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Selection Indices for Yield Improvement in Bread Wheat (*Triticum aestivum* L.)

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Fifty diverse genotypes of bread wheat were evaluated in a randomized block design with three replication for the study of selection indices during Rabi, 2013. Thirty-one selection indices involving grain yield per plant (X_1) and four yield components *viz.*, biological yield per plant (X_2), number of grains per main spike (X_3), 1000-grain weight (X_4) and grain weight per main spike (X_5) were constructed using the discriminant function analysis. Discriminant function analysis indicated that selection efficiency of the function was improved by increasing the number of characters in the index. Among the single character indices, number of grains per main spike exhibited higher genetic advance and relative efficiency over straight selection for grain yield per plant. The index based on five characters *viz.*, grain yield per plant, biological yield per plant, number of grains per main spike, 1000-grain weight and grain weight per main spike recorded the highest genetic advance as well as relative efficiency and selection efficiency. These characters could be advantageously exploited in the bread wheat breeding programmes.

Keywords: Discriminant function, relative efficiency, expected genetic advance, selection indices and bread wheat.

Wheat (*Triticum aestivum* L.) is the staple food for a large part of the world population including India. At present world population is about seven billion and is growing at the rate of one billion every fourteen years. India is second most populous country with more than one billion people. Food grains requirement of India is estimated to be 250 million tones by 2025. Understanding of interrelationship between component characters helps in determining which character to select when improvement of the related complex character is desired. Yield in crop is a quantitative traits and has a complex genetic control mechanism and hence, direct selection it not much effective on it. The plant breeder has certain desired plant characteristics in his mind while selecting for particular genotypes and for this he applies various weight to different traits for arriving on decisions. This suggests the use of selection index which gives proper weight to each of the two or more character to be considered. Hazel and Lush (1943) showed that the selection based on such an index is more efficient than selecting individually for the various characters. An application of discriminant function developed by Smith (1936) helps to identify important combination of yield components useful for selection by formulating suitable selection indices. Therefore, the objective of the present study was to construct and assess the efficiency of selection indices in wheat

MATERIALS AND METHODS

Fifty genotypes of bread wheat were sown in a Randomized Block Design (RBD) with three replications during *rabi* 2013. Each genotype was

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accommodated in a single row of 2.5 m length with a spacing of 22.5 cm between rows. The experiment was surrounded by two guard rows to avoid damage and border effects. The fertilizers in the experimental area was applied at the rate of 120 kg N_2 ha^{-1}, 60 kg P_2O_5 ha^{-1} and 40 kg K_2O ha^{-1}. Other recommended agronomical practices in vogue were followed for reaping good crop. Data were recorded on randomly selected five plants from each genotype and average value was used for the statistical analysis for 14 characters *viz*., days to 50% flowering, grain filling period, days to maturity, plant height, number of effective tillers per plant, length of main spike, peduncle length of main spike, number of spikelet per main spike, number of grains per main spike, grain weight per main spike, 1000 grain weight, grain yield per plant, biological yield per plant, harvest index. Discriminant function analysis described by Dabholkar (1992) 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.

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 basis for the development of the selection indices has been provided by Smith (1936), Hazel (1943) and Robinson *et al.* (1951). Hazel and Lush (1943) stated that the superiority of selection based on index increases with an increase in the number of characters under selection and Mc Vetty and Evans (1980) and Esheghi *et al*. (2011) also suggested that the selection index to be superior to direct selection in wheat. A total of thirty one selection indices (Table 1) based on five characters constructed in all possible combinations revealed that the selection efficiency was high over straight selection when selection was based on individual components. Number of grain per mains spike showed a genetic advance of 17.60 %, which was higher than those calculated for other characters including grain yield per plant suggested that number of grains per main spike proved to be better selection index based on one character.

