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RESEARCH ARTICLE

Variability and character association in cowpea using *Bradyrhizobium* strain

■ **S.P. SHARMA, P.P. SHARMA, S.R. NEHRA AND C.L. KHATIK**

SUMMARY

A field experiment was carried out using twenty genotypes of cowpea [*Vigna unguiculata* (L.) walp] at Rajasthan College of Agriculture, Udaipur during 2008-09 treated with two *Bradyrhizobium* strains. Association studies revealed that seed yield per plant showed significant positive co-rrelation with pods per plant in all the environments, biological yield (E_1 and E_2), harvest index (E_1 and E_3), protein content (E_3), days to maturity, nodule fresh weight and nitrogen content in (E_3), most of these characters were also mutually correlated. Path analysis studies for seed yield revealed direct and indirect contribution of biological yield, harvest index, branches per plant, plant height and number of nodules (E_1), pods per plant, nodule fresh weight, protein content and nodule dry weight (E_2), nodule dry weight, branches per plant, protein content and plant height (E_3). While the protein content revealed direct as well as indirect contribution of biological yield, number of nodules, harvest index, 100 seed weight and nodule fresh weight (E_1), number of nodules, seed yield per plant, leghaemoglobin content and nitrogen content in (E_2), seed yield per plant, harvest index, number of nodules and nodule fresh weight in (E_3).

Key Words : Cowpea, Seed yield, Characters, Genotypes

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Cowpea [*Vigna unguiculata* (L.) walp] is a self pollinated crop, belonging to family Leguminaceae and sub-family Papilionaceae. Cowpea seed contains 25 per cent protein, 56 per cent carbohydrate, 500 IU of vitamin B and 3.2 per cent minerals. Besides these it also contains 1.9 per cent methionine of the total protein. Nodulation which is one of the primary component of symbiotic nitrogen fixation depends on the genotype of the crop, the bacterial strains and the environmental factors. Hence, there is a need to identify specific genotypes which can interact favourably with rhizobial strains to capitalize high nitrogen fixation (Balachandar *et. al.*, 2003).

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MATERIAL AND METHODS

A field experiment was conducted at Rajasthan College of Agriculture, Udaipur (Rajasthan) during season of 2008-09 with different strain of *Bradyrhizobium*. The experimental material for the present research work (Twenty diverse genotypes) were obtained from Central Arid Zone Research Institute (CAZRI), Jodhpur. These genotypes were planted in compact family Block Design with three replications in three environments namely, with *Bradyrhizobium* strain-I treatment,

with *Bradyrhizobium* strain-II treatment and without *Bradyrhizobium* treatment (control). Each entry was grown in five rows of four meter length with row to row and plant to plant distance of 45 cm and 10 cm, respectively. Observations were recorded on five randomly selected competitive plants of each genotype in each replication and environment except days to 75 per cent maturity and protein content. The estimation of protein content was carreid out by Microkjeldhal's method and Nessler's reagent method for estimation of nitrogen content in plant.

RESULTS AND DISCUSSION

Analysis of variance showed highly significant difference between genotypes as well as over the environments indicating presence of sufficient variability in the experimental material (Table 1). The mean square due to environment and G x E were also significant for all the characters indicating differences between environments and differential response of genotypes in different environments. Success of breeding programme is largely dependent on the extent of genetic variability present in the material, greater the diversity in the material better are the chances for evolving promising and desired types. The genetic facts are inferred from phenotypic observations which are the results of genotype and environment and their interaction. Since environment has a great influence on many quantitative and

