



## Research Article

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# Study of Genetic Relationship in Cowpea [*Vigna unguiculata* (L.) Walp] Genotypes for Quantitative Traits and Hydration Index

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## Abstract

Thirty genotypes of cowpea [*Vigna unguiculata* (L.) Walp] were evaluated for 13 characters during kharif -2020 at Research Farm, Division of Botany, College of Agriculture, Pune-05. The genotypes were assessed for quantitative characters viz., days to first flowering, days to 50% flowering, days to maturity, number of branches per plant, number of clusters per plant, pods per cluster, seeds per pod, pod length, seed yield per plant, harvest index, 100 seed weight, hydration capacity and hydration index. The analysis of variance revealed that the mean sum of squares due to genotypes i.e., treatments for all the characters studied were highly significant. Correlation analysis revealed that seed yield per plant showed highly significant positive correlation with harvest index (0.860 and 0.867) followed by pod length (0.855 and 0.856), number of branches per plant (0.758 and 0.769) at phenotypic and genotypic level, respectively. The estimates of GCV and PCV were observed highest for hydration capacity followed by 100 seed weight, cluster per plant indicating good scope for improvement through selection. Path analysis study revealed significantly positive direct effect of pod length (0.398) on seed yield per plant followed by harvest index (0.325). For D<sup>2</sup> analysis, the 30 genotypes were grouped into 7 clusters. The D<sup>2</sup>-values ranged from 21.26 to 48.46. The Cluster-I was the largest with 14 genotypes followed by clusters-II with 8 genotypes and IV and 4 genotypes, respectively. Based on inter-cluster and intra-cluster distance the genotypes viz., PCP-1506, CP-11, CP-37, CP-36, CP-33, Phule Sonali and Phule Vithai suggested for future breeding programme.

**Keywords:** Coefficient of variance, Correlation, Cowpea, Genetic divergence, Path analysis.

## INTRODUCTION

Cowpea [*Vigna unguiculata* (L.) Walp] is a third mostly grown legume crop in developing countries which belongs to the order *Rosales*, family *Leguminaceae* (*Fabaceae*) and genus *Vigna*. This crop is native to West Africa [1]. Cowpea is considered as “Poor man’s meat” due to its rich source of nutrients especially high protein (23.8%) and vitamins. 100 gram of cowpea provides 343 kcal energy, carbohydrate (59.6g), fiber (10.7 g), calcium (85mg), iron (9.95mg), magnesium (333mg) and vitamin-c (1.5mg) (USDA, Food Data Central).

Cowpea is grown in over 2/3 of the developing world as a companion or relay crop with major cereal. Globally, cowpea being grew on 14.5 million ha with 6.5 million tonnes of annual production [2]. In Indian, it is a minor pulse crop cultivated mainly in arid and semi-arid tracts of Punjab, Haryana, Delhi and Uttar Pradesh on approximately 3.9 million ha area with 2.21 million tonnes of total production. An average productivity of cowpea is 6.07 tonnes/ha.

Study of correlation between grain yield and its contributing components improves the efficiency of breeding programs through the use of appropriate selection indices. Path analysis allows a breakdown of the estimated correlations in direct and indirect effects of each character on a basic variable. Coefficient of variation is a measure commonly applied to present variation in agricultural traits and to compare the variation of different traits in a population under study. D<sup>2</sup> statistics technique used to detect multivariate distance metrics for evaluation of genetic diversity present in breeding material. Diversity in plant genetic resources provides opportunity for plant breeders to develop new and improved cultivars with desirable characteristics.

