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Selection Indices in Chickpea (*Cicer arietinum* L.)

J.V. JIVANI[1], D.R. MEHTA[2], LATA J. RAVAL[3] AND H.P. VIRANI[4]

Department of Genetics and Plant Breeding, Collage of Agriculture
Junagadh Agricultural University, Junagadh-362 001 (Gujarat)

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ABSTRACT

Sixty-three selection indices involving seed yield per plant and its five components were constructed using discriminate function technique. The efficiency of selection increased with inclusion of more characters in the index. The index based on five characters *viz.*, seed yield per plant, biological yield per plant, harvest index, 100-seed weight and number of pods per plant recorded maximum genetic gain (54.522g) and relative efficiency (809.893%) followed by index based on all the six characters namely seed yield per plant, biological yield per plant, harvest index, 100-seed weight, number of pods per plant and days to maturity which possessed genetic gain and relative efficiency of 54.289g and 806.432%, respectively. The use of both these indices is advocated for selecting high yielding genotypes of chickpea.

Keyword: Selection indices, discriminate function, chickpea.

Chickpea (*Cicer arietinum* L.) is one of the most important grain legume crops, occupying first position both in area and production among the pulses grown in India. The crop is largely cultivated on marginal and sub-marginal lands of arid and semi-arid tropics. Seed yield is a complex trait, governed by a polygenic system and is highly influenced by the fluctuation in the environments (Raval and Dobariya, 2005). Therefore, selection of plants based directly on seed yield ha^{-1} would not be very reliable in many cases. The effectiveness of component approach to selection breeding is well appreciated. An application of discriminat function developed by Fisher (1936) and first applied by Smith (1936) helps to identify important combination of yield components useful for selection by formulating suitable selection indices. Therefore, the object of the present study was to constuct and assesses the efficiency of selection indices in chickpea.

[1]PG Student, [2]Associate Professor, [3]Assistant Professor [4]Associate Professor

MATERIALS AND METHODS

A field trial was conducted using 105 diverse genotypes of chickpea during Rabi 2009-10 in a randomized block design with three replications at Pulses Research Station, Junagadh Agricultural University, Junagadh. Each entry was sown in a single row of 4.0 m length with a spacing of 45 x 10 cm. The observations were recorded on five randomly selected plants in each entry and in each replication and their mean values used for the statistical analysis. For constructing the selection indices, the characters with high and significant genetic correlation coefficients and sizable direct effects on seed yield were considered. In this context, the seed yield per plant (X_1) along with its five components *viz.*, biological yield per plant (X_2), harvest index (X_3), 100-seed weight (X_4), number of pods per plant (X_5) and days to maturity (X_6) were identified and considered for construction of selection indices. The model suggested by Robinson *et al.* (1951) was used for the construction of selection indices and the development of required discriminant function. A total of 63 selection indices were constructed using six traits. 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%.

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 showed that the genetic advance and relative efficiency assessed for different indices were higher than straight selection when the selection was based on component characters which further increased considerably with the inclusion of two or more characters. The highest efficiency was noted when five characters ($X_1+X_2+X_3+X_4+X_5$) or all the six characters were considered. Thus, selection indices are more reliable and realistic for selecting desirable genotypes since they are constructed by giving proper weightage on the characters associated with the seed yield per plant.

The maximum genetic advance (GA) and relative efficiency (RI) in single character was 32.669g and 485.146%, respectively for number of pods per plant and it was increased 45.001g genetic advance and 668.464% relative efficiency, respectively in two character combinations viz., harvest index and number of pods per plant (X_3+X_5) and 49.754g GA and 739.067% RI in three character combinations viz., biological yield per plant, harvest index and number of pods per plant ($X_2+X_3+X_5$). Thus, there was an increase in the genetic gain as well as on relative efficiency with an increase in the character combinations. In four character combinations *viz.*, seed yield per plant, biological yield per plant, harvest index and number of pods per plant ($X_1+X_2+X_3+X_5$), the highest genetic advance and relative efficiency was 54.152g and 804.397%, respectively. Whereas the maximum genetic advance and relative efficiency in five characters combinations viz., seed yield per plant, biological yield per plant, harvest index, 100-seed weight and number of pods per plant ($X_1+X_2+X_3+X_4+X_5$) was 54.522g and 809.893%, respectively. Robinson *et al.* (1951) in corn recorded a progressive increase in efficiency of selection indices with inclusion of every additional character in the index formula. Hazel and Lush (1943) also stated that the superiority of selection based on index increased with an increase in the number of characters under selection. In chickpea, Sandhu and Singh (1972), Patil and Pokle (1975), Shashi *et al.* (1984), Rahman and Rahman (1992), Samal and Jagdev (1996), Sable *et al.*, (2003) and Raval and Dobariya (2005) were also reported that an increase in characters resulted in an increase in genetic gain and that the selection indices improved the efficiency than the straight selection for seed yield alone.