The highest genetic gain (Table 1) of 21.91% was obtained when selection was simultaneously based on discriminant function of two characters, *e.g*. biological yield per plant (X_2) and number of grains per main spike (X_3). When three characters, *e.g.* grain yield per plant (X_1), biological yield per plant (X_2) and number of grains per main spike (X_3) were taken together, the genetic advance increased to 23.98%. Index based on combination of four characters, *i.e.* grain yield per plant (X_1), biological yield per plant (X_2), number of grains per main spike (X_3) and 1000-grain weight (X_4) recorded high genetic gain of 26.44%. The maximum gain of 27.27% was achieved by taking five characters at a time, *i.e.* grain yield per plant (X_1) and four yield components viz., biological yield per plant (X_2), number of grains per main spike (X_3), 1000-grain weight (X_4) and grain weight per main spike (X_5). Thus, there was an increase in the genetic gain as well as relative efficiency with an increase in the character combinations.

Thus, the current study revealed that the index which includes more than one character, gave high genetic advance, suggesting the utility of constructing of selection indices for effecting simultaneous improvement in 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. Smith (1936), Rao (1974), Ferdous *et al.* (2010) and Kemelew (2011) 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 grain yield alone.

Therefore, due weightage should be given to days to maturity while formulating selection index of wheat crop. Overall, selection index consisting of four traits *viz.*, grain yield per plant, biological yield per plant, number of grains per main spike,

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

S. No.	Selection Index	Discriminant Function	Expected Genetic advance (%)	Relative Efficiency
1	2	3	4	5
1	X_1Grain yield/plant (g)	0.9574 X_1	3.223	100.00
2	X_2Biological yield/plant (g)	0.9602 X_2	7.533	233.73
3	X_3 No. of grains/main spike	0.9904 X_3	17.601	546.11
4	X_4 1000-grain weight(g)	0.9868 X_4	13.613	422.37
5	X_5 grain weight/main spike	0.9902 X_5	0.944	29.29
6	$X_1.X_2$	1.019X_1+0.949 X_2	10.289	319.24
7	$X_1.X_3$	0.937 X_1+0.994 X_3	19.125	593.39
8	$X_1.X_4$	0.981X_1+0.989 X_4	15.207	471.83
9	$X_1.X_5$	0.933X_1+1.132 X_5	3.916	121.50
10	$X_2.X_3$	0.956X_2+0.997X_3	21.915	679.96
11	$X_2.X_4$	0.965X_2+0.990X_4	16.398	508.78
12	$X_2.X_5$	0.951 X_2+1.169X_5	8..018	248.77
13	$X_3.X_4$	0.986X_3+0.982 X_4	19.284	598.33
14	$X_3.X_5$	0.986X_3+1.136 X_5	18.254	566.37
15	$X_4.X_5$	0.985X_4+1.058 X_5	14.022	435.06
16	$X_1.X_2.X_3$	0.971X_1+0.960X_2+0.997X_3	23.978	743.97
17	$X_1.X_2.X_4$	1.059X_1+0.941 X_2+0.987 X_4	18.804	583.43
18	$X_1.X_2.X_5$	0.973X_1+0.952 X_2+1.219 X_5	10.838	336.27
19	$X_1.X_3.X_4$	0.984X_1+0.987 X_3+0.984 X_4	21.526	667.89
20	$X_1.X_3.X_5$	0.884 X_1+0.983 X_3+1.423 X_5	19.831	615.30
21	$X_1.X_4.X_5$	0.960 X_1+0.987 X_4+1.129 X_5	15.702	487.19
22	$X_2.X_3.X_4$	0.966 X_2+0.992 X_3+0.986 X_4	23.857	740.21
23	$X_2.X_3.X_5$	0.949X_2+0.988 X_3+1.293 X_5	22.591	700.90
24	$X_2.X_4.X_5$	0.954X_2+0.984 X_4+1.233 X_5	16.937	525.50
25	$X_3.X_4.X_5$	0.942X_3+0.939 X_4+2.007 X_5	20.146	625.07
26	$X_1.X_2.X_3.X_4$	1.022 $X_1$0.985 X_4+0.955 X_2+0.991 X_3	26.446	820.54
27	$X_1.X_2.X_3.X_5$	0.879 $X_1$1.526 X_5+0.976 X_2+0.983 X_3	24.680	765.75
28	$X_1.X_2.X_4.X_5$	1.021 $X_1$1.223 X_5+0.942 X_2+0.984 X_4	19.380	601.30
29	$X_1.X_3.X_4.X_5$	0.939 $X_1$2.124 X_5+0.941 X_3+0.942 X_4	22.393	694.79
30	$X_2.X_3.X_4.X_5$	0.961 $X_2$2.120 X_5+0.944 X_3+0.940 X_4	24.695	766.21
31	$X_1.X_2.X_3.X_4.X_5$	0.947 X_1+0.969 X_2+0.942 X_3 0.941 X_4+2.217 X_5	27.279	846.39

