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Discriminate function analysis in Indian bean (*Lablab purpureus* L.)

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Abstract
Fifty diverse genotypes of Indian bean were evaluated in a Randomized Block Design with three replications to the study of selection indices during late *kharif* 2016-17. Sixty-three selection indices were constructed using the discriminant function technique revealed that the efficiency of selection increased with the inclusion of more number of characters in the index. The selection index based on five characters *viz.*, green pod yield per plant, number of pods per plant, 10-green pod weight, plant height and reproductive phase duration exhibited maximum relative efficiency. Selection of these characters increase pod yield in Indian bean. The expected genetic advance and relative efficiency assessed for different indices increased considerably when selection was based on two or more characters.

Keywords: selection index, discriminate function and Indian bean

Introduction
Lablab purpureus L. (Syn. *Dolichos lablab* L., 2n=22) is an important legume as well as vegetable crop cultivated in the tropical region of Asia, Africa and America. It belongs to the family *Fabaceae*, sub family *Faboideae*, tribe *phaseoleae*, and the genus *Lablab* included several distinct species but is currently regarded as monospecific. The crop has multipurpose use. It is one of the excellent pod vegetable crops grown in India. The green pods and tender leaves are popular vegetables. In addition to high nutritional value, Indian bean fodder is also palatable and the cattle are nourished well. Incorporating this crop into pastures improves the quality, palatability and digestibility of pastures. In India the major Indian bean growing states are Karnataka, Tamil Nadu, Andhra Pradesh and Gujarat. It is a self-pollinated crop but often cross pollination up to 6-10% may occur due to frequent movement of insects (Free, J. B. 1993) [1]. Field bean is remarkably adaptable to wider area under diverse climate conditions such as arid, semi-arid, sub-tropical and humid regions where temperatures vary between 22^0 and 35^0 C, low land and uplands and many types of soil with pH varying from 4.4 to 7.8. It is a drought tolerant crop, which comes up well with the rainfall between 600 and 800 mm per annum (Yadav 2003) [4].

It is believed that pulses may have lower genetic potential than cereals, however, the available evidences indicate that the pulse crops have as high or higher genetic potential for yield than cereals (Jain, 1975) [2]. Poor yield potentiality of Indian bean may be due to the indeterminate genotypes adapted to poor management practices as it was constantly grown under marginal lands, residual moisture or stress conditions by the farmers. However, the crop is very famous in context to kitchen gardening especially tribal areas for easy availability of pods throughout year. One may frequently observe climbing vines of Indian bean on roofs of tribal huts.

Pod yield is governed by polygenic system and highly influenced by the fluctuations in the environment. Hence, selection of plants based directly on pod yield would not be very much reliable in many cases. Selection based on suitable selection index has been found to be superior to direct selection for pod yield. Thus, selection indices help the plant breeders to discriminant desirable genotypes on the basis of phenotypic performance. Therefore, the present study was conducted with keep objective in mind, to construct the selection indices using pod yield and its component traits.

Materials and Methods
The present investigation was conducted to assess selection indices in Indian bean. The trial was conducted at the Instructional Farm, College of Agriculture, Junagadh Agricultural University, Junagadh during late *kharif* 2016-17. Junagadh is situated at 21.5^0 N latitude and 70.5^0 E longitude with an elevation of 82.92 meters above the mean sea level. The soil of experimental site is medium black with pH 7.8. Fifty genotypes of Indian bean were sown on 27^{th} September, 2016 in a randomized block design with three replications. Each line had ten

plants of single genotype which was sown with a spacing of 75 cm × 45 cm. Data were recorded for days to first flowering, days to 50 per cent flowering, days to maturity on plot basis as well as reproductive phase duration, days to first picking, days to last picking, number of picking, plant height, number of branches per plant, number of pods per plant, pod length, pod width, 10-green pod weight, green pod yield per plant, number of seeds per pod, 100-seed weight and seed yield per plant on five randomly selected competitive plants from each entry. Selected plants were tagged before the emergence of first flower. There were two sets of plants in each entry. First five plants were used for recording observations on green pod and the remaining plants were kept for recording observations based on seed related traits and their averages were used in the statistical analysis. Selection indices carried out as per the procedure suggested by Smith (1936) [3].

