Received : 11 Mar 2019 | Revised : 11 Dec 2019 | Accepted : 19 Dec 2019

Electronic Journal of Plant Breeding

Research Article

Character association and principal component analysis for seed yield and its contributing characters in greengram (*Vigna radiata* (L.) Wilczek)

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Abstract

A total of 74 green gram germplasm collections were evaluated for yield and its component characters through principal component analysis for determining the pattern of genetic diversity. Eight quantitative parameters *viz.,* plant height, number of primary branches, number of clusters per plant, number of pods per cluster, number of pods per plant, pod length, number of seeds per pod and single plant yield were measured. The largest variation was observed for plant height with a coefficient of variation (CV) of 58.98% followed by the number of pods per plant (35.16). The number of pods per cluster has shown the least variation with a CV of 0.50 %. Estimates of correlation coefficient showed a positive significant association of single yield with the number of pods per cluster and the number of pods per plant. The principal component analysis was used to assess the genetic diversity among the 74 germplasm collections. The results of PCA revealed that the cumulative variance of 79.90% by the first four axes with an Eigenvalue of 1.0 indicates that the identified traits within the axes exhibited greater influence on the phenotype. Amongst the first four PCs, PC1 accounted for a high proportion of total variance (32.60%) and the remaining three principal components *viz.,* PC2, PC3, and PC4 revealed 20.70, 14.30 and 12.30% of the total variance, respectively. Hence, it is suggested that the traits such as pod length, number of seeds per pod (PC 2), number of pods per cluster (PC 3) and single plant yield (PC 4) in the first four principal components contributed to major variation among germplasm collections. Hence, these traits are considered as key traits for selection criteria for developing high yielding cultivars of green gram.

Keywords

Green Gram - character association - principal component analysis - grain yield

INTRODUCTION

Green gram is an important grain legume crop grown in India and believed to be originated from India. India is the leading green gram cultivator with up to 55% of the total world acreage and 45% of total production (Rishi, 2009: Singh *et al*. 2013). In Tamil Nadu, the green gram is cultivated in an area of 2.5 lakhs hectare with a production of 1.34 lakh tonnes and a productivity of 536 kg/ha (AICRP-MULLaRP Annual Report, 2016-17). Grain yield is a complex character and its expression depends upon the interplay of a number of component characters. An insight into the association between grain yield and other traits helps to improve the efficiency of selection. To develop a new variety there is a need for the magnitude of genetic variability in the base material and vast variability for desired characters. A piece of good knowledge of genetic diversity or genetic similarity could be helpful in long term selection gain in plants (Meena *et al.,* 2015). Hence, genetic variability and diversity are of prime interest to the plant breeder as it plays a key role in framing a successful breeding program. Information on nature and magnitude of variation in the population and the extent of environmental influence on the expression of characters are necessary for effective selection (Santosh Arya *et al.,* 2013). A high magnitude of variability in a population provides the opportunity for selection to evolve a variety having desirable characters. A large number of variables are often measured by plant breeders, some of which may not be of sufficient discriminatory power for germplasm evaluation, characterization, and management. Recently Principal Component Analysis (PCA) used to reveal patterns and eliminate redundancy in data sets (Adams, 1995; Amy and Pritts, 1991) as morphological and physiological variations routinely occur in crop plants. Keeping in view the aforesaid problems, an attempt was made to assess the character association and variation among the genotypes to identify traits that contribute to variability in the green gram germplasm collections.

MATERIAL AND METHODS

The experimental material consisted of 74 germplasm accessions of green gram [*Vigna radiata* (L.) Wilczek] which were evaluated during *rabi* 2017 - 18 at National Pulses Research Centre (NPRC), Vamban, Pudukkottai, Tamil Nadu. All the entries were raised in the plot size of 2.4 m^2 adopting a spacing of 30 x 10 cm. Recommended agronomic practices were followed to maintain the crop stand. The biometrical observations on eight quantitative traits *viz.,* plant height, number of primary branches, number of clusters per plant, number of pods per cluster, number of pods per plant, pod length, number of seeds per pod, single plant yield were recorded on five randomly selected plants from each entry. The average of these five plants was used for statistical analysis. The data were analyzed using STAR (version 1.4) developed by IRRI, Philippines. The Principal Component Analysis was carried out to identify plant traits that contribute most of the observed variation among the genotypes. It was done by the method described by Upadhyaya *et al.* (2002).

RESULTS AND DISCUSSION

The correlation coefficient measures the mutual relationship between various plant characters and determines the component characters on which selection can be relied upon for genetic improvement of yield. The progress in the breeding program for economic characters often depends on the availability of large germplasm representing a diverse genetic variation. To ensure the efficient and effective use of crop germplasm, its characterization is necessary. The multivariate analysis provides a good evaluation of landraces by identifying the traits that should be further evaluated at the genetic level (Rabbani *et al*., 1998). Dasgupta and Das (1984) considered multivariate analysis as the best tool for choosing promising genotypes for the breeding programme. The estimates of correlation coefficients (**Table 1**) revealed that single plant yield showed a significant positive association with the number of pods per cluster (0.534) and number of pods per plant (0.467). Hence, selection based on these traits seemed to improve seed yield per plant. Among the yield components, the number of pods per plant had a significant positive association with plant height (0.312), number of primary branches (0.312), number of clusters per plant (0.742) and number of pods per cluster (0.564). The significant association among seed yield components indicated that correlated response to selection for these traits will increase the improvement of seed yield. Results of Principal Component Analysis revealed four principal components with eigenvalues of unity (one) and accounted for 79.90 per cent of the total variance in the data (**Table 2**). Amongst first four PCs, PC1 with eigenvalue 2.6 accounted high proportion of the total variance (32.60) and the remaining three principal components *viz.,* PC2, PC3 and PC4 with eigenvalue 1.7, 1.1 and 1.0 recorded 20.40, 11.30 and 10.20 per cent of total variance, respectively, while the other Principal

