Evaluation of Wheat (*T. aestivum* L.) Germplasm for Yield and Yield Attributes

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Four hundred ninety five germplasm lines of wheat including two checks were grown during the *rabi* season of 1999-2000 at the research farm of RAU, Pusa, Bihar, Samastipur, to evaluate yield and yield attributing characters. Observations were recorded on grain yield per plant and six other characters. Correlation and path coefficient analyses were done to find out associations between characters and to assess the direct and indirect influence of each character on seed yield.

Large variation was observed for all the characters studied. Correlation and path coefficient analyses showed that number of productive tillers per plant, 1000 grain weight and number of grains per ear were major direct contributor to grain yield per plant. Based on the multiple regression coefficient of six quantitative traits taken, number of productive tillers per plant, number of grains per ear and 1000 grain weight were found to be significant contributors towards grain yield. Therefore, these characters should receive maximum attention while selecting high yielding plants in wheat breeding.

Key Words: Correlation, Germplasm, Multiple regression, Path correlation, Selection criteria

Germplasm is the reservoir of genetic diversity which is often exploited for developing improved varieties of a crop. Considerable amount of genetic variability should exist in the germplasm for their utilization in breeding superior cultivars. The importance of genetic diversity for selecting specific parents and recombining them to recover specific genotype (depending upon ones objectives) in autogamous crops has been emphasized many times (Murty *et al.*, 1966, Jatasara *et al.*, 1983 and Cox *et al.*, 1990). Selection of specific parent from existing germplasm is totally dependent upon the availability of characterization of those germplasm for their different traits. The precise information regarding nature and degree of genetic diversity present in germplasm could help the plant breeder to select proper parents for evolving superior varieties. In view of these facts, 495 germplasm were:

a) Studied for yield and yield attributing characters to work out association between components characters.
b) Computation of correlation coefficient and to select elite germplasm lines between yield and yield component characters.

Materials and Methods

A total of 495 germplasm of wheat (mostly the entries from different international wheat screening nursery) available at wheat breeding section of RAU, Pusa, were evaluated for yield and yield attributing characters. These accessions were sown in the *rabi* of 1999-2000 at the research farm of RAU, Pusa (25°59'N latitude and 84° 40'E longitude, altitude 51.81 m). Each accession was grown in a single row of 3 m length, spaced 23 cm apart from row to row and 10 cm from plant to plant. The recommended package of practices was followed to raise good crop.

Observations were recorded on days to 75 percent flowering, plant height, number of productive tillers per plant, length of ear head, number of grains per ear, 1000 grain weight and grain yield per plant. Observations were recorded on five randomly taken competitive plants except for days to 75 percent flowering which were recorded on visual observation for flowering of approximately 75 percent of plants in each row.

Mean, range (minimum and maximum), variance and phenotypic coefficient of variability (CV%) were determined for all characters undertaken. Simple correlation and path coefficient analyses were done to determine the interrelationship between two characters and for their direct and indirect effect to seed yield (Li, 1956). Multiple regression analysis was worked out and on that basis selection indices were formulated to selected germplasm with high score.

Results and Discussion

There was considerable range of variation for all 7 characters under study (Table 1). The coefficient of variation was high (>30%) for grain yield per plant, number of productive tillers per plant and 1000 grain weight, medium (between 15% and 30%) for number

Table 1. Range, mean, variance and coefficient of variation among four hundred ninety five germplasm of wheat for seven quantitative characters

Sl.No.	Characters	Range mean	General	Variance of variance	Coefficient
1.	Days to 75 percent flowering	66.00-100.00	80.23	24.93	6.22
2.	Plant height (cm)	34.67-135.00	88.06	99.21	11.31
3.	Number of productive tillers per plant	2.00-14.00	5.89	3.93	33.63
4.	Ear length (cm)	5.17-30.70	10.33	2.30	14.69
5.	Number of grains per ear	25.76-90.00	57.25	98.29	17.32
6.	1000 grain weight (g)	18.80-66.22	40.49	171.71	32.36
7.	Grain yield per plant (g)	7.30-88.18	35.57	177.87	37.49

of grains per ear and small (<15%) for ear length, plant height and days to 75 percent flowering. Singh (1983) and Tiwary (1983) got similar result for tillers per plant and yield per plant. Kumar (2000) observed maximum coefficient of variation for length of ear head.

