



E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2017; 6(5): 1488-1492
Received: 03-07-2017
Accepted: 04-08-2017

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Character association and path analysis of yield contributing traits and quality parameter in chickpea (*Cicer arietinum* L.)

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Abstract

Forty genotypes along with three check varieties of chickpea (*Cicer arietinum* L.) were assessed to work out the association of different seed yield traits, direct and indirect effects of their various attributes on seed yield. Seed yield per plant showed significant and positive correlation with pods per plant, seed yield per plant showed highly significant and negative correlation with days to 50% flowering and non-significant correlation with other characters. The characters showing significant positive correlation among yield and important characters would be highly effective and efficient in improving respective traits. Path analysis identified pods per plant and seedling length as important components having high order of direct effect to secondary branches per plant and vigour index as important components having high order of indirect effect on seed yield per plant. The characters identified above as important direct and indirect yield components merit due consideration in formulating selection strategy in chickpea for selection of high yielding varieties.

Keywords: Chickpea (*Cicer arietinum* L.), Character association, Path analysis, Seed yield, Quality parameters

Introduction

Chickpea is an important pulse crop in India. It is grown in *Rabi* season in India. Globally, the pulses are the second most important group of crops. These are used for food for human and other animals. Pulses are an important food crop due to their high protein and essential amino acid (methionin, cystein and tryptophan) required for the proper growth and development of human body. On an average pulse contain 20-25 *per cent* protein and dry seed. Chickpea (*Cicer arietinum* L.) belongs to genus *Cicer*, tribe *Cicereae*, family *Fabaceae*, and subfamily *Papilionaceae*. It originated in south-eastern Turkey. The *Cicer* is of Latin origin, derived from the greek word 'kikus' meaning force or strength. Among pulse, chickpea occupies a premier position in respect of area and production in the world. It is grown in an area 13.20 m ha and the production is around 11.60 m tonnes with an average productivity of 880 kg per ha. India is also greater consumer as well as importer of chickpea in the world. In India, chickpea is grown about 9.93 m ha area and producing 9.53 m tonnes grain with productivity of 960 kg per ha. In Uttar Pradesh, it is cultivated on area of 577 thousand ha with grain yield production is 475 thousand tonnes and productivity of wheat crops is 824 kg per ha respectively 2013-14 (Anonymous, 2015) [1]. It is cultivated throughout the country excepting high altitude and coastal region. However, the major chickpea producing state are Madhya Pradesh, Rajasthan, Maharashtra, Karnataka and Andhra Pradesh. Which contribute more than 90 per cent of the national production.

At germination levels it not only involves speed and totality germination but also punching power of the seedling at different range of environmental condition. Thus study of correlation and direct and indirect effects of seed traits provides the basis for successful plant. The objective of this study was to determine the correlation and path analysis of yield and yield contributing characters in chickpea to assess their suitability in a breeding plant.

Materials and Methods

The study was designed to work out the status of association of different seed yield traits and direct and indirect effects of these different traits on seed yield per plant among forty chickpea genotypes at field experiment under present investigation was conducted during *Rabi* 2014-15 at the Student's Instructional Farm and lab experiments were conducted in Seed Testing Laboratory, Seed Technology Section, N. D. University of Agriculture and Technology,

Narendra Nagar (Kumarganj), Faizabad (U.P.) India. The experimental materials of studies comprised of forty chickpea varieties/ lines/ genotypes excluding three check varieties viz., GCP 105, KWR108 and DCP92-3 these varieties were procured from genetic stock available in pulse section, Department of genetics and Plant Breeding, N. D. University of Agriculture and Technology, Narendra Nagar (Kumarganj), Faizabad (U.P.) India. The experiment was laid out in Randomized Block Design. The observation were recorded on twelve different seed yield traits viz., days to 50% flowering, days to maturity, plant height, number of primary branches per plant, number of secondary branches per plant, number of pods per plant, number of seeds per pod, 100-seed weight, Germination, Seedling length, Vigour index and Seed yield per plant. Standard statistical techniques such as correlation between different characters and path coefficient analysis. Seed germination percentage was investigated under lab condition germination was estimated on the basis of 100 randomly selected kept for germination in germination paper at room temperature in germinator. The samples were kept in seed germinator maintained at 20° c ±1. Ten seedlings were randomly taken from each replication. On 8th day seedlings were measured on meter scale, the unite length was in cm. The vigour index was conducted as per the method prescribed by Abdul-Bali and Anderson (1973) and expressed in whole number. The seed were kept for germinate following ISTA method. The seedling were measured for seedling length to obtain seedling length.

