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Studies on genetic variability for quantitative characters in chickpea (*Cicer arietinum*L.)

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ABSTRACT

A field experiment was conducted in Chickpea during Rabi season 2013-14 at Crop Research Centre of Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut (U.P.) India. The present investigation entitled, "Studies on genetic variability for quantitative characters in chickpea (Cicer arietinum L.)". All the 45 Chickpea genotypes were sown in randomized block design. The characters under study were namely days to 50% flowering, days to maturity, plant height, number of primary branches per plant, pods per plant, seeds per pod, 100-seed weight, biological yield per plant, harvest index and grain yield per plant. Analysis of variance showed high significant variance among the genotypes for all the characters, under study, indicating wide spectrum of variability among the genotypes. The Phenotypic coefficient of variation PCV observed high then genetic coefficient of variation (GCV) for all the character. High GCV % was observed for number of pods per plant, followed by biological yield per plant. High heritability coupled with high genetic advance observed for 100 seed weight, number of pod per plant, biological yield per plant, grain yield per plant for days to maturity and number of pod per plant. In genera the character association studies, showed highly significant and positive correlation for grain yield with biological yield per plant, days to maturity number of primary branches per plant and number of pod per plant at genotypic and phenotypic levels. Path coefficient analysis of grain yield and its contributing characters revealed that biological yield per plant, harvest index, 100 seed weight and days to maturity had the highest positive direct effect on grain yield. The direct effect of days to flowering, number of pod per plant, plant height, number of seed per pod and grain per plant showed negative direct effects on grain yield but their correlation with grain yield was significantly positive which may be due to high positive indirect effects via other characters.

***KEY WORDS**:- Correlation coefficient, Path coefficient analysis*

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INTRODCTION

Chickpea (*Cicer arietinum* L.) is also known as garbanzo bean, chana (north India), Indian pea, ceci bean, Bengal gram; it is an edible legume of the family *Fabaceae* and subfamily *Faboideae*; diploid with 2n =2x = 16 [1] having a genome size of approximately 931 Mb. It is a highly self-pollinated crop with an out crossing rate of less than 1%. The genus *Cicer* comprises one cultivated species (*Cicer arietinum* L.) and 42 wild species. Chickpeas are a helpful source of zinc, folate and protein. They are also very high in dietary fiber and hence a healthy source of carbohydrates for persons with insulin sensitivity or diabetes. Chickpeas are low in fat and most of this is polyunsaturated. One hundred grams of mature boiled chickpeas contains 164 calories, 2.6g of fat (of which only 0.27g is saturated), 7.6g of dietary fiber and 8.9g of protein. Chickpeas also provide dietary calcium (49–53mg/100g). According to the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) chickpea seeds contain on average- 23% protein, 64% total carbohydrates (47% starch, 6%soluble sugar), 5% fat, 6% crude fiber and 3% ash. High mineral content has been reported for phosphorus (340 mg/100g), calcium (190 mg/100g), magnesium (140 mg/100g), iron (7 mg/100g), zinc (3 mg/100g).

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 India it is cultivated on 9.21 million hectares with production of 8.22 million tones [2].In Uttar Pradesh, the area under chickpea is around 0.51 m ha. with a production 0.62 million tones at an average productivity of 824 kg/ha [3]. However, the overall production and productivity of the country is much lower 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. Chickpea plant is cool season crop very sensitive to excess moisture, high humidity and cloudy weather, which adversely affect its yield through limited flower production and seed set. In order to make this crop competitive with those grown during winter season, breeding of high yielding and input responsive varieties is the only solution. Yield improvement and its stability are, therefore, the two most important breeding objectives for this crop.

The success of chickpea improvement programme largely depends on the wealth of the genetic resources and are the most valuable and essential basic raw material to meet the current and future needs in chickpea crop improvement programme. Knowledge about the amount, kind and magnitude of variability in the germplasm and genetic relationships among breeding materials could be an invaluable tool in crop improvement strategies [4]. In light of increased recognition and its importance, evaluation and characterization of chickpea germplasm has received greater attention of the plant breeders [5]. Thus, the evaluation of germplasm is not only useful in selection of core collection but also for its utilization in breeding programmes.

