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Research Note

Selection indices for yield improvement in bread wheat (*Triticum aestivum* L.)

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Abstract

The discriminant-function technique was used to construct selection indices in 48 genotypes of bread wheat (*Triticum aestivum* L.). Sixty-three selection indices involving grain yield per plant and its five components were constructed using the discriminant function technique. The efficiency of selection increased with the inclusion of more characters in the selection index. The index based on four characters *viz.,* grain yield per plant, the number of grains per main spike, grain weight per main spike and biological yield per plant recorded the highest genetic gain and relative efficiency. The use of these indices is advocated for selecting high yielding genotypes of bread wheat.

Keywords

Selection indices, discriminant function, relative efficiency, and bread wheat

Wheat (*Triticum aestivum* L.) is the second most important cereal crop of India after rice. It occupies an area of 30.78 million hectares with a total production of 98.51 million tons and a productivity of 3200 kg/ha, respectively. In Gujarat wheat was grown on 996000 hectares area with a total production of 2738000 tonnes production and productivity of 2750 kg/ha during 2016-17 (Anon., 2018). Grain yield is governed by a polygenic system and is highly influenced by the fluctuations in the environment. Hence, the selection of genotypes based solely on grain yield would not be reliable in many cases. Selection based on a suitable selection index has been found to be superior to direct selection for grain yield. An application of discriminant function developed by Fisher (1936) and first applied by Smith (1936) helps to identify the important combinations of yield components useful for selection by formulating suitable selection indices. Therefore, the object of the present study was to construct and assess the efficiency of selection indices in bread wheat.

The experimental material consisted of 70 bread wheat genotypes evaluated in randomized block design with three replications at Sagidividi Farm, Department of Seed Science and Technology, Junagadh Agricultural University, Junagadh during R*abi* 2017-18 under the normal sown irrigated conditions. Recommended agronomic practices were followed to raise a good crops. The observations on ten agronomic traits *viz.,* days to 50% flowering, days to maturity, grain filling period (days), plant height (cm), the number of productive tillers per plant, ear length (cm), the number of grains per main spike, grain weight per main spike (gm), grain yield per plant (gm), biological yield per plant (gm), harvest index (%) and 1000 grain weight (gm) were recorded at appropriate crop growth stage. For constructing the selection indices, the characters with high and significant genetic correlation coefficients and sizable direct effects on grain yield were considered. In this context, grain yield per plant (X_1) along with five components *viz. the* number of grains per main spike (X_2), grain weight per main spike (X_3), biological yield per plant (X_4), harvest index (X_5) and the number of productive tillers per plant (X_6) were identified and considered. The model suggested by Robinson *et al.* (1951) was used for the construction of selection indices and the development of the required discriminant function. A total of 63 selection indices were constructed using six traits. The respective genetic advance through selection was also calculated as per the formula suggested by Robinson *et al.* (1951). The relative efficiency of different discriminant functions in relation to straight selection for grain yield were assessed and compared, assuming the efficiency of selection for grain yield per plant as 100%.

Selection indices for grain yield per plant and other characters were constructed and examined to identify their relative efficiency in the selection of superior genotypes. The data on selection indices, discriminant functions, genetic gain, relative efficiency and relative efficiency per character are presented in **Table 2.** The results suggested that the selection efficiency was higher, in general, over straight selection when the selection was based on component character, which further increased with the inclusion of two or more characters. The highest efficiency was noted when four characters were considered. Selection indices are, thus, more realistic for selecting desirable genotypes since they are constructed by giving proper weightage on the characters associated with yield. Robinson *et al.* (1951) in corn recorded a progressive increase in efficiency of selection indices with the inclusion of every additional character in the index formula. 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 Esheghi *et al.* (2011) and Shah *et al.* (2016) also suggested that the selection index be superior to direct selection in bread wheat.

Table 1. Genotypic path coefficient analysis showing direct (diagonal and bold) and indirect effects of different characters on grain yield per plant in bread wheat.