Further, it was observed that the straight selection for seed yield was not that much rewarding (GA=6.732g, RI=100%) as it was through its components like biological yield per plant (GA=11.325g, RI=168.226%), harvest index (GA=21.186g, RI=314.706%), hundred seed weight (GA=7.247g, RI=107.650%), number of pods per plant (GA=32.660g, RI=485.146%), days to maturity (GA=7.100g, RI=105.466%) and its combinations. The maximum efficiency in selection for seed yield was exhibited by a discriminant function involving seed yield per plant, biological yield per plant, harvest index, 100-seed weight and number of pods per plant ($X_1+X_2+X_3+X_4+X_5$) which had a maximum genetic advance and relative efficiency of 54.522g and 809.893%, respectively, followed by an index of all the six characters ($X_1+X_2+X_3+X_4+X_5+X_6$) with 54.289g genetic advance and 806.432% relative efficiency. High efficiency in selection was based on seed yield per plant, number of pods per plant, 100-seed weight and days to maturity or in combination of all these four characters has been reported by Sandhu and Singh (1972), Patil and Pokle (1975), Shahi *et al.* (1984), Rahman and Rahman (1992) and Sarvaliya (1993) and Raval and Dobariya (2005).

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

Sr. No.	Selection index	Discriminant function	Expected genetic advance	Relative efficiency (%)
1	Seed yield per plant (X_1)	$0.815X_1$	6.732	100.000
2	Biological yield per plant (X_2)	$0.682X_2$	11.325	168.226
3	Harvest index (X_3)	$0.758X_3$	21.186	314.706
4	100-seed weight (X_4)	$0.799X_4$	7.247	107.650
5	Number of pods per plant (X_5)	$0.774X_5$	32.660	485.146
6	Days to maturity (X_6)	$0.630X_6$	7.100	105.466
7	X_1+X_2	$0.832X_1 + 0.673X_2$	15.728	233.630
8	X_1+X_3	$0.816X_1 + 1.044X_3$	27.452	407.784
9	X_1+X_4	$0.816X_1 + 0.781X_4$	10.254	152.317
10	X_1+X_5	$0.828X_1 + 0.771X_5$	36.382	540.434
11	X_1+X_6	$0.812X_1 + 0.609X_6$	9.453	140.419
12	X_2+X_3	$0.685X_2 + 0.820X_3$	25.508	378.907
13	X_2+X_4	$0.683X_2 + 0.822X_4$	13.992	207.843
14	X_2+X_5	$0.684X_2 + 0.787X_5$	37.380	555.258
15	X_2+X_6	$0.684X_2 + 0.691X_6$	14.361	213.324
16	X_3+X_4	$0.758X_3 + 0.783X_4$	22.609	335.844
17	X_3+X_5	$0.759X_3 + 0.817X_5$	45.001	668.464
18	X_3+X_6	$0.757X_3 + 0.489X_6$	20.725	307.858
19	X_4+X_5	$0.792X_4 + 0.757X_5$	32.347	480.496
20	X_4+X_6	$0.801X_4 + 0.652X_6$	10.440	155.080
21	X_5+X_6	$0.774X_5 + 0.530X_6$	32.962	489.632
22	$X_1+X_2+X_3$	$0.843X_1 + 0.671X_2 + 0.821X_3$	29.941	444.756
23	$X_1+X_2+X_4$	$0.832X_1 + 0.673X_2 + 0.805X_4$	17.942	266.518
24	$X_1+X_2+X_5$	$0.844X_1 + 0.671X_2 + 0.785X_5$	41.535	616.979
25	$X_1+X_2+X_6$	$0.828X_1 + 0.676X_2 + 0.673X_6$	17.849	265.137
26	$X_1+X_3+X_4$	$0.830X_1 + 0.762X_3 + 0.762X_4$	26.432	392.632
27	$X_1+X_3+X_5$	$0.840X_1 + 0.761X_3 + 0.810X_5$	49.158	730.214
28	$X_1+X_3+X_6$	$0.826X_1 + 0.762X_3 + 0.471X_6$	24.483	363.681
29	$X_1+X_4+X_5$	$0.830X_1 + 0.772X_4 + 0.752X_5$	36.290	539.067
30	$X_1+X_4+X_6$	$0.813X_1 + 0.784X_4 + 0.631X_6$	12.457	185.042
31	$X_1+X_5+X_6$	$0.824X_1 + 0.771X_5 + 0.508X_6$	36.536	542.721
32	$X_2+X_3+X_4$	$0.685X_2 + 0.820X_3 + 0.790X_4$	27.007	401.173
33	$X_2+X_3+X_5$	$0.687X_2 + 0.821X_3 + 0.804X_5$	49.754	739.067
34	$X_2+X_3+X_6$	$0.687X_2 + 0.819X_3 + 0.575X_6$	25.738	382.323

Cont.

