Electronic Journal of Plant Breeding, 5(2): 268-271 (June 2014)
ISSN 0975-928X

Research Note

Selection indices for improvement of seed yield in Soybean [*Glycine max* (L.) Merrill]

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(Received: 04 Apr 2014; Accepted: 05 May 2014)

Abstract

Sixty one diverse genotypes of soybean were evaluated in a randomized block design with three replications to study of selection indices under rainfed conditions during *kharif* 2012. Sixty-three selection indices involving seed yield and five yield components *viz.*, number of primary branches per plant, 100-seed weight, biological yield per plant, harvest index and days to maturity were constructed using the discriminant function technique. Discriminant function analysis indicated that selection efficiency of the function was improved by increasing number of characters in the index. Among the single character index, biological yield per plant exhibited higher genetic advance and relative efficiency over straight selection for seed yield. The index based on five characters *viz*., seed yield per plant, 100 seed weight, biological yield per plant, harvest index and days to maturity recorded the highest genetic advance as well as relative efficiency and selection efficiency. These characters could be advantageously exploited in the soybean breeding programmes.

Key words: Soybean, discriminant function, relative efficiency, selection indices.

Plant yield is a complex character involving of number of contributing components. Yield is also the ultimate criterion which a plant breeder has always to keep in view, while evolving a new variety with high yield potential. However, while carrying out selection for a highly variable character like seed yield, straight selection may not always be efficient. At such stage, a selection index technique in which selection is based upon more than one variable simultaneously may prove useful. This report examines various selection indices for improvement of grain yield and evaluate their efficiency in soybean.

A set of 61 genotypes of soybean were sown at the Instructional Farm, Junagadh Agricultural University, Junagadh during *kharif* 2012. Each entry was accommodated in a single row of 4.0 m length spaced at 45 cm between rows and 10 cm between plants within the row. The genotypes were randomly allotted to the plot in each replication. The experiment was surrounded by guard row to avoid damage and border effects. The recommended package of practices was followed to raise a good crop. Data were recorded on randomly selected five plants from each genotype and average value was used for the statistical analysis for 15 characters *viz*., days to 50 % flowering, days to maturity, plant height (cm), number of primary branches per plant, number of clusters per plant, number of pods per plant, number of pods per cluster, pod length (cm), number of seeds per pod, 100-seed weight (g), biological yield per plant (g), harvest index (%), protein content (%), oil content (%) and seed yield per plant (g). Observations on days to 50% flowering and days to maturity were recorded on per plot basis.

Discriminant function analysis described by Dabholkar (1999) was used to construct the selection indices involving six characters, seed yield per plant (X_1), number of primary branches per plant (X_2), 100-seed weight (X_3), biological yield per plant (X_4), harvest index (X_5) and days to maturity (X_6). For computing selection indices, seed yield per plant was considered as the dependent variable with the relative efficiency of 100 per cent. The model suggested by Robinson *et al*. (1951) was used for the construction of genetic advance as well as selection indices and development of a required discriminant function using six characters along with seed yield per plant.

A total of 63 selection indices based on six characters constructed in all possible combinations revealed that the selection efficiency was higher over straight selection when selection was based on individual components (Table 1). Biological yield per plant showed a genetic advance of 6.79%, which was higher than those calculated for other characters including seed yield per plant suggested that biological yield per plant proved to be better index selection based on one character. The highest genetic gain of 55.90% was obtained when selection was simultaneously based on discriminant function of two characters, *e.g.* number of pods per plant (X_3) and harvest index (X_4). When three characters, *e.g.* number of clusters per plant (X_1), number of pods per plant (X_3), harvest index (X_4) were taken together, the genetic advance increased to 182.74%. Combination of four characters, *i.e.* number of clusters per plant (X_1), number of pods per plant (X_2), biological yield per plant (X_4), and harvest index (X_5) at a time still recorded high genetic gain of 195.87%. The maximum gain was achieved to 224.78% by taking five characters at a time, *i.e.* seed yield (X_1), number of clusters per plant (X_3), number of pods per plant (X_4), biological yield per plant (X_5) and harvest index (X_6) (Table 3). The function that includes all the six characters gave the highest genetic advance (13.71%).

