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DETERMINING THE HERITABILITY AND RELATIONSHIP BETWEEN YIELD AND YIELD COMPONENTS IN CHICKPEA (*CICER ARIETINUM* L.)

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Abstract

Heritability and relationship of quantitative traits was studied in 36 genotypes of chickpea. Analysis of variance showed highly significant differences among genotypes for primary branches, secondary branches, plant height, pods per plant, biological and grain yield. The high heritability associated with high genetic advance was recorded for plant height. Moderate heritability associated with high genetic advance was observed for biological yield whereas primary branches, secondary branches and grain yield had low heritability associated with low genetic advance. Number of pods per plant exhibited low heritability with high genetic advance. Low heritability percentage coupled with low and moderate genetic advance, observed for primary and secondary branches respectively, indicated that these traits were greatly influenced by environment. The genotypic association of primary branches with grain yield was negative. Their phenotypic correlation was however, positive and non-significant. The genotypic correlation of secondary branches with grain yield was positive. A positive and non-significant relationship between primary branches and pods per plant was obtained. The relationship between number of pods and biological yield was positive and highly significant; both of these traits had significant and positive correlation with grain yield. On the basis of these results it can be suggested that plant height, number of pods per plant and biological yield may be given more importance while making selection for higher yield potential in chickpea.

Introduction

Chickpea is grown as an important source of vegetable protein throughout the world and has a major contribution to the total protein obtained from various sources in Pakistan. The protein contents of chickpea vary from 18-30%. The total area, production and yield of pulses and chickpea in Pakistan during the year 1998-99 were, 1531 and 1076 thousand hectare, 951 and 697 thousand tones and 621and 648 kg per hectare respectively (Anon., 1999-2000). Chickpea is an important pulse crop of rainfed areas of Pakistan, where it is grown on marginal lands. The average yield of this crop is generally low because of drought, susceptibility to diseases and low yield potential of varieties. The profitable yield can only be obtained through genetic improvement for resistance to both biotic and abiotic stresses and high yield potential. Genetic variability is a prerequisite for such improvement, where as heritability is an important parameter for the success of breeding programme (Burton & De vane, 1953). Simultaneous consideration of heritability estimates and genetic advance give more useful information for predicting the performance of individuals in the generations of any breeding programme (Johnson *et al.*, 1955).

Phadnis *et al.*, (1970) studied relationships among various plant characteristics and grain yield in chickpea and determined yield components, which should be primarily examined in plant breeding. Kumer & Arora (1991) determined that biological yield plant^{-1}, pods plant^{-1}, 100 seed mass and plant height were the major yield components for selection in chickpea. Güler *et al.*, (2001) also studied the relationships among yield and yield components to determine characteristics which directly affect yield and concluded that both the linear relationship among traits and their direct effects on yield be given importance while breeding for high yield potential. The inadequate knowledge of inter-relationship among various traits and practice of unilateral selection frequently results into interrogated progress in plant breeding (Bhatt, 1977). Knowledge of association between yield and yield components is, therefore, useful in determining suitable selection criteria for maximum genetic gain (Singh *et al.*, 1981).

The present study was, therefore, conducted to assess the extent of genetic variability, characters correlation, heritability and genetic advance for six quantitative traits in 36 genotypes of chickpea. The information obtained will be utilized in devising the breeding strategy in chickpea improvement.

Materials and Methods

The experimental material consisted of 36 advance genotypes (F_8 and F_9) of chickpea, developed at National Agricultural Research Centre, Islamabad, and ICRISAT, India. The experiment was planted during *rabi* 1998-99 at National Agricultural Research Centre, Islamabad, Pakistan in a Randomized Complete Block Design with three replications. Each plot consisted of four rows, 4m long with row x row distance of 30 cm and plant to plant distance of 10cm. The recommended crop husbandry practices were adopted to raise the crop. However, the experiment was conducted under rainfed condition. Ten competitive plants were selected at random to record data on primary branches, secondary branches, plant height (cm), number of pods per plant, biological yield (gm), and grain yield (gm) per plant. The averaged data were subjected to analysis of variance to establish the level of significance of variation between genotypes. Genotypic and phenotypic correlation coefficients alongwith genotypic and phenotypic variance, coefficient of variability and heritability (broad sense) were computed using the procedure of Steel & Torrie (1980) and Dewey & Lu (1959). Genetic advance was calculated by using the formula:

$G = Kh \times Op$

where 'K' is selection differential at 5% selection intensity i.e., 2.06, 'h' is heritability in broad sense and 'Op' is phenotypic standard deviation.

