Pak. J. Bot., 36(1): 75-81, 2004.

PATH COEFFICIENT ANALYSIS IN CHICKPEA (*CICER ARIETINUM* L.) UNDER RAINFED CONDITIONS

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Abstract

Variability, heritability, genetic advance, correlation coefficients and path coefficients for yield and its components were conducted in 24 advance lines 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. High direct effects were contributed by biological yield and harvest index although the later had negative association with grain yield. Moreover, it was noticed that high indirect contribution was via biological yield by most of the yield components and hence these two parameters (biological yield and harvest index) should be given more consideration while deciding about selection criteria of genotypes for rainfed conditions.

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 after dry bean and dry peas. Being rich in protein, pulse crops are playing a significant role in human diet especially when mixed with the cereal grains. Among four major pulses grown in Pakistan, chickpea is the most important and is playing a vital role in providing food for the poor people of this country. It is generally cultivated under rainfed agriculture system. In Pakistan, it is cultivated on 972,000 ha with production of 565,000 tons (Anon., 2000). The national average of chickpea yield is less than that of the world average. The major reason for this low yield is the unavailability of genotypes with high yield potential and adaptability to different ecological zones.

To improve the genetic level of this crop, plant breeders are continuously engaged to meet the demands of an ever-increasing population. The approaches to make significant genetic improvement in chickpea production need information on nature and magnitude of genetic variation in quantitative characters and their inter-relationship in population comprising diverse genotypes. Several researchers (Malik *et al.*, 1983; Malik *et al.,* 1988; Ghafoor *et al.,* 1990 and Ghafoor *et al.,* 2000) have emphasized the utility of the estimates of h^2 and genetic advance in the prediction of response of quantitative characters to selection in chickpea.

Islam *et al.,* (1984) reported 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. A selection index based on a more pods and primary branches and low secondary branch number to improve yield in chickpea was suggested

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by Khan *et al*., (1989) and Bakhsh *et al*., (1993). The present investigation was conducted with the objectives to determine the significance of various economic traits, through meaningful correlation and path coefficients studies, in increasing the economic yield of advance breeding lines included in national uniform yield trial 2000 for variety development process. The available information will be helpful to devise an efficient selection criterion to select the most desirable, high yielding genotypes or pure lines of chickpea under rainfed conditions.

Materials and Methods

Twenty-four candidate varieties of chickpea obtained from different national institutions were planted in a randomized complete block design (RCBD) with four replications, in the experimental field at National Agricultural Research Center (NARC), Islamabad during the year 1999-2000. Six rows of 4m length were planted in each plot 30cm apart and 10cm plant to plant spacing. Recommended cultural practices were adopted to maintain a healthy crop growth. No irrigation was applied and the experiment was conducted under rainfed condition where minimum rain was received during crop period. Data were recorded on days to flowering and maturity (50%), 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). The data were subjected to analysis of variance to test the level of significance among the genotypes for different characters under study (Steel & Torrie, 1980). Genetic parameters, genetic correlation coefficients and path coefficients were computed according to the methods followed by Singh & Chaudhry (1979). The significance of genotypic correlation coefficients was tested with the help of standard errors as suggested by Reeve & Rao (1981) whereas path coefficient analysis was conducted according to Dewey & Lu (1959).

Results and Discussion

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 90281, while the lowest yield was obtained by the genotype 99103. The values of phenotypic coefficients of variability were higher than genotypic coefficients of variability indicating the influence of environment upon the recorded characters (Table 2). Sandhu *et al*., (1978), Malik *et al*., (1988) and Ahmad & Rabbani (1992) have reported similar results in urdbean, chickpea and in ricebean respectively. 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 the highest for secondary branches (42.89), followed by primary branches (34.95), biological yield (30.24), pods per plant (27.08), and grain yield (26.65), while it was the lowest for days to maturity (2.48) and days to flowering (2.53). It indicated that progress for improvement achieved could be through simple selection like secondary branches, biological yield and pods per plant. Heritability alone is not very useful but this statistic along with 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. High heritability for secondary branches and biological yield coupled with high genetic advance, indicated that additive genes effect were important in determining these characters.

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

Character	Mean ± SE	Range	CD	h (%)	G.A.*	G.A. (%)
Days to Flowering	123.15 ± 0.65	117.5 – 126.3	2.40	67	3.11	2.53
Days to Maturity	175.05 ± 0.80	170.8 – 179	2.96	71	4.34	2.48
Plant Height	62.84 ± 3.99	39.2 - 73.6	14.77	41	8.84	14.06
Primary Branches	3.20 ± 0.28	2.4 - 3.95	1.04	23	1.12	34.95
Secondary Branches	9.37 ± 0.39	7.95 - 11.6	1.44	65	4.02	42.89
Pods per Plant	34.17 ± 2.27	19.3 - 41.5	8.42	53.4	9.25	27.08
100 Seed Weight	21.87 ± 0.12	16.98 - 23.98	0.01	99	3.12	14.25
Biological Yield	28.04 ± 2.28	15.4 - 37.5	8.44	58	8.48	30.24
Grain Yield	15.18 ± 1.10	8.4 - 20.1	4.08	58	4.05	26.65
Harvest Index	55.06 ± 1.25	47.6 - 59.3	4.62	4.6	3.25	5.91

Mean ± SE= Mean ± Standard Error; CD= Critical Differences at 5% level; 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.

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

Correlation co-efficient analysis

The genotypic, phenotypic and environmental correlation coefficients revealed that the genotypic correlations were higher than phenotypic for most of the characters (Table 3). The environmental correlation coefficients showed negligible effects, indicating negligible environmental influence.

Grain yield per plant was positive 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 by Malik *et al*., (1987) and Khan *et al*., (1989). Days to flowering were positively and strongly 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 and biological yield, but it had a high negative correlation with primary branches. Khan *et al*., (1989) reported negative correlation between plant height and primary branches. Pods per plant had strong association with biological yield while biological yield had a negative correlation with harvest index that revealed inefficiency of biomass in converting economic yield.

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 to break undesirable linkage (Ghafoor *et al*., 1990).

The results of genotypic correlation coefficients were partitioned into direct and indirect effects through various yield contributing characters (Table 4). The direct effects of all the characters were positive except days to maturity, plant height and primary braches where it was negative. The highest direct effect was exhibited by biological yield and it was followed by harvest index although the later was negatively associated with grain yield. Ashraf *et al*., (2002) also observed the similar type of results in wheat. The direct effects of days to flowering, secondary branches, number of pods per plant and 100 seed weight ratio were positive. Khan *et al*., (1989) and Yadev *et al*., (2001) had reported similar types of results in chickpea and in urdbean respectively. The present study conducted under rainfed conditions indicated that biological yield and harvest index had the maximum contribution in determining grain yield in chickpea. It was also observed that high indirect contribution was also exhibited via biological yield by most of the yield components and hence these two traits may be given more emphasis while selecting high yielding chickpea genotypes for rainfed agriculture system.

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(Received for publication 25 July 2002)