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Character association studies for growth and yield contributing characters in vegetable cowpea [*Vigna unguiculata* (L.) Walp.]

Ankita Belwal, Moneddula Dhathri, Jyothsna J, Riya Pandey, Subhashree Subhasmita and Priyanka Rawat

Abstract

The present research experiment was carried out during Kharif season 2021 and consisted of forty genotypes of vegetable cowpea obtained from different places with two check varieties Pusa Komal and Kashi Kanchan. to find out correlation, path coefficient analysis for 15 characters. These forty genotypes of vegetable cowpea were sown in Randomized Block Design & replicated thrice at Vegetable Research Centre, at GBPUA&T Pantnagar. High positive significant correlation for green pod yield per hectare (q) reported by pod length (cm), 100 seed weight (g), no of pods per plot, no. of pods/plant, green pod weight, green pod yield/plant and green pod yield/plot. Path coefficient analysis showed positive direct effect on green pod yield per hectare (q) was exhibited by green pod yield/plot, Days taken for 50% flowering, 100 seed weight. Hence, the characters showing high positive relation with green pod yield/plant can be identified & utilized for improvement of existing germplasm of vegetable cowpea.

Keywords: Vegetable cowpea, cowpea, correlation, yield, germplasm, correlation, path analysis, genotypes

Introduction

Vegetable Cowpea [*Vigna unguiculata* (L.) Walp.] is a leguminous vegetable grown in India for its long and tender green pods. Cowpea is an essential component crop of sustainable cropping systems in the sub-humid tropics and arid regions. Cowpea provides the protein to humans; it is a good source of dietary protein (18-35%) and lysine. Correlation gives the relation between two or more characters either in positive direction or negative direction (Gomez and Gomez, 1984) [4]. Correlations are helpful to ascertain the real components of yield which is a complex character. Association of characteristics among different traits helps us to select them while breeding. Path association study which is a standard partial regression analysis gives the direct effect of one character or variable on others and with help of this, correlation is divided into direct & indirect effects. Path Analysis study which was given by Wright, (1921) [9] was advantageous in segregating the correlation coefficient obtained into direct & indirect effect.

Materials and Methods

The present research work has been done at Vegetable research centre, GBPUA&T, Pant Nagar during Kharif season 2021. The experiment material taken for the research was of forty genotypes of vegetable cowpea collected from different sources and two check varieties selected are Pusa Komal & Kashi Kanchan. The design used for present experiment is RBD and each of the genotypes is replicated thrice. Genotypes were sown in plots with plot size of 3.6 square metre. The distance between two rows and two plants was maintained 45 cm and 10 cm respectively. Formula given by Falconer (1964) [3] used to evaluate the Phenotypic and genotypic correlations. Formula given by Dewey and Lu (1959) [2] was helpful in studying the Path analysis by segregating the coefficients of correlation into the direct & indirect effects.

Result and Discussion

Correlation coefficient

The Genotypic and Phenotypic correlation coefficients among fifteen quantitative characters are presented in Table 1 and Table 2 respectively. In general, the genotypic coefficient was higher in magnitude compared to phenotypic correlation coefficient.

The correlation coefficient at phenotypic level and genotypic level was recorded to be highly significant and positive for green pod yield per hectare with characters No. of pods per cluster, pod length (cm), No. of seeds per pod, 100 seed weight (g), No. of pods/plant, No. of pods per plot, green pod weight (g), green pod yield/plant (g) and green pod yield/plot (kg). For the remaining characters the value of correlation was found to be non-significant. Days taken for flowering associated positively with Days taken for maturity at both the levels which are supported by Vir and Singh (2014) [8].

Genotypic correlation coefficient

The genotypic correlation of plant height was positive and significantly correlated with No. of pods per cluster (0.597**), No. of seeds per pod (0.236**), No. of pods/plant (0.250**) and No. of pods per plot (0.186*). For the character Days taken for 1st flowering positive and highly significant correlation was recorded for Days taken for 50% flowering (0.944**), Days taken for first pod emergence (0.990**), Days taken for first pod edible maturity (0.990**), No. of pods per cluster (0.294**) and Pod length (0.346**) and No. of seeds per pod (0.383**).