Results and Discussion

The mean squares of various traits (Table 1) indicated that there were significant differences between genotypes for all the characters except for number of primary branches per plant.

The minimum numbers of primary branches (2.6) were observed in ICC11514 X ILC3279A4/12 and maximum number of primary branches (3.73) in ICCV91227, while minimum secondary branches (8.07) were observed in CM72 and maximum (15.47) in C44 X ICC7770 A3/16. Maximum plant height (61.87cm) was noted in the cross CM72 X ILC3279A2/26 and minimum (37.03cm) in ICCV91229. Maximum and minimum number of pods per plant (68.60) and (30.80), respectively, were observed in ICC11514 x ILC3279A4/8 and ICC11514 X ILC3279A4/12, respectively. The maximum biological

Table 1. Mean values of six characters in thirty-six genotypes of chickpea.

Cross	Primary branches/plant	Secondary branches/plant	Plant height(cm)	No. of pods/plant	Biological yield (gm)	Grain yield(gm)
Punjab-91	3.30	9.57	53.17	34.73	26.38	11.07
C44 X ILC7770-A3/22	2.70	13.47	49.73	67.80	39.20	18.71
CM72 X ILC3279A1/21	3.33	10.87	51.10	42.30	26.05	15.49
ICC11514 X ILC3279A4/17	3.30	9.33	51.90	45.70	28.93	15.23
ICC11514 X ILC3279A4/19	2.77	9.97	47.50	39.37	25.31	12.06
ICC11514 X ILC3279A4/26	3.20	9.87	49.97	33.80	24.51	13.21
ICC11514 X ILC3279A4/12	2.60	9.13	47.80	30.80	20.44	10.36
ICC11514 X ILC3279A4/23	2.77	9.50	50.60	39.47	24.67	12.45
ICC11514 X ILC3279A4/18	2.73	9.77	49.90	45.43	28.86	13.46
ICC11514 X ILC3279A4/1	3 00	13.60	51.23	57.13	35.29	17.68
ICC11514 X ILC3279A4/8	3.03	15.20	51.50	68.60	43.95	21.61
ICC11514 X ILC3279A4/15	2.83	11.10	50.87	45.47	26.75	13.12
C44 X E100Y(M) A6/11	2.87	13.47	53.63	64.13	36.23	17.51
CM72 X ILC3279A1/6	3.13	11.90	53.23	42.23	26.18	11.73
C44 X ICC7770A3/16	3.07	15.47	52.90	62.03	36.77	18.83
C44 X ICC7770A3/20	2.80	11.80	50.10	54.63	34.79	15.85
C44	3.37	9.70	50.63	46.53	29.99	15.19
CM72 X ILC3279A2/26	2.97	11.73	61.87	52.17	30.77	13.01
ICC11514 X ILC3279A4/14	2.80	9.60	54.03	40.07	24.88	11.78
ICC11514 X ILC3279A4/2	2.83	12.63	53.87	59.67	35.20	18.66

Table 1 (Cont'd)

Cross	Primary branches/plant	Secondary branches/plant	Plant height(cm)	No. of pods/plant	Biological yield (gm)	Grain yield(gm)
ICCV89416	2.97	8.13	44.70	31.67	15.76	6.91
ICCV91227	3.73	13.13	47.03	62.83	24.57	10.88
ICCV89407	3.17	12.43	42.20	43.63	18.55	10.85
ICCV89410	3.33	13.60	38.73	44.73	19.48	9.99
ICCV89418	2.63	14.53	44.50	62.57	32.89	16.80
ICCV89412	3.17	9.67	40.10	41.10	15.59	7.76
ICCV10136(C)	2.80	13.07	41.03	42.27	16.17	9.21
ICCV89420	3.70	14.23	44.60	49.27	21.62	11.51
ICCV91208	3.10	14.87	45.27	52.63	26.81	12.60
ICCV89405	3.23	10.80	45.33	64.10	24.64	12.95
ICCV89421	3.00	11.57	42.43	45.20	19.30	10.42
ICCV 91209	3.37	12.77	39.37	44.03	19.58	10.40
CM72	2.97	8.07	42.60	36.80	24.26	12.35
ICCV91229	3.50	13.37	37.03	57.20	21.39	11.12
ICCV89408	3.50	12.7	38.07	47.80	17.41	8.99
ICCV91225	2.73	10.93	39.83	43.03	16.88	8.75
Mean Square	0.26	12.63**	98.38*	331.68**	154.66**	35.98**