Characters	Days to 50% flowering	Days to maturity	Grain filling period (days)	Plant height (cm)	No. of productive tillers per plant	Ear length (cm)	No. of grains per main spike	Grain weight per main spike (g)	Biological yield per plant (g)	Harvest index (%)	1000-grain weight (g)	Genotypic correlation with grain yield per plant
Days to 50% flowering	**-0.1289**	-0.0710	-0.0105	0.1451	0.0408	-0.0145	0.0196	0.0871	0.0825	0.1318	0.0002	0.2822*
Days toMaturity	-0.0672	**-0.1360**	-0.0793	0.1519	0.0466	0.0161	-0.0026	0.0031	0.0332	0.0367	0.0008	0.0033
Grain filling period (days)	-0.0100	-0.0803	**-0.1344**	0.1201	-0.0004	-0.0065	-0.0075	-0.0476	-0.0826	0.0161	-0.0007	-0.2338*
Plant height(cm)	-0.0670	-0.0740	-0.0578	**0.2790**	-0.0077	-0.0832	0.0107	0.0329	0.0235	-0.0026	-0.0009	0.0528
No. of productive tillers per plant	-0.0166	-0.0200	0.0002	-0.0067	**0.3168**	0.0051	-0.0006	-0.1597	0.0776	0.1603	-0.0085	0.3477**
Ear length(cm)	-0.0114	0.0133	-0.0053	0.1410	-0.0098	**-0.1647**	0.0121	0.0315	0.0667	-0.0247	-0.0008	0.0479
No. of grains per main spike	-0.0446	0.0063	0.0178	0.0529	-0.0035	-0.0353	**0.0566**	0.2633	0.2661	0.0689	-0.0006	0.6479**
Grain weight per main spike (g)	-0.0268	-0.0010	0.0153	0.0219	-0.1209	-0.0124	0.0356	**0.4184**	0.2352	0.0849	0.0124	0.6627**
Biological yield per plant (g)	-0.0199	-0.0085	0.0208	0.0123	0.0460	-0.0206	0.0282	0.1843	**0.5341**	-0.1720	0.0022	0.6068**
Harvest index (%)	-0.0358	-0.0105	-0.0046	-0.0015	0.1071	0.0086	0.0082	0.0749	-0.1937	**0.4744**	0.0023	0.4294 **
1000-grain weight (g)	-0.0013	-0.0066	0.0058	-0.0151	-0.1611	0.0081	-0.0020	0.3091	0.0698	0.0655	**0.0168**	0.2890*

*,** Significant at 5% and 1% levels, respectively.

The maximum relative efficiency in a single character discriminant function of 544.93% was exhibited by the number of grains per main spike. However, it increased up to 828.99% in two-character combination involving the number of grains per main spike and biological yield per plant (X_2+X_4); 848.19% in three-character combination involving the number of grains per main spike, grain weight per main spike and biological yield per plant ($X_2+X_3+X_4$); 924.64% in four-character combination involving grain yield per plant, the number of grains per main spike, grain weight per main spike and biological yield per plant ($X_1+X_2+X_3+X_4$); and in case of five and six-character combination, it was 934.78% involving grain yield per plant, the number of grains per main spike, grain weight per main spike, biological yield per plant and the number of productive tillers per plant ($X_1+X_2+X_3+X_4+X_6$). 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.

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Table 2. Selection index, discriminant function, expected genetic advance in yield and relative efficiency from the use of different selection indices in bread wheat

