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Correlation studies in cowpea (*Vigna unguiculata* L.)

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Abstract
A field experiment was conducted to estimate the genetic variability and genetic divergence in Cowpea. Thirty-One genotypes were sown in a randomized block design with two replications, during *kharif* 2018 at Research farm, Department of Agricultural Botany, V.N.M.K.V. Parbhani. The objective of the experiment was to identify divergent to be used as donor parents in hybridization programmes. The observations were recorded on 12 characters *viz.,* Plant height (cm), number of primary branches per plant, days to 50% flowering, number of pods per plant, number of seeds per pod, mean pod weight (g), pod length (cm), pod width (cm), days to first pod harvest, 100 seed weight (g), pod yield per plant (gm), pod yield per hectare (Kg). Analysis of variance and mean performance for pod yield and its components revealed significant differences among all the genotypes for all the characters there by indicating presence of variability in genotypes studied. From correlation studies, it was observed that pod yield per plant had exhibited highly significant positive association with number of pods per plants, number of primary branches per plants, plant height and number of seeds per pod. Whereas maximum significant and negative correlation was shown by days to first pod harvest. In the present studies, the characters plant height (cm), number of primary branches per plant, days to 50% flowering, number of seeds per pod, number of pods per plant and pod length showed positive and significant correlation with pod yield per plant. Pod yield per hectare recorded high positive significant correlation with number of primary branches per plant (0.6115r_g, 0.4548r_p) at 1% level of significance. It also showed positive significant correlation with number of pods per plant (0.2321r_g, 0.2595rp) and number of seeds per pod (0.3760r_g, 0.2984rp) at both 5% and 1% levels of significance. These results are supported by Patel *et al.* (2016). The magnitude of genotypic correlation was higher than phenotypic correlation for all the traits that indicated inherent association between various characters.

Keywords: Genotypic correlation, Cowpea, yield per plant

Introduction
Cowpea [*Vigna unguiculata* (L.)] is one of the most ancient a legume crop known to man. It is widely adopted and grown all over the world. Cowpea, which is commercially grown throughout India for its long green pods as a vegetable, seeds as pulses and foliage as fodder for milch animal. It is considered as one of the oldest legumes and referred as "Poor man's meat". Cowpea *(Vigna unguiculata*) has the largest usable protein content of all cultivated legumes and is arguably one of the most important plant protein source as a valuable and dependable commodity crop for farmer and grain traders (Nwosu *et al.*, 2013). In India, the cowpea is grown in an area of about 3.9 million ha with a production of 2.21 million tones having a productivity of 625 kg per ha compare to world India productivity is low, so still there is scope to improve the productivity of the cowpea. (Mohankumar, 2016) [7]. There are several diverse uses of cowpea due to which the varietal requirement in terms of plant type, pod type, maturity, pattern of use and growth are required to develop to suit the diverse regions of the country. Therefore, in cowpea selection and evaluation programme has become more complex and no single variety can be recommended to full fill the breeding objectives (Barrett, 1987) [2]. Thus, there is a growing need to develop suitable varieties for a specific region and or use. However, production is constrained by low and variable grain yield, grain quality, susceptibility to diseases and pests and the less availability of improved cultivars. There is association between yield and yield contributing traits in cowpea. Hence one has to access genotypic association existing between yield and its components, while selecting such complex character directly. Correlation shows nature and extent of such association between any two characters. The correlation of characters in cowpea offers a good scope because of its extravert nature of pistil comparatively easier handling, wider adaptability and presence of maximum variability.

Thus, the present investigation aims to study correlation studies in cowpea among 31 vegetable cowpea genotypes at Research farm of Department of Agricultural Botany, College of Agriculture Parbhani.

Materials and Methods

The present investigation was undertaken to study genetic variability studies in thirty one genotypes of cowpea [*Vigna unguiculata* (L.)]. The experimental material consists of thirty one genotypes of cowpea including one check. All these thirty one genotypes were planted during *kharif* 2018. The experimental material was sown on 4 July, 2018 by dibbling two seeds per hill. Recommended agronomical and plant protection practices were followed regularly. The observations were recorded for the characters *viz*; day to 50% flowering, pod yield per hectare, plant height, number of primary branches per plant, pod length. Number of pods per plant, number of seeds per pod, 100 seed weight, mean pod weight, pod width, days to first pod harvest and pod yield per plants. Mean values of the five plants selected at random in each plot were used for statistical analysis. The data based on the mean of individual plants selected for observation were statistically analyzed using the method described by Panse and Sukhatme (1985) [8] to find out overall total variability present in the material under study for each character and for all the population. In order to study the extent of association between different traits, the genotypic and phenotypic simple correlation coefficients were worked out from the respective variances and covariance's. The formulae as suggested by Johnson *et al.* (1955) [3] were used for calculating simple correlation coefficients.