Correlation analysis showed (Table 2) that grain yield per plant had positive and significant correlation with plant height, number of productive tillers per plant, ear length, number of grains per ear and 1000 grain weight. Plant breeder should give more emphasis for high tillering ability of a genotype grains per ear and also 1000 grain weight, as it is directly associated with grain yield. Similar approach was also followed Nanda *et al.* (1980).

Days to 75 percent flowering had positive and significant correlation with number of productive tillers per plant and number of grains per ear but had negative and highly significant interrelationship with 1000 grain weight. Furthermore, it has negative correlation with grain yield per plant. Plant height had significant and positive correlation with all other component traits. Number of productive tillers per plant had positive and significant correlation with number of grains per ear. Ear length had significant and positive correlation with number of grains per ear and 1000 grain weight whereas number of grains per ear had negative and significant correlation with 1000 grain weight.

Kumar (2000) observed significant and positive correlation between yield per plant and tiller per plant. The significant and positive correlation between yield per plant and grain weight was also reported by Mikheev (1992), Deswal *et al.* (1997). Significant and negative association of 1000 grain weight with grain yield was reported by Khan *et al.* (1999).

Path Correlation Co-efficient

Phenotypically, number of productive tillers per plant had maximum positive direct effect on yield per plant followed by 1000 grain weight and number of grain per ear and also these traits showed highly significant positive correlation with grain yield per plant. Therefore, these traits may be considered as important yield components for wheat improvement (Table 3).

Ear length also has highly significant positive correlation as well as positive direct effect of medium magnitude on grain yield per plant. Plant height showed negative direct effect on grain yield per plant however, its indirect effects via all other yield contributing traits were positive which ultimately showed a significant and positive correlation between plant height and grain

Table 2. Phenotypic correlation coefficient between different pairs of quantitative characters in wheat germplasm

Characters	Plant height (X_2)	Number of productive tillers per plant (X_3)	Ear length (cm) (X_4)	Number of grains per ear (X_5)	1000-grain weight (g) (X_6)	Grain yield per plant (g) (Y)
Days to 75 percent flowering (X_1)	-0.053	0.151**	-0.057	0.196**	-0.482**	-0.032
Plant Height (X_2)		0.091*	0.230**	0.093*	0.248**	0.174**
Number of productive tillers per plant (X_3)			0.027	0.233**	-0.081	0.809**
Ear length (cm) (X_4)				0.175**	0.203**	0.170**
Number of grains per ear (X_5)					-0.176**	0.376**
1000-grain weight (g) (X_6)						0.217**

*, ** Significant at 5 and 1 percent levels of significance, respectively

Table 3. Direct (diagonal) and indirect phenotypic effect of different characters towards grain yield in wheat germplasm

Sl.No.	Characters	Days to 75 per cent flowering	Plant height (cm)	Number of productive tillers per plant	Ear length (cm)	Number of grains per ear	1000 grain weight (g)	Grain yield per plant (g)
1.	Days to 75 percent flowering	**-0.0574**	-0.0003	0.1181	0.0026	0.0487	-0.1391	-0.0320
2.	Plant height (cm)	0.0030	**-0.0052**	0.0712	0.0103	0.0231	0.0716	0.1740**
3.	Number of productive tillers per plant	-0.0087	0.0005	**0.7824**	0.0012	0.0579	-0.0234	0.8090**
4.	Ear length (cm)	0.0033	-0.0012	0.0211	**0.0447**	0.0435	0.0586	0.1700**
5.	Number of grains per ear	-0.0113	-0.0005	0.1823	0.0078	**0.2484**	-0.0508	0.3760**
6.	1000-grain weight (g)	0.0277	-0.0013	-0.0634	0.0091	-0.4370	**0.2886**	0.2170**

The residual effect =0.4499

** Significant at 1 percent level of significance

yield per plant in the present study. Direct and positive effect of grain weight on yield per plant was also reported by Mandal *et al.* (1997). In wheat positive direct effect of effective tillers per plant on yield per plant in the present study was also observed by Rao *et al.* (1993).

Number of grains per ear had direct positive phenotypic effect on yield per plant. Similarly direct positive phenotypic effect of number of grains per ear on grain yield per plant was also observed by Mandal *et al.* (1995).

Thus path coefficient analysis suggested that number of productive tillers per plant, 1000 grain weight and number of grains per ear were important characters which may be given due importance for the improvement of grain yield per plant.

Phenotypic residual effect indicated that there were other characters which should have been identified and included in the study in order reduce it.