Thus, study revealed that the index which includes more than one character gave high genetic advance suggesting the utility of construction of selection indices for effecting simultaneous improvement of several characters. Hazel and Lush (1943) stated that the superiority of selection based on index increases with an increase in the number of characters under selection. Singh *et al.* (1979), Dhumale *et al.* (1992), Rao (1974), Searle (1965) and Smith (1936) also were with the same opinion that an increase in characters results in an increase in genetic gain and that the selection indices improve the efficiency than the straight selection for yield alone.

It is interesting to note that selection efficiency improved with an increase in number of characters in combination with yield. For example, average selection efficiency of 110.84% when one character was included in selection function. Similarly, the selection efficiency was 1246.55% for two characters, 2693.97% for three characters, 2693.97% for four characters, 5096.54% for four characters, but 4276.56% for five characters and 557.23% for six characters selection efficiency were comparably low than former three and four characters indices (Table 2).

Some of the selection indices with high relative efficiency listed in Table 3 indicated that the highest efficiency was observed with six characters combination (557.23%). Selection indices with six characters, *i.e*. seed yield (X_1), number of primary branches per plant (X_2), 100-seed weight (X_3), biological yield per plant (X_4), harvest index (X_5) and days to maturity (X_6), therefore, appear to be more useful. It can be seen that seed yield per plant (X_1), harvest index (X_5), 100-seed weight (X_3) and biological yield per plant (X_4) were the characters being commonly involved in more number of the combinations, the next being number of primary branches per plant (X_2) and days to maturity (X_6) in order (Table 2).

Further, in the present study, there was a 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 grain with minimum number of characters considering the basic philosophy of saving time and labour in a selection programme.

In the present study, selection index based on five characters (seed yield per plant+100-seed weight + biological yield/plant + harvest index + days to maturity) showing genetic gain (224.78%) and selection efficiency (9137.40%) could be advantageously exploited in the soybean breeding programmes. The results of the present study also revealed that the descriminant function method of making selection in plants appeared 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 seed yield advancement in soybean.

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Electronic Journal of Plant Breeding, 5(2): 268-271 (June 2014)
ISSN 0975-928X

Table 1. Average selection efficiency of different combination of characters in soybean

No. of characters in the index	Selection Efficiency (%)
One	110.84
Two	1246.55
Three	2693.97
Four	5096.54
Five	4276.56
Six	557.23

Table 2. Highest selection efficiency with character combinations in soybean

Sr. No.	Character	Selection efficiency
1	Biological yield/plant	276.01
2	Seed yield per plant + biological yield/plant	3173.57
3	Seed yield per plant +100-seed weight + biological yield/plant	7428.45
4	Seed yield per plant + biological yield/plant + harvest index	5515.04
5	Seed yield per plant + 100-seed weight + biological yield/plant + harvest index	8658.53
6	Seed yield per plant + 100-seed weight + biological yield/plant + days to maturity	7705.28
7	Seed yield per plant + 100-seed weight + biological yield/plant + harvest index + days to maturity	9137.39
8	Seed yield per plant + number of primary branches per plant + biological yield/plant + harvest index + days to maturity	8374.39
9	Seed yield per plant + number of primary branches per plant + 100-seed weight + biological yield/plant + harvest index + days to maturity	557.23

Table 3. Selection index, discriminant function, expected genetic advance in yield and relative efficiency from the use of different selection indices in soybean

