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Genetic Divergence Analysis in Vegetable Cowpea (Vigna unguiculata subsp. unguiculata [L.]) Genotypes

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Abstract
In order to assess the divergence among 22 cowpea genotypes, mahalanobis D^2 statistics was applied. The analysis of variance revealed significant differences among the genotypes for all the traits. The 22 genotypes were grouped into 6 clusters, where clusters I was the largest, containing eleven genotypes followed by the clusters III (5 genotypes) and cluster II with three genotypes. The inter cluster distance was maximum between cluster III and VI followed by cluster III and V. Based on inter cluster distance and per se performance of genotypes, the entries viz., VU 1, VU 2, VU6, VU 8 and VU 21 were selected, which could be intercrossed to recover good recombinants and desirable segregants. The pod yield per plant contributed maximum divergence (66.23%) which was followed by pod weight (20.78%) and plant height (8.23%).

Keywords
D^2 statistics; Genetic diversity; Vegetable cowpea; Vigna unguiculata

Background
Vegetable cowpea (Vigna unguiculata L. Walp) is one of the important food legumes and a valuable component of the traditional cropping systems in the semiarid tropics (Singh et al., 2002; Ayisi et al., 2000). The crop is adaptable to harsh environments and withstands extreme temperatures, water limiting conditions and poor soil fertility. It yields well in harsh environments where other food legumes do not thrive. Due to adaptation versatility, ability to fix atmospheric nitrogen and considerable level of seed protein, minerals and vitamin contents cowpea should significantly contribute as viable and alternative crop in low input farming systems.

Conventional procedure of indiscriminate hybridization on a massive scale in any crop results in an immense wastage of resources. Quatset (1979) opined that most often asked question among breeders is how to choose parents for crossing. Greater success can be achieved through judicious choice of parents for hybridization based on genetic divergence. Crosses between divergent parents usually produce greater heterosis than those between closely related ones (Moll and Stuber, 1971). Genetic divergence studies are the vital tools for the evaluation of germplasm lines and selection of parents for the breeding programme. So, the present study was undertaken to measure genetic diversity among the germplasm lines. Such information will be helpful for breeders to plan hybridization programme. Inclusive of diverse parents in hybridization programme can serve the purpose of combining desirable genes or to obtain superior recombination. Among several methods of multivariate analysis available to study genetic diversity in biological population, the D^2 analysis had been a perfect test in the quantitative estimation of genetic diversity.

Results and Discussion
Analysis to estimate D^2 values was done on the basis of relative magnitude of D^2 values, all the twenty two genotypes were grouped into 6 clusters (Table 1). Among the clusters, cluster I was the biggest clusters with 11 genotypes. Cluster III was the second largest clusters with five genotypes followed by cluster II
with three genotypes. The clusters IV, V, VI were consisting of only one genotype in each. Similar studies were conducted by Lesly et al., 2006; Lingaraju, 2009.

Table 1 Distribution of 22 genotypes of cowpea into six clusters

| Cluster | Number of genotypes | Name of the genotypes                      |
|---------|---------------------|---------------------------------------------|
| I       | 11                  | VU 3, VU 4, VU 5, VU 7, VU 9, VU 10, VU 11, VU 13, VU 15, VU 16, VU 17 |
| II      | 3                   | VU 2, VU 14, VU 18                          |
| III     | 5                   | VU 1, VU 6, VU 19, VU 20, VU 22             |
| IV      | 1                   | VU 24                                       |
| V       | 1                   | VU 21                                       |
| VI      | 1                   | VU 8                                        |

Table 2 Inter and intra (diagonal) cluster values of average of $D^2$ and $D$ values

| Cluster I   | Cluster II | Cluster III | Cluster IV | Cluster V | Cluster VI |
|-------------|------------|-------------|------------|-----------|------------|
| Cluster I   | 11.16      | 21.14       | 36.93      | 17.17     | 20.99      | 27.89      |
| Cluster II  | 11.13      | 24.78       | 26.18      | 37.59     | 44.81      |            |
| Cluster III | 14.63      | 36.93       | 53.59      | 61.25     |            |            |
| Cluster IV  | 0.00       | 26.65       | 30.04      | 44.15     |            |            |
| Cluster V   | 0.00       | 16.15       |            | 38.91     |            |            |
| Cluster VI  | 0.00       |            |            | 250.48    |            |            |