Genotypic correlation of Days taken for 50% flowering was significantly positive correlated with Days taken for first pod emergence (0.987**), Days taken for first pod edible maturity (0.987**), No. of pods per cluster (0.303**), Pod length (0.380**) and No. of seeds per pod (0.416**). For Days taken for first pod emergence genotypic correlation was positive and significantly correlated with Days taken for first pod edible maturity (0.944**), Pod length (0.406**), No. of seeds per pod (0.413**) and No. of pods per cluster (0.231*). For Days taken for first pod edible maturity, it was positive significantly correlated with pod length (0.409**), No. of seeds per pod (0.423**) and No. of pods per cluster (0.241*). For No. of primary branches, it was negative and non-significantly correlated with No. of pods per cluster (-0.058), pod length (-0.018 P, - 0.031), No. of seeds per pod, (-0.145), 100 seed weight (-0.153).

No. of pods/plant (0.048) is positively correlated but showed no significance to No. of primary branches/plant. For No. of pods per cluster genotypic correlation showed significant and positive correlated with No. of seeds per pod (0.279**) yield/plot (-0.438**), green pod yield per hectare (-0.386**) and 100 seed weight (- 0.234*). For pod length, it was significantly positive correlated with all the characters namely, No. of seeds per pod (0.560**), 100 seed weight (0.481**), No. of pods/plant (0.424**), No. of pods per plot (0.407**), green pod weight (0.719**), green pod yield/plant (0.714**).

For No. of seeds per pod genotypic correlation was significantly positive correlated with No. of pods/plant (0.233*), No. of pods per plot (0.210*), green pod weight (0.224*) and green pod yield/plant (0.201*) rest all the other characters were found to be non-significant. The character 100 seed weight exhibit having significant positive correlation with green pod weight (0.648**), green pod yield/plant (0.374**).

The genotypic correlation of No. of pods/plant was having significant positive correlation with No. of pods per plot (0.984**), green pod yield/plant (0.675**). For the No. of pods per plot is having significant positive correlation with green pod yield/plant (0.664**). The green pod weight is having significant positive correlation with all the characters namely, green pod yield/plant (0.791**), green pod yield/plot (0.784**) and green pod yield per hectare (0.780**).

Phenotypic correlation coefficient

The phenotypic correlation for plant height was significantly positive correlation with No. of pods per cluster (0.326**), No. of seeds per pod (0.214*) No. of pods/plant (0.246**). Phenotypic correlation of Days taken for first flowering was significantly positively correlated with Days taken for 50% flowering (0.972**), Days taken for first pod emergence (0.981**), Days taken for first pod edible maturity (0.981**), Pod length (0.297**). Days taken for first flowering exhibit significantly positive correlation with Days taken for first pod emergence (0.952**), edible maturity (0.952**), Pod length (0.300**), No. of seeds per pod (0.370**) No. of pods per plot (0.034**), 100 seed weight (-0.043**) is negative and significantly correlated and all other characters was found to be non-significant for the character. For the character Days taken for first pod emergence phenotypic correlation was significantly and positive correlated with Days taken for first pod edible maturity (0.988**), pod length (0.353**) and No. of seeds per pod (0.376**).

The character Days taken for first pod edible maturity was significantly and positively correlated with pod length (0.357**), No. of seeds per pod (0.0378**). Phenotypic correlation of No. of primary branches was negatively and non significantly correlated with all the characters. For the character No. of pods per cluster phenotypic correlation per cluster was significantly positive correlated with No. of seeds per pod (0.197*), Negative significant correlation was noticed with green pod weight (-0.274**), green pod yield/plant (-0.232*). Phenotypic correlation of pod length was significantly and positively correlated with No. of seeds per pod (0.415**), green pod weight (0.661**), 100 seed weight (0.0343**), No. of pods/plant (0.370**).