Results and Discussions

Correlation coefficient was worked out at phenotypic and genotypic levels for different yield contributing characters and seed quality parameters in Chickpea (*Cicer arietinum* L.) genotypes are presented in Table 1 and 2, respectively. Seed yield per plant exhibited highly significant and negative correlation with days to 50% flowering (-0.3913) and where as pods per plant (0.3098) characters showed significant and positive correlation with this traits. The correlation coefficients of seed yield per plant with remaining nine characters were non-significant (Raval and Dobariya, 2003, Muhammad *et al.*, 2003, Muhammad *et al.*, 2004, Raout *et al.*, 2004, Rao Renukadevi and Subbalakshmi, 2006 Rao, 2005, Lokere *et al.*, 2007, Bhawani *et al.*, 2008, Thakur and Sirohi, 2009, Sreelakshmi *et al.*, 2010, Ojha *et al.*, 2011, Qurban *et al.*, 2011, Singh and Shiva Nath, 2012 and Aycicek and Babagil, 2013) [10, 9, 14, 15, 13, 8, 3, 20, 19, 11, 12, 2]. Highly significant and positive correlation coefficient of vigour index with seedling length (0.8665) was recorded along with positive and significant correlation with seed germination (0.3713). The correlation coefficients of this character with rest of traits were registered non-significant. 100-seed weight possessed significant and positive correlation with primary branches per plant (0.3670), plant height (0.3320) and secondary branches per plant (0.3150) besides remaining character viz. days to 50% flowering, days to maturity, pods per plant, seeds per plant, seed germination, seedling length, vigour index and seed yield per plant were found non-significant. Pods per plant indicated highly significant and positive correlation with secondary branches per plant (0.4035) where as the remaining traits were possessed non-significant correlation with above mentioned trait (Yadav *et al.*, 2001, Jeena and Arora, 2002, Kumar *et al.*, 2002, Muhammad *et al.*, 2003, Singh and Sindhu, 2008, Bhawani *et al.*, 2008, Thakur and Sirohi, 2009, Sreelakshmi *et al.*, 2010, Yadav *et al.*, 2010, Ojha *et al.*, 2011 and Qurban *et al.*, 2011)

[23, 6, 7, 10, 8, 3, 20, 21, 19, 11, 12]. Significant and positive correlation of secondary branches per plant was noted with primary branches per plant (0.3291) and plant height (0.2890), while the rest of all the characters exhibited non-significant correlation with this character. Days to maturity exhibited highly significant and positive correlation with days to 50% flowering (0.6304), whereas remaining traits were possessed non-significant association with this character. On the other hand seedling length, seed germination, seeds per pod, primary branches per plant and plant height were expressed non-significant association with all the attributes (Yadav *et al.*, 2001, Jeena and Arora, 2002, Kumar *et al.*, 2002, Muhammad *et al.*, 2003 [10], Singh and Sindhu, 2008, Bhawani *et al.*, 2008, Thakur and Sirohi, 2009, Sreelakshmi *et al.*, 2010, Yadav *et al.*, 2010, Ojha *et al.*, 2011 and Qurban *et al.*, 2011) [23, 6, 7, 10, 18, 3, 20, 21, 19, 11, 12].

The direct and indirect effects of different characters on seed yield per plant at phenotypic and genotypic levels are presented in Table 3 and 4 respectively. Path coefficient is a tool to partition the observed correlation coefficient into direct and indirect effects of yield components on seed yield to provide clearer picture of character association for formulating efficient selection strategy. Path analysis has emerged as a powerful and widely used technique for understanding the direct and indirect contribution of different characters to economic yield in crop plant so that relative importance of various yield contributing characters can be assessed. The results of path coefficient analysis using simple correlation coefficient among 12 characters are given in Table 4. The highest positive direct effect on seed yield per plant was exhibited by pods per plant (0.3667) followed by seedling length and negative direct effect on days to 50% flowering followed by vigour index, secondary branches per plant. The highest negative indirect effect on seed yield/plant was exerted by days to maturity (-0.2756) followed by vigour index. The highest positive indirect effect on seed yield/plant was exerted by secondary branches per plant (0.1480) *via* pods per plant followed by vigour index *via* seedling length while the negative indirect effect was exerted by seeds per pod (-0.0960) followed by plant height and 100-seed weight. The remaining estimates of the indirect effects in the present analysis were too low to be considered important. The residual effect observed was 0.8383 which indicates that some of the characters which might contribute to yield have not been included in the study. The direct and indirect effects of different characters on seed yield per plant at genotypic level are presented in Table 4.7. Pods per plant (0.6559), followed by days to maturity, vigour index and primary branches per plant exerted high order positive direct effects on seed yield per plant, while high negative direct effect was shown by days to 50% flowering, seedling length and seed germination. The direct effects of the rest characters were very low. Days to 50% flowering (0.4903) followed by seedling length exerted very high order of positive indirect effect on seed yield per plant *via* days to 50% flowering and vigour index, respectively. Plant height also exerted substantial positive indirect effects on seed yield per plant. The remaining estimates of indirect effects obtained in path coefficient analysis at genotypic level were too low to be considered of any consequence (Chander *et al.*, 2001, Raout *et al.*, 2004, Renukadevi and Subbalakshmi, 2006) [14, 15]. Considering the overall result it is apparent that certain information obtained here will help in future for improving existing chickpea genotypes.