Table 1 : Mean squares for characters in cowpea for pooled analysis

Sr. No.	Characters	Replication	Treatment	Varieties	Environment	V x Env.	Error
1.	Number of nodules	21.04	98.70**	124.89**	1533.91**	10.08**	2.16
2.	Nodule fresh weight	44.85	7101.84**	4149.00**	165023.50**	266.59**	42.47
3.	Nodule dry weight	2.68	494.24**	430.80**	8574.47**	100.69**	19.24
4.	Days to maturity	0.63	152.84**	196.51**	1192.61**	76.29**	1.98
5.	Plant height	16.53	1708.60**	5257.49**	75.67**	20.10*	11.35
6.	Branches per plant	0.07	5.63**	8.33**	81.59**	0.28**	0.07
7.	Pods per plant	0.19	21.62**	50.46**	124.11**	1.80**	0.76
8.	Seed yield per plant	0.47	19.29**	50.02**	48.48**	2.39**	0.33
9.	100 seed weight	0.12	24.03**	65.81**	78.98**	0.24*	0.16
10.	Biological yield	2.84	194.03**	536.61**	142.49**	25.45**	9.79
11.	Harvest index	0.72	44.87**	82.72**	425.71**	5.89**	0.48
12.	Leghaemoglobin content	6.11	393.67**	896.60**	133.43**	155.91**	17.15
13.	Nitrogen content	0.01	15.08**	32.23**	107.30**	1.65**	0.01
14.	Protein content	0.01	14.11**	13.29**	263.76**	1.39**	0.28

* and ** indicate significance of values at P=0.05 and 0.01, respectively

Table 2 : Genotypic co-efficient of variation (GCV), phenotypic co-efficient of variation (PCV), heritability (h^2) and genetic gain for fourteen characters in cowpea for pooled analysis

Characters	GCV %	PCV %	h^2%	GA % mean
Number of nodules	11.80	12.75	85.53	22.47
Nodule fresh weight	10.14	10.63	91.04	19.92
Nodule dry weight	11.42	14.09	65.61	19.05
Days to maturity	5.13	5.49	87.14	9.85
Plant height	22.61	22.83	98.09	46.12
Branches/plant	17.55	18.21	92.86	34.83
Pods per plant	26.53	28.33	87.70	51.18
Seed yield/plant	35.64	36.72	94.25	71.27
100 Seed weight	15.29	15.45	97.89	31.15
Biological yield per plant	27.40	29.66	85.31	52.12
Harvest index	13.15	13.51	94.70	26.35
Leghaemoglobin content	6.44	7.07	82.76	12.06
Nitrogen content	10.22	10.23	99.88	21.04
Protein content	5.22	5.75	82.64	9.78

qualitative characters, the observed variability can be grouped under heritable and non- heritable components and can be estimated by parameters like genotypic co-efficient of variation (GCV), heritability (broad sense) and genetic gain. This would help the breeder in developing and formulating selection programme for genetic improvement of crop plants. Estimates of phenotypic co-efficient of variation (PCV) were slightly higher than genotypic co-efficient of variation (GCV) for all characters in all the environments. Low difference between GCV and PCV indicated that the variability was primarily of genotypic in nature (Table 2). Characters with high estimates of GCV and PCV could be exploited through selection. The traits like leghaemoglobin content, nitrogen content, days to maturity and protein content (all sets of analysis), number of nodules and nodule fresh weight (E_1 and E_2), nodule dry weight showed low estimates of PCV as well as GCV indicating that these characters were highly influenced by the environmental fluctuations and having low variations.

Estimates of genotypic and phenotypic co-efficient of variation alone do not assess the amount of heritable variation which in turn can be estimated by heritability. High heritability in broad sense (about 75%) was recorded for nodule fresh weight, nitrogen content, 100 seed weight, plant height, days to maturity, branches per plant, pods per plant, harvest index, seed yield per plant and number of nodules in all the environments. Nodule dry weight in all the environments, leghaemoglobin content in E_1, E_2 and pooled analysis, biological yield in E_1, E_3 and pooled analysis and protein content in E_2, E_3 and over pool basis. Johnson *et al.* (1955) suggested that heritability and genetic advance when calculated together would become more useful in predicting the resultant effect of selection on phenotypic expression.

