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Assessment of Genetic Variability and Interrelationship among Some Agronomic Traits in Chickpea

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ABSTRACT

Twenty chickpea genotypes were studied for various yield parameters under field conditions to estimate correlation co-efficients and linkage distance. Analysis of variance of yield and its components revealed significant differences between genotypes for six out of nine traits studied. Maximum variation was recorded for pods per plant followed by secondary branches per plant, biological yield, grain yield and harvest index. Highly significant and positive correlation of grain yield was found with biological yield, secondary branches and number of pods/plant. Secondary branches were positively correlated with number of pods per plant and grain yield per plant, whereas it was negatively associated with 100 grain weight. Cluster diagram based on Euclidean dissimilarity placed all the genotypes in three clusters at 50% linkage distance. Cluster I, II and III possessed 8, 5 and 7 genotypes, respectively. Means of various traits for each character showed that genotypes with maximum number of secondary branches, pods per plant, biological yield and seed yield per plant were placed together in cluster III. Genotypes with maximum harvest index and 100 seed weight were placed in cluster II and I, respectively.

Key Words: Chickpea; Genetic variability; Heritability; Correlation; Cluster analysis

INTRODUCTION

Chickpea (*Cicer arietinum* L.) is an important source of vegetable protein in the world. The Asian region contributes 70% to the total world's production. The major chickpea producing countries in Asia are India (65%), Pakistan (7.5%) and Turkey (6.5%). In Pakistan it is cultivated on 1.07 million hectares with production of 842 thousands tons (GOP, 2006-2007). The productivity of chickpea in Pakistan is low and instable, which may be attributed to the evolution of cultivars with narrow genetic base making them vulnerable to biotic stresses. Cultivar with narrow genetic base emerged due to the extensive use of few and closely related germplasm lines in crop improvement program. Diverse genetic backgrounds of parental lines provide the allelic variation necessary to create favorable new gene combinations.

Genetically diverse germplasm is therefore, needed in breeding programs to enhance the productivity and diversity of cultivars. Utilization of introduced germplasm is one way to enhance the genetic diversity. The knowledge of genetic parameter in new germplasm is however, essential for understanding and their manipulation in crop improvement program. Bakhsh *et al.* (1998) reported a consistent and positive association of biological yield per plant, pods per plant, harvest index and secondary branches per plant with grain yield. Saleem *et al.* (2002) observed high co-efficient of variability for grain yield and other yield parameters in chickpea. Arshad *et al.* (2003) studied heritability and correlation in chickpea and found high heritability for secondary branches and biological yield coupled with high genetic advance that showed additive gene effects to be important in determining these characters. Grain yield had positive and significant correlation with plant height, pods per plant, 100-seed weight and biological yield. Raval and Dobariya (2003) estimated genetic variability and interrelationships for thirteen yield components in chickpea. The seed yield was positively and significantly correlated with biological yield per plant, 100-seed weight, number of pods per plant, harvest index, number of secondary branches per plant and plant spread at both genotypic and phenotypic levels, while correlation of seed yield with days to 50% flowering, days to maturity and number of seeds per pod was negative and significant.

Babbar and Patel (2005) observed that biological yield, 50% podding and harvest index contribute maximum to seed yield in chickpea. Khan *et al.* (2006) studied thirteen chickpea cultivars for the genetic variability, heritability, genetic advance and correlations. They reported that genotypic co-efficient of variation was relatively low for days to flowering, days to maturity and plant height, while it was high for pods plant^{-1}, 100-seed weight and seed yield kg ha^{-1}

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indicating low environmental impact for these characters. Singh (2007) observed that seed yield had highly significant positive correlation with biological yield per plant, pods per plant, harvest index and secondary branches per plant. They proposed that emphasis may be given on these characters for selecting high yielding genotypes in chickpea.

With the same back ground, present studies were carried out to seek information on variation and association of economically important characters with yield in exotic genotypes of Desi (indiginous) type chickpea. This information will help to select diverse genotypes with desired attributes for pyramiding traits through hybridization.