Results and Discussion

The results for selection indices furnished in Table 1. For constructing the selection indices, the characters which had highly significant correlation with green pod yield per plant were considered. In this context, green pod yield per plant (X_1) along with five component characters *viz.*, number of pods per plant (X_2), 10-green pod weight (X_3), plant height (X_4), days to 50% flowering (X_5) and reproductive phase duration (X_6) were identified. Sixty-three selection indices were constructed in all possible combinations of the five yield contributing characters along with green pod yield per plant. The data on selection indices, discriminant functions, genetic advance and relative efficiency are given in Table 1 assuming the efficiency of selection for green pod yield per plant as 100%.

The maximum relative efficiency (RI) in single character discriminant function was only 27.86% by number of pods per plant. However, it increased up to 113.07% in two character combinations (green pod yield per plant and number of pods per plant); 117.95% in three characters combinations (green pod yield per plant, number of pods per plant and 10-green pod weight) and 122.39% in four characters combinations (green pod yield per plant, number of pods per plant, 10-green pod weight and reproductive phase duration). Thus, there was an increase in relative efficiency with an increase in the character combinations.

The highest relative efficiency of 122.83% was exhibited by a selection index involving five component characters *viz.*, green pod yield per plant, number of pods per plant, 10-green pod weight, plant height and reproductive phase duration ($X_1+X_2+X_3+X_4+X_6$). The selection index on the based on all the six characters recorded 121.33% relative efficiency. While calculating relative efficiency per character, it was observed that maximum relative efficiency was recorded by direct selection of number of pods per plant (27.86%). The higher relative efficiency per character was recorded in various combinations of traits. i.e. X_1+X_2 (56.54%) > $X_1+X_2+X_3$ (39.32%) > $X_1+X_2+X_3+X_6$ (30.60%) as compared to straight selection of number of pods per plant (27.86%).

Table 1: Selection index, Discriminate function, Expected genetic advance in pod yield and Relative efficiency from the use of different selection indices of Indian bean

Sr. No.	Selection index	Discriminate function	Expected genetic advance	Relative efficiency (%)	Relative efficiency per character (%)
1	X_1: Green pod yield per plant	0.907 X_1	437.27	100.0	100.00
2	X_2: Number of pods per plant	0.805 X_2	121.80	27.86	27.86
3	X_3: 10-green pod weight	0.954 X_3	26.45	6.05	6.05
4	X_4: Plant height	0.926 X_4	64.09	14.66	14.66
5	X_5: Days to 50% Flowering	0.952 X_5	17.54	4.01	4.01
6	X_6: Reproductive phase duration	0.952 X_6	25.26	5.78	5.78
7	X_1+X_2	0.940 X_1 + 0.516 X_2	494.38	113.07	56.54
8	X_1+X_3	0.781 X_1 + 3.903 X_3	463.72	106.07	53.03
9	X_1+X_4	0.908 X_1 + 0.991 X_4	446.06	102.02	51.01
10	X_1+X_5	0.887 X_1 - 0.338 X_5	430.08	98.37	49.18
11	X_1+X_6	0.874 X_1 + 2.293 X_6	453.33	103.68	51.84
12	X_2+X_3	0.803 X_2 + 0.851 X_3	120.19	27.49	13.74
13	X_2+X_4	0.803 X_2 + 0.887 X_4	126.69	28.98	14.49
14	X_2+X_5	0.799 X_2 + 0.658 X_5	119.72	27.38	13.69
15	X_2+X_6	0.803 X_2 + 1.233 X_6	130.35	29.81	14.91
16	X_3+X_4	0.972 X_3 + 0.926 X_4	72.85	16.66	8.33
17	X_3+X_5	0.934 X_3 + 0.917 X_5	25.07	5.73	2.87
18	X_3+X_6	0.970 X_3 + 0.968 X_6	44.39	10.15	5.08
19	X_4+X5	0.919 X_4 + 1.076 X_5	73.32	16.77	8.38
20	X_4+X6	0.928 X_4 + 0.980 X_6	72.10	16.49	8.25
21	X_5+X6	0.979 X_5 + 0.968 X_6	25.03	5.73	2.86
22	$X_1+X_2+X_3$	0.680 X_1 + 1.022 X_2 + 5.305 X_3	515.75	117.95	39.32
23	$X_1+X_2+X_4$	0.944 X_1 + 0.504 X_2 + 0.831 X_4	499.35	114.21	38.07
24	$X_1+X_2+X_5$	0.914 X_1 + 0.525 X_2 - 0.667 X_5	487.51	111.50	37.17
25	$X_1+X_2+X_6$	0.895 X_1 + 0.544 X_2 + 2.613 X_6	510.59	116.78	38.93
26	$X_1+X_3+X_4$	0.781 X_1 + 3.939 X_3 + 0.870 X_4	472.59	108.09	36.03
27	$X_1+X_3+X_5$	0.773 X_1 + 3.792 X_3 + 0.090 X_5	456.29	104.36	34.79
28	$X_1+X_3+X_6$	0.763 X_1 + 3.724 X_3 + 2.035 X_6	479.22	109.61	36.54
29	$X_1+X_4+X_5$	0.884 X_1 + 1.117 X_4 - 0.514 X_5	440.05	100.65	33.55
30	$X_1+X_4+X_6$	0.874 X_1 + 0.942 X_4 + 2.311 X_6	462.38	105.75	35.25
31	$X_1+X_5+X_6$	0.864 X_1 + 0.129 X_5 + 2.163 X_6	445.79	101.96	33.99
32	$X_2+X_3+X_4$	0.802 X_2 + 0.879 X_3 + 0.892 X_4	127.10	29.08	9.69