Highest genetic gain was recorded for seed yield per plant (E_3 and E_1 67.84 and 66.48), biological yield per plant (E_3 63.86 and E_1 61.64), pods per plant (E_1 58.66 and E_3 55.68). In the present investigation, high genetic gain along with high heritability and GCV was recorded for seed yield per plant and plant height (all sets of analysis), biological yield, pods per plant, branches per plant and 100 seed weight (E_1 and E_3).The other characters such as number of nodules, nodule fresh weight, nodule dry weight, harvest index and nitrogen content, (in all the environments), biological yield, pods per plant, branches per plant and 100 seed weight in (E_2) showed moderate to high genetic gain along with high heritability and moderate to high GCV. It appeared that these characters might be exhibiting predominance of additive gene effects (Panse, 1957). Hence, selection for these traits would be effective for genetic improvement of grain yield with better nutritional quality as well as high nitrogen fixing efficiency of crop plants (cowpea). On the other hand, the characters such as days to maturity, leghaemoglobin content and protein content showed low genetic gain along with low heritability and low GCV in all the environments and pool analysis, hence, these characters seemed to be greatly affected by environment and strong evaluation programme should to be taken for their exploitation.

In general, a close agreement exists between genotypic and phenotypic correlation co-efficient indicating that the environmental influences were non-significant. Although, genotypic correlations were generally higher than their co-rresponding phenotypic correlations for most of the traits, this may be due to the masking efficiency of environment in modifying the total expression of the genotypes (Table 3). In the present study, seed yield per plant was significantly and positively correlated with pods per plant in all the environments. Biological yield showed positively correlation with seed yield in E_1, E_2. Harvest index was positively co-rrelated with seed yield in E_1, E_3. Protein content and harvest index showed positively correlated with seed yield in E_3, nodule fresh weight, nitrogen content and days to maturity in E_3 was positively correlated with seed yield. 100 seed weight showed significant negative correlation with grain yield in environment-E_3. Similar associations for one or other aforesaid component characters with seed yield were also reported by Nehru and Kangaiah (1998) in soybean for protein content and Bandyopadhyay (1991) and Mathur *et al.* (1998) in *Vigna mungo* for nodule number and weight and nitrogen content. Protein content had significant positive correlation with number of nodules in all the environments, nodule fresh weight showed significant positive correlation with protein content in E_1 and E_2, days to maturity and nitrogen content was positively and significantly correlated with protein content in environment-E_2 and pooled analysis. Seed yield per plant was positively correlated with protein content in E_3 and pooled analysis, leghaemoglobin content and 100 seed weight in E_3 were significantly and positively correlated with nitrogen content, biological yield was positively correlated with protein content in pooled analysis. Branches per plant, 100 seed weight and plant height showed significant negative correlation with protein content in E_3. Therefore, from the present correlation study it could be conclude that seed yield and protein content showed strong positive correlation with most of the characters were also mutually correlated. Hence, simultaneously selection for all these traits would result in genetic improvement of seed yield in cowpea.

As observed from correlation study seed yield, exhibited significant positive correlation with pods per plant in all the environments. Highest direct effect was exhibited by biological yield (0.713), followed by protein content (0.473), harvest index (0.468), number of nodules (0.326), branches per plant (0.181), 100 seed weight (0.116) and plant height (0.09) in favourable direction whereas contribution of nodule dry weight (-0.348), days to maturity (-0.303), nitrogen content (-0.227), nodule fresh weight (-0.204), pods per plant (-0.064) and leghaemoglobin content (-0.036) was in unfavourable direction (Table 4). Biological yield exhibited positive correlation and highest direct effect on grain yield because of indirect

Table 3 : Genotypic and phenotypic correlation between fourteen characters in cowpea for pooled analysis

