GENETIC ANALYSIS OF SEGREGATING GENERATION OF INTER VARIETAL CROSSES IN GREENGRAM (*Vigna radiata* (L.) Wilczek)

By

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THESIS
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1999

DECLARATION

I hereby declare that this thesis entitled "**Genetic analysis of segregating generation of inter varietal crosses in greengram (*Vigna radiata* (L.) Wilczek)**" 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,
31.8-1999

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CERTIFICATE

Certified that this thesis entitled "**Genetic analysis of segregating generation of inter varietal crosses in greengram (*Vigna radiata* (L.) Wilczek)**" is a record of research work done independently by **Shri. R. Ebenezer Babu Rajan** 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

1. INTRODUCTION

Pulses form an integral part of Indian agricultural system. They occupy an indispensable position in the world agriculture by virtue of their high protein content and contributions towards soil fertility through biological nitrogen fixation by bacteria prevalent in their root nodules and play vital role in furthering sustainable agriculture.

Pulses serve as a valuable supplement to the cereal based diet especially in areas where availability of animal protein is less. Greengram (*Vigna radiata* (L.) Wilczek) is the third important pulse crop of the country after chickpea and pigeonpea. It is well known for its high biological value and digestibility. It is predominantly a rainfed crop but being photo-thermo insensitive and short duration can be accommodated in multiple cropping system.

As per the latest estimates, the current production of pulses in India is 14.80 million tonnes (Anonymous, 1997) but unfortunately this is not sufficient to meet even the minimum needs of the increasing population. Consequently its per capita availability has declined from 70 g in 1956 to 34 g in 1996. This is against the minimum requirement of 60 g and the optimum requirement of 104 g per capita per day. It is thus desirable that the place of pulses in the farming system be made secure in order to maintain nutritional standards.

The total production of pulses in Kerala is only 13,674 tonnes (Anonymous, 1999). Among pulses greengram is one of the most important pulse crops of Kerala, and cultivated in uplands during rabi season and in summer rice fallows during the third crop season. The cultivation of legumes are reported to be beneficial to the succeeding cereal crop (Nambiar *et al.*, 1988). The amount of biological N_2 fixed in greengram meets upto 50 per cent of N_2 requirements with rhizobial symbiosis (IRRI, 1972). Singh and Murthy (1988) suggested the possibility of breeding legumes for improved N_2 fixation.

Hence this study was programmed to assess the genetic variability, correlation, direct and indirect effects of yield and its components and biological N_2 fixation traits in the F_2 generation of 21 crosses. The information obtained will be useful to fix a selection criteria for improvement in the segregating generations. Main objective of this study was to identify F_2 progenies superior for yield and biological N_2 fixation.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

Greengram is an excellent and cheap source of high quality and easily digestible protein. It occupies an important place in the diet of the people in the state, next to cereals. There is much scope for increasing the production of pulses by genetic improvement. Availability of a variety with appreciable grain yield and reasonably good nitrogen fixation ability can increase the production and improve the nitrogen content of the soil. Selection for yield and biological nitrogen fixation *per se* is often difficult, especially in early segregating generations. Hence information on heritability and correlation is helpful in selecting superior plants. Review of the available literature relevant to the studies in greengram and other pulses are presented.

2.I. Variability

Greengram

Medhi *et al.* (1980) observed high genotypic coefficient of variation (GCV) for grain yield, 100 seed weight, and number of pods per plant.

Cheema and Khan (1984) evaluated F_1 and F_2 of 4 crosses in greengram and reported the F_1 overdominance affected almost all characters. The highest dominance value for seeds per pod observed was 6.44. Selection in the F_2 based on plant height, primary branches per plant, pods per plant and seed yield per plant was recommended.

Rathnaswamy *et al.* (1986) evaluated seventy seven greengram genotypes for the nodulation efficiency under field conditions and reported large variation for nodule number among the host genotypes both at flowering and maturity phases. They found that the nodulating ability and dry matter production (DMP) components behaved independently in the population and suggested that selection may be useful for improving nodulation efficiency and yield potential.

Natarajan *et al.* (1988) studied variability in fortyfive diverse genotypes and reported the highest genotypic coefficient of variation for seed yield, pod number and plant height.

The genetics of biological nitrogen fixation traits in greengram was studied by Singh and Murthy (1988) and reported that there was considerable variation for total nitrogen, total dry matter and nodule fresh weight / plant.

Ilhamuddin *et al.* (1989) evaluated 22 cultivars and recorded high genotypic and phenotypic variances for plant height whereas both genotypic and phenotypic coefficient of variations were high for grain yield per plant.

Sagar and Deore (1990) reported that genotypic coefficient of variation was the highest for harvest index followed by grain yield per plant and days to 50 per cent flowering.

Borah and Hazarika (1995) studied variability in 112 exotic genotypes of greengram for yield and its components and observed high estimates of genotypic variances for plant height and number of pods per plant.

Patil and Shinde (1995) observed large amount of variability in greengram for plant height, days to maturity, pods per plant, pod length, 100 seed weight and grain yield. Genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were found to be more or less similar for all the characters except for number of pods per plant and number of seeds per pod.

Khorgade (1995) evaluated 30 genotypes of greengram for various genetic parameters and reported that number of branches per plant, seed yield, number of pods per plant and number of clusters per plant exhibited high genotypic coefficient of variation

Veerabadhiran and Jehangir (1995) studied variability in 27 genotypes and reported high genotypic coefficient of variation for seed yield, pods per plant, clusters per plant and seeds per pod.

Manivannan *et al.* (1996) reported high estimates of phenotypic and genotypic coefficient of variation for seed yield per plant and pods per plant.

Based on variability studies in greengram Veerabadhiran *et al.* (1996) reported that seed yield per plant and plant height showed moderate genotypic coefficient of variation.

Reddy (1997) reported that both phenotypic and genotypic coefficient of variation were higher for branches per plant followed by grain yield per plant and pods per plant. The difference between phenotypic and genotypic coefficient of variation was narrow for days to maturity, pod length, plant height, branches per plant and pods per plant suggesting that these characters are less influenced by environment.

Blackgram

The effect of inoculation and phosphate manuring on nodulation, nitrogen content in shoot and root and yield of blackgram was studied by Sahu (1973). The results revealed that inoculation or phosphatization increased nodulation, nitrogen content in shoot and root, dry matter content in shoot and root portions and yield. The nitrogen status of the soil was reported to be appreciably increased by cultivating blackgram.

Luthra and Singh (1978) evaluated F_3 population of 4 crosses of blackgram and found that there was an association between genotypic coefficient of variation and heritability.

Patel and Shah (1982) studied various genetic parameters in 20 strains of blackgram and reported high genotypic coefficients of variation for pod length and plant height.

Ramaswami and Oblisami (1984) conducted field experiments with 430 collections of blackgram comprising of short, medium and long duration varieties in red sandy loam soil under both inoculated and uninoculated conditions and reported that short duration varieties recorded significantly higher harvest index than medium or long duration varieties and the inoculation with rhizobia significantly increased the grain yield and harvest index.

Philip (1987) reported high values of phenotypic and genotypic coefficient of variation for leaf area index at blooming and harvest stages, branches per plant and plant height. Low GCV was recorded for days to 50 per cent flowering and harvest.

Sharma and Rao (1988) studied variability in parents, F_1's and F_2's of six intervarietal crosses of blackgram and revealed considerable variation for yield and its components.

Reddy and Singh (1989) studied BC_1 F_2 population and revealed that introgression of wild germplasm created large amount of genetic variability and ultimately the frequency of transgressive segregants for yield increased. These results suggested that only one backcross with the recurrent parent may be enough to achieve higher proportion of transgressive segregation in the wide crosses of blackgram.

Based on variability studies in blackgram Abraham *et al.* (1992 a) reported wide range of variability for branches per plant, number of abnormal, oblique and unfilled pods per plant, leaf area index at 50 per cent flowering and 100 per cent flowering, photosynthetic efficiency at 50 per cent and 100 per cent flowering.

Renganayaki and Sree Rengasamy (1992 b) reported high phenotypic and genotypic coefficient of variation for dry leaf weight followed by seed yield and leaf area.

Anuradha and Krishnamurthy (1993) reported a wide range of variation in the harvest index of 45 genotypes with low genotypic and phenotypic coefficient of variation.

Suryawanshi and Rao (1995) in their studies with 46 genotypes of blackgram reported that genotypic coefficient of variation was maximum for seed yield per plant followed by pod length, harvest index, plant height, pods per plant and number of seeds per pod.

Cowpea

Vaidi and Singh (1983) evaluated 60 F_3 and 50 F_4 populations of a cross between C_{34} x C_{85} varieties and reported high estimate of phenotypic and genotypic coefficient of variation for branch number, cluster number and yield.

Siddique and Gupta (1991 a) worked out estimates of variability in cowpea and reported high genotypic and phenotypic coefficient of variation for pods per plant, plant height and seed yield.

Renganayaki and Sree Rengasamy (1992 a) reported wide genotypic and phenotypic coefficient of variation for plant height and pods per plant.

Savithriamma (1992) reported a wide genotypic coefficient of variation ranging from 7.94 (seeds per pod) to 31.859 (plant height) and high genotypic variances for plant height, pods per plant and pod length.

Mathur (1995) worked out variability in F_2's and parents and reported the highest value of genotypic coefficient of variation for grain yield per plant followed by pods per plant. He also revealed that the highest and positive genotypic and phenotypic co-variances were noted in pod length Vs seeds per pod.

Sreekumar (1995) reported the predominance of non additive gene action for total weight of nodules, weight of effective nodules and nitrogen content in the plant at 50 per cent flowering in cowpea.

Backiyarani and Nadarajan (1996) in their studies with 34 genotypes of cowpea observed high genotypic coefficient of variation for leaf area index, pods per plant and clusters per plant.

Redgram

Kumar Rao and Dart (1979) studied genetic variability for nodulation and nitrogen fixation in pigeonpea and concluded that cultivars differ with respect to nodulation and nitrogen fixation.

In vitro studies conducted by Sreekumar (1982) proved that two cultivars viz., T_{24} and Bahar differed significantly with nitrogen fixation in controlled conditions in pigeonpea.

Shoram (1983) worked out estimates of variability in 100 genotypes of pigeonpea and reported high genotypic coefficient of variation for pods per plant, days to maturity, plant height and days to 50 per cent flowering.

Sidhu *et al.* (1985) reported that variability was highest for pods per plant and lowest for seeds per pod.

Natarajan *et al.* (1990) reported that genotypic coefficient of variation was highest for pod number per plant followed by clusters per plant and seed yield. It was lowest for seeds per pod.

Aher *et al.* (1998) evaluated 64 genotypes of pigeonpea and observed wide genetic variability in plant height, plant spread, number of secondary branches per plant and days to 50 per cent flowering.

Other pulse crops

Rao and Venkateswarlu (1983) studied sixteen varieties of *V. aconitifolia* and found that they differ in nodules per plant, nodule dry weight per plant, nitrogenase activity and seed yield per plant. There was no correlation between nitrogenase activity and other traits indicating no contribution of nitrogenase activity to yield.

Islam *et al.* (1984) evaluated 140 varieties in kabuli chickpea and reported that variability was wide for pods and yield per plant but narrow for days to flowering and maturity.

Rao and Nanda (1994) observed significant variability for days to maturity, plant height, pods per plant, harvest index and seed yield in horsegram.

Mandal and Dana (1998) reported that phenotypic and genotypic coefficient of variation were higher for grain yield per plant and pods per plant in rice bean.

2.2 Heritability and genetic advance

Greengram

Panse (1957) reported high heritability coupled with low genetic advance for days to flower, pod length and grain yield indicating non additive gene action.

Natarajan *et al.* (1988) evaluated forty-five diverse genotypes and reported the highest heritability (97.3) for hundred seed weight followed by days to flowering (93.2), plant height (73.7) and pod length (69.7). Seed yield showed the highest genetic advance followed by plant height, 100 seed weight and pods per plant.

Srinivas and Bunitivong (1991) reported medium heritability for grain yield whereas pods per plant expressed high heritability.

Borah and Hazarika (1995) noticed high estimates of heritability along with high genetic advance for plant height, pods per plant, seed yield per plant, clusters per plant, days to 50 per cent flowering and days to maturity.

High genetic advance was found to be accompanied by comparatively high estimates of heritability in case of branches per plant, clusters per plant, pods per plant and seed yield (Khorgade, 1995).

In a study involving 89 genotypes of greengram, Patil and Shinde (1995) observed high heritability for plant height, days to flowering, days to maturity, pods per plant, pod length, 100 seed weight and grain yield. High heritability coupled with high genetic advance was observed for plant height, days to maturity, pod number per plant and 100 seed weight. High heritability coupled with low genetic advance was observed for days to flower, pod length and grain yield.

Singh and Singh (1995) reported that the relative importance of yield components was in the order of seed weight, pods per plant and seeds per pod. They also suggested that selection based on seed weight would be effective in the segregating generation as it has high heritability.

Veerabadhiran and Jehangir (1995), in their studies with 27 genotypes of greengram reported high heritability estimates for plant height, days to 50 per cent flowering and clusters per plant. Plant height showed the highest genetic advance followed by days to flowering.

Hedge *et al.* (1996) reported that heritability estimates were high for days to first flowering (0.94), days to first pod maturity (0.93), clusters per plant (0.71) and pods per plant (0.74). The expected genetic advance was also high for pods per plant and moderate for days to flowering, days to maturity, clusters per plant and grain yield per plant.

Reddy (1997) recorded the highest heritability for days to maturity followed by plant height and pod length. High genetic advance as percentage of mean was observed for branches per plant, pods per cluster and plant height.

Blackgram

Patel and Shah (1982) evaluated 20 strains in blackgram and found that pod length and plant height had high heritability and genetic advance. High heritability coupled with low genetic advance was observed for seeds per pod, 100 seed weight and pods per cluster.

A study of 25 strains of blackgram by Patil and Narkhede (1987) indicated high heritability alongwith high genetic advance for yield per plant, pod length and plant height.

Philip (1987) observed high heritability for days to pod harvest and leaf area index at blooming and harvest. Harvest period, plant height and branches per plant showed moderate to high heritability and genetic gain under partial shaded conditions.

Based on the analysis of data from parents, F_1's, F_2's of six intervarietal crosses, Sharma and Rao (1988) reported that heritability estimates were higher for days to flowering, days to maturity, pod-bearing length and 100 seed weight.

Abraham *et al.* (1992 b) noticed high heritability alongwith high genetic advance for accumulation of dry matter at 50 per cent flowering and 100 per cent flowering, leaf area index at 50 per cent flowering, number of days to blooming and number of days to first harvest. High heritability coupled with low genetic advance was observed for grain yield per plot and grain pod ratio.

