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GENETIC VARIABILITY AND CORRELATION STUDIES IN CHICKPEA (*CICER ARIETINUM* L.)

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Abstract

Genotypic and phenotypic variability, heritability, genetic advance and correlation studies for yield and its components were conducted in 24 genotypes of chickpea. High heritability with low genetic advance of days to flowering, days to maturity and 100 seed weight indicated the influence of dominant and epistatic genes for these traits. High heritability of secondary branches and biological yield coupled with high genetic advance revealed that additive gene effects are important in determining these characters. Grain yield had positive and significant correlation with plant height, pods per plant, 100-seed weight and biological yield.

Introduction

Chickpea (*Cicer arietinum* L.) commonly known as gram is the fifth most important food legume crop in the world after soybean, groundnut, dry beans and peas. It ranks third among the world's pulse crops (dry bean and dry peas). Being rich in protein, pulse crops are playing a significant role in balanced human diet, especially when mixed with the cereal grains. Among four major pulses grown in Pakistan, chickpea is playing a major role in providing food for the poor people of this country. It ranks first in pulse crops grown in Pakistan with respect to area (972000 ha) and production (565000 tons) (Anon., 1999-2000).

Plant breeders are continuously endeavoring to improve the genetic potential of yield of this crop so as to meet the demands of an ever-increasing population. The approaches to make significant improvement in chickpea production, require information on nature and magnitude of genetic variation in quantitative characters and their inter-relationship in population comprising diverse genotypes, which are important pre-requisites for systematic breeding programme. Several researchers (Singh *et al.*, 1977; Malik *et al.*, 1983; Malik *et al.*, 1988; Ghafoor *et al.*, 1990, 2000) have emphasized the utility of the estimates of genetic components in the prediction of response of quantitative characters to selection.

Islam *et al.*, (1984) found high and positive correlation of yield per plant with pods per plant and number of secondary branches per plant and recommended these traits as selection criteria in chickpea. Whereas, a selection index based on more pods and primary branches and low number of secondary branch to improve yield in chickpea was suggested by Singh *et al.*, (1985). Khan *et al.*, (1989) and Bakhsh *et al.*, (1993) have also studied the genetic variability and correlation. The present study was aimed to determine the significance of various parameters through meaningful correlation studies in increasing or decreasing the economic yield of chickpea genotypes for variety development process. The available information will be very helpful for an efficient selection criterion in selecting the most desirable, high yielding genotypes/pure lines of chickpea.

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Materials and Methods

Twenty-four genotypes of chickpea were planted in a randomized complete block design (RCBD) with four replications, in the experimental field of the National Agricultural Research Center, Islamabad during the year 1999-2000. Each plot consisted of six rows with four meter length. The plant-to-plant and row-to-row spacing was maintained at 10cm and 30cm, respectively. Recommended cultural practices were adopted to maintain a healthy crop growth. Ten plants were randomly selected for recording data with respect days to flowering (50%) and maturity (on plot basis), plant height (cm), primary branches, secondary branches, number of pods per plant, 100 seed weight (gm), biological yield (gm), grain yield (gm) and harvest index (% age). Harvest index was calculated as ratio between grain yield per plant and biological yield per plant. The average data were subjected to the analysis of variance to test the significance level of variation among the genotypes for different characters under study (Steel & Torrie, 1980). Genetic parameters and correlation coefficients were computed according to the methods suggested by Singh & Chaudhry (1979). The significance of genotypic correlation coefficients was tested with the help of standard errors as suggested by Reeve & Rao (1981).

Result and Discussion

The analysis of variance of 24 genotypes of chickpea showed that the genotypes differed significantly for all the characters recorded, indicating a considerable range of genetic variability (Table 1). The maximum grain yield was recorded in the genotype 90261 while the lowest yield was obtained in the genotype 99103. Genetic parameters including genotypic and phenotypic variances, genotypic and phenotypic coefficients of variability, heritability and genetic advance were also computed (Table 2). The values of phenotypic coefficients of variability were higher than genotypic coefficients of variability indicating the influence of environment upon the recorded characters. Similar results have been reported by Sandhu *et al.*, (1978), Malik *et al.*, (1988) and Ahmad & Rabbani (1992). Estimates of heritability in broad sense varied from 23% for primary branches to 99% for 100 seed weight. The genetic advance (5% selection intensity) was highest for secondary branches (42.89), which was followed by primary branches (34.95), biological yield (30.24), pods per plant (27.08), and grain yield (26.65) etc., while it was lowest for days to maturity (2.48) and days to flowering (2.53), respectively. It indicated that maximum progress for improvement by selection is possible in the characters like secondary branches, biological yield and pods per plant. Heritability alone is not very useful but heritability estimates alongwith genetic advance is valuable (Johnson *et al.*, 1955). For days to flowering, days to maturity and 100 seed weight, high heritability was associated with low genetic advance, indicating the influence of dominant and epistatic genes for these characters. A reasonable high heritability for secondary branches and biological yield was coupled with high genetic advance, indicating that additive genes effect were important in determining these characters. These results are in close agreement to those of Das & Dana (1982).