Sr. No.	Selection index	Discriminant function	Expected genetic advance	Relative efficiency (%)
1	**2**	**3**	**4**	**5**
1	X_1 Seed yield per plant	X_1	2.46	100.00
2	X_2 No. of primary branches/plant	X_2	1.26	51.22
3	X_3 100-seed weight	X_3	0.16	6.50
4	X_4 Biological yield /plant	X_4	6.79	276.02
5	X_5 Harvest index	X_5	4.27	173.58
6	X_6 Days to maturity	X_6	1.42	57.72
7	$X_1.X_2$	$0.375X_1 + 0.108X_2$	1.92	78.09
8	$X_1.X_3$	$0.570X_1 + 0.746X_3$	2.93	119.23
9	$X_1.X_4$	$5.708X_1 + 44.61X_4$	78.07	3173.58
10	$X_1.X5$	$2.394X_1 + 16.08X_5$	28.39	1154.07
11	$X_1.X6$	$1.192X_1 + 6.649X_6$	11.97	486.59
12	$X_2.X3$	$0.069X_2 +-0.013X_3$	0.37	15.00
13	$X_2.X4$	$2.452X_2 + 29.47X_4$	51.27	2084.15
14	$X_2.X_5$	$0.958X_2 + 10.44X_5$	18.16	738.21
15	$X_2.X_6$	$0.480X_2 + 4.792X_6$	8.34	338.94
16	$X_3.X_4$	$2.892X_3 + 32.14X_4$	55.90	2272.36
17	$X_3.X_5$	$2.285X_3 + 17.74X_5$	31.06	1262.60
18	$X_3.X_6$	$0.455X_3 + 5.032X_6$	8.75	355.73
19	$X_4.X_5$	$6.111X_4 +20.64 X_5$	42.22	1716.26
20	$X_4.X_6$	$4.328X_4 + 8.181X_6$	23.55	957.32
21	$X_5.X_6$	$2.859X_5 + 11.75X_6$	22.51	915.04
22	$X_1.X_2.X_3$	$0.384X_1 + 0.052X_2 + 0.484X_3$	2.11	85.94
23	$X_1.X_2.X_4$	$-5.92X_1 + 15.45X_2 + 227.9X_4$	116.20	4723.58

