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Short Research Article

Studies on Character Association and Path Analysis for Yield and its Contributing Traits in Chickpea [*Cicer arietinum* (L.)]

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Abstract

The experiment was conducted at the Experimental Farm, Department of Plant Breeding and Genetics, Rajasthan College of Agriculture, MPUAT, Udaipur, during *rabi* season 2012−13, in randomized block design with three replications. The experimental material comprised of 20 genotypes. Each genotype was sown in four rows of 4 m length and 1.20 m width with spacing of 30 cm between the rows and 10 cm between the plants within rows. At both genotypic and phenotypic level plant height was exhibited highly significant and positive correlation with days to maturity. However, it was exhibited non- significant and negative correlation with days to 50% flowering at both genotypic and phenotypic level. Days to maturity exhibited non-significant and positive association with days to 50% flowering at both genotypic and phenotypic level. Seed yield plant^{-1} showed significantly and positive correlation with harvest index, number of seeds pod^{-1}, primary branches plant^{-1}, number of pods plant^{-1}, biomass plant^{-1}, and 100-seed weight indicating that an intense selection for these characters will improve seed yield in chickpea. Path coefficient analysis revealed that day to maturity, primary branches plant^{-1}, biomass plant^{-1}, harvest index protein content and number of seeds pod^{-1} were major characters influencing seed yield directly and indirectly. The component of residual effects of path analysis was low residual effect indicated that characters for path analysis were adequate and appropriate. The results indicated that number of seeds pod^{-1} is responsible for manipulation of seed yield in chickpea.

1. Introduction

Chickpea (*Cicer arietinum* L.) is an important *Rabi* pulse crop of rainfed areas of India. Chickpea is one of the world's most important but less-studied leguminous food crop with 740-Mb genome size. Chickpea ranks third among pulses, fifth among grain legumes, and 15th among grain crops of the world (Khan et al., 2011). This crop is highly proteinaceous and seed are used in various ways for human consumption. Chickpea is a good source of carbohydrates (52.4−70.9%), proteins (17−26%), fats (3.8−10.2%) and essential minerals (Ca, Fe), (Saxena et al., 2013). Seed yield in chickpea is a complex character like other crop determined by various components. Correlation coefficient analysis is a hardy technique, which elaborates the degree and extent of relationship among important plant characters and it provides basic criteria for selection and leads to directional model based on yield and its components in the field experiments. Yet the information it supplies about the nature of association is often incomplete. Path coefficient analysis provides an effective means of partitioning correlation coefficients into unidirectional pathways and alternative pathways thus permitting a critical examination of specific factors that produce a given correlation, which can be successfully employed in formulating an effective selection programme. Through this technique yield attributing characters can be ranked and specific traits producing a given correlation can be headed (Rao et al., 2006). The present study was undertaken to analyze the association between yield and its attributes in chickpea. With these objectives, the present study was undertaken for the genetic improvement on chickpea.

2. Materials and Methods

The experiment was conducted at the Experimental Farm, Department of Plant Breeding and Genetics, Rajasthan College of Agriculture, MPUAT, Udaipur, during *rabi* season 2012−13, in randomized block design with three replications. Udaipur is situated at an altitude of 579.5 m amsl, latitude 24°35′ North and longitude 74°42′ East. The experimental material comprised of 20 genotypes. Each genotype was sown in four rows of 4 m length and 1.20 m width with a spacing of 30 cm between the rows and 10 cm between the plants within rows. The crop was well managed for optimum growth and yield. The data were recorded on plant height (cm), primary branches plant^{-1}, number of pods plant^{-1}, number of seeds pod^{-1}, 100-seed weight (g), biomass plant^{-1} (g), harvest index (%) and seed yield plant^{-1} (g) on five randomly chosen competitive plants in each genotype in each replication except days to 50% flowering days to maturity which were recorded on plot basis. Protein content of the seeds was also estimated by using Micro kjeldahl's method (1883.). Two samples of chickpea grains per treatment per replication were analyzed and average was taken. The mean values of selected competitive plants were averaged and expressed as mean of the respective characters per replication. The Genotypic and phenotypic correlation coefficients were calculated from the phenotypic and genotypic components of variances and co-variances as per the procedure suggested by Fisher (1954) and Al-Jibouri et al. (1958). The direct and indirect effects of the yield components on the yield were estimated by path co-efficient analysis as suggested by Wright (1921) and elaborated by Dewey and Lu (1959). The path coefficients were obtained by solving the 'p' normal equations following the matrix method given by Singh and Chaudhary (1977).

