Discriminate function analysis in cowpea 
(Vigna unguiculata (L.) Walp.)

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Abstract
The discriminant function technique was used to construct selection indices in forty two genotypes of cowpea (Vigna unguiculata (L.) Walp.). Sixty three selection indices involving seed yield per plant and its five components were constructed using the discriminant function technique. The efficiency of selection increased considerably when the selection was based on two character combinations i.e. the number of pods per plant and the number of seeds per pod followed by an index based on three characters viz., the number of clusters per plant and the number of pods per plant and seed yield per plant. The use of these indices is advocated for selecting high yielding genotypes of cowpea as in practice the plant breeder might be interested in the maximum gain with the minimum number of characters.

Key words
Selection indices, discriminate function, relative efficiency and cowpea

INTRODUCTION
Cowpea (Vigna unguiculata (L.) Walp.) autogamous leguminous crop of India is an important versatile food crop. It has multifarious uses like fodder, cover crop and green manure and provides high quality protein in the form of vegetable and pulse to the human diet. It is a drought tolerant crop and thrives in warm weather (21 - 35ºC) and well adapted to the drier regions of the tropics, where other food legumes do not perform well. Bestowed with a series of merits, cowpea is also known for some biological bottlenecks of poor productivity due to inefficient plant types with the less and slow conversion of dry matters to the grain. Therefore, there is an urgent need to develop high yielding varieties in cowpea. Seed yield is governed by a polygenic system and highly influenced by the fluctuations in the environment. Selection of plants based directly on seed yield would not be very much reliable in many cases. It is felt that progress can be accelerated if simultaneous selection for most of the economic characters contributing to seed yield is considered. For this purpose, the utilization of appropriate multiple selection criteria based on the selection indices would be more desirable. An application of discriminant function developed by Fisher (1936) and first applied by Smith (1936) helps to identify an important combination of yield components useful for selection by formulating suitable selection indices. Therefore, the object of the present study was to construct and assesses the efficiency of selection indices in cowpea.

MATERIALS AND METHODS
A field trial was conducted using 42 diverse genotypes of cowpea in a Randomized Block Design with three replications at Pulses Research Station, Junagadh Agricultural University, Junagadh. A single row of 4 m length and plants were spaced at 45 x 10 cm. The recommended package of practices was followed for cultivation. In each replication, observations were recorded on five randomly selected competitive plants and their mean values were used for statistical analysis. The observations were recorded on 11 morphological characters viz., days to 50 per cent flowering, days to maturity, plant height (cm), the number of primary...
branches per plant, the number of clusters per plant, the number of pods per cluster, the number of pods per plant, pod length (cm), the number of seeds per pod, 100-seed weight and seed yield per plant. Days to 50 per cent flowering and days to maturity were recorded on a plot basis. For constructing the selection indices, the characters which had a high and positive correlation with seed yield per plant and direct effects on seed yield were considered. In this context, 6 characters, namely, seed yield per plant \( (X_i) \), days to 50 per cent flowering \( (X_j) \), the number of clusters per plant \( (X_k) \), the number of pods per plant \( (X_l) \), the number of seeds per pod \( (X_m) \) and 100-seed weight \( (X_n) \) were identified and considered. A total of sixty three selection indices were constructed using five traits per sowing condition. The respective genetic advance through selection was also calculated as per the formula suggested by Robinson et al. (1951). The relative efficiency of different discriminant functions in relation to straight selection for seed yield were assessed and compared, assuming the efficiency of selection for seed yield per plant as 100 %. Relative efficiency per character was calculated by relative efficiency divided by the number of characters are involved in them.

**RESULTS AND DISCUSSION**

Selection indices for seed yield per plant and other characters were constructed and examined to identify their relative efficiency in the selection of superior genotypes. The results on selection indices, discriminant functions, expected genetic gain and relative efficiency are presented in **Table 1**. The results suggested that the selection efficiency was higher, in general, over straight selection when the selection was based on the component character like days to 50 per cent flowering and the number of pods per plant. Selection indices thus, aim at determining the most valuable genotypes as well as the most suitable combination of traits with intention of indirectly improving the yield in different plants. Hazel and Lush (1943) showed that the selection based on such an index was more efficient than selecting individually for the various characters.

**Table 1. Selection index, discriminant function, expected genetic advance in seed yield and relative efficiency from the use of different selection indices in 42 genotypes of cowpea**

