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RESEARCH ARTICLE

ASSOCIATION ANALYSIS OF CHICKPEA (*CICER ARIETINUM* L.) GENOYPES UNDER DIFFERENT MOISTURE REGIMES

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ABSTRACT

Thirty genotypes including two standard checks were tested under rainfed and irrigated situations separately. Correlation coefficient analysis revealed that pods plant^{-1}and biological yield plant^{-1} was positively associated with seed yield under both situations. In rainfed condition secondary branches and hundred seed weight also showed positive association with seed yield and in irrigated condition pod-bearing length had shown positive association with seed yield. Path analysis revealed that hundred seed weight, pods plant^{-1}, seeds pod^{-1}, plant height and primary branches plant^{-1} under rainfed, and biological yield, pods plant^{-1}, hundred seed weight, plant height, primary branches plant^{-1} and days to maturity under irrigated condition were found to be major contributors to the seed yield. These traits should get priority in selection scheme for high seed yield.

INTRODUCTION

Seed yield is a complex and highly variable character, which is a resultant of cumulative effects of its component characters. Therefore, direct selection for yield per se is hardly effective. The yield components are not always independent in their action but sometimes interlinked. Hence, selection practiced for one character may simultaneously bring changes in the other trait. Thus, to effect change in a character such as seed yield in the desired direction, it is almost mandatory to have an in-depth understanding of association among yield and its attributing traits. Further, to plan an effective selection strategy it is imperative to have comprehensive knowledge of relative importance of direct and indirect influence of component characters on the dependent complex trait, such as yield. Path analysis is an effective technique to estimate the direct and indirect effect of component trait on dependent variable seed yield. The focus of the current study is to understand the direct and indirect effects of the component characters on seed yield, under rain-fed and irrigated conditions separately.

MATERIALS AND METHODS

The experimental material comprised of 28 genotypes from ICRISAT, Hyderabad along with two standard checks (Annigeri-1 and ICC-4958). The experiment was laid out in a randomized complete block design with three replications separately under rainfed (stress) and irrigated (non-stress) conditions separately, during the *rabi* (dry) 2001 season at Indira Gandhi Agricultural University Farm, Raipur. Observations were recorded for ten agronomic and three quality traits separately under both conditions. The correlation coefficients were estimated following (Miller *et al.,* 1958) and the path coefficient as per the method of (Dewey and Lu 1959) for both rainfed and irrigated conditions.

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RESULTS AND DISCUSSION

Correlation coefficient

Direct selection for complex traits such as seed yield is often not very effective. Indirect selection for some of the component traits associated with seed yield may be rewarding. Correlation studies provide an opportunity to study the magnitude and direction of association of yield with its components and also among various components. Correlation coefficients obtained from present study are presented in Table 1 and 2. The discussions are hereunder situation wise.

Rainfed condition

The seed yield was positively associated with pods plant^{-1}, hundred seed weight, biological yield plant^{-1} and secondary branches plant^{-1} under rainfed conditions. This indicates that under rainfed condition greater emphasis should be given on these characters. Similar relationship of these traits had also been reported earlier (Khorgade *et al.,* 1995; Singh *et al.,* 1996; Singh *et al.,* 1997; Kulkarni 2001). Genotypic correlation coefficients revealed that days to 50 per cent flowering had

Table 1. Inter relationship of seed yield and its attributing traits in chickpea under rainfed condition