24	$X_1.X_2.X_5$	$-1.82X_1 + 6.008X_2 + 82.19X_5$	60.00	2439.02
25	$X_1.X_2.X_6$	$-0.56X_1 + 2.305X_2 + 32.39X_6$	23.72	964.23
26	$X_1.X_3.X_4$	$-6.12X_1 + 21.47X_3 + 250.5X_4$	182.74	7428.46
27	$X_1.X_3.X_5$	$-1.68X_1 + 7.384X_3 + 85.26X_5$	62.32	2533.50
28	$X_1.X_3.X_6$	$-0.40X_1 + 3.355X_3 + 34.10X_6$	25.09	1019.80
29	$X_1.X_4.X_5$	$2.254X_1 + 61.56X_4 +139.8X_5$	135.67	5515.04
30	$X1.X4.X_6$	$4.186X_1 + 48.75X_4 + 51.72X_6$	82.21	3341.87
31	$X_1.X5.X_6$	$0.671X_1 + 26.77X_5 + 71.97X_6$	65.53	2663.82
32	$X_2.X_3.X_4$	$-5.83X_2 + 13.94X_3 + 176.0X_4$	128.23	5212.60
33	$X_2.X_3.X_5$	$-1.91X_2 + 4.219X_3 + 58.87X_5$	42.86	1742.28
34	$X_2.X_3.X_6$	$-0.83X_2 + 1.928X_3 + 26.84X_6$	19.54	794.31
35	$X_2.X_4.X_5$	$-0.62X_2 + 43.78X_4 + 110.2X_5$	101.37	4120.73
36	$X_2.X_4.X_6$	$1.098X_2 + 32.72X_4 + 41.29X_6$	59.69	2426.42
37	$X_2.X_5.X_6$	$0.065X_2 + 18.70X_5 + 41.09X_6$	40.44	1643.90
38	$X_3.X_4.X_5$	$-0.002X_3 + 48.07X_4 +114.0X_5$	107.87	4384.96
39	$X_3.X_4.X_6$	$1.736X_3 + 36.89X_4 + 43.85X_6$	66.64	2708.93
40	$X_3.X_5.X_6$	$-0.66X_3 + 21.02X_5 + 65.43X_6$	55.31	2248.34
41	$X_4.X_5.X_6$	$4.595X_4 + 30.53X_5 + 62.29X_6$	67.68	2751.20
42	$X_1.X_2.X_3.X_4$	$0.230X_1 +-1.345X_2 + 3.175X3 + 0.440X_4$	9.49	385.77
43	$X_1.X_2.X_3.X_5$	$2.762X_1 + -0.249X_2 + -0.442X_3 + -0.732X_5$	5.83	236.92
44	$X_1.X_2.X_3.X_6$	$2.623X1 + -0.161X2 + 0.729X3 + -0.829X6$	4.84	196.91
45	$X_1.X_2.X_4.X_5$	$16.19X_1 + 18.10X_2 + 259.97X_4 + -8.910X_5$	195.87	7962.20
46	$X_1.X_2.X_4.X_6$	$17.38X_1 + 15.63X_2 + 236.85X_4 + -9.091X_6$	172.46	7010.57
47	$X_1.X_2.X_5.X_6$	$6.962X_1 + 8.135X_2 + 115.07X_5 + -3.772X_6$	83.49	3393.92
48	$X_1.X_3.X_4.X_5$	$18.07X_1 + 24.67X_3 + 293.52X_4 + -9.711X_5$	213.00	8658.54
49	$X_1.X_3.X_4.X_6$	$19.32X_1 + 21.97X_3 + 260.33X_4 + -9.920X_6$	189.55	7705.29
50	$X_1.X_3.X_5.X_6$	$8.254X_1 + 9.815X_3 + 118.66X_5 + -4.214X_6$	86.30	3508.10
51	$X_1.X_4.X_5.X_6$	$23.70X_1 + 64.38X_4 + 177.33X_5 + -8.715X_6$	158.59	6446.75
52	$X_2.X_3.X_4.X_5$	$-3.73X_2 + 16.46X_3 + 212.44X_4 + -1.296X_5$	153.98	6259.30
53	$X_2.X_3.X_4.X_6$	$-0.26X_2 + 14.05X_3 + 179.23X_4 + -2.209X_6$	129.52	5265.01
54	$X_2.X_3.X_5.X_6$	$-1.83X_2 + 6.404X_3 + 89.148X_5 + -0.424X_6$	64.67	2628.82
55	$X_2.X_4.X_5.X_6$	$-0.42X_2 + 46.20X_4 + 140.66X_5 + -0.465X_6$	119.59	4861.32
56	$X_3.X_4.X_5.X_6$	$3.542X_3 + 50.562X_4 + 145.56X_5 + -1.760X_6$	125.90	5117.89
57	$X_1.X_2.X_3.X_4.X_5$	$-6.509X_1 + -1.909X_2 + 1.896X_3 + 2.476X_4 + 2.172X_6$	12.27	498.70
58	$X_1.X_2.X_3.X_4.X_6$	$20.58X_1 + -1.009X_2 + 3.516X_3 + -5.720X_4 + -4.777X_6$	13.73	558.10
59	$X_1.X_2.X_3.X_5.X_6$	$5.377X_1 + -0.408X_2 + -1.132X_3 + -1.408X_5 + -0.816X_6$	5.96	242.32
60	$X_1.X_2.X_4.X_5.X_6$	$143.22X_1 + 21.68X_2 + 274.03X_4 + -46.999X_5 + -31.494X_6$	206.01	8374.30
61	$X_1.X_3.X_4.X_5.X_6$	$160.94X_1 + 29.008X_3 + 298.14X_4 +-52.554X_5 + -35.394X_6$	224.78	9137.40
62	$X_2.X_3.X_4.X_5.X_6$	$-141.02X_2 + 12.504X_3 + 209.19X_4 + 0.121X_5 + 33.360X_6$	168.47	6848.34
63	$X_1.X_2.X_3.X_4.X_5.X_6$	$-8.713X_1 + -2.239X_2 +1.586X_3 + 3.098X_4 + 2.966X_5 + -0.0266X_6$	13.71	557.24