Results

The data was subjected to analysis of variance to study the differences among thirty one genotypes for quantitative characters. The analysis of variance is presented in Table 1. The treatment mean sum of squares was found to be significant for all the twelve characters studied this indicates the presence of substantial amount of variation among these genotypes for the characters *viz.* Plant height (cm), number of primary branches per plant, days to 50% flowering, number of pods per plant, number of seeds per pod, mean pod weight (g), pod length (cm), pod width (mm), days to first pod harvest, 100 seed weight (g), pod yield per plant (g), pod yield per hectare (kg) was also noted significant. Thus considerable amount of genetic variability was present in the experimental material which can be exploited for improvement of pod yield and yield related attributes in cowpea. The character wise mean values are as follows

Table 1: Analysis of variance for twelve quantitative traits

Sr. No	Character	Mean sum of squares		
		Replications (d.f=1)	Treatment (d.f=30)	Error (d.f=30)
1	Plant height (cm)	23.167	535.71**	24.93
2	No. Of primary branches per plant	2.322	4.960**	1.064
3	Days to 50 % flowering	4.996	18.88**	6.806
4	Number of pods per plant	3.485	36.86**	5.581
5	Number of seeds per pod	0.542	7.189**	2.395
`6	Mean pod weight (g)	3.755	14.00**	3.202
7	Pod length (cm)	0.085	42.60**	6.833
8	Pod width (mm)	0.012	0.016*	0.004
9	Days to first pod harvest	0.109	21.93**	8.500
10	100 seed weight (g)	2.189	3.003**	0.969
11	Pod yield per plant (g)	301.57	411.18**	178.19
12	Pod yield per hectare (kg)	24640.26	17433104.35**	1039270.51

**Significant at 5% and 1% level

Correlation coefficient analysis

While selecting a suitable plant type, association studies would provide reliable information on nature, extent and direction of selection, especially when there is a need to combine high yield potential with desirable agronomic traits and pod quality characters. The genotypic (r_g) and phenotypic (r_p) correlation coefficients were worked out for twelve characters in 31 genotypes of cowpea and the data is presented in Table 2.

Plant height recorded high positive, significant correlation with number of primary branches per plant ($0.4321r_g$, $0.3564r_p$) at 1% level of significance. It also shows positive significant correlation with number of seeds per pod ($0.3189r_g$, $0.2741r_p$) at 5% level of significance.

Table 2: Estimation of genotypic and phenotypic correlation coefficients for different characters of cowpea

Character		Plant Height (cm)	Number of primary branches per plant	Days to 50% flowering	Number of pods per plant	Number of seeds per pod	Mean pod weight (g)	Pod length (cm)	Pod width (mm)	Days to first pod harvest	100 seed weight (g)	Pod yield/ plant (g)	Pod yield (kg/ha)
Plant height	G	1.0000	0.4321**	0.2755*	0.1729	0.3189*	0.1318	0.1595	-0.2056	0.1249	-0.1113	0.1181	0.2303
	P	1.0000	0.3564**	0.0972	0.1344	0.2741*	0.0925	0.1013	-0.1888	0.0810	-0.0704	0.0966	0.2199
Number of primary branches per plant	G		1.0000	0.0617	0.4171*	0.6495**	-0.0349	0.2916*	-0.2632*	-0.0241	-0.2064	0.4530**	0.6113**
	P		1.0000	0.1459	0.2875*	0.3133*	-0.0468	0.2054*	-0.1860	0.0418	-0.2002	0.2866*	0.4548**
Days to 50 per cent flowering	G			1.0000	0.2328	0.6518**	0.0967	-0.2842*	0.0048	0.4175**	0.0801	-0.0221	0.0056
	P			1.0000	0.1746	0.2676*	0.0677	-0.0754	-0.0405	0.1895	0.1000	-0.0016	-0.0052
Number of pods per plant	G				1.0000	0.1876	-0.2496	0.2130	0.2606	-0.1431	-0.0450	0.9713**	0.2321
	P				1.0000	0.1521	-0.0982	0.1388	0.0183	-0.0023	0.0197	0.6395**	0.2595*
Number of seeds per pod	G					1.0000	0.0592	0.0797	0.1594	0.4085**	0.0223	-0.0647	0.3760**
	P					1.0000	-0.0114	0.0455	-0.0382	0.1760	0.0271	0.0023	0.2984*

Mean pod weight (g)	G						1.0000	-0.1298	-0.1662	0.4558**	0.1918	-0.3930**	-0.1601
	P						1.0000	0.0368	-0.1526	0.3234**	-0.0517	-0.1510	-0.1067
Pod length (cm)	G							1.0000	-0.1444	-0.4355**	-0.2156	0.3792**	0.2037
	P							1.0000	.-0.0434	-0.2509*	-0.1383	0.1915	0.1521
Pod width (mm)	G								1.0000	-0.1105	-0.0348	0.1094	-0.2268
	P								1.0000	-0.0183	0.0294	0.0162	-0.1471
Days to first pod harvest	G									1.0000	0.3100	-0.0813	-0.4789**
	P									1.0000	0.1489	-0.0101	-0.2965*
100 seed weight (g)	G										1.0000	0.0828	-0.2192
	P										1.0000	-0.0271	-0.1228
Pod yield per plant (g)	G											1.0000	0.1953
	P											1.0000	0.1225
Pod yield (kg/ha)	G												1.0000
	P												1.0000