S.N.	Character		Plant height	Primary branches	Secondary branches	Pod bearing length	Days to maturity	Pods plant^{-1}	Seeds pod^{-1}	Biological yield	100 seed weight	Seed yield plant^{-1}
1.	Days to 50%	P	0.151	-0.137	0.001	0.179	0.738**	-0.036	-0.310	0.022	0.188	-0.017
	flowering	G	0.194	-0.169	0.214	0.192	0.784**	-0.032	-0.325	0.009	0.195	-0.004
		E	-0.011	-0.155	-0.279	0.166	0.314	-0.150	-0.084	0.135	-0.038	-0.203
2.	Plant height	P		0.242	-0.002	0.724**	0.136	0.019	-0.169	0.300	0.128	0.116
		G		0.463**	-0.073	0.870**	0.176	0.016	-0.228	0.449*	0.160	0.142
		E		-0.007	0.033	0.410	0.006	0.069	0.082	0.147	-0.024	0.025
3.	Primary	P			0.188	0.346	-0.159	-0.037	-0.280	0.309	0.301	0.154
	branches	G			0.292	0.628**	-0.263	-0.074	-0.425*	0.467**	0.487**	0.263
		E			0.172	0.010	0.004	0.084	-0.067	0.105	-0.120	-0.062
4.	Secondary	P				0.075	0.047	0.127	0.077	-0.081	0.210	0.327
	branches	G				0.299	0.210	0.333	0.221	-0.230	0.523**	0.801**
		E				-0.020	-0.061	0.101	0.017	-0.026	0.277	0.279
5.	Pod bearing	P					0.155	-0.069	-0.271	0.349	0.339	0.155
	length	G					0.195	-0.084	-0.331	0.499**	0.401*	0.203
		E					0.007	0.009	-0.016	-0.147	0.081	-0.081
6.	Day to maturity	P						-0.101	-0.209	-0.096	0.108	-0.023
		G						-0.105	-0.235	-0.092	0.118	-0.018
		E						-0.065	0.054	-0.126	-0.025	-0.071
7.	Pods plant^{-1}	P							0.106	0.278	-0.325	0.594**
		G							0.105	0.307	-0.332	0.592**
		E							0.129	0.016	-0.022	0.685
8.	Seeds pod^{-1}	P								-0.296	-0.566**	-0.023
		G								-0.309	-0.587**	-0.038
		E								-0.229	-0.040	0.230
9.	Biological	P									0.231	0.407*
	yield	G									0.250	0.449**
		E									0.085	0.095
10.	100 seed	P										0.426*
	weight	G										0.430*
		E										0.392

Table 2. Inter relationship of seed yield and its attributing traits in chickpea under irrigated condition

S.N.	Character		Plant height	Primary branches	Secondary branches	Pod bearing length	Days to maturity	Pods plant^{-1}	Seeds pod^{-1}	Biological yield	100 seed weight	Seed yield plant^{-1}
1.	Days to 50% flowering	P	0.130	-0.115	-0.032	-0.029	0.703**	0.000	-0.161	0.088	0.146	-0.023
		G	0.175	-0.266	-0.054	-0.044	0.725**	-0.005	-0.163	0.096	0.159	-0.029
		E	-0.018	0.203	0.031	-0.031	0.419	0.051	-0.092	-0.084	-0.140	0.015
2.	Plant height	P		-0.097	-0.042	0.326	0.024	0.072	-0.027	0.319	0.123	0.238
		G		-0.541**	-0.297	0.679**	0.052	0.092	-0.026	0.442*	0.175	0.318
		E		0.252	0.240	0.072	-0.069	0.032	-0.077	-0.081	-0.045	0.084
3.	Primary branches	P			0.508**	-0.010	-0.031	-0.164	-0.029	-0.071	-0.007	-0.098
		G			0.620**	-0.049	-0.021	-0.481**	-0.049	-0.074	0.019	-0.276
		E			0.448	0.008	-0.080	0.202	-0.015	-0.169	-0.089	0.085
4.	Secondary branches	P				-0.078	-0.082	-0.123	-0.133	0.021	0.266	0.063
		G				-0.038	-0.109	-0.393*	-0.174	0.028	0.357*	-0.091
		E				-0.105	-0.051	0.352	-0.157	0.017	0.176	0.317
5.	Pod bearing length	P					-0.068	0.127	-0.152	0.405*	0.097	0.227
		G					-0.046	0.179	-0.276	0.809**	0.267	0.516**
		E					-0.176	0.103	-0.010	-0.174	-0.231	-0.047
6.	Day to maturity	P						0.130	0.052	0.062	0.012	0.174
		G						0.161	0.071	0.032	-0.018	0.181
		E						-0.049	-0.369	0.503	0.399	0.162
7.	Pods plant^{-1}	P							0.082	0.005	-0.314	0.464**
		G							0.092	0.023	-0.368*	0.393*
		E							-0.001	-0.159	0.050	0.710
8.	Seeds pod^{-1}	P								-0.300	-0.586**	-0.082
		G								-0.299	-0.591**	-0.078
		E								-0.356	-0.511	-0.225
9.	Biological yield	P									0.268	0.513**
		G									0.245	0.580**
		E									0.687	0.213
10.	100 seed weight	P										0.238
		G										0.213
		E										0.489

Table 3. Genotypic Path coefficients showing direct and indirect effects of different traits on seed yield per plant in chickpea under rainfed condition