33	$X_2+X_3+X_5$	0.790 X_2	+	0.713 X_3	+	0.488 X_5		116.61	26.68	8.89
34	$X_2+X_3+X_6$	0.792 X_2	+	0.687 X_3	+	1.384 X_6		131.45	30.07	10.02
35	$X_2+X_4+X_5$	0.801 X_2	+	0.906 X_4	+	0.803 X_5		128.38	29.37	9.79
36	$X_2+X_4+X_6$	0.799 X_2	+	0.873 X_4	+	1.282 X_6		136.66	31.26	10.42
37	$X_2+X_5+X_6$	0.639 X_2	+	5.887 X_5	+	10.623 X_6		286.42	65.51	21.84
38	$X_3+X_4+X_5$	0.994 X_3	+	0.919 X_4	+	1.076 X_5		78.70	18.01	6.00

Table 1: Contd…

Sr. No.	Selection index	Discriminate function							Expected genetic advance	Relative efficiency (%)	Relative efficiency per character (%)
39	$X_3+X_4+X_6$	0.976 X_3	+	0.927 x_4	+	0.994 X_6			83.86	19.18	6.39
40	$X_3+X_5+X_6$	1.103 X_3	+	1.022 X_5	+	0.936 X_6			40.80	9.33	3.11
41	$X_4+X_5+X_6$	0.909 X_4	+	1.165 X_5	+	1.053 X_6			78.45	17.94	5.98
42	$X_1+X_2+X_3+X_4$	0.685 X_1	+	1.010 X_2	+	5.271 X_3	+	0.864 X_4	520.93	119.15	29.79
43	$X_1+X_2+X_3+X_5$	0.687 X_1	+	0.979 X_2	+	4.875 X_3	-	0.254 X_5	508.41	116.28	29.07
44	$X_1+X_2+X_3+X_6$	0.330 X_1	+	1.794 X_2	+	9.948 X_3	+	2.424 X_6	535.11	122.39	30.60
45	$X_1+X_2+X_4+X_5$	0.913 X_1	+	0.535 X_2	+	1.018 X_4	-	0.678 X_5	493.38	112.84	28.21
46	$X_1+X_2+X_4+X_6$	0.898 X_1	+	0.528 X_2	+	0.778 X_4	+	2.677 X_6	515.95	118.01	29.50
47	$X_1+X_2+X_5+X_6$	0.882 X_1	+	0.548 X_2	-	0.114 X_5	+	2.440 X_6	503.22	115.09	28.77
48	$X_1+X_3+X_4+X_5$	0.775 X_1	+	3.786 X_3	+	0.962 X_4	+	0.177 X_5	466.25	106.64	26.66
49	$X_1+X_3+X_4+X_6$	0.761 X_1	+	3.773 X_3	+	0.836 X_4	+	2.084 X_6	488.33	111.69	27.92
50	$X_1+X_3+X_5+X_6$	0.759 X_1	+	3.673 X_3	+	0.472 X_5	+	1.974 X_6	471.56	107.85	26.96
51	$X_1+X_4+X_5+X_6$	0.864 X_1	+	1.047 X_4	+	0.063 X_5	+	2.135 X_6	456.02	104.30	26.07
52	$X_2+X_3+X_4+X_5$	0.795 X_2	+	0.769 X_3	+	0.932 X_4	+	0.633 X_5	127.37	29.13	7.28
53	$X_2+X_3+X_4+X_6$	0.789 X_2	+	0.702 X_3	+	0.878 X_4	+	1.424 X_6	139.50	31.90	7.98
54	$X_2+X_3+X_5+X_6$	0.784 X_2	+	0.609 X_3	+	0.669 X_5	+	1.358 X_6	126.81	29.00	7.25