Table 1. Correlation coefficients of grain yield and its component characters in green gram

Characters	Plant height	Number of primary branches	Number of clusters plant	Number of pods per cluster	Number of pods per plant	Pod length	Number of seeds per pod	Single plant yield
Plant height	1.000	0.146	0.083	0.419**	0.312**	0.066	-0.046	0.054
Number of primary branches		1.000	0.136	0.164	0.312**	0.019	0.005	0.127
Number of clusters plant			1.000	0.070	0.742**	0.067	0.104	0.192
Number of pods per cluster				1.000	0.564**	0.054	0.122	0.534**
Number of pods per plant					1.000	0.033	0.096	0.467**
Pod length						1.000	0.682**	-0.017
Number of seeds per pod							1.000	0.059
Single plant yield								1.000

*Significant at P = 0.05 ** Significant at P = 0.01

Components (*i.e.* PC 5 to PC 8) had weak or no discriminatory power. Thus, the most important descriptors were those associated with the first four principal components. Eigenvalues of eight principal components have been shown in the scree plot (**Fig. 1**). The criterion of Raji (2002) was chosen to determine the cut-off limit for the coefficients of the proper vectors. This criterion treated coefficients was greater than 0.3 as having large effect to be considered important while traits having a coefficient value lesser than 0.3 were considered not to have important effects on the overall variation observed in the present study. Eigenvectors (loadings) of the first four principal components were presented in **Table 3**. The results showed that all the characters contributed negatively to the first component. In the second principal component (PC2), characters that contributed to the component include pod length (0.694) and the number of seeds per pod (0.688). Thus, this component was the weighted average of the characters which determine the yield level.

While all other characters contributed negatively to the second component. In the third principal component (PC3), the number of pods per cluster (0.480) and plant height (0.459) contributed the highest and while single plant yield (0.143), pod length (0.077) and number of seeds per pod (0.018) contributed less. These traits have the largest participation in the divergence and carry the largest portion of its variability. The principal component used for genotype differentiation could distinguish between high yielding genotypes with more the number of pods per cluster. These results are in agreement with the findings Salini *et al.* (2010) for plant height and Asaigbe *et al.* (2014) for the number of pods per plant. Single plant yield (0.602) contributed more to the variation and the number of pods per cluster (0.184) and number al

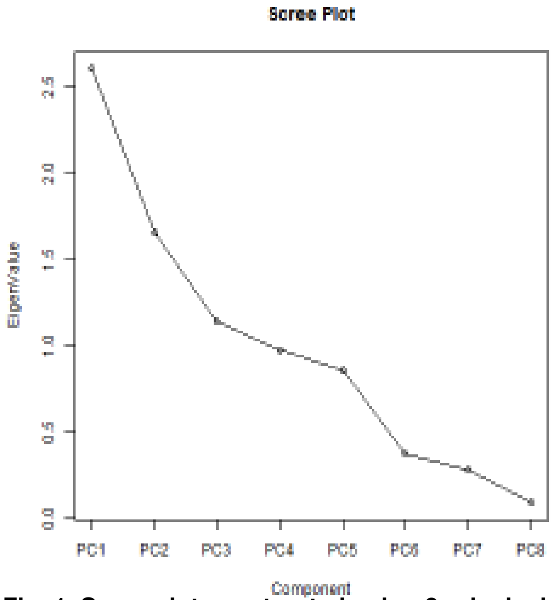

Fig. 1. Scree plot constructed using 8 principal components

Table 2. Eigenvalues and percentage of variation in for different principal components in 74 genotypes of green gram

Principal component	Eigen value	Per cent variation	Cumulative variation
PC1	2.6	32.60	32.60
PC2	1.7	20.70	53.30
PC3	1.1	14.30	67.60
PC4	1.0	12.30	79.90
PC5	0.9	10.80	90.60
PC6	0.4	4.70	95.40
PC7	0.3	3.50	98.90
PC8	0.1	1.10	100.00

Table 3. Eigenvalue, factor scores and contribution of the first four principal component axes to variation in green gram genotypes

Variables	PC1	PC2	PC3	PC4
Plant height	-0.284	-0.101	0.459	-0.548
Number of primary branches	-0.246	-0.084	-0.062	-0.529
Number of clusters plant	-0.376	-0.002	-0.678	-0.071
Number of pods per cluster	-0.459	-0.075	0.480	0.184
Number of pods per plant	-0.563	-0.098	-0.263	-0.014
Pod length	-0.116	0.694	0.077	-0.108
Number of seeds per pod	-0.149	0.688	0.018	0.079
Single plant yield	-0.394	-0.111	0.143	0.602
Eigenvalue	2.6	1.7	1.1	1.0
Per cent variation	32.60	20.70	14.30	12.30
Cumulative variation	32.60	53.30	67.60	79.90

It is concluded that plant height, the number of primary branches, the number of clusters per plant, the number of pods per cluster and the number of pods per plant are the major yield contributing characters and hence during selection, weightage should be given to these characters for the development of high yielding cultivars of green gram. The Principal Component Analysis reveals the total contribution of characters to the variation. The first four principal components with an eigenvalue of 1.0 accounted for 79.90 % of the total variation. The traits pod length, number of seeds per pod in PC 2, plant height and number of pods per cluster in PC 3 and single plant yield in PC 4 are important productivity factors and hence these traits could be effectively used for selection among the tested entries for yield improvement program in green gram.

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