Traits	Days to 50% flowering	Plant height	Primary branches	Secondary branches	Pod bearing length	Days to maturity	Pods plant^{-1}	Seeds pod^{-1}	Biological yield	100 seed weight	Hard seeds	Protein content	Seed yield plant^{-1}
Days to 50% flowering	-0.172	0.061	-0.031	0.000	-0.098	0.232	-0.030	-0.201	0.002	0.201	0.033	-0.001	-0.004
Plant height	-0.033	0.314	0.084	0.000	-0.446	0.052	0.015	-0.141	0.081	0.165	0.052	0.000	0.142
Primary branches	0.029	0.145	0.181	0.000	-0.322	-0.078	-0.070	-0.263	0.084	0.501	0.054	0.001	0.263
Secondary branches	-0.037	-0.023	0.053	0.000	-0.153	0.062	0.316	0.137	-0.041	0.538	-0.052	0.001	0.801
Pod bearing length	-0.033	0.273	0.114	0.000	-0.513	0.058	-0.080	-0.205	0.090	0.413	0.085	0.001	0.203
Day to maturity	-0.135	0.055	-0.048	0.000	-0.100	0.296	-0.100	-0.145	-0.017	0.121	0.054	-0.001	-0.018
Pod plant^{-1}	0.005	0.005	-0.013	0.000	0.043	-0.031	0.951	0.065	0.056	-0.341	-0.147	0.000	0.592
Seeds pod^{-1}	0.056	-0.072	-0.077	0.000	0.170	-0.069	0.100	0.619	-0.056	-0.604	-0.105	0.000	-0.038
Biological yield	-0.001	0.141	0.085	0.000	-0.256	-0.027	0.292	-0.191	0.181	0.257	-0.031	0.000	0.449
100 seed weight	-0.034	0.050	0.088	0.000	-0.206	0.035	-0.315	-0.363	0.045	1.029	0.101	0.000	0.430
Hard seeds	0.027	-0.077	-0.046	0.000	0.204	-0.075	0.650	0.304	0.026	-0.482	-0.215	0.000	0.317
Protein content	-0.037	-0.004	-0.061	0.000	0.090	0.059	0.084	-0.063	0.004	0.011	-0.024	-0.004	0.055

Table 4. Genotypic Path coefficients showing direct and indirect effects of different traits on seed yield per plant in chickpea under irrigated condition

Traits	Days to 50% flowering	Plant height	Primary branches	Secondary branches	Pod bearing length	Days to maturity	Pods plant^{-1}	Seeds pod^{-1}	Biological yield	100 seed weight	Hard seeds	Protein content	Seed yield plant^{-1}
Days to 50% flowering	-0.337	0.095	-0.111	0.006	0.036	0.180	-0.004	-0.035	0.093	0.107	-0.055	-0.005	-0.029
Plant height	-0.059	0.542	-0.226	0.032	-0.557	0.013	0.069	-0.006	0.430	0.117	-0.030	-0.009	0.318
Primary branches	0.090	-0.293	0.417	-0.067	0.040	-0.005	-0.361	-0.011	-0.072	0.013	-0.017	-0.010	-0.276
Secondary branches	0.018	-0.161	0.258	-0.108	0.031	-0.027	-0.295	-0.037	0.027	0.240	-0.028	-0.009	-0.091
Pod bearing length	0.015	0.368	-0.021	0.004	-0.820	-0.012	0.135	-0.059	0.787	0.180	-0.056	-0.004	0.516
Day to maturity	-0.244	0.028	-0.009	0.012	0.038	0.248	0.121	0.015	0.031	-0.012	-0.045	-0.002	0.181
Pod plant^{-1}	0.002	0.050	-0.200	0.043	-0.147	0.040	0.751	0.020	0.022	-0.247	0.052	0.009	0.393
Seeds pod^{-1}	0.055	-0.014	-0.021	0.019	0.227	0.018	0.069	0.214	-0.291	-0.397	0.043	0.001	-0.078
Biological yield	-0.032	0.239	-0.031	-0.003	-0.663	0.008	0.017	-0.064	0.974	0.165	-0.034	0.004	0.580
100 seed weight	-0.054	0.095	0.008	-0.039	-0.219	-0.004	-0.276	-0.127	0.239	0.672	-0.064	-0.017	0.213
Hard seeds	0.131	-0.113	-0.051	0.021	0.325	-0.078	0.273	0.064	-0.230	-0.303	0.142	0.012	0.195
Protein content	-0.031	0.099	0.089	-0.021	-0.070	0.008	-0.144	-0.006	-0.074	0.238	-0.035	-0.049	0.004

