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VP Gulwane
M.Sc. Scholar, Department of Agricultural Botany, Post Graduate Institute, MPKV, Rahuri, Maharashtra, India

GN Deore
Associate Professor & Officer In-Charge, Agriculture Research Station, Savalivihir, Maharashtra, India

DS Thakare
Assistant Professor, Department of Genetics and Plant Breeding, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra, India

Corresponding Author:
VP Gulwane
M.Sc. Scholar, Department of Agricultural Botany, Post Graduate Institute, MPKV, Rahuri, Maharashtra, India

Correlation and path analysis studies in chickpea (*Cicer arietinum* L.)

VP Gulwane, GN Deore and DS Thakare

Abstract
The investigation on “Genetic diversity studies in chickpea (*Cicer arietinum* L.)” was conducted on 44 genotypes of chickpea to know the correlation and direct and indirect effects for yield and yield contributing characters as the direct effect is mainly responsible for positive association of the genotype with seed yield per plant. The experiment was evaluated in a Randomized Block Design (RBD) with three replications.

The significant positive correlation was observed between seed yield per plant with plant height, number of secondary branches per plant, number of pods per plant and 100-seed weight. While, seed yield per plant exhibited significant negative correlation with days to 50 percent flowering and days to maturity both at phenotypic and genotypic level.

In the present study, path coefficient analysis showed that 100 seed weight (0.721) had highest direct effect on seed yield per plant followed by number of pods per plant (0.660), number of seeds per pod (0.232), number of secondary branches per plant (0.202) and plant height (0.065). These direct effects are mainly responsible for positive association of these characters with seed yield per plant. Path coefficient analysis revealed that 100-seed weight had highest direct effect on seed yield per plant followed by number of pods per plant, number of seeds per pod, number of secondary branches per plant, plant height. Whilst, days to 50 percent flowering and days to maturity showed negative direct effect. The number of secondary branches exerted its effect on seed yield through number of pods per plant and 100 seed weight suggesting that the indirect selection through such traits would be effective in yield improvement.

Therefore, emphasis should be given on 100 seed weight, number of pods per plant, number of seeds per pod and number of secondary branches per plant while making selection for desired improvement for grain yield in chickpea.

Keywords: Chickpea, correlation, path analysis, direct and indirect effects

1. Introduction

Pulses production in India is characterized by diversity of crops and their regional specificity based on adaption to prevailing agro climatic conditions. This group of crops can utilize limited soil moisture and nutrients more efficiently than cereals. Pulses have a significant role in farming systems as a substitute for fallow in cereal rotations.

Chickpea (*Cicer arietinum* L.) is traditionally grown in many parts of the world since ancient time, both in Asia and Europe. Chickpea (*Cicer arietinum* L.) is an annual, cleistogamous, self-pollinated and diploid (2n=16) grain legume crop grown in a wide range of environments including the Mediterranean, South and West Asia, North America, and North and East Africa. It belongs to genus Cicer and tribe Cicerae Alef and family Fabaceae. Chickpea is known to have nine annual and thirty five perennial species (Van der Maesen *et al.*, 2007) [17]. Based on seed protein electrophoresis, Ladizinsky and Adler (1976) considered *Cicer reticulatum* the wild progenitor of cultivated chickpea and South Eastern Turkey as the center of origin for the crop. Among the pulses, chickpea is important *Rabi* crop of India. Nearly 90 percent of the crop is cultivated under rainfed condition on receding soil moisture and on marginal lands. In India, area under chickpea was 10.17 million ha, production of over 11.35 million tons and the ever highest productivity level of 1116 kg ha^{-1} (Anonymous, 2019-20) [1, 2]. In India, Madhya Pradesh, Uttar Pradesh, Rajasthan, Maharashtra, Andhra Pradesh, Tamil Nadu and Telangana are major chickpea producing states contributing more than 88 percent to the total chickpea production. Madhya Pradesh is the single largest producer in the country accounting for over 40 percent of total production followed by Rajasthan, Maharashtra, Uttar Pradesh and Karnataka Maharashtra grows total pulses on about 43.87 lakh ha area producing 40.27 lakh tons and the productivity of pulses 918 kg ha^{-1} in the year 2019-20.

