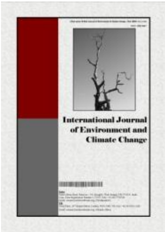

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Estimation of Genetic Variability and Correlation Analysis for Quantitative Traits in Chickpea (*Cicer arietinum* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present investigation were to assess the Genetic variability, heritability, genetic advance, correlation coefficient analysis and path coefficient analysis for chickpea(*Cicer arietinum*.L) genotypes for 13 quantitative traits during *Rabi* 2021-2022 at field experiment center, Department of Genetics and Plant Breeding, Naini Agriculture Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Uttar Pradesh . To perform the study, 13 quantitative traits of 31 chickpea genotypes were measured using Randomized Block Design replicated thrice. The mean sum of Squares due to genotypes showed significant differences for all the characters under study at 1% level of significance. The estimates of the phenotypic coefficient of variation found higher than their corresponding genotypic coefficient of variation which indicates the presence of environment effect on expression on characters studied. High heritability coupled with high genetic advance as percent of mean was observed for the traits like Number of pods per plant, Seed yield per plant, Harvest index and Biological yield per plant Indicates that most likely the heritability might be due to additive gene effect and selection may be effective segregating generations for improvement of traits. Seed yield per plant exhibited significant and positive correlation with Plant height, Seed index, Biological yield per plant , Number of secondary branches and Number of pods per plant was found to possess positive significant association with grain yield per plant both

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genotypic and phenotypic level. Further, correlation and path analysis also proved the importance of Plant height, Seed index and Harvest index. Hence, they could be used as selection indices for further improvement in Chickpea varieties.

Keywords: Genetic variability; heritability; additive gene effect significant; Cicer aritenum.

1. INTRODUCTION

“The word Cicer is a derivative from the Greek word Krios reffering to a well-known family cicero. Arietinum is derived from the latin word arise meaning ram which refers to rams head shape of Chickpea” (Singh et al., 1985).

“Chickpea (*Cicer arietinum L*.) is an important rabi season legume having extensive geographical distribution . Chickpea is a diploid species with chromosome number (2n=2x =16). It is self-pollinated crop and belong to sub family palilionoideae, and tribe, Cicer of family leguminoase. Later on, Chickpea is the third most important pulse crop in world after beans and peas.Chickpea plays important role to improve soil fertility by fixing atmospheric nitrogen with help of root nodules” (Anabessa *et al.,* 2006). “Chickpea is the native south eastern Turkey and Syria” [1].

“Pulses grains contains 20-25 percent on dry seed weight which is almost 2.5 -3.0 times of the value normally found cereals” (Singh, 1985). These crops have additional advantage for sustainable agriculture, because soil enriching availabilities and varied use of food and fodder.A healthy crop of chickpea can fix upto 141 kg nitrogen per hectare, pulse production , Trade and consumption of India.

Chickpea breeding strategy entails assembling or producing variable germplasam and selecting superior genotype from the germplasam for use in hybridization programmes to create superior varieties [2-6]. Estimating genetic variability, heritability, and genetic advance is required at all stages. Genetic improvement of any crop is primarily determined by the amount of genetic variability present in plant breeding material, as well as the extent to which yield and quality characteristics are heritable from generation to generation [7-10]. Understanding the influence of environment necessitates the estimation of genotypic and phenotypic coefficients [11,12]. “Genetic variability refers to the presence of difference among the individual of plant population The existing variability is essential for improvement of genetic material” [13]. “It is prerequisite for any breeding programme, which provides opportunity for plant breeder for selection of high yielding genotypes. However information on the occasion between yield and its various components provide the basis for selection of improved varities” [14].

“Heritability and genetic advance as percent of mean are reliable tool in selection programme to get clear picture of scope of improvement of various characters through selection” [15-20]. “The identification of chickpea genotypes rich with protein and macro nutrients along with good yield help the breeders to identify the donars to future breeding .Keeping this in view , the present investigation was carried out from the following object to carried out from the genetic variability for yield and quality traits in chickpea” [21].

