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Analysis of Correlation and Path Coefficient for Grain yield and its Attributing Traits in Chickpea (*Cicer arietinum* L.) under Timely Sown conditions

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ABSTRACT: Chickpea is a multifunctional annual legume crop, considered to be the country's most diverse crop. However, there is a scarcity of data in the country on genetic variation, yield association and yield-attributing characteristics of Chickpea. Therefore, an investigation was conducted to estimate the correlation coefficient and path coefficient between seventy-nine lines of chickpea (60 F_1s, 15 lines and 4 testers) (*Cicer arietinum* L.) at Student's Instructional Farm, ANDUAT, Kumarganj, Ayodhya during *Rabi* season 2020-21.The data were observed for eleven metric traits *viz*., Days to 50% flowering (DFF), Days to maturity (DM), Plant height (PH) (cm), Primary branches/plant (PBPP), Secondary branches/plant (SBPP), Pods/plant (PPP), Seeds/pod (SPP), 100 seed weight (g), Biological yield/plant (BYPP) (g), Harvest index (HI) (%) and Seed yield/plant (SYPP) (g). At genotypic level, the significant positive correlation coefficient was recorded for the characters plant height (cm) with 100 seed weight (g). Investigation of correlation coefficients revealed that the amount of genetic correlation coefficient was very close to phenotypic correlation coefficient in most cases, suggesting the existence of inherent associations among the traits studied. The trait pods/plant exhibited highly significant and positive correlation with grain yield/plant, seeds/pod showed highly positive significant correlation with biological yield/plant, biological yield/plant showed strong correlation with grain yield/plant and harvest index. The results indicated that biological yield/plant exerted direct and positive effect on grain yield/plant and it also exerted indirect effect on grain yield/plant *via*100-seed weight followed by pods/plant. The trait harvest index possessed significant indirect effect on grain yield/plant *via* pods per plant.

Keywords: Chickpea, *Cicer arietinum*, grain yield, correlation coefficient, path coefficient.

INTRODUCTION

Chickpea (*Cicer arietinum* L.), is a self-pollinated pulse crop, botanically belonging to family *Fabaceae*, is among the most important *rabi* pulse crops in India and contributes about 20% to the total pulse production at global level. Chickpea is a diploid (2n = 2x = 16) crop having genome size of 732 Mb. It is a cool season pulse crop which grown under eight geographically diverse agro-climatic conditions in more than 44 countries representing all the continents. India, the largest chickpea producer with about 11.35 mt production from 10.17 mha area and 1116 kg/ha productivity, holds about 67% in global chickpea production (Directorate of Economics & Statistics, DAC&FW). The total production of chickpea in the year 2019-20 was 11.35 mt(Directorate of Economics and Statistics, 2020).Moreover, its seed coats and pod covers are used as fodder for animals. Proteins are an important constituent of chickpea seed and responsible for nutritional and socio-economic importance. The chickpea seed is a rich source of proteins as well as carbohydrates which together constitute about 80% of the total dry weight. The genetic resources of the genus *Cicer* L. are not only limited in comparison to other key food legumes and cereal crops, but they also comprise numerous endemic species classified as endangered by the International Union for Conservation of Nature. (Toker *et al.*, 2021). As it is an excellent source of protein, fits well in cropping systems and tolerates drought, this crop occupies a vital place in our daily diet. Concerning its importance is quite need to increase its yield potential; regarding these several genetic improvement methods have been employed. As seed yield is the most important and complex character controlled by polygenes, it is also governed by a lot of physiological changes within the plant and many environmental factors also interfere when cultivated, that is why it is not an effective character for selection. Investigation of genetic variability and a

correlation study between yield and its components of genotypes could assist in meeting the demand for high grain production and nutrition (Saleh *et al.*, 2020). The objectives of this study were to evaluate the association among grain yield and yield attributing traits and to determine the direct and indirect effects of these traits on grain yield in chickpea under timely sown conditions.