The chickpea area in Maharashtra was about 23.21 lakh ha with production 25.97 lakh tons and the productivity level of 1118 kg ha^{-1} (Anonymous, 2019-20) [1, 2].

Pulses are important constituents of the Indian diet and supply a major part of the protein requirement. Chickpea provides high quality protein, particularly for vegetarians. It is also used as a feed for livestock. Like other pulse crops chickpea has multiple function in the traditional farming systems in many developing countries.

Chickpea seed contain on average 22 percent protein, 4.5 percent fat, 63 percent Carbohydrates, 1-5 percent crude fibre, 2.7 percent ash and 358 calories (Miao *et al*., 2009) [10]. Being fairly tolerant to soil moisture stress, it occupy important position in different cropping system. Chickpea (*Cicer arietinum* L.) is mainly divided into two types Desi and Kabuli. Desi type is characterized by small, coloured seeds, angular shape with high percentage of fibre and Kabuli type characterized by large, ram-head-shaped, coloured seeds with low percentage of fibre. It is mostly used in the form of dhal. An acrid liquid from the glandular hairs is collected by spreading a cloth over the crop at night, which absorbs the exudation with the dew, it contains malic and oxalic acid and is used medicinally and as vinegar. Due to its high protein content, health benefits and various domestic uses there is wide scope for production of chickpea and develop small scale industries.

The cultivation of chickpea is very wide hence the information about the nature and magnitude of genetic divergence is essential and there is need to critically analyze the formulation of yield in diverse material of chickpea. Indeed this in turn helps in establishing the selection strategy and identification of diverse parents which upon hybridization lead to a wide spectrum of gene combination.

Association of one or more characters influenced by large number of genes is elaborated statistically by estimating correlation coefficients. Genotypic correlation coefficient provides a measure of genotypic conjugation between characters. While the method of partitioning the correlation into direct and indirect effects by path coefficient analysis suggested by Wright (1921) [18] provides useful information on the relative merit of the trait in the selection criteria.

2. Material and Methods

The investigation of 44 genotypes which were obtained from the Principal Scientist, Pulses Improvement Project, M.P.K.V., Rahuri. The experiment was evaluated in a Randomized Block Design (RBD) with three replications each genotype was sown in single row of 4 m length with spacing 30 cm between row and 10 cm within rows. The observations were recorded on five randomly selected plants from each treatment in each replication for eight morphological characters *viz*., Days to maturity, Days to 50% flowering, Plant height, number of secondary branches per plant, number of pods per plant, number of seeds per pod, 100-seed weight, seed yield per plant (g).

Analysis of variance commonly applicable to the Randomized Block Design (Panse and Sukhatme, 1995) [13]. Analysis of covariance was carried out by taking two characters at a time. The genotypic co-variance was calculated as per Johnson *et al.,* (1955) [7]. Appropriate variances and co-variances were used for calculating phenotypic and genotypic correlation coefficients (Johnson *et al.*, 1955) [7]. The significance of the phenotypic correlation coefficient was tested by referring to formula given by Fisher and Yates (1943) [5]. The significance of correlation coefficients was tested from the statistical table of correlation coefficient at 1 and 5 percent level of significance (Snedcor and Cochran, 1967) [15].

To establish a cause and effect relationship the first step used was to partition genotypic and phenotypic correlation coefficient into direct and indirect effects by path analysis as suggested by Dewey and Lu (1959) [4] and developed by Wright (1921) [18]. The second step in path analysis is to prepare path diagram based on cause and effect relationship. In the present study, path diagram was prepared by taking yield as the effect i.e. function of various components like X_1, X_2, X_3.... X_n.

3. Results and Discussion

The analysis of variance revealed significant genotypic differences for all the eight characters. Mean sum of squares due to treatments were significant for all the characters indicating genotypes differed significantly.

