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ANALYSIS OF VARIABILITY FOR ECONOMICALLY IMPORTANT TRAITS IN CHICKPEA (*CICER ARIETINUM* L.)

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ABSTRACT

Chickpea is the premier pulse crop of India grown on about 8.25 million ha. area with a production of 7.05 million tones, which accounts for 75% of the world chickpea production. In Karnataka, the area under chickpea is around 6.50 lakh ha. with a production of 3.1 lakh tonnes at an average productivity of 620kg/ha. However, the overall production and productivity of the country is much lower than the other countries. The success of chickpea improvement programme largely depends on the wealth of the genetic resources and are the most valuable and essential basic raw material to meet the current and future needs in chickpea crop improvement programme. The present investigation consisted of one hundred and seventy nine chickpea genotypes were evaluated for genetic variability in qualitative and quantitative traits of economic importance in simple lattice design with two replications. Analysis of data revealed that the genotypes exhibited highly significant differences for days to 50 % flowering, plant height (cm), number of primary branches, number of pods per plant, days to maturity, 100 seed weight (g), harvest index and grain yield per plant(g). A considerable variation between genotypes for qualitative traits such as early plant vigour, growth habit, seed colour, seed shape and testa texture was also recorded. The grain yield showed highly significant positive association with number of pods per plant, harvest index, number of primary branches, plant height, and number of seeds per pod at phenotypic level. However, days to maturity was negatively correlated with grain yield. Genetic variability for plant height, number of primary branches, number of pods per plant and 100 seed weight respectively ranged from 23.2–49.6 cm, 1.8–5.6, 12.4–66.4 and 9.0–30.0. Whereas grain yield per plant varied from 1.7–30.0g, and harvest index ranged from 0.02–0.46 while the variation for days to flowering was in the range of 44.0–76.0 and 89.0–114.0 for days to maturity. The variation revealed in this study would be exploited in breeding programs aimed at development of high yielding genotypes.

KEYWORDS: Chickpea *Cicer arietinum L.,* Environmental Variability, Fertilizing Crops

INTRODUCTION

Chickpea (*Cicer arietinum* L.) is the premier pulse crop of India consumed by people from almost all parts of the country and grown on about 8.25 million ha. area with a production of 7.05 million tonnes which accounts for 67.2% of the world chickpea production. In Karnataka, the area under chickpea is around 6.50 lakh ha. with a production of 3.1 lakh tonnes at an average productivity of 620kg/ha. However, the overall production and productivity of the country is much lower than the other countries. There is an acute shortage of this pulse and as a result India is importing chickpea from other countries. Chickpea plant is cool season crop very sensitive to excess moisture, high humidity and cloudy weather, which adversely affect its yield through limited flower production and seed set (Kay, 1979). In order to make this crop competitive with those grown during winter season, breeding of high yielding and input responsive varieties is the only solution. Yield improvement and its stability are, therefore, the two most important breeding objectives for this crop.

The success of chickpea improvement programme largely depends on the wealth of the genetic resources and are the most valuable and essential basic raw material to meet the current and future needs in chickpea crop improvement programme. Knowledge about the amount, kind and magnitude of variability in the germplasm and genetic relationships among breeding materials could be an invaluable tool in crop improvement strategies (Joshi and Dhawan, 1966; Murty and Arunachalam, 1966; Smith *et al*., 1991 and Kumar and Arora, 1992). In light of increased recognition and its importance, evaluation and characterization of chickpea germplasm has received greater attention of the plant breeders (Virmani *et al*., 1983; Bakhsh *et al*., 1992). Thus, the evaluation of germplasm is not only useful in selection of core collection but also for its utilization in breeding programmes. Virmani *et al*., (1983) evaluated mungbean germplasm, classified it into various groups based on different traits and identified accessions with high yield potential for further utilization to develop stable and high yielding cultivars with a broad genetic base. The genetically diverse genotypes are likely to produce heterotic effect and superior segregants when incorporated in hybridization to hasten crop improvement programme. In lentil germplasm categorization it was observed that short statured lentil genotypes were high yielding and possessed some other good agronomic characters (Bakhsh *et al*., 1992). Selection of high yielding accessions from the blackgram local germplasm might prove their superiority in advance testing under various agro climatic conditions (Ghafoor *et al*., (1989).