Table 3 Cluster means for twelve characters in 44 diverse accessions of Cowpea

|               | 1    | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 10   | 11   | 12   |
|---------------|------|------|------|------|------|------|------|------|------|------|------|------|
| Cluster I     | 134.24| 5.83 |     | 11.44| 33.79| 21.25| 17.59| 2.40 | 5.62 | 16.45| 10.75| 42.91|
| Cluster II    | 111.26| 5.78 |     | 11.98| 36.33| 22.91| 20.74| 2.42 | 5.79 | 17.56| 10.76| 41.56|
| Cluster III   | 122.05| 7.05 |     | 11.15| 34.40| 22.60| 26.19| 2.67 | 10.69| 15.60| 13.59| 28.93|
| Cluster IV    | 58.90 | 5.33 | 9.12 | 31.67| 20.43| 12.40| 7.23 | 8.70 | 11.33| 10.64| 39.00| 197.89|
| Cluster V     | 114.57| 5.22 | 9.80 | 32.00| 21.57| 16.87| 2.13 | 3.87 | 16.00| 12.56| 46.33| 154.33|
| Cluster VI    | 119.27| 5.22 | 10.32| 31.33| 25.73| 15.00| 1.87 | 4.13 | 14.00| 7.58 | 70.33| 230.63|

Note: 1 Plant height (cm); 2 Primary branches/plant; 3 Petiole length (cm); 4 Days to flowering; 5 Peduncle length (cm); 6 Pod length (cm); 7 Pod girth (cm); 8 Pod weight (g); 9 Seeds per pod; 10 100 Seed weight (g); 11 Pods per plant; 12 Pod Yield per plant (g)

Inter and intra cluster distances between genotypes were presented in Table 2. The highest inter-cluster distance was observed between clusters III and cluster VI (61.25) followed by clusters III and V (53.59), II and VI (44.81). The lowest intra-cluster distance other than the solitary clusters was in the cluster of II (11.13). Three Clusters i.e. IV, V, VI had showed zero intra cluster distance. Twenty two clusters in between minimum and maximum values were observed showing different divergence groups. While, the highest intra-cluster distance was observed in cluster III (14.63) followed by cluster I (11.16).

Based on the mean values of different clusters (Table 3) the mean pod yield per plant had highest mean for cluster II (266.09 g) and lowest mean for cluster V (154.33 g). The cluster I had highest mean value for plant height (134.24), cluster II had highest value for days to flowering (36.33), peduncle length (11.98), seeds per pod (17.56) and pod yield per plant (266.09). Cluster III had highest value for Primary branches/plant (7.05), Pod length (26.19 cm), pod weight (10.69 g) and 100 seed weight (13.59 g). Highest mean value recorded for peduncle length (25.73) and pods per plant (70.33). Similar finding
observed by Pandey, 2007.

In the present investigation to assess the percentage contribution of different important traits towards the genetic divergence are calculated Table 4. Among the characters that contributed to genetic divergence the maximum contribution of 66.23% was recorded by pod yield per plant followed by pod weight (20.78) and plant height (8.23). These observations were in accordance with, Backiyarani et al. (2000).

Table 4 Relative contribution of twelve characters towards genetic divergence in 44 cowpea germplasm

| S. NO | Characters               | Number of times ranked first | Contribution |
|-------|-------------------------|-----------------------------|--------------|
| 1     | Plant height (cm)       | 19                          | 8.23         |
| 2     | Primary branches/plant  | 0                           | 0.00         |
| 3     | Petiole length (cm)     | 0                           | 0.00         |
| 4     | Days to flowering       | 0                           | 0.00         |
| 5     | Peduncle length cm)     | 0                           | 0.00         |
| 6     | Pod length (cm)         | 3                           | 1.30         |
| 7     | Pod girth (cm)          | 0                           | 0.00         |
| 8     | Pod weight (g)          | 48                          | 20.78        |
| 9     | Seeds per pod           | 0                           | 0.00         |
| 10    | 100 Seed weight (g)     | 4                           | 1.73         |
| 11    | Pods per plant          | 4                           | 1.73         |
| 12    | Yield per plant (g)     | 153                         | 66.23        |
|       | Total                   | 231.00                      | 100.00       |

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