For the character of No. of seeds per pod correlation coefficient was significant and positively correlated with No. of pods/plant (0.203**) and No. of pods per plot (0.187*) having significant positive correlation with green pod weight (0.648**), green pod yield/plant (0.374**). The character 100 seed weight is having significant positive correlation with green pod weight (0.488**), green pod yield/plant (0.280**). No. of pods/plant was having significant positive correlation with No. of pods per plot (0.978**), green pod yield/plant (0.666**). No. of pods per plot is having significant positive correlation with green pod yield/plant (0.655**). The character green pod weight is having significant positive correlation with green pod yield/plant (0.793). Green pod yield/plant is having significant positive correlation with green pod yield/plot (0.970 **) and green pod yield per hectare (0.955**).

Table 1: Correlation values for green pod yield per hectare and yield contributing traits at genotypic level

Characters	Plant height (cm)	Days taken for first flowering	Days taken for 50% flowering	Days taken for first pod emergence	Days taken for first pod edible maturity	No. of primary branches	No. of pods per cluster	Pod length	No. of seeds per pod	100 seed weight (gm)	No. of pods/plant	No. of pods per plot	Green pod weight	Green pod yield/plot	Green pod yield/plot	Green pod yield per hectare
Plant height (cm)	1.00	0.083	0.068	0.077	0.077	0.018	0.597**	-0.036	0.236**	-0.155	0.250**	0.186*	-0.308**	-0.139	-0.167	-0.173
Days taken for first flowering		1.00	0.944**	0.990**	0.990**	0.118	0.294**	0.346**	0.383**	-0.081	0.101	0.072	0.00	-0.006	-0.015	-0.013
Days taken for 50% flowering			1.00	0.987**	0.987**	0.110	0.303**	0.380**	0.416**	-0.050	0.069	0.040	0.035	-0.007	-0.010	-0.006
Days taken for first pod emergence				1.00	0.944**	0.106	0.231*	0.406**	0.413**	-0.011	0.123	0.092	0.049	0.038	0.034	0.032
Days taken for first pod edible maturity					1.00	0.109	0.241*	0.409**	0.423**	-0.008	0.142	0.097	0.058	0.042	0.047	0.041
No. of primary branches						1.00	-0.058	-0.031	-0.145	-0.153	0.048	0.046	-0.148	-0.066	-0.042	0.009
No. of pods per cluster							1.00	-0.104	0.279**	-0.234*	-0.106	-0.144	-0.489**	-0.419**	-0.438**	-0.386**
Pod length								1.00	0.560**	0.481**	0.424**	0.407**	0.719**	0.714**	0.734**	0.719**
No. of seeds per pod									1.00	0.160	0.233*	0.210*	0.224*	0.201*	0.175	0.125
100 seed weight(gm)										1.00	-0.180*	-0.211*	0.648**	0.374**	0.308**	0.323**
No. of pods/plant											1.00	0.984**	0.156	0.675**	0.670**	0.653**
No. of pods per plot												1.00	0.128	0.664**	0.665**	0.640**
Green pod weight													1.00	0.791**	0.784**	0.780**
Green pod weight														1.00	0.990**	0.976**
Green pod yield/plot															1.00	0.986**

Table 2: Correlation values for green pod yield per hectare and its contributing traits at phenotypic level