The main objective of most of the breeding programmes is aimed at increasing the yield (Lal & Tomer 1980). Although a great success in breeding of high yielding crops has been achieved through simple selection from germplasm, there is considerable scope for further increase in the yield by hybridization and selection. The adaptation to the existing soil and climatic conditions and development of lines for new environments in which chickpea would be grown in future can also be achieved through hybridization between selected germplasm lines (Roberts *et al*., 1980). Hence, the major objectives of the present investigation were to evaluate the new chickpea lines for genetic variability in various qualitative and quantitative traits, and to establish relationship between different traits.

MATERIALS AND METHODS

The present investigations were carried out with 179 diverse chickpea germplasm accessions maintained at AICRP on chickpea, University of Agricultural Sciences, GKVK, Bangalore were sown during rabi 2009. The experiment was laid out in a simple lattice design with two replications. Each genotype was grown in a single row of 4 m length with a row to row spacing of 30 cm and 10 cm from plant to plant. The fungicide treated seeds were drill sown in already opened rows and subsequently thinned to maintain the recommended spacing. All the recommended package of practices was adopted to raise the crop. Five randomly selected plants from each genotype in each replication were chosen for recording the observations to estimate the degree of genetic variability among accessions. The data were recorded on quantitative characters such as plant height (cm), number of primary branches, days to 50% flowering, number of pods per plant, number of seed per pod, days to maturity, biological yield (g), grain yield (g), 100 seed weight (g) and harvest index. The qualitative traits like early plant vigour, growth habit, flower colour, seed shape and seed surface were also recorded. The seed colour was recorded on randomly selected 100 seeds, immediately after threshing. The mean values of all the quantitative characters were subjected to statistical analysis (Panse and Sukhatme, 1961). The genotypes were classified into different groups according to the values of various traits.

RESULTS AND DISCUSSIONS

The analysis of variance revealed that there were significant differences between genotypes for all the characters except for number of seeds per pod indicating the presence of genetic variability among the genotypes. Highly significant ($P< 0.01$) variation for various traits revealed the importance of chickpea germplasm in the crop improvement programme

(Singh, 1988, Arshad *et al*., 2003). A wide range of variation was observed for maximum and minimum values of all the characters except number of seeds per pod which recorded lower range value (Table 1). The magnitude of the phenotypic coefficient of variation (PCV) was slightly higher than their corresponding genotypic coefficient variation (GCV) for all the characters indicated least influence of environment in the expression of these traits. The grain yield per plant and number pods per plant recorded higher PCV of 39.20% and 35.83% respectively and GCV of 30.95% and 29.62% respectively compared to other traits. Grain yield is highly dependent character; hence the coefficient of variability also showed the cumulative effects and resulted in higher magnitude. The results are in conformity with the earlier findings of Sharma *et al*., (2005)

Table 1: Analysis of Variance and Estimates of Mean, Range, Components of Variance, Heritability (h^2) and Genetic Advance as Percent of Mean for Different Quantitative Traits in Chickpea Germplasm

	Character	MSS	Mean $\pm$ SEm	Range	PCV	GCV	h^2	GAM
1	Days to 50% flowering	57.92**	57.80 $\pm$0.88	44.0 – 76.0	18.7	15	80.1	30.82
2	Plant height (cm)	53.53**	34.36 $\pm$0.14	23.2 - 49.6	17.2	12.9	75.1	26.59
3	No. of primary branches plant^{-1}	1.95*	3.02 $\pm$0.14	1.8 - 5.6	15.8	10.9	68.5	22.35
4	No. of pods plant^{-1}	347.66*	42.44 $\pm$0.34	12.4 - 66.4	35.8	29.6	82.7	61.08
5	No. of seeds pod^{-1}	0.21	1.02 $\pm$0.00	1.0 - 2.0	16.1	14.9	92.3	30.59
6	Days to maturity	36.51*	103.51 $\pm$0.08	89.0 – 114.0	8.65	6.25	72.3	12.87
7	Grain yield plant^{-1} (g)	94.23*	9.10 $\pm$0.03	1.7 - 53.0	39.2	31	79	63.75
8	100 seed weight(g)	36.74*	16.79 $\pm$0.11	9.0 - 30.0	23	21.3	92.6	43.8
9	Harvest index	0.13*	0.09 $\pm$0.00	0.02 - 0.46	10.2	8.27	81.5	17.04