MATERIALS AND METHODS

The present study was carried out during the Rabi season of 2007-2008 in the experimental area of Pulses programme at the National Agricultural Research Center (NARC) Islamabad. Experimental material was comprised of 20 exotic genotypes of desi chickpea received from International Crops Research Institute for Semi-Arid Tropics (ICRISAT). The experiment was laid out in randomized complete block design (RCBD) with 3 replications. Each plot consisted of 3 lines of 4 m length. The plant-to-plant and row-to-row distance was maintained at 10 cm and 30 cm, respectively. The experiment was conducted under rain fed condition on well-drained loam soil without application of fertilizer. However, weeding was done manually to keep the experiment weed free. Five plants were chosen at random from the central row of each plot for data recording on days to maturity, biological yield, plant height, primary branches, secondary branches, number of pods per plant, grain yield per plant and 100 seed weight. Means values were used for analysis of variance according to Steel and Torrie (1980) to determine the significance of difference among genotypes. Genetic parameters and correlation co-efficients were worked out according to the method suggested by Singh and Chaudhary (1979). Cluster analysis was performed to determine the genetic distances between genotypes and cluster diagram was constructed following Ward's method using the means of the genotypes.

RESULTS

The results of analysis of variance and other genetic parameters showed significant differences among the genotypes for biological yield, number of secondary branches, number of pods per plant, 100-seed weight, seed yield per plant and harvest index (Table I). Almost all the traits showed a wide range of variation except days to maturity (Table II). Maximum days to maturity (174) were recorded in ICCV 07109, whereas three genotypes (ICCV 07103, ICCV 07106 & ICCV 07112) took minimum days (168) to mature. There was a great variation in biological yield among genotypes that ranged from 6.99 g to 27.67 g. Number of secondary branches ranged from 2 to 10. Number of pods plant^{-1} varied from 6 to 32 and ICCV 07101 exhibited maximum number of pods (32). The variation for 100-seed weight ranged from 22.28 g to 38.63 g. The highest seed yield plant^{-1} was recorded for genotype ICCV 07101 (9.75 g) and ICCV 07111 showed minimum seed yield (2.41 g). Number of pods plant^{-1} (60.6) seed yield plant^{-1} (6.4), biological yield plant^{-1} (23.2) and harvest index (62.5) showed considerably high genotypic component of variability. High heritability estimates were observed for 100-seed weight (0.99), harvest index (0.96), secondary branches (0.86) and seed yield plant^{-1} (0.69) Table II.

Correlation co-efficient of yield and its components in chickpea indicated that most of the traits studied in the present investigation were positively and significantly correlated with yield (Table III). However, negative association of some traits with grain yield as that of 100-seed weight (-0.329) was also obtained. Significant and positive correlation of grain yield was found with biological yield (0.771), primary branches (0.537), secondary branches (0.617) and number of pods plant^{-1} (0.778). Biological yield per plant was positively correlated with primary branches (0.66), secondary branches (0.735) and number of pods plant^{-1} (0.782). Primary branches showed strong positive association with secondary branches and number of pods plant^{-1}. Secondary branches were positively correlated with number of pods plant^{-1} (0.687) and seed yield plant^{-1} (0.617), but this character had negative relationship with 100-seed weight (-0.338). Cluster diagram based on Euclidean dissimilarity constructed by Ward's method revealed three clusters at 50% linkage distance (Fig. 1). Cluster I, II and III, respectively possessed 8, 5 and 7 genotypes. Means of various traits for each character showed that genotypes with maximum number of secondary branches, pods per plant, biological yield and seed yield per plant were placed together in cluster III. Genotypes with maximum harvest index were placed in cluster II and genotypes with maximum 100-seed weight were placed in cluster I (Table IV).

DISCUSSION

The estimation of genetic variability is prerequisite for breeding programs aimed at crop improvement. The evaluation of exotic germplasm under taken in the present study revealed significant differences among the genotypes for biological yield, number of secondary branches, number of pods plant^{-1}, 100 seed weight, seed yield plant^{-1} and harvest index. Among these traits, secondary branches, number of pods per plant, seed yield per plant biological yield/plant and harvest index showed considerably high genotypic component of variability. The high phenotypic variance as compared to genotypic variance signifies the role of environment in character expression. The estimates of genotypic and phenotypic variances provide information on the extent of variability. The heritable portion of this

Table I: Means and analysis of variance for yield and its associated components in 20 chickpea genotypes