Multiple Regression Analysis and Selection Index

The partial regression coefficient for grain yield per plant on days to 75 percent flowering, plant height, number of productive tillers per plant, ear length, number of grains per ear and 1000 grain weight were computed and presented in Table 4. The dependent variable i.e. grain yield per plant has non-significant relationship with two independent variables i.e. plant height and ear length. After that two multiple regression-equation were formulated (Table 4), first by taking all six component characters and second after deleting plant height and ear length. It was done because partial regression coefficient due to above mentioned two dropped characters were insignificant. The efficiency of multiple regression equations were determined and found to be r^2 (I)- 79.8 and r^2 (II)=79.6. Obviously, in the selection programme stress on the days to 75 percent flowering, number of productive tillers per plant, number of grains per ear, 1000 grain weight would be more rewarding than taking the all six characters.

Relative ranking and selection score of 495 germplasm including two checks for yield per plant on the basis of six and four yield contributing characters were worked out. The rank correlation coefficient was 0.88 and 0.83 between observed grain yield per plant and predicted grain yield per plant for six and four yield attributing characters, respectively. Following top ten line and also two checks (HP 1731 and HUW 234), exhibited same ranking for both criteria are 7th SMN-

Table 4. Multiple regression coefficient of different quantitative characters on grain yield in wheat germplasm.

Sl.No.	Multiple regression of yield per plant on	When all the six characters were included	After deleting two characters i.e. plant height and ear length
1.	Days to 75 percent flowering	-0.151*±0.0629	-1.49*±0.003
2.	Plant height	-0.008±0.029	
3.	Number of productive tillers per plant	5.265**±0.142	5.260**±0.141
4.	Ear length	0.394±0.189	
5.	Number of grains per ear	0.334**±0.029	0.345**±0.029
6.	1000-grain weight	0.500**±0.042	0.516**±0.040

R^2 value for all six characters= 0.789

R^2 value for four characters=0.796 (after deleting plant height of ear length)

*, ** Significant at 5 percent and 1 percent significant: levels, respectively

Two regression equations were

$Y = -26.065 - 0.151 X_1 - 0.008 X_2 + 5.264 X_3 + 0.394 X_4 + 0.334 X_5 + 0.500 X_6$ ..... (1)

(With all six characters were included)

$Y = -24.165 - 0.149 X_1 + 5.260 X_2 + 0.345 X_3 + 0.516 X_4$ .....(2)

(After deleting two characters i.e. Plant height and ear length)

22, 6th HTWYT-14, 6th HTWYT-27, 6th HTWYT-23, 7th SMN-12, 6th HTWYT-15, 6th HTWYT-19, 7th SMN-20, 6th HTWYT-31 and 7th SMN-15. Mean performance of top ten high yielder wheat germplasm for seven quantitative characters was given in Table 5.

Obviously, in the selection programme based on days to 75 percent flowering, number of productive tillers per plant, number of grains per ear and 1000 grain weight is easier to follow and equally rewarding than taking all six characters. The importance of effective tillers per plant and grain weight in selection programme was also supported by the results of Das and Dasgupta (1980) and Raut and Khorgade (1989). The importance of grains per ear, plant height, spike length was also suggested by Madhy (1988). The importance of ear length in selection criteria was suggested by Kumar (2000).

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Table 5. Mean performance of top ten high yielder wheat germplasms for seven quantitative characters

Sl. No.	Germplasm	Days to 75 per cent flowering	Plant height	Tillers per plant	Ear length	Number of grains per ear	1000 grain	Grain yield per plant
1.	7th SMN-22	83	90.67	14.00	10.83	61.67	46.60	88.18
2.	6th HTWYT-14	83	77.43	14.00	8.27	58..00	38.60	72.42
3.	6th HTWYT-27	86	92.73	12.00	9.27	68.00	45.64	72.64
4.	6th HTWYT-23	73	74.67	12.00	10.87	54.67	40.80	61.42
5.	7th SMN-12	80	84.67	11.67	10.00	54.00	47.52	73.22
6.	6th HTWYT-15	83	76.47	11.67	8.67	69.33	37.88	58.72
7.	6th HTWYT-19	83	94.50	10.66	11.67	68.00	42.20	76.04
8.	7th SMN-20	79	83.33	11.33	9.17	53.33	43.90	60.08
9.	6th HTWYT-31	87	85.67	11.33	10.77	60.33	38.20	52.34
10.	7th SMN-15	83	90.33	10.67	10.93	57.67	45.60	65.98
C_1	HP-1731	74	81.50	6.67	10.88	57.00	34.60	47.15
C_2	HUW-234	68	91.83	8.00	9.57	52.67	47.24	52.00

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