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Selection of yield contributing traits in chickpea genotypes by correlation and path analysis studies

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Abstract
Identification of potent parents having particular yield contributing traits is one of the important aspects of various crops breeding programme. For this purpose a study was carried out with sixty chickpea genotypes in Rabi 2014-15 at Pulses Improvement Project, Mahatma Phule Krishi Vidhyapeeth, Rahuri, Maharashtra, India. Experiment was conducted on sixty chickpea genotypes with Randomized Block Design in two replications. Each plot consisted of single row of 4 meter length with a spacing of 45 × 10 cm. Correlation studies revealed that, significant negative correlation between seed yield per plant and 50 per cent flowering and number of seeds per plant and significant positive correlation between seed yield per plant and number of pods per plant, plant height, number of secondary branches per plant, plant spread, 100 seed weight, and number of primary branches per plant. Path coefficient analysis exposed that number of pods per plant had highest direct effect on seed yield per plant followed by 100 seed weight, plant height and days to maturity except number of seeds per pod and days to 50 per cent flowering which are having negative effect on seed yield. This experiment suggests satisfying characters should be chosen for chickpea yield improvement based on the present analysis results.

Keywords: Chickpea, *Cicer arietinum* L., genotypes, path coefficient analysis, correlation analysis, seed yield

Introduction
Chickpea (*Cicer arietinum* L.) is the second most important cool season pulse crop in the world and is grown in at least 33 countries (Anonymous, 2002) [1]. Chickpea is an important Rabi pulse crop of India and is largest producer of chickpea in the world sharing 65.2% of area and 65.4% of production the area under chickpea was 9.93 million ha, production was 9.53 million tons and productivity was 960 kg/ha during 2013-14 (Anonymous, 2014) [2]. Chickpea acquires importance as it provides food for humans as well as for livestock. Furthermore, Chickpea pod covers and seed coats can also be used as fodder. Its contains 22 per cent protein, 63 per cent carbohydrates, 4.5 per cent fat, 8.0 per cent crude fibre and 2.7 per cent ash (Miao *et al*., 2009) [3]. Chickpea is low in sodium and fat, high in protein content. It is excellent source of both soluble and insoluble fibre, complex carbohydrates, vitamins and minerals. Chickpea crop has got special importance in Indian diet because it can be consumed in a various ways such as split seeds are used in the form of *dal*, parched, fried, roasted and boiled as snack food, sweet and condiments. The seeds are ground to flour known as *besan* and used in preparing various dishes like *pakora, laddu etc*. The tender leaves of Chickpea are used as fresh green vegetables, while dry plant parts above ground are used as cattle feed. Exudation from leaves called "*amb"* contains oxalic and malic acids which possess medicinal value and used for intestinal disorders, stomach aches, blood purification *etc*. The germinated seeds are prophylactic against scurvy disease.

Yield improvement is one of the most important considerations for a breeder. In traditional breeding method correlation and path analysis studies for yield criteria are important aspects for effective plant type selection. The correlation coefficient studies are needed to know the associations of plant characters with seed yield. For determination of the amount of direct and indirect effects of the causal components on the effect components i.e. seed yield; path analysis is studied. The path analysis is powerful tools for qualifying the degree of divergence at genotype level in respect of several traits considered together. By this analysis we can measure the divergence among the various genotypes and we can also know the direct and indirect effect of various plant characters on yield. Thus the present investigation was carried out to study the degree and direction of relationship between different characters and direct and indirect contribution of independent variables on dependent one among 60 genotypes of Chickpea.

Materials and Methods

Sixty Chickpea genotypes (table 1) including three checks *viz*., Digvijay, Vijay and Vishal were obtained from NBPGR, New Delhi and Pulses Improvement Project, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra. The latitude and longitude of the experiment location are 19.4^0N and 74.8^0E, respectively. The mean altitude is 532 meter above mean sea level and comes under the drought prone area with average annual rainfall of 542 mm. The annual average maximum and minimum temperature ranges between 30 and 40 °C and 10 to 20 °C respectively. These germplasm lines were sown in Randomized Block Design with two replications during *rabi* 2014-15 at pulses research institute, Rahuri, Maharashtra. Each plot consisted of single row of 4 meter length with a spacing of 45 × 10 cm. In each row ten plants were selected for each genotypes for recording characters *viz*. days to 50 per cent flowering, days to maturity, plant height, number of primary branches/plant, number of secondary branches per plant, plant height, plant spread, number of pods/plant, number of seeds pod, 100 seed weight, seed yield per plant along with this their mean values were used for statistical analysis. Correlation was worked out according to the methods Johnson *et al.* (1955) [10] and path coefficient analysis by Dewey and Lu (1959) [11] and Wright (1921) [12]. Data analysis was done using INDOSTAT software.

