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Association studies for various yield components involving winter and spring wheat genotypes

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Abstract

Five elite and diverse genotypes, each of spring and winter ecotypes of wheat, alongwith their 45 F_1 hybrids, were evaluated to study the variability and to identify the important yield-contributing traits. Enormous genetic variability was observed among the genotypes for all the traits studied. Positive associations of plant height, tillers per plant, spikelets per spike, grains per spike, 1000-grain weight and harvest index were observed with grain yield per plant indicating these traits to be important for selection. Tillers per plant with maximum direct and indirect effects via other traits contributed significantly towards grain yield as shown by path coefficient analysis.

Introduction

Bread wheat (*Triticum aestivum* L. em Thell) is the premier staple crop of the world having wider adaptation amongst all the cereal crop species and is grown across variable environments. A tremendous increase in wheat production has been achieved in our country since the times of 'Green Revolution' particularly with the introduction and exploitation of the 'Norin 10' dwarfing genes, *Rht* 1 and *Rht* 2 in the mid 60s. However, at present, almost a plateau has been arrived at in the production and productivity of this so important crop due to static acreage and continuous increase in population. In order to overcome this situation, one of the breeding approaches is to utilize the physiologically distinct winter wheat gene-pool, which acts as the reservoir of many useful genes, for the genetic amelioration of predominantly grown spring wheat cultivars in Indian subcontinent following winter x spring wheat hybridization. Grain yield, economically the most important character, depends largely on the inheritance of several component traits for its expression and is highly influenced by fluctuating environmental conditions. Selection for yield *per se* is, therefore not effective. Grafius (1959) advocated that rapid improvement in yield results, if selection is practised for component traits instead of direct selection for yield. However, the rate of improvement depends upon the nature of association between yield and other component traits since more directly and positively a trait is associated with grain yield, the higher will be the success of selection programme. Therefore, this study was undertaken to generate knowledge about the extent and nature of direct and indirect effects of the component traits on yield, besides getting information on the nature and magnitude of association between them, in order to formulate an effective selection programme for grain yield improvement in wheat.

Material and Methods

The material for the present study consisted of five elite and diverse genotypes, each of spring (HPW 42, HPW 89, HW 3024, PW 552 and UP 2418) and winter (Saptdhara, Sentry, VWFW 452, W 10 and WW 24) ecotypes of wheat alongwith their 45 F_1 hybrids (excluding reciprocals) generated in diallel mating design. In order to fulfill the vernalization requirement of winter wheat genotypes and winter x winter wheat hybrids at Palampur, their germinating seeds were subjected to cold treatment at 4 ± 0.5 °C temperature on wet filter paper for 30 days prior to their shifting to the field. 45 F_1 hybrids alongwith ten parental genotypes were raised during *rabi* 2000-01 in Randomized Block Design with three replications and were sown individually in single row, 1.5 m long and 25 cm apart. Observations were recorded on five randomly selected competitive plants for nine morpho-physiological characters viz., days to flowering, days to maturity, plant height, tillers per plant, spikelets per spike, grains per spike, grain yield per plant, 1000-

grain weight and harvest index. Coefficient of variability was estimated as per the method of Johnson *et al.* (1955a). Correlation coefficients were calculated according to Johnson *et al.* (1955 b) and path coefficient analysis as per the method given by Dewey and Lu (1959).

Results and Discussion

Variability studies

The experimental material exhibited adequate variability for all the traits studied as shown in the variance analysis indicating that the genotypes differed significantly among themselves (Table 1).The phenotypic coefficients of variation (PCV) were higher than the genotypic coefficients of variation (GCV) for all the traits mainly due to environmental influence. Moderate to high estimates of PCV and GCV were obtained for tillers per plant, spikelets per spike, grains per spike and grain yield per plant as was also reported by Krishnawat and Sharma (1998). Moderate to high heritability coupled with moderate to high genetic advance were observed for plant height, spikelets per spike, grains per spike, grain yield per plant and 1000-grain weight, which indicate that these characters are mainly influenced by additive gene effects and selection therefore, may be effective for these traits. The heritability estimates were also high for days to flowering and days to maturity and were moderate for harvest index but these traits were having low genetic advance. This is in confirmation to the earlier reports of Tiwari and Rawat (1993) and Singh *et al.* (2003). This enunciates that these traits are highly influenced by environmental effects and high heritability is mainly due to the favourable influence of the environment rather than genotypes.

Association studies and path analysis

The estimates of phenotypic and genotypic correlation coefficients revealed that the magnitude of genotypic correlations were higher than the

Table 1. Variance and parameters of variability for various yield-contributing traits

Characters	Variance	Mean ± SE (m)	Range	PCV (%)	GCV (%)	h^2bs	GA (%)
Days to flowering	226.34*	129.9 ± 1.97	115.7 - 148.3	7.02	6.51	86.00	12.45
Days to maturity	406.02*	172.0 ± 1.67	149.3 - 198.3	6.90	6.69	94.10	13.38
Plant height (cm)	179.35*	77.0 ± 1.61	55.4 - 89.6	10.47	9.83	88.10	18.99
Tillers per plant	1.11*	3.1 ± 0.40	1.9 - 4.7	26.43	14.85	31.60	17.42
Spikelets per spike	18.07*	18.0 ± 0.67	11.0 - 22.0	14.59	13.09	80.60	24.28
Grains per spike	315.64*	49.6 ± 2.06	20.4 - 70.1	21.50	20.26	88.80	39.33
Grain yield per plant (g)	11.50*	5.8 ± 0.66	1.6 - 9.0	37.34	31.81	72.60	55.86
1000-grain weight (g)	77.59*	51.7 ± 1.44	41.9 - 64.2	10.60	9.44	79.40	17.31
Harvest index (%)	52.27*	44.7 ± 1.71	29.7 - 54.7	10.80	8.52	62.30	13.85