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## MATERIAL AND METHODS

The experimental material consisted of 30 genotypes including 4 checks of cowpea were obtained from Pulse and Oilseed Crops Research Station, Pandharpur, Dist- Solapur, Maharashtra. The study was conducted during *Kharif, 2020* at Research Farm, Division of Botany, College of Agriculture, Pune-05. Experiment was laid in a Randomized Block Design with the spacing of 45×10cm<sup>2</sup> and 3.5 m of row length in three replications. The genotypes were evaluated for 13 characters *viz.*, days to first flowering (no.), days to 50% flowering (no.), days to maturity (no.), number of branches per plant, number of clusters per plant, pods per cluster (no.), seeds per pod (no.), pod length (cm), seed yield per plant (g), harvest index (%), 100 seed weight (g), hydration capacity (g seed<sup>-1</sup>) and hydration index. The mean of five randomly selected plants from each replication were used for statistical analysis. To understand and estimate the association among the characters, genotypic and phenotypic correlation coefficients were worked out by method given by Singh and Chaudhary [3]. Path coefficient analysis was done according to the procedure suggested by Dewey and Lu [4]. The analysis of variance was done by Panse and Sukhatme [5]. The generalized distance between two populations was defined by Mahalanobis [6] and cluster formation was done by following Tocher's method as described by Rao [7].

## RESULTS AND DISCUSSION

The present investigation was conducted to study genetic relationship in cowpea [*Vigna unguiculata* (L.) Walp] genotypes for quantitative characters. The analysis of variance (Table. 1) revealed that the mean sum of squares due to genotypes *i.e.*, treatments for all the characters studied were highly significant which indicated presence of appreciable amount of variability among the genotypes.

The estimates of GCV were observed highest for hydration capacity followed by 100 seed weight, number of clusters per plant and PCV were observed highest for 100 seed weight, hydration capacity, and number of clusters per plant indicating good scope for improvement through selection. The highest difference between GCV and PCV values was observed for pods per cluster followed by branches per plant indicating that environment played role in expression of these characters. The lowest difference between GCV and PCV values observed for harvest index and seeds per pod indicating that environment played less role in expression of these characters and can be rely on the phenotype while carrying out selection.

The genotypic correlation was high in magnitude than corresponding phenotypic correlation. Earlier worker Santos *et al.* [8] also found the same result. Seed yield per plant showed highly significant positive correlation with harvest index, pod length, number of branches per plant, and pods per cluster, number of clusters per plant, 100 seed weight, seeds per pod, days to 50% flowering, hydration capacity, days to first flowering at

genotypic and phenotypic level. These findings are similar with Nguyen *et al.* [9], Sabale *et al.* [10], Vijay kumar *et al.* [11] and Pethe *et al.* [12].

The phenotypic coefficient of variation was higher than genotypic coefficient of variation for all the quantitative traits under observation which indicates that the genotypes influenced by environment (Table 3). The results are confirmed by earlier findings of Khan *et al.* [13], Devi and Jayamani [14] and Bamji *et al.* [15].

Study of path coefficient analysis was done by the method suggested by Dewey and Lu [4] is presented in Table 4. The character pod length showed highest direct effect on seed yield per plant followed by harvest index, days to 50% flowering and pods per cluster. However, the negative direct effect of days to first flowering (-0.153) followed by days to maturity (-0.038) was observed on seed yield per plant. The Shanko *et al.* [16] and Lokesh and Murthy [17] confirmed similar results. The Residual value after the analysis was found to be 0.265 which indicates the little role of environment and gives the measure of effect of other possible independent variables which were not included in this study.

For diversity analysis, the 30 genotypes were grouped into 7 clusters. The D<sup>2</sup>-values ranged from 21.26 to 48.46. The Cluster-I was the largest with 14 genotypes followed by clusters-II with 8 genotypes and IV and 4 genotypes, respectively. Remaining 4 clusters were monogenotypic indicating wide diversity from the rest and also from each other (Table 5). The performance for mean cluster values of 13 quantitative characters is presented in (Table 7).

Looking to the percent contribution of 13 characters of cowpea for total divergence, the character 100 seed weight (56.09%) showed maximum contribution to the total divergence. It is followed by cluster per plant (12.18%) and seeds per pod (9.20%), harvest index (6.21%), days to maturity (5.29%), pods per cluster (1.15%), pod length (1.15) while, hydration capacity (0.23%) and hydration index (0.23%) contributed least (Table. 8). Girish *et al.* [18], Nagalakshmi *et al.* [19], Khanpara [20] also reported the similar findings. The genotypes PCP- 1506, CP-11, CP-37, Phule Vithai, PCP-1008, CP-07, CP-36, Phule Sonali, CP- 39, CP-33 are suggested for future breeding programme.

