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Study on relationship and selection index for yield and yield contributing characters in spring wheat

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Abstract

The present study was conducted with twenty bread wheat genotypes at the experimental field of Bangladesh Agricultural University (BAU), Mymensingh, during the period from November 2008 to March 2009 to assess the relationship and selection index among yield and important yield attributing characters. Days to maturity, grains per spike, 100-grain weight and harvest index showed significant and positive correlation with grain yield per plant. Path coefficient analysis suggested that grains per spike followed by 100-grain weight and effective tillers per plant contributed maximum to grain yield positively and directly. Thus, selection based on these characters might be effective for improving grain yield. Selection indices were constructed through the discriminate functions using eight characters. From the results, the highest relative efficiency was observed with the selection index based on three characters; plant height and grains per spike and grain yield per plant. The present investigation indicates that the index selection based on these three characters might be more effective and efficient for selecting high yielding wheat genotypes.

Keywords: Spring wheat, Relationship, Selection index, Yield contributing characters

Introduction

Wheat (*Triticum aestivum*) is the second most important cereal crop in Bangladesh on the basis of acreage and production, next to rice (BBS, 2007). Currently the total cropped area of Bangladesh is 3,51,23,400 acres, of which wheat covers an area of 9,87,960 acres (BBS, 2007). Average yield of the improved cultivars is about 3 tons per hectare in farmers' field whereas in some developed countries it reaches to 8 tons per hectare (FAO, 1999).

The knowledge of relationship between yield and yield contributing characters is important for planning yield improvement programme in any crop. In breeding programme, correlation studies provide reliable and useful information on the nature, extent and direction of relationship. With the inclusion of more variables in the correlation studies, indirect effect becomes complex (Nandan and Pandya, 1980). So, the path coefficient analysis has been used by many researchers for getting a clear and complete picture of relationship of independent variables on dependent variable.

The path coefficient analysis helps the breeder to explain direct and indirect effects and it has been extensively used by various researchers. Relationship between yield and yield contributing characters studied through genotypic correlation accompanied with path coefficient analysis has been studied by many authors in spring wheat (Das and Mondal, 1984 and Uddin, 1998). Construction of selection indices and their analysis would give the most appropriate weight age to the phenotypic values of each of two or more characters to be used simultaneously for selection. Among the many methods of constructing selection indices, discriminate function was wide used by the researchers. The present study was therefore, carried out to study the relationship between yield and yield contributing characters and efficiency of selection indices in selection constructed from them.

Materials and Method

The experiment was conducted at the experimental field of the Department of Genetics and Plant Breeding, Bangladesh Agricultural University (BAU), Mymensingh during the period from November 2008 to March 2009. The study included 20 genotypes of bread wheat collected from wheat germplasm collection of the Department of Genetics and Plant Breeding, Bangladesh Agricultural University (BAU), Mymensingh.

The experiment was set in a randomized complete block design with three replications. The plot size was 2.5m × 1.5m with plant spacing 25 cm between rows and plot to plot distance was 40 cm. The following data were taken from 10 randomly selected plants from each plot: days to 90% maturity, plant height, effective tillers per plant, spike length, spikelets per spike, 100 grain weight, biological yield, harvest Index and grain yield per plant.

Genotypic and Phenotypic correlation coefficients were estimated according to the formula suggested by Johnson *et al.* (1955), Miller *et al.* (1958) and Singh and Chaudhury (1985) and then the data were subjected to path coefficient analysis. Selection indices were constructed using the method developed by Smith (1936) based on the discriminate function of Fisher (1936).

Results and Discussion

Study of correlation coefficient between yield and different yield contributing characters at phenotypic and genotypic level showed that grain yield per plant was positively and significantly correlated with grains per spike, 100-grain weight and harvest index (Table 1). Some of the yield contributing characters showed significant and positive correlation between them. There were significant and positive correlation of days to 90% maturity with spike length and harvest index with 100-grain weight at genotypic and phenotypic levels. Again, days to 90% maturity showed negative and significant correlation with harvest index. This result suggests that early maturing genotypes gave higher harvest index and late maturing genotypes gave lower harvest index. Both 100-grain weight and harvest index had the negative and significant correlation with effective tillers per plant.

Table 1. Genotypic and phenotypic correlations among seed yield and different characters of spring wheat

Characters		Plant height	Effective tillers	Spike length	Grains/spike	Grain weight	Harvest index	Grains yield
Maturity	G	0.490*	0.135	0.149	-0.062	-0.177	-0.469*	-0.209
	P	0.418	0.141	0.091	-0.084	-0.069	-0.408	-0.145
Plant Height	G		-0.238	0.156	0.222	0.043	-0.281	-0.019
	P		-0.078	0.226	0.211	0.052	-0.239	0.117
Effective Tillers	G			-0.185	-0.252	-0.487*	-0.458*	0.032
	P			-0.041	-0.134	-0.204	-0.382	0.134
Spike Length	G				0.327	-0.167	-0.269	-0.105
	P				0.396	-0.117	-0.136	0.209
Grains per Spike	G					-0.141	0.192	0.651**
	P					-0.109	0.192	0.588**
100-Grain weight	G						0.789**	0.460*
	P						0.537*	0.358
Harvest Index	G							0.626**
	P							0.556*

* Significant at 5% level ** Significant at 1% level

Path coefficient analysis showed that all the characters plant height, effective tillers per plant, grains per spike, 100-grain weight and harvest index influenced grain yield directly in positive direction (Table 2). They are the primary yield components in spring wheat. Among them, grains per spike had high positive correlation with grain yield. Grains per spike also influenced grain yield indirectly via plant height, spike length and harvest index in positive direction.