*: Significant at 5% level of probability.

**: Significant at 1% level of probability.

NS: Non significant.

yield and grain yield per plant were recorded in ICC11514 X ILC3279A4/8 and ICCV89412, respectively. The considerable range of variation recorded in all the traits except for primary branches provides a good opportunity for improvement of chickpea grain yield. Such variability for various characters has already been reported in food legumes including chickpea (Bakhsh *et al.*, 1999).

The partitioning of variance (Table 2) revealed that high heritability (77%) was associated with high genetic advance (9.94%) in plant height indicating the additive type of gene action involved in the inheritance of this character; this relationship indicated that plant height could be manipulated according to the requirement. Moderate heritability (56%) along with high genetic advance was recorded for biological yield, providing opportunity for its improvement. However, care must be exercised while breeding for this trait as it is influenced by environment. The moderate heritability (46%) and genetic advance (4.14%) for grain yield per plant provided little chances for its improvement. However, single plant selection followed by pedigree selection may lead to some improvement in this trait. Number of pods per plant exhibited low heritability 34% with high genetic advance 9.88%, which means that selection based on phenotypic observation will be of little importance in this character, though a significant improvement may be possible through pedigree selection. Primary and secondary branches exhibited low heritability (27% and 24%, respectively) and low genetic advance (0.23% and 1.4%, respectively). Therefore, there seems a limited scope of improvement in these traits.

Table 2. Genetic parameters for six characters in chickpea.

Variables	GV	PV	GCV	PCV	H	GA%
Primary branches/plant	0.05	0.17	7.05	13.44	0.27	0.23
Secondary branches/plant	2.04	8.54	12.19	24.96	0.24	1.44
Plant height	29.94	38.49	11.53	13.07	0.77	9.94
No. of pods/plant	67.34	197.00	16.96	29.02	0.34	9.88
Biological yield	40.98	72.60	24.51	32.64	0.56	9.90
Grain yield	8.68	18.61	22.64	33.15	0.46	4.14

GV: Genotypic Variance, PV: Phenotypic Variance, GCV: Genotypic Coefficient of Variation, PCV: Phenotypic Coefficient of Variation, H: Heritability in broad sense (2.06), GA%: Genetic Advance in terms of percentage.

These results are comparable to the results reported by various researchers including Ramana & Singh (1987), Malik *et al.*, (1988), Naidu *et al.*, (1991) and Awan (1995). These authors have reported high heritability with high genetic advance, high heritability with low genetic advance and low heritabality with low genetic advance in various characters of different pulse crops. However, there were some differences between results of present study and those already reported, which may be attributed to different species/genotypes used in different studies. From the present results and those already published, it can be concluded that number of pods per plant, number of secondary branches per plant and total biological yield deserve more importance in breeding programmes aimed at yield improvement in chickpea.

The correlation coefficients (Table 3) indicated that genotypic correlation of primary branches with grain yield was negative and highly significant. In the case of secondary branches the genotypic correlation with grain yield was non-significant and positive. Previous reports presented by Bakhsh *et al.*, (1991), Wadud & Yaqoob (1989) showed

Table- 3: Genotypic (G) and phenotypic (P) correlation among six characters in of chickpea.