3.1 Correlation Studies

The correlation coefficient between seed yield and its components were estimated at genotypic and phenotypic level. The genotypic (rg) and phenotypic (rp) correlations for eight characters studied are presented in Table 1. In general, genotypic correlation coefficients were higher than their corresponding phenotypic correlations.

Table 1: Estimates of phenotypic (above diagonal) and genotypic correlation coefficients (below diagonal) among seed yield and yield contributing characters in forty four chickpea genotypes

Sr. No.	Name of character	Days to 50 percent flowering	Days to maturity	Plant height (cm)	Number of secondary branches/ plant	Number of pods / plant	Number of seed / pod	100 seed weight (g)	Seed yield/ plant (g)
1.	Days to 50 percent flowering	1.000	0.552**	-0.010	-0.101	0.042	-0.106	-0.385**	-0.324**
2.	Days to maturity	0.571**	1.000	-0.017	-0.280**	-0.001	-0.049	-0.258**	-0.288**
3.	Plant height (cm)	-0.013	-0.010	1.000	0.054	-0.093	-0.095	0.331**	0.216*
4.	Number of secondary branches/ plant	-0.108	-0.310**	0.049	1.000	0.471**	0.152	-0.152	0.447**
5.	Number of pods/plant	0.050	-0.021	-0.106	0.450**	1.000	0.055	-0.268**	0.555**
6.	Number of seeds/pod	-0.112	-0.052	-0.115	0.140	0.040	1.000	-0.200*	0.151
7.	100 seed weight (g)	-0.389**	-0.271**	0.345**	-0.189**	-0.310**	-0.214*	1.000	0.468**
8.	Seed yield /plant (g)	-0.344**	-0.335**	0.228*	0.413**	0.528**	0.130	0.471**	1.000

*and ** significant at P= 5 and P = 1 level of significance, respectively

3.1.1 Association of Seed Yield with its Components
It is revealed from Table 1 that, significant positive correlation was reported between seed yield per plant with plant height, number of secondary branches per plant, number of pods per plant and 100 seed weight. Non-significant positive correlation was reported between seed yield per plant with number of seeds per pod. However, correlation with days to 50 percent flowering and days to maturity was negative and significant.

3.2. Interrelationship of Yield Components
3.2.1 Days to 50 percent flowering
Days to 50 percent flowering showed significant positive correlations with days to maturity (rg = 0.571, rp = 0.552) while it was significant and negatively correlated with 100 seed weight (rg = -0.389, rp = -0.385), seed yield per plant (rg = -0.344, rp = -0.324). It also showed non-significant positive correlation with number of pods per plant and non-significant negative correlation with plant height, number of secondary branches per plant, number of seeds per pod both at genotypic and phenotypic levels.

3.2.2 Days to maturity
Days to maturity exhibit significant positive correlations with days to 50 percent flowering (rg = 0.571, rp = 0.552) and significant negative association with number of secondary branches per plant (rg = -0.310, rp = -0.280),100 seed weight (rg = -0.271, rp = -0.258), seed yield per plant (rg = -0.335, rp = -0.288) and further it showed non significant negative correlation with rest of all characters *viz.* plant height, number of pods per plant, number of seeds per pod.

3.2.3 Plant height
Plant height recorded significant positive association with 100 seed (rg =0.345, rp =0.331), seed yield per plant (rg = 0.228, rp = 0.216) both at genotypic and phenotypic levels. Other characters are non-significant such as number of secondary branches per plant (positively) and days to 50 percent flowering, days to maturity, number of pods per plant, number of seeds per pod (negatively).

3.2.4 Number of secondary branches per plant
Number of secondary branches per plant showed positive and significant correlation with number of pods per plant (rg =0.450, rp =0.471), seed yield per plant (rg = 0.413, rp = 0.447). It also exhibited significant negative correlation with days to maturity (rg = -0.310, rp = -0.280) both at genotypic and phenotypic levels except 100 seed weight (rg = -0.189, rp = -0.1522) showed significant negative association at genotypic and non-significant negative correlation at phenotypic levels. Further it showed non-significant, positive correlation with plant height, number of seeds per pod and negative correlation with days to 50 percent flowering.