“Correlation studies provide knowledge of association among different characters and grain yield. The study of association among various traits is useful for breeders in selecting genotypes possessing crop of desired traits” [22] .However, “it is only genetic variation which is heritable and hence important in any selection program” [23].

“In so far, simple correlation does not provide the adequate information about contribution of each factors towards yield. Therefore, the techniques of path coefficient analysis are utilized to have an idea of direct and indirect effect contribution of a traits towards yield ,end product” (Nandan et al., 2010).

There are two types of effects in the path analysis model. The direct effect is the first, and the indirect effect is the second. When an exogenous variable has an arrow pointing towards the dependent variable, it is said to have a direct effect. When an exogenous variable has an effect on the dependent variable, both directly and indirectly.

Research gap:

- Information about genetic variability helps us to study about the selection of parental genotypes.
- By using genetic variability and correlation, we can go for selection of best lines and

selection of genotypes based on yield attributing triats.

- The present study is to identify the best genotype which give high yield and mature early.

The present investigation was therefore undertaken in chickpea with following objective:

1. To estimate the extent of variability for yield contributing characters in chickpea.
2. To study the association between different characters.
3. To find out direct and indirect effect of components characters on yield in chickpea.

2. MATREIALS AND METHODS

2.1 Experimental Site

The present investigation was carried out at the Field experimentation center of the Department of Genetics and Plant Breeding, Naini Agriculture Institute, Sam Higginbottom University of Technology and Sciences, Prayagraj, (U.P).The study took place during Rabi season 2021-2022.The experimental field was located at the left side of the Allahabad-Rewa (National Highway) new bridge road. It was about 5km away from the Prayagraj. All types of facilities are necessary for the cultivation of successful crop including field preparation, inputs and irrigation facilities were provides from the department of Genetics of Plant Breeding, SHUATS.

2.2 Experimental Design

Under conditions, the 31 Chickpea genotypes were grown in Rabi season 2021-2022 using a Randomized Block Design with three replications for each genotype. All Chickpea genotypes were sown in Rabi 2021-2022 on and December 4th. Each genotype were planted in a row that was 2 meters long. The crop was raised using the recommended set of practices with a 30 cm between rows and 10cm between plants spacing. To examine the impact of various traits for heritability, correlation, path analysis, and genetic variability on Grain yield over time, 31 genotypes were grown during Rabi2021-2022.

2.3 Parameters

On the basis of five competitive plants selected at random from each replication, replication-specific data were collected for the following thirteen (13) quantitative traits:1) Days to 50% flowering, 2) Days to 50% pod setting, 3) Days to maturity, 4) Number of primary branches, 5) Number of secondary branches, 6) Plant height, 7) Number of pods per plantl,8) Number of seeds per plant, 9) Number of seeds per pod, 10) Biological yield , 11) Harvest index, 12) Seed Index, and 13) Grain yield per plant.

2.4 Data Analysis

All of the recorded data for the characters under consideration were analyzed for variance using the Panse and Sukhatme (1967) formula [24]. Additionally, the genetic parameters genotypic coefficient of variance (GCV), phenotypic coefficient of variance (PCV), heritability in the broadest sense, genetic advance as percent of mean, and correlation analysis, path analysis were carried out by using the appropriate statistical procedure. These additional components of variance included phenotypic, genotypic, and environmental variance.

