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Selection indices in F_3 generation of chickpea (*Cicer arietinum* L.)

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Abstract
Nineteen F_3s + one check variety of chickpea were grown at the Pulses Research Station, Junagadh Agricultural University, Junagadh during *rabi* 2016-17 to construct selection indices for 11 traits (days to 50% flowering, days to maturity, plant height (cm), number of branches per plant, number of pods per plant, first pod bearing node (cm), number of seeds per pod, 100-seed weight (g), seed yield per plant (g), biological yield per plant (g) and harvest index %). The discriminant function technique was used to create 31 selection indices involving seed yield and four yield components. The inclusion of more characters in the index increased the efficiency of selection. The selection index based on four characters *viz.*, seed yield per plant, number of branches per plant, number of pods per plant and harvest index exhibited maximum relative efficiency. Therefore, these indices may be useful for selection of higher seed yield in chickpea.

Keywords: Selection indices**,** chickpea, relative efficiency

Introduction
Chickpea (*Cicer arietinum* L.) is origin to India and Central Asia. While selecting for a specific genotype, the plant breeder has certain desired plant characteristics in mind, and he applies different weights to different traits to arrive at decisions. This suggests using a selection index that assigns appropriate weight to each of the two or more characters to be considered. Hazel and Lush (1943) [1] demonstrated that the Selection based on such an index is more efficient than selecting each character individually. They also stated that the superiority of selection based on index increases with an increase in the number of characters under selection. In the present study also, the expected genetic advance and relative efficiency assessed for different indices increased considerably when selection was based on two or more characters.

Material and Methods
Nineteen F_3 generation + 1 check of chickpea were evaluated in randomized block design with three replications during with *rabi* 2016-17 at Pulses Research Station, Junagadh Agricultural University, Junagadh under irrigated condition. Each F_3 population was accommodated in two rows of 4 m length with line-line and plant-plant spacing of 45 × 15 cm. Recommended practices were followed to raise a good crop. The data were collected on 20 randomly selected and tagged plants for plant height (cm), number of branches per plant, number of pods per plant, first pod bearing node (cm), number of seeds per pod, seed yield per plant (g), biological yield per plant (g) and harvest index (%). The observations for days to 50% flowering, 100-seed weight (g) and days to maturity were recorded on plot basis. The model suggested by Robinson *et al*. (1951) [2] was used for the construction of selection indices and development of a required discriminant function.

Results and Discussion
Seed yield is a complex entity associated with many contributing traits, which are interrelated among themselves. The interdependency of contributing traits affects the selection criteria. Selection indices based on discriminant function is one of the most sophisticated and efficient technique for plant breeders for selection of suitable plant type based on phenotypic worth of different component characters. Selection indices of different character combinations without yield were constructed to identify characters, which will be helpful in selection programme. The data on selection indices, discriminant functions, genetic gain and relative efficiency are given in Table 1., assuming the efficiency of direct selection for seed yield per plant as 100%.

The results suggested that the selection efficiency was higher over straight selection when the selection was based on component character, which further increased with the inclusion of two or more characters. The highest genetic gain (18.516) and relative efficiency (3070.794) was noted when four characters were considered together. When the relative efficiency of single character index was measured, it was noted that the maximum efficiency of 2081.393% was exhibited by harvest index followed by number of pods per plant 1922.720% and biological yield per plant 234.494%. Among the combination involving two component characters, number of pods per plant and biological yield per plant (X_3+X_4) exhibited maximum relative efficiency of 2675.787% followed by number of pods per plant and harvest index(X_3+X_5); seed yield per plant and harvest index (X_1+X_5); number of branches per plant and harvest index (X_2+X_5) and biological yield per plant and harvest index (X_4+X_5) having relative efficiency of 2508.59, 2129.571, 2096.603 and 1912.22%, respectively. The selection index based on three character combinations indicated that a discriminant function with number of branches per plant, number of pods per plant and harvest index (X_2+X_3+X_5) possessed maximum relative efficiency of 3048.043%. In four character selection index, a function involving seed yield per plant, number of branches per plant, number of pods per plant and harvest index (X_1+X_2+X_3+X_5) exerted maximum relative efficiency of 3070.794%. The selection index based on all the five characters *viz.*, seed yield per plant, number of branches per plant, number of pods per plant, biological yield per plant and harvest index (X_1+X_2+X_3+X_4+X_5) recorded 2982.541% relative efficiency.