Days to 90% maturity effect on grain yield which is desirable for selecting early maturing genotypes with high yield. It is evident from the results that grains per spike, 100-grain weight and effective tillers per plant contributed to grains yield highly in positive direction. So, these three characters should be considered in selection index for improvement of yield in spring wheat.

Table 2. Path coefficients of different yield and yield contributing characters on grain yield in spring wheat

Characters	Days 90% maturity	Plant height (cm)	Effective tillers (no)	Spike length (cm)	Grains per spike (no)	100-grain weight (g)	Harvest index (%)	Total correlation to grain yield/ Plant (g)
Days to 90% maturity	**-0.061**	0.035	0.098	-0.016	-0.058	-0.142	-0.0657	-0.209
Plant height	-0.0298	**0.072**	-0.174	-0.017	0.208	0.035	-0.1135	-0.019
Effective tillers	-0.082	-0.017	**0.729**	0.0197	-0.236	-0.391	-0.0642	0.032
Spike length	-0.009	0.011	-0.135	**-0.107**	0.306	-0.134	-0.0377	-0.105
Grains per spike	0.004	0.016	-0.184	-0.035	**0.936**	-0.113	0.0269	0.651
100-grain weight	0.011	0.003	-0.355	0.018	-0.132	**0.804**	0.1118	0.460
Harvest index	0.029	-0.058	-0.334	0.029	0.179	0.641	**0.1402**	0.626

Residual effect, R = 0.336

Different selection indices were formulated using different combinations of yield and yield contributing traits and their expected genetic advance and relative efficiencies were estimated (Table 3). It was observed that among all selection indices, the index based on plant height + grains per spike + grain yield per plant had the maximum genetic advance with relative efficiency. Among the others, the indices based on grains per spike + grain yield, days to maturity + grains per spike + grain yield and effective tillers per plant + grains per spike + 100-grain weight + grain yield showed high genetic advance with relative efficiency over straight selection for grain yield alone. Therefore, improvement of grain yield through these selection indices are suggested. Shiv *et al*. (2008) suggested that number of tillers per plant, numbers of spikelets per ear, number of grains per ear, grain weight per ear, 100-grain weight and biological yield could form effective selection indices for selection of high yielding genotypes of wheat. Bergale *et al.* (2002) suggested that the number of spikes per plant, grains per spike and harvest index must be given preference in selection along with optimum plant height and days to flowering to select the superior wheat genotypes.

Table 3. Selection indices for grain yield and their relative efficiency in spring wheat

Index	Genetic advance	Relative efficiency
X_8	1.52	100
$X_2 + X_8$	17.042	1121.18
$X_3 + X_8$	1.142	75.13
$X_5 + X_8$	146.731	9653.36
$X_1 + X_2 + X_8$	227.602	14973.68
$X_1 + X_3 + X_8$	4.028	265
$X_1 + X_5 + X_8$	90.164	5931.84
$X_2 + X_5 + X_8$	284.736	18732.6
$X_2 + X_3 + X_5 + X_8$	16.79	1104.61
$X_3 + X_5 + X_6 + X_8$	69.751	4588.88
$X_2 + X_5 + X_6 + X_8$	11.23	738.82
$X_1 + X_2 + X_3 + X_4 + X_8$	29.848	1963.68
$X_1 + X_2 + X_3 + X_4 + X_5 + X_6 + X_7 + X_8$	22.48	1478.95

X_1- Days to 90% maturity (days), X_2 - Plant height, X_3 - Effective tillers per plant, X_4 - Spike length, X_5- Grains per spike, X_6 - 100-grain weight, X_7 - Harvest index, X_8 - Grain yield per plant

Singh and Diwivedi (1999) suggested that number of effective tillers per plant, number of grains per ear, grain weight per ear, biological yield per plant and harvest index to be included in selection criteria for improvement of grain yield in wheat. Utilizing the best selection index (plant height + grains per spike + grain yield per plant), the relative genetic score of each genotype was determined. It was found that the genotypes Protiva, BAW-966, BAW-970, SA-3, Balaka and BAW-1004 were superior among all the 20 genotypes having optimal combination of attributes. Considering total rank values, the genotypes Peacock, SA-92, BAW-1008, Pavon-76, BAW-949, Sonora-64 and BAW-1004 were found to be superior.

Table 4. Comparison between relative genetic score of 20 wheat genotypes based on the best selection index ($X_2 + X_5 + X_8$) with their total rank value

Genotypes	Selection score	Total rank value
Pavon-76	41.48	21
Kav-2	36.28	11
BAW-970	597.85	12
Sonalika	491.46	13
Akbar	500.08	11
BAW-949	516.37	21
BAW-861	498.88	10
SA-3	589.16	15
Mayoor	485.97	16
BAW-1008	515.73	24
TP-1	543.85	10
BAW-966	619.84	14
Sonora-64	480.24	21
Bulbul	530.31	18
BAW-1004	584.97	21
BAW-1006	561.56	11
SA-92	604.45	22
Peacock	496.28	29
Balaka	588.98	5
Protiva	674.75	16

X_2 - Plant height X_8 – Grain yield X_5 – Grains per spike

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