3. Results and Discussion

Through correlation and path analysis, the nature and extent of association between different characters influencing yield and causes of association can be better understood which helps in formulation of selection criteria for improvement of yield. Estimates of genotypic correlations in general were higher than phenotypic In general directions of phenotypic and genotypic correlations were almost same for the most of the character combinations. A perusal of Table 1 revealed that seed yield plant^{-1} exhibited highly significant and significant positive correlation with harvest index (0.790**), number of seeds pod^{-1} (0.675**), primary branches plant^{-1} (0.611**), number of pods plant^{-1} (0.401**), biomass plant^{-1} (0.493**) and 100-seed weight (0.330*) respectively at genotypic level. Protein content also exhibited negative significant association with seed yield plant^{-1} (-0.308*) at genotypic level.

Harvest index (0.670**) followed by number of seeds pod^{-1} (0.415**), primary branches plant^{-1} (0.400**), number of pods plant^{-1} (0.356**), biomass plant^{-1} (0.355**) and 100-seed weight (0.298*) were showed positive highly significant and significant correlation with seed yield plant^{-1} respectively at phenotypic level. However days to 50% flowering and days to maturity exhibited non-significant and negative correlation with seed yield plant^{-1} at both genotypic and phenotypic level.

Protein content showed positive and highly significant correlation with days to maturity (0.789**) and days to 50% flowering (0.531**) at genotypic level. Days to maturity also exhibited positive and highly significant correlation with protein content (0.349**) at phenotypic level. Harvest index (-540**) and number of pods plant^{-1} (-0.427**) were showed highly significant and negative correlation with protein content at genotypic level.

Number of seeds pod^{-1} exhibited highly significant and significant positive correlation with harvest index (0.643** and 0.280*) at both genotypic and phenotypic level respectively. However, harvest index also showed highly significant and negative correlation with days to maturity (-0.648** and -0.449**) at both genotypic and phenotypic level. At genotypic level primary branches (0.994**) followed by number of pods plant^{-1} (0.574**) and plant height (0.358**) were showed highly significant and positive correlation with biomass plant^{-1}. Biomass plant^{-1} also exhibited highly significant and positive correlation with primary branches plant^{-1} (0.585**) and number of pods plant^{-1} (0.393**) at phenotypic level. Days to 50% flowering, days to maturity, number of seeds pod^{-1} and 100-seed weight were revealed non-significant but positive correlation with biomass plant^{-1} at both genotypic and phenotypic level. Plant height (0.240) also exhibited non-significant and positive association with biomass plant^{-1} at phenotypic level.

100-seed weight exhibited highly significant and positive correlation with primary branches plant^{-1} (0.402**) and days to maturity (0.376**) at genotypic level. It was also exhibited highly significant and positive correlation with days to maturity (0.333**) at phenotypic level. At genotypic level number of seeds pod^{-1} showed highly significant and positive correlation with number of pods plant^{-1} (0.359**) and plant height (0.344**).

Number of pods plant^{-1} exhibited highly significant and positive correlation with primary branches plant^{-1} (0.909** and 0.489**) and plant height (0.726** and 0.477**) at both genotypic and phenotypic level.

Primary branches plant^{-1} showed significantly and positive correlation with plant height (0.559** and 0.255*) at both genotypic and phenotypic level. Primary branches plant^{-1} also showed significant and positive correlation with days to maturity (0.316*) at genotypic level. However, it exhibited non-significant and negative correlation with days to 50% flowering at both genotypic and phenotypic level.

At both genotypic and phenotypic level plant height was exhibited highly significant and positive correlation with days to maturity (0.448** and 0.337**). However, it was exhibited non- significant and negative correlation with days to 50% flowering (-0.110 and -0.030) at both genotypic and phenotypic level. Days to maturity exhibited non-significant and positive association with days to 50% flowering (0.165 and 0.151) at

Table 1: Genotypic and phenotypic correlation for seed yield and its component traits in chickpea

