The Bioscan 10(4): 2027-2030, 2015 (Supplement on Genetics and Plant Breeding) www.thebioscan.in
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES

SELECTION INDICES FOR YIELD IMPROVEMENT IN WHEAT (*TRITICUM AESTIVUM* L.) IN NORMAL IRRIGATION CONDITION UNDER LATE SOWN CONDITION

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KEYWORDS
Wheat
Discriminant Function
Relative Efficiency
Selection Indices

Received on :
16.07.2015

Accepted on :
21.10.2015

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ABSTRACT
Sixty-three selection indices, involving grain 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 six characters *viz.*, grain yield per plant, grain weight per main spike, number of grain per main spike, ear length, biological yield per plant and harvest index followed by a selection index involving five component characters *viz.*, grain yield per plant, number of grain per main spike, ear length, biological yield per plant and harvest index.under normal irrigation condition exhibited maximum gain(26.91g, 25.70 g) and relative efficiency (1217.45%, 1163.03%), respectively. It is expected that grain yield could be improved if due consideration is given to these traits in future breeding programme of wheat.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the staple food for a large part of the world population including India. Yield is governed by a polygenic system and is highly influenced by the fluctuations in the environment. Hence, selection of plant based directly on yield would not be very reliable in many cases. The effectiveness of component approach to selection breeding is well appreciated. An application of discriminant function developed by Fisher (1936) and first applied by Smith (1936) helps to identify important combinations of yield component useful for selection by formulating suitable selection indices. Selection indices aimed at determining the most valuable genotype as well as the most suitable combinations of traits with the intention of indirectly improving the yield in different plants. The effect of selection index is measured based on the genetic progress that can be achieved using selection index as compared to the corresponding genetic gain to be attained using direct selection for grain yield alone as described (Allard R. W. 1960). Selection index is most widely used for selection of several traits at a time. Several researchers' *viz.*, Siahpoosh *et al.* (2001), Singh *et al.* (2003) and Kemelew (2011) used selection index and discriminant function analysis for improvement of wheat. Plant breeders get more success using the index selection for incensing the expected genetic advance by using direct and indirect selection of the different trait (Smith *et al.*, 1981; Weyhrich *et al.*, 2004) Therefore the objective of the present study was to construct and assess the efficiency of selection index in wheat.

MATERIALS AND METHODS

The field trial was conducted using 40 diverse genotypes of wheat (*Triticum aestivum* L.) during *Rabi* 2013-2014 in a Randomized Block Design with three replications at Wheat Research Station, Junagadh Agricultural University, Junagadh.Each entry was accommodated in a single row of 2.0 m length with a spacing of 22.5 cm. Five competitive plants per genotype in each replication were selected randomly and observations were recorded on different characters and their averages were used for statistical analysis except days to 50% flowering and days to maturity while taken as plot basis. For construction selection indices, the character with high and significant genetic correlation coefficient and sizable direct effect on grain yield were considered. In this context, the grain yield per plant (X_1) along with five components *viz.* grain weight per main spike (X_2), number of grain per main spike (X_3), ear length (X_4), biological yield per plant (X_5) and harvest index (X_6) under normal irrigated condition were identified and considered for construction of selection indices. The selection indices were constructed with various character combinations as per method of Smith (1936) and Hezal (1943).Total 63 selection indices were constructed in all possible combinations of the five yield contributing characters and grain yield per plant. Their respective genetic advance was calculated as per the formula suggested by Robinson *et al.* (1951) and relative efficiency of different discriminant functions in relation to straight selection for grain yield was assessed and compared, assuming the efficiency of selection for seed yield as 100%.

RESULTS AND DISCUSSION

Selection indices for grain yield and other characters were constructed and examined to identify their relative efficiency in the selection of superior genotypes. . The results on selection indices, discriminant function, expected genetic gain and relative efficiency are presented in Table 1. The result 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 increase considerable with further increase considerably with the inclusion of two or more characters.

The highest efficiency was noted when six character *viz*., grain yield per plant, grain weight per main spike, number of grain per main spike, ear length, biological yield per plant and harvest index (X1+X2+X3+X4+X5+X6) all were considered. Thus selection indices are more reliable and realistic for selecting desirable genotype since they are constructed by giving proper weightage on the character associates with grain yield per plant. Shiv *et al*. (2008) suggested that number of tiller per plant, number of spikelets per ear, number of grain per ear, grain weight per ear, 100-grain weight and biological yield could form effective selection indices for selection of high yielding genotype of wheat.

