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

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Abstract

Seventy diverse genotype of soybean were evaluated in a randomized block design with three replications to study of selection indices under rainfed conditions during *kharif* 2019-20. Thirty-one selection indices involving seed yield per plant and four yield components *viz.*, number of pods per plant, number of clusters per plant, biological yield per plant and harvest index 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, number of pods per plant exhibited higher genetic advance and relative efficiency over straight selection for seed yield per plant. The index based on three characters *viz.*, number of pods per plant, number of clusters per plant and biological yield per plant possessed high genetic gain and relative efficiency. These characters could be advantageously exploited in the soybean breeding programmes.

Keywords: Soybean, discriminant function, relative efficiency, selection indices

Introduction

Soybean [*Glycine max* (L.) Merrill] being a potentially high yielding crop can play an important role in boosting oilseed production in the country. Linnaeous (1737) [5] proposed the name Glycine and described soybean plant as Phaseolus max in his book Genera plantarum. It belongs to family Leguminosae, sub family Papilionaceae with chromosome number 2n=40. 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. An application of discriminant function developed by Smith (1936) [7] helps to identify important combination of yield components useful for selection by formulating suitable selection indices.

Materials and Methodology

The present investigation was carried out at the Sagdividi Farm, Department of Seed Science and Technology, College of Agriculture, Junagadh Agricultural University, Junagadh during *Kharif* 2019-20. The weather during the growing season was favourable for normal growth and development of crop. The experimental material consisted of 70 diverse genotypes of soybean were sown on 8th August, 2019 in a randomized block design with three replications. The pure seeds of these genotypes were obtained from the Research Scientist (Oilseed), Agriculture Research Station, Junagadh Agricultural University, Amreli. Each genotype was sown in a single row plot of 2.0 m length with a spacing of 45 cm × 15 cm. The genotypes were randomly allotted to the plots in each replication. All the recommended agronomical practices along with necessary plant protection measures were followed timely for the successful raising of the crop. The observations were recorded on these five randomly selected plants in each replication and in each genotype for 14 characters *viz.*, days to flowering, days to maturity, number of branches per plant, plant height, number of pods per plant, number of seeds per pod, number of clusters per plant, number of pods per cluster, pod length, seed yield per plant, 100-seed weight, biological yield per plant, harvest index and oil content. But in case of days to flowering and days to maturity observations were counted on plot basis. The model suggested by Robinson *et al.* (1951) [6] was used for the construction of selection indices and development of a required discriminant function.

Results and Discussion

For constructing the selection indices, the characters which had highly significant correlation with seed yield per plant and positive direct effect on seed yield were considered. In this context, the seed yield per plant (X_1) along with four components viz., number of pods per plant (X_2), number of clusters per plant (X_3), biological yield per plant (X_4) and harvest index (X_5) were identified and considered. For computing selection indices, seed yield per plant was considered as the dependent variable with the relative efficiency of 100%.

A total of 31 selection indices based on five 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.

It is interesting to note that relative efficiency improved with an increase in number of characters in combination with yield Table 2. The maximum relative efficiency (RI) in single character discriminant function was 845.98% for number of pods per plant. However, it increased up to 1024.58% in two character combinations number of pods per plant (X_2) and number of clusters per plant (X_3); 1201.40% in three characters combinations number of pods per plant (X2), number of clusters per plant (X_3) and biological yield per plant (X_4) and 1294.14% in four characters combinations seed yield per plant (X_1), number of pods per plant (X_2), number of clusters per plant (X_3) and biological yield per plant (X4). Thus, there was an increase in relative efficiency with an increase in the character combinations. In five character combinations, the highest relative efficiency (1342.21%) was observed by combinations of characters seed yield per plant (X_1), number of pods per plant (X_2), number of clusters per plant (X_3), biological yield per plant (X_4) and harvest index (X_5).

Hazel and Lush (1943) [3] 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. Adsul and Monpara (2014) [1], Kachhadia *et al*., (2014) [4] and Bizari *et al*. (2017) [2] were also with the same opinion that an increase in characters resulted in an increase in genetic gain and that the selection indices improve 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=2.24 g, RI=100%) as it was through its components like number of pods per plant (GA=18.95 g, RI=845.98%), number of clusters per plant (GA=5.22 g, RI=233.04%), biological yield per plant (GA=4.40 g, RI=196.43%) and harvest index (GA=2.53 g, RI=112.95%). Among the combination involving two component characters, number of pods per plant and number of clusters per plant (X2+X3) with the 22.95 g genetic advance and 1024.58% relative efficiency. The selection index based on three character combinations indicated that a discriminant function with number of pods per plant, number of clusters per plant and biological yield per plant (X2+X3+X4) possessed 26.91 g genetic advance relative efficiency of 1201.40%. The selection index of four characters viz., seed yield per plant, number of pods per plant, number of clusters per plant and biological yield per plant (X1+X2+X3+X4) with the 28.99 g genetic advance and 1294.14% relative efficiency. The maximum efficiency in selection for seed yield was exhibited by a discriminant function involving seed yield per plant, number of pods per plant, number of clusters per plant, biological yield per plant and harvest index (X1+X2+X3+X4+X5) which had a genetic advance and relative efficiency of 30.07 g and 1342.21%.