Anuradha and Krishnamurthy (1993) observed moderate heritability and low genetic advance for harvest index.

Suryawanshi and Rao (1995) while studying 46 genotypes of blackgram reported that medium heritability coupled with high to medium expected genetic advance as percentage of mean was observed for seed yield, pod length and harvest index.

Cowpea

Dumbre *et al.* (1982) observed that pod number, seeds per pod and size of seed have considerable value of coheritability in schemes of indirect selection for grain yield.

Vaidi and Singh (1983) analysed the F_3 and F_4 populations and revealed that heritablity and expected genetic advance was high for branch number, cluster number and yield.

Thiyagarajan (1989) studied heritability and genetic advance in 7 parents and their F_1 hybrids and reported that heritability and genetic advance were high for plant height, number of seeds per pod and 100 seed weight.

Siddique and Gupta (1991 a) observed that heritability and genetic advance were quite high for seed yield, pods per plant and plant height.

Renganayaki and Sree Rengasamy (1992 a) reported maximum genetic advance estimates expressed as percentage of mean for plant height and pods per plant in cowpea.

Savithriamma (1992) reported that the heritability values ranged from

15.23 per cent for pods per plant to 71.41 per cent for 100 seed weight and observed high heritability for plant height and pod length.

Backiyarani and Nadarajan (1996) observed that heritability and genetic advance were quite high for harvest index, leaf area index, single plant yield and seeds per pod.

Redgram

Godawat (1980) reported high heritability for number of primary branches (89.05 per cent) and grain yield per plant (50.96 per cent). The highest genetic gain was reported for grain yield (43.51 per cent) followed by number of primary branches (39.90 per cent).

Sidhu *et al.* (1985) reported that heritability estimates were high for pods per plant, seed yield and plant height. Genetic advance was high for pods per plant.

Natarajan *et al.* (1990) reported high heritability and genetic advance for pods per plant, clusters per plant and seed yield.

High heritability and genetic advance were observed for days to maturity, plant height and pods per plant (Takalkar *et al.*, 1998).

Aher *et al.* (1998) evaluated 64 genotypes in pigeonpea and reported high heritability accompanied with high genetic advance for number of secondary and primary branches per plant followed by grain yield per plant, days to 50 per cent flowering, plant spread and plant height.

Other pulse crops

Seetin and Barnes (1977) reported high heritability estimate for nitrogen fixation characters in alfalfa.

Hardarson and Jones (1979) reported in white clover that the host plant can influence with rhizobium strains. The specificity in nodulation is broadly heritable and can be enhanced by selection.

In Spanish clover, Pinchbeck *et al.* (1980) found the importance of additive gene effects alone, for biological nitrogen fixation traits such as nitrogen content per plant nodule fresh weight and plant dry weight.

Smith *et al* (1982) reported high heritability estimate for nitrogen fixation characters like nodule number, nodule fresh weight, plant dry weight and nitrogen content in crimson clover. High heritability estimate with large variation present for nitrogen fixation gave feasibility for the selection for increased nitrogen fixation in the species.

Dobhal and Rana (1994) in their studies with 23 genotypes of horsegram observed high heritability coupled with high genetic advance for clusters per plant, grain yield and days to flowering.

Sood *et al.* (1994) noticed high heritability estimates for seed yield (73.6 per cent), days to maturity (76 per cent) and days to flowering (94 per cent) in horsegram.

Mandal and Dana (1998) in ricebean reported relatively high heritability and genetic advance for pods per plant and grain yield per plant.

2.3 Correlation studies

Greengram

Singh and Malhotra (1970) recorded significant positive genotypic association of seed yield with number of clusters per plant, number of pods per plant, number of seeds per pod and length of pod. The number of pods per plant had the highest positive genotypic correlation.

Rathnaswamy *et al.* (1978) reported highly significant genotypic correlation of grain yield with number of pods per plant and number of seeds per pod.

Gupta *et al.* (1982) found that yield per plant had significant positive correlations with pods per plant and clusters per plant in greengram.

Shanmugam *et al.* (1984) studied the nodulation characters in greengram and blackgram and observed positive correlation between nodule number, nodule dry weight and nitrogenase activity at vegetative, flowering and pod developing phases.

Singh *et al.* (1985) studied the nodulation character in greengram and reported that three nodulation traits were positively correlated with total nitrogen per plant. They also suggested that since nodulation traits had moderate to high heritability, the character can be improved through selection.

Rathinaswamy *et al.* (1986) examined the nodulation efficiency of 77 greengram genotypes for nodule number at flowering and maturity under field conditions. Nodule number varied from 2 to 28 at flowering and from 0 to 22 at maturity. Nodule number was not correlated with seed yield and dry matter production either at flowering or at maturity, although some genotypes had high nodule number and high seed yield.

Natarajan and Palanisamy (1988) evaluated fifteen greengram hybrids and their eight parents and reported seed yield was significantly and positively correlated with pod weight (r = 0.9) and total DMP (r = 0.5).

Raut *et al.* (1988) observed significant positive correlation of yield with seeds per pod, number of branches per plant and clusters per plant at genotypic level.

Singh and Murthy (1988) observed that, total nitrogen showed very high positive correlation with total dry weight and nodule fresh weight indicating that selection for total nitrogen may be based on total dry weight or nodule fresh weight. Total nitrogen estimated from the plant showed significant positive correlation with grain yield and harvest index, while the correlation of total nitrogen with other components viz., total biomass, days to flower, plant height, number of pods per plant and pod length were non - significant.

Character association studies by Patil and Narkhede (1989) in greengram, revealed that 100 seed weight, pod length, pods per plant and plant height had significant positive correlation with yield.

Holkar and Raut (1992) reported significant positive correlation of seed yield with pods per plant and pod length. Days to flowering and maturity were negatively correlated with seed yield.

Naidu *et al.* (1994) reported significant association between clusters per plant and pods per plant whereas non-significant positive association of pod length with seeds per pod was noticed.

Reddy *et al.* (1994) in their correlation studies in greengram indicated that pods per plant, clusters per plant and seeds per pod had strong positive association among themselves and also with grain yield.

Borah and Hazarika (1995) noticed that seed yield per plant had highly significant and positive correlation with pods per plant, plant height, clusters per plant, pod length and branches per plant.

Based on correlation studies in F_2 population of greengram Singh *et al.* (1995) reported that seed yield was positively associated with plant height, clusters per plant and pods per plant.

Veerabadhiran and Jehangir (1995) observed high positive correlation and intercorrelation among seed yield, pods per plant, clusters per plant and seeds per pod.

Hedge *et al.* (1996) reported that grain yield per plant had significant and positive correlation with clusters per plant, pod length and seeds per pod. They also recorded significant and positive correlation among the components, branches per plant with clusters per plant and pods per plant, clusters per plant with pods per plant, pod length with seeds per pod whereas clusters per plant showed significant negative correlation with seeds per pod.

Manivannan and Nadarajan (1996) reported that seed yield had significant positive association with plant height, clusters per plant, pods per plant and pod length and non-significant association with branches per plant and seeds per pod. They also reported that plant height showed significant and positive association with branches per plant, clusters per plant, pods per plant and pod length whereas cent flowering, photosynthetic efficiency at 50 per cent and 100 per cent flowering and harvest index.

Suryawanshi and Rao (1995) reported that pod length had the highest positive correlation with seed yield followed by days to flowering. Days to flowering had positive correlation with days to maturity and pods per plant, seeds per pod with pods per plant and plant height with days to flowering and pods per plant.

Shrivastava *et al.* (1996) observed that seed yield was significantly associated with pods per plant, seeds per pod and pod length.

Cowpea

Veerupakshappa *et al.* (1980) studied correlation in different segregating generation of cowpea and observed positive correlation of seed yield with pods per plant, seeds per pod and seed weight in F_1. They also showed positive correlation of pod length with seeds per pod while showed a negative correlation with plant height.

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

Renganayaki and Sree Rengasamy (1992 a) reported that seed yield per plant showed significant and positive association with total dry matter production, pod length and seed per pod.

Sawant (1994) found that seed yield was significantly and positively associated with branches per plant, pods per plant, pod length, seeds per pod and harvest index.

Tamilselvam and Vijendradas (1994) recorded significant positive correlation of seed yield per plant with plant height, branches per plant, pods per plant, pod length and seeds per pod. They also reported positive association among plant height, days to flowering (50 per cent), clusters per plant and pod length.

Mathur (1995) worked out correlation in F_2's and its parents and revealed that yield showed positive correlation with plant height, pods per plant, pod length, pod width and seeds per pod.

Naidu *et al.* (1996) concluded from their correlation studies that seed yield per plant was significantly correlated with pods per plant and pod length whereas seeds per pod showed non-significant positive correlation with seed yield.

Redgram

Ganesamurthy and Dorairaj (1990) reported that seed yield was positively correlated with pods per plant, clusters per plant, branches per plant, plant height, leaf area index, seeds per pod, days to flowering and harvest index.

Natarajan *et al.* (1990) reported that pods per plant, clusters per plant and plant height were positively and significantly correlated with seed yield whereas seed size was negatively correlated with it.

Salunke *et al.* (1995) recorded significant and positive association of grain yield with pods per plant, branches per plant and plant height. They also reported that pods per plant was positively and significantly associated with primary branches per plant and plant height.

Sarma and Roy (1995) observed that seed yield had positive association with branches per plant, pods per plant, seeds per pod and harvest index and also correlated with one another.

Aher *et al.* (1998) studied correlation in 64 genotypes and revealed that all the characters studied showed significant positive correlation with grain yield.

Other pulse crops

Rupela and Dart (1981) studied the genetics of nodulation and N_2 fixation in chickpea. They found significant correlations between nodulation parameters and grain yield.

Islam *et al.* (1984) studied correlation in 140 varieties of kabuli chickpea and found that yield per plant was highly and positively correlated with pods per plant and number of secondary branches per plant.

Singh and Ghai (1984) reported positive association between N_2 fixation and plant height, nodes on the main stem, first pod bearing node, internode length, grains per plant, total plant weight and grain yield in pea.

Oliveira *et al.* (1987) evaluated F_5 and F_6 of 2 crosses of soybean and revealed consistent positive correlation between days to maturity and plant height and between plant height and lodging.

Das *et al.* (1989) stated that, in soybean seed yield was significantly correlated with plant height and number of pods, nodules per plant and seeds per pod.

Lokesha and Shivasanker (1990) observed strong association of pod and seed yield with plant dry weight, number of leaves at 60 days and number of single poded clusters in cluster bean.

Based on correlation studies in rice bean, Sharma and Hore (1994) reported that grain yield had significant and positive correlation with pods per plant, seeds per pod, plant height and pod length at phenotypic level.

Shivakumar (1998) reported that grain yield of chickpea had positive correlation with plant height, number of branches, dry matter accumulation, number of pods, number of seeds per pod and 100 grain weight. He also revealed that number of pods per plant, seeds per pod and 100 seed weight were most important yield contributing characters towards higher grain production in chickpea.

2.4 Path analysis

Greengram

Vidyadhar *et al.* (1984) analysed the data on yield and ten yield related and other quantitative traits from thirty six greengram varieties and revealed that the number of clusters per plant, seeds per pod and 100 seed weight had direct effect on seed yield.

Natarajan *et al.* (1988) reported pods per plant followed by seeds per pod had the highest positive direct effects on seed yield.

Raut *et al.* (1988) reported maximum direct positive effect on seed yield through seeds per pod, clusters per plant and pods per plant.

Pundhir *et al.* (1992) reported that pods per plant had marked positive direct effect and indirect effect on seed yield.

Naidu *et al.* (1994) reported that pods per plant had positive direct effect on seed yield whereas clusters per plant and branches per plant had direct negative effect.

Reddy *et al.* (1994) reported that pods per plant, clusters per plant and seeds per pod had high magnitudes of positive direct effect on grain yield and their indirect effects were also positive.

Based on path coefficient analysis Kumar *et al.* (1995) reported that positive direct effects were observed for pods per plant and plant height.

Singh *et al.* (1995) analysed the F_2 plants of greengram and revealed that pods per plant and clusters per plant were the major factors contributing to seed yield. Seed size also had positive direct effect on seed yield.

Veerabadhiran and Jehangir (1995) evaluated 27 greengram genotypes and revealed that the number of pods had the greatest positive direct effect on seed yield.

Manivannan and Nadarajan (1996) reported that pods per plant had high direct effect on seed yield followed by pod length and plant height. Branches per plant and seeds per pod recorded moderate negative effect on seed yield.

Blackgram

Patel and Shah (1982) reported that clusters per plant followed by pods per plant had maximum positive direct effects on grain yield.

Patil and Narkhede (1987) reported that pods per plant was the most reliable component in selecting high yielding genotypes rather than plant height despite its high direct effect on yield as indicated by path analysis.

Philip (1987) reported that under partial shaded conditions days to pod harvest initiation and pods per plant were the traits exerting high positive direct effect on seed yield while LAI exerted negative direct effect.

Abraham (1988) observed that leaf area index at 50 per cent flowering had the maximum direct effect on harvest index, followed by pods per plant, pod length and seeds per pod under partially shaded conditions.

Renganayaki and Sree Rengasamy (1992 b) found that primary leaf area and plant height had higher positive direct effect on seed yield.

Shrivastava *et al.* (1996) revealed that pods per plant and seeds per pod were the common factors influencing seed yield in path coefficient analysis.

Cowpea

Siddique and Gupta (1991 b) reported that pods per plant had a strong positive direct effect as well as indirect effect on seed yield.

Renganayaki and Sree Rengasamy (1992 a) found that plant height exerted maximum positive direct effect on seed yield followed by primary leaf area. The indirect effect of plant height on seed yield through the other traits were also greater.

Sawant (1994) reported that pods per plant had the highest positive direct effect on seed yield followed by seeds per pod, harvest index, plant height and pod length.

Redgram

Natarajan *et al.* (1990) after path coefficient analysis reported that clusters per plant, pods per plant, and plant height were the most important characters contributing to seed yield.

Jahagirdar and Nerkar (1994) reported that number of pods both at phenotypic and genotypic level had high positive direct effect on grain yield whereas plant height showed negative direct effect.

According to Salunke *et al.* (1995) pods per plant and seeds per pod had high direct positive effect on grain yield.

Other pulse crops

Dobhal and Rana (1994) reported that clusters per plant and days to flowering had positive direct effect on yield in horsegram.

In rice bean, Mandal and Dana (1998) reported high positive direct effect for 50 per cent pod maturation, pods per plant and branches per plant.

2.5 Selection index

Based on discriminant function analysis, Banerjee *et al.* (1976) reported that an index based on a combination of yield, days to flowering and number of pods were more efficient.