The genotype CP-33, PCP-1506 (days to first flowering), CP-33 (days to 50% flowering), CP-7 (days to maturity), CP-11 (number of branches per plant, pod per cluster, seeds per pod, pod length, harvest index, hydration capacity, seed yield per plant), Phule Sonali (number of clusters per plant), CP-36 (100 seed weight) and CP-33 (hydration index) were found to be superior on the basis of their mean performance.

Therefore, it can be concluded that genotypes, CP-33, PCP-1506, CP-11, Phule Sonali and CP- 36 were the best genotypes showing desired *per se* performance for yield contributing traits and can be used as potent parents for crop improvement programme.

**Table 1:** Analysis of variance for 13 characters in cowpea

S. No.	Character	Mean sum of square		
		Replication (2)	Genotype (29)	Error (58)
1	Days to first flowering (No)	2.711	14.494**	1.930
2	Days to 50% flowering (No)	3.611	31.101**	3.128
3	Days to maturity (No)	4.300	98.348**	3.679
4	Number of branches per plant	0.172	1.253**	0.109
5	Number of clusters per plant	0.023	2.530**	0.040
6	Pods per cluster (No.)	0.043	0.345**	0.072
7	Seeds per pod (No.)	0.125	4.595**	0.091
8	Pod length (cm)	0.103	3.604**	0.160
9	Harvest Index (%)	0.035	27.719**	1.231
10	100 seed weight (g)	0.059	7.663**	0.078
11	Hydration capacity	0.0001	0.001**	0.0001
12	Hydration Index	0.005	0.121**	0.005

13	Seed yield per plant (g)	0.182	12.534**	0.806
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\*,\*\* significant at 5 and 1 % level, respectively.

**Table 2:** Estimates of variability parameters for seed yield and its contributing characters in thirty cowpea genotypes.

S. No.	Character	Mean	Range	GCV (%)	PCV (%)
1	Days to flowering (No)	35.88	32.00-39.00	5.70	6.89
2	Days to 50% flowering (No)	46.24	38.33-52.67	6.60	7.63
3	Days to maturity (No)	84.23	68.67-91.00	6.67	7.05
4	Number of branches per plant	4.09	2.73-5.40	15.09	17.11
5	Number of cluster per plant	5.28	3.90-7.10	17.27	17.68
6	Pods per cluster (No)	3.27	2.82-4.27	9.21	12.36
7	Seeds per pod (No)	12.00	8.95-13.70	10.21	10.51
8	Pod length (cm)	12.93	11.17-15.44	8.28	8.84
9	Seed yield per plant (g)	35.97	31.10-42.83	8.26	8.82
10	Harvest index (%)	10.40	7.50-13.40	15.29	15.52
11	100 seed weight (g)	0.10	0.07-0.15	17.27	19.89
12	Hydration capacity (g-1seed)	1.10	0.78-1.59	17.92	19.10
13	Hydration index	15.16	10.88-21.84	13.04	14.32

**Table 3:** Estimates of genotypic (above diagonal) and phenotype correlation coefficients (below diagonal) among seed yield and 13 yield contributing characters in thirty cowpea genotypes