Genotypes	Days to Maturity	Plant Height (cm)	No. of Primary Branches Plant^{-1}	No. of Secondary Branches plant^{-1}	No. of Pods plant^{-1}	100 Seed weight (g)	Biological Yield (g)	Seed yield plant^{-1} (g)	Harvest index (%)
ICCV 07101	171	39.20	3	8	32	26.08	20.25	9.75	49.15
ICCV 07102	169	47.35	2	3	10	21.73	8.210	4.08	48.40
ICCV 07103	168	39.60	2	5	16	22.23	14.39	6.94	47.20
ICCV 07104	173	46.60	2	7	20	25.55	27.67	9.78	36.65
ICCV 07105	172	41.40	4	10	17	20.75	22.04	5.58	27.65
ICCV 07106	168	41.10	2	6	21	21.88	18.99	6.12	31.10
ICCV 07107	171	41.30	2	6	14	30.16	12.74	5.55	44.75
ICCV 07108	173	41.40	2	8	25	38.23	25.23	7.92	32.65
ICCV 07109	174	44.50	2	4	14	33.59	13.46	3.96	30.70
ICCV 07110	171	37.70	2	4	6	39.63	6.99	2.55	35.20
ICCV 07111	170	49.05	1	4	10	26.69	8.14	2.41	30.30
ICCV 07112	168	46.00	1	5	11	20.93	9.05	3.58	39.75
ICCV 07113	170	46.80	2	6	19	23.33	22.10	5.60	25.65
ICCV 07114	170	43.70	2	4	10	34.22	10.28	3.55	32.25
ICCV 07115	169	40.85	1	5	12	34.58	15.41	4.73	29.30
ICCV 07116	170	38.10	2	6	13	30.36	13.07	4.50	35.20
ICCV 07117	169	38.55	2	6	13	29.93	14.39	4.41	29.30
ICCV 07118	169	38.65	1	5	15	33.08	12.87	6.64	51.80
ICCC 37	171	46.00	2	6	27	21.28	24	7.490	31.60
BITTAL 98	171	46.05	2	5	7	25.94	10.61	3.08	30.00
Mean Square (V)	6.31	25.70	0.27	6.75**	90.94*	78.53**	77.44*	9.32**	127.61**
Mean Square (R)	10.0	6.89	0.40	0.72	108.24	4.37	65.66	0.17	3.48
CV %	1.03	9.24	25.46	12.77	24.73	7.56	30.0	26.3	4.37
LSD (P<0.05)	3.65	15.55	0.90	1.46	11.53	4.42	11.64	3.55	3.29

Table II: Mean, Range, Co-efficient of variability and Heritability of nine traits in twenty chickpea genotypes

Traits	Mean	Range	Genotypic variance	Phenotypic variance	Heritability (BS)
Days to Maturity	170	168-174	1.63	4.68	0.35
Plant Height (cm)	42.7	37.7-49.0	5.07	20.62	0.25
No. of Primary Branches Plant^{-1}	2	1-4	0.04	0.23	0.17
No. of Secondary Branches plant^{-1}	5.7	3-10	3.13	3.62	0.86
No. of Pods plant^{-1}	15.6	6-32	60.6	90.9	0.67
100 Seed weight (g)	28	22.2-38.6	36.9	41.6	0.99
Biological Yield (g)	15.5	6.9-27.6	23.2	54.2	0.43
Seed yield plant^{-1} (g)	5.4	2.4-9.7	6.4	9.3	0.69
Harvest index (%)	35.5	25.6-51.8	62.5	65.0	0.96

Table III: Correlation co-efficients among 9 traits in 20 chickpea genotypes

	DM	PH	PB	SB	NP/P	100-SW	BY	HI	GY/P
DM		0.16	0.20	0.24	0.35*	0.20	0.40*	-0.197*	0.28
PH			0.15	-0.16	0.06	-0.25	0.20	-0.189	0.01
PB				0.58**	0.54**	-0.16	0.66**	-0.126	0.54**
SB					0.69**	-0.34*	0.74**	-0.093*	0.62**
NP/P						-0.36*	0.78**	0.120	0.78**
100-SW							-0.25	0.246**	-0.33
BY								-0.161	0.77**
HI									0.29*

**Significant at 1% probability level

*Significant at 5% probability level

DM=Days to maturity; PH=Plant height; PB=Primary branches; SB=Secondary branches ; NP/P=No. of pods per plant; 100-SW=100 Grain weight; BY=Biological yield; GY/P=Grain yield per plant; HI= Harvest index