Malhotra and Sodhi (1977) using discriminant function technique in pigeonpea reported that number of branches, number of pods and number of clusters should be given due weightage for an effective selection.

Singh *et al.* (1977) reported that an index based on number of primary branches per plant, number of clusters per plant, number of pods per plant and number of seeds per pod would be most efficient for yield improvement.

Tikka *et al.* (1977) concluded that for the most efficient selection index plant height and pods per plant should be included in cowpea.

In greengram, Misra (1985) constructed selection indices and reported that the most effective index comprised of pods per plant, 100 seed weight, seeds per pod, reproductive period, clusters per plant and yield per plant.

Sudha Rani (1989) based on her studies reported that pods per plant, seeds per pod, leaf area and days to maturity were the yield contributing characters used for the formulation of selection index in blackgram.

Dahat *et al.* (1995) reported that number of primary and secondary branches per plant and pods per plant can be used as selection indices for grain yield improvement in pigeonpea.

Kumar and Shambulingappa (1996) reported that the best selection index to be considered were pods per plant and clusters per plant in rice bean.

MATERIALS AND METHODS

3. MATERIALS AND METHODS

The research programme was carried out at the Department of Plant Breeding and Genetics, College of Agriculture, Vellayani, Thiruvananthapuram, during 1998-99 in rabi season.

3.1. Materials

The experimental material consisted of F_2 seeds collected from twenty-one intervarietal hybrids of greengram and their seven parents (Table 1).

3.2 Experiment

The parents and their F_2 population were raised in a field experiment laid out in randomised block design with three replications in the upland during rabi season. The seeds were sown at a spacing of 25 x 15 cm in 3 m^2 plots, so that 240 plants could be accommodated in each plot. The cultural and management practices were followed according to the package of practices of recommendations of Kerala Agricultural University, 1996. Ten sample plants were selected at random from each plot for recording the observations.

Table 1. List of parental varieties and hybrid combinations used for the genetic analysis

Sl. No.	Parents / hybrid combinations		Sl. No.	Hybrid combinations	
1.	Pusa - 9333	P_1	15.	KM-1285 x MG-368	P_2 x P_4
2.	KM - 1285	P_2	16.	KM-1285 x IIPRM-3	P_2 x P_5
3.	NDM - 88-14	P_3	17.	KM-1285 x CoGG-902	P_2 x P_6
4.	MG - 368	P_4	18.	KM-1285 x LG-444	P_2 x P_7
5.	IIPRM - 3	P_5	19.	NDM-88-14 x MG-368	P_3 x P_4
6.	CoGG - 902	P_6	20.	NDM-88-14 x IIPRM-3	P_3 x P_5
7.	LG - 444	P_7	21.	NDM-88-14 x CoGG-902	P_3 x P_6
8.	Pusa - 9333 x KM - 1285	P_1 x P_2	22.	NDM-88-14 x LG-444	P_3 x P_7
9.	Pusa - 9333 x NDM-88-14	P_1 x P_3	23.	MG-368 x IIPRM-3	P_4 x P_5
10.	Pusa - 9333 x MG-368	P_1 x P_4	24.	MG-368 x CoGG-902	P_4 x P_6
11.	Pusa - 9333 x IIPRM-3	P_1 x P_5	25.	MG-368 x LG-444	P_4 x P_7
12.	Pusa - 9333 x CoGG-902	P_1 x P_6	26.	11-PRM-3 x CoGG-902	P_5 x P_6
13.	Pusa - 9333 x LG - 444	P_1 x P_7	27.	11-PRM-3 x LG-444	P_5 x P_7
14.	KM-1285 x NDM-88-14	P_2 x P_3	28.	CoGG-902 x LG-444	P_6 x P_7

Observations recorded

3.2.1 Length of primary root at 50 per cent flowering

Ten sample plants were uprooted carefully without injuring root at 50 per cent flowering and length of the primary root was measured in centimetres.

3.2.2 Number of secondary roots at maturity

Ten sample plants were uprooted carefully at harvest and counted the number of secondary roots and the mean value was recorded.

3.2.3 Shoot / root ratio

The ratio of the shoot dry weight to root dry weight is expressed as shoot / root ratio. The root and shoot portion of the uprooted ten sample plants were cut and separated. The root and shoot portions were sundried separately for two days followed by oven drying at 60 - 70^{0}C for one day. The dry weight of root and shoot were recorded separately and the ratio was worked out.

3.2.4 Weight of nodules in the root at 50 per cent flowering

The nodules present in the roots of the ten samples were separated and fresh weight was recorded in milligrams.

3.2.5 Dry weight of plants at maturity

Ten sample plants were sundried for two days followed by oven drying for one day at 60 - 70^{0}C. The dry weight of each plant was taken separately and mean was recorded in grams.

3.2.6 Nitrogen content in plants at maturity

Ten sample plants were uprooted at maturity, sundried for two days and then oven dried at 60 - 70^{0}C for one day. Properly dried plants were powdered and from this 0.5 g was taken for the nitrogen estimation by Microkjeldahl method.

3.2.7 Plant height

Height of the ten sample plants from ground to the tip of the main stem was measured at maturity and mean was worked out in centimeters.

3.2.8 Number of clusters per plant

The number of pod bearing clusters in the randomly selected observational plants were counted and the average was worked out and recorded.

3.2.9 Number of pods per plant

Total number of pods from the observational plants were counted and mean was recorded.

3.2.10 Number of seeds per pod

The average number of seeds per pod was worked out from ten pods selected from each sample plant.

3.2.11 Hundred grain weight

Random sample of hundred seeds were selected from each plot at harvest and mean weight was recorded in grams.

3.2.12 Grain yield

Grain yield (economic yield) obtained from the observational plants was recorded and the mean expressed in grams.

3.2.13 Harvest index

Harvest index was calculated by using the following formula and expressed in grams.

$$\text{Harvest index} = \frac{\text{Economic yield per plant}}{\text{Biological yield}}$$

Biological yield - Total dry weight of all plant parts including grain yield expressed in grams.

3.3 Statistical analysis

The data collected from the above experiment were subjected to statistical analysis.

3.3.1 Analysis of variance

The analysis of variance was carried out for all the traits to find out whether there is any significant differences among the F_2 segregating generation and parents in respect of various traits. For the computation of the analysis of variance, the following procedure proposed by Panse and Sukhatme (1957) for randomised block designs with fixed effects model was used, and the significance of the treatment effects were tested by the F test.

ANOVA table

Source	Degrees of freedom	Sum of squares	Mean squares	F
Replication	(r-1)	SS_R	MSR	MSR / MSE
Treatment	(v-1)	SS_V	MST	MST / MSE
Error	(r-1) (v-1)	SS_{RV}	MSE	

3.3.2 Components of variances

Components of variances for each character was worked out following the procedure of Jhonson *et al.* (1955).

Estimate of Genotypic Variance

$$V_g = \frac{MST - MSE}{r}$$

where, V_g = genotypic variance

MST = Mean square for treatments

MSE = Mean square for error, which is an estimate of environmental variance

r = number of replications

Estimate of phenotypic variance

$$V_p = V_g + V_e$$

Where, V_p = phenotypic variance

V_g = genotypic variance

V_e = Error (Environmental) variance (MSE)

Coefficient of variation

Both phenotypic and genotypic coefficient of variation were calculated as suggested by Singh and Chaudhary (1985).

Phenotypic coefficient of variation (PCV)

$$PCV = \frac{\sqrt{V_p}}{Mean} \times 100$$

Genotypic coefficient of variation (GCV)

$$GCV = \frac{\sqrt{V_g}}{Mean} \times 100$$

Heritability and genetic advance

Heritability in broad sense (h^2) (Hanson *et al.*, 1956).

$$h^2 = \frac{V_g}{V_p} \times 100$$

Where h^2 = Heritability coefficient

Genetic advance (G.A.) as per cent of mean (Allard, 1960)

$$G.A. = K\, h^2 \frac{\sqrt{V_p}}{\bar{x}} \times 100$$

Where K is the selection differential

= 2.06 in the case of 5 per cent selection in large samples

= 1.76 in the case of 10 per cent selection in large samples

$\overline{x}$ = grand mean

3.3.3 Genotypic and phenotypic correlation coefficients

The genotypic and phenotypic correlation coefficients were worked out as given in Singh and Chaudhary (1985).

$$rg_{ij} = \frac{COVg_{ij}}{\sqrt{Vg_i \times Vg_j}}$$

$COVg_{ij}$ = Genotypic co-variance of traits i and j
Vg_i = Genotypic variance of trait i
Vg_j = Genotypic variance of trait j

$$COVg_{ij} = \frac{MSPT - MSPE}{r}$$

Where, MSPT = Mean sum of products for treatments for the i^{th} and j^{th} traits

MSPE = Mean sum of products for error for i^{th} and j^{th} traits

Phenotypic correlation coefficient

$$r_{pij} = \frac{COVp_{ij}}{\sqrt{Vp_i \times Vp_j}}$$

$COVp_{ij}$ = Phenotypic co-variance of traits i and j

= $COVg_{ij}$ + MSPE for i^{th} and j^{th} traits

Vp_i = Phenotypic variance of trait i

Vp_j = Phenotypic variance of trait j

3.3.4 Path coefficient analysis

The techniques of path coefficients was first used for plant selection by Dewey and Lu (1959). This method splits the correlation coefficient into measures of direct and indirect effects. In the present study genotypic correlations were used for the path analysis. The grain yield (Y) is taken as the dependent variable and those characters with significant genotypic correlation with grain yield were used as the independent variables. The association of the independent variables on yield, due to their direct effect or due to their indirect effect via other component characters was clearly revealed by the analysis of path coefficients.

The path coefficients were obtained as the solution of a set of simultaneous equations connecting the genotypic correlation of the selected characters, which were expressed in the matrix form as

$$\begin{bmatrix} 1 & r_{12} & r_{13} & \cdots\cdots & r_{1k} \\ & 1 & r_{23} & \cdots\cdots & r_{2k} \\ & & & & \vdots \\ & & & & r_{(k-1),k} \\ & & & & 1 \end{bmatrix} \begin{bmatrix} P_{1y} \\ P_{2y} \\ \vdots \\ P_{ky} \end{bmatrix} = \begin{bmatrix} r_{1y} \\ r_{2y} \\ \vdots \\ r_{ky} \end{bmatrix}$$

i.e., $B_{kk} . C_{k1} = A_{k1}$

$C_{k1} = B^{-1}_{kk} . A_{k1}$

Where r_{1y} to r_{ky} denote the genotypic correlation coefficients between causal factors 1 to k and dependent variable (y), r_{12} to $r_{(k-1),k}$ denote the genotypic correlation coefficients among all possible combinations of causal factors and P_{1y} to P_{ky} denote the direct effects (path coefficients) of characters 1 to k on yield (y). B^{-1} is the inverse of matrix B. The residual factor which measures the contribution of the traits not included in the causal scheme was obtained by the formula

$$R^2 = 1 - \sum_{i=1}^{k} P_{iy}\, r_{iy}$$

Indirect effects of different characters on yield was obtained as follows :

Indirect effect of the ith character on yield through jth character = $P_{iy} \times r_{ij}$

The correlations and path coefficients along with the residual effects were shown in the form of a diagram, which will clearly illustrate the cause and effect relationship among the selected characters.

3.3.5 Selection index

Selection index provides a tool when simultaneous improvement of several characters became necessary. The selection index developed by Smith (1936), using discriminant function of Fisher (1936) was used to obtain a score to each of the parent / combination under study. Eight characters having high genotypic correlation with yield and having economic importance were identified for the construction of the index.

It was assumed that the economic value of a plant is determined by these characters and the merit (H) is expressed as a linear function of these character as

$$H = a_1 G_1 + a_2 G_2 + \ldots\ldots\ldots\ldots + a_n G_n$$

When G_1, G_2 .... Gn are the genotypic values of the n^{th} character studied, a_1, a_2 .... a_n are the weights assigned in each of the characters. It was further assumed that the economic weightage assigned to each character as the same, i.e., $a_1 = a_2$ .... $a_n = 1$ (unity).

As the merit described by the above equation cannot be directly evaluated. The phenotypic value (I) of a parent / combination is expressed as

$$I = b_1x_1 + b_2x_2 + \ldots\ldots\ldots\ldots + b_n x_n$$

The above 'b' coefficients were evaluated in such a manner that the correlation of I on H will be maximum. Then the selection of genotypes based on the function I will have maximum gain. The 'b' coefficients were worked out by solving a set of simultaneous equations connecting the phenotypic and genotypic variances and covariance of the selected characters. The index criterion based on the function I was obtained for all the parents / combinations, and they were arranged in the descending order of index scores for better selection.

RESULTS

4. RESULTS

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

4.1 Analysis of variance

Analysis of variance for thirteen characters (Table 2) revealed significant difference among the treatments for all the characters. The mean values of thirteen characters are presented in Table 3.

4.1.1 Variability

The length of primary root at 50 per cent flowering showed non-significant difference between parents and the F_2 populations. Among the parents NDM-88-14 recorded the maximum length of primary root (8.89 cm) and KM-1285 (7.20 cm) recorded the minimum. The F_2 populations varied from 6.43 cm (CoGG-902 x LG-444) to 10.37 cm (KM-1285 x NDM-88-14). The cross NDM-88-14 x CoGG-902 was on par with KM-1285 x NDM-88-14.

The parents and the F_2 populations showed non-significant difference for number of secondary roots at maturity. The parental varieties ranged from 7.55 (CoGG-902) to 12.07 (MG-368). The F_2 plants of the cross Pusa-9333 x KM-1285, recorded the highest number (12.88) followed by NDM-88-14 x 11 PRM-3 and was on par with Pusa-9333 x KM-1285. The lowest mean value was recorded by Pusa-9333 x NDM-88-14 (7.5).

Table 2. Analysis of variance for thirteen characters in the F_2 generation of greengram (*Vigna radiata* (L.) Wilczek)

Sl. No.	Characters	Mean square			
		Replication	Treatment	Parents Vs F_2 population	Error
1.	Length of primary root at 50 % flowering	0.515	2.334	1.516	0.528
2.	Number of secondary roots at maturity	5.954	5.927	0.027	0.645
3.	Shoot / root ratio	1.642	8.337	19.212	1.231
4.	Weight of nodules in the root at 50 % flowering	133.297	4009.867	2536.875	246.532
5.	Dry weight of plants at maturity	0.038	2.676	16.716	0.152
6.	Nitrogen content in plants at maturity	0.156	0.124	0.0081	0.043
7.	Plant height	50.813	124.627	167.762	14.022
8.	Number of clusters per plant	0.0011	0.486	0.779	0.030
9.	Number of pods	0.467	5.739	6.548	0.286
10	Number of seeds per pod	0.350	2.755	9.99	0.867
11.	100 grain weight	0.053	0.907	3.765	0.017
12.	Grain yield	0.422	2.713	14.410	0.186
13.	Harvest index	0.0013	0.016	0.0031	0.0011

Table 3 Contd.....