2.5 Plant Material

The experimental material for present study is obtained from the Department of Genetics and Plant Breeding, SHUATS, Prayagraj (Allahabad). The details of experimental material are as follows:

Chart 1. Experimental material

Sr. No	Genotypes	Sr. No	Genotypes
1	IARI 64	17	IARI 122
2	IARI 65	18	IARI 123
3	IARI 68	19	IARI 124
4	IARI 69	20	IARI 128
5	IARI 70	21	IARI 130
6	IARI 72	22	IARI 137
7	IARI 73	23	IARI 147
8	IARI 75	24	IARI 149
9	IARI 81	25	IARI 155
10	IARI 82	26	IARI 163
11	IARI 83	27	IARI 168
12	IARI 96	28	IARI 172
13	IARI 99	29	IARI 174
14	IARI 100	30	IARI 176
15	IARI 118	31	PUSA 362 (CHECK)
16	IARI 121		

2.6 Statistical Analysis

1. Analysis of variance [24]
2. Coefficient of variation [25]
   a. Genotypic coefficient of variation (GCV)
   b. Phenotypic coefficient of variation (PCV)

3. Heritability broad sense [25]
4. Genetic advance [26]
5. Correlation coefficient analysis [27]
6. Path coefficient analysis [28]

3. RESULTS AND DISCUSSION

3.1 Variance for Quantitative Characters in Chickpea (*Cicer aritenum* L.)

There is a lot of room for improvement in these traits, including grain yield per plant, as long as the material is put through a careful selection process. The presence of variability may be substantial because of the variety of the materials used and the environmental factors that affect the phenotypes.

ANOVA for different characters is present in Table 1. The mean squares due to genotypes showed highly significant differences (α=0.01) for all characters indicating the presence of substantial amount of genetic variability among the Chickpea genotypes.

In Fig. 1 which revealed a wide range of variation for all traits studies the mean values, the coefficient of variation (C.V.), standard error of the mean (SEm+), the critical difference (C.D.) at 5% and 1%, range of 31 genotypes for 13 quantitative characters are presented.

- On the basis of Mean performance, the highest Seed Yield per Plant per hill was observed for chickpea genotypes IARI 149(19.37gm), PUSA 362 (18.4), IARI 68 (6.65) were found to be superior in Grain Yield per Plant.
- In the current study, the PCV was higher than the corresponding GCV for every trait, indicating that the environment had an impact. The lowest GCV (percent) value was 1.725 (Days to maturity), and the highest value was 38.905 (Harvest index).
- A similar pattern was followed by PCV (percent), which ranged from a lowest value of 2.733 (Days to Maturity) to a highest value of 39.891 (Harvest index).

3.2 Heritability

- The present investigation, all traits showed the high heritability ranging from 92.90% to 99.90%. Seed yield per plant (96.34%) showed the highest heritability among all the characters followed by Number of seeds per plant (95.148%), (95.121%) Harvest index.
- There is no evidence of low or moderate heritability in these characters. The present study's high heritability values for the traits under consideration showed that those traits were less influenced by the environment and helped in the effective selection of traits based on phenotypic expression by using a simple selection method. These high heritability values also suggested the potential for genetic improvement.

3.3 Genetic Advance as Percentage of Mean

- In the present investigation all the characters showed highest genetic advance as a percentage of mean except plant height, Days to Maturity, Number of Grains per Plant and Days to 50% flowering. Harvest Index (78.166) showed highest genetic advance as percentage of mean, followed by, Number of seeds per pod (72.543), Biological yield per plant (66.604). While moderate genetic advance as a percent of mean was observed.
- Except for plant height, days to maturity, and number of grains per plant, all the characters under study displayed high heritability along with high genetic advance as a percentage mean, indicating that the characters are primarily governed by additive gene action. Therefore, due to the accumulation of more additive genes leading to further improvement, direct selection of these characters based on phenotypic expression by simple selection method would be effective.

3.4 Phenotypic Correlation Coefficient

In the present investigation, seed yield per plant showed positive significant association with Number of pods per plant (0.581**), Number of seeds per plant (0.683**), Number of seeds per pod (0.237**) Seed index (0.254**) and Harvest index (0.622*). While positive and non-significant association showed with Days to 50% pod setting(0.1365), Days to Maturity (0.1354), plant height (0.0994) and Number of primary branches per plant (0.1836). Negative and non-significant association showed with Days to 50% flowering (-0.0415).