The maximum genetic advance (GA) and relative efficiency (RI) in single character discriminant fuction was 16.90g and 764.70% in normal irrigation for number of grain per main spike and it was increased 19.69g genetic advance and 890.80% relative efficiency respectively in two character combinations *viz*., number of grain per main spike and harvest index (X3+X6) and 21.97g GA and 994.08% RI in three character combinations *viz*., number of grain per main spike, biological yield per plant and harvest index (X3+X5+X6). 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, the highest genetic advance and relative efficiency were 23.90g and 1081.35% for grain

Table 1: Selection index, discriminant function, expected genetic advance in grain yield and relative efficiency from the use of different selection indices in normal irrigated wheat under late shown condition

Sr. No.	Selection index	Discriminant function	Expected genetic advance	Relative efficiency (%)
1	2	3	4	5
1	X1 Grain yield per plant	0.742X1	2.21	100.00
2	X2 Grain weight per main spike	0.945X2	0.83	37.55
3	X3 Number of grain per main spike	0.910X3	16.90	764.70
4	X4 Ear length	0.788X4	2.25	101.81
5	X5 Biological yield per plant	0.685X5	2.75	124.43
6	X6 Harvest index	0.249X6	3.53	159.72
7	X1.X2	0.616X1 + 1.793X2	3.02	136.79
8	X1.X3	0.973X1 + 0.911X3	18.50	837.23
9	X1.X4	0.815X1 + 0.896X4	4.10	185.56
10	X1.X5	1.084X1 + 0.498X5	5.05	228.39
11	X1.X6	1.644X1 + 0.152X6	6.14	277.84
12	X2.X3	4.878X2 + 0.756X3	17.78	804.29
13	X2.X4	1.410X2 + 0.713X4	2.91	131.80
14	X2.X5	2.030 X2 +0.577X5	3.56	161.09
15	X2.X6	4.432X2 + 0.197X6	5.32	240.76
16	X3.X4	0.897 X3 +1.160X4	18.68	845.05
17	X3.X5	0.921X3 + 0.918X5	18.93	856.64
18	X3.X6	1.020X3 + 0.174X6	19.69	890.80
19	X4.X5	0.974X4 + 0.716X5	4.65	210.16
20	X4.X6	1.223X4 + 0.250X6	5.19	234.80
21	X5.X6	1.249X5 + 0.311X6	6.46	292.29
22	X1.X2.X3	0.667X1 + 5.905X2 + 0.740X3	19.42	878.86
23	X1.X2.X4	0.697X1 + 2.011X2 + 0.762X4	4.88	220.79
24	X1.X2.X5	0.818X1 + 2.692X2 + 0.487X5	5.89	266.68
25	X1.X2.X6	1.031X1 + 4.651X2 + 0.152X6	7.43	336.34
26	X1.X3.X4	0.997X1 + 0.891X3 + 1.223X4	20.32	919.39
27	X1.X3.X5	0.745X1 + 0.941X3 + 0.910X5	20.68	935.92
28	X1.X3.X6	1.858X1 + 0.971X3 + 0.072X6	21.62	978.36
29	X1.X4.X5	1.115X1 + 1.036X4 + 0.493X5	6.81	308.12
30	X1.X4.X6	1.654X1 + 1.064X4 + 0.154X6	7.70	348.53
31	X1.X5.X6	4.372X1 + -1.133X5 + -0.08X6	8.67	392.10
32	X2.X3.X4	4.686X2 + 0.764X3 + 1.001X4	19.52	883.37
33	X2.X3.X5	5.665X2 + 0.753X3 + 0.732X5	19.84	897.62
34	X2.X3.X6	10.394X2 + 0.654X3 + 0.144X6	21.00	950.15
35	X2.X4.X5	2.205X2 + 0.806X4 + 0.630X5	5.42	245.14
36	X2.X4.X6	5.247X2 + 0.519X4 + 0.197X6	6.77	306.52
37	X2.X5.X6	4.735X2 + 0.828X5 + 0.247X6	7.76	350.90
38	X3.X4.X5	0.902X3 + 1.227X4 + 0.922X5	20.76	939.47

Table 1: Cont....