MATERIALS AND METHODS

The experiment under present investigation entitled ''Studies on Genetic variability for quantitative characters in chickpea (*Cicer arietinum* L.)" was carried out during *Rabi* 2013-14 at Crop Research Centre, Sardar Vallabhbhai Patel University of Agriculture & Technology Meerut (U.P.).The collections of 45 varieties/strains of chickpea (*Cicer arietinum* L.) germplasm comprising indigenous as well as exotic genotypes, constituted the experimental materials for this study. These genotypes exhibiting wide spectrum of variability for various agronomic and morphological characters were obtained from IIPR, Kanpur, IARI, New Delhi and SVPUAT&T, Meerut. The experimental material comprised of 45 genotypes of chickpea (*Cicer arietinum* L.)". Selected on the basis of place of origin and morphological characters. All selected genotype were shown in RBD with three replication at Crop Research Centre, SVPUA&T, Meerut during *Rabi season* 2013-14 each genotype was sown in five rows of three meter length. The row to row and plant to plant distance maintain at 30 and 10 cm respectively. Recommended agronomic practices were followed to rise a good crop. The present study on chickpea was carried out to estimate the Correlation coefficient, path coefficient analysis.

RESULT AND DISCUSSION

To study the associations between various traits and their relative importance in selection. The correlation coefficient was estimated at the genotypic and phenotypic levels and values are the presented in (Table-1, 2). The magnitude of correlation in relation to their corresponding phenotypic values form a sound basis for their practical implication. The genotypic correlation in the general were similar in sign and lightly higher in magnitude than their corresponding phenotypic correlation At genotypic level days to 50 per cent flowering showed positive and significant correlations with days to maturity (0.206) and biological yield per plant (0.185). In general days to 50% flowering showed positive non-significant correlation with plant height (0.158), number of primary branches per plant (0.002), number of pod per plant (0.006), number of seeds per pod (0.130), 100 seed weight (0.090) and grain yield per plant (0.120). Days to 50% flowering revealed negative and significant correlation with harvest index (-0.196) in table.At phenotypic level days to 50 per cent flowering showed positive and significant correlations with days to maturity (0.178) and biological yield per plant (0.176). In general days to 50% flowering showed positive non-significant correlation with number of pod per plant (0.016), number of seed per pod (0.120), 100 seed weight (0.067) and grain yield per plant (0.119). Whereas days to 50% flowering showed non significant and negative correlation with plant number of primary branches per plant (-0.001) and harvest index (-0.140) exhibited non significant and negative. Days to maturity showed positive and significant correlation number of primary branches per plant (0.528), number of pod per plant (0.534), number of seed per pod (0.284), biological yield per plant (0.312) and grain yield per plant (0.303). While it showed negative and significant correlation with 100 seed weight (-0.537). Negative and non-significant correlation was found with harvest index (-0.129) at genotypic level. Days to maturity

showed positive and significant correlation with days to 50% flowering (0.178), number of primary branches (0.528), number of pod per plant (0.519), number of seed per pod (0.250), number of biological yield per plant (0.304) and grain yield per plant (0.287), While it showed negative and highly significant correlation with 100 seed weight (-0.515). Negative and non-significant correlation with harvest index (-0.082) at phenotypic level .At genotypic level plant height showed significantly positive correlations with number of seed per pod (0.180) and biological yield per plant (0.208) at genotypic level. This trait expressed positive non-significant relationship with days to maturity (0.156), number of pods per plants (0.002) and grain yield per plant (0.036). Where negatively significant correlations exhibited with harvest index (-0.287) and 100 seed weight (-0.220). Although it showed negative and negative correlation with this character number of primary branches per plant (-0.022). At phenotypic level plant height showed positive non-significant relationship with days to 50% flowering (0.120), days to maturity (0.119), number of seed per pod (0.108), number of primary branches per plant (0.004), biological yield per plant (0.141) and grain yield per plant (0.013). Whereas negatively non significant correlations exhibited with number of pod per plant (-0.009), harvest index (-0.144) and 100 seed weight (-0.130). At genotypic level primary branches per plant showed positive and significant correlation with days to maturity (0.582), number of pod per plant (0.627), biological yield per plant (0.193), harvest index (0.218) and grain yield per plant (0.312) and non significant positive correlation with number of seeds per pod (0.004). However, it showed negative and significant correlation with 100 seed weight (-0.555). At phenotypic level primary branches per plant showed positive and significant correlation with days to maturity (0.528) number of pod per plant (0.579) and biological yield per plant (0.180). It expressed positive non-significant correlations with plant height (0.004), number of seeds per pod (0.019) and harvest index (0.135) and grain yield per plant (0.271). However, it showed negative and significant correlation with days to 50% flowering (-0.001) and 100 seed weight (-0.487). At genotypic level, pods per plant exhibited positive and significant associations with days to maturity (0.534), primary branches per plant (0.627), number of seed per pod (0.279), biological yield per plant (0.484) and grain yield per plant (0.576). This character showed positive non-significant correlations with harvest index (0.109) plant height (0.002), days to 50% flowering (0.006) and showed Negative significant correlations with this 100 seed weight (-0.805).