Sl. No.	Parents / F_2 generation of their crosses	Plant height (cm)	No. of clusters per plant	Number of pods	No. of seeds per pod	100 grain weight (g)	Grain yield (g)	Harvest index
1	Pusa-9333 (P_1)	49.78	2.86	7.06	10.87	5.16	3.84	0.48
2	KM-1285 (P_2)	54.67	2.57	8.48	11.07	4.10	4.07	0.54
3	NDM-88-14 (P_3)	45.44	2.10	6.91	10.80	4.13	3.00	0.50
4	MG-368 (P_4)	46.67	2.53	8.57	12.13	4.87	4.96	0.61
5	11 PRM-3 (P_5)	54.89	2.13	7.02	11.60	4.12	3.30	0.33
6	CoGG-902 (P_6)	40.33	2.79	8.60	11.40	2.91	2.81	0.48
7	LG-444 (P_7)	46.43	2.57	4.82	11.66	4.06	2.25	0.45
8	$P_1 \times P_2$	46.33	3.57	8.07	11.47	5.26	4.81	0.46
9	$P_1 \times P_3$	46.22	2.72	7.13	10.40	4.63	3.41	0.51
10	$P_1 \times P_4$	41.77	3.08	9.43	10.87	5.03	5.02	0.46
11	$P_1 \times P_5$	42.84	2.02	7.94	11.13	4.74	4.10	0.44
12	$P_1 \times P_6$	51.11	2.23	7.16	12.00	5.33	4.54	0.44
13	$P_1 \times P_7$	41.55	2.76	5.69	10.27	5.53	3.19	0.49
14	$P_2 \times P_3$	66.22	3.38	8.19	14.07	5.21	5.76	0.59
15	$P_2 \times P_4$	49.11	2.38	7.46	11.60	4.33	3.64	0.41
16	$P_2 \times P_5$	51.11	2.60	6.94	12.80	4.59	4.01	0.39
17	$P_2 \times P_6$	58.31	3.27	10.10	12.13	4.90	5.81	0.58
18	$P_2 \times P_7$	58.83	3.04	10.88	12.27	4.84	6.17	0.60
19	$P_3 \times P_4$	57.31	2.90	8.18	12.13	4.61	4.37	0.39
20	$P_3 \times P_5$	53.78	2.78	9.04	12.40	4.18	4.58	0.53
21	$P_3 \times P_6$	53.11	2.85	8.28	13.20	4.72	4.95	0.51
22	$P_3 \times P_7$	48.44	2.20	5.00	12.73	4.27	2.65	0.39
23	$P_4 \times P_5$	51.33	2.16	6.72	14.07	4.22	3.85	0.39
24	$P_4 \times P_6$	44.76	2.30	9.04	12.87	4.21	4.76	0.52
25	$P_4 \times P_7$	63.24	3.01	7.22	12.60	4.99	4.43	0.44
26	$P_5 \times P_6$	55.44	2.34	7.56	12.07	4.61	4.04	0.45
27	$P_5 \times P_7$	52.68	2.85	8.62	12.03	4.21	4.27	0.37
28	$P_6 \times P_7$	49.11	2.77	9.15	12.13	3.92	4.32	0.47
	S E	2.16	0.10	0.31	0.54	0.08	0.25	0.02
	C D (5%)	6.31	0.29	0.90	1.57	0.22	0.73	0.06

Shoot/root ratio was significantly high in the F_2 population than the parents. In the parental varieties, 11PRM-3 recorded the highest mean (14.8), whereas the lowest mean (9.63) was recorded by MG-368. Among the F_2 segregants this ratio ranged from 9.04 (Pusa-9333 x LG-444) to 15.68 (Pusa-9333 x KM-1285). The F_2 plants of the crosses KM-1285 x CoGG-902, CoGG-902 x LG-444 and NDM-88-14 x LG-444 were on par with Pusa-9333 x KM-1285.

The weight of nodules in the root at 50 per cent flowering was significantly high in the parents compared to the F_2 populations. The parental varieties varied from 36.66 mg (KM-1285) to 140.00 mg (CoGG-902). The plants of the F_2 generation ranged from 14.33 mg (Pusa-9333 x KM-1285) to 135 mg (Pusa-9333 x NDM-88-14) which was on par with 11PRM-3 x LG-444 and KM-1285 x CoGG-902.

The parents and F_2 population showed non-significant difference for nitrogen content in plants at maturity. The nitrogen content in the parents varied from 0.60 per cent (LG-444) to 1.03 per cent (Pusa-9333). In F_2 the highest mean of 1.26 per cent was recorded by the cross Pusa-9333 x MG-368 followed by Pusa-9333 x NDM-88-14 (1.16) which was on par with the crosses Pusa-9333 x CoGG-902, Pusa-9333 x 11PRM-3, Pusa-9333 x LG-444, KM-1285 x NDM-88-14 and MG-368 x 11PRM-3. The lowest mean was recorded by MG-368 x LG-444 (0.61).

Significant variation when compared to the parents was observed in the F_2 for plant height. The mean value of the parents ranged from 40.33 cm (CoGG-902) to 54.89 cm (11PRM-3). The parent KM-1285 (54.67 cm) and Pusa-9333

(49.78 cm) were on par with 11PRM-3. In F_2 the plant height ranged from 41.55 cm (Pusa-9333 x LG-444) to 66.22 cm (KM-1285 x NDM-88-14). The F_2 plants of the cross MG-368 x LG-444 was on par with KM-1285 x NDM-88-14.

Number of clusters per plant was significantly high in the F_2 segregating generation than the parents. The number of clusters in the parents varied from 2.10 (NDM-88-14) to 2.86 (Pusa-9333). In the F_2 population, the highest mean (3.57) was recorded by the Pusa-9333 x KM-1285 which was on par with KM-1285 x NDM-88-14 (3.38) while Pusa-9333 x 11 PRM-3 recorded the lowest mean (2.02).

The number of pods per plant was significantly high in the F_2 population compared to the parents. Among parents the highest mean (8.60) was recorded by CoGG-902 followed by MG-368 and the lowest mean (4.82) was recorded by LG-444. The F_2 population recorded the mean ranging from 5.00 (NDM-88-14 x LG-444) to 10.88 (KM-1285 x LG-444). The F_2 plants of the crosses KM-1285 x CoGG-902 (10.10) was on par with KM-1285 x LG-444.

The mean of the F_2 population was significantly higher than the parents for number of seeds per pod. The parental varieties varied from 10.80 (NDM-88-14) to 12.13 (MG-368). Among the F_2 populations, the highest mean (14.07) was recorded by the crosses KM-1285 x NDM-88-14 and MG-368 x 11 PRM-3. The F_2 plants of the crosses NDM-88-14 x CoGG-902, MG-368 x CoGG-902, KM-1285 x 11 PRM-3, NDM-88-14 x LG-444 and MG-368 x LG-444 were on par with KM-1285 x NDM-88-14. The lowest mean was recorded by Pusa-9333 x LG-444 (10.27).

Hundred grain weight was significantly high in the F_2 populations than the parental varieties. It ranged from 2.91 g (CoGG-902) to 5.16 g (Pusa-9333) in the parents. Among the F_2 segregating populations, the highest mean (5.53) was recorded by Pusa-9333 x LG-444, which was on par with Pusa-9333 x CoGG-902 (5.33). The lowest value was obtained for CoGG-902 x LG-444 (3.92).

The F_2 progenies were significantly higher than their parents for grain yield. Among the parents MG-368 recorded highest mean value (4.96) followed by KM-1285 (4.07) whereas the lowest mean value (2.25) was obtained for LG-444. In the F_2 population, grain yield varied from 2.65 g (NDM-88-14 x LG-444) to 6.17 g (KM-1285 x LG-444). The grain yield of F_2 plants of the cross KM-1285 x CoGG-902 (5.81) and KM-1285 x NDM-88-14 (5.76) were on par with KM-1285 x LG-444.

Among the parental varieties, MG-368 recorded the highest mean for harvest index (0.61) closely followed by KM-1285 (0.54) whereas the lowest harvest index was obtained for 11PRM-3 (0.33). In the F_2 population highest mean was recorded by KM-1285 x LG-444 (0.60) followed by KM-1285 x NDM-88-14 (0.59) for this trait, while the lowest mean value of (0.37) was recorded by (11PRM-3 x CoGG-902).

4.1.2 Genetic parameters

Phenotypic variance, genotypic variance, coefficients of variation, heritability and genetic advance were estimated for thirteen traits.

4.1.2.1 Phenotypic and genotypic coefficients of variation

The phenotypic, genotypic variance and coefficient of variation for thirteen characters studied are presented in Table 4 and Figure 1.

Table 4. Phenotypic and genotypic variances and coefficient of variation for thirteen characters in the F_2 generation of greengram (*Vigna radiata* (L.) Wilczek)

Sl. No.	Characters	Variance		Coefficient variation	
		Phenotypic	Genotypic	Phenotypic	Genotypic
1.	Length of primary root at 50 per cent flowering	1.130	0.602	13.35	9.74
2.	Number of secondary roots at maturity	2.406	1.761	15.68	13.41
3.	Shoot / root ratio	3.600	2.369	15.44	12.53
4.	Weight of nodules in the root at 50 per cent flowering	1500.977	1254.445	57.82	52.86
5.	Dry weight of plants at maturity	0.993	0.841	32.02	29.46
6.	Nitrogen content in plants at maturity	0.070	0.027	32.78	20.28
7.	Plant height	50.890	36.868	14.06	11.97
8.	Number of clusters per plant	0.182	0.152	15.98	14.60
9.	Number of pods	2.104	1.818	18.52	17.22
10.	Number of seeds per pod	1.49	0.629	10.23	6.63
11.	100 grain weight	0.313	0.296	12.29	11.95
12.	Grain yield	0.256	0.253	24.29	21.98
13.	Harvest index	0.006	0.005	16.38	14.73

Among the different characters studied the highest genotypic coefficient of variation (GCV) was observed for weight of nodules at 50 per cent flowering (52.86 per cent) followed by dry weight of plants at maturity (29.46 per cent), nitrogen content in plants at maturity (20.28 per cent) and grain yield (21.98 per cent). The least GCV was observed for number of seeds per pod (6.63 per cent). The highest phenotypic coefficient variation (PCV) was observed for weight of nodules in the root at 50 per cent flowering (57.82 per cent) followed by nitrogen content in plants at maturity (32.78 per cent) dry weight of plants at maturity (32.02 per cent) and grain yield (24.29 per cent). The least PCV was observed for number of seeds per pod (10.23 per cent).

The difference between genotypic and phenotypic coefficient of variation was minimum for 100 grain weight (0.34) and maximum for nitrogen content in plants at maturity (12.50 per cent) followed by weight of nodules in the root at 50 per cent flowering, length of primary root at 50 per cent flowering and number of seeds per pod.

4.1.2.2 Heritability and genetic advance

The estimates of heritability and genetic advance for thirteen characters studied are presented in Table 5 and Figure 2. The high heritability estimate were recorded for 100 grain weight (94.52 per cent) followed by number of pods (86.41 per cent), dry weight of plants at maturity (84.69 per cent), nitrogen content in plants at 50 per cent flowering (83.69 per cent), weight of nodules in the root at 50 per cent flowering (83.58 per cent), number of clusters per plant

Table 5 Estimates of heritability and genetic advance for thirteen characters in the F_2 generation of greengram (*Vigna radiata* (L.) Wilczek)

Sl. No.	Characters	Heritability percentage (h^2) (%)	Genetic advance as % of mean at 5 %
1.	Length of primary root at 50 per cent flowering	53.27	14.64
2.	Number of secondary roots at maturity	73.19	23.64
3.	Shoot / root ratio	65.80	20.93
4.	Weight of nodules in the root at 50 per cent flowering	83.58	99.55
5.	Dry weight of plants at maturity	84.69	55.86
6.	Nitrogen content in plants at maturity	38.28	25.84
7.	Plant height	72.45	20.98
8.	Number of clusters per plant	83.46	27.47
9.	Number of pods	86.41	32.97
10.	Number of seeds per pod	42.04	8.86
11.	100 grain weight	94.52	23.93
12.	Grain yield	81.87	40.97
13.	Harvest index	80.85	27.28

Fig. 1 **Phenotypic and genotypic coefficient of variation for the thirteen characters in the F_2 generation of greengram (*Vigna radiata* (L.) Wilczek)**