MATERIALS AND METHODS

The experiment was conducted by undertaking nineteen chickpea genotypes (fifteen lines and four testers) with two standard checks, which were initially screened for desired characters. The parents namely ICCV 10, JG 11, JG 14, JG 16, JG 315, NDG 5-21, NDG 11-12, Phule G 5, BG 362, HC 3, Rajash, Vaibhav, RSG 888, PDG 84-16, JAKI 9218 were used as lines (females) of chickpea which were crossed with four testers (male) namely Pant G 186, BG 372, GCP 105 and Udai were collected from genetic stock available in Chickpea Section, Department of Genetics and Plant Breeding, ANDUAT Kumarganj, Ayodhya. These genotypes were crossed in Line × Tester design to produce 60 F_1sduring *Rabi* season 2019-20 and were evaluated in the following year during *Rabi* season 2020-21. The final experimental material comprising of seventy-nine (60 F_1s, 4 testers and 15 lines) was grown in RBD with 3 replications, each replication consisting two rows of 4m length and spacing of 30 cm (R × R) & 10cm (P × P) in timely sown conditions at Student's Instructional Farm, ANDUAT, Kumarganj, Ayodhya. Recommended packages and practices were given to raise a healthy and productive crop. The data were observed for eleven metric traits *viz*., Days to 50% flowering (DFF), Days to maturity (DM), Plant height (PH) (cm), Primary branches/plant (PBPP), Secondary branches/plant (SBPP), Pods/plant (PPP), Seeds/pod (SPP), 100 seed weight (g), Biological yield/plant (BYPP) (g), Harvest index (HI) (%) and Seed yield/plant (SYPP) (g). These observations were recorded at maturity of crop from five randomly selected plants for most of the traits except Days to 50% flowering and days to maturity which was recorded on whole plot basis.

The genotypic and phenotypic correlation coefficient (r) between various traits were estimated according to the formulae given by Searle, (1961) and Path coefficient analysis was carried out according to Dewey and Lu (1959). Seed yield or grain yield/plant (g) was supposed to be dependent variable (effect) which is influenced directly and indirectly byall other characters *i.e.*, independent variables (causes).

RESULTS AND DISCUSSION

Correlation coefficient. Relationship between seed yield and its attributing characters were estimated through analysis of coefficient of correlation among them. Genotypic and Phenotypic correlation coefficients between eleven quantitative characters of 79 chickpea lines are shown in Table 1 and 2 respectively. Correlation analysis revealed that the amount of genetic correlation coefficient was very close to phenotypic correlation coefficient in most cases, suggesting the existence of inherent associations among the traits studied. The phenotypic coefficient of correlation in some traits were higher than their genotypic coefficient of correlation, which designate the masking effect of environment that can change the expression of traits at phenotypic level.

At genotypic level (Table 1), the characters days to 50% flowering, days to maturity, primary branches/plant and secondary branches/plant didn't show any significant correlation with any of the characters studied. The trait plant height (cm) exhibited significant positive correlation with 100-seed weight (g) (0.711) followed by biological yield/plant (g) (0.493), grain yield/plant (g) (0.488), harvest index (%) (0.311) and pods/plant (0.300). Supported by the observations earlier reported by the workers *i.e.*, 100-SW (0.589) and BYPP (0.536).

Table 1: The estimates of genotypic correlation coefficient among 11 characters in Chickpea.

Characters	Days to 50 % flowering	Days to maturity	Plant height (cm)	Primary Branches/ Plant	Secondary Branches/ Plant	Pods / plant	Seeds/ pod	100-seed weight (g)	Biological yield/ plant (g)	Harvest index (%)	Grain yield/ plant (g)
Days to 50 % flowering	**1**	1.01	0.076	0.141	-0.031	-0.015	-0.14	0.131	0.016	-0.033	0.025
Days to maturity		**1**	0.071	0.138	-0.043	-0.02	-0.142	0.126	0.009	-0.034	0.02
Plant height (cm)			**1**	0	0.123	0.300**	0.091	0.715**	0.493**	0.331**	0.488**
Primary Branches/ Plant				**1**	-0.011	0.015	0.005	0.02	-0.012	0.122	0.00
Secondary Branches/ Plant					**1**	0.042	0.046	0.089	0.152	-0.084	0.111
Pods/plant						**1**	0.031	0.502**	0.712**	0.719**	0.758**
Seeds/pod							**1**	0.118	0.534**	0.105	0.507**
100-seed weight (g)								**1**	0.759**	0.505**	0.766**
Biological yield/plant (g)									**1**	0.482**	0.986**
Harvest index (%)										**1**	0.603**
Grain yield/plant (g)											**1**

*, ** Significant at 5% and 1% probability level

Table 2: The estimates of phenotypic correlation coefficient among 11 characters in Chickpea.