3.2.5 Number of pods per plant
The number of pods per plant recorded significant positive correlation with number of secondary branches per plant (rg = 0.450, rp = 0.471), seed yield per plant (rg = 0.528, rp = 0.555). However, it exhibited significant negative correlation with 100 seed weight (rg = -0.310, rp = -0.268). Among rest of all characters days to 50 percent flowering, number of seeds per pod and days to maturity, plant height showed non-significant positive and negative association respectively.

3.2.6 Number of seed per pod
The number of seed per pod showed significant negative correlation with 100 seed weight (rg= -0.214, rp = -0.200). However, it showed non-significant positive correlation with number of secondary branches per plant, number of pods per plant, seed yield per plant and non-significant negative correlation with days to 50 percent flowering, days to maturity and plant height both at genotypic and phenotypic levels.

3.2.7 100 seed weight
It showed significant positive correlation with plant height (rg = 0.345, rp = 0.331), seed yield per plant (rg = 0.471, rp = 0.468). Whilst, it showed significant negative correlation with days to 50 percent flowering (rg = -0.389, rp = -0.385), days to maturity (rg = -0.271, rp = -0.258), number of pods per plant (rg = -0.310, rp = -0.268), number of seed per pod (rg = -0.214, rp = -0.200) both at genotypic and phenotypic levels except number of secondary branches per plant (rg = -0.189, rp = -0.152) showed significant negative association at genotypic and non-significant negative correlation at phenotypic levels.
In the present investigation, seed yield per plant exhibited significant positive correlation with plant height, number of secondary branches per plant, number of pods per plant and 100 seed weight. These results are supported by Tiwari *et al.* (2016) [16] harvest index, 100 seed weight, seeds per pod, number of effective pods per plant, total number of pods per plant, number of primary branches per plant per plant and plant height were the most important characters, which possessed positive association with seed yield per plant. Kumar *et al.* (2019) [8] correlation analysis revealed that grain yield exhibited significant and positive correlation with number of pods per plant and while it showed significant and negative association with days to maturity. Shanmugam and Kalaimagal (2019) [14] traits such as number of secondary branches, number of seed per plant, 100 seed weight, biological yield per plant and harvest index exhibited significant positive correlation with seed yield per plant. Seed yield per plant exhibited significant negative correlation with days to 50 percent flowering and days to maturity, this finding are in accordance with the earlier worker Banik *et al.* (2017) [3] and Kumar *et al.* (2019) [8].

4. Path Coefficient Analysis
In order to achieve a clear picture of inter-relationship of various component traits with seed yield per plant, direct and indirect effects were calculated using path coefficient analysis at genotypic level. Seed yield, a polygenic trait is influenced by various components directly as well as indirectly *via* other traits, which create a complex situation before a breeder for making selection. Therefore, path coefficient analysis could provide a more realistic picture of the inter-relationship, as it considers direct as well as indirect effects of the variables by partitioning the correlation coefficient into direct and indirect effects were given in Table 2.

Table 2: Estimates of genotypic direct (diagonal) and indirect effects (above and below diagonal) of component characters on seed yield in forty four chickpea genotype

Sr. No.	Name of character	Days to 50 percent flowering	Days to Maturity	Plant height (cm)	Number of secondary branches/ plant	Number of pods / plant	Number of seed / pod	100 seed weight (g)	Genotypic correlation with Seed yield/ plant (g)
1.	Days to 50 % flowering	-0.0276	-0.020	-0.001	-0.022	0.033	-0.026	-0.281	-0.344**
2.	Days to maturity	-0.016	-0.035	-0.001	-0.063	-0014	-0.012	-0.196	-0.335**
3.	Plant height (cm)	0.0004	-0.0003	0.065	0.010	-0.070	-0.027	0.249	0.228*
4.	Number of secondary branches/ plant	0.003	0.011	0.003	0.202	0.297	0.033	-0.136	0.413**
5.	Number of pods/plant	-0.001	0.001	-0.007	0.091	0.660	0.001	-0.224	0.528**
6.	Number of seeds/pod	0.003	0.002	-0.008	0.028	0.026	0.232	-0.154	0.130
7.	100 seed weight (g)	0.011	0.009	0.023	-0.038	-0.205	-0.050	0.721	0.471**

Residual effect (R) = 0.403, Underlined figures indicate direct effect

4.1.1 Days to 50 percent flowering
Days to 50 percent flowering showed negative direct effect (-0.0276) and it had negative indirect effect *via* almost all the characters except number of pods per plant (0.033), thus leading to negative correlation with seed yield (-0.344).