Characters	Days to first flowering (No.)	Days to 50% Flowering (No.)	Days to maturity (No.)	Number of branches per plant	Number of Clusters per plant	Pods per cluster (No.)	Seeds per pod (No.)	Pod length(cm)	Seed yield per plant (g)	Harvest Index (%)	100 seed weight (g)	Hydration capacity(gseed <sup>-1</sup> )	Hydration Index
Days to first flowering (No.)	1.000	0.858**	0.009	-0.017	0.124	0.359**	-0.085	0.281**	0.181	0.174	0.116	0.158	-0.371
Days to 50% flowering (No.)	0.859**	1.000	0.116	0.117	0.056	0.312**	-0.034	0.313**	0.289**	0.288**	0.199	0.151	-0.414
Days to maturity (No.)	0.067	0.160	1.000	-0.057	-0.130	-0.005	0.488**	0.095	-0.060	-0.141	-0.380	-0.263	-0.300
Number of branches per plant	0.034	0.139	-0.028	1.000	0.500**	0.538**	0.227*	0.612**	0.769**	0.756**	0.187	0.037	-0.162
Number of clusters per plant	0.144	0.078	-0.111	0.492**	1.000	0.310**	-0.129	0.328**	0.432**	0.582**	-0.028	-0.041	-0.110
Pods per cluster (No.)	0.367**	0.318**	0.029	0.549**	0.310**	1.000	0.217*	0.595**	0.693**	0.635**	0.136	0.271**	-0.113
Seeds per pod (No.)	-0.040	0.001	0.495**	0.236*	-0.117	0.215*	1.000	0.510**	0.350**	0.077	-0.167	-0.024	-0.057
Pod length (cm)	0.315**	0.335**	0.120	0.609**	0.333**	0.565**	0.507**	1.000	0.856**	0.692**	0.153	0.076	-0.183
Seed yield per plant (g)	0.234*	0.324**	-0.020	0.758**	0.437**	0.665**	0.361**	0.855**	1.000	0.860**	0.365**	0.251*	-0.023
Harvest Index (%)	0.221*	0.323**	-0.102	0.732**	0.581**	0.586**	0.097	0.690**	0.867**	1.000	0.354**	0.121	-0.176
100 seed weight (g)	0.140	0.215*	-0.354	0.191	-0.020	0.138	-0.154	0.165	0.357**	0.362**	1.000	0.409**	0.175
Hydration capacity (gseed <sup>-1</sup> )	0.191	0.178	-0.223	0.073	-0.030	0.251*	-0.006	0.098	0.237*	0.162	0.408**	1.000	0.677**
Hydration Index	-0.276	-0.333	-0.259	-0.122	-0.093	-0.065	-0.035	-0.144	-0.064	-0.135	0.186	0.665**	1.000

**Table 4:** Direct (diagonal) and indirect (above and below diagonal) path effects of different characters towards seed yield.

Characters	Days to first flowering (No.)	Days to 50% Flowering (No.)	Days to maturity (No.)	Number of branches per plant	Number of clusters per plant	Pods per cluster (No.)	Seeds per pod (No.)	Pod length (cm)	Harvest Index (%)	100 seed weight (g)	Hydration capacity (gseed <sup>-1</sup> )	Hydration Index	Seed yield per plant (g)
Days to flowering (No.)	-0.153	0.136	0.000	-0.002	0.004	0.051	-0.009	0.112	0.057	0.012	0.003	-0.030	0.181
Days to 50% flowering (No.)	-0.132	0.158	-0.004	0.015	0.002	0.044	-0.004	0.124	0.094	0.021	0.003	-0.033	0.289**
Days to maturity (No)	-0.001	0.018	-0.038	-0.007	-0.005	-0.001	0.050	0.038	-0.046	-0.040	-0.005	-0.024	-0.060
Number of branches per plant	0.003	0.019	0.002	0.131	0.017	0.076	0.023	0.243	0.246	0.020	0.001	-0.013	0.769**
Number of clusters per plant	-0.019	0.009	0.005	0.066	0.034	0.044	-0.013	0.130	0.189	-0.003	-0.001	-0.009	0.432**
Pods per cluster (No.)	-0.055	0.049	0.000	0.071	0.011	0.142	0.022	0.237	0.207	0.014	0.005	-0.009	0.693**
Seeds per pod (No.)	0.013	-0.005	-0.019	0.030	-0.004	0.031	0.103	0.200	0.025	-0.018	0.000	-0.005	0.350**
Pod length (cm)	-0.043	0.050	-0.004	0.080	0.011	0.084	0.052	0.398	0.225	0.016	0.001	-0.015	0.856**
Harvest Index (%)	-0.027	0.046	0.005	0.099	0.020	0.090	0.008	0.275	0.325	0.038	0.002	-0.014	0.867**
100 seed weight (g)	-0.018	0.032	0.014	0.025	-0.001	0.019	-0.017	0.061	0.115	0.106	0.007	0.014	0.357**
Hydration capacity (gseed <sup>-1</sup> )	-0.024	0.024	0.010	0.008	-0.001	0.038	-0.002	0.030	0.039	0.043	0.018	0.054	0.237**
Hydration Index	0.057	-0.066	0.011	-0.021	-0.004	-0.016	-0.006	-0.073	-0.057	0.019	0.012	0.080	-0.064