| Sr. No. | Selection index | Discriminant function | Expected genetic advance | Relative efficiency (%) | Relative coefficient per character (%) |
|---------|-----------------|-----------------------|--------------------------|-------------------------|---------------------------------------|
| 1       | \( X_i \) Seed yield per plant | 0.9446 \( X_i \) | 6.977 | 100.000 | 100.000 |
| 2       | \( X_j \) Days to 50 per cent flowering | 0.9482 \( X_j \) | 10.129 | 145.178 | 145.178 |
| 3       | \( X_k \) Number of clusters per plant | 0.9796 \( X_k \) | 4.579 | 65.637 | 65.637 |
| 4       | \( X_l \) Number of pods per plant | 0.9586 \( X_l \) | 12.433 | 178.213 | 178.213 |
| 5       | \( X_m \) Number of seeds per pod | 0.737 \( X_m \) | 2.538 | 36.371 | 36.371 |
| 6       | \( X_n \) 100-seed weight | 0.9898 \( X_n \) | 6.320 | 90.587 | 90.587 |
| 7       | \( X_i \) \( X_j \) | 0.9277 \( X_i \) \+ 0.9360\( X_j \) | 9.746 | 139.694 | 69.847 |
| 8       | \( X_i \) \( X_k \) | 1.7579 \( X_i \) \+ 0.8206\( X_k \) | 12.600 | 180.603 | 90.302 |
| 9       | \( X_i \) \( X_l \) | 3.7638 \( X_i \) \+ 2.9607\( X_l \) | 5.656 | 81.069 | 40.535 |
| 10      | \( X_i \) \( X_m \) | 1.4426 \( X_i \) \+ 0.5485\( X_m \) | 10.914 | 156.437 | 78.219 |
| 11      | \( X_j \) \( X_k \) | 1.0998 \( X_j \) \+ 0.5664\( X_k \) | 3.527 | 50.551 | 25.275 |
| 12      | \( X_j \) \( X_l \) | 1.6111 \( X_j \) \+ 0.3416\( X_l \) | 11.972 | 171.600 | 85.800 |
| 13      | \( X_k \) \( X_m \) | 1.7849 \( X_k \) \+ 1.9962\( X_m \) | 10.544 | 151.132 | 75.566 |
| 14      | \( X_i \) \( X_m \) | 2.1931 \( X_i \) \+ 0.5946\( X_m \) | 14.976 | 214.658 | 107.329 |
| 15      | \( X_j \) \( X_n \) | 2.8298 \( X_j \) \+ 1.1857\( X_n \) | 5.613 | 80.450 | 40.225 |
| 16      | \( X_k \) \( X_n \) | 1.4962 \( X_k \) \+ 1.8418\( X_n \) | 18.566 | 266.116 | 133.058 |
| 17      | \( X_i \) \( X_m \) | 0.7287 \( X_i \) \+ 0.8101\( X_m \) | 6.377 | 312.608 | 37.406 |
| 18      | \( X_j \) \( X_n \) | 0.3730 \( X_j \) \+ 0.3492\( X_n \) | 3.703 | 53.070 | 26.535 |
| 19      | \( X_k \) \( X_n \) | 3.7284 \( X_k \) \+ 1.1280\( X_n \) | 25.506 | 365.594 | 182.797 |
| 20      | \( X_i \) \( X_m \) | 2.5325 \( X_i \) \+ 0.6467\( X_m \) | 17.293 | 247.875 | 123.937 |
| 21      | \( X_j \) \( X_n \) | 0.3376 \( X_j \) \+ 0.4160\( X_n \) | 12.635 | 181.103 | 90.551 |
| 22      | \( X_k \) \( X_m \) \( X_i \) | 0.9431 \( X_k \) \+ 0.9229\( X_m \) \+ 0.9262\( X_i \) | 9.686 | 138.828 | 46.276 |
| 23      | \( X_j \) \( X_m \) \( X_i \) | 0.9310 \( X_j \) \+ 0.8943\( X_m \) \+ 0.9212\( X_i \) | 14.655 | 210.060 | 70.020 |
The maximum relative efficiency in single character discriminant function was 178.213 per cent which was exhibited by the number of pods per plant. However, it increased up to 365.594 per cent in two character combinations (the number of pods per plant and the number of seeds per pod); 315.534 per cent, in three character combinations (seed yield per plant, the number of clusters per plant and the number of pods per plant); 331.192 per cent, in four character combinations (seed yield per plant, the number of clusters per plant, the number of pods per plant and the number of seeds per pod).
(GA = 6.977 g, RI = 100 %) as it was through its components like the number of clusters per plant, the number of pods per plant and the number of seeds per pod or in their combinations. The maximum efficiency in selection for seed yield was exhibited by a discriminant function involving the number of pods per plant and the number of seeds per pod, which had a genetic advance and relative efficiency of 25.506 g and 365.594 per cent, respectively, followed by an index of three characters (seed yield per plant, the number of clusters per plant and the number of pods per plant) with 22.014 g genetic advance and 315.534 per cent, relative efficiency. Similar results were reported by Patel et al. (2007), Jatav (2011), Khanpara et al. (2015) and Siddhi Shah et al. (2016).

Further, there was an increase in the relative efficiency of the succeeding index which contained a character viz., the number of pods per plant in common in all character combinations. However, in practice, the plant breeder might be interested in the maximum gain with the minimum number of characters. In this context, the selection index involving the number of pods per plant and the number of seeds per pod \( X_4 \times X_5 \) could be advantageously exploited in the cowpea breeding programmes. The present study also revealed that the discriminant function method of making selections in plants appeared to be the most useful as compared to the straight selection for seed yield alone and hence, due weightage should be given to the important selection indices while making the selection for yield advancement in cowpea.

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