Table 1. Analysis of variance (ANOVA) among 31 chickpea genotypes for 13 quantitative traits

Sl. No.	Source	Replication	Treatment	Error
	Degrees of freedom	**2**	**29**	**58**
1	Days to fifty percent flowering	8.7110	82.048**	4.389
2	Days to fifty percent pod setting	2.0330	46.575**	6.884
3	Days to Maturity	22.433*	16.952**	5.675
4	Plant height (cm)	0.7240	152.171**	6.956
5	Number of primary branches	0.0220	0.14**	0.033
6	Number of secondary branches	0.0140	1.102**	0.11
7	Number of pods per plant	1.7710	128.851**	2.724
8	Number of seeds per plant	2.110	308.596**	5.158
9	Number of seeds per pod	0.0080	0.378**	0.011
10	Seed Index (%)	3.6820	87.037**	1.908
11	Biological yield per plant (g)	0.8820	45.766**	0.784
12	Harvest Index (%)	40.350	825.481**	13.875
13	Seed yield per plant (g)	0.1660	5.58**	0.07

*,** *Significant at 5% and 1% level of significance respectively*

Table 2. Genetic parameters for 13 quantitative characters in chickpea genotypes

Sl. No.	Parameters	GCV	PCV	h^2 (Broad Sense)	Genetic Advance	Gen.Adv as % of Mean
1	Days to fifty percent flowering	6.84	7.397	85.502	9.691	13.028
2	Days to fifty percent pod setting	3.939	4.857	65.776	6.077	6.582
3	Days to Maturity	1.725	2.733	39.846	2.521	2.243
4	Plant height (cm)	18.386	19.663	87.435	13.402	35.416
5	Number of primary branches	8.214	11.415	51.769	0.28	12.174
6	Number of secondary branches	12.338	14.242	75.045	1.026	22.018
7	Number of pods per plant	28.918	29.84	93.915	12.944	57.73
8	Number of seeds per plant	36.102	37.011	95.148	20.209	72.543
9	Number of seeds per pod	26.072	27.179	92.02	0.692	51.52
10	Seed Index (%)	29.496	30.472	93.701	10.622	58.817
11	Biological yield per plant (g)	33.166	34.023	95.03	7.776	66.604
12	Harvest Index (%)	38.905	39.891	95.121	33.046	78.166
13	Seed yield per plant (g)	29.675	30.234	96.34	2.74	60.002

GCV: Genotypic Coefficient of Variation, PCV: Phenotypic Coefficient of Variation, H^2: Heritability, GA% of Mean: Genetic Advance at percent of mean

