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

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Abstract

Two hundred and nineteen chickpea genotypes were studied for genetic variability in qualitative and quantitative traits of economic importance. The experiment was planted in RCBD with 2 replications. Results revealed highly significant differences for plant height (cm), number of primary and number of secondary branches, number of pods per plant, 100 seed weight (gm), biological yield per plant (g), harvest index and grain yield/plant. A considerable variation between genotypes for qualitative traits such as growth habit, seed shape and testa texture was also recorded. The correlation coefficients of primary branches, secondary branches, pods per plant, biological yield and harvest index with grain yield were positive and highly significant. However, days to maturity were negatively correlated with grain yield. Genetic variability for plant height, number of primary branches, number of secondary branches, number of pods per plant and total biological yield respectively ranged from 40 – 90 cm, 1.5 – 6.5, 1.1 – 15.5, 1-75 and 1.5 – 50.5 g/plant. Whereas grain yield per plant varied from 5.5 – 25.5g, and harvest index ranged from 10 – 70. The variation for days to flowering was in the range of 120 – 150. The variation revealed in this study would be exploited in breeding programs aimed at development of high yielding genotypes.

Introduction

Chickpea (*Cicer arietinum* L.) commonly known as gram is the fifth most important food legume crop in the world- following soybean, groundnut, dry bean and dry pea. It is the major pulse crop with respect to consumption and cultivated area in Pakistan. The annual production varied from 767.1 to 397 thousand tons due to fluctuation in its productivity during 1997-98 to 2000-01, respectively (Anon., 2001). There are two major types of chickpea i.e., Kabuli and *Desi* (brown). Kabuli type is grown in temperate regions while the *Desi* type of chickpea is grown in the semi-arid tropics (Muehlbauer & Singh, 1987). Chickpea plant is very sensitive to excess moisture, high humidity and cloudy weather, which adversely affect its yield through limited flower production and seed set (Key, 1979). Average yield of chickpea in Pakistan is very low and unstable as compared to other chickpea producing countries of the world (Anon., 2000). Yield improvement and its stability are, therefore, the two most important breeding objectives for this crop.

The presence of genetic variability is pre-requisite for any breeding programme aimed at improvement of crop yields. Because of increased recognition and its importance, evaluation and characterization of chickpea germplasm has received 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

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utilization in breeding programmes. Ghafoor *et al*., (1990); Bakhsh *et al*., (1991), Hussain *et al*., (1991); and Saeed & Rehman (1992) and Arshad *et al*., (2004) reported statistically highly significant differences for some agronomic traits in various legumes. 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. 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). Ghafoor *et al*., (1989) indicated that high yielding accessions selected from the blackgram local germplasm might prove their superiority in advance testing under various agro climatic conditions.

The main objective of most of the breeding programmes is to increase the yield (Lal & Tomer 1980). Although a great success in breeding of high yielding crops has been achieved through selection from germplasm, there is considerable scope for further increase in the yield by hybridization and selection. The adaptation to the existing environments 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). 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

Two hundred and nineteen chickpea genotypes developed by national and international research institutes, were obtained and planted in the field at National Agricultural Research Center (NARC), Islamabad, Pakistan. These genotypes were developed by breeders either through selection or hybridization with special attention for yield potential and blight resistance. The experiment was planted in Randomized Complete Block Design with two replications. Each genotype was grown in a single row of 4 m length. Plant to plant and row-row distance was maintained at 10 cm and 30 cm, respectively. Before sowing the seeds were treated with a fungicide. The seeds were drilled and thinned to maintain the recommended distance. All other cultural practices recommended by Malik (1994) were adopted to raise the crop.

To estimate the degree of genetic variability among accessions, the observations were recorded on five randomly selected plants of each genotype in each replication. The data were recorded on quantitative characters such as plant height (cm), number of primary branches, number of secondary branches, pods per plant, number of seed per pods, biological yield (g), grain yield (g), 100 seed weight (g) and harvest index. The time to 50% flowering were recorded on plot basis at the stage when 50% of the plants had flowered. The time (days) taken by a genotype from sowing to this stage were recorded as days to 50% flowering. The qualitative traits like, growth habit and flower colours were also recorded on plot basis. The seed colour was recorded on randomly selected 100 seeds, immediately after threshing. The means of all the quantitative characters were subjected to statistical analysis (Steel & Torrie, 1966). The genotypes were classified into different groups according to the values of various traits.