Table 2. Average selection efficiency of different combination of characters in bread wheat

No. of characters in the index	Selection efficiency (%)
One	266.3
Two	454.32
Three	602.57
Four	729.71
Five	846.31

1000-grain weight and harvest index could be advantageously exploited in the bread wheat breeding programmes. 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 grain yield alone and hence, due weightage should be given to the important selection indices while making selection for grain yield advancement in bread wheat.

The relative efficiency (RE%) of various selection indices presented in Table 3 indicated

Table 3. Highest selection efficiency with characters combination in bread wheat

S.N.	Characters	Selection efficiency (%)
1	Number of grains per main spike	546.11
2	Biological yield per plant + Number of grains per main spike	697.96
3	Number of grains per main spike + 1000-grain weight	598.33
4	Grain yield per plant + Biological yield per plant + Number of grains per main spike	743.97
5	Biological yield per plant + Number of grains per main spike + 1000-grain weight	740.21
6	Grain yield per plant + Biological yield per plant + Number of grains per main spike + 1000-grain weight	820.54
7	Biological yield per plant + Number of grains per main spike + 1000-grain weight + grain weight per main spike	766.21
8	Grain yield per plant + Biological yield per plant + Number of grains per main spike + 1000-grain weight + grain weight per main spike	846.39

that when relative efficiency of single character index was measured over straight selection for grain yield per plant, the efficiency was declined to less than 100 per cent. This observation indicated that the indirect selection through individual traits over straight selection for pod yield per plant alone would not be effective.

It is interesting to note that selection efficiency (Table 2) improved with an increase in number of characters in combination with yield. For example, average selection efficiency of 266.3%, when one character was included in selection function. Similarly, the selection efficiency was 454.32% for two characters, 602.57% for three characters, 729.71% for four characters and 846.31% for five characters selection indices improve the selection efficiency than the straight selection for yield alone with an increase in the number of characters under selection.

Some of the selection indices with high relative efficiency listed in Table 1 indicated that the highest efficiency was observed with a combination of five characters (846.39%). Selection indices with five characters, *i.e.* grain yield per plant (X_1) and four yield components viz., biological yield per plant (X_2), number of grains per main spike (X_3), 1000-grain weight (X_4) and grain weight per main spike (X_5), therefore, appear to be more useful. It can be seen that grain yield per plant (X_1), biological yield per plant (X_2) and number of grains per main spike were the characters being commonly involved in more number of the combinations, 1000-grain weight (X_4) and grain weight per main spike (X_5)the next being and in order (Table 3).

Keeping in view, the basic idea of saving time and labour in a selection programme, it would be desirable to base the selection of few characters. In the present study, selection index based on five characters gave maximum genetic gain and high efficiency over straight selection, but practically it is more cumbersome to use in the selection exercise. However, in practice, the plant breeder might be interested in maximum gain with minimum number of characters. In the present study, selection index based on three characters (Grain yield per plant + Biological yield per plant + Number of grains per main spike) showing genetic gain (23.97%) and selection efficiency (743.97%) comparable to some extent of those based on four or more characters, which is more desirable and practically possible to use breeder than the index that includes more number of characters. Therefore, from this investigation, it is concluded that improvement of grain yield in bread wheat could be achieved by selecting the parents with these three characters; Grain yield per plant + Biological yield per plant + Number of grains per main spike.

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