Table- 1 Genotypic correlation coefficient among ten characters in Chickpea (*Cicer arietinum* L.)

Genotypes	Days of 50% flowering	Days of maturity	Plant height (cm)	No of primary branches per plant	No of pod per plant	No of seed per pod	Biological yield per plant	Harvest index	100 seed weight in (g)	Grain yield per plant
Days of 50% flowering	1.000	0.206*	0.158	0.002	0.006	0.130	0.185*	-0.196**	0.090	0.120
Days of maturity		1.000	0.156	0.582**	0.534**	0.284**	0.312**	-0.129	-0.537**	0.303**
Plant height in (cm)			1.000	0.022	0.002	0.180*	0.208*	-0.287**	-0.220**	0.036
No of primary branches per plant				1.000	0.627**	0.004	0.193*	0.218*	-0.555**	0.312**
No of pod per plant					1.000	0.279**	0.484**	0.109	-0.805**	0.576**
No of seed per plant						1.000	-0.038	-0.162	-0.466**	-0.078
Biological yield per plant							1.000	-0.357**	-0.366**	0.877**
Harvest index								1.000	-0.094	0.106
100 seed weight in (g)									1.000	0.458**
Grain yield per plant										1.000

NOTE : *, ** Significant at 1% and 5% level

Table- 2. Phenotypic correlation coefficient among ten characters in Chickpea (*Cicer arietinum* L.)

Genotypes	Days of 50% flowering	Days of maturity	Plant height (cm)	No of primary branches per plant	No of pod per plant	No of seed per pod	Biological yield per plant	Harvest index	100 seed weight in (g)	Grain yield per plant
Days of 50% flowering	1.000	0.178*	0.120	-0.001	0.016	0.120	0.176*	-0.140	0.067	0.119
Days of maturity		1.000	0.119	0.528**	0.519**	0.250**	0.304**	-0.082	-0.515**	0.287**
Plant height in (cm)			1.000	0.004	-0.009	0.108	0.141	-0.144	-0.130	0.013
No of primary branches per plant				1.000	0.579**	0.019	0.180*	0.135	-0.487**	0.271**
No of pod per plant					1.000	0.255**	0.466**	0.054	-0.781**	0.517**
No of seed per plant						1.000	-0.019	-0.111	-0.437**	-0.051
Biological yield per plant							1.000	-0.315**	-0.340	0.820**
Harvest index								1.000	-0.079	0.252**
100 seed weight in (g)									1.000	-0.411**
Grain yield per plant										1.000

Table-3 Genotypic path coefficient analysis for ten characters in Chickpea (*Cicer arietinum L.*)

Genotypes	Days of 50% flowering	Plant height in (cm)	No of primary branches per plant	No of pod per plant	No of seed per pod	Days of maturity	Biological yield per plant	Harvest index	100 seed weight in (g)	R with Grain yield per plant
Days of 50% flowering	**-0.001**	0.012	0.002	0.004	0.003	0.011	0.196	-0.094	-0.006	0.120
Plant height in (cm)	0.002	**-0.074**	0.001	0.006	0.004	0.008	0.220	-0.137	0.014	0.036
No of primary branches per plant	0.001	0.002	**-0.030**	-0.034	0.001	0.031	0.204	0.104	0.034	0.312**
No of pod per plant	0.007	0.000	-0.019	**-0.054**	0.007	0.028	0.511	0.052	0.050	0.576**
No of seed per pod	0.002	-0.013	-0.003	-0.015	**0.025**	0.015	-0.040	-0.078	0.029	-0.078
Days of maturity	0.008	-0.011	-0.018	-0.029	0.007	**0.053**	0.330	-0.062	0.033	0.303**
Biological yield per plant	0.001	-0.015	-0.006	-0.026	-0.001	-0.017	**1.057**	-0.171	0.023	0.877**
Harvest index	0.002	0.021	-0.007	-0.006	0.004	-0.007	-0.377	**0.479**	0.006	0.106
100 seed weight in (g)	0.005	0.016	0.017	0.043	-0.011	-0.028	-0.387	-0.045	**-0.062**	-0.458**