Results and Discussion

In order to maintain and utilize germplasm efficiently it is important to investigate the extent of genetic variability it contains. Moreover, the success of breeding programs largely depends upon the magnitude of genetic variability available in the germplasm (Smith *et al*., 1991). The results of the present study showed that there were significant differences between genotypes for all the characters. The minimum and maximum values for each trait indicated wide range of differences between genotypes for various characters (Table 1). Number of secondary branches per plant, number of pods per plant, biological yield per plant (g) and grain yield per plant (g) ranged from 1.4–13.4, 3–65, 2.2–49.8 and 1.3–21.7, while 100-seed weight (g) and harvest index varied from 12.3–28.7g and 10.7–65.8, respectively.

Table 1. Analysis of variance for different quantitative traits in chickpea genotypes.

Traits	MS	Mean	Range
Days to 50% flowering	36.20**	131.00 ± 0.28	122 – 146
Pant height (cm)	2.25**	63.94 ± 0.40	44.8 – 85.3
No. of primary branches per plant	1.08**	3.32 ± 0.05	1.7 – 5.8
No. of secondary branches per plant	10.81**	4.96 ± 0.16	1.4 –13.4
No. of pods per plant	315.09**	21.03 ± 0.85	3 – 65
No. of seeds per pod	0.13**	1.55 ± 0.02	1 – 2.3
Biological yield per plant (g)	156.64**	16.78 ± 0.59	2.2 – 49.8
Grain yield per plant (g)	26.97**	5.43 ± 0.25	1.3 – 21.7
100-seed weight (g)	16.40	19.95 ± 0.19	12.3 – 28.7
Harvest index	131.34	30.05 ± 0.05	10.7 – 65.8

**, Significant at 0.01; ±SD= Standard Deviation; MS= Mean Square

Highly significant ($P < 0.01$) variation for various traits revealed the importance of chickpea germplasm. Genetic variation in chickpea for different characters has already been reported by various workers who used germplasm for their studies (Singh, 1988, Wadud & Yaqoob, 1989; Bakhsh *et al*., 1991; Hussain *et al.*, 1991; Saeed & Rehman, 1992; Arshad *et al*., 2004). The numbers of genotypes in various classes of quantitative characters are given in Table 3. Genotypes normally distributed for most of the characters. Maximum number of genotypes for biological yield, harvest index and pods per plant were present in classes, 10-20 g, 30-40 g and 15-30 g. The variation for morphological traits revealed marked differences for Plant growth habit, seed color, flower color and pod size (Table 2). The frequency distribution of genotypes under various categories of these morphological traits showed that maximum genotypes had erect growth habit, brown *testa* color, pink flower color and medium pod size. Since these genotypes were recently developed and collected from germplasm therefore, it appeared that these would be the popular morphological traits for consumers as indicated by Nakayama *et al*., (1998). The morphological characters of plants are considered to be the first step in the description and classification of plant germplasm (Smith & Smith, 1989; Kurlovich, 1998). Some times these traits were used as markers for other qualitative or quantitative character of plants. However, in the present study no such relationship was worked out or established.

Table 2. Frequency distribution of various qualitative traits in chickpea germplasm.

Character		No. of accession	Frequency %
Growth habit	Erect	202	92
	Semi erect	15	6.85
	Spreading	2	0.91
Flower color	Purple	192	87.67
	White	27	12.33
Seed color	Black	3	1.37
	Dark brown	2	0.91
	Brown	149	68.04
	Brown beige	35	15.98
	Yellow beige	18	8.22
	Orange	4	1.83
	Ivory white	8	3.65

The correlation coefficient presented showed that number of pods per plant, number of secondary branches and harvest index were positively and highly significantly ($P< 0.01$) correlated with each other and with the grain yield (Table 4). However, days to maturity were negatively correlated with grain yield and other characters. From these findings it could be proposed that genotypes with high values of characters that had positive correlation with grain yield can be utilized in hybridization for the development of genotypes with a combination of these traits. Various workers have already reported similar results from their studies on various legumes (Malik *et al*., 1987). Mather & Mathur (1996) and Arshad *et al*., (2003) reported negative correlation of days to flowering with grain yield in chickpea. However, Bhambota (1994) showed that there was non-significant correlation between maturity days and grain yield. Sarviyayal & Goyal (1994) and Ali *et al*., (1991) proposed pods per plant and 100-seed weight as selection criteria for high yielding genotypes. Our results showed that biological yield per plant (g), Harvest index, number of secondary branches and number of pods per plant 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 genotypes with high values of these characters have been identified and listed in Table 6 that would be utilized in breeding programme. The mean values for various characters in genotypes falling under different categories of harvest index presented in Table 5 revealed that increase in harvest index up to the level of 50 was associated with improvement in these traits. Beyond 50% level of harvest index, a decrease in the number of pods per plant, number of secondary branches, biological yield and grain yield per plant was noticed. Therefore, any effort for increasing harvest index beyond 50 would negatively affect grain yield and other yield components. However, further investigation is required to confirm relationship between various levels of harvest index and yield components.