Characters	r	Days to maturity	Plant height (cm)	Primary branches plant^{-1}	Number of pods plant^{-1}	Number of seeds pod^{-1}	100-seed weight (g)	Biomass plant^{-1} (g)	Harvest index (%)	Protein content (%)	Seed yield plant^{-1} (g)
Days to 50% flowering	G	0.165	-0.110	-0.243	-0.016	-0.081	-0.240	0.016	-0.220	0.531**	-0.225
	P	0.151	-0.030	-0.020	-0.010	-0.071	-0.220	0.051	-0.212	0.197	-0.185
Days to maturity	G		0.448**	0.316*	0.120	-0.025	0.376**	0.218	-0.648**	0.789**	-0.206
	P		0.337**	0.107	0.005	-0.048	0.333**	0.152	-0.449**	0.349**	-0.166
Plant height (cm)	G			0.559**	0.726**	0.344**	0.166	0.358**	-0.138	-0.133	0.153
	P			0.255*	0.477**	0.093	0.123	0.240	-0.093	-0.109	0.042
Primary branches plant^{-1}	G				0.909**	0.136	0.402**	0.994**	0.025	-0.187	0.611**
	P				0.489**	0.227	0.176	0.585**	-0.010	-0.117	0.400**
No. of pods plant^{-1}	G					0.359**	0.002	0.574**	0.112	-0.427**	0.401**
	P					0.246	-0.000	0.393**	0.017	-0.173	0.356**
No. of seeds pod^{-1}	G						-0.145	0.250	0.643**	0.040	0.675**
	P						-0.083	0.155	0.280*	0.037	0.415**
100-seed weight (g)	G							0.205	0.020	-0.251	0.330*
	P							0.167	0.012	-0.110	0.298*
Biomass plant^{-1} (g)	G								-0.040	-0.104	0.493**
	P								-0.155	-0.023	0.355**
Harvest index (%)	G									-0.540**	0.790**
	P									-0.132	0.670**
Protein content (%)	G										-0.308
	P										-0.089

*Significant at p=0.05; ** at p=0.01

both genotypic and phenotypic level.

These findings character association in chick pea are also with the similar trends of results reported by Bhavani et al. (2008); Vekariya et al. (2008); Vaghela et al. (2009); Yucel and Anlarsal (2010); Usman et al. (2012); Yadav et al. (2014) and Gaur et al. (2014) for seed yield plant^{-1} and most of the yield attributing traits.

The direct and indirect effects of ten dependent characters on seed yield plant^{-1} as independent character was obtained in path coefficient analysis using genotypic correlation coefficient are presented in Table 2 The highest positive direct effect on seed yield plant^{-1} was exhibited by harvest index (1.571) followed by days to maturity (0.516), biomass plant^{-1} (0.393), primary branches plant^{-1} (0.300), plant height (0.252) and protein content (0.123). In contrast number of seeds pod^{-1} (-0.474) followed by number of pods plant^{-1} (-0.295), 100-seed weight (-0.180) and days to 50% flowering were contributed negative direct effect on seed yiel

Number of seeds pod^{-1} (1.010) and number of pods plant^{-1} (0.176) exhibited considerable positive indirect effect on seed yield plant^{-1} via harvest index but, days to maturity (-1.018), protein content (-0.848), days to 50% flowering (-0.346) and plant height (-0.217) showed considerable negative indirect effect on it via harvest index. Primary branches plant^{-1} (0.391) followed by number of pod plant^{-1} (0.226) and plant height (0.141) were exhibited considerable positive indirect effect on seed yield plant^{-1} via biomass plant^{-1}. Biomass plant^{-1} (0.298) showed considerable positive indirect effect on seed yield plant^{-1} followed by number of pods plant^{-1} (0.273), plant height (0.168) and 100-seed weight (0.121) via primary branches plant^{-1}. Numbers pods plant^{-1} (0.183), primary branches plant^{-1} (0.141) and days to maturity (0.113) were exhibited considerable positive indirect effect on seed yield plant^{-1} via plant height. Protein content (0.407) followed by plant height (0.231), 100-seed weight (0.194), primary branches plant^{-1} (0.163) and biomass plant^{-1} (0.112) were exhibited considerable positive indirect effect on seed yield plant^{-1} via days to maturity. The remaining estimates of the indirect effect in the present study were too low to be negligible importance. The component of residual effects of path analysis was -0.019 very low residual effect indicated that characters for path analysis were adequate and appropriate.

The direct and indirect effects of ten dependent characters on seed yield plant^{-1} as independent character was obtained in path coefficient analysis using phenotypic correlation coefficient are presented in Table 2 Path coefficient analysis revealed that the maximum positive direct effect was observed for harvest index (0.681) followed by biomass plant^{-1} (0.284), 100-seed weight (0.245), number of pods plant^{-1} (0.236) and number of seeds pod^{-1} (0.136) on seed yield plant^{-1}. However, plant height (-0.151) had considerable negative direct effect on seed yield plant^{-1}. Number of seeds pod^{-1} had considerable positive indirect effect on seed yield plant^{-1} via harvest index. Whereas, days to maturity (-0.306) and days to 50% flowering (-0.144) were exhibited considerable negative indirect effect on seed yield plant^{-1} via harvest index. Number of primary branches plant^{-1} (0.166) and number of pods plant^{-1} (0.112) were revealed that positive and considerable indirect effect on it via biomass plant^{-1}. Primary branches plant^{-1} (0.115) and plant height (0.112) were exhibited positive and considerable indirect effect on seed yield plant^{-1} via number of pods plant^{-1}. The remaining estimates of the indirect effect of phenotypic path in the present study were too low to be negligible importance. The component of residual effects of path analysis was 0.210 low residual effect indicated that characters for path analysis were adequate and appropriate.