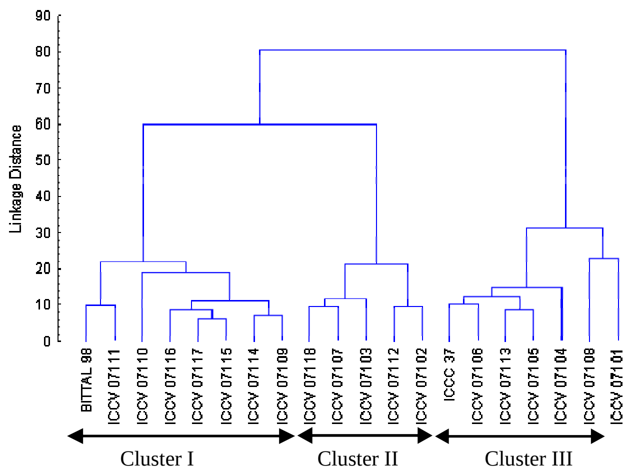
variation is determined by the estimates of heritability. Therefore, heritability estimates give better idea about possible gain through selection. High heritability for secondary branches, seed yield per plant, 100-seed weight and harvest index indicated the scope of their improvement through selection for these traits (Sidramappa *et al.*, 2008). The parameters with high genotypic variability and high heritability could be focused for genetic improvement in chickpea. Similar findings have already been reported by Ali *et al.* (2002), Kaur *et al*. (2004), Qureshi *et al*. (2004), Sharma *et al.* (2005) and Singh (2007).

Grain yield is a complex character that is outcome of interaction between many plant traits, which are in turn influenced by their genetic make up and environment,

Table IV: Means and standard deviations of three clusters with number of genotypes for nine variables

Traits	Cluster I (8)	Cluster II (5)	Cluster III (7)
Days to Maturity	170.5 ± 1.60	169.0 ± 1.22	171.33 ± 1.86
Plant Height (cm)	42.31 ± 4.16	42.58 ± 3.89	42.62 ± 2.97
Secondary Branches plant^{-1}	4.38 ± 1.30	4.80 ± 1.10	7.50 ± 1.52
No. of Pods plant^{-1}	10.63 ± 2.92	13.20 ± 2.59	23.67 ± 5.43
100 Seed weight (g)	33.56 ± 4.23	25.76 ± 3.92	25.63 ± 5.75
Biological Yield (g)	11.54 ± 3.02	11.45 ± 2.67	23.03 ± 3.24
Seed yield plant^{-1} (g)	3.65 ± 0.90	5.36 ± 1.50	7.77 ± 1.77
Harvest index (%)	31.86 ± 2.85	46.53 ± 4.90	33.94 ± 7.68

Fig. 1: Dendogram of twenty chickpea genotypes



where plant is grown. Therefore, the direct evaluation and improvement of grain yield itself may be misleading due to involvement of environmental component. Therefore, it is very important to analyze the data for relative contribution of various components to yield performance. The simple correlation analysis is an important tool for this purpose. Correlation coefficients of yield and its components estimated in this study indicated that most of the traits studied in the present investigation were positively and significantly correlated with yield. However, negative association of some traits with grain yield as that of 100-seed weight was also obtained. Significant and positive correlation of grain yield was found with biological yield, primary branches, secondary branches and number of pods/plant. These results were confirmed by the findings of Raval and Dobariya, 2003; Toker, 2004; Qureshi *et al.*, 2004; Obaidullah *et al.*, 2006. Biological yield per plant was positively correlated with primary branches and secondary branches and number of pods per plant. Meena *et al.* (2006) also reported the similar results in chickpea. Primary branches showed strong positive association with secondary branches and number of pods per plant. Secondary branches were positively correlated with number of pods per plant and grain yield per plant, whereas it had negative association with 100-grain weight. Therefore, increase in secondary branches will increase number of pods per plant and grain yield per plant with negative effect on 100 grain weight, which itself is negatively correlated with grain yield. Renukadevi and Subbalakshmi (2006) reported the positive direct effect of these characters on yield/plant in chickpea genotypes. Singh (1982) also observed negative correlations between grain weight and grain yield.

Cluster analysis signifies the extent of genetic diversity and that is of practical use in plant breeding Sultana *et al.* (2006). The germplasm used in this study was grouped in Cluster I, II and III, which respectively possessed 8, 5 and 7 genotypes. Means of various traits for each character showed that genotypes with maximum number of secondary branches, pods per plant, biological yield and seed yield per plant were placed together in cluster III. Genotypes with maximum harvest index were placed in cluster II and genotypes with maximum 100-seed weight were placed in cluster I. The cluster analysis supported the results of correlation analysis, both indicated that pods per plant, secondary branches per plant and biological yield per plant may be improved simultaneously and put together in a single genotype for yield improvement. This was obvious from the fact that all the three components are positively associated with yield and with themselves. Furthermore, genotypes with high mean values for these characters and those with high grain yield were grouped in same cluster.

It can be suggested from the present investigation that the exotic material evaluated in this study can be exploited for yield improvement through improvement and pyramiding of component traits such as secondary branches, biological yield plant^{-1} and number of pods plant^{-1}.

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