*, Significant at 0.05; **, Significant at 0.01; SEm= Standard Error of means; MSS = Mean Sum of Squares

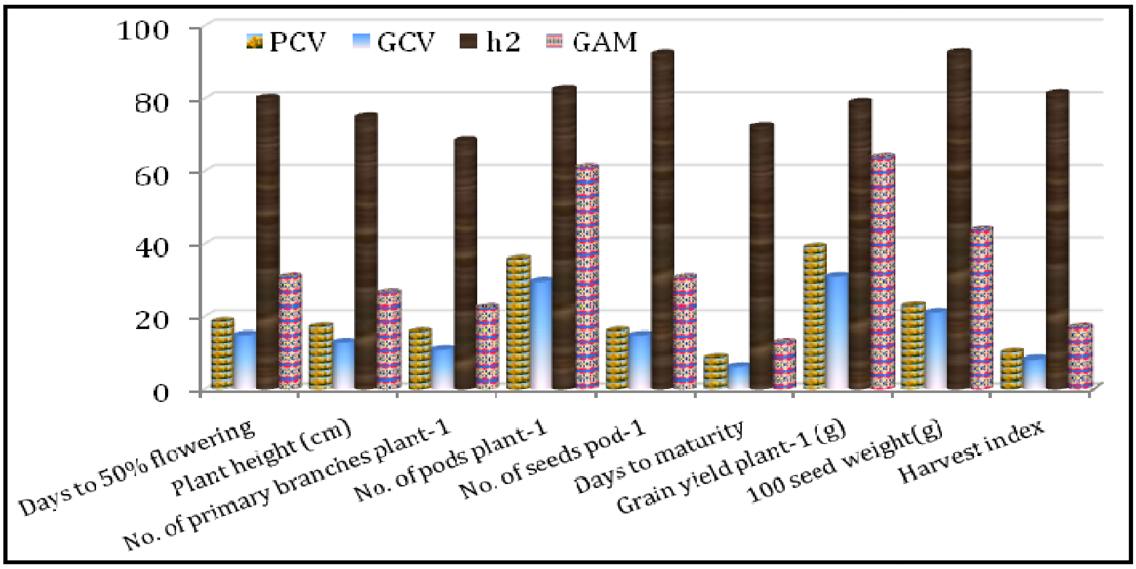

Figure 1: Phenotypic Coefficient of Variation (PCV), Genotypic Coefficient Variation (GCV), Heritability (h2) and Genetic Advance as Percent of Mean (GAM) for Quantitative Characters in Chickpea

The estimate of PCV and GCV value give only the extent of variability existing for various traits, but does not give any information about the heritable portion of it, rather is revealed by heritability estimates. The knowledge of heritability enables the plant breeder to decide the course of selection procedure to be followed under a situation to get possible gains of selection. The high estimates of heritability along with high variation was observed for 100 seed weight, number of seeds per pod, number of pods per plant, days to 50% flowering, grain yield per plant, number of primary branches per plant and plant height. These findings are in accordance with the results of Singh and Rao (1991), Chavan et al., (1994) and Samal and Jagadev (1994). The harvest index and days to maturity recorded high heritability with low variation. The scope of heritability estimates is restricted as it changes with change in environment and experimental material etc., (Swarup and Chaugale, 1982). Hence, the use of heritability values coupled with genetic advance will give an idea about the nature of gene action governing a particular character (Johnson *et al*., 1955) and hence, it would be more reliable and useful in forming selection procedure. High heritability in broad sense coupled with high genetic advance as per cent mean was recorded for grain yield per plant, number of pods per plant, 100 seed weight, days to 50% flowering and number of seeds per pod suggesting that these traits under the control of additive gene action and potential possibilities exist for the improvement of these traits through simple selection (Figure. 1). Similar results were reported by Patil (1996) that high genetic advance as per cent mean for grain yield per plant, 100 seed weight and number of pods per plant. Moderate genetic advance for plant height, number of primary branches, harvest index and days to maturity could be due to low genetic variability for these traits. However, a high heritability value for these traits suggests that to some extent selection will be an effective strategy in improving these traits (Table 1). The variation for morphological traits revealed marked differences for early plant vigour, growth habit, seed color, seed shape and seed surface (Table 2). The frequency distribution of genotypes under various categories of these morphological traits showed that maximum genotypes had good early plant vigour, semi erect growth habit, brown *testa* color, angular seed shape and rough seed surface.