Correlation coefficient: The genotypic, phenotypic and environmental correlation coefficients revealed that the genotypic correlations were higher than phenotypic ones for most of the characters (Table 3). The environmental correlation coefficients showed negligible effects, indicating low environmental influence. All references in the text hereafter are referred to the genotypic correlations.

Table 1. Results of analysis of variance parameters for 24 genotypes of chickpea (*Cicer arietinum* L.).

S. No.	Genotype	DF	DM	PH	PB	SB	NP/P	100SW	BY	GY	HI
1	92CC079	123.75	171.50	73.30	2.90	8.05	35.55	22.17	29.13	16.35	56.35
2	92CC076	123.75	174.50	62.50	3.30	8.41	26.20	20.84	27.26	14.15	50.64
3	9280C	125.00	177.50	66.90	3.20	11.2	37.05	22.40	35.66	19.15	53.77
4	96051	122.25	174.25	49.55	3.15	7.95	40.15	21.22	32.66	17.75	54.34
5	90280	123.50	174.25	65.35	3.35	10.4	36.00	23.98	35.30	20.05	57.00
6	90261	124.25	174.75	64.65	2.75	8.25	38.65	21.11	37.50	18.75	52.08
7	94014	122.00	178.25	59.60	3.95	11.45	33.90	22.57	27.49	14.95	54.31
8	A-16	121.75	174.50	66.50	2.95	8.25	39.11	23.52	28.69	15.60	53.48
9	93012	118.00	175.50	73.60	3.10	8.86	32.20	23.80	27.97	16.00	56.99
10	93009	117.50	174.75	72.20	2.40	9.65	36.60	20.90	27.82	16.20	58.34
11	99101	124.75	178.50	58.20	3.55	10.8	32.40	20.25	24.41	13.90	57.05
12	99102	123.25	179.25	51.50	2.75	8.90	30.70	21.50	18.07	10.85	59.31
13	99103	126.25	175.50	39.20	3.85	9.45	19.30	21.75	15.36	8.40	55.94
14	91A001	124.25	178.50	64.30	3.80	9.11	28.50	22.52	27.17	15.30	56.55
15	91A039	122.50	177.50	60.80	3.35	10.05	40.55	22.71	29.72	17.10	56.80
16	CMNK287-3	124.25	179.00	65.00	3.90	11.60	41.45	21.62	29.97	15.45	51.59
17	NCS95004	123.25	171.25	65.25	3.40	8.15	39.25	22.17	32.02	17.25	53.97
18	NCS950183	122.75	171.75	63.25	2.65	10.45	28.95	21.23	20.90	11.65	55.97
19	NCS950012	123.75	170.75	69.50	3.25	9.40	29.60	20.66	37.25	14.10	47.60
20	NCS96002	123.00	173.75	57.20	2.80	8.86	30.80	20.85	22.15	12.50	57.35
21	NCS96003	124.50	173.50	59.85	2.80	8.85	30.65	23.71	24.48	13.60	55.49
22	NCS950010	122.75	171.50	66.55	2.95	8.71	36.00	22.78	26.90	14.90	55.67
23	C-44	124.25	176.75	66.50	3.45	9.80	38.80	23.52	34.00	18.35	54.36
24	Paidar-91	124.25	174.00	66.90	3.15	8.26	37.70	16.98	21.17	11.95	56.52
MS (V)		15.304**	27.63**	242.458**	0.698**	5.058**	115.517**	9.144**	137.03**	31.562**	27.779**
MS (R)		15.444**	1.472^{ns}	125.003^{ns}	1.233*	1.456^{ns}	116.055**	0.006**	63.337*	29.061**	10.455^{ns}
MS (E)		1.676	2.563	63.664	0.318	0.607	20.679	0.01	20.778	4.865	6.237

* and **= Significant at 0.05 and 0.01 percent probability level, respectively.

DF= Days to Flowering (50%); DM= Days to Maturity; PH= Plant Height (cm); PB= Primary Branches; SB= Secondary Branches; NP/P= Number of Pods per Plant; BY= Biological Yield (gm); GY= Grain Yield (gm); HI = Harvest Index (%)

Table 2. Genetic parameters for various quantitative characters in 24 chickpea lines grown at the National Agricultural Research Center, Islamabad.

Character	Mean	Range	SE	CD	G. VAR	P. VAR	G. COV	P. COV	H (%)	G.A.*	G.A. (%)
Days to flowering	123.15	117.5 - 126.3	0.65	2.40	3.41	5.08	1.50	1.83	67	3.11	2.53
Days to maturity	175.05	170.8 – 179	0.80	2.96	6.27	8.83	1.43	1.70	71	4.34	2.48
Plant height	62.84	39.2 - 73.6	3.99	14.77	44.70	108.36	10.64	16.57	41	8.84	14.06
Primary branches	3.20	2.4 - 3.95	0.28	1.04	0.10	0.41	9.65	20.11	23	1.12	34.95
Secondary branches	9.37	7.95 - 11.6	0.39	1.44	1.11	1.72	11.26	14.00	65	4.02	42.89
Pods per plant	34.17	19.3 - 41.5	2.27	8.42	23.71	44.39	14.25	19.50	53.4	9.25	27.08
100 Seed weight	21.87	16.98 - 23.98	0.12	0.01	2.29	2.29	6.92	6.92	99	3.12	14.25
Biological yield	28.04	15.4 - 37.5	2.28	8.44	29.06	49.84	19.22	25.18	58	8.48	30.24
Grain yield	15.18	8.4 - 20.1	1.10	4.08	6.67	11.54	17.02	22.38	58	4.05	26.65
Harvest index	55.06	47.6 - 59.3	1.25	4.62	5.39	11.62	4.22	6.19	4.6	3.25	5.91