Sr. No.	Selection index	Discriminant function	Expected genetic advance	Relative efficiency (%)	Relative efficiency per character (%)
1	X1 Grain yield/ plant	0.515X1	2.76	100	100
2	X2 No. of grains/ main spike	0.999X2	15.04	544.93	544.93
3	X3 Grain weight/ main spike	0.314X3	0.81	29.35	29.35
4	X4 Biological yield/ plant	0.942X4	11.2	405.80	405.80
5	X5 Harvest index	0.168X5	0.17	6.16	6.16
6	X6 No. of productive tillers/ plant	0.876X6	1.99	72.10	72.10
7	X1.X2	1.183X1 + 0.944X2	17.01	616.30	308.15
8	X1.X3	0.994X1 + 0.881X3	3.34	121.01	60.51
9	X1.X4	0.972X1 + 0.985X4	13.06	473.19	236.59
10	X1.X5	0.996X1 + 0.379X5	2.83	102.54	51.27
11	X1.X6	1.017X1 + 0.850X6	3.96	143.48	71.74
12	X2.X3	0.957X2 + 1.177X3	15.57	564.13	282.07
13	X2.X4	0.960X2 + 1.008X4	22.88	828.99	414.49
14	X2.X5	0.963 X2 +2.110X5	15.07	546.01	273.01
15	X2.X6	0.963X2 + 0.815X6	15.14	548.55	274.28
16	X3.X4	-6.010 X3 +1.174X4	12.07	473.32	236.66
17	X3.X5	0.612X3 -19.327X5	3.67	132.97	66.49
18	X3.X6	0.729X3 + 0.817X6	8.30	300.72	165.36
19	X4.X5	0.981X4 + 0.508X5	8.98	325.36	162.68
20	X4.X6	0.987X4 + 0.838X6	5.70	206.52	103.26
21	X5.X6	1.418X5 + 0.851X6	7.74	280.43	140.22
22	X1.X2.X3	1.226X1 + 0.951X2 + 0.621X3	4.22	152.90	50.97
23	X1.X2.X4	1.133X1 + 0.951X2 + 0.992X4	7.76	281.16	93.72
24	X1.X2.X5	1.196X1 + 0.943X2 + 0.566X5	17.05	617.75	205.92
25	X1.X2.X6	1.324X1 + 0.927X2 + 0.681X6	17.22	623.91	207.97
26	X1.X3.X4	0.950X1 + 1.030X3 + 0.988X4	13.50	489.13	163.04
27	X1.X3.X5	1.014X1 + 0.858X3 + 0.394X5	3.41	123.55	41.18
28	X1.X3.X6	1.614X1 -1.309X3 + 0.314X6	4.27	154.71	51.57
29	X1.X4.X5	1.100X1 + 0.957X4 -1.098X5	13.04	472.46	157.49
30	X1.X4.X6	1.025X1 + 0.981X4 + 0.827X6	13.61	493.12	164.37
31	X1.X5.X6	1.020X1 + 0.777X5 + 0.854X6	4.04	146.38	48.79
32	X2.X3.X4	1.006X2 + 0.977X3 + 0.952X4	23.41	848.19	282.73
33	X2.X3.X5	0.957X2 + 1.144X3 + 2.104X5	15.60	565.22	188.41
34	X2.X3.X6	0.972X2 + 0.697X3 + 0.767X6	15.61	565.58	188.53
35	X2.X4.X5	0.953X2 + 1.023X4 + 2.686X5	22.87	828.62	276.21
36	X2.X4.X6	0.956X2 + 1.016X4 + 0.771X6	23.09	836.59	278.84
37	X2.X5.X6	0.957X2 + 4.785X5 + 0.252X6	15.09	546.74	182.25
38	X3.X4.X5	1.123X3 + 0.976X4 + 0.365X5	11.53	417.75	139.25
39	X3.X4.X6	0.668X3 + 0.999X4 + 0.778X6	11.98	434.06	144.67
40	X3.X5.X6	-2.134X3 + 5.253X5 + 0.355X6	1.57	56.88	18.96
41	X4.X5.X6	0.989X4 + 1.298X5 + 0.830X6	11.62	421.01	140.34
42	X1.X2.X3.X4	1.157X1 + 0.956X2 + 0.718X3 + 0.993X4	25.52	**924.64**	231.16
43	X1.X2.X3.X5	1.243X1 +0.950X2 + 0.600X3 + 0.499X5	17.60	637.68	159.42
44	X1.X2.X3.X6	-1.093X1 + 2.783X2 -17.404X3 -0.650X6	23.27	843.12	210.78
45	X1.X2.X4.X5	1.190X1 +0. 951X2 + 0.978X4 +0.117X5	24.98	905.07	226.27
46	X1.X2.X4.X6	1.284X1 + 0.934X2 + 0.989X4 + 0.673X6	25.26	915.22	228.80
47	X1.X2.X5.X6	1.135X1 + 0.928X2 + 1.111X5 + 0.683X6	17.27	625.72	156.43
48	X1.X3.X4.X5	1.117X1 + 0.928X3 + 0.953X4 -1.197X5	13.47	488.04	122.01
49	X1.X3.X4.X6	1.556X1 -1.040X3 + 0.979X4 + 0.352X6	14.00	507.25	126.81
50	X1.X3.X5.X6	1.623X1-1.290X3 + 0.367X5 + 0.328X6	4.36	157.97	39.49
51	X1.X4.X5.X6	1.150X1 + 0.951X4 - 0.970X5 + 0.847X6	13.59	492.39	123.10
52	X2.X3.X4.X5	0.950X2 + 1.031X3 + 1.024X4 + 2.733X5	23.40	847.83	211.96
53	X2.X3.X4.X6	0.970X2 + 0.466X3 + 1.027X4 + 0.687X6	23.58	854.35	213.59
54	X2.X3.X5.X6	0.976X2 + 0.483X3 + 3.504X5 + 0.681X6	15.66	567.39	141.85
55	X2.X4.X5.X6	0.938X2 + 1.052X4 + 4.609X5 + 0.660X6	23.09	836.59	209.15
56	X3.X4.X5.X6	0.355X3 + 1.023X4 + 2.971X5 + 0.675X6	11.93	432.25	108.06
57	X1.X2.X3.X4.X5	1.209X1 + 0.957X2 + 0.691X3 + 0.982X4 + 0.258X6	25.52	924.64	184.93
58	X1.X2.X3.X4.X6	2.171X1 + 0.962X2 -2.783+X3 + 0.979X4 -0.111X6	25.80	934.78	186.96
59	X1.X2.X3.X5.X6	2.382X1 + 0.954X2 -3.439X3 + 0.501X5 -0.290X6	17.83	646.01	129.20
60	X1.X2.X4.X5.X6	1.345X1 + 0.934X2 + 0.973X4 + 0.000X5-0.684X6	25.26	915.22	183.04
61	X1.X3.X4.X5.X6	1.850X1-1.278X3 + 0.923X4 -2.579X5 + 0.331X6	13.98	506.52	101.30
62	X2.X3.X4.X5.X6	0.963X2 - 0.523X3 + 1.109X4 + 7.627X5 + 0.348X6	23.59	854.71	170.94
63	X1.X2.X3.X4.X5.X6	2.573X1 + 0.963X2 -3.471X3 + 0.927X4 -2.199X5 - 0.286X6	25.80	934.78	155.80

