



ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(6): 4121-4125
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www.thepharmajournal.com

Received: 01-03-2023

Accepted: 05-04-2023

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Correlation and path analysis studies in interspecific crosses of cowpea (*Vigna ssp.*)

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Abstract

An experiment was conducted with eleven genotypes in the *rabi* season of 2017-18 at research and education farm, Department of Agriculture Botany, College of Agriculture, Dapoli. Observations were recorded on twelve characters *viz.*, days to initiation of flowering, day to 50 percent flowering, days to first pod picking, plant height (cm), number of primary branches per plant, number of clusters per plant, number of pods per cluster, number of pods per plant, pod length (cm), green pod weight per plant (g), harvest index (%) and protein content (%). The correlation study revealed that the characters *viz.*, plant height, number of primary branches per plant, number of clusters per plant, number of pods per cluster, number of pods per plant and pod length had a highly significant positive correlation with green pod weight per plant (g) at both phenotypic and genotypic level. The path coefficient analysis revealed a positive direct effect of characters *viz.*, plant height, number of clusters per plant, number of pods per cluster, number of pods per plant, pod length and harvest index on green pod weight per plant at both genotypic and phenotypic level while, days to initiation of flowering and days to 50% percent flowering at phenotypic and genotypic level respectively. Based on association analysis studies, it can be concluded that the selection criteria based on plant height, number of clusters per plant, number of pods per plant and pod length can provide a better result for improvement of green pod weight per plant in cowpea under study.

Keywords: Cowpea, correlation, path analysis

Introduction

Cowpea [*Vigna unguiculata* (L.) Walp.] is an annual, autogamous leguminous vegetable crop of India that belongs to the family Leguminosae (Mackie and Smith, 1935) [12] with a chromosome number of $2n=2x=22$ (Darlington and Wylie, 1955) [6]. It is one of the most widely adapted; drought-tolerant, versatile and nutritious grain legumes or pulse crops used as dry seed or green pod as vegetable or as a forage crop and known as poor man's meat as it is enriched with protein, minerals and vitamins (Steele, 1972) [21]. Dry seeds are used to prepare several snacks and main meal dishes. It contains high amount of quality protein 23.4%, carbohydrate 60.3%, fat 1.8% and sufficient amount of calcium 76 mg/100 gm, iron 57 mg/100gm and vitamins such as thiamine 0.92 mg/100g, riboflavin 0.18 mg/100g and nicotinic acid 1.9 mg/100g (Chatterjee and Bhattacharya, 1986) [4]. The green tender pods contain moisture 84.6%, protein 4.3%, carbohydrate 8.0%, fats 0.2% and are also a rich sources of calcium, phosphorus and iron (Aykroyd, 1963) [2]. The crops also help in maintaining soil fertility through symbiotic nitrogen fixation.

In India cowpea is extensively grown particularly in the southern states *viz.*, Andhra Pradesh, Karnataka and Tamil Nadu. Maharashtra is also a good producer of cowpea with an area of 11800 ha and productivity of 390 kg/ha of which Konkan region contributes an area of 1300 ha and productivity of 410 kg/ha. In the world, cowpea is grown in an area 14.5 of million ha (Anon., 2017) [1]. Path coefficient analysis is an important technique for partitioning the correlation coefficient into direct and indirect effects of the causal components on the complex component.

Materials and Methods

The present investigation was carried out at Research and Education Farm, College of Agriculture, Dapoli, Dist. Ratnagiri (M.S.) during the *rabi* season of 2017-18. The material for the present study comprised eleven genotypes of interspecific crosses of cowpea. The experiment was conducted in Compact Family Block Design with three replications. The plot size was 2.4x4 m.

The seeds were dibbled at 80 cm distance from row to row and 40 cm between plant to plant. The fertilizer dose was applied @ 25 kg N: 50 kg P₂O₅ per hectare. The operation, like thinning was done within 10 days after sowing to maintain one plant per hill. Other cultural practices were carried out as per the standard recommendations. The simple correlation coefficients and path analysis between yield and yield components were estimated as per the standard

procedure.