X_1 - Length of primary root at 50 per cent flowering

X_2 - Number of secondary roots at maturity

X_3 - Shoot / root ratio

X_4 - Weight of nodules in the root at 50 per cent flowering

X_5 - Dry weight of plants at maturity

X_6 - Nitrogen content in plants at maturity

X_7 - Plant height

X_8 - Number of clusters per plant

X_9 - Number of pods

X_{10} - Number of seeds per pod

X_{11} - 100 grain weight

X_{12} - Grain yield

X_{13} - Harvest index

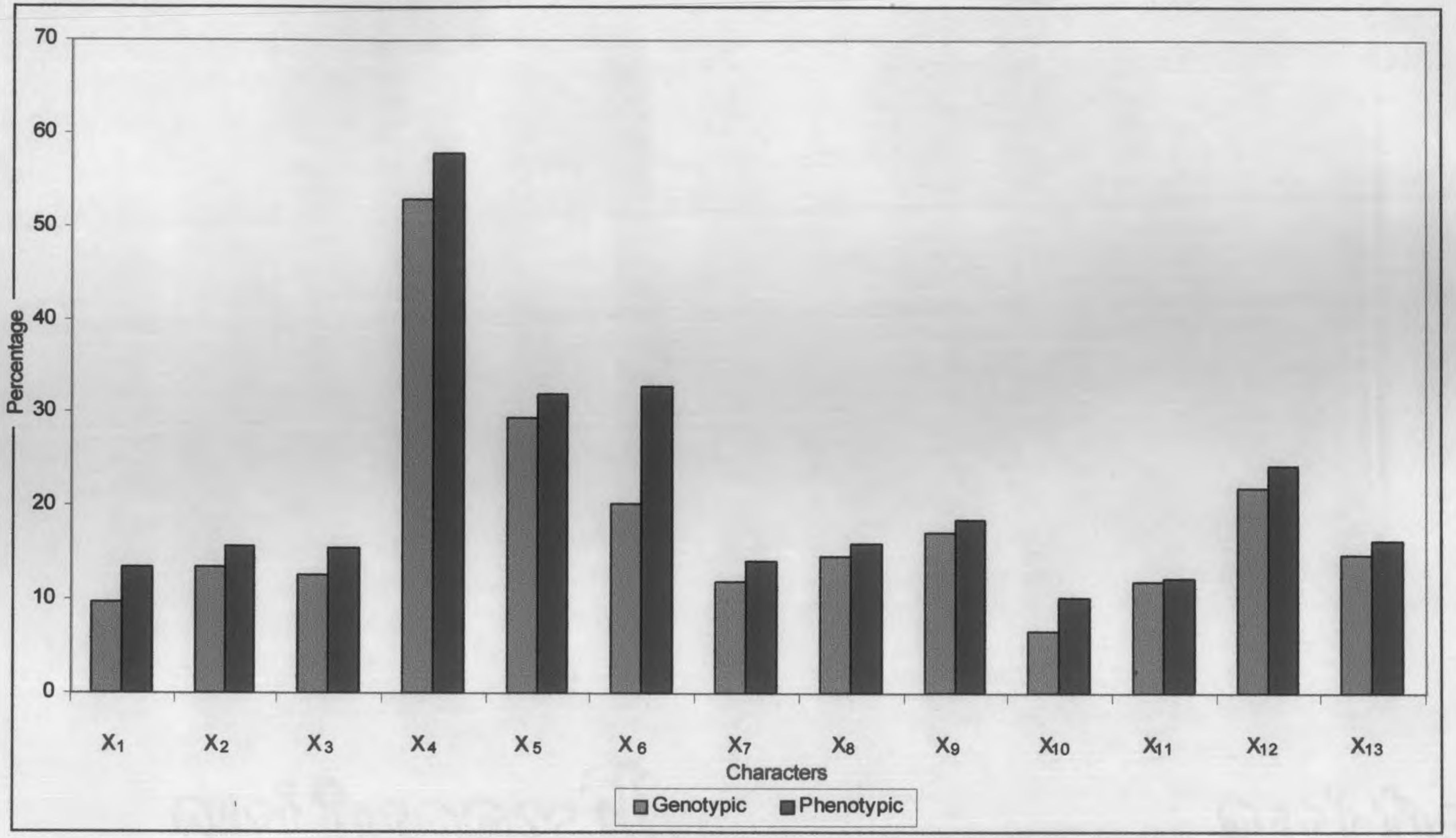


Fig. 1. Genotypic and phenotypic coefficient of variation for the thirteen characters in the F_2 generation of greengram (*Vigna radiata* (L.) Wilczek)

Fig. 2 Heritability and genetic advance for the thirteen characters in the F_2 generation of greengram (*Vigna radiata* (L.) Wilczek)

X_1 - Length of primary root at 50 per cent flowering

X_2 - Number of secondary roots at maturity

X_3 - Shoot / root ratio

X_4 - Weight of nodules in the root at 50 per cent flowering

X_5 - Dry weight of plants at maturity

X_6 - Nitrogen content in plants at maturity

X_7 - Plant height

X_8 - Number of clusters per plant

X_9 - Number of pods

X_{10} - Number of seeds per pod

X_{11} - 100 grain weight

X_{12} - Grain yield

X_{13} - Harvest index

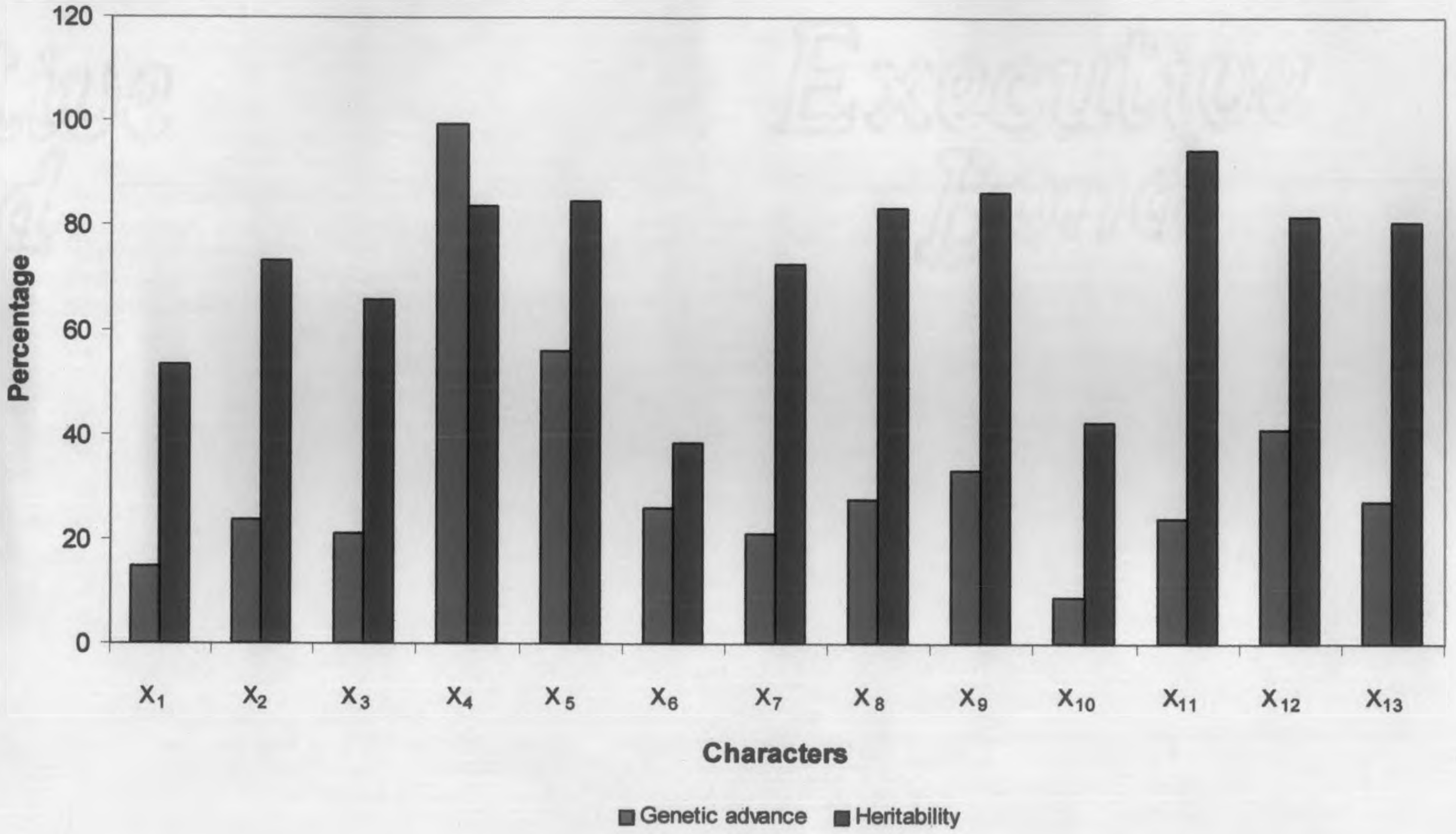


Fig. 2. Genetic advance and Heritability for the thirteen characters in the F_2 generation of greengram (*Vigna radiata* (L.) Wilczek)

(83.46 per cent), grain yield (81.87 per cent), harvest index (80.85 per cent) number of secondary roots at maturity (73.19), plant height (72.45) and shoot/root ratio (65.80). Heritability was medium in the case of length of primary root at 50 per cent flowering (53.27 per cent), number of seeds per pod (42.04 per cent) and nitrogen content in plants at maturity (38.28 per cent).

The genetic advance, as percentage of mean was maximum for weight of nodules in the root at 50 per cent flowering (99.55 per cent) followed by dry weight of plants at maturity (55.86 per cent), grain yield (40.97 per cent), number of pods (32.97 per cent), number of clusters per plant (27.47 per cent), harvest index (27.28 per cent), nitrogen content in plants at maturity (25.84 per cent), hundred grain weight (23.93 per cent), number of secondary roots at maturity (23.64 per cent), plant height (20.98 per cent) and shoot/root ratio (20.93 per cent). Genetic advance was lowest for number of seeds per pod (8.86 per cent) followed by length of primary root at 50 per cent flowering (14.64 per cent).

4.1.3 Correlations

Phenotypic and genotypic correlation between yield and twelve other characters and their *inter-se* associations were estimated and presented in Table 6, 7 and graphically presented in Figure 3 and 4.

4.1.3.1 Phenotypic correlations between yield and 12 other characters

Grain yield recorded significant positive phenotypic correlation with all the characters except length of primary root at maturity, shoot/root ratio, weight of

Table 6. Phenotypic correlation coefficients of grain yield and twelve characters in the F_2 generation of greengram (*Vigna radiata* (L.) Wilczek)

Characters	Length of primary root at 50 % flowering	No. of secondary roots at maturity	Shoot / root ratio	Weight of nodules in the root at 50 % flowering	Dry weight of plants at maturity	N_2 content in plants at maturity	Plant height	No. of clusters per plant	No. of pods	No. of seeds per pod	100 grain weight	Grain yield	Harvest index
Length of primary root at 50 % flowering	1.000												
No. of secondary roots at maturity	-0.074	1.000											
Shoot / root ratio	0.110	0.083	1.000										
Weight of nodules in the root at 50 % flowering	0.064	-0.370**	-0.150	1.000									
Dry weight of plants at maturity	0.094	0.111	0.464**	-0.066	1.000								
N_2 content in plants at maturity	0.061	-0.003	-0.284*	0.292	-0.082	1.000							
Plant height	0.289*	0.177	0.278*	-0.156	0.437**	-0.157	1.000						
No. of clusters per plant	0.093	0.069	0.218	-0.074	0.078	-0.042	0.276*	1.000					
No. of pods	-0.220	0.159	0.098	-0.254*	0.000	-0.101	0.227	0.436**	1.000				
No. of seeds per pod	0.202	0.147	0.213	0.120	0.337**	-0.324**	0.446**	0.061	0.092	1.000			
100 grain weight	0.149	0.208	-0.087	-0.144	0.177	0.302*	0.198	0.333**	-0.019	-0.058	1.000		
Grain yield	-0.013	0.283*	0.123	-0.322**	0.201	-0.059	0.468**	0.522**	0.781**	0.439**	0.450**	1.000	
Harvest index	0.015	0.088	-0.157	-0.143	-0.519**	-0.006	0.101	0.386**	0.489**	0.068	0.209	0.529**	1.000

* Significant at 5 % level

** Significant at 1 % level

Table 7. Genotypic correlation coefficients of grain yield and twelve characters in the F_2 generation of greengram (*Vigna radiata* (L.) Wilczek)

Characters	Length of primary root at 50 % flowering	No. of secondary roots at maturity	Shoot / root ratio	Weight of nodules in the root at 50 % flowering	Dry weight of plants at maturity	N_2 content in plants at maturity	Plant height	No. of clusters per plant	No. of pods	No. of seeds per pod	100 grain weight	Grain yield	Harvest index
ngth of primary root at 50 % flowering	1.000												
). of secondary roots at maturity	-0.085	1.000											
oot / root ratio	0.033	0.075	1.000										
eight of nodules in the root at % flowering	0.119	-0.508**	-0.249	1.000									
y weight of plants at maturity	0.067	0.117	0.608**	-0.079	1.000								
content in plants at maturity	0.079	0.004	-0.623**	0.338**	-0.215	1.000							
nt height	0.319*	0.182	0.406**	-0.221	0.507**	-0.366**	1.000						
. of clusters per plant	0.201	0.035	0.264*	-0.061	0.084	-0.065	0.371**	1.000					
. of pods	-0.267	0.169	0.123	-0.279*	0.037	-0.062	0.244	0.454**	1.000				
. of seeds per pod	0.274*	0.162	0.316*	-0.137	0.492**	-0.460**	0.690**	0.053	0.132	1.000			
) grain weight	0.236	0.274*	-0.101	-0.154	0.218	0.555**	0.248	0.386*	-0.012	-0.036	1.000		
in yield	-0.002	0.320**	0.164	-0.355**	0.266*	0.101	0.546**	0.579**	0.808**	0.362**	0.507**	1.000	
vest index	0.010	0.093	-0.237	-0.157	-0.591**	0.107	0.156	0.404**	0.529**	-0.028	0.236	0.558**	1.000

Significant at 5 % level

Significant at 1 % level

nodules in the root at 50 per cent flowering, dry weight of plants at maturity and nitrogen content of plants. The maximum positive phenotypic correlation with grain yield was recorded for number of pods (0.781) followed by harvest index (0.529) and negative correlation was recorded by weight of nodules in the root at 50 per cent flowering (-0.322). Shoot/root ratio (0.123) and dry weight of plants at maturity (0.201) showed non-significant positive phenotypic correlation with grain yield.

Length of primary root at 50 per cent flowering recorded significant positive phenotypic correlation with plant height (0.289). The dry weight of plants at maturity (0.094), number of clusters per plant (0.093), number of seeds per pod (0.202) and 100 grain weight (0.149) had positive but non-significant correlations. Number of pods (-0.220) recorded non-significant negative correlation with length of primary root at 50 per cent flowering.

Number of secondary roots at maturity recorded non-significant positive phenotypic correlation with dry weight of plants at maturity (0.111), plant height (0.177), number of pods (0.159) number of seeds per pod (0.147) and 100 grain weight (0.208). The correlation between this character and weight of nodules in the root at 50 per cent flowering (-0.370) was significant and negative.

Shoot-root ratio had significant positive phenotypic correlation with dry weight of plants at maturity (0.464) and plant height (0.278). The number of clusters per plant (0.218), number of pods (0.098) and number of seeds per pod (0.213) recorded positive but non-significant correlations. The weight of nodules in the root at 50 per cent flowering (-0.150) and harvest index (-0.157) recorded non-significant negative correlations and nitrogen content at maturity (-0.284) recorded significant negative correlation with shoot-root ratio.

Weight of nodules in the root at 50 per cent flowering recorded significant positive phenotypic correlation with nitrogen content in plants at maturity (0.292) and significant negative correlation with number of pods (-0.254) and grain yield (-0.322). The plant height (-0.156), number of seeds per pod (-0.120), 100 grain weight (-0.144) and harvest index (-0.143) had non-significant negative correlation with weight of nodules in the root at 50 per cent flowering.

Dry weight of plants at maturity showed significant positive phenotypic correlation with plant height (0.437) and number of seeds per pod (0.337) and non-significant correlation with 100 grain weight (0.177). The phenotypic correlation of this character with harvest index (-0.519) was negative and significant.

Nitrogen content of plants showed significant positive phenotypic correlation with 100 grain weight (0.302). This character recorded non-significant negative correlation with plant height (-0.157) and number of pods (-0.101) and it was significant and negative correlation with number of seeds per pod (-0.324).