Resi=0.02467

At phenotypic level, pods per plant exhibited positive and highly significant associations with, days to maturity (0.519), number of primary branches per plant (0.579), number of seed per plant (0.255), biological yield per plant (0.466),100 seed weight (0.781) and grain yield per plant (0.517). It showed positive non-significant correlations with and days to 50% flowering (0.016) and harvest index (0.054). On other hand number of pods per plant showed negative highly significant correlations with plant height(-0.009) and 100 seed weight (-0.781). Number of Seeds per pod showed positive and significant correlations with days to maturity (0.284) plant height (0.180), number of pod per plant (0.279) at genotypic level. Negative and significant correlation was observed for this trait with 100 seed weight (-0.466). It showed negative non-significant correlation with biological yield per plant (-0.038), harvest index (-0.162), and grain yield per plant (-0.078). Number of Seeds per pod showed positive and

significant correlations with and number of pod plant (0.255), days to maturity (0.250) at phenotypic level. Negative and highly significant correlation was observed for this trait with 100 seed weight (-0.437) . It showed negative non-significant correlation with biological yield per plant (-0.019), harvest index (-0.111), and grain yield per plant (-0.051) it showed the positive and significant correlation with days to 50% flowering (0.120).Biological yield per plant showed positive and significant correlation with days to maturity (0.312), plant height (0.208), number of primary branches per plant (0.193) and number of pod per plant (0.484), grain yield per plant (0.877). While it showed negative and significant correlation with harvest index (-0.357) and 100 seed weight (-0.366) at genotypic level. Biological yield per plant showed positive and significant correlation with days to maturity (0.304), number of pod plant (0.466) and grain yield per plant (0.820), while it showed negative and significant correlation with 100 seed weight (-0.340) and harvest index (-0.315) at phenotypic level.

Table-4 Phenotypic path coefficient analysis for ten characters in Chickpea (*Cicer arietinum* L)

Genotypes	Days of 50% flowering	Plant height in (cm)	No of primary branches per plant	No of pod per plant	No of seed per pod	Days of maturity	Biological yield per plant	Harvest index	100 seed weight in (g)	R with Grain yield per plant (g)
Days of 50% flowering	**0.010**	0.007	0.000	0.000	0.003	0.005	0.175	-0.079	-0.002	0.119
Plant height in (cm)	-0.001	**-0.054**	0.000	0.000	0.002	0.003	0.140	-0.081	0.004	0.013
No of primary branches per plant	0.000	0.000	**-0.001**	-0.010	0.000	0.014	0.180	0.076	0.013	0.271**
No of pod per plant	0.000	0.001	0.000	**-0.018**	0.005	0.013	0.464	0.030	0.021	0.517**
No of seed per pod	0.001	-0.006	0.000	-0.004	**0.021**	0.006	-0.019	-0.062	0.012	-0.051
Days of maturity	0.002	-0.006	0.000	-0.009	0.005	**0.026**	0.302	-0.046	0.014	0.287**
Biological yield / plant	0.002	-0.008	0.000	-0.008	0.000	0.008	**0.995**	-0.177	0.009	0.820**
Harvest index	-0.001	0.008	0.000	-0.001	-0.002	-0.002	-0.313	**0.562**	0.002	0.252**
100 seed weight in (g)	0.001	0.007	0.000	0.014	-0.009	-0.013	-0.013	-0.044	**-0.027**	-0.411**