Sr. No	Characters		Nodule fresh weight	Nodule dry weight	Days to maturity	Plant height	Branches per plant	Pods per plant	Seed yield per plant	100 seed weight	Biological yield per plant	Harvest Index	Leghaemoglobin content	Nitrogen content	Protein content
1.	No. of nodules	g	0.871**	0.740**	0.398	-0.138	0.426	0.268	0.165	0.077	0.196	0.425	0.510*	0.308	0.188
		p	0.850**	0.670**	0.374	-0.129	0.408	0.250	0.109	0.068	0.161	0.383	0.478*	0.180	0.068
2.	Nodule fresh wt.	g		0.808**	0.250	-0.040	0.520*	0.353	0.239	0.147	0.236	0.516*	0.715**	0.162	1.176
		p		0.757**	0.245	-0.040	0.507*	0.341	0.138	0.142	0.209	0.466*	0.687**	0.110	0.046
3.	Nodule dry wt.	g			0.246	0.053	0.482*	0.122	0.081	0.299	0.203	0.404	0.588**	0.126	0.049
		p			0.226	0.050	0.448*	0.113	0.055	0.274	0.193	0.351	0.538*	0.094	0.013
4.	Days to maturity	g				0.085	0.197	0.083	0.400	0.046	0.123	0.455*	0.146	0.017	0.792**
		p				0.083	0.188	0.077	0.243	0.042	0.109	0.420	0.135	0.008	0.222
5.	Plant height	g					0.052	0.044	-0.139	0.014	-0.047	0.135	-0.011	-0.153	-0.471*
		p					0.050	0.041	-0.044	0.005	-0.043	0.140	-0.012	-0.131	-0.079
6.	Branches/plant	g						0.484*	0.103	0.451*	0.135	0.362	0.382	0.021	-0.331
		p						0.464*	0.057	0.432	0.120	0.329	0.364	0.019	-0.087
7.	Pods/plant	g							0.544*	-0.068	0.642**	0.355	0.291	0.071	-0.024
		p							0.298	-0.062	0.575*	0.295	0.271	0.058	-0.023
8.	Seed yield/plant	g								-0.265	0.964**	0.470*	0.067	0.270	0.440*
		p								-0.300	0.345	0.534*	-0.010	-0.425	0.839**
9.	100 Seed wt.	g									-0.230	0.101	0.198	0.096	-0.423
		p									-0.163	0.028	0.198	0.186	-0.284
10.	Biological yield	g										0.296	0.134	0.015	0.548*
		p										0.192	0.134	0.150	-0.070
11.	Harvest index	g											0.388	0.444*	0.174
		p											0.325	0.043	0.382
12.	Leghaemoglobin	g												-0.068	-0.071
		p												-0.003	-0.078
13.	Nitrogen content	g													0.553*
		p													-0.549*
14.	Protein content	g													
		p													

g, p genotypic and phenotypic co-rrelations co-efficient, respectively, *and ** indicate significance of values at P=0.05 and 0.01, respectively

Table 4 : Path co-efficient analysis for seed yield showing direct and indirect effect of fourteen characters in cowpea for pooled analysis

Sr. No	Characters	Number of nodules	Nodule fresh weight	Nodule dry weight	Days to maturity	Plant height	Branches per plant	Pods per plant	100 seed weight	Biological yield per plant	Harvest index	Leghaemoglobin content	Nitrogen content	Protein content	Genotypic correlation with seed yield (r)
1.	No.of nodules	0.326	-0.178	-0.257	-0.121	-0.013	0.077	-0.017	0.009	0.140	0.199	-0.018	-0.070	0.089	0.165
2.	Nodule fresh wt.	0.234	-0.204	-0.281	-0.076	-0.004	0.094	-0.023	0.017	0.168	0.241	-0.026	-0.037	0.083	0.239
3.	Nodule dry wt.	0.241	-0.165	-0.348	-0.075	0.005	0.087	-0.008	0.035	0.145	0.189	-0.021	-0.029	0.023	0.081
4.	Days to maturity	0.130	-0.051	-0.086	-0.303	0.008	0.035	-0.005	0.005	0.088	0.213	-0.005	-0.004	0.375	0.400
5.	Plant height	-0.045	0.008	-0.018	-0.026	0.091	0.009	-0.003	0.002	-0.034	0.063	0.000	0.035	-0.223	-0.139
6.	Branches/plant	0.139	-0.106	-0.168	-0.060	0.005	0.181	-0.031	0.052	0.096	0.170	-0.014	-0.005	-0.157	0.103
7.	Pods/plant	0.087	-0.072	-0.043	-0.025	0.004	0.088	-0.064	-0.008	0.458	0.157	-0.011	-0.016	-0.011	0.544
8.	100 seed weight	0.025	-0.030	-0.104	-0.014	0.001	0.082	0.004	0.115	-0.164	0.047	-0.007	-0.022	-0.200	-0.265
9.	Biological yield	0.064	-0.048	-0.071	-0.037	-0.004	0.025	-0.041	-0.027	0.713	0.139	-0.005	-0.003	0.259	0.964
10.	Harvest index	0.138	-0.105	-0.140	-0.138	0.012	0.065	-0.021	0.012	0.211	0.468	-0.014	-0.101	0.082	0.470
11	Leghae-moglobin	0.166	-0.146	-0.204	-0.044	-0.001	0.069	-0.019	0.023	0.095	0.182	-0.036	0.016	-0.034	0.067
12.	Nitrogen content	0.100	-0.033	-0.044	-0.005	-0.014	0.004	-0.004	0.011	0.010	0.208	0.002	-0.227	0.262	0.270
13.	Protein content	0.061	-0.036	-0.017	-0.240	-0.043	-0.060	0.002	-0.049	0.391	0.082	-0.003	-0.126	0.473	0.440