Characters	Plant height (cm)	Days taken for first flowering	Days taken for 50% flowering	Days taken for first pod emergence	Days taken for first pod edible maturity	No. of primary branches	No. of pods per cluster	Pod length	No. of seeds per pod	100 seed weight (gm)	No. of pods/plant	No. of pods per plot	Green pod weight	Green pod yield/plot	Green pod yield/plot	Green pod yield per hectare
Plant height(cm)	1.00	0.083	0.065	0.076	0.076	0.018	0.326**	-0.032	0.214*	-0.123**	0.246**	0.183*	-0.301**	-0.136**	-0.165	-0.172
Days taken for first flowering		1.00	0.972**	0.981**	0.981**	0.116	0.152	0.297**	0.344**	-0.070	0.097	0.068	-0.004	-0.012	-0.018	-0.010
Days taken for 50% flowering			1.00	0.952**	0.952**	0.106	0.173	0.300**	0.370**	-0.043**	0.062	0.034**	0.025	-0.014	-0.018	-0.010
Days taken for first pod emergence				1.00	0.988**	0.103	0.129	0.353**	0.376**	-0.007	0.123	0.091	0.047	0.037	0.034	0.032
Days taken for first pod edible maturity					1.00	0.105	0.132	0.357**	0.378**	-0.004	0.135	0.099	0.058	0.038	0.043	0.059
No. of primary branches						1.00	-0.012	-0.018	-0.144	-0.095	0.048	0.046	-0.140	-0.060	-0.041	0.011
No. of pods per cluster							1.00	-0.121	0.197*	-0.113	-0.059	-0.064	-0.274**	-0.232*	-0.234*	-0.213*
Pod length								1.00	0.415**	0.343**	0.370**	0.362**	0.661**	0.647**	0.641**	0.624**
No. of seeds per pod									1.00	0.128	0.203*	0.187*	0.173	0.158	0.147	0.104
100 seed weight(gm)										1.00	-0.143	-0.171	0.488**	0.280**	0.258**	0.265**
No. of pods/plant								SS			1.00	0.978**	0.151	0.666**	0.657**	0.640**
No. of pods per plot												1.00	0.127	0.655**	0.652**	0.626**
Green pod weight													1.00	0.793**	0.764**	0.761**
Green pod weight														1.00	0.970**	0.955**
Green pod yield/plot															1.00	0.984**

Table 3: Path phenotypic co-efficients of yield and yield related traits of vegetable cowpea

Characters	Plant height (cm)	Days taken for first flowering	Days taken for 50% flowering	Days taken for first pod emergence	Days taken for first pod edible maturity	No. of primary branches	No. of pods per cluster	Pod length	No. of seeds per pod	100 seed weight (gm)	No. of pods/plant	No. of pods per plot	Green pod weight	Green pod yield/plant	Green pod yield/plot
Plant height(cm)	-0.0244	-0.0020	-0.0016	-0.0019	-0.0005	-0.0004	-0.0080	0.0008	-0.0052	0.0030	-0.0060	-0.0045	0.0073	0.0033	0.0040
Days taken for first flowering	0.0028	0.0335	0.0326	0.0328	0.0350	0.0039	0.0051	0.0099	0.0115	-0.0023	0.0032	0.0023	-0.0001	-0.0004	-0.0006
Days taken for 50% flowering	0.0051	0.0773	0.0796	0.0758	0.0765	0.0084	0.0137	0.0239	0.0294	-0.0034	0.0049	0.0027	0.0020	-0.0011	-0.0015
Days taken for first pod emergence	-0.0085	-0.1090	-0.1059	-0.1112	-0.1082	-0.0115	-0.0143	-0.0392	-0.0418	0.0008	-0.0137	-0.0101	-0.0053	-0.0041	-0.0037
Days taken for first pod edible maturity	0.0065	0.0040	0.0027	0.0086	0.0098	0.0072	0.0057	0.0046	0.0026	0.0089	0.0043	0.0047	0.0061	0.0076	0.0049
No. of primary branches	0.0009	0.0055	0.0050	0.0049	0.0079	0.0472	-0.0006	-0.0009	-0.0068	-0.0045	0.0023	0.0022	-0.0066	-0.0028	-0.0019
No. of pods per cluster	0.0119	0.0056	0.0063	0.0047	0.0067	-0.0004	0.0365	-0.0044	0.0072	-0.0041	-0.0021	-0.0023	-0.0100	-0.0085	-0.0086
Pod length	-0.0001	0.0005	0.0005	0.0006	0.0015	0.0000	-0.0002	0.0017	0.0007	0.0006	0.0006	0.0006	0.0011	0.0011	0.0011
No. of seeds per pod	-0.0109	-0.0176	-0.0189	-0.0192	-0.0151	0.0074	-0.0101	-0.0212	-0.0512	-0.0066	-0.0104	-0.0096	-0.0088	-0.0081	-0.0075
100 seed weight(gm)	-0.0022	-0.0012	-0.0007	-0.0001	-0.0002	-0.0017	-0.0020	0.0060	0.0023	0.0175	-0.0025	-0.0030	0.0086	0.0049	0.0045
No. of pods/plant	0.0631	0.0248	0.0159	0.0316	0.0330	0.0124	-0.0151	0.0949	0.0521	-0.0368	0.2568	0.2153	0.0387	0.01710	0.01687
No. of pods per plot	-0.0387	-0.0144	-0.0073	-0.0192	-0.0180	-0.0098	0.0135	-0.0766	-0.0396	-0.0361	-0.2069	-0.2114	-0.0269	-0.1385	-0.1379
Green pod weight	-0.0174	-0.0002	0.0015	0.0027	0.0048	-0.0081	-0.0158	0.0382	0.0100	0.0282	0.0087	0.0074	0.0578	0.0458	0.0442
Green pod weight	0.0067	0.0006	0.0007	-0.0018	-0.0012	0.0030	0.0113	-0.0317	-0.0078	-0.0137	-0.0326	-0.0321	-0.0389	-0.0490	-0.0475
Green pod yield/plot	-0.1599	-0.0176	-0.0178	0.0327	0.0356	-0.0397	-0.2274	0.6224	0.1428	0.2499	0.6376	0.06330	0.7417	0.9413	0.9705