Parameters		Secondary branches/plant	Plant height (cm)	No. of pods per plant	Biological yield (gm)	Grain yield (gm)
Primary Branches per Plant	rG	0.0571	-0.4773**	-0.0646	-0.5496**	-0.5515**
	rP	0.2475	-0.0968	0.1326	-0.0473	0.002
Secondary Branches per plant	rG	1	-0.2919	0.753**	0.2463	0.3149
	rP	1	0.0749	0.7427**	0.512	0.5119**
Plant	rG		1	0.0724	0.7033**	0.6181**
Height	rP		1	0.2619	0.66**	0.5585**
Number of Pods per plant	rG			1	0.6135**	0.6505**
	rP			1	0.7535**	0.7145**
Biological Yield	rG				1	0.9933**
	rP				1	0.9262**

*: Significant at 5% level of probability.

**: Significant at 1% level of probability.

NS: Non significant.

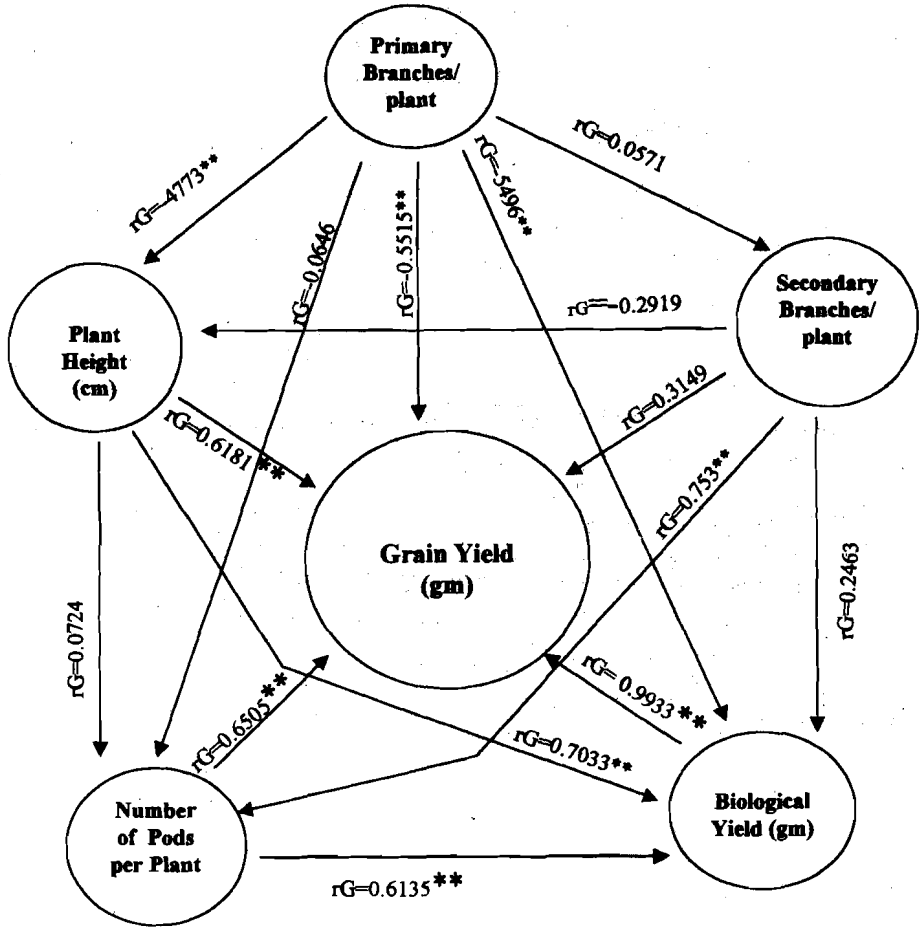

Fig. 1. Diagrammatic presentation of relationship between yield and its five components in chickpea genotypes.
rG=Genotypic correlation.

positive and significant association of secondary branches with grain yield in chickpea. The association between number of pods per plant and grain yield was positive and highly significant. Similarly biological yield and plant height were positively and highly significantly associated with grain yield (Fig. 1).

The results obtained showed that the improvement in grain yield could be made through improving characters like number of pods per plant, number of secondary branches per plant and biological yield. Therefore, selection pressure should be directed towards these traits to improve the grain yield.

Singh & Singh (1989), Akdağ & Sehirali (1992) reported positive and significant relationship of seed yield per plant with the number of pods per plant and harvest index and negative and significant relationships between seed yield per plant and 1000 seed

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