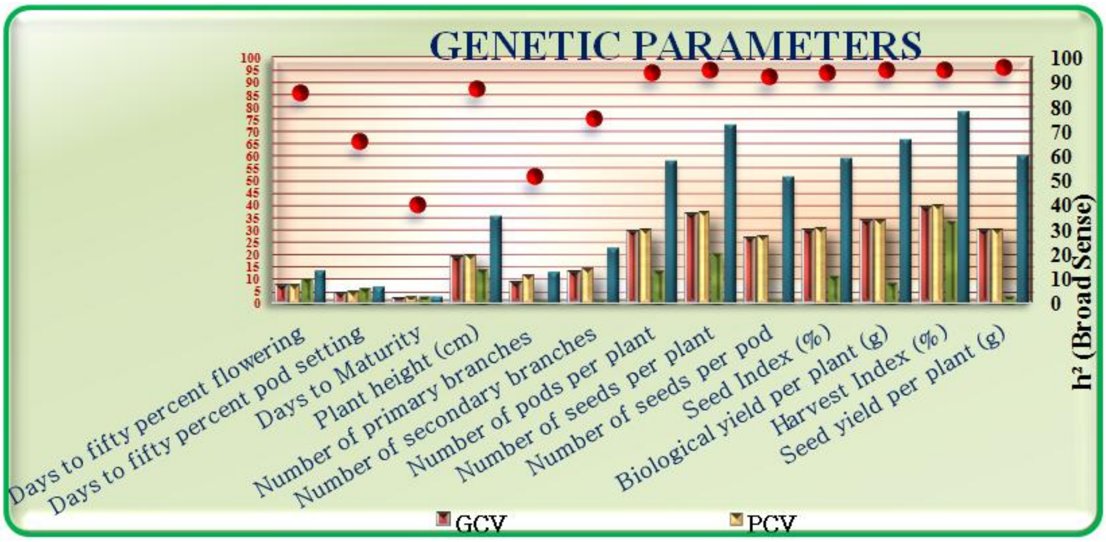

Fig. 1. Bar diagram depicting GCV, PCV, heritability and genetic advance for 13 quantitative characters of Chickpea

a

b

c

Images (a-c). Field image of the study

3.5 Genotypic Correlation Coefficient

In the correlation, among the yield attributing characters revealed that Grain Yield per Plant per plant was positively and significantly associated with Biomass (0.919**), Number of Productive Tillers (0.499**), Number of Total Tillers (0.455**), Plant Height (0.422**), Flag Leaf Length (0.393**), Panicle Length (0.258*). But positively and non-significant correlation was found with Harvest Index (0.212), Number of Grains per Panicle (0.228), Test Weight (0.018). Negative and non-significant associated with Days to 50% flowering (- 0.058), Days to Maturity (-0.040), Flag Leaf Width (-0.039).

3.6 Phenotypic Path Coefficient Analysis

Phenotypic path coefficients are calculated using the phenotypic correlation coefficient. It divides the phenotypic correlation coefficients into direct and indirect impact measurements [28]. Seed yield per plant significant with positive correlation with number of pods per plant (0.581**), number of seeds per plant (0.683**), harvest index (0.622**), number of seeds per pod (0.237*), seed index (0.254*). While non-significant positive correlation with days to 50% pod setting (0.13), days to maturity (0.135), plant height (0.09), primary branches (0.18), secondary branches (0.056), biological yield per plant (0.16), negative correlation with days to 50% flowering (-0.0415).

3.7 Genotypic Path Coefficient Analysis

A perusal of the results on path coefficient for yield and yield components genotypic to be of similar direction and magnitude in general. Further the genotypic path co-efficient were observed to be of higher magnitude, compared to phenotypic path coefficient indicating the masking effect of environment. Seed yield per plant significant with positive correlation with number of pods per plant (0.581**), number of seeds per plant (0.683**), harvest index (0.622**),number of seeds per pod (0.237*), seed index (0.254*). While non-significant positive correlation with days to 50% pod setting (0.13), days to maturity (0.135), plant height (0.09), primary branches (0.18), secondary branches (0.056), biological yield per plant (0.16), negative correlation with days to 50% flowering (-0.0415).

4. CONCLUSION

From the present investigation it was concluded that among 31 genotypes of Chickpea on the basis of mean performance IARI 149 maximum seed yield per plant over the followed check variety PUSA 362. It is also concluded that analysis of variance showed significant variation among different genotypes for all characters studied. Harvest Index exhibited high estimates of GCV and PCV. While characters likeNumber of seeds per plant, Biological yield per plant, Seed yield per plant, Seed index, Number of pods per plant and number of seeds per pod exhibited moderate estimates of GCV and PCV both. Genetic parameters also revealed that high heritability (broad sense) was observed for all characters except for days to 50% flowering, days to 50% pod setting, days to maturity, plant height, number of primary branches. Seed yield per plant exhibited significant and positive association with days to maturity, number of pods per plant, number of primary branches per plant, number of seeds per pod, harvest index and biological yield per plant at both genotypic and phenotypic level. Path coefficient analysis revealed that characters like biological yield and harvest index exhibited direct positive effect at both phenotypic and genotypic level. Therefore, these characters should be given priority during selection for improvement in Chickpea.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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