Table 4: Path genotypic (G) co-efficients of yield and yield related traits of vegetable cowpea

Characters	Plant height (cm)	Days taken for first flowering	Days taken for 50% flowering	Days taken for first pod emergence	Days taken for first pod edible maturity	No. of primary branches	No. of pods per cluster	Pod length	No. of seeds per pod	100 seed weight (gm)	No. of pods/plant	No. of pods per plot	Green pod weight	Green pod yield/plant	Green pod yield/plot
Plant height (cm)	-0.0951	-0.0079	-0.0065	-0.0073	-0.0053	-0.0018	-0.0568	0.0034	-0.0225	0.0148	-0.0237	-0.0177	0.0293	0.0132	0.0159
Days taken for first flowering	-0.1205	-1.4436	-1.4439	-1.4292	-1.4250	-0.1699	-0.4249	-0.4993	-0.5524	0.1167	-0.1461	-0.1034	-0.0006	0.0083	0.0221
Days taken for 50% flowering	0.1347	1.9825	1.9822	1.9570	1.9598	0.2179	0.6016	0.7535	0.8248	-0.0999	0.1364	0.0788	0.0690	-0.0138	-0.0203
Days taken for first pod emergence	-0.0260	-0.3364	-0.3355	-0.3398	-0.3388	-0.0360	-0.0784	-0.1379	-0.1403	0.0037	-0.0420	-0.0312	-0.01680	-0.0128	-0.0115
Days taken for first pod edible maturity	0.0047	0.0031	0.0014	0.0048	-0.0022	-0.0037	-0.0012	0.0054	0.0032	0.0039	-0.0076	0.0058	0.0074	0.0058	0.0034
No. of primary branches	0.0013	0.0085	0.0080	0.0077	0.0098	0.0724	-0.0042	-0.0022	-0.0105	-0.0111	0.0035	0.0033	-0.0107	-0.0048	-0.0031
No. of pods per cluster	0.1558	0.0768	0.0792	0.0602	0.0666	-0.0151	0.2609	-0.0273	0.0728	-0.0610	-0.0276	-0.0375	-0.1275	-0.1092	-0.1144
Pod length	0.0286	0.2780	0.3056	0.3261	0.3282	0.0246	0.0840	-0.8039	-0.4501	-0.3864	-0.3412	-0.3268	-0.5779	-0.5739	-0.5897
No. of seeds per pod	0.0061	0.0098	0.0107	0.0106	0.0119	-0.0037	0.0072	0.0144	0.0257	0.0041	0.0060	0.0054	0.0058	0.0052	0.0045
100 seed weight (gm)	-0.0872	-0.0454	-0.0283	-0.0062	-0.0041	-0.0861	-0.1312	0.2698	0.0897	0.5612	-0.1009	0.1185	0.3634	0.2097	0.1728
No. of pods/plant	0.1150	0.0466	0.0317	0.0569	0.0575	0.0222	-0.0488	0.1956	0.1072	-0.0829	0.4608	0.4536	0.0721	0.3110	0.3085
No. of pods per plot	0.0300	0.0116	0.0064	0.0148	0.0179	0.0074	-0.0232	0.0656	0.0339	-0.0341	0.1588	0.1613	0.0206	0.1071	0.1073
Green pod weight	-0.1093	0.0001	0.0124	0.0175	0.0185	-0.0524	-0.1737	0.2554	0.0797	0.2300	0.0556	0.0454	0.3552	0.2811	0.2784
Green pod weight	0.3691	0.0154	0.0186	-0.1001	-0.1000	0.1749	1.1151	-1.9011	0.5364	-0.9950	-1.7973	-1.7689	-2.1075	-2.6631	-2.6366
Green pod yield/plot	-0.5752	-0.0529	-0.0354	0.1164	0.1185	-0.1457	-1.5134	2.5326	0.6037	1.0630	2.3113	2.2960	2.7058	3.4180	3.4522