Table 3. Frequency distribution of quantitative traits in chickpea germplasm.

Character	Class interval	No. of accessions	Percentage
Days to flowering (50%)	120.00 – 130.50	121	55.2
	130.60 – 140.50	97	44.3
	140.60 – 150.50	1	0.50
Days to maturity (50%)	140.50 – 150.50	1	0.50
	150.60 – 160.50	4	1.80
	160.60 – 170.50	209	95.40
	170.50 – 180.50	5	2.30
Plant height (cm)	40.00 – 50.00	1	0.46
	50.10 – 60.00	47	21.46
	61.10 – 70.00	144	65.75
	70.10 – 80.00	24	10.96
	80.10 – 90.00	3	1.37
No. of primary branches per plant	1.5 – 2.5	21	9.59
	2.6 – 3.5	138	63.01
	3.6 – 4.5	43	19.63
	4.6 – 5.5	14	6.39
	5.6 – 6.5	3	1.37
No. of secondary branches per plant	1.1 – 5.5	151	68.95
	5.6 – 10.5	59	26.94
	10.6 – 15.5	9	4.11
No. of pods per plant	1.0 – 15.0	86	39.27
	15.1 – 30.0	87	39.73
	30.1 – 45.0	33	15.07
	45.1 – 60.0	11	5.02
	60.1 – 75.0	2	0.91
No. of seeds per pods	1.0 – 1.5	144	65.75
	1.5 – 2.0	70	31.96
	2.0 – 2.5	5	2.28
Biological yield per plant (g)	1.5 – 10.5	48	22
	10.6 – 20.5	105	48
	20.6 – 30.5	48	22
	30.6 – 40.5	9	4
	40.6 – 50.5	9	4
Grain yield per plant (g)	0.1 – 5.5	142	65
	5.6 – 10.5	55	25
	10.6 – 15.5	16	7.3
	15.6 – 20.5	5	2.3
	20.6 – 25.5	1	0.5
100 seed weight (g)	1.5 – 10.5	8	3.6
	10.6 – 20.5	133	60.7
	20.6 – 30.5	68	31.1
	30.6 – 40.5	10	4.6
Harvest index	10.20 – 20.00	22	10.01
	20.10 – 30.00	87	39.7
	30.10 – 40.00	92	42.00
	40.10 – 50.00	15	6.9
	50.10 – 60.00	1	0.5
	60.10 – 70.00	2	0.9

Table 4. Simple correlation between important traits of chickpea.

Character	Secondary branches	No. of pods	Biological yield	Harvest index	Days to maturity	Grain yield
Primary branches	0.39**	0.50**	0.59**	0.02	-0.05	0.47**
Secondary branches		0.75**	0.79**	0.26**	-0.14**	0.75**
No. of pods			0.91**	0.47**	-0.34**	0.95**
Biological yield				0.27**	-0.23**	0.93**
Harvest index					-0.33**	0.53**
Days to maturity						-0.35**

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

Table 5. Relationship of important chickpea traits with different classes of harvest index.

Characters	Range of harvest index				
	10 –20	**20.1 – 30**	**30.1 - 40**	**40.1 – 50**	**>50**
Primary branches	3.67± 0.9	3.16 ± 0.7	3.32 ± 0.7	3.66 ± 0.8	2.93 ± 0.6
Secondary branches	4.09 ± 2.1	4.48 ± 2.2	5.39 ± 2.3	6.39 ± 2.9	4.73 ± 2.8
Pods per plant	11.5 ± 5.9	16.43 ± 8.5	25.05 ± 11.5	37.37 ± 1.8	14.96 ± 5.7
Seeds per pod	1.2 ± 0.2	1.47 ± 0.2	1.63 ± 0.25	1.62 ± 0.2	1.7 ± 0.3
Biological yield	13.8 ± 8.4	14.4 ± 7.4	18.52 ±8.39	24.98 ± 8.4	8.84 ± 2.3
Grain yield	2.29 ± 1.7	4.03 ± 2.3	6.60 ± 3.2	10.86 ± 5.6	4.6 ± 2.6

±SD= Standard Deviation

Table 6. Genotypes identified as source of important traits for development of high yielding varieties through hybridization.

Genotypes	100-seeds weight (g)	Harvest index	Biological yield (g)	Grain yield (g)
NCS950214	24.1	49.7	43.3	21.7
92CC0767	19.2	43.4	43.7	19.1
BRS-14	22.8	36.5	49.8	18.1
96051	23.1	42.8	41.7	17.9
CMC55S	18.1	38.3	46.2	17.3
NCS950185	20.9	39.3	41.7	16.3
CMC94M	18.6	40.4	38.3	15.4
NCS95004	25.5	26.5	48.0	14.8
NCS95021	19.4	44.7	29.1	13.7

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