Results and Discussion

The correlation coefficient and path analysis for green pod weight per plant and its contributing characters for eleven genotypes at phenotypic and genotypic levels are presented in Tables 1, 2 and 3.

Table 1: Estimates of correlation coefficient between different characters in f₃ generation of interspecific crosses of cowpea.

Characters		Days to initiation of flowering	Days to 50% flowering	Days to first pod picking (days)	Plant height (cm)	No. of primary branches per plant	No. of clusters per plant	No. of pods per cluster	No. of pods per plant	Pod length (cm)	Harvest index (%)	Protein content (%)	Green pod weight per plant (g)
Days to initiation of flowering	P	1.0000	0.9295**	0.8954**	-0.2710**	0.0825	-0.2369*	-0.0900	-0.2726**	-0.3622**	0.0428	-0.0742	-0.3858**
	G	1.000	0.9901**	0.9419**	-0.2878**	0.0967	-0.2609**	-0.0722	-0.2877**	-0.3838**	0.0496	-0.0935	0.4001**
Days to 50% flowering	P		1.0000	0.8430**	-0.2762**	0.0269	-0.2371*	-0.0783	-0.2600**	-0.3750**	0.0017	-0.0149	-0.3563**
	G		1.000	0.9104**	-0.2951**	0.0358	-0.2675**	-0.0580	-0.2827**	-0.3985**	0.0081	-0.0151	-0.3776**
Days to first pod picking (days)	P			1.0000	-0.0732	0.2594**	-0.0779	-0.1138	-0.1597	-0.2609**	-0.1650	-0.1211	-0.2439*
	G			1.000	-0.0775	0.2701**	-0.0837	-0.0989	-0.1623	-0.2843**	-0.1799	-0.1529	-0.2492**
Plant height (cm)	P				1.0000	0.5717**	0.8570**	0.2200*	0.8547**	0.7366**	-0.0393	-0.5091**	0.8744**
	G				1.000	0.5817**	0.8691**	0.2497**	0.8767**	0.7418**	0.0396	-0.5341**	0.8814**
No. of primary branches per plant	P					1.0000	0.5545**	0.1564	0.5318**	0.4359**	0.3652**	-0.4783**	0.4756**
	G					1.000	0.5749**	0.1952*	0.5553**	0.4486**	0.3709**	-0.5005**	0.4829**
No. of clusters per plant	P						1.0000	0.1910*	0.8140**	0.7167**	0.0088	-0.5532**	0.8507**
	G						1.000	0.2232*	0.8366**	0.7318**	0.0108	-0.5948**	0.8677**
No. of pods per cluster	P							1.0000	0.5208**	0.2649**	-0.0575	-0.2110*	0.3603**
	G							1.000	0.5366**	0.2814**	-0.0613	-0.2416*	0.4095**
No. of pods per plant	P								1.0000	0.7410**	0.0687	-0.5509**	0.8672**
	G								1.000	0.7590**	-0.0645	-0.5913**	0.9023**
Pod length (cm)	P									1.0000	0.0413	-0.4089**	0.7604**
	G									1.000	0.0451	-0.4384**	0.7698**
Harvest index (%)	P										1.0000	-0.0707	0.0691
	G										1.000	-0.0708	0.0710
Protein content (%)	P											1.0000	-0.4094**
	G											1.000	-0.4267**

P: Phenotypic level G: Genotypic level *Significant at 5% ** Significant at 1%

Table 2: Path analysis for different characters at phenotypic level in f₃ generation of interspecific crosses of cowpea.