significant positive association with days to maturity; plant height with primary branches, pod bearing length and biological yield. Similarly primary branches had positive correlation with pod bearing length, seeds pod^{-1}, biological yield and hundred seed weight. Similarly secondary branches had expressed positive association with hundred seed weight; pod bearing length with biological yield and hundred seed weight. Negative correlation of seeds pod^{-1} with hundred seed weight clearly indicates that increase in number of seeds pod^{-1} will affect the seed size. In accordance to this similar relationship between these traits reported earlier (Kulkarni 2001; Chaudhary *et al.,* 1992; Manjare *et al.,* 1997; Tripathi and Aroar 1991; Bhambota *et al.,* 1994; Jivani and Yadavendra 1988). Simple correlation of seed mass with per cent hard seeds and protein content revealed that seed characters had significant negative association with per cent hard seeds. This clearly indicates that under sized seed might have the tendency of mechanical hardiness leading to less water imbibition. Similar findings were reported earlier (Kulkarni 2001).

Irrigated condition

Correlation coefficients for seed yield and its components estimated under irrigated condition revealed that seed yield was positively associated with pod bearing length, pods plant^{-1} and biological yield. In accordance to this similar findings had been reported earlier (Khorgade *et al.,* 1995; Singh *et al.,* 1996; Singh *et al.,* 1997; Kulkarni 2001; Bhattacharya *et al.,* 1995; Venugopal 2000; Yadav *et al.,* 1999; Yadav *et al.,* 2002). Correlation coefficients estimated under non-stress condition showed that plant growth characters were influenced by environment. Days to 50 per cent flowering was significant and positively associated with days to maturity. These findings are agreement with some earlier reports (Kulkarni 2001; Manjare *et al.,* 1997; Reddy and Rao 1988; Deshmukh and Patil 1995). Plant height had shown negative association with primary branches per plant and significant positive association with pod bearing length and biological yield. Similar findings were also reported earlier (Kulkarni 2001; Tripathi and Aroar 1991; Bhattacharya *et al.,* 1995). However, primary branches had positive and significant association with secondary branches but both traits had negative association with pods plant^{-1} indicating that supplement irrigation is not proving beneficial in increasing the pods plant^{-1}. Hence, there is need to have genotypes responding to irrigation. Similar reports were also presented earlier (Kulkarni 2001; Ozdemir 1996). Secondary branches plant^{-1} had positive association with hundred seed weight. Negative correlation of hundred seed weight with pods plant^{-1} and seeds pod^{-1} was observed. Similar to the present findings (Tripathi and Aroar 1991) reported earlier. On the contrary to what is seen under rainfed conditions, the association among quality characters showed a positive in trend under irrigated condition. This indicating relatively high uptake of nitrogen from the soil, as evidenced by average values of protein content 21.39 per cent under irrigated as against 19.46 per cent under rainfed condition.

Path coefficient analysis

The correlation coefficient analysis provides information about the direction and magnitude of association between pairs of characters. The correlation coefficient by itself does not provide a clear picture of these interactions. But, in order to plan an effective selection strategy it is important to have knowledge of relative importance of direct and indirect influence of component characters on the dependent complex trait, such as yield. The technique of path analysis introduced by (Wright 1921) enables us to estimate the direct and indirect effect of component trait on dependent variable seed yield. The path coefficients obtained (Table 3 and 4) under rainfed and irrigated conditions are discussed separately.

Rainfed condition

The results revealed that among the growth characters plant height had the highest direct effect on seed yield. Similarly, among yield attributing traits hundred seed weight followed by pods plant^{-1} had the highest direct effects on seed yield. Phenological trait such as days to maturity had considerable direct contribution towards seed yield. Other characters having substantial contribution towards seed yield were seeds pod^{-1}, primary branches plant^{-1} and biological yield plant^{-1}. Higher direct effects with negative sign were also observed for pod bearing length and days to 50 per cent flowering under rainfed condition. These results are in agreement with earlier reports (Sindhu and Prasad 1987). Pod bearing length though had negative direct effects yet had indirect contribution through hundred seed weight and plant height. Similarly, 50 per cents flowering also had contributed allot towards seed yield through days to maturity. These results are in conformity with the results of earlier workers (Yadav *et al.,* 2002; Gowda 1972; Singh *et al.,* 1985; Salimatha and Bahl 1986; Singh and Paroda 1986; Paliwal *et al.,* 1987). Apart from direct effects, days to 50 per cent flowering had also shown positive indirect effects through days to maturity and hundred seed weight. Plant height and primary branches had moderate direct effects and substantial indirect effect through hundred seed weight. Secondary branches had shown indirect effect through hundred seed weight and pods plant^{-1}.