Table 1: List of sixty genotypes of chickpea

S. No	Genotype/ Source	Sr. No.	Genotype/ Source
N.B.P.G.R., New Delhi			
1.	ICC 2732	2.	ICC 2776
3.	ICC 2791	4.	ICC 2990
5.	ICC 3045	6.	ICC 3775
7.	ICC 3956	8.	ICC 6620
9.	ICC 7855	10.	ICC 7892
11.	EC 267159	12.	EC 267301
13.	EC 412927	14.	EC 441827
15.	EC 442698	16.	EC 498751
17.	EC 498756	28.	EC 538495
19.	EC 555296	20.	EC 555299
21.	EC 555405	22.	IC 83353
23.	IC 83362	24.	IC 83688
25.	IC 84000	26.	ICC 84068
27.	IC 95076	28.	IC 95077
29.	IC 116280	30.	IC 116357
31.	IC 117744	32.	IC 147167
33.	IC 244382	34.	IC 244629
35.	IC 248149	36.	IC 251836
37.	IC 257446	38.	IC 267309
39	IC 269007	40.	IC 269578
41.	IC 269628	42.	IC 270781
43.	IC 270930	44.	IC 270944
45.	IC 270969	46.	IC 275224
47.	IC 275535	48.	IC 275857
49.	IC 327534	50.	IC 323034
51.	IC 350844	52.	IC 486329
53.	IC 486999	54.	IC 487002
55.	IC 487126	56.	IC 487357
57.	IC 244670		
Pulses Improvement Project, M.P.K.V., Rahuri.			
58.	Digvijay (ch)	59.	Vijay (ch)

Results and Discussion

In character association studies; significant positive correlation was observed between seed yield per plant and number of pods per plant, plant height, number of secondary branches per plant, plant spread, 100 seed weight and number of primary branches per plant and significant negative correlation was observed between seed yield per plant and 50% flowering and number of seeds per plant (table-2). Correlation coefficient estimation was done at both genotypic and phenotypic level. The genotypic correlation coefficients were higher than their corresponding phenotypic correlations exhibiting more involvement of additive genes. Highly positive and significant correlation observed for plant spread with plant height (r_g = 0.9266, r_p = 0.7185) followed by number of pods per plant with seed yield per plant (r_g = 0.6358, r_p = 0.6115). This indicates the simultaneous improvement of these characters through selection will be rewarding. These results were in accordance with Saleem and Ali (1999) [4], Muhammad *et al.* (2004) [5], Talebi *et al.* (2007) [6].

To know the direct and indirect effects of these traits on seed yield correlations were further portioned into direct and indirect effects through path coefficient analysis (table 3). Path coefficient analysis exposed that number of pods per plant had highest direct effect (0.89) on seed yield per plant followed by 100 seed weight (0.82), plant height (0.39) and days to maturity (0.15) except number of seeds per pod and days to 50 per cent flowering which are having negative effect on seed yield. The path coefficient analysis revealed that number of pods per plant had highest direct effect (0.89) on seed yield per plant followed by 100 seed weight (0.82) and plant height (0.39). These direct effects are mainly responsible for positive association of these characters with

seed yield per plant. These results were similar with Saleem *et al.* (2002) [7], Gohil and Patel (2010) [8]. Number of seeds per pod and days to 50 per cent flowering, these two characters had negative correlation with seed yield per plant. Similar results were obtained by Padmavathi *et al.* (2013) [9], Saleem and Ali (1999) [7], Muhammad *et al.* (2004) [5]. The results of variability, correlation and path analysis indicated that 100 seed weight, seed yield per plant, number of pods per plant, number of secondary branches per plant, plant height were the major yield contributing characters as they showed positive and significant association with seed yield and also had high positive effects. Thus these characters could be considered as the most important for selection in order to improve the seed yield in chickpea.