Characters	Days to initiation of flowering	Days to 50% flowering	Days to first pod picking (days)	Plant height (cm)	No. of primary branches per plant	No. of clusters per plant	No. of pods per cluster	No. of pods per plant	Pod length (cm)	Harvest index (%)	Protein content (%)	Green pod weight per plant (g)
Days to initiation of flowering	-0.0640	0.1276	-0.1496	-0.1163	-0.0035	-0.0802	-0.0089	-0.0540	-0.0313	0.0037	-0.0092	-0.3858**
Days to 50% flowering	-0.0595	0.1373	-0.1409	-0.1185	-0.0012	-0.0803	-0.0078	-0.0514	-0.0324	0.0001	-0.0018	-0.3563**
Days to first pod picking (days)	-0.0573	0.1158	-0.1671	-0.0314	-0.0111	-0.0264	-0.0113	-0.0316	-0.0226	0.0141	-0.0151	-0.2439**
Plant height (cm)	0.0174	-0.0379	0.0122	0.4289	-0.0245	0.2903	0.0218	0.1691	0.0637	-0.0034	-0.0633	0.8744**
No. of primary branches per plant	-0.0053	0.0037	-0.0433	0.2452	-0.0428	0.1878	0.0155	0.1052	0.0377	0.0313	-0.0595	0.4756**
No. of clusters per plant	0.0152	-0.0326	0.0130	0.3676	-0.0237	0.3387	0.0189	0.1611	0.0620	-0.0008	-0.0688	0.8507**
No. of pods per cluster	0.0058	-0.0108	0.0190	0.0944	-0.0067	0.0647	0.0991	0.1030	0.0229	-0.0049	-0.0262	0.3603**
No. of pods per plant	0.0175	-0.0357	0.0267	0.3666	-0.0228	0.2757	0.0516	0.1979	0.0641	-0.0059	-0.0685	0.8672**
Pod length (cm)	0.0232	-0.0515	0.0436	0.3160	-0.0187	0.2428	0.0262	0.1466	0.0865	-0.0035	-0.0508	0.7604**
Harvest index (%)	-0.0274	0.0002	-0.0276	0.0169	0.0156	0.0030	-0.0057	0.0136	0.0036	0.0857	-0.0088	0.0691
Protein content (%)	0.0048	-0.0020	0.0202	-0.2184	0.0205	-0.1874	-0.0209	-0.1090	-0.0354	-0.0061	0.1243	-0.4094**

Residual effect = 0.3455 *Significant at 5%, **Significant at 1%, Bold figures indicate direct effect

Table 3: Path analysis for different characters at genotypic levels in f3 generation of interspecific crosses of cowpea

Characters	Days to initiation of flowering (days)	Days to 50% flowering (days)	Days to first pod picking (days)	Plant height (cm)	No. of primary branches per plant	No. of clusters per plant	No. of pods per cluster	No. of pods per plant	Pod length (cm)	Harvest index (%)	Protein content (%)	Green pod weight per plant (cm)
Days to initiation of flowering (days)	0.5737	-0.1559	-0.4440	-0.1275	-0.0082	-0.1120	-0.0063	-0.0953	-0.0088	0.0065	-0.0223	-0.4001**
Days to 50% flowering (days)	0.5680	-0.1574	-0.4292	-0.1308	-0.0030	-0.1148	-0.0050	-0.0936	-0.0091	0.0011	-0.0036	-0.3776**
Days to first pod picking (days)	0.5403	-0.1433	-0.4714	-0.0343	-0.0230	-0.0359	-0.0086	-0.0538	-0.0065	0.0237	-0.0364	-0.2492**
Plant height (cm)	-0.1651	0.0465	0.0365	0.4432	-0.0494	0.3732	0.0216	0.2904	0.0169	-0.0052	-0.1272	0.8814**
No. of primary branches per plant	0.0555	-0.0056	-0.1274	0.2578	-0.0850	0.2468	0.0169	0.1839	0.0102	0.0488	-0.1192	0.4829**
No. of clusters per plant	-0.1497	0.0421	0.0394	0.3852	-0.0489	0.4294	0.0193	0.2771	0.0167	-0.0014	-0.1416	0.8677**
No. of pods per cluster	-0.0414	0.0091	0.0466	0.1107	-0.0166	0.0958	0.0867	0.1777	0.0064	-0.0081	-0.0575	0.4095**
No. of pods per plant	-0.1650	0.0445	0.0765	0.3886	-0.0472	0.3592	0.0465	0.3312	0.0173	-0.0085	-0.1408	0.9023**
Pod length (cm)	-0.2202	0.0627	0.1340	0.3288	-0.0381	0.3142	0.0244	0.2514	0.0228	-0.0059	-0.1044	0.7698**
Harvest index (%)	-0.0284	-0.0013	-0.0848	0.0175	0.0315	0.0046	-0.0053	0.0214	0.0010	0.1316	-0.0168	0.0710
Protein content (%)	-0.0536	0.0024	0.0721	-0.2367	0.0425	-0.2554	-0.0209	-0.1958	-0.0100	-0.0093	0.2381	-0.4267**

