moderate values for both heritability and genetic gain, which again limits the scope for improvement of the crop based these traits . Days taken for fifty per cent flowering, duration of the crop, number of pickings and number of nodes per plant showed low heritability and low genetic gain suggesting poor response for selection under normal situation.

5.3 Correlation

Correlation provides information on the nature and extend of association between characters in a population. The component characters always show inter-relationship. When the breeder applies selection pressure on a trait, the population under selection is not only improved for that trait, but also improved in respect of other characters associated with it. This facilitates simultaneous improvement of two or more characters. Therefore,analysis of yield in terms of genotypic and phenotypic correlation coefficient of component characters leads to the understanding of characters that can form the basis of selection. The genotypic correlation between the characters provides a reliable measure of genetic association between the characters and helps to differentiate the vital association useful in breeding from non - vital ones (Falconer, 1981). Here correlation between grain yield per plant and other 20 characters and their inter correlations were estimated.

5.3.1. Correlation between grain yield per plant and other characters.

Seed yield per plant exhibited positive genotypic correlation with days taken for pod harvest initiation, duration of the crop and number of pickings. This was in consonance with the findings of Philip (1987) for days taken for pod harvest initiation in black gram and Singh (1985) in cowpea. Number of branches per plant showed positive correlation with yield. Similar results were observed by Muthiah and Sivasubramanian (1981) and Verma (1992) in black gram, Satyan et al. (1989) and Pundir et al. (1992) in green gram, Tyagi and Koranne (1988) in cowpea, Patel and Patel (1992) in pigeon pea.

The positive genotypic correlation of grain yield with number of pod clusters per plant observed in this study was in unison with the results of Waryari (1988) in black gram, Malik et al. (1987) and Raut et al. (1988) in greengram, Siddique and Gupta. (1991) in cowpea and Naidu et al. (1985) in broad bean.

The high positive genotypic correlation of number of pods per plant and weight of pods with seed yield observed in this study was in agreement with the report of Sudha Rani (1989) and Siby (1994) in black gram, Pundir et al. (1992) in green gram, Patil and Bhapkar (1987) in cowpea, Sharma and Maloo (1988) in chickpea.

Length of pod and 100 seed weight had positive correlation with seed yield. Similar trends were reported by Patil and Narkhede (1987), Ranganayaki and Sreerangasamy (1992) in black gram, Pundir et al. (1992) in green gram and Patil et al. (1989) in cowpea.

Spread of root and biological yield also showed positive association with seed yield which is in confirmity with the reports of Siby (1994) in black gram. For biological yield similar results were reported by Kumar and Arora (1991) in chickpea and Singh et al. (1992) in rice bean.

In the present study days taken for fifty per cent flowering exhibited negative association with seed yield which is contrary to the results of Philip (1987) in black gram and Patil et al.(1989) in cowpea. Leaf area index, plant height and number of seeds per pod had negative correlation with grain yield which was in agreement with the finding of Anitha (1989) in green gram. Rust disease incidence showed negative correlation with seed yield. This indicate the adverse effect of this disease on yield.

By looking at the correlation of other characters with yield it can be concluded that per plant yield can be improved by exercising selection for the characters pod clusters per plant, number of pods per plant, length of pod, 100 seed weight, spread of root and biological yield.

5.3.2. Inter-se correlation between other characters.

The positive association of days taken for fifty per cent flowering with days to pod harvest initiation , number of branches per plant, number of seeds per pod and 100 seed weight has helped to conclude that days taken for fifty per cent flowering is an index for number of days needed to initiate pod harvest. This is in confirmity with the findings of Philip (1987) in black gram. It can also be inferred that late flowering lines had more branches, more number of seeds per pod and increased seed weight. Number of pickings and number of pods per plant were negatively correlated with days to fifty per cent flowering which indicate that the late flowering plants produced only limited number of pods. Abraham et al.(1992) in black gram reported contradictory results for positive correlation of days to fifty per cent flowering with numbers of seeds per pod.

Days taken for pod harvest initiation had positive correlation with duration of the crop, leaf area index, height of the plant, number of nodes per plant, number of pod clusters per plant, spread of root, days taken for completion of harvest and biological yield. These results help to conclude that lines which took longer time for pod harvest initiation were taller, with more number of pod clusters and also with increased biological yield.

The positive association of duration of the crop with height, leaf area index, spread of root, days taken for completion of harvest and biological yield showed that long duration types were taller with more leaves, good root spread and with good dry matter production.

Leaf area index exhibited positive correlation with all the characters except number of pickings, weight of pods, number of seeds per pod and length of root which is in agreement with the findings of Singh _et al._ (1977) in pigeon pea and Anitha (1989) in green gram.

Positive association of plant height with number of pod clusters per plant, number of branches per plant, number of pods per plant and pod length was in accordance with the findings of Muthiah and Sivasubramanian (1981) in black gram and Upadhaya _et al._ (1980) in green gram. These results indicate that taller plants produced more number of pods with more branches and longer pods.

At the genotypic level positive association of branches per plant with plant height was in confirmity with the finding of Angadi (1976) in cowpea. This character shows positive association with 100 seed weight, length of root and also with biological yield. Malhotra _et al_. (1974) in green gram reported significant association between number of branches and number of seeds per pod which is contrary to the results of present study.

Number of pod clusters per plant was positively correlated with number of pods per plant which is in confirmity with the results obtained by Sandhu et al. (1980) in black gram. Number of pods per plant recorded positive genotypic correlation with biological yield. Uprety et al. (1979) in cowpea and Abraham et al. (1992) in black gram observed same results.