**Table 5:** Distribution of 30 cowpea genotypes into different clusters.

Clusters	No. of genotypes included	Name of genotypes
I	14	PCP-1122, PCP-1401, PCP-1406, PCP-1131, CP-31, PCP-1111, CP-35, PCP-1407, PCP-1112, CP-34, CP-19, CP-32, PCP-1110, PCP-1102.
II	8	Phule Rukhmini, Phule Vithai, CP-37, CP-05, CP-11, Phule Pandhari, CP-01, RC-101,
III	1	PCP-1008
IV	4	CP-36, PMCP-1016, CP-07, PCP-1405.
V	1	Phule Sonali.
VI	1	CP-39
VII	1	CP-33

**Table 6:** Average intra (bold) and inter-cluster distance (D<sup>2</sup>) values for seven clusters in thirty cowpea genotypes.

Clusters	I	II	III	IV	V	VI	VII
I	<b>21.266</b>	32.230	24.614	48.466	42.944	38.179	33.291
II		<b>24.339</b>	26.640	38.015	26.857	29.044	30.654
III			<b>0.000</b>	38.213	34.533	24.631	34.658
IV				<b>26.282</b>	33.636	32.891	32.488
V					<b>0.000</b>	34.561	30.272
VI						<b>0.000</b>	36.066
VII							<b>0.000</b>

**Table 7:** Mean values of the seven clusters for thirteen characters in 30 cowpea genotypes.

Cluster No.	Days to first flowering (No.)	Days to 50% Flowering (No.)	Days to maturity (No.)	Number of branches per plant	Number of clusters per plant	Pods per cluster (No.)	Seeds per pod (No.)	Pod length(cm)	Harvest index (%)	100 seed weight (g)	Hydration capacity (g seed <sup>-1</sup> )	Hydration Index	Seed yield per plant (g)
CL-I	35.98	46.05	87.31	3.78	4.89	3.18	12.41	12.69	34.15	9.24	0.10	1.10	14.16
CL-II	36.13	46.75	80.13	4.57	6.02	3.49	11.96	13.53	38.89	10.72	0.10	1.02	16.91
CL-III	39.00	52.67	90.33	3.53	5.03	3.13	11.43	13.02	34.66	10.90	0.08	0.78	14.23
CL-IV	34.50	45.42	80.25	4.10	4.67	3.09	11.39	12.25	34.99	12.83	0.11	1.24	14.74
CL-V	37.67	48.00	77.67	4.63	7.10	3.57	9.83	12.60	38.91	11.55	0.14	1.22	15.22
CL-VI	37.00	48.00	91.00	4.80	5.07	3.70	11.97	15.05	42.24	12.51	0.08	0.79	18.16
CL-VII	32.00	38.33	83.67	3.97	5.77	3.03	11.83	12.44	34.30	10.63	0.12	1.59	14.83

**Table 8:** Per cent contribution of 13 different characters of cowpea genotype for divergence.

Sr. No.	Name of character	Times Ranked 1st	Contribution%
1	Days to first flowering (No)	0	0.00%
2	Days to 50% flowering (No)	0	0.00%
3	Days to maturity (No)	23	5.29%
4	Number of branches per plant	0	0.00%
5	Number of clusters per plant	52	12.18%
6	Pods per cluster (No.)	5	1.15%
7	Seeds per pod (No.)	40	9.20%
8	Pod length (cm)	5	1.15%
9	Harvest Index (%)	27	6.21%
10	100 seed weight (g)	244	56.09%
11	Hydration capacity	1	0.23%
12	Hydration Index	37	8.51%
13	Seed yield per plant(g)	1	0.23%

**Conflict of Interest**

None declared.

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