Characters	Days to 50 % flowering	Days to maturity	Plant height (cm)	Primary Branches/ Plant	Secondary Branches/ Plant	Pods / plant	Seeds/ pod	100-seed weight (g)	Biological yield/ plant (g)	Harvest index (%)	Grain yield/ plant (g)
Days to 50 % flowering	1	0.999**	0.075	0.11	-0.03	-0.016	-0.139	0.129	0.011	-0.033	0.020
Days to maturity		1	0.069	0.116	-0.041	-0.019	-0.14	0.124	0.006	-0.031	0.017
Plant height (cm)			1	-0.003	0.121	0.298**	0.085	0.711**	0.488**	0.325**	0.482**
Primary Branches/ Plant				1	-0.006	0.014	-0.007	0.017	-0.012	0.105	0.001
Secondary Branches/ Plant					1	0.042	0.039	0.089	0.149	-0.084	0.108
Pods/plant						1	0.025	0.501**	0.706**	0.708**	0.751**
Seeds/pod							1	0.112	0.535*	0.137	0.512*
100-seed weight (g)								1	0.754**	0.498**	0.760**
Biological yield/plant (g)									1	0.483**	0.986**
Harvest index (%)										1	0.604**
Grain yield/plant (g)											**1**

*, ** Significant at 5% and 1% probability level

Pods/plant exerted significant and positive correlation with grain yield/plant (0.758) followed by harvest index (0.719), biological yield/plant (0.711) and 100-seed weight (0.502) respectively. Same observations were also recorded by Babar and Patel (2005), *i.e*., BYPP (0.751) and Kumar *et al.*, (2019), *i.e.*, GYPP (0.0.270).

Seeds/pod showed highly positive significant correlation with biological yield/plant (0.534) followed by grain yield/plant (0.507). These are similar with the results observed by Babbar *et al.* (2012), *i.e.*, SYPP (0.65).

The trait 100-seed weight possessed significant and positive correlation with the characters biological yield/plant, grain yield/plant and harvest index (*i.e.*, 0.759, 0.766 and 0.505 respectively). Such types of results were also reported by the earlier workers Agrawal *et al.*, (2018), *i.e.*, BYPP = 0.355 and HI = 0.311.

Biological yield/plant exerted strong correlation with grain yield per plant (0.966) and harvest index (0.482). Malik *et al.* (2010), *i.e.*, GYPP (0.77).

Harvest index possessed significant positive correlation with grain yield/plant (0.603) (Table 1). These results are also in agreement with earlier reports of Malik *et al*., (2010), *i.e.*, HI (0.29).

Path coefficient. Coefficient of correlation only measures the degree and correlation between two traits. Although, this may not give the fair idea under complex conditions. Under such conditions, path coefficient provides a better way of estimating the direct as well as indirect effects *via* other variables on the end product *i.e.*, seed yield, by partitioning correlation coefficients. The direct and indirect effects on seed yield were estimated for all characters under study, which provided a better index for selection rather than correlation coefficient.

Table 3: Genotypic direct and indirect effects of yield component characters on seed yield in Chickpea.

Characters	Days to 50 % flowering	Days to maturity	Plant height (cm)	Primary Branches/ Plant	Secondary Branches/ Plant	Pods / plant	Seeds/ pod	100-seed weight (g)	Biological yield/ plant (g)	Harvest index (%)	Grain yield/ plant (g)
Days to 50 % flowering	**0.034**	0.034	0.003	0.005	-0.001	-0.001	-0.005	0.004	0.001	-0.001	0.025
Days to maturity	-0.016	**-0.016**	-0.001	-0.002	0.001	0.0001	0.002	-0.002	0.0001	0.001	0.020
Plant height (cm)	-0.001	-0.001	**-0.010**	0.0001	-0.001	-0.003	-0.001	-0.007	-0.005	-0.003	0.488**
Primary Branches/ Plant	-0.002	-0.002	0.0001	**-0.013**	0.0001	0.0001	0.0001	0.0001	0.0001	-0.002	0.0001
Secondary Branches/ Plant	0.001	0.001	-0.002	0.0001	**-0.016**	-0.001	-0.001	-0.001	-0.002	0.001	0.111
Pods/plant	0.002	0.002	-0.035	-0.002	-0.005	**-0.117**	-0.004	-0.059	-0.083	-0.084	0.758**
Seeds/pod	0.010	0.010	-0.007	0.0001	-0.003	-0.002	**-0.072**	-0.009	-0.039	-0.008	0.507**
100-seed weight (g)	-0.012	-0.011	-0.064	-0.002	-0.008	-0.045	-0.011	**-0.089**	-0.068	-0.045	0.766**
Biological yield/plant (g)	0.017	0.010	0.529	-0.013	0.163	0.764	0.573	0.815	**1.073**	0.517	0.986**
Harvest index (%)	-0.007	-0.008	0.075	0.028	-0.019	0.162	0.024	0.114	0.109	**0.226**	0.603**