Table 1: Estimates of phenotypic correlation coefficient among different characters in chickpea genotypes

Characters	Days to maturity	Plant height (cm)	Primary branches/Plant	Secondary branches/Plant	Pods/plant	Seeds/pod	100-seed weight (g)	Germination (%)	Seedling length (cm)	Vigour index	Seed yield/plant (g)
Days to 50% flowering	0.6304**	0.1402	-0.0505	0.0182	0.0110	-0.0040	0.1180	0.0397	-0.0107	-0.0707	-0.3913**
Days to maturity		0.0744	-0.0394	0.0799	0.0618	-0.1689	0.2310	-0.1274	0.0552	0.0190	-0.2228
Plant height (cm)			0.2671	0.2890*	0.0873	0.0971	0.3320*	-0.1740	0.0571	-0.0248	0.0002
Primary branches/plant				0.3291*	0.0661	0.0711	0.3670*	0.2455	0.1889	0.2535	0.1359
Secondary branches/plant					0.4035**	-0.1769	0.3150*	0.0273	0.2211	0.2248	0.0687
Pods/plant						-0.1546	0.0360	0.0943	0.1051	0.1761	0.3098*
Seeds/pod							-0.0460	-0.0920	-0.0212	0.0063	-0.0807
100-seed weight (g)								-0.0575	0.0762	0.0775	0.0609
Germination (%)									0.1666	0.3713*	0.0668
Seedling length (cm)										0.8665**	-0.0253
Vigour index											0.0039

*,** Significant at 5 % and 1% probability levels, respectively.

Table 2: Estimates of genotypic correlations coefficient among different characters in chickpea genotypes

Characters	Days to maturity	Plant height (cm)	Primary branches/plant	Secondary branches/plant	Pods/plant	Seeds/pod	100-seed weight (g)	Germination (%)	Seedling length (cm)	Vigour index	Seed yield /plant (g)
Days to 50% flowering	0.8161	0.1145	-0.1025	0.0818	-0.0276	0.0150	0.1740	-0.3095	-0.0338	-0.0626	-0.5005
Days to maturity		0.1216	-0.0628	0.0489	0.0641	-0.2217	0.3120	-0.1974	0.1052	0.0475	-0.2473
Plant height (cm)			0.4536	0.4130	0.1191	0.1341	0.4050	-0.3882	0.0641	-0.0239	0.0311
Primary branches/plant				0.4328	0.0675	0.0832	0.4390	0.3689	0.2416	0.2984	0.1772
Secondary branches/plant					0.5552	-0.1964	0.3910	0.0505	0.3324	0.2996	0.0900
Pods/plant						-0.2006	0.0240	0.0837	0.2799	0.2327	0.4624
Seeds/pod							-0.0650	-0.1092	0.1126	0.0275	-0.0826
100-seed weight (g)								-0.0316	0.1160	0.0787	0.0806
Germination (%)									0.2473	0.5045	0.0701
Seedling length (cm)										0.8766	-0.0277
Vigour index											-0.0097

Table 3: Direct and indirect effect of different characters on seed yield per plant at phenotypic level in chickpea genotypes