55	$X_2+X_4+X_5+X_6$	0.797 X_2	+	0.862 X_4	+	1.092 X_5	+	1.333 X_6	137.07	31.35	7.83
56	$X_3+X_4+X_5+X_6$	1.001 X_3	+	0.907 X_4	+	1.174 X_5	+	1.058 X_6	87.22	19.95	4.99
57	$X_1+X_2+X_3+X_4+X_5$	0.685 X_1	+	0.989 X_2	+	4.907 X_3	+	0.998 X_4	514.54	117.68	23.54
		-0.226 X_5									
58	$X_1+X_2+X_3+X_4+X_6$	0.665 X_1	+	0.995 X_2	+	4.966 X_3	+	0.818 X_4	537.03	122.83	24.57
		+2.388X_6									
59	$X_1+X_2+X_3+X_5+X_6$	0.662 X_1	+	0.989 X_2	+	4.775 X_3	+	0.271 X_5	524.04	119.86	23.97
		+2.386 X_6									
60	$X_1+X_2+X_4+X_5+X_6$	0.884 X_1	+	0.544 X_2	+	0.896 X_4	+	0.001 X_5	509.41	116.51	23.30
		+2.493 X_6									
61	$X_1+X_3+X_4+X_5+X_6$	0.759 X_1	+	3.738 X_3	+	0.863 X_4	+	0.772 X_5	481.75	110.19	22.04
		+2.067 X_6									
62	$X_2+X_3+X_4+X_5+X_6$	0.786 X_2	+	0.672 X_3	+	0.887 X_4	+	0.921 X_5	138.54	31.69	6.34
		+1.437 X_6									
63	$X_1+X_2+X_3+X_4+X_5+X_6$	0.663 X_1	+	0.987 X_2	+	4.827 X_3	+	0.863 X_4	530.49	121.33	20.22
		+0.569 X_5	+	2.480 X_6							

The present study showed that there was consistent increase in the relative efficiency of the succeeding index with simultaneous inclusion of each character. 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 green pod yield per plant alone and hence, due weightage should be given to important selection indices while making selection for pod yield advancement in Indian bean.

Conclusion

Sixty-three selection indices, involving green pod yield per plant and five yield components, were constructed using the discriminant function technique. The efficiency of selection increased with the inclusion of more number of characters in the index. The selection index based on five characters *viz.* green pod yield per plant, number of pods per plant, 10-green pod weight, plant height and reproductive phase duration was the most efficient one and for obtaining higher yielding lines, maximum weightage should be given to these attributes while making selection.

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