These findings are in consonance to the results obtained by Narayana et al. (2002); Arora et al. (2003); Bhavani et al.

Table 2: Direct (diagonal) indirect (off diagonal) effects of genotypic and phenotypic path for seed yield and it's component traits in chickpea

Characters	Path	Days to 50% flowering	Days to maturity	Plant height (cm)	Primary branches plant^{-1}	Number of pods plant^{-1}	Number of seeds pod^{-1}	100-seed weight (g)	Biomass plant^{-1} (g)	Harvest index (%)	Protein content (%)	r with seed yield plant^{-1}
Days to 50% flowering	G	-0.021	0.085	-0.028	-0.073	0.005	0.038	0.043	0.006	-0.346	0.065	-0.225
	P	-0.009	0.007	0.005	-0.002	-0.002	-0.010	-0.054	0.015	-0.144	0.010	-0.185
Days to maturity	G	-0.003	0.516	0.113	0.095	-0.036	0.012	-0.068	0.086	-1.018	0.097	-0.206
	P	-0.001	0.045	-0.051	0.010	0.001	-0.007	0.081	0.043	-0.306	0.017	-0.166
Plant height (cm)	G	0.002	0.231	0.252	0.168	-0.214	-0.163	-0.030	0.141	-0.217	-0.016	0.153
	P	0.000	0.015	-0.151	0.023	0.112	0.013	0.030	0.068	-0.063	-0.005	0.042
Primary branches plant^{-1}	G	0.005	0.163	0.141	0.300	-0.268	-0.065	-0.072	0.391	0.039	-0.023	0.611**
	P	0. 000	0.005	-0.038	0.091	0.115	0.031	0.043	0.166	-0.007	-0.006	0.400**
No. of pods plant^{-1}	G	0.000	0.062	0.183	0.273	-0.295	-0.170	0.000	0.226	0.176	-0.052	0.401**
	P	0.000	0.000	-0.072	0.045	0.236	0.034	0.000	0.112	0.011	-0.009	0.356**
No. of seeds pod^{-1}	G	0.002	-0.013	0.087	0.041	-0.106	-0.474	0.026	0.098	1.010	0.005	0.675**
	P	0.001	-0.002	-0.014	0.021	0.058	0.136	-0.020	0.044	0.190	0.002	0.415**
100-seed weight (g)	G	0.005	0.194	0.042	0.121	0.000	0.069	-0.180	0.081	0.031	-0.031	0.330*
	P	0.002	0.015	-0.019	0.016	0.000	-0.011	0.245	0.047	0.008	-0.005	0.298*
Biomass plant^{-1} (g)	G	0.000	0.112	0.090	0.298	-0.170	-0.119	-0.037	0.393	-0.063	-0.013	0.493**
	P	0.000	0.007	-0.036	0.053	0.093	0.021	0.041	0.284	-0.106	-0.001	0.355**
Harvest index (%)	G	0.005	-0.334	-0.035	0.008	-0.033	-0.305	-0.004	-0.016	1.571	-0.066	0.790**
	P	0.002	-0.020	0.014	-0.001	0.004	0.038	0.003	-0.044	0.681	-0.007	0.670**
Protein content (%)	G	-0.011	0.407	-0.034	-0.056	0.126	-0.019	0.045	-0.041	-0.848	0.123	-0.308*
	P	-0.002	0.016	0.016	-0.011	-0.041	0.005	-0.027	-0.007	-0.090	0.050	-0.089

Genotypic residual value are -0.019 and phenotypic residual value are 0.210

(2008) for number of secondary branches plant^{-1}, followed by days to maturity, days to 50% flowering and harvest index, and Singh and Sandhu (2008), Borate and Dalvi (2010), Usman et al. (2012); Jivani et al. (2013) were observed maximum positive direct effect for harvest index, followed by biological yield plant^{-1}, number of pods plant^{-1}, and 100-seed weight towards seed yield and were considered to be the most promising traits for selection for higher seed yield in chickpea.

4. Conclusion

Seed yield plant^{-1} showed significantly and positive correlation with harvest index, number of seeds pod^{-1}, primary branches plant^{-1}, number of pods plant^{-1}, biomass plant^{-1}, and 100-seed weight indicating that an intense selection for these characters will improve seed yield in chickpea. Path coefficient analysis revealed that day to maturity, primary branches plant^{-1}, biomass plant^{-1}, harvest index protein content and number of seeds pod^{-1} were major characters influencing seed yield directly and indirectly.

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