Table 2: Frequency Distribution of Various Qualitative Traits in Chickpea Germplasm

Sl. No.	Character		No. of Accessions	Frequency
1	Early plant vigour	Poor	30	16.76
		Good	130	72.63
		Very good	19	10.61
2	Growth habit	Erect	5	2.79
		Semi-erect	93	51.96
		Semi-spreading	81	45.25
3	Seed Colour	Black	3	1.68
		Brown	143	79.89
		Beige(white)	26	14.53
		Yellow	4	2.23
		Green	3	1.68
4	Seed shape	Angular	167	93.3
		Owl's head	11	6.15
		Pea shaped	1	0.56
5	Seed surface	Rough	172	96.09
		Smooth	4	2.23
		Tuberculated	3	1.68

The correlation coefficient studies to elucidate the relationship between different traits with yield, revealed that plant height, number of primary branches per plant, number of pods per plant, number of seeds per pod and harvest index was positively and highly significantly ($P < 0.01$) associated with each other and with the grain yield per plant (Table 3). However, days to maturity was negatively correlated with grain yield and other characters while, days to 50% flowering had non-significant correlation with yield. Similar results were reported by several other workers from their studies on various legumes (Malik *et al*., 1987). A negative correlation of days to flowering with grain yield in chickpea was reported by Mather & Mathur (1996) and Arshad *et al*., (2003). However, Bhambota *et al*., (1994) showed that maturity days was non-significantly correlated with grain yield. Sharma and Saini (2010) reported highly significant correlation of grain yield with number of branches per plant and number of pods per plant. Sarviyayal & Goyal (1994) and Ali *et al*., (1991) proposed pods per plant and 100-seed weight as selection criteria for high yielding genotypes. Present results showed that plant height, Number of primary branches, number of pods per plant, number of seeds per pod and harvest index had highly significant positive relationship with grain yield. These components play an important role in the partitioning of grain yield. Hence these characters may be put together in a single genotype for yield improvement. Tripathi (1998) analysed 100 genotypes for 13 yield components and suggested that plant height, biological yield and pods per plant should be the basis of selection criteria for yield improvement in chickpea. Similarly in the present study the genotypes with high values of these characters have been identified and listed in Table 4 that would be utilized in breeding programmes aimed at development of high yielding varieties.

Table 3: Phenotypic Correlation among Nine Important Traits of Chickpea

	1	2	3	4	5	6	7	8	9
1	1.000	0.257**	0.095	0.089	0.560**	-0.202*	-0.248**	0.210*	0.042
2		1.000	0.367**	0.432**	0.255**	0.228*	-0.097	0.227*	0.480**
3			1.000	0.501**	0.066	0.025	-0.099	0.025	0.489**
4				1.000	0.031	0.476**	-0.186*	0.267**	0.927**
5					1.000	-0.341**	-0.204*	-0.331**	-0.011
6						1.000	-0.023	0.095	0.240**
7							1.000	0.292**	0.122
8								1.000	0.912**
9									1.000

*, **, Significant at P<0.05 and 0.01 respectively

1:	Days to 50% flowering	5:	Days to maturity
2:	Plant height (cm)	6:	No. of seeds pod^{-1}
3:	No. of primary branches $plant^{-1}$	7:	100 seed weight(g)
4:	No. of pods $plant^{-1}$	8:	Harvest index
		9:	Grain yield $plant^{-1}$ (g)

Table 4: Accessions Identified as Source of Important Traits for Development of High Yielding Varieties through Hybridization

Sl.No.	Accessions	100 Seed Weight	Biological Yield	Grain Yield (g)	Harvest Index
1	IC-552293	23.4	115.22	53.00	0.46
2	IC-552284	19.2	109.52	46.00	0.42
3	IC-552335	17.8	111.51	41.26	0.37
4	IC-552282	16.9	120.62	31.36	0.26
5	IC-552291	17.5	104.26	28.15	0.27
6	IC-552286	18.1	104.17	25.00	0.24
7	IC-552244	20.3	96.17	22.12	0.23
8	IC-552280	17.7	100.27	22.06	0.22
9	IC-552287	19.8	98.86	20.76	0.21
10	IC-552267	30.2	101.00	20.20	0.20

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