G = Genotypic correlation coefficient, P = Phenotypic correlation coefficient *, ** Indicates significant at 5 % and 1 % level of significant

Number of primary branches per plant recorded high positive, significant correlation with pod yield per ha (0.6113r_g, 0.4548r_p) and pod yield per plant (0.4530rg, 0.2866rp) both at 1% levels of significance. It also showed positive significant correlation plant height (0.4321 r_g, 0.3564 r_p), number of pods per plant (0.4171r_g, 0.2875r_p), number of seeds per pod (0.6495 r_g, 0.3133r_p) at both 1% and 5% level of significance. Number of primary branches per plant recorded negative, significant correlation with pod width (-0.2632r_g, -0.1818r_p), at both 5% level of significance. Days to 50% flowering recorded positive, significant correlation with days to first pod harvest (0.4175r_g, 0.1895r_p,) and number of seeds per pod (0.6518rg,0.2676r_p) both at 1% level of significance. This character exhibited negative significant correlation with pod length (-0.2842rg, - 0.0754r_p) at 5% level of significance. Number of pods per plant recorded high, positive, significant correlation with pod yield per plant (0.9713rg, 0.6395rp) at 1% level of significance. This character also showed significant correlation with number of primary branches per plant (0.4171rg, 0.2875rp) and pod yield per ha (0.3321r_g, 0.2595r_p) at both 1% and 5% levels of significance. Number of seeds per pod exhibited significant positive correlation with pod yield per hacter (0.3760r_g,0.2984r_p), at both 1% and 5% levels of significance only. Mean pod weight exhibited high significant positive correlation with days to first pod harvest (0.4558r_g, 0.3234r_p), at 1% level of significance. This character exhibited negative significant correlation with pod yield per plant (-0.3930rg, - 0.1510rp) at 1% level of significance. Pod length exhibited significant positive correlation with number of primary branches per plant (0.2916r_g0.2054r_p) and number of seeds per pod (0.2797r_g, 0.2555r_p) both at 5% level of significance. This character exhibited negative and significant correlation with days to first pod harvest (-0.4355r_g,-0.2509r_p) and days to 50% flowering (-0.2842 r_g, -0.0754rp) at 1% & 5% levels of significance. This trait exhibited positive significant correlation with days to 50 per cent flowering (0.4175r_g, 0.1895r_p) and mean pod weight (0.4558rg, 0.3234rp) at both 1% levels of significance. This character exhibited negative significant correlation with pod yield per hacter (-0.4789rg, -0.2965rp) and pod length (-0.4355r_g, 0.2509r_p) both at 1% and 5% level of significance. This trait recorded high positive significant correlation with number of primary branches per plant (0.6113r_g, 0.4548r_p) at 1% level of significance. It also showed positive significant correlation with number of seeds per pod (0.3760r $_g$,0.2984rp) at both 1% and 5% level of significance. This character exhibited negative significant correlation with days to first pod harvest (-0.4789rg, 0.2965rp) at 1% and 5% level of significance.

Pod yield being a complex character, it is very difficult to improve by selecting the genotypes for yield *per se*. Therefore, identifying the characters which are closely related and which have contributed to yield becomes highly essential. In this context, correlation is an important tool to measure the direction and strength of relationship of different component characters on seed yield. Similar information is provided by Manggoel *et al.* (2012), Sapara *et al.* (2014) and Patel *et al.* (2016) [6, 11, 9]. In the present studies, the characters plant height (cm), number of primary branches per plant, days to 50% flowering, number of seeds per pod, number of pods per plant and pod length showed positive and significant correlation with pod yield per plant. These results are supported by Manggoel *et al.* (2012), Thorat *et al.* (2013), Sapara *et al.* (2014) and Patel *et al.* (2016) [6. 11. 9]. Pod yield per hectare recorded high positive significant correlation with number of primary branches per plant (0.6115r_g, 0.4548r_p) at 1% level of significance. It also showed positive significant correlation with number of pods per plant (0.2321r_g, 0.2595rp) and number of seeds per pod (0.3760r_g, 0.2984rp) at both 5% and 1% levels of significance. These results are supported by Patel *et al.* (2016) [9]. The magnitude of genotypic correlation was higher than phenotypic correlation for all the traits that indicated inherent association between various characters. The findings were in agreement to Pathak and Jamwal (2002) and Venkatesan *et al.* (2003) [10, 15]. In the present findings significant positive phenotypic correlation pod yield per plant was observed with number of pods per plant, pod weight indicating that these characters are the primary yield determinant in cowpea. The earlier findings of Pathak and Jamwal (2002), Kutty *et al.* (2007) and Lal *et al.* (2007) [10, 4, 5] for number of pods per plant, Venkatesan *et al.*, (2003) [15] for number of pods per plant, Singh *et al.* (2004), Anbumalarmathi *et al.* (2005) and Sharma *et al.* (2007) [13, 1, 12] for number of pods per plant.

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