Plant height recorded significant positive phenotypic correlation with number of clusters per plant (0.276) and number of seeds per pod (0.446) and non-significant positive phenotypic correlation with number of pods (0.227), 100 grain weight (0.198) and harvest index (0.101).

Number of clusters per plant showed significant positive phenotypic correlation with number of pods (0.436), 100 grain weight (0.333) and harvest index (0.386).

Number of pods showed significant positive phenotypic correlation with harvest index (0.489) and non-significant positive phenotypic correlation with number of seeds per pod (0.092).

Hundred grain weight showed non-significant positive phenotypic correlation with harvest index (0.209).

4.1.3.2 Genotypic correlation between yield and 12 other characters

Grain yield recorded significant positive genotypic correlation with all the other characters except length of primary root at 50 per cent flowering, shoot / root ratio, weight of nodules in the root at 50 per cent flowering and nitrogen content of plant at maturity. The genotypic correlation with grain yield was maximum for number of pods (0.808), followed by number of clusters per plant (0.578). The number of secondary roots at maturity (0.320), dry weight of plants at maturity (0.266), plant height (0.546), number of seeds per pod (0.362), 100 grain weight (0.507) and harvest index (0.558) had significant positive genotypic correlations with grain yield. Weight of nodules in the root at 50 per cent flowering (-0.355) had negative significant genotypic correlation with grain yield. The shoot / root ratio (0.164) and total nitrogen content of plant (0.101) showed non-significant positive genotypic correlation with grain yield.

Length of primary root at 50 per cent flowering recorded significant positive genotypic correlation with plant height (0.319) and number of seeds per

Fig. 3 Genotypic correlation diagram of yield and twelve other characters in parents and their F_2 generation of greengram (*Vigna radiata* (L.) Wilczek)

X_1 - Length of primary root at 50 per cent flowering

X_2 - Number of secondary roots at maturity

X_3 - Shoot / root ratio

X_4 - Weight of nodules in the root at 50 per cent flowering

X_5 - Dry weight of plants at maturity

X_6 - Nitrogen content in plants at maturity

X_7 - Plant height

X_8 - Number of clusters per plant

X_9 - Number of pods

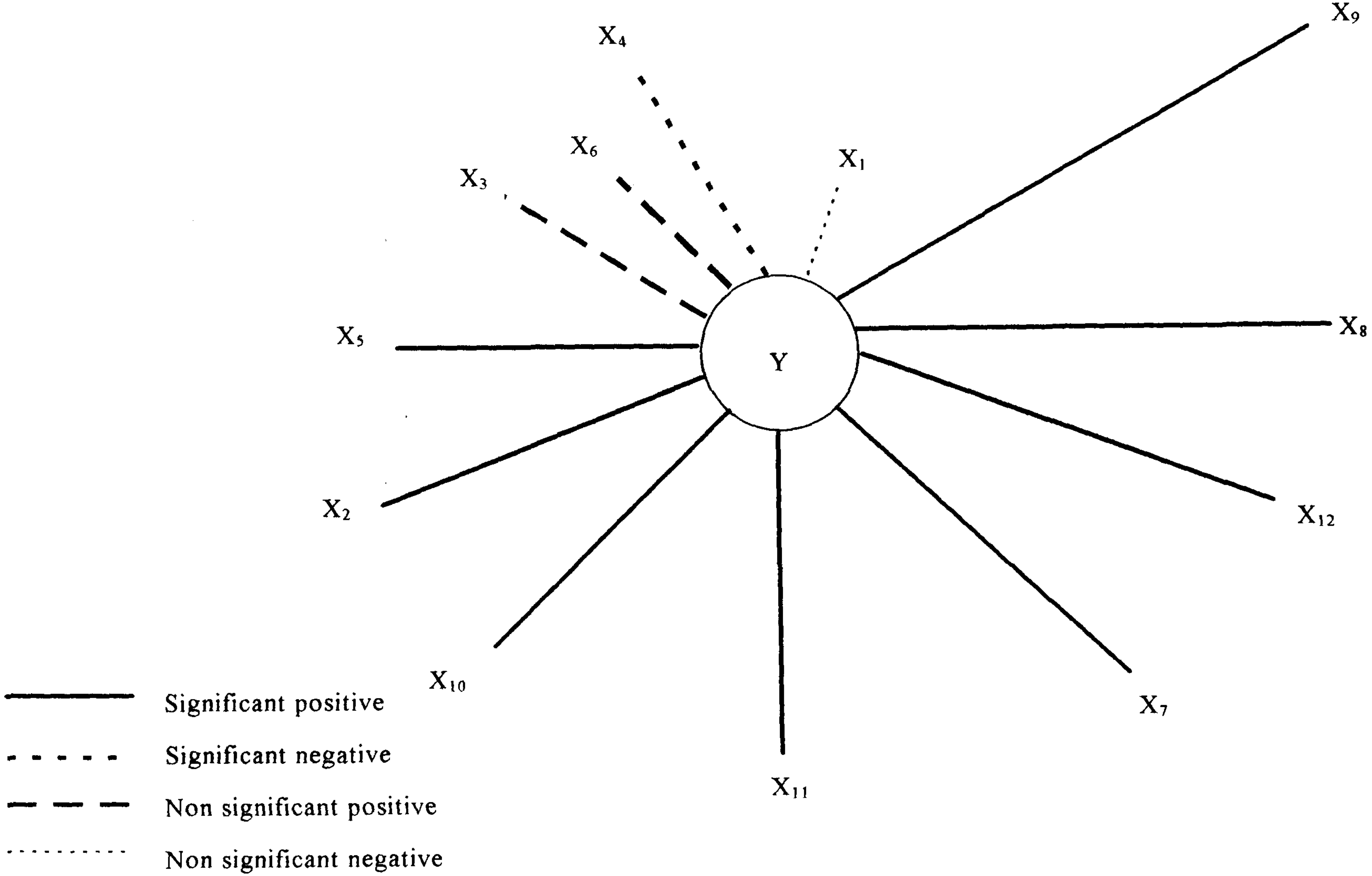
X_{10} - Number of seeds per pod

X_{11} - 100 grain weight

X_{12} - Harvest index

Y - Grain yield

Fig. 3 Genotypic correlation diagram of yield and twelve other characters in parents and their F_2 generation of greengram (*Vigna radiata* (L.) Wilczek)



pod (0.274) and significant negative genotypic correlation with number of pods (-0.267). This character recorded non-significant genotypic correlations with the remaining characters.

Number of secondary roots at maturity recorded significant positive genotypic correlation with 100 grain weight (0.274), whereas dry weight of plants at maturity (0.117), plant height (0.182), number of pods (0.169), number of seeds per pod (0.162) and harvest index (0.093) had positive but non-significant correlations. The correlation between this character and weight of nodules in the root at 50 per cent flowering (-0.508) was significant and negative.

Shoot / root ratio had significant positive genotypic correlations with plant height (0.406), number of clusters per plant (0.264) and number of seeds per pod (0.316) whereas number of pods (0.123) recorded positive but non-significant correlations. Weight of nodules in the root at 50 per cent flowering (-0.249), 100 grain weight (-0.101) and harvest index (-0.237) recorded non-significant negative correlations and nitrogen content in plants at maturity (-0.623) was significant and negative.

Weight of nodules in the root at 50 per cent flowering recorded significant positive genotypic correlation with nitrogen content in plants at maturity (0.338). This character recorded significant negative genotypic correlation with number of pods (-0.254) and non-significant negative correlation with plant height (-0.156), number of seeds per pod (-0.120), 100 grain weight (-0.144) and harvest index (-0.143).

Dry weight of plants at maturity showed significant positive genotypic correlation with plant height (0.507) and number of seeds per pod (0.492) and

Fig. 4 **Correlation diagram showing genotypic correlation in all possible combinations between thirteen characters in greengram (*Vigna radiata* (L.) Wilczek)**

X_1 - Length of primary root at 50 per cent flowering

X_2 - Number of secondary roots at maturity

X_3 - Shoot / root ratio

X_4 - Weight of nodules in the root at 50 per cent flowering

X_5 - Dry weight of plants at maturity

X_6 - Nitrogen content in plants at maturity

X_7 - Plant height

X_8 - Number of clusters per plant

X_9 - Number of pods

X_{10} - Number of seeds per pod

X_{11} - 100 grain weight

X_{12} - Grain yield

X_{13} - Harvest index

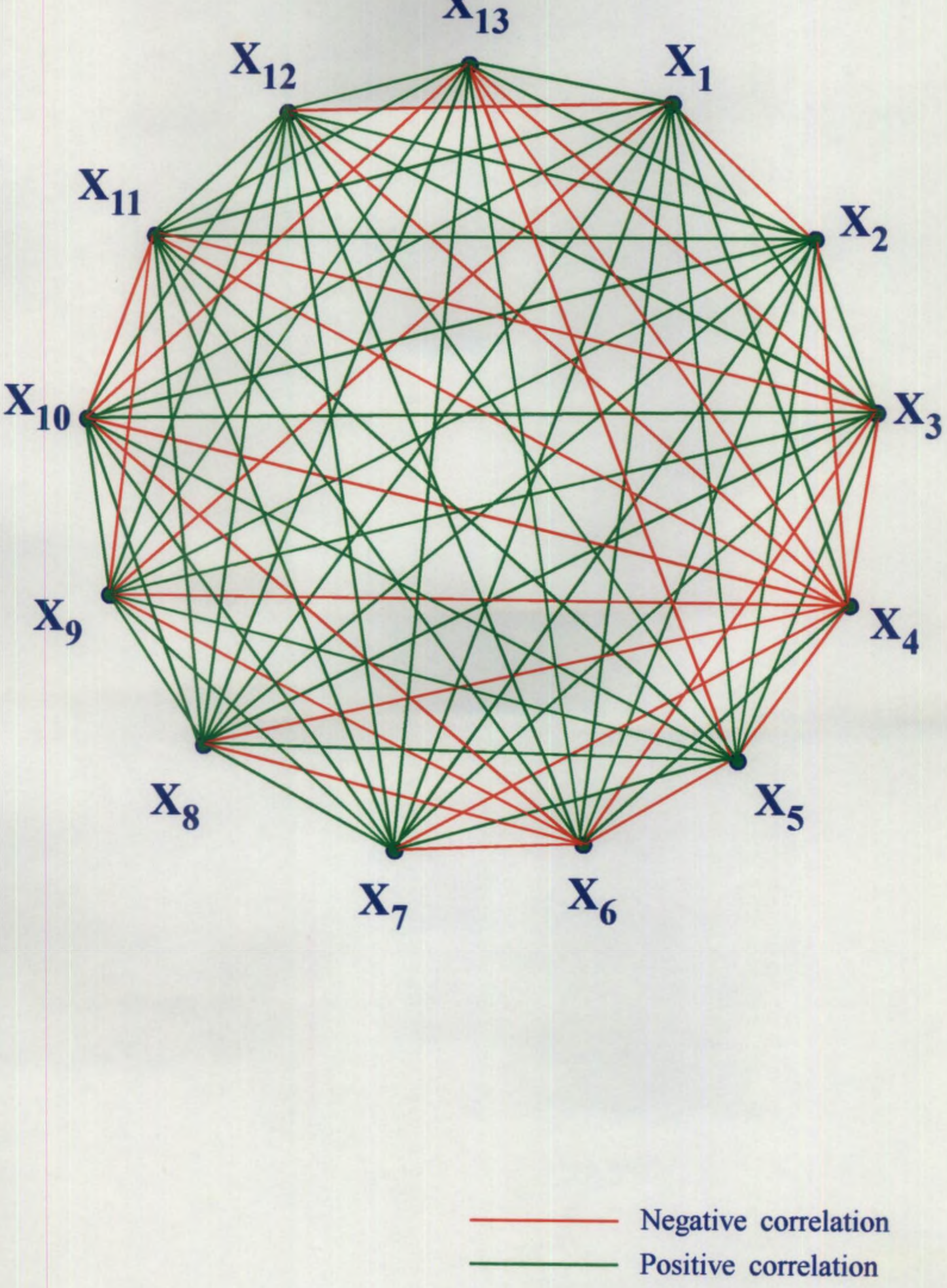


Fig. 4. Correlation diagram (showing genotypic correlations in all possible combinations)

non-significant positive genotypic correlation with 100 grain weight (0.218). The correlation between this character and harvest index (-0.591) was significant but negative. Nitrogen content in plants at maturity (-0.215) showed non-significant negative genotypic correlation with dry weight of plants at maturity.

Nitrogen content of plants recorded significant positive genotypic correlation with 100 grain weight (0.555) and non-significant positive genotypic correlation with harvest index (0.107). This character recorded significant negative genotypic correlations with plant height (-0.366) and number of seeds per pod (-0.460).

Plant height showed significant positive genotypic correlation with number of clusters per plant (0.371) and number of seeds per pod (0.690) and non-significant positive genotypic correlations with number of pods (0.244), 100 grain weight (0.248) and harvest index (0.156).

Number of pods recorded significant positive genotypic correlation with harvest index (0.529) and non-significant positive genotypic correlation with number of seeds per pod (0.132).

The genotypic correlation between 100 grain weight and harvest index (0.236) was non-significant and positive.