Residual Factors = 0.07200

At genotypic level (Table 3) the results revealed that the character biological yield/plant (1.073) possessed direct positive effect on grain yield/ plant followed by harvest index (HI) (0.226) and days to 50% flowering (DFF) (0.034) and it also exerted indirect effect on grain yield/plant *via* 100-seed weight (0.815) followed by pods/plant (0.764), seeds/pod (0.573), plant height (0.529) and harvest index (0.517). These results are supported by earlier results reported by the workers Kumar *et al.* (2019), *i.e.*, BYPP (1.026), *i.e.*, BYPP(0.840) and HI (0.288); and Agrawal *et al.* (2018), *i.e.*, BYPP (0.960) and HI (0.259).

The trait harvest index exhibited significant indirect effect on grain yield/plant (0.603) *via* pods/plant (0.162), 100-seed weight (0.114), biological yield/plant (0.109) respectively. These results are also in agreement with the earlier results reported by Talebi *et al*., (2007), *i.e.*, HI(0.901) and Pods/plant (0.210). Rest of the characters did not exert substantial amount of indirect on grain yield.

Table 4: Phenotypic direct and indirect effects of yield component characters on seed yield in Chickpea.

Characters	Days to 50 % flowering	Days to maturity	Plant height (cm)	Primary Branches/ Plant	Secondary Branches/ Plant	Pods / plant	Seeds/ pod	100-seed weight (g)	Biological yield/ plant (g)	Harvest index (%)	Grain yield/ plant (g)
Days to 50 % flowering	**-0.272**	-0.272	-0.021	-0.030	0.008	0.004	0.038	-0.035	-0.003	0.009	0.020
Days to maturity	0.288	**0.289**	0.020	0.033	-0.012	-0.005	-0.040	0.036	0.002	-0.009	0.017
Plant height (cm)	-0.001	-0.001	**-0.009**	0.000	-0.001	-0.003	-0.001	-0.006	-0.004	-0.003	0.482**
Primary Branches/ Plant	-0.001	-0.001	0.000	**-0.011**	0.000	0.000	0.000	0.000	0.000	-0.001	0.001
Secondary Branches/ Plant	0.000	0.001	-0.002	0.000	**-0.013**	-0.001	-0.001	-0.001	-0.002	0.001	0.108
Pods/plant	0.002	0.002	-0.033	-0.002	-0.005	**-0.110**	-0.003	-0.055	-0.078	-0.078	0.751**
Seeds/pod	0.010	0.010	-0.006	0.001	-0.003	-0.002	**-0.074**	-0.008	-0.040	-0.010	0.512*
100-seed weight (g)	-0.011	-0.010	-0.060	-0.001	-0.008	-0.042	-0.009	**-0.085**	-0.064	-0.042	0.760**
Biological yield/plant (g)	0.012	0.006	0.521	-0.013	0.159	0.754	0.572	0.806	**1.068**	0.516	0.986**
Harvest index (%)	-0.007	-0.007	0.072	0.023	-0.019	0.156	0.030	0.110	0.107	**0.221**	0.604**

Residual Factors = 0.0730

CONCLUSION

In briefly, the genotypes of chickpea studied have the enough ability for integrating definite salient and principal traits. Estimation of correlation and path coefficient disclosed that the grain yield/plant, biological yield/plant and 100-seed weight were the most prominent traits for yield improvement in chickpea. While selecting for yield improvement in chickpea the highest importance should be given to these characters.

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Conflict of Interest. None.

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