Among all the 31 selection indices, the index based on four characters *viz.*, seed yield per plant, number of branches per plant, number of pods per plant and harvest index (X_1+X_2+X_3+X_5) possessed the highest genetic gain and relative efficiency (18.516 and 3070.794%) as compared to straight selection for seed yield only. It is suggested that selection based on four characters would be more effective for yield improvement in chickpea.

Table 1: Selection index, discriminant function, expected genetic advance in seed yield and relative efficiency from the use of different selection indices of chickpea

Sr. No	Selection index	Discriminant function	Expected genetic advance	Relative efficiency (%)	R. E. per character (%)
1	X_1: Seed yield per plant	0.524	0.603	100.000	100.000
2	X_2: Number of branches per plant	0.321	0.035	5.804	5.804
3	X_3: Number of pods per plant	0.808	11.594	1922.72	1922.72
4	X_4: Biological yield per plant	0.647	1.414	234.494	234.494
5	X_5: Harvest index	0.532	12.550	2081.393	2081.393
6	$X_1 + X_2$	$0.536X_1 + 2.168X_2$	0.667	110.715	55.357
7	$X_1 + X_3$	$0.861X_1 + 0.811X_3$	11.487	1905.139	952.569
8	$X_1 + X_4$	$0.624X_1 + 0.676X_4$	1.668	276.768	138.384
9	$X_1 + X_5$	$-0.351X_1 + 0.553X_5$	12.841	2129.571	1064.785
10	$X_2 + X_3$	$6.138X_2 + 0.797X_3$	11.641	1930.571	965.285
11	$X_2 + X_4$	$0.483X_2 + 0.648X_4$	1.422	235.836	117.918
12	$X_2 + X_5$	$13.464X_2 + 0.533X_5$	12.642	2096.603	1048.301
13	$X_3 + X_4$	$0.957X_3 + 4.591X_4$	16.134	2675.787	1337.893
14	$X_3 + X_5$	$0.684X_3 + 0.485X_5$	15.126	2508.59	1254.295
15	$X_4 + X_5$	$-0.519X_5 + 0.449X_5$	11.530	1912.22	956.109
16	$X_1 + X_2 + X_3$	$0.821X_1 + 7.969X_2 + 0.795X_3$	11.549	1915.419	638.472
17	$X_1 + X_2 + X_4$	$0.636X_1 + 2.264X_2 + 0.669X_4$	1.702	282.269	94.089
18	$X_1 + X_2 + X_5$	$- 0.393X_1 + 15.612X_2 + 0.555X_5$	12.959	2149.096	716.365
19	$X_1 + X_3 + X_4$	$0.957X_1 + 0.802X_3 + 0.458X_4$	11.293	1872.83	624.276
20	$X_1 + X_3 + X_5$	$-0.070X + 0.867X_3 + 0.571X_5$	18.369	3046.332	1015.444
21	$X_1 + X_4 + X_5$	$-76.142X_1 + 62.226X_4 + 7.174X_5$	9.761	1618.87	539.623
22	$X_2 + X_3 + X_4$	$7.286X_2 + 0.783X_3 + 0.394X_4$	11.436	1896.628	632.209
23	$X_2 + X_3 + X_5$	$17.595X_2 + 0.842X_3 + 0.558X_5$	18.379	3048.043	1016.014
24	$X_2 + X_4 + X_5$	$15.883X_2 - 0.702X_4 + 0.435X_5$	11.662	1934.029	644.676
25	$X_3 + X_4 + X_5$	$0.856X_3 - 0.382X_4 + 0.484X_5$	17.356	2878.407	959.469
26	$X_1 + X_2 + X_3 + X_4$	$0.910X_1 + 8.991X_2 + 0.783X_3 + 0.409X_4$	11.364	1884.639	471.159
27	$X_1 + X_2 + X_3 + X_5$	$-0.288X_1 + 20.526X_2 + 0.821X_3 + 0.578X_5$	18.516	3070.794	767.698
28	$X_1 + X_2 + X_4 + X_5$	$13.183X_1 + 29.671X - 10.365X_4 - 0.622X_5$	12.360	2049.876	512.469
29	$X_1 + X_3 + X_4 + X_5$	$9.949X_1 + 0.896X_3 - 7.353X_4 - 0.287X_5$	17.628	2923.514	730.878
30	$X_2 + X_3 + X_4 + X_5$	$21.469X_1 + 0.805X_3 - 0.734X_4 + 0.458X_5$	17.519	2905.369	726.342
31	$X_1 + X_2 + X_3 + X_4 + X_5$	$14.905X_1 + 35.733X_2 + 0.833X_3 - 11.649X_4 - 0.739X_5$	17.984	2982.541	596.508

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