However, in practice the plant breeder might be interested in maximum gain with minimum number of characters. In this context, the selection index consisting number of pods per plant, number of clusters per plant and biological yield per plant (X2+X3+X4) with the 26.91 g genetic advance and 1201.40% relative efficiency could be advantageously exploited in the soybean breeding programmes. The data on selection indices, discriminant functions, genetic gain, relative efficiency and relative efficiency per character are presented in Table 3.

High efficiency in selection based on number of pods per plant, number of clusters per plant and biological yield per plant or in combination of all these three characters has been reported by Adsul and Monpara (2014) [1].

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

No. of characters in the index	Relative Efficiency (%)
One	297.68
Two	550.11
Three	822.68
Four	1082.75
Five	1342.21

Table 2: Highest Relative efficiency with character combinations in soybean

Sr. No.	Character	Relative efficiency (%)
1.	Number of pods/plant	845.98
2.	Number of pods/plant + number of clusters/ plant	1024.58
3.	Number of pods/plant + biological yield/plant	1022.81
4.	Number of pods/plant + number of clusters/ plant + biological yield/plant	1201.40
5.	Seed yield/ plant + number of pods/plant + biological yield/plant	1115.48
6.	Seed yield/ plant + number of pods/plant + number of clusters/ plant	1115.09
7.	Seed yield/ plant + number of pods/plant + number of clusters/ plant + biological yield/plant	1294.14
8.	Number of pods/plant + number of clusters/ plant + biological yield/plant + harvest index	1247.76
9.	Seed yield/ plant + number of pods/plant + number of clusters/ plant + biological yield/plant + harvest index	1342.21

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 efficieny (%)
1.	X_1 Seed yield per plant	$0.997X_1$	2.24	100.00
2.	X_2 No. of pods/ plant	$0.988X_2$	18.95	845.98
3.	X_3 No. of clusters/ plant	$0.946X_3$	5.22	233.04
4.	X_4 Biological yield/plant	$0.964X_4$	4.40	196.43
5.	X_5 Harvest index	$0.564X_5$	2.53	112.95
6.	$X_1.X_2$	$1.378X_1 + 0.949X_2$	20.97	936.06
7.	$X_1.X_3$	$1.156X_1 + 0.903X_3$	7.00	312.72
8.	$X_1.X_4$	$1.447X_1 + 0.760X_4$	6.59	294.40
9.	$X_1.X_5$	$1.270X_1 + 0.528X_5$	4.19	186.90
10.	$X_2.X_3$	$1.001X_2 + 0.927X_3$	22.95	1024.58
11.	$X_2.X_4$	$0.980X_2 + 1.040X_4$	22.91	1022.81
12.	$X_2.X_5$	$1.008X_2 + 0.585X_5$	19.99	892.21
13.	$X_3.X_4$	$0.790X_3 + 0.567X_4$	6.31	281.87
14.	$X_3.X_5$	$1.044X_3 + 0.565X_5$	6.47	288.76
15.	$X_4.X_5$	$1.055X_4 + 0.562X_5$	5.84	260.79
16.	$X_1.X_2.X_3$	$1.516X_1 + 0.954X_2 + 0.894X_3$	24.98	1115.09
17.	$X_1.X_2.X_4$	$1.655X_1 + 0.956X_2 + 0.828X_4$	24.99	1115.48
18.	$X_1.X_2.X_5$	$1.824X_1 + 0.926X_2 + 0.537X_5$	22.05	984.38
19.	$X_1.X_3.X_4$	$1.542X1 + 0.909X_3 + 0.789X_4$	10.92	487.59
20.	$X_1.X_3.X_5$	$1.453X1 + 0.888X_3 + 0.530X_5$	8.37	373.69
21.	$X_1.X_4.X_5$	$2.122X_1 + 0.554X_4 + 0.503X_5$	8.05	359.21
22.	$X_2.X_3.X_4$	$0.985X_2 + 0.921X_3 + 1.089X_4$	26.91	1201.40
23.	$X_2.X_3.X_5$	$1.015X_2 + 0.950X_3 + 0.594X_5$	23.98	1070.75
24.	$X_2.X_4.X_5$	$0.989X_2 + 1.096X_4 + 0.590X_5$	23.95	1069.08
25.	$X_3.X_4.X_5$	$0.967X_3 + 1.082X_4 + 0.568X_5$	10.08	450.11
26.	$X_1.X_2.X_3.X_4$	$1.746X_1 + 0.960X_2 + 0.897X_3 + 0.854X_4$	28.99	1294.14
27.	$X_1.X_2.X_3.X_5$	$1.960X_1 + 0.931X_2 + 0.892X_3 + 0.540X_5$	26.06	1163.23
28.	$X_1.X_2.X_4.X_5$	$2.434X_1 + 0.936X_2 + 0.641X_4 + 0.521X_5$	26.07	1163.71
29.	$X_1.X_3.X_4.X_5$	$2.242X_1 + 0.894X_3 + 0.582X_4 + 0.508X_5$	12.21	544.90
30.	$X_2.X_3.X_4.X_5$	$0.990X_2 + 0.938X_3 + 1.140X_4 + 0.598X_5$	27.95	1247.76
31.	$X_1.X_2.X_3.X_4.X_5$	$2.519X_1 + 0.940X_2 + 0.893X_3 + 0.669X_4 + 0.526X_5$	30.07	1342.21

Conclusions

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 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 traits such as number of pods per plant, number of clusters per plant and biological yield per plant has high genetic gain of with relative efficiency. So maximum weightage should be given to these functions while making selection. The present study also revealed that the discriminant 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 seed yield advancement in soybean crop.

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