* Significant at 5% level

Table 2. Genotypic (below diagonal) and phenotypic (above diagonal) correlation coefficients among various yield-contributing traits

Characters	Days to flowering	Days to maturity	Plant height (cm)	Tillers per plant	Spikelets per spike	Grains per spike	Grain yield per plant (g)	1000-grain weight (g)	Harvest index (%)
Days to flowering		0.858*	0.239	0.260	0.505*	0.061	0.118	-0.261	-0.326*
Days to maturity	0.874		0.195	0.241	0.479*	0.086	0.143	-0.218	-0.283*
Plant height (cm)	0.240	0.201		0.401*	0.453*	0.438*	0.528*	0.338*	0.041
Tillers per plant	0.406	0.431	0.614		0.547*	0.395*	0.593*	0.138	0.107
Spikelets per spike	0.599	0.547	0.495	0.856		0.640*	0.653*	0.059	0.138
Grains per spike	0.077	0.092	0.498	0.741	0.704		0.740*	0.277*	0.442*
Grain yield per plant(g)	0.155	0.178	0.670	1.028	0.718	0.833		0.444*	0.332*
1000-grain weight(g)	-0.313	-0.244	0.448	0.239	0.054	0.304	0.502		0.260
Harvest index (%)	-0.446	-0.361	0.053	0.226	0.194	0.579	0.465	0.381	

* Significant at 5% level

Table 3. Genotypic (G) and phenotypic (P) path coefficient analysis for different yield-contributing traits

Characters		Days to flowering	Days to maturity	Plant height (cm)	Tillers per plant	Spikelets per spike	Grains per spike	1000-grain weight	Harvest index (%)	Correlation with yield
Days to flowering	G	**0.390**	-0.254	-0.007	0.611	-0.432	0.004	-0.042	-0.114	0.155
	P	**-0.077**	0.043	0.019	0.067	0.119	0.023	-0.065	-0.009	0.118
Days to maturity	G	0.341	**-0.290**	-0.006	0.648	-0.395	0.005	-0.033	-0.092	0.178
	P	-0.066	**0.050**	0.015	0.062	0.112	0.032	-0.054	-0.008	0.143
Plant height (cm)	G	0.094	-0.058	**-0.029**	0.924	-0.358	0.025	0.060	0.014	0.670
	P	-0.018	0.010	**0.079**	0.102	0.107	0.164	0.084	0.001	0.528*
Tillers per plant	G	0.158	-0.125	-0.018	**1.504**	-0.618	0.037	0.032	0.058	1.028
	P	-0.020	0.012	0.032	**0.256**	0.129	0.147	0.034	0.003	0.593*
Spikelets per spike	G	0.233	-0.159	-0.014	1.288	**-0.722**	0.035	0.007	0.050	0.718
	P	-0.039	0.024	0.036	0.140	**0.235**	0.239	0.015	0.004	0.653*
Grains per spike	G	0.030	-0.027	-0.014	1.114	-0.508	**0.050**	0.041	0.148	0.833
	P	-0.005	0.004	0.035	0.101	0.150	**0.374**	0.069	0.013	0.740*
1000-grain weight	G	-0.122	0.071	-0.013	0.360	-0.039	0.015	**0.134**	0.097	0.502
	P	0.020	-0.011	0.027	0.035	0.014	0.104	**0.248**	0.007	0.444*
Harvest index (%)	G	-0.174	0.105	-0.002	0.341	-0.140	0.029	0.051	**0.255**	0.465
	P	0.025	-0.014	0.003	0.027	0.032	0.165	0.06	**0.028**	0.332*

* Significant at 5% level

Residual effects: Genotypic (G) = -0.245, Phenotypic (P)= 0.259

corresponding phenotypic correlations, indicating the inherent association among various traits studied (Table 2). Days to flowering and days to maturity showed positive association with spikelets per spike but negative with harvest index which suggests that selection should be made for early maturing genotypes so as to harness high harvest index. Grain yield per plant was found to be positively correlated with plant height, tillers per plant, spikelets per spike, grains per spike, 1000-grain weight and harvest index. Plant height was positively correlated with tillers per plant, spikelets per spike, grains per spike and 1000-grain weight. Tillers per plant and spikelets per spike had positive association with almost all the traits except 1000-grain weight and harvest index. This is in accordance with the results of Baisakh and Nayk (1991), Kinyua *et al.* (1992), Jadhav, (1994) and Jat and Dhankar (2003). Path coefficient analysis (Table 3) revealed that significantly positive correlation of plant height, tillers per plant, spikelets per spike, grains per spike, 1000-grain weight and harvest index with grain yield per plant is mainly due to the direct and indirect effects via tillers per plant which is in accordance with the results of Deshmukh *et al.* (1990). Hence, tillers per plant is the most important yield contributing trait and the selection for this trait would be rewarding for wheat improvement.

From these findings, it can be concluded that selection for any/all the traits studied, particularly in early flowering genotypes will lead to the corresponding improvement in grain yield per plant because the genes which tend to enhance the traits such as plant height, tillers per plant, spikelets per spike, grains per spike, 1000-grain weight and harvest index also increase grain yield per plant due to their positive and high genotypic correlation. Selection should not be made for delayed flowering because it will lower the value of harvest index due to the negative association between days to flowering and harvest index.

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