Residual effect = 0.2885, *Significant at 5%, **Significant at 1%, (Bold figures indicate direct effect)

Correlation

The character green pod weight per plant had highly significant positive correlation with plant height, number of primary branches per plant, number of clusters per plant, pods per cluster, number of pods per plant and pod length while, non-significant positive correlation with harvest index at both genotypic and phenotypic level. These results are in agreement with Ullah *et al.* (2011) [22], Mishra M. (2013) [15] and Sohilkumar V.K. (2014) [20].

Plant height exhibited a positive and highly significant positive correlation with number of primary branches per plant, number of clusters per plant, number of pods per plant, pod length and number of pods per cluster at genotypic and phenotypic levels. This result is in confirmation of the findings of Sapara and Javia (2014) [18].

The number of primary branches per plant showed a positive and highly significant correlation with green pod weight per plant, clusters per plant, number of pods per plant, pod length and harvest index, while, non-significant positive correlation with pods per cluster at both genotypic and phenotypic level. Vidya *et al.* (2002) [26] and Rambabu *et al.* (2016) [17] observed positive correlation between number of primary branches per plant and green pod weight per plant.

Days to first flowering showed a positive and significant correlation with days to 50 percent flowering and days to first pod picking. It had non-significant positive correlation with number of primary branches per plant, harvest index and highly significant negative correlation with plant height, number of pods per plant, pod length, green pod weight per plant while, significant negative correlation with number of clusters per plant at both genotypic and phenotypic level.

Whereas, non-significant negative correlation with protein content. Mahmudul *et al.* (2012) [13] reported negative correlation between days to first flowering and pod yield in string beans.

A positive correlation was observed between days to 50% flowering and days to first pod picking. It had positive but nonsignificant correlation with the number of primary branches per plant, harvest index. While the character days to first pod picking negatively correlated with harvest index and green pod weight per plant both at genotypic and phenotypic levels. Mishra M. (2013) [15] recorded positive inter-correlation between days to 50% flowering and days to first pod picking. The negative correlation of days to 50% flowering and days to first pod picking with green pod yield per plant was reported by Mahmudul *et al.* (2012) [13] respectively.

Pod length is an important parameter considered for improvement which was positively correlated with plant height, number of primary branches per plant, number of clusters per plant, number of pods per plant, pod weight and harvest index. While, negatively and significantly correlated with days to initiation of flowering, days to fifty percent flowering, days to first pod picking and protein content. Sapara and Javia (2014) [18] and Patel *et al.* (2016) [16] reported significant positive correlation between pod length green pod yield at both genotypic and phenotypic level.

The number of pods per cluster showed highly significant positive correlation with pods per plant, pod length and green pod weight per plant. As the number of pods in a cluster increases, automatically number of pods in a plant increases thus yield also. The same observations were recorded by

Sharma *et al.* (2015) ^[19]. Whereas, positive and highly significant correlation between number of pods per plant and green pod yield per plant at phenotypic level was reported by Sapara and Javia (2014) ^[18].