Sr. No.	Selection index	Discriminant function	Expected genetic advance	Relative efficiency (%)
35	$X_2+X_4+X_5$	$0.685X_2 + 0.815X_4 + 0.771X_5$	37.364	555.021
36	$X_2+X_4+X_6$	$0.685X_2 + 0.824X_4 + 0.713X_6$	16.705	248.143
37	$X_2+X_5+X_6$	$0.687X_2 + 0.787X_5 + 0.592X_6$	38.068	565.478
38	$X_3+X_4+X_5$	$0.759X_3 + 0.776X_4 + 0.799X_5$	45.054	669.251
39	$X_3+X_4+X_6$	$0.757X_3 + 0.786X_4 + 0.512X_6$	22.345	331.922
40	$X_3+X_5+X_6$	$0.758X_3 + 0.817X_5 + 0.394X_6$	44.336	658.586
41	$X_4+X_5+X_6$	$0.795X_4 + 0.757X_5 + 0.550X_6$	32.758	486.601
42	$X_1+X_2+X_3+X_4$	$0.844X_1 + 0.672X_2 + 0.821X_3 + 0.772X_4$	31.358	465.805
43	$X_1+X_2+X_3+X_5$	$0.855X_1 + 0.670X_2 + 0.820X_3 + 0.801X_5$	54.152	804.397
44	$X_1+X_2+X_3+X_6$	$0.840X_1 + 0.675X_2 + 0.821X_3 + 0.559X_6$	29.985	445.410
45	$X_1+X_2+X_4+X_5$	$0.846X_1 + 0.671X_2 + 0.797X_4 + 0.767X_5$	41.684	619.192
46	$X_1+X_2+X_4+X_6$	$0.829X_1 + 0.676X_2 + 0.807X_4 + 0.695X_6$	19.965	296.569
47	$X_1+X_2+X_5+X_6$	$0.840X_1 + 0.765X_2 + 0.784X_5 + 0.574X_6$	42.060	624.777
48	$X_1+X_3+X_4+X_5$	$0.842X_1 + 0.760X_3 + 0.754X_4 + 0.792X_5$	49.355	733.140
49	$X_1+X_3+X_4+X_6$	$0.827X_1 + 0.762X_3 + 0.765X_4 + 0.493X_6$	26.026	386.601
50	$X_1+X_3+X_5+X_6$	$0.837X_1 + 0.760X_3 + 0.811X_5 + 0.374X_6$	48.431	719.415
51	$X_1+X_4+X_5+X_6$	$0.827X_1 + 0.775X_4 + 0.753X_5 + 0.530X_6$	36.542	542.810
52	$X_2+X_3+X_4+X_5$	$0.688X_2 + 0.821X_3 + 0.782X_4 + 0.787X_5$	50.008	742.840
53	$X_2+X_3+X_4+X_6$	$0.688X_2 + 0.819X_3 + 0.792X_4 + 0.598X_6$	27.346	406.209
54	$X_2+X_3+X_5+X_6$	$0.689X_2 + 0.819X_3 + 0.804X_5 + 0.478X_6$	49.521	735.606
55	$X_2+X_4+X_5+X_6$	$0.687X_2 + 0.816X_4 + 0.770X_5 + 0.612X_6$	38.137	566.503
56	$X_3+X_4+X_5+X_6$	$0.758X_3 + 0.779X_4 + 0.799X_5 + 0.414X_6$	44.474	660.636
57	$X_1+X_2+X_3+X_4+X_5$	$0.857X_1 + 0.669X_2 + 0.819X_3 + 0.764X_4 + 0.782X_5$	54.522	809.893
58	$X_1+X_2+X_3+X_4+X_6$	$0.841X_1 + 0.675X_2 + 0.820X_3 + 0.773X_4 + 0.581X_6$	31.507	468.018
59	$X_1+X_2+X_3+X_5+X_6$	$0.851X_1 + 0.673X_2 + 0.819X_3 + 0.800X_5 + 0.461X_6$	53.847	799.866
60	$X_1+X_2+X_4+X_5+X_6$	$0.842X_1 + 0.674X_2 + 0.798X_4 + 0.766X_5 + 0.595X_6$	42.284	628.105
61	$X_1+X_3+X_4+X_5+X_6$	$0.838X_1 + 0.760X_3 + 0.756X_4 + 0.762X_5 + 0.394X_6$	48.714	723.619
62	$X_2+X_3+X_4+X_5+X_6$	$0.690X_2 + 0.819X_3 + 0.784X_4 + 0.786X_5 + 0.498X_6$	49.852	740.523
63	$X_1+X_2+X_3+X_4+X_5+X_6$	$0.853X_1 + 0.673X_2 + 0.819X_3 + 0.766X_4 + 0.782X_5 + 0.482X_6$	54.289	806.432

The present study showed consistent increase in the relative efficiency of the succeeding index with simultaneous inclusion of each character. However, in practice, the plant breeder might be interested in maximum gain with minimum number of characters. In such a case, selection index consisting of four traits *viz*., seed yield per plant, biological yield per plant harvest index and number of pods per plant could be advantageously exploited in the chickpea breeding programmes. The present study also revealed that the discriminate function method of making selections in plants appears to be the most useful than the straight selection for seed yield alone and hence, due weightage should be given to the important selection indices while making selection for yield advancement in chickpea.

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