Residual effect = 0.1515

Table 5: Path co-efficient analysis for protein content showing direct and indirect effect of fourteen characters in cowpea for pooled analysis

Sr. No.	Characters	Number of nodules	Nodule fresh weight	Nodule dry weight	Days to maturity	Plant height	Branches per plant	Pods per plant	Seed yield / plant	100 seed weight	Biological yield per plant	Harvest index	Leghaem-oglobin content	Nitrogen content	Genotypic correlation with seed yield (r)
1.	Number of nodules	0.375	-0.708	0.887	0.007	0.019	-0.261	0.142	0.505	-0.009	-0.518	-0.263	0.048	-0.037	0.188
2.	Nodule fresh weight	0.327	-0.813	0.967	0.005	0.006	-0.319	0.188	0.729	-0.017	-0.624	-0.320	0.068	-0.020	0.176
3.	Nodule dry weight	0.278	-0.657	1.198	0.004	-0.007	-0.296	0.065	0.246	-0.035	-0.536	-0.251	0.056	-0.015	0.049
4.	Days to maturity	0.149	-0.203	0.295	0.018	-0.012	-0.121	0.044	1.222	-0.005	-0.325	-0.282	0.014	-0.002	0.792
5.	Plant height	-0.052	0.033	0.064	0.002	-0.140	-0.032	0.023	-0.426	-0.002	0.125	-0.084	-0.001	0.018	-0.471
6.	Branches/plant	0.160	-0.423	0.578	0.004	-0.007	-0.613	0.257	0.316	-0.053	-0.357	-0.225	0.036	-0.003	-0.331
7.	Pods/Plant	0.101	-0.287	0.147	0.002	-0.006	-0.297	0.531	1.662	0.008	-1.696	-0.208	0.028	-0.008	-0.024
8.	Seed yield /plant	0.062	-0.194	0.096	0.007	0.020	-0.063	0.289	3.056	0.031	-2.546	-0.292	0.006	-0.033	0.440
9.	100 seed weight	0.029	-0.120	0.358	0.001	-0.002	-0.277	-0.036	-0.810	-0.118	0.608	-0.063	0.019	-0.012	-0.423
10.	Biological yield	0.073	-0.192	0.243	0.002	0.007	-0.083	0.341	2.945	0.027	-2.642	-0.184	0.013	-0.002	0.548
11.	Harvest Index	0.159	-0.419	0.484	0.008	-0.019	-0.222	0.178	1.437	-0.012	-0.783	-0.620	0.037	-0.054	0.174
12.	Leghaemoglobin content	0.191	-0.581	0.704	0.003	0.002	-0.234	0.155	0.204	-0.023	-0.353	-0.241	0.095	0.008	-0.071
13.	Nitrogen content	0.115	-0.132	0.150	0.000	0.021	-0.013	0.037	0.825	-0.011	-0.039	-0.275	-0.006	-0.121	0.553

Residual effect = 0.9780

contribution through protein content, harvest index, number of nodules (Barhate *et al.*, 2004). Number of nodules, pods per plant, biological yield, harvest index, leghaemoglobin content exhibited positive correlation and direct effect on seed yield due to its indirect contribution through one another and also due to protein content.