4.1.2 Days to maturity
Days to maturity exhibited direct negative effect on seed yield (-0.035). It had negative indirect effects through almost all the characters and thus leading to negative correlation with seed yield (-0.335).

4.1.3 Plant height
The plant height showed positive direct effect (0.065) on seed yield. The indirect effects of it were positive through days to 50 percent flowering (0.0004), number of secondary branches per plant (0.010), 100 seed weight (0.249). Thus, leading to total genotypic correlation with seed yield is significant and positive (0.228).

4.1.4 Number of secondary branches per plant
The number of secondary branches per plant showed positive direct effect (0.202) on seed yield. It showed positive indirect effect on all characters except 100 seed weight (-0.136). It showed positive and highly significant correlation with seed yield per plant (0.413).

4.1.5 Number of pods per plant
It had highly significant and positive correlation with seed yield (0.528). It showed positive direct effect (0.660) on seed yield and positive indirect effect on number of secondary branches per plant (0.091). It shows the indirect negative effect for days to 50 percent flowering, plant height, 100 seed weight

4.1.6 Number of seeds per pod
Number of seed per pod showed positive direct effect (0.232) on seed yield. It had positive indirect effect *via* almost all the characters except plant height (-0.008), 100 seed weight (-0.154) thus leading to positive correlation with seed yield (0.130).

4.1.7 100 seed weight
Among the all characters studied, number of pods per plant showed high and positive direct effect on seed yield (0.721). It showed positive indirect effects for all the characters except number of secondary branches per plant (-0.038), number of pods per plant (-0.205), number of seeds per pod (-0.050). Its correlation with seed yield was highly significant and positive (0.471).

The direct effect of number of pods per plant on seed yield per plant was reported by the other workers namely Paliwal *et al.* (1987) [12] found that 100 seed weight had the highest positive direct effect on yield, followed by pods per plant, seeds per pod, Jeena *et al.* (2002) [13] biological yield exhibited highest positive correlation with seed yield coupled with highest positive direct effect on it, Muhammad *et al.* (2004) [11] and Yucel *et al.* (2006) [19] reported the direct effect of other characters on seed yield per plant.

Days to 50 % flowering and days to maturity had negative direct effect on seed yield. The similar result was reported earlier by Zena *et al.*, (2008) [20] 50 % flowerings period has shown negative direct effect on the yield of gram.

5. Conclusion
Correlation studied at both genotypic and phenotypic levels were made to resolve the direction of magnitude of association among characters. The significant positive correlation was reported between seed yield per plant with plant height, number of secondary branches per plant, number of pods per plant and 100 seed weight. This indicates simultaneous improvement of these characters through selection whereas, days to 50% flowering and days to maturity showed negative correlation with seed yields per plant at genotypic as well as phenotypic level indicates early genotype also produce higher grain yield. Non-significant positive correlation was reported between seed yield per plant with number of seeds per pod.

Path coefficient analysis revealed that 100 seed weight (0.721) had highest direct effect on seed yield per plant followed by number of pods per plant (0.660), number of seeds per pod (0.232), number of secondary branches per plant (0.202) and plant height (0.065). The direct effect is mainly responsible for positive association of the genotype with seed yield per plant. Therefore, emphasis should be given on these characters while making selection for desired improvement for grain yield in chickpea. These traits also showed significant positive association with seed yield per plant except number of seeds per pod as it shows non-significant positive association. Whereas, days to 50 percent flowering and days to maturity showed significant negative association with seed yield per plant indicates early genotype also produce higher grain yield. The number of secondary branches exerted its effect on seed yield through number of pods per plant and 100 seed weight suggesting that the indirect selection through such traits would be effective in yield improvement.