Pod bearing length though had negative direct effect yet had positive indirect contribution through hundred seed weight, plant height and primary branches plant^{-1}. Pods plant^{-1} had high direct effect on seed yield but had negative indirect effect via hundred seed weight. Seeds pod^{-1} had high direct effect on seed yield. It also had positive indirect effect via pod bearing length and pods plant^{-1} and negative indirect effect through hundred seed weight. Biological yield had negligible direct effect but had considerable indirect effects through pods plant^{-1}, hundred seed weight and plant height that might be useful in increasing the harvest index in chickpea. Its negative indirect effect via pod bearing length indicated that increase in plant height is not increasing the reproductive portion of chickpea plant. Hundred seed weight had the highest positive direct effect on seed yield but also had negative indirect effects through seeds pod^{-1}, pods plant^{-1} and pod bearing length. Thus in order to increase seed yield under rainfed condition attributes like hundred seed weight, pods plant^{-1} and seeds pods^{-1} seem to be more important. In addition to these primary branches plant^{-1}, days to maturity, plant height and biological yield should also get due weightage in selection scheme for increasing number of effective pods with medium to bold seeds.

Irrigated condition

Path analysis revealed that biological yield, pods plant^{-1}, hundred seed weight, plant height and primary branches plant^{-1} had shown considerable positive direct effect on seed yield. Other characters like days to maturity and seeds pod^{-1} had also shown substantial contribution towards seed yield. Negative direct effects of pod bearing length, days to 50 per cent flowering and secondary branches plant^{-1}, indicated that irrigation might affect the growth and phenological traits. These results are in line with earlier studies (Khorgade *et al.,* 1995; Bhambota *et al.,* 1994; Bhattacharya *et al.,* 1995; Yadav *et al.,* 2002; Reddy and Rao 1988; Gowda 1972; Salimatha and Bahl 1986; Tripathi *et al.,* 1995). Apart from direct contribution, component characters also contributed indirectly towards seed yield. In this study days to 50 per cent flowering had positive indirect effect through days to maturity and hundred seed weight, but had negative indirect effects through primary branches plant^{-1}. Plant height had positive indirect effects through biological yield and hundred seed weight. It had negative indirect effect through pod bearing length and primary branches plant^{-1}. Primary branches plant^{-1} had shown considerable positive direct effect on seed yield but had negative indirect effects through pods plant^{-1} and plant height. It is appreciable that secondary branches plant^{-1} had positive indirect effects through primary branches plant^{-1} and hundred seed weight, but had shown negative indirect effect through pods plant^{-1} and plant height. Pod bearing length had positive indirect effect on seed yield through plant height, pods plant^{-1}, biological yield and hundred seed weight. Days to maturity had positive indirect effects on seed yield through pods plant^{-1} and negative indirect effects through days to 50 per cent flowering. Pods plant^{-1} had negative indirect effect on seed yield via primary branches plant^{-1}, pod bearing length and hundred seed weight. Biological yield had positive indirect effect on seed yield through plant height and hundred seed weight but also had negative indirect effect through pod bearing length. Hundred seed weight had shown positive indirect effect via biological yield and negative effect through pod bearing length and pods plant^{-1}. Thus, from the path analysis it is revealed that while considering the selection parameters for maximization of grain yield under irrigated condition, emphasis should be given for the characters like biological yield, pods plant^{-1}, hundred seed weight and plant height. These findings are in agreement with some earlier report (Katiyar *et al.,* 1981).

REFERENCES

Bhambota, S.K., Sood, B.C. and Gartan, S.L. 1994. Contribution of different characters towards seed yield in chickpea (*Cicer arietinum* L.). *Indian J. Genet.* 54(4): 381-388.

Bhattacharya, A., Singh, D.N. and Raj, D. 1995. Associations of yield and yield components under soil moisture stress and non stress conditions in chickpea. *Legume Res.* 18(4): 193-199.

Chaudhary, B.D., Singh, D.P., Singh, P. and Singh, P. 1992. Inter relationship between morpho-physiological characters and seed yield in chickpea genotypes under irrigated field conditions. *J. Res.* 22(2): 91-96.

Deshmukh, R.B. and Patil, J.V. 1995. Association among yield, yield components and morphologic traits in chickpea. *Indian J. Pulses Res.* 8(2): 123-127.