Protein content exhibited significant positive correlation with number of nodules in all the environments (Sharma, 2003). In pooled analysis, the highest direct effect was exhibited by seed yield per plant (3.056) followed by nodule dry weight (-1.198), pods per plant (0.531), number of nodules (0.375) leghaemoglobin content (0.095) and days to maturity (0.018) in favourable direction whereas contribution of biological yield (-2.642), nodule fresh weight (-0.813), harvest index (-0.620), branches per plant (-0.613), plant height (-0.140), nitrogen content (-0.121) and 100 seed weight (-0.118) was in unfavourable direction (Table 5).

It was observed that the characters change their path with change in the environments the traits contributing towards grain yield. Hence, due emphasis should be placed on these traits while breeding for high seed yield in cowpea for both environments (Raverkar and Tilak, 2002). Therefore, these genotypes should be incorporated in further breeding programme to improve nitrogen fixing efficiency of cowpea aimed to increase yield. Seed yield per plant, number of nodules, days to maturity, plant height, pods per plant and 100 seed weight exhibited significant positive correlation and positive effect on nitrogen content due to its indirect contribution through one another and also due to nodule dry weight and leghaemoglobin content.

Based on results obtained from the present study it can be concluded that selection for seed yield per plant, pods per plant, branches per plant, plant height, nodule dry weight, number of nodules would enhance the nitrogen fixing efficiency and productivity levels of cowpea and would help in identifying superior stable genotypes.

REFERENCES

Balachandar, D., Nagarajan, P. and Gunasekaran, S. (2003). Effect of organic amendments and micronutrients on nodulation and yield of blackgrram in acid soil. *Leg. Res.*, **26**(3): 192-195.

Bandyopdhyay, S.K. (1991). Symbiotic efficiency a criterion for selection of agronomically superior strains in [*Vigna mungo* (L.) Wilzek.] *Exp. Genet.*, **7**(2) : 26-30.

Barhate, B.C., Bendre, N.J., Mahase, L.B. and Aher, R.P. (2004). Effect of *Rhizobium* strains on nodulation and grain yield of chickpea (*Cicer arietinum* L.). *Leg. Res.*, **27**(2): 151-152.

Johnson, H.W., Robinson, H.F. and Comstock, R.E. (1955). Estimate of genetic and environmental variability in soybean. *Agron. J.*, **46** : 314-318.

Kumari, K.S.M. and Nair, S.K. (2003). Use of acid tolerant strains of *Brodyrhizobium* sp. for blackgram and green gram. *Leg. Res.*, **26**(1) : 60-62.

Mathur, V.L., Kant, L. and Joshi, A. (1998). Study of nodulation leghaemoglovin content and NRA in blackgram [*Vigna mungo* (L.) Hepper]. *Leg. Res.*, **21** (4) : 221-224.

Nehru, S.D. and Kangaiah, S. (1998). Effect of *Rhizobium japonicum* strain on nodulation and yield of soybean [*Glycine max* (L.) Merrill]. *Crop Improv.*, **25** (2) : 235-236.

Panse, V.G. (1957). Genetics of quantitative characters in relation to plant breeding. *Indian J. Genet.*, **17**: 318-328.

Raverkar, K.P. and Tilak, K.V.B.R. (2002). Improved mycorrhizal colonization, nodulation status, biomass production and nutrient uptake in soybean due to inoculcation with *Bradyrhizobium japonicum*. *Leg. Res.*, **25**(1) : 32-36.

Sharma, S. (2003). Response of various isolates of *Bradyrhizobium* inoculation on protein content and its yield attributes of green gram [*Vigna radiate* (L.) wilczek]. *Leg. Res.*, **26**(1):28-31.