Sr. No.	Selection index	Discriminant function	Expected genetic advance	Relative efficiency (%)
1	2	3	4	5
39	X3.X4.X6	0.996X3 + 1.271X4 + 0.182X6	21.45	970.57
40	X3.X5.X6	0.978X3 + 1.359X5 + 0.252X6	21.97	994.08
41	X4.X5.X6	1.123X4 + 1.243X5 + 0.314X6	8.11	366.82
42	X1.X2.X3.X4	0.734X1 + 5.521X2 +0.745X3 + 1.063X4	21.20	959.32
43	X1.X2.X3.X5	0.445X1 + 6.826X2 +0.738X3 + 0.853X5	21.65	979.39
44	X1.X2.X3.X6	1.222X1 + 10.513X2 + 0.641X3 + 0.087X6	22.86	1034.17
45	X1.X2.X4.X5	0.875X1 + 2.734X2 + 0.864X4+0.504X5	7.64	345.73
46	X1.X2.X4.X6	1.137X1 + 5.272X2 + 0.527X4 + 0.146X6	8.95	404.79
47	X1.X2.X5.X6	4.409X1 + 5.631X2 + -1.681X5 + -0.165X6	10.03	453.86
48	X1.X3.X4.X5	0.808X1 + 0.912X3 + 1.328X4 + 0.866X5	22.54	1019.80
49	X1.X3.X4.X6	1.875X1 + 0.953X3 + 1.188X4 + 0.078X6	23.40	1058.75
50	X1.X3.X5.X6	7.420X1 + 1.007X3 + -3.106X5 + -0.468X6	23.90	1081.35
51	X1.X4.X5.X6	4.132X1 + 1.280X4 + -1.020X5 + -0.057X6	10.32	466.97
52	X2.X3.X4.X5	5.305X2 + 0.757X3 + 1.080X4 + 0.767X5	21.63	978.90
53	X2.X3.X4.X6	10.339X2 + 0.667X3 + 0.862X4 + 0.148X6	22.69	1026.74
54	X2.X3.X5.X6	10.534X2 + 0.648X3 + 0.935X5 + 0.200X6	23.20	1049.72
55	X2.X4.X5.X6	5.227X2 + 0.595X4 + 0.900X5 + 0.252X6	9.32	421.62
56	X3.X4.X5.X6	0.955X3 + 1.253X4 + 1.366X5 + 0.259X6	23.77	1075.61
57	X1.X2.X3.X4.X5	0.525X1 + 6.368X2 + 0.740X3 + 1.141X4 + 0.838X6	23.45	1061.18
58	X1.X2.X3.X4.X6	1.324X1 + 10.308X2 + 0.655X3 + 0.861X4+0.075X6	24.57	1111.60
59	X1.X2.X3.X5.X6	6.649X1 + 11.516X2 + 0.643X3 + -3.062X5 + -0.445X6	25.18	1139.16
60	X1.X2.X4.X5.X6	2.159X1 + 5.986X2 + 0.648X4 + -0.112X5 + 0.082X6	11.56	523.17
61	X1.X3.X4.X5.X6	7.131X1 + 0.976X3 + 1.359X4 + -2.917X5 + -0.430X6	25.70	1163.03
62	X2.X3.X4.X5.X6	10.265X2 + 0.658X3 + 0.935X4 + 0.987X5 + 0.208X6	24.93	1128.19
63	X1.X2.X3.X4.X5.X6	6.347X1 +11.187X2 +0.649X3 + 1.008X4 + -2.814X5 + -0.405X6	26.91	1217.45

yield per plant, number of grain per main spike, biological yield per plant and harvest index (X1+X3+X5+X6). Whereas the maximum genetic advance and relative efficiency in five character combinations *viz*., grain yield per plant, number of grain per main spike, ear length, biological yield per plant and harvest index (X1+X3+X4+X5+X6) was 25.70g and 1163.03% respectively,.

Ferdous *et al*. (2011) and KemelewMuhe (2011) were stated that the increase in characters results in increase in genetic gain and that the selection indices improve the efficiency than the straight selection for grain yield alone. Hazel and Lush (1943) stated that the selection based on such an index is more efficient than selecting individually for the various characters. They also stated that the superiority of selection based on index increases with an increase in the number of character under selection. Mavetty and Evans (1980) and Esheghi *et al*. (2011) also suggested that the selection index to be superior to direct selection in wheat.

Further, it was observed that the straight selection for grain yield was not that much rewarding (GA=2.21g, RI=100%) as it was through its component like grain weight per main spike (GA=0.83g, RI=37.55%), number of grain per main spike (GA=16.90g, RI=764.70%), ear length (GA=2.25g, RI=101.81%), biological yield per plant (GA=2.75g, RI=124.43%), harvest index (GA=3.53g, RI=159.72%) and or in their combinations.

The maximum efficiency in selection for grain yield was exhibited by a discriminant function involving grain yield per plant, grain weight per main spike, number of grain per main spike, ear length, biological yield per plant and harvest index (X1+X2+X3+X4+X5+X6) which had a genetic advance and relative efficiency of 26.91g and 1217.45%, respectively followed by an index of five characters grain yield per plant, number of grain per main spike, ear length,biological yield per plant and harvest index with the 25.70g genetic advance and 1163.03% relative efficiency. High efficiency in selection based on grain yield per plant, ear length, number of grain per main spike, biological yield per plant and harvest index in combination of all these five characters.Singh and Diwivedi (1999) suggested that number of effective tillers per plant, number of grains per spike, grain weight per spike, biological yield per plant and harvest index to be included in selection criteria for improvement of grain yield in wheat. Bergale *et al*. (2002) also suggested that the number of spike per plant, grain per spike and harvest index must be given preferencein selection along with optimum plant height and days to flowering to select the superior wheat genotypes, while Singh *et al*. (2013) also suggested that the plant height, number of tillers per plant, number of spiklets per peniclealong with grain yield per plant are useful to select the superior rice genotypes.

The present study showed consistent increase in the relative efficiency of the succeeding index with simultaneous inclusion of each character. Therefore, improvements of grain yield through these selection indices are suggested. 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*., grain yield per plant, number of grain per spike, biological yield per plant and harvest index could be advantageously exploited in the wheat breeding programmes. The present study also revealed that the discriminant function method of making selection in plant appears to be the most useful than the straight selection for grain yield alone and hence, due weightage should be given to the important selection indices while making selection for grain yield advancement in wheat breeding programme.

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