The character number of clusters per plant and number of pods per plant exhibited highly significant positive correlation with green pod yield per plant. These characters contribute towards yield. Vidya *et al.* (2002) ^[26] recorded highly positive and significant correlation between number of pods per plant and green pod yield per plant while Valarmathi *et al.* (2006) ^[23] observed positive and significant correlation between number of clusters per plant and green pod yield per plant.

Harvest index showed a significant positive correlation with primary branches per plant which, was in confirmation with the results of Kulkarni *et al.* (1994) ^[9] in Cowpea while, protein content had non-significant negative correlation with green pod yield per plant, plant height, number of primary branches, number of clusters per plant and number of pods per plant at both genotypic and phenotypic level.

Path analysis

The character plant height had high positive direct effect on green pod weight per plant at both genotypic and phenotypic level. It positively affected green pod yield through days to initiation of flowering, days to first pod picking, number of clusters per plant, pods per cluster, number of pods per plant, pod length at both genotypic and phenotypic level. Kumar *et al.* (2002) ^[10] and Mishra M. (2013) ^[15] observed higher magnitude of positive direct effects of plant height on green pod yield in Cowpea.

The character number of primary branches per plant reported negative direct effect on green pod weight per plant at both genotypic and phenotypic level. Its indirect positive effects via, days to 50 percent flowering, plant height, number of clusters per plant, pods per cluster, number of pods per plant, pod length and harvest index. While, it showed negative indirect effects via days to initiation of flowering, days to first pod picking, protein content. The result was in conformation with the reports of Sharma *et al.* (2015) ^[19] for seed yield in Cowpea.

Days to first flowering had positive direct effect on green pod weight per plant at genotypic level while, the negative direct effect at phenotypic level. It had low positive indirect effects on days to 50% flowering and harvest index. Sharma *et al.* (2015) ^[19] and Khandait *et al.* (2016) ^[7] observed same positive direct effect of days to first flowering on green pod yield per plant in Vegetable Cowpea. Days to 50% flowering and days to first pod picking had positive direct effect on green pod weight per plant at phenotypic level while, negative direct effect at genotypic level. It had a positive indirect effect through days to initiation of flowering and harvest index at genotypic level. Similar result was recorded by Leonardo *et al.* (2016) ^[11] and Khandait *et al.* (2016) ^[7] for days to 50% flowering at phenotypic level. The character pod length showed low positive direct effect on green pod weight per plant both at genotypic and phenotypic level. Venkatesan *et al.* (2003) ^[25] observed similar results in Cowpea.

The characters pods per cluster, number of clusters per plant and number of pods per plant had positive direct effect on green pod weight per plant at both the genotypic and phenotypic level. This was in conformation with Venkatesan *et al.* (2003) ^[25] for number of pods per plant and Manggoel *et al.* (2012) ^[14] for number of clusters per plant in Cowpea.

The character harvest index positively affected green pod weight per plant. Its indirect positive effects via, days to 50 percent flowering, plant height, number of primary branches per plant, number of clusters per plant, number of pods per plant and pod length at both the genotypic and phenotypic levels. While, it showed negative indirect effects via, days to initiation of flowering, days to first pod picking and pods per cluster and protein content. This result was similar to the observation of Kulkarni *et al.* (1994) ^[9] in Vegetable Cowpeas at genotypic level for seed yield per plant and dry pod yield per plant. Character protein content in seed shows low positive direct effect on green pod yield. Similar results were obtained by Konda *et al.* (2008) ^[8] in black gram, Chattopadhyay and Dutta (2010) ^[5] in Dolichos bean while, Bhagavati *et al.* (2018) ^[3] reported a positive direct effect of protein content on pod yield per plant in the yard-long-bean character plant height, number of pods per cluster, number of clusters per plant, number of pods per plant, pod length and harvest index had a positive direct effect on green pod weight per plant. While days to first pod picking and the number of primary branches per plant had a negative direct effect on green pod weight per plant at genotypic and phenotypic levels. Whereas, the character days to first flowering had a positive direct effect on green pod weight per plant at genotypic level and negative direct effect at the phenotypic level.

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