Dewey, D.R. and Lu, K.H. 1959. Correlation and path coefficient analysis of components of crested wheat grass seed production. *Agron. J.* 51: 515-518.

Gowda, C.L.L. 1972. Path coefficient analysis for yield and yield components in bengal gram (*Cicer arietinum* L.) M.Sc. Thesis, GBPUAT, Pantnagar, India.

Jivani, L.L. and Yadavendra, J.P. 1988.Correlation and path coefficient analysis in chickpea. *Indian J. Pulses Res.*I (1): 34-37.

Katiyar, P.W., Sood, O.P. and Kalia, N.R. 1981. Selection criteria in chickpea. *Int. Chickpea Newsle.* 4: 5-6.

Khorgade, P.W., Khedkar, R.P. and Narkhede, M.N. 1995. Character association and path analysis under normal and late sown conditions in chickpea. *Indian J. Pulses Res.* 8(2): 128-132.

Kulkarni, G. 2001. Determination of selection criteria for maximisation of grain yield in chickpea (*Cicer arietinum* L.) under rainfed and irrigated conditions. M.Sc. thesis, IGAU, Raipur, India.

Manjare, M.R., Mhase, L.B. and Aher, R.P. 1997. Correlation and path analysis in chickpea (*Cicer arietinum* L.) *Legume Res.* 20(1): 64-66.

Miller, D.A., Williams, J.C., Robinson, H.F. and Compstock, K.B. 1958. Estimates of genotypic and environmental variances and covariance in planned cotton and their implication in selection. *Agron. J.* 50: 126-131.

Ozdemir, S. 1996. Path coefficient analysis for yield and its components in chickpea. *Int. Chickpea and Pigeonpea Newsle.* 3: 19-21.

Paliwal, K.K., Ramgiri, S.R., Lal, M.S., Kottu, G.K. and Mishra, R. 1987. Correlation and path coefficient analysis in chickpea (*Cicer arietinum* L.). *Legume. Res.* 10(1): 47-48.

Reddy, R.K. and Rao, S.K. 1988. Analysis on yield factor in segregating population of chickpea (*Cicer arietinum* L.). *Legume Res.* 11(1): 27-31.

Salimatha, P.M. and Bahl, P.N. 1986. Association analysis and plant ideotype in chickpea (*Cicer arietinum* L.,). *Exp. Genet.* 2: 41-46.

Sindhu, J.S. and Prasad, S. 1987. Causation and analysis in chickpea. *Research and Development Reporter.* 4(2): 136-140.

Singh, D.; Sharma, P.C. and Kumar, R. 1997. Correlation and path coefficient analysis in chickpea. *Crop Res.* 13(3): 625-629.

Singh, I.B., Singh, H.G., Chauhan, Y.S. and Singh, K.N. 1985. Path coefficient analysis in chickpea (*Cicer arietinum* L.). *Crop Improv.* 12(1): 62-63.

Singh, I.S., Hussain, M.A. and Gupta, A.K. 1996. Efficacy of selection in early generation in chickpea. *Indian J. Pulses Res.* 9(2): 124-126.

Singh, O. and Paroda, R.S. 1986. Association analysis of grain yield and its components in chickpea following hybridization and a combination of hybridization and mutagenesis. *Indian J. Agric. Sci.* 56(2): 139-141.

Tripathi, A.K., Pathak, M.M., Singh, K.P. and Singh, R.P. 1995. Path coefficient analysis in chickpea. *Indian J. Pulses Res.* 8(1): 71-72.

Tripathi, K.N. and Aroar, P.P. 1991. Variability and correlation studies and their implication in chickpea selection. *Indian J. Pulses. Res.* 4(2): 151-153.

Venugopal, P. 2000. Studies on genetic variability and character association for yield and its components in F_6 population of chickpea (*Cicer arietinum* L.) under stress and non-stress condition. M.Sc. Thesis, IGAU, Raipur, India.

Wright, S. 1921. Correlation and causation. *J. Agric. Res.* 20: 557-587.

Yadav, V.S., Singh, D. Yadav, S.S. Kumar, J. and Singh, D. 1999. Correlation and path analysis in chickpea. *Ann. Agric. Res.* 20(4): 461-465.

Yadav, V.S., Singh, D., Yadav, S.S. and Kumar, J. 2002. Correlation and path analysis in chickpea. *Indian J. Pulses Res.* 15(1): 19-22.

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