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)	Germination (%)	Seedling length (cm)	Vigour index	Correlation with seed yield/plant (g)
Days to 50% flowering	-0.4372	0.0157	0.0013	-0.0053	-0.0022	0.0040	0.0001	0.0124	0.0041	-0.0012	0.0170	-0.3913
Days to maturity	-0.2756	0.0249	0.0006	-0.0041	-0.0099	0.0226	0.0057	0.0243	-0.0133	0.0066	-0.0046	-0.2228
Plant height (cm)	-0.0613	0.0018	0.0092	0.0283	-0.0361	0.0320	-0.0032	0.0349	-0.0181	0.0068	0.0060	0.0002
Primary branches/plant	0.0221	-0.0009	0.0024	0.1059	-0.0411	0.0242	-0.0024	0.0385	0.0256	0.0226	-0.0611	0.1359
Secondary branches/plant	-0.0079	0.0019	0.0026	0.0348	-0.1249	0.1480	0.0060	0.0330	0.0028	0.0265	-0.0542	0.0687
Pods/plant	-0.0048	0.0015	0.0008	0.0070	-0.0504	0.3667	0.0052	0.0037	0.0098	0.0126	-0.0424	0.3098
Seeds/Pod	0.0020	-0.0042	0.0009	0.0075	0.0221	-0.0567	-0.0339	-0.0047	-0.096	-0.0025	-0.0015	-0.0807
100-seed weight (g)	-0.0516	0.0057	0.0030	0.0389	-0.0393	0.0131	0.0015	0.1050	-0.0060	0.0091	-0.0187	0.0609
Germination (%)	-0.0174	-0.0031	-0.0016	0.0260	-0.0034	0.0345	0.0031	-0.0060	0.1043	0.0200	-0.0896	0.0668
Seedling length (cm)	0.0046	0.0013	0.0005	0.0200	-0.0276	0.0385	0.0007	0.0080	0.01739	0.1200	-0.2090	-0.0253
Vigour index	0.0309	0.0004	-0.0002	0.0268	-0.0281	0.0645	-0.0002	0.0081	0.0387	0.1040	-0.2412	0.0039

Residual effect = 0.2383, Bold figures indicate direct effects.

Table 4: Direct and indirect effects of different characters on seed yield per plant at genotypic level of chickpea genotypes

Characters	Days to 50% flowering	Days to maturity	Plant height (cm)	Primary branches/plant	Secondary branches/plant	Pods/plant	Seeds/Pods	100-seed weight (g)	Germination (%)	Seedling length (cm)	Vigour index	Correlation with seed yield /plant (g)
Days to 50% flowering	-1.0599	0.4903	-0.0430	-0.0475	-0.0135	-0.0181	0.0028	0.0188	0.1800	0.0244	-0.0349	-0.5005
Days to maturity	-0.8650	0.6008	-0.0456	-0.0291	-0.0081	0.0420	-0.0414	0.0338	0.1147	-0.0759	0.0264	-0.0247
Plant height (cm)	-0.1214	0.0730	-0.3753	0.2101	-0.0684	0.0781	0.0250	0.0439	0.2257	-0.0462	-0.0133	0.0311
Primary branches/plant	0.1086	-0.0377	-0.1702	0.4633	-0.0717	0.0442	0.0155	0.0476	-0.2145	-0.1744	0.1663	0.1772
Secondary branches/plant	-0.0867	0.0294	-0.1550	0.2005	-0.1657	0.3641	-0.0367	0.0424	-0.0294	-0.2400	0.1670	0.0900
Pods/plant	0.02924	0.0385	-0.0447	0.0312	-0.0920	0.6559	-0.0374	0.0026	-0.0486	-0.2020	0.1297	0.4624
Seeds/pod	-0.0159	-0.1332	-0.0503	0.0385	0.0325	-0.1316	0.1868	-0.0070	0.0635	-0.0813	0.0153	-0.0826
100-seed weight (g)	-0.1842	0.1872	-0.1519	0.2035	-0.0648	0.0159	-0.0120	0.1085	0.0184	-0.0837	0.0439	0.0806
Germination (%)	0.3281	-0.1186	0.1457	0.1709	-0.0083	0.0549	-0.0204	-0.0034	-0.5814	-0.1785	0.2812	0.0701
Seedling length (cm)	0.0359	0.0632	-0.0240	0.1119	-0.0550	0.1836	0.0210	0.0126	-0.1438	-0.7218	0.4887	-0.0277
Vigour index (g)	0.0664	0.0285	0.0090	0.1383	-0.0496	0.1526	0.0051	0.0085	-0.2933	-0.6328	0.5574	-0.0097

Residual effect = 0.1404 Bold figures indicate direct effects.

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