SE= Standard Error; CD= Critical Differences at 5% level; G.VAR= Genotypic Variance; P.VAR= Phenotypic Variance; G.COV= Genotypic Covariance; P.COV= Phenotypic Covariance; H (%)= Heritability in Broad Sense; G.A= Genetic Advance (5% selection intensity); G.A. (%)= Genetic Advance in percentage of mean

Table 3. Genotypic (rg), Phenotypic (rph) and Environmental (re) Correlation Coefficients among different pairs of characters in 24 chickpea genotypes grown at the National Agricultural Research Center, Islamabad.

X		X1	X2	X3	X4	X5	X6	X7	X8	X9
X1	rg	1								
	rph	1								
	re	1								
X2	rg	0.122	1							
	rph	0.037	1							
	re	-0.153	1							
X3	rg	-0.551**	-0.342	1						
	rph	-0.243	-0.195	1						
	re	0.106	-0.024	1						
X4	rg	0.569**	0.710**	-0.610**	1					
	rph	0.287	0.228	0.022	1					
	re	0.126	-0.125	0.313	1					
X5	rg	0.121	0.615**	-0.035	0.540**	1				
	rph	0.070	0.381	0.003	0.380	1				
	re	-0.027	-0.111	0.042	0.328	1				
X6	rg	-0.286	0.078	0.548**	-0.159	0.006	1			
	rph	-0.141	-0.001	0.290	-0.059	0.059	1			
	re	0.077	-0.133	0.062	-0.006	0.138	1			
X7	rg	-0.177	0.090	0.125	0.145	0.152	0.081	1		
	rph	-0.145	0.076	0.0810	0.068	0.122	0.059	1		
	re	-0.010	0.200	0.123	0.064	-0.055	-0.003	1		
X8	rg	-0.056	-0.139	0.614**	0.013	0.066	0.640**	0.315	1	
	rph	-0.083	-0.122	0.395	0.099	0.054	0.497*	0.241	1	
	re	-0.129	-.095	0.189	0.165	0.034	0.317	0.079	1	
X9	rg	-0.215	0.026	0.548**	-0.096	0.078	0.788**	0.466*	0.917**	1
	rph	-0.158	-0.001	0.474*	0.109	0.070	0.588**	0.350	0.848**	1
	re	-0.065	-0.050	0.414*	0.252	0.058	0.338	0.074	0.753**	1
X10	rg	-0.366	0.286	-0.251	-0.376	0.016	-0.089	0.071	-0.607**	-0.197
	rph	-0.128	0.169	-0.065	-0.160	-0.063	-0.025	0.048	-0.493*	-0.195
	re	0.182	0.014	0.079	-0.057	-0.165	0.038	-0.052	-0.376	-0.196

** and ** = Significant at 0.05 and 0.01 percent probability level, respectively.

X= Characters; X1= Days to Flowering; X2= Days to Maturity; X3= Plant Height; X4= Primary Branches; X5= Secondary Branches; X6= Pods per Plant; X7= 100 Seed Weight; X8= Biological Yield; X9= Grain Yield; X10= Harvest Index

Grain yield per plant was positively and significantly correlated with plant height, pods per plant, 100 seed weight and biological yield but it was negatively correlated with days to flowering, primary branches and harvest index. These results are in close agreement with some earlier reports of Singh *et al.*, (1977); Luthra & Singh (1978); Malik *et al.*, (1987) and Khan *et al.*, (1989). Days to flowering were positively and significantly correlated with primary branches while it had negative and highly significant association with plant height. Days to maturity was positively and highly significantly correlated with primary branches and secondary branches. Plant height had positive and significant association with pods per plant grain yield and biological yield but it had a high negative correlation with primary branches. Khan *et al.*, (1989) also reported negative correlation between plant height and primary branches. Primary branches were found to be positively and significantly correlated with secondary branches. Pods per plant had strong association with biological yield while biological yield had a negative and highly significant correlation with harvest index.

Positive and strong association of plant height, pods per plant, 100 seed weight and biological yield with grain yield revealed importance of these characters in determining yield. The negative associations of character pairs like biological yield vs. harvest index and pods per plant vs. harvest index are likely to impose problem in combining these important traits in one genotype. Suitable recombination might be obtained through bi-parental mating, mutation breeding or diallal selective mating by breaking undesirable linkage (Ghafoor *et al.*, 1990).

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