Table 2: Genotypic (above diagonal) and Phenotypic (below diagonal) correlation coefficients in chickpea.

Sr. No.	Days to 50% flowering	Days to maturity	Number of primary branches per plant	Number of secondary branches per plant	Plant height (cm)	Plant spread (cm)	Number of pods per plant	Number of seeds per pod	100 seed weight (g)	Seed yield per plant (g)
	1	2	3	4	5	6	7	8	9	10
1	1.000	0.626 **	-0.039	-0.158	0.210 *	0.136	-0.029	0.115	-0.008	-0.017
2	0.620 **	1.000	0.191 *	-0.056	0.441 **	0.370 **	0.044	-0.046	0.001	0.120
3	-0.035	0.180 *	1.000	0.573 **	0.612 **	0.490 **	0.166	-0.064	0.137	0.328 **
4	-0.155	-0.058	0.542 **	1.000	0.447 **	0.358 **	0.334 **	0.207 *	-0.037	0.457 **
5	0.186 *	0.376**	0.489 **	0.384 **	1.000	0.927 **	0.257 **	-0.090	0.240 **	0.512 **
6	0.118	0.315 **	0.431 **	0.314 **	0.719 **	1.000	0.205 *	-0.053	0.210 *	0.390 **
7	-0.027	0.053	0.146	0.304 **	0.221 *	0.175	1.000	0.169	-0.439**	0.636 **
8	0.092	-0.071	-0.046	0.189 *	-0.064	0.010	0.081	1.000	-0.481**	-0.032
9	-0.007	0.001	0.133	-0.036	0.213 *	0.188 *	-0.418**	-0.428**	1.000	0.329 **
10	-0.019	0.107	0.300 **	0.445 **	0.430 **	0.338 **	0.612 **	-0.029	0.323 **	1.000

*, ** indicate significant at 5 and 1 per cent level, respectively

Table 3: Direct and indirect effects of ten causal variables on seed yield in chickpea

S.N.	Characters	Days to 50% flowering	Days to maturity	Number of primary branches per plant	Number of secondary branches per plant	Plant height (cm)	Plant spread (cm)	Number of pods per plant	Number of seeds per pod	100 seed weight (g)	Total genotypic correlation with seed yield per plant
1	Days to 50% flowering	-0.116	0.094	0.004	-0.023	0.083	-0.049	-0.026	0.024	-0.007	-0.017
2	Days to maturity	-0.073	0.150	-0.019	-0.008	0.174	-0.135	0.040	-0.010	0.001	0.120
3	Number of primary branches per plant	0.005	0.029	-0.100	0.084	0.242	-0.178	0.148	-0.014	0.113	0.328**
4	Number of secondary branches per plant	0.018	-0.008	-0.057	0.147	0.177	-0.130	0.298	0.044	-0.031	0.457**
5	Plant height (cm)	-0.025	0.066	-0.061	0.066	0.395	-0.337	0.229	-0.019	0.197	0.512**
6	Plant spread (cm)	-0.016	0.055	-0.049	0.053	0.366	-0.364	0.182	-0.011	0.173	0.390**
7	Number of pods per plant	0.003	0.007	-0.017	0.049	0.102	-0.074	0.891	0.036	-0.361	0.636**
8	Number of seeds per pod	-0.013	-0.007	0.006	0.031	-0.036	0.019	0.150	0.212	-0.395	-0.032
9	100 seed weight (g)	0.001	0.000	-0.014	-0.006	0.095	-0.076	-0.391	-0.102	0.821	0.329**
R SQUARE = 0.9441		Underlined figures indicate direct effect.									
RESIDUAL EFFECT = 0.236		*, ** indicate significant at 5 and 1 per cent level, respectively									

Conclusion

Emphasis should be given while making selection for number of pods per plant, 100 seed weight, plant height and days to maturity as these traits also showed significant positive association with seed yield per plant. So that selection for high seed yield should be based on biomass (biological yield) and harvest index in chickpea. The seed yield in chickpea can be improved by selecting an ideotype having higher number of pods per plant as well as greater plant height and 100 seed weight.

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