4.1.4 Path analysis

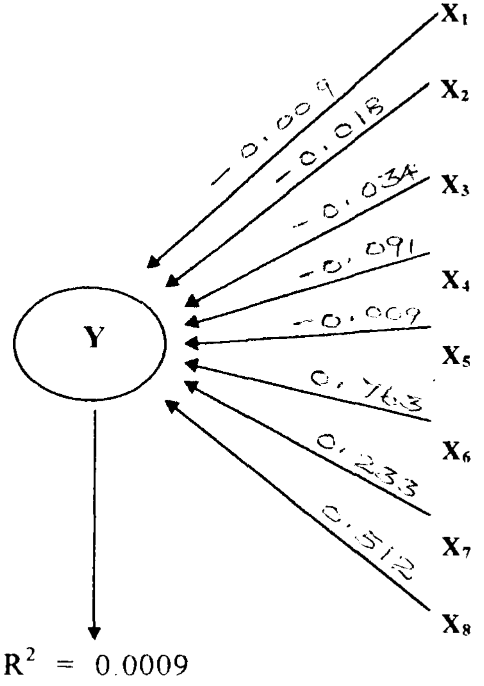
Correlation studies help in designing appropriate selection strategies while path coefficient analysis reveals the cause and effect relationship. The direct effect of a character on yield and the indirect effects through the other characters

Table 8. Direct and indirect effects of the various component characters on yield in the F_2 generation of greengram (*Vigna radiata* (L.) Wilczek)

Sl. No.	Characters	No. of secondary roots at maturity	Weight of nodules in the root at 50 per cent flowering	Dry weight of plants at maturity	Plant height	No. of clusters per plant	Number of pods	Number of seeds per pod	100 grain weight	Genotypic correlation with yield
1.	Number of secondary roots at maturity	-0.009	0.009	-0.004	0.017	0.000	0.129	0.038	0.140	0.320
2.	Weight of nodules in the root at 50 per cent flowering	0.004	-0.018	0.003	-0.020	0.001	-0.214	-0.032	-0.079	-0.355
3.	Dry weight of plants at maturity	-0.001	0.001	-0.034	0.046	-0.001	0.028	0.115	0.112	0.266
4.	Plant height	-0.002	0.004	-0.017	0.091	-0.004	0.186	0.161	0.127	0.546
5.	Number of clusters per plant	0.000	0.001	-0.003	0.034	-0.009	0.347	0.012	0.198	0.579
6.	Number of pods	-0.002	0.005	-0.001	0.022	-0.004	0.763	0.031	-0.006	0.808
7.	Number of seeds per pod	-0.001	0.003	-0.017	0.063	-0.001	0.101	0.233	-0.019	0.362
8.	100 grain weight	-0.002	0.003	-0.001	0.023	-0.004	-0.009	-0.008	0.512	0.507

The effects along the diagonal are direct effects.
Residual effect (R^2) = 0.0009

Fig. 5 Path diagram showing direct effects and inter relationships in parents and their F_2 populations of greengram (*Vigna radiata* (L.) Wilczek)



-508						
0.117	-0.079					
0.182	-0.221	0.507				
0.035	-0.061	0.084	0.371			
0.169	-0.280	0.037	0.244	0.454		
0.162	-0.137	0.492	0.690	0.053	0.132	
0.274	-0.154	0.218	0.248	0.386	-0.012	-0.036

(The genetic correlation of the trait X_1 with remaining characters are given in column 1 and X_2 with other traits are given in column 2 and so on)

Y - Grain yield per plant
X_1 - No. of secondary roots at maturity
X_2 - Weight of nodules in the root at 50 % flowering
X_3 - Dry weight of plants at maturity
X_4 - Plant height
X_5 - Number of clusters per plant
X_6 - Number of pods
X_7 - Number of seeds per pod
X_8 - 100 grain weight
R^2 - Residual effect

can be studied. The following characters having significant genotypic correlation with yield viz., number of secondary roots at maturity, weight of nodules in the root at 50 per cent flowering, dry weight of plants at maturity, plant height, number of clusters per plant, number of pods, number of seeds per pod, 100 grain weight were used to identify the direct and indirect effects on yield. The direct and indirect effects of above characters are presented in Table 8. The path diagram showing the direct effects and genotypic correlations of eight component characters on grain yield are presented in Figure 5.

A perusal of Table 8 revealed that maximum direct effect on yield was contributed by number of pods per plant (0.763) and its genotypic correlation with grain yield was also high (0.808) indicating number of pods has high direct effect on yield.

Another character with high direct effect on grain yield was hundred grain weight (0.512) and its genotypic correlation with grain yield was also high in magnitude (0.507).

Number of seeds per pod had a positive direct effect on grain yield (0.233) and its genotypic correlation with grain yield was (0.362).

Plant height had low positive direct effect on grain yield (0.091) and its genotypic correlation was (0.546).

Number of clusters per plant exhibited positive genotypic correlation with grain yield (0.579), even though its direct effect on grain yield was negative (-0.009).

Number of secondary roots at maturity exhibited a positive genotypic correlation (0.320) with grain yield and direct effect on yield was negligible (-0.009).

Dry weight of plants at maturity exhibited positive genotypic correlation with grain yield (0.266) and its direct effects was negligible (-0.034).

Weight of nodules in the root at 50 per cent flowering had negative direct effect on grain yield (-0.018) and its correlation was also negative (-0.355).

The residual effect (the effect due to other characters not included in the path analysis) was very small (R^2 = 0.0009), indicating that adequate characters were utilized for this study.

4.1.5 Selection index

Discriminant function technique was adopted for the construction of a selection index using grain yield and biological nitrogen fixation traits. The characters viz, number of secondary roots at maturity (X_1), weight of nodules in the root at 50 per cent flowering (X_2), dry weight of plants at maturity (X_3), plant height (X_4), number of clusters per plant (X_5), number of pods per plant (X_6), number of seeds per pod (X_7), 100 grain weight (X_8) and grain yield (X_9) having significant genotypic correlation with yield were included for constructing selection index. These component characters showed relatively stronger association with yield and formed a valuable selection index for yield and nitrogen fixation in the segregating F_2 generation. Equal weightage was given for all selected characters in the construction of this index.

Table 9 Selection criterion for parents and F_2 population of their crosses in greengram (*Vigna radiata* (L.) Wilczek)

Sl. No.	Parents and F_2 population of the crosses	Index value	Ranking position
1.	Pusa-9333 (P_1)	167.99	3
2.	KM-1285 (P_2)	90.23	24
3.	NDM-88-14 (P_3)	94.18	23
4.	MG-368 (P_4)	96.39	22
5.	11 PRM-3 (P_5)	96.97	21
6.	CoGG-902 (P_6)	170.77	1
7.	LG-444 (P_7)	128.39	11
8.	$P_1 \times P_2$	78.34	28
9.	$P_1 \times P_3$	169.17	2
10.	$P_1 \times P_4$	88.44	25
11.	$P_1 \times P_5$	110.20	12
12.	$P_1 \times P_6$	150.11	7
13.	$P_1 \times P_7$	114.34	14
14.	$P_2 \times P_3$	132.59	8
15.	$P_2 \times P_4$	103.95	18
16.	$P_2 \times P_5$	150.44	6
17.	$P_2 \times P_6$	159.66	4
18.	$P_2 \times P_7$	98.58	20
19.	$P_3 \times P_4$	116.47	13
20.	$P_3 \times P_5$	78.84	26
21.	$P_3 \times P_6$	101.72	19
22.	$P_3 \times P_7$	130.05	10
23.	$P_4 \times P_5$	132.11	9
24.	$P_4 \times P_6$	109.62	16
25.	$P_4 \times P_7$	122.23	12
26.	$P_5 \times P_6$	79.65	27
27.	$P_5 \times P_7$	155.09	5
28.	$P_6 \times P_7$	108.85	17

The selection index computed was

$$I = (-1.963)\ x_1 + (0.772)\ x_2 + (1.806)\ x_3 + (0.352)\ x_4 + (5.909)\ x_5 + (0.854)\ x_6 + (2.660)\ x_7 + (2.550)\ x_8 + (-0.618)\ x_9$$

The above index was used to workout a selection criterion to each parent and F_2 populations of their crosses and were ranked accordingly. The selection criterion are presented in Table 9 along the ranking of each genotype. The highest value was recorded by the parent CoGG-902 (170.77) followed by Pusa-9333 x NDM 88-14 (169.17), Pusa - 9333, KM-1285 x CoGG-902 and 11 PRM-3 x LG-444. The lowest value was recorded by the cross Pusa-9333 x KM-1285 (78.34).

DISCUSSION

5. DISCUSSION

Information on different genetic parameters is a pre-requisite for selecting superior progenies in the segregating generation. The grain yield is the sum total of contribution made by its components. Selection is the fundamental process in the development of superior varieties, and it depends on the variability available in the population. Selection based on yield alone is not very efficient, but based on its components as well could be more efficient (Evans, 1978). Knowledge concerning the heritability of quantitative characters and their associated genetic and environmental variance and co-variance may be useful as a tool for improving the efficiency of selection in segregating populations.

5.1 Variability

An estimate of the extent of variability available in a population is of immense value to the breeder to select superior genotypes for crop improvement. Only the genetic proportion of the total variability contributes to gain under selection. So knowledge on the nature and magnitude of genetic variation governing the inheritance of quantitative characters like yield and its components is essential (Allard, 1960).

In the present study, analysis of variance of 13 characters revealed significant differences for all the characters studied in the seven parents and F_2 population of their 21 crosses. The results revealed the existence of high variability for majority of the characters in seven parents and in the F_2 populations of their crosses. Earlier, Sharma and Rao (1988) revealed considerable variation for yield and its components in parents, F_1's and F_2's of six intervarietal crosses of blackgram. Patel and Shinde (1995) in greengram and Rao and Nanda (1994) in horsegram also reported significant variability for plant height, pods per plant and grain yield.

Genetic variation, so essential for selection, however cannot be measured directly. Only the external expression, i.e., genetic variance as modified by the environment is measurable as phenotypic variance. The variability available in a population could be partitioned into heritable and non-heritable components with the aid of genetic parameters like genotypic coefficient of variation (GCV), heritability (h^2) and genetic advance (GA), which serve as useful guidelines for selection.

The GCV provides a valid basis for comparing and assessing the range of genetic variability for quantitative characters and PCV measures the extent of total variation. High values of PCV with correspondingly high values of GCV were observed for weight of nodules in the root at 50 per cent flowering, followed by dry weight of plants at maturity, total nitrogen content of plant and grain yield which indicated the presence of high degree of genetic variation and better scope for the improvement of these characters through selection. Similar results were reported for grain yield by Manivannan *et al* (1996) and Reddy (1997) in greengram and Siddique and Gupta (1991) in cowpea.

The low estimates of GCV for number of seeds per pod and length of primary root at 50 per cent flowering indicated limited scope for improvement of these traits due to low magnitude of variability. This is in accordance with the results of Sidhu *et al.* (1985) and Natarajan *et al* (1990) in redgram for number of seeds per pod. However Veerabadhiran and Jehangir (1995) in greengram and Suryawanshi and Rao (1995) in blackgram reported high genotypic coefficient of variation for number of seeds per pod.

The difference between PCV and GCV was maximum for total nitrogen content, followed by weight of nodules in the root at 50 per cent flowering, length of primary root at 50 per cent flowering and number of seeds per pod revealing the influence of environment on these characters. The difference was the lowest for 100 grain weight followed by number of pods, number of clusters per plant, harvest index and plant height. This indicates that variation observed in these characters were mainly due to genetic causes and that environment had only negligible influence over them. This was supportive to the findings of Reddy (1997) in greengram for pod length, plant height and pods per plant.

5.2 Heritability and genetic advance

Heritability estimates provide an exact and precise information of the influence of environment on various characters. Robinson *et al.* (1966) classified heritability into low (< 30 per cent), medium (30 - 60 per cent) and high (> 60 per cent). Burton (1952) suggested that GCV alongwith heritability would provide a picture of the amount of advance to be expected by genotypic selection. In the present study, 100 grain weight followed by number of pods, dry weight of plants at maturity, weight of nodules in the root at 50 per cent flowering, number of clusters per plant, grain yield, harvest index, number of secondary roots at maturity, plant height and shoot/root ratio recorded high heritability. This can be attributed to the fact that these characters are least influenced by environment and there would be greater correspondence between phenotypes and breeding value (Johnson *et al.*, 1955). High heritability for pods per plant, clusters per plant and seed yield is in agreement with findings of Borah and Hazariaka (1995) and Khorgade (1995) in greengram, Sahu *et al.* (1985) and Natarajan *et al.* (1990) in redgram. However, Savithriamma (1992) recorded low heritability for pods per plant in cowpea. Patel and Shinde (1995) in greengram reported high heritability for pods per plant, plant height, 100 seed weight, and grain yield. Backiyarani and Nadarajan (1996) in cowpea also observed high heritability for harvest index. However, Anuradha and Krishamurthy (1993) observed moderate heritability for harvest index. The higher heritability estimates obtained in the study for weight of nodules in the root at 50 per cent flowering was in accordance with the findings of Hardarson and Jones (1979) in white clover and Smith *et al.* (1982) in crimson clover. However, Singh *et al.* (1985) reported moderate to high heritability to nodulation traits in greengram.

Heritability was moderate for length of primary root at 50 per cent flowering, total nitrogen content of plant and number of seeds per pod in the present study. Contrary to this, Patel and Shah (1982) in blackgram, Thiagarajan (1989), Backiyarani and Nadarajan (1996) in cowpea and Smith *et al.* (1982) reported high heritability for nitrogen content of plant in crimson clover.

High heritability estimates indicate the effectiveness of selection based on good phenotypic performance, but does not necessarily mean a high genetic gain for a particular trait. Johnson *et al.* (1955) pointed out that high heritability estimates alongwith high genetic advance were more useful than the heritability values alone in predicting the resultant effect for selecting the best individual.

Low genetic advance was observed for harvest index, total nitrogen content of plants, number of clusters per plant, number of seeds per pod and 100 grain weight. This was in line with the findings of Anuradha and Krishnamurty (1993) for harvest index in blackgram. Patel and Shah (1982) observed low genetic advance for seeds per pod and 100 grain weight in blackgram conformed the result obtained in the present study. On the contrary, Vaidi and Singh (1983) noticed high genetic advance for number of clusters per plant in cowpea.

Eventhough heritability estimates are useful in the selection of superior genotypes on the basis of phenotypic performance of the characters, it does not give a clear picture on the extent of improvement that can be achieved. Hence Johnson *et al.* (1955) have suggested that alongwith the heritability estimates, the genetic advance should also be considered for identifying characters during selection programme. In the present study, high heritability estimates alongwith high genetic advance were recorded for weight of nodules in the root at 50 per cent flowering, dry weight of plants at maturity, grain yield, number of pods, number of clusters per plant, harvest index, hundred grain weight, number of secondary roots at maturity, plant height and shoot/root ratio. According to Panse (1957) the characters with high heritability and high genetic advance were controlled by additive gene action and therefore these characters can be improved by selection. The report of Pinchbeck *et al.* (1980) in spanish clover that nodule fresh weight is controlled by additive gene action also conform the result obtained in the present study. High heritability alongwith high genetic advance recorded for plant height, pods per plant, clusters per plant and yield by Borah and Hazarika (1995) in greengram, plant height, number of pods and grain yield by Siddique and Gupta (1991 a) in cowpea, clusters per plant, pods per plant and grain yield by Khorgade (1995) in grengram, Natarajan *et al.* (1990) in redgram, hundred grain weight by Patil and Shinde (1995) in greengram and Thiyagarajan (1989) in cowpea and harvest index by Backiyarani and Nadarajan (1996) in cowpea were in conformity with the persent findings.

Medium heritability with high genetic advance was recorded for nitrogen content in plants at maturity. Medium heritability with low genetic advance were recorded for length of primary root at 50 per cent flowering and number of seeds per pod. However high heritability with low genetic advance for seeds per pod was reported by Patel and Shah (1982) in blackgram.

Based on genotypic coefficient of variation, heritability and genetic advance it can be concluded that selection based on weight of nodules at 50 per cent flowering, grain yield, number of pods, number of clusters per plant, harvest index and hundred grain weight will be very effective for improvement of grain yield and nitrogen fixation traits in greengram.