Weight of pods was positively associated with number of pods per plant, number of pod clusters per plant and length of pod suggesting simultaneous improvement of these traits. Hundred seed weight was found positively correlated with all characters except with number of seeds per pod. This indicates that highest improvement in yield can be achieved by increasing 100 seed weight.

Length of root and spread of root had positive association with major yield components like number of pod clusters per plant, number of pods per plant and 100 seed weight. The high positive association of days taken for completion of harvest and duration of the crop clearly indicate that as the day for completion of harvest increases duration of the crop also increases.

Biological yield had positive correlation with leaf area index, height of the plant, number of pods per plant and pod clusters per plant in accordance with the finding of Siby (1994) in black gram. This shows the simultaneous improvement of these characters.

5.4 Selection index.

A selection index was formulated to increase the efficiency of selection taking into account the yield and the important characters contributing to yield and adaptability like leaf area index, number of pods per plant, weight of pods, number of seeds per pod and 100 seed weight. Earlier Sudha Rani (1989) constituted a selection index for selection of drought tolerant varieties based on drought tolerant parameters and selected top ranking five varieties. Similarly, based on the index constructed, twenty per cent selection was exercised and top ranking six superior varieties viz. Co - Bg 309, Co - Bg - 9, B - 3 - 8 - 8 - 1, WBG - 67, Co - Bg - 303 and T - 9 were identified and recommended for future use in breeding programme.

SUMMARY

The present study was conducted at the Department of Plant Breeding and Genetics, College of Agriculture, Vellayani during January to April 1995 to asses the yield potential and adaptability of black gram varieties in summer rice fallows.

Thirty varieties from different agroclimatic conditions were evaluated in a randomised complete block design with three replications. Data were collected from ten plants selected at random from a population size of hundred plants per entry on twenty one characters viz. days taken for 50 per cent flowering, days taken for pod harvest initiation, duration of the crop, number of pickings, leaf area index, height of the plant, number of branches per plant, number of nodes per plant, number of pod clusters per plant, number of pods per plant, length of pod, weight of pods, number of seeds per pod, seed yield per plant, 100 seed weight, length of root, spread of root, days taken for completion of harvest, stomatal distribution, biological yield and reaction to rust disease. The mean was worked out and subjected to statistical analysis.

SUMMARY

Salient findings of the study are the following :

Analysis of variance showed significant difference among the varieties with respect to all the characters except number of pickings. This indicates the presence of sufficient variability for all the afore mentioned characters in the thirty black gram varieties evaluated.

High genotypic and phenotypic coefficients of variation were observed for the characters, incidence of rust disease, leaf area index, biological yield, seed yield per plant and height of plant. This indicates immense exploitable variability reserve in these lines and the scope for improvement through selection.

High heritability estimates observed for leaf area index, height of plant, days taken for pod harvest initiation, number of pods per plant, length of pod, number of seeds per pod, 100 seed weight, days taken for completion of harvest and stomatal distribution promulgate meagre influence of the environment in the expression of these characters.

Genetic advance was maximum for reaction to rust disease followed by leaf area index, height of plant, number of pod clusters per plant, stomatal distribution and biological yield.

High heritability coupled with high genetic advance recorded for leaf area index, height of plant, number of pods per plant and stomatal distribution helps to deduce that permanent improvement can be achieved by imparting selection on these traits.

Correlation values of grain yield with number of pickings, number of branches per plant, number of pod clusters per plant, number of pods per plant, length of pod, days taken for pod harvest initiation, weight of pods, 100 seed weight, spread of root, duration of the crop and biological yield were positive. Weight of pods had the highest positive correlation coefficient followed by number of pods per plant and number of pod clusters per plant indicating that yield can be increased indirectly by improving these components.

High heritability, genetic advance and correlation of number of pods per plant with seed yield; moderate heritability, genetic advance and high correlation of number of pod clusters per plant with seed yield help to conclude that improvement of these traits ultimately result in increased yield.

A selection index is formulated to improve the efficiency of selection based on the characters, leaf area index, number of pods per plant, weight of pods, number of seeds per pod, grain yield and 100 seed weight. The varieties are ranked and top ranking six varieties viz. Co-Bg-309, Co-Bg-9, B-3-8-8-1, WBG-67, Co-Bg-303 and T-9 are selected by exercising twenty per cent selection.

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YIELD POTENTIAL AND ADAPTABILITY OF BLACK GRAM GENOTYPES FOR RICE FALLOWS

By

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ABSTRACT OF THE THESIS

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ABSTRACT

A research programme was carried out at the Department of Plant Breeding and Genetics, College of Agriculture, Vellayani during January-April 1995 with the objective of assessing yield potential and adaptability of black gram genotypes in summer rice fallows. Thirty varieties were evaluated adopting a randomised complete block design with three replications. Data on twenty one characters were collected and subjected to statistical analysis. Analysis of variance revealed significant difference among the varieties for all the characters except number of pickings. Genotypic and phenotypic coefficients of variation were highest for incidence of rust disease, leaf area index, biological yield, seed yield per plant and height of plant. High heritability coupled with high genetic advance was recorded for leaf area index, height of plant, number of pods per plant and stomatal distribution suggesting the reliability of these characters during selection

programme. High positive genotypic correlation of pod weight, number of pods per plant and number of pod clusters per plant with grain yield has indicated that selection based on the above components result in the improvement of grain yield. Selection index based on yield contributing characters has enabled to select six high yielding adaptable black gram genotypes viz. Co-Bg-309, Co-Bg-9, B-3-8-8-1, WBG-67, Co-Bg-303 and T-9.