Resi = 0.02861

Harvest index revealed significant and positive correlation for number of primary branches per plant (0.218) whereas it showed significant but negative association with plant height (0.287) and biological yield per plant (0.357) at genotypic level. Harvest index revealed significant and significant and positive correlation for grain yield per plant (0.252). It showed the highly significant and negative correlation with biological yield per plant (-0.315) at phenotypic level. Whereas harvest index revealed positive non significant with number of primary branches per plant (0.135) and number of pod per plant (0.054) At genotypic level 100 seed weight showed significantly negative correlation with all character except days to 50% flowering (0.090). 100 seed weight showed significant and negative correlation with all character except days to 50% flowering (0.067) at phenotypic level. Grain yield per plant exhibited positive and significant correlations with number of primary branches per plant (0.312), number of pod per plant (0.576), days to maturity (0.303) and biological yield per plant (0.877) and 100 seed weight (0.458), Whereas it showed positive and non significant association with days to 50% flowering (0.120) and plant height (0.036) and harvest index (0.106). Showed number of seed per pod (-0.078) negative and non significant correlation with this character at genotypic level.Grain yield per plant exhibited positive and significant correlations with number of days to maturity (0.287), primary branches per plant (0.271), number of pod per plant (0.517), and biological yield per plant (0.822) and harvest index (0.252) at phenotypic level. While grain yield per plant revealed positive and non significant correlation with days to 50% flowering (0.119) and plant height (0.013). The negative and significant correlation with to 100 seed weight (-0.411). The negative and non significant correlation with number seeds per pod (-0.051). The path coefficient measures direct and indirect effect of independent characters on dependent character, which in the present case is grain yield per plant. The path coefficient analysis helps in partitioning of the total correlation into its direct and indirect components. The direct and indirect effect

of characters on grain yield per plant at genotypic and phenotypic level were studied. The resulted of path analysis is presented in (Table-3, 4). Maximum and very highly positive direct effect was observed for biological yield per plant (1.057) followed by harvest index (0.479). Negative direct effect observed for days to 50% flowering, plant height (-0.074), number of primary branches per plant (-0.030), number of pod per plant (-0.054) and 100 seed weight (-0.062). Days to 50% flowering with positive direct effect showed indirect effect for plant height, number of primary branches per plant (0.001), number of pod per plant (0.006), number of seeds per pod (0.004), days to maturity (0.008). Biological yield per plant (0.220) showed the negative indirect effect for harvest index (-0.137). Day to maturity showed positive between day to maturity and grain yield was recorded (0.303). Direct effect of this character was (0.053) and indirect effect via biological yield per plant was (0.330). Which is maximum in all the indirect effect and more then direct effect for this character. Plant height showed positive correlation on grain yield per plant. Direct effect of this character was (-0.074) and indirect effect for biological yield per plant was high (0.220). Number of primary branches per plant showed positive correlation with seed yield. Direct effect of this character was (-0.030) and indirect effect via biological yield was high (0.204) followed by harvest index (0.104). The positive correlation between grain yield per plant and number of pods per plant was observed (0.576). Direct effect of this character was negative (-0.054) and indirect effect of this character via biological yield per plant was maximum (0.511). Correlation between number of seeds per pod and grain yield per plant was negative but very low. Direct effect of this character was positive (0.025). Indirect effect of this character recorded low then direct effect via all character except 100 seed weight (0.029). Biological yield per plant a highly positive correlation was observed between biological yield per plant and grain yield per plant. Direct effect of this character was very high (1.057) and indirect effect was very low via all character. This suggests that biological yield per plant direct contribute to grain yield. Correlation between harvest index and grain yield per plant was positive. Direct effect of this character was 0.479 and direct was observed very low then direct effect.100 seed weight a negative correlation was observed between 100 seed weight and grain yield per plant (-0.458). Direct effect of this character was negative (-0.062) and indirect effect was also negative except days to 50% flowering, plant height and number of branches per plant very low. Direct effect was observed maximum for biological yield per plant (0.995) followed harvest index (0.562). Whereas negative direct effect was observed for plant height (-0.054), number of primary branches per plant (-0.001),number of pod plant (0.018) and 100 seed weight (-0.027). Days to 50% flowering had positive direct effect and indirect effect for all the characters except harvest index, 100 seed weight. Which showed negative direct effect (-0.079) and (-0.002) respectively. Days to maturity reveled positive correlation with grain yield per plant (0.287). Direct effect of this character was observed positive and high (0.026) in compare to indirect effect via all character except biological yield per plant .which was found highly positive correlation (0.302). Its indicate that biological yield for plant contribute indirect effect to develop the early maturity genotype. Plant height showed positive correlation with grain yield per plant (0.013). Direct effect of this character was (-0.004) and indirect effect for biological yield per plant was high (0.140) then rest character.

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