5.3 Correlation

Correlations provide information on the nature and extent of relationship between characters in a population, thus facilitating effective selection and simultaneous improvement of two or more characters. Therefore, analysis of yield in terms of genotypic and phenotypic correlation coefficients of component characters, leads to the understanding of characters that can form the basis of selection. In this study correlation between grain yield per plant and other twelve characters and their *inter-se* associations were estimated.

5.3.1 Correlation between grain yield per plant and other characters

Yield is a complex character, which is the outcome of a number of genetic factors and the environmental conditions, occurring at various stages of plants growth. Therefore, selection made for this character merely on the basis of its phenotypic expression are likely to be misleading. Hence analysis of yield in terms of genotypic and phenotypic correlation coefficient of component characters leads to 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 the non-vital ones (Falconer, 1981).

In the present study, genotypic correlations were in general higher than their corresponding phenotypic correlation for all the characters under study which may be due to the modifying effect of environment on association of characters at genic level. This was in line with the findings of Philip (1987) in blackgram.

Grain yield per plant exhibited positive genotypic correlation with all the characters except for length of primary root at 50 per cent flowering and weight of nodules in the root at 50 per cent flowering. These results revealed the importance of these components in increasing the seed yield. The highest degree of association between pods per plant and grain yield indicated that pods per plant is the most reliable component of yield and can be very well utilized as an indicator of yield. Singh and Malhotra (1970), Holker and Raut (1992), Reddy *et al.* (1994), Borah and Hazarika (1995) in greengram, Sarker *et al.* (1984) in blackgram and Veerupakshappa *et al.* (1980) in cowpea also reported similar results in the F_2 population.

The positive genotypic correlation of grain yield per plant with pods per plant, clusters per plant, plant height, seeds per pod and harvest index was in perfect agreement with the results of Abraham *et al.* (1992) in blackgram and Genesamurthy and Dorairaj (1990) in redgram.

A high positive genotypic correlation of clusters per plant, number of pods per plant and number of seeds per pod with grain yield per plant observed in this study was in conformity to reports of Singh and Malhotra (1970), Reddy *et al.*

(1994) and Veerabadhiran and Jehangir (1995) in greengram and Philip (1987) in blackgram.

In the present study, plant height and 100 seed weight exhibited positive correlation with grain yield per plant. This was in line with the findings of Patil and Narkhede (1989) in greengram and Shivakumar (1998) in chickpea. The positive phenotypic correlation of grain yield per plant with plant dry weight observed was in accordance with the results of Lokesha and Shivasanker (1990) in cluster bean.

Weight of nodules in the root at 50 per cent flowering, exhibited a significant negative correlation with grain yield per plant indicated that simultaneous improvement of weight of nodules and yield is very difficult by selection. This was in line with the findings of Rao and Venkateshwarlu (1983) in *Vigna aconitifolia*. Contrary to this, positive significant correlation between grain yield and weight of nodules was reported by Singh and Murthy (1988) in greengram and Singh and Ghai (1984) in pea. Some of the combinations had reasonably good nodulation and high seed yield in the present study is in conformity with the results obtained by Rathinaswamy *et al.* (1986) in greengram.

5.3.2 *Inter-se* correlation between characters

Selection based on yield components to be more successful, data on inter-relationships among the yield components is necessary, as it gives a more reliable information rather than a knowledge on association between yield and its components alone.

Length of primary root recorded positive genotypic correlation for weight of nodules in the root at 50 per cent flowering, plant height, number of clusters per plant, number of seeds per pod and 100 grain weight and negative correlation with number of pods. From these associations it can be inferred that simultaneous improvement of weight of nodules, plant height, number of clusters, number of seeds per pod and 100 grain weight is possible by improving the length of primary root.

Positive genotypic correlation existed between number of secondary roots at maturity, dry weight of plants at maturity, plant height, number of pods, number of seeds per pod, 100 grain weight and grain yield. This positive interrelationship facilitate simultaneous improvement.

Weight of nodules in the root at 50 per cent flowering had high positive genotypic correlation with shoot/root ratio and total nitrogen content of plants and negative correlation with number of pods. This was in conformity with the findings of Singh and Murthy (1988) for weight of nodules and nitrogen content of plants.

Height of plant exhibited significant positive genotypic correlation with shoot/root ratio, dry weight of plants at maturity, number of clusters per plant and number of seeds per pod and negative correlation with nitrogen content in plants at maturity. Similar results were observed for clusters per plant and pods per plant by Manivannan and Nadarajan (1996) in greengram. Philip (1987) also observed positive correlation between plant height, clusters per plant and seeds per pod in blackgram. Tamilselvan and Vijendradas (1994) observed positive association of palnt height with number of clusters was in line with the findings of the present study.

In the present study, clusters per plant had positive association with pods per plant, seeds per pod, 100 grain weight and harvest index. This was in line with the findings of Naidu *et al.* (1994) in greengram and Luthra and Singh (1978) in the F_3 population of blackgram for clusters per plant and pods per plant. Positive association between number of clusters per plant, pods per plant and seeds per pod, recorded in this study was in perfect agreement with the results of Reddy *et al.* (1994) and Veerabadhiran and Jehangir (1995) in greengram.

Harvest index had positive association with number of pods and number of clusters per plant. This was in accordance with the findings of Sarma and Roy (1995) for harvest index with pods per plant.

5.4 Path coefficient analysis

As the correlation coefficients are insufficient to explain the cause and effect relationship among the traits for an effective manipulation of the characters, the path coefficient analysis was carried out. The path analysis furnishes a method of partitioning the correlation coefficients into direct and indirect effects and provide the actual contribution of an attribute and its influence through other traits. Plant height, number of pods, number of seeds per pod, and 100 grain weight exerted positive direct effect while number of secondary roots at maturity, weight of nodules in the root at 50 per cent flowering, dry weight of plants at maturity and number of clusters per plant exerted negative direct effect on grain yield per plant.

Highest positive direct effect was exerted by number of pods per plant on grain yield per plant. This was in agreement with the findings of Natarajan *et al.* (1988), Pundir *et al.* (1992), Naidu *et al.* (1994), Reddy *et al.* (1994), Kumar *et al.* (1995), Singh *et al.* (1995), Veerabadhiran and Jehangir (1995), Manivannan and Nadarajan (1996) in greengram. This indicated that number of pods per plant is a highly reliable component of yield.

In the present study, another important character with high direct effect on grain yield was 100 grain weight. The indirect effects through other traits are negligible. Vidyadhar *et al.* (1984) in greengram also reported positive direct effect of 100 grain weight on grain yield.

Number of seeds per pod showed positive direct effect on grain yield and its genotypic correlation coefficient with grain yield was also higher than its direct effect. This is due to positive indirect effect through number of pods. Similar results were obtained for Vidyadhar *et al.* (1984), Natarajan *et al.* (1988), Raut *et al.* (1988) and Reddy *et al.* (1994) in greengram, Abraham (1988) and Shirivastava *et al.* (1996) in blackgram, Sawant (1994) in cowpea and Salunke *et al.* (1995) in redgram. Contrary to this, Manivannan and Nadarajan (1996) reported negative direct effect on grain yield.

Plant height showed positive direct effect on grain yield and its correlation coefficient was higher than its direct effect. This is due to its positive indirect effect via, number of pods, number of seeds per pod and 100 grain weight. This was in accordance with the findings of Manivannan and Nadarajan (1996) in greengram.

Renganayaki and Sree Rengasamy (1992) reported that plant height had greater indirect effect on grain yield. This was in line with the present study.

It was noted that clusters per plant, exhibiting significant and high positive genotypic correlation with yield, exerted negative direct effect on grain yield. This may be due to its positive indirect effects via, number of pods per plant and 100 seed weight. Naidu *et al.* (1994) in greengram also reported negative direct effect of clusters per plant on grain yield.

Number of secondary roots at maturity and dry weight of plants at maturity showed negative direct effects on grain yield but their correlation with yield was positive. This is due to positive direct effects through other traits.

Weight of nodules in the root at 50 per cent flowering had negative direct effect on grain yield and its genotypic correlation was also negative.

The residual effect was relatively very low, indicating that adequate characters were utilized for the study.

It is inferred from path analysis that number of pods per plant which recorded significant and high positive correlation coefficient and also high positive direct effect might be regarded as the prime character to be considered during selection of grain yield per plant.

5.5 Selection index

Discriminant function analysis developed by Fischer (1936) gives information on proportionate weightage to be given to the yield components. Thus a selection index was formulated to increase the efficiency of selection by taking into account, the important characters contributing to yield. Further Hazel (1943) suggested that selection based on a suitable index is more efficient than individual selection for the character.

Number of pods per plant, hundred grain weight, seeds per pod, plant height, number of clusters per plant, number of secondary roots at maturity, dry weight of plants at maturity, weight of nodules in the roots at 50 per cent flowering together with grain yield per plant, were used for constructing selection index. Similarly Banerjee *et al.* (1976) recorded that the index based on pods per plant and yield was more efficient in blackgram. Misra (1985) in greengram suggested that an index based on pods per plant, hundred seed weight, seeds per pod, clusters per plant and yield per plant is effective for identifying superior genotypes.

Thus based on the selection index values, the top ranking five genotypes viz., CoGG - 902, Pusa-9333 x NDM-88-14, Pusa-9333, KM-1285 x CoGG-902 and 11PRM-3 x LG-444 with the highest scores were identified as genetically superior from other parents and crosses of F_2 population for yield and biological nitrogen fixation.

SUMMARY

6. SUMMARY

The research programme was carried out at the Department of Plant Breeding and Genetics, College of Agriculture, Vellayani during rabi season, 1998-99. The present study "Genetic analysis of segregating generation of inter varietal crosses in greengram (*Vigna radiata* (L.) Wilczek)" was undertaken to identify the superior progenies in the F_2 generation for both yield and biological nitrogen fixation.

Seven parental varieties and F_2 population of their 21 crosses (without reciprocals) of greengram were evaluated in a randomised block design with three replications. Data on the following characters namely length of primary root at 50 per cent flowering, number of secondary roots at maturity, shoot/root ratio, weight of nodules in the root at 50 per cent flowering, dry weight of plants at maturity, nitrogen content of plants at maturity, plant height, number of clusters per plant, number of pods, number of seeds per pod, hundred grain weight, grain yield and harvest index were collected.

The data were subjected to analysis of variance and co-variance. Genetic parameters like genotypic and phenotypic coefficients of variation (GCV and PCV respectively), heritability (h^2), genetic correlations and path coefficients were estimated. Selection index was also formulated to identify superior genotypes.

The salient results obtained in this study are the following :

The analysis of variance revealed highly significant differences among the treatments for all the characters. The parents and their F_2 progenies showed significant difference with respect to shoot/root raio, weight of nodules in the root at 50 per cent flowering, plant height, number of clusters per plant, number of pods, number of seeds per pod, hundred grain weight and grain yield.

High genotypic and phenotypic coefficient of variations were observed for the characters weight of nodules in the root at 50 per cent flowering followed by dry weight of plants at maturity, nitrogen content in plants at maturity and grain yield indicating the presence of high amount of genetic variability for the above characters and the scope for their improvement through selection.

A perusal of heritability estimates indicated high heritability for hundred grain weight, number of pods, dry weight of plants at maturity, weight of nodules in the root at 50 per cent flowering, number of clusters per plant, grain yield and harvest index, number of secondary roots at maturity, plant height and shoot/root ratio. High heritability and comparatively high genetic advance was observed for weight of nodules in the root at 50 per cent flowering followed by dry weight of plants at maturity, grain yield, number of pods, number of clusters per palnt, harvest index, hundred grain weight, number of secondary roots at maturity, plant height and shoot/root ratio.

In general, genotypic correlation coefficients were higher than their corresponding phenotypic correlation coefficients. This revealed that the phenotypic expressions of these correlations are reduced owing to the influence of the environment. Grain yield per plant exhibited positive association with all the characters except length of primary root at 50 per cent flowering and weight of nodules in the root at [illegible] per cent flowering. Among the yield components, number of pods per plant had high positive association with grain yield.

Studies on direct and indirect effects revealed high positive direct effect and high positive correlation for number of pods per plant and hundred grain weight. This clearly indicated that pods per plant and hundred grain weight were the important characters influencing grain yield.

A selection index was formulated to improve the efficiency of selection based on the characters, number of pods, hundred grain weight, number of seeds per pod, plant height, number of clusters per plant, number of secondary roots at maturity, dry weight of plants at maturity, weight of nodules in the root at 50 per cent flowering together with grain yield per plant. CoGG-902, Pusa-9333 x NDM-88-14, Pusa-9333, KM-1285 x CoGG-902 and 11PRM-3 x LG-444 were identified as the five top rankers for both yielding ability and biological nitrogen fixation.

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GENETIC ANALYSIS OF SEGREGATING GENERATION OF INTER VARIETAL CROSSES IN GREENGRAM (*Vigna radiata* (L.) Wilczek)

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ABSTRACT

The research programme was carried out at the Department of Plant Breeding and Genetics, College of Agriculture, Vellayani during rabi season 1998-99, with the objective of identifying superior progenies in the F_2 generation for yielding ability and nitrogen fixation potential. Seven parents and F_2 progenies of their 21 crosses of greengram were evaluated, adopting a randomised block design with three replications. The data collected for thirteen quantitative characters were analysed statistically. The genetic parameters, correlation and path coefficients were studied and a selection index was formulated to identify superior genotypes.

The treatments showed significant difference for all the characters. High genotypic coefficient of variation was observed for weight of nodules in the root at 50 per cent flowering, dry weight of plants at maturity, nitrogen content of plants at maturity and grain yield. High heritability coupled with high genetic advance was observed for weight of nodules in the root at 50 per cent flowering followed by dry weight of plants at maturity, grain yield, number of pods, number of cluslters per plant, harvest index, hundred grain weight, number of secondary roots at maturity, plant height and shoot/root ratio indicating additive gene action and reliability of these characters during selection programme for crop improvement.

High positive genotypic correlation for number of pods per plant followed by number of clusters per plant, harvest index, plant height, hundred grain weight and number of seeds per pod indicated selection based on one or more of the above components may result in the improvement of grain yield. The path coefficient analysis revealed high positive direct effects of number of pods on grain yield. In addition hundred grain weight and number of seeds per pod also showed positive direct contribution to grain yield.

A selection index was constructed based on grain yield per plant and eight yield contributing characters identified through correlation and path analysis. Based on the selection index one of the parental varieties CoGG-902 ranked first followed by Pusa-9333 x NDM-88-14, Pusa-9333, KM-1285 x CoGG-902 and 11PRM-3 x LG-444 were identified as superior for yielding ability and nitrogen fixing potential.