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7. References
1. Anonymous. District wise General Statistical Information of Agriculture Department, (MS), 2019-20, Part-II.
2. Anonymous. Project coordinator (chickpea) report, Indian Ins. Pulses Res., Kanpur; c2019-20.
3. Banik Mahamaya, Deore GN, Mandal Ajit Kumar, Shah Pankaj. Selection of yield contributing traits in chickpea genotypes by correlation and path analysis studies. Pharm. Inn. J. 2017;6(11):402-405.
4. Dewey DR, Lu KH. A correlation and path coefficient analysis of components of crested wheatgrass seed production. J Agron. 1959;51:515-518.
5. Fisher RA, Yates F. Statistical Tables for Biological, Agricultural and Medical Research. Edinburgh and London: Oliver and Boyd; c1943.
6. Jeena AS, Arora PS, Utpreti MC. Path coefficient analysis for increasing yield of chickpea. Bhartiya Krishi Anusadhan Patrik. 2005;20(1):32-35.
7. Johnsson HW, Robinson HF, Comstock RE. Estimation of genetic and environmental variability in soybean. Agron. J. 1955;47:314-318.
8. Kumar Anand, Anil Kumar, Ravi Ranjan Kumar, Sanjay Kumar, Satyendra, Kumari Rajani. Genetic variability, correlation and path coefficient analysis for yield and its component traits in chickpea. (*Cicer arietinum* L.). Int. J Chem. Stud. 2019;6:837-840.
9. Ladizinsky G, Adler A. Genetic relationships among the annual species of (*Cicer arietinum* L.) Theor. App. Genet. 1976;48(4):197-203.
10. Miao M, Zhang T, Jiang B. Characterisations of kabuli and desi chickpea starches cultivated in China. Food Chem. 2009;113:1025-1032.
11. Muhammad Arshad, Bakhsh A, Ghafoor A. Path coefficient analysis in chickpea (*Cicer arietinum* L.) under rainfed conditions. Pak. J Bot. 2004;36(1):75-81.
12. Paliwal KK, Ramgir SR, Lal NS, Kouttee GK, Mishra R. Correlation and path coefficient analysis in chickpea. Legume Res. 1987;10(1):44-48.
13. Panse VG, Sukhatme PV. Statistical methods for agricultural workers. ICAR, Pub. (IVth Ed.), New Delhi; c1995. p. 145-150.
14. Shanmugam Mohan, Kalaimagal Thiyagarajan. Genetic Variability, Correlation and Path Coefficient Analysis in Chickpea (*Cicer arietinum* L.) for Yield and its Component Traits. Int. J Curr. Microbiol. App. Sci. 2019;8(5):1801-1808.
15. Snedecor GW, Cochron WG. Statistical methods. 6th oxford and IBH Publ. Co. Calcutta; c1967. p. 172.
16. Tiwari A, Babbar Anita, Pal N. Genetic variability, correlation and path analysisin yield and yield components in chickpea (*Cicer arietinum* L.) Int. J Agric. Sci. 2016;8(54):2884-2886.
17. Van der Maesen LJG, Maxted N, Javadi F, Coles S, Davies AM. Taxonomy of Cicer revisited. In: S.S. Yadav, R. Redden, W. Chen and B. Sharma (eds.), Chickpea Breeding and Management. CABI International; c2007. p. 14-46.
18. Wright S. Correlation and causation. J Agric. Res. 1921;20:557-565.
19. Yucel DO, Anlarsal AE, Yucel C. Genetic variability, correlation and path analysis of yield and yield contributing characters in chickpea (*Cicer arietinum* L.). Turk. J Agric. 2006;30:183-188.
20. Zena AS, Arora PP, Upreti MC. Path coefficient analysis for enhancing the yield of chickpea, Bhartiya Krishi Anusandhan Patrika. 2008;23:3-4.