Further, it was observed that the straight selection for grain yield (X_1) was not that much rewarding (GA = 2.76g, RI = 100%) as it was through its components like the number of grains per main spike (X_2), grain weight per main spike (X_3), biological yield per plant (X_4), harvest index (X_5) and the number of productive tillers per plant (X_6) or in their combinations. Among all the 63 selection indices, the index based on five characters *viz.,* grain yield per plant, the number of grains per main spike, grain weight per main spike, biological yield per plant and the number of productive tillers per plant (X1+X2+X_3+X_4+X_6) possessed the highest genetic gain and relative efficiency (25.80 g and 934.78%) as compared to straight selection for grain yield. Another important selection index identified was with the inclusion of four characters *viz.,* grain yield per plant, the number of grains per main spike, grain weight per main spike and biological yield per plant (X_1+X_2+X_3+X_4) that possessed higher genetic gain (25.52 g) and relative efficiency (924.64%). However, in practice, the plant breeder might be interested in maximum gain with the minimum number of characters. In this context, the selection index consisting of grain yield per plant, the number of grains per main spike, grain weight per main spike and biological yield per plant (X_1+X_2+X_3+X_4) could be advantageously exploited in the wheat breeding programs. High efficiency in a selection based on grain yield per plant, the number of grains per main spike, grain weight per main spike and biological yield per plant or in the combination of all these four characters has been reported by Raiyani *et al.,* (2015). The present study revealed that the discriminant function method of making selections in plants appeared to be the most useful as compared to the straight selection for grain yield alone and hence, due weightage should be given to the important selection indices while making the selection for yield advancement in wheat.

REFERENCES

Anonymous, 2018. Director's Report of AICRP on Wheat and Barley 2016-17, Ed: Singh, G. R. ICAR-Indian Institute of Wheat and Barley Research, Karnal, Haryana, India. Report 87.

Esheghi, R., Javid, O. and Samira, S. 2011. Genetic gain through selection indices in hulless barley. *Int. J Agric. and Biol.,***13**:191-197.

Ferdous, M. F, Shamsuddin, A. K. M, Hasna, D. and Bhuiyan, M. M. R. 2010. Study on relationship and selection index for yield and yield contributing characters in spring wheat. J Bangladesh Agril. Univ.,**8**:191-194. [Cross Ref]

Fisher, R. A. 1936. The use of multiple measurements in taxonomic problems. *Annals Eugen*.,**7**:179-188. [Cross Ref]

Hazel, L. N. and Lush, J. L. 1943. The efficiency of three method of selection. *J. Hered.,***33**:393-399. [Cross Ref]

Kemelew, M.2011. Selection index in durum wheat (*Triticum turgidum* var. *durum*) variety development. *Academic J Pl. Sci.,***4**:77-83.

Raiyani, G. D., Patel, K., Javia, R. M., Bhatiya, V.J.and Ramani, V. V. 2015. Selection indices for yield improvement in bread wheat under late sown condition. *Asian J. Bio Sci.,***10**(2):148-152. [Cross Ref]

Robinson, H. F., Comstock, R. E. and Harvey, P. H. 1951. Genotypic and phenotypic correlations in corn and their implications in selection. *Agron. J.***43**:282-287. [Cross Ref]

Shah, S., Mehta, D. R. and Raval, L. 2016. Selection indices in bread wheat (*Triticum aestivum* L.). *Electron. J. Plant Breed.,* 7(2):459-463. [Cross Ref]

Smith, H. F. 1936. A discriminant function for plant selection. *Ann. Eugn.***7**:240-250. [Cross Ref]