Path analysis

Path analysis was carried out at phenotypic and genotypic level considering green pod yield per hectare as dependent character and its attributes viz., plant height (cm), Days taken for first flowering, Days taken for 50% flowering, Days taken for first pod emergence, Days taken for first pod edible maturity, No. of primary branches, No. of pods per cluster, Pod length (cm), No. of seeds per pod, 100 seed weight (gm), No. of pods/plant, No. of pods per plot, green pod weight, green pod yield/plant, green pod yield/plot as independent characters. Each component has two path actions viz., direct effect on yield and indirect effect through the components which are not revealed by variability studies. The results at phenotypic and genotypic levels are presented in table 3 and table 4 respectively.

The trends for phenotypic path coefficient were as follows. The highest positive direct effect on green pod yield per hectare was contributed by the character, green pod yield/plot followed by No. of pods/plant, Days taken for 50% flowering, green pod weight (g), No. of primary branches, No. of pods per cluster, Days taken for first flowering, 100 seed weight (g), Days taken for first pod edible maturity and pod length. While negative direct effect exhibited by plant height, Days taken for first pod emergence, No. of seeds per pod, No. of pods per plot and green pod weight.

The genotypic path coefficient analysis reported that the highest positive direct effect on green pod yield per hectare was contributed by the character, green pod yield/plot followed by Days taken for 50% flowering, 100 seed weight, No. of pods/plant, green pod weight, No. of pods per cluster, No. of pods per plot, No. of seeds per pod, No. of primary branches. While negative direct effect exhibited through plant height, Days taken for first flowering, Days taken for first pod emergence, Days taken for first pod maturity, pod length, green pod yield/plot.

Chaudhry *et al.* (2020) ^[1] reported highest positive direct effect on yield was registered by the pod length (0.7762) followed by No. of branches/plant (0.6779) and No. of pods/plant (0.4633). Similar results are also reported by Patel (2017) ^[7]. Similar results were reported by (Narayankutty *et al.*, 2003) ^[6].

Conclusion

The traits which are genetically associated helps us to know that importance should be given to pod length (cm), 100 seed weight (g), No. of pods/plant, green pod weight, green pod yield/plant for the selection of superior genotypes. With help of Path analysis, it can be concluded that high positive direct effect (q) was exhibited by green pod yield/plant, Days taken for 50% flowering, 100 seed weight.

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