Indian J. Genet., 55 (4): 399–405 (1995)

ESTIMATION OF VARIABILITY PARAMETERS AND PATH COEFFICIENTS FOR CERTAIN METRIC TRAITS IN WINTER WHEAT (*TRITICUM AESTIVUM* L. EM. THELL.)

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(Received: March 9, 1992; accepted: June 10, 1995)

ABSTRACT

Phenotypic and genotypic coefficients of variation (PCV, GCV), heritability, genetic advance (GA) and path coefficients for 12 characters were estimated in 50 genotypes of winter wheat (*Triticum aestivum*). High estimates of PCV, GCV, heritability and GA indicated scope for improvement through simple selection for grain weight/spike, grain yield/plant, grains/spike, 1000-grain weight, biological yield/plant, harvest index, tillers/plant, spikes/plant, and plant height. However, there was little variability and scope for selection in the material for days to flowering and maturity and spikelets/spike. Path analysis further indicated the importance of biological yield/plant, harvest index and grain weight/spike, as these characters showed highest direct effects on grain yield. Winter wheat genotypes, viz., Tufilar, NS 879/4, Bolal, Opal and Kavkaz were identified as good combiners for grain yield and other desirable characters.

Key words: Winter wheat, variability, path coefficient.

The basic difference between winter and spring wheats is in their vernalization requirement. There is no requirement of vernalization treatment in spring wheat, while the winter types fail to flower unless their vernalization requirement is fulfilled. Pugsley [1] categorised wheat into three major groups as genetically spring, genetically semiwinter and genetically winter based on genes governing vernalization response, while geographic isolation and specific climatic requirements divide it into only two distinct ecotypes, i.e. winter and spring wheats. Winter and spring wheats appear to constitute a wide reservoir of useful genes for each other's improvement. Therefore, crossing of these two ecotypes is likely to bring complementary factors together for the improvement of yield and other characters [2–4]. Winter wheat may contribute drought tolerance to spring wheat and serve as additional source of resistance genes against stripe rust [5], leaf rust [6], powdery mildew and *Septoria*. In addition, winter x spring wheat crosses could produce spring genotypes

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with a wide range of maturity suitable for cultivation in different ecological conditions. India being predominantly a spring wheat growing country, very few efforts have been made to study winter wheats under Indian conditions. However, recently a few winter wheats have been used in the Indian wheat improvement programme to develop drought and disease resistant spring wheat varieties. It becomes, therefore, imperative to generate basic information on various aspects of winter wheat to facilitate selection of desirable parents for hybridization. With this objective the present study has been undertaken to assess the magnitude of variation and relative importance of different characters in a collection of 50 winter wheat genotypes. Path coefficient analysis was performed to quantify direct and indirect contributions of yield components and developmental traits to grain yield.

MATERIALS AND METHODS

Fifty genotypes of winter wheat were evaluated in randomized complete block design with 3 replications at Hawalbagh (Almora), situated at an altitude of 1250 m above m.s.l. Each genotype was grown in a 2.5 x 0.90 m plot keeping 30 cm distance between rows. The plants were spaced at 10 cm distance within the rows. Recommended doses of fertilizers and irrigation were applied to raise a good crop. Five competitive plants were randomly selected from the middle row of each experimental plot to record observations on quantitative characters on plant basis, while days to 50% flowering and maturity were recorded on plot basis.

Analysis of variance was performed following the standard procedures. The phenotypic and genotypic coefficients of variability (PCV, GCV) were computed according to the method suggested by Burton [7], heritability (broad sense) and genetic advance (GA) as per Johnson et al. [8]. Path coefficient analysis was done using genotypic correlation coefficients by the method of Dewey and Lu [9].

RESULTS AND DISCUSSION

Analysis of variance indicated highly significant differences among genotypes for all the characters. High magnitude of variation in the experimental material was also reflected by high values of mean and range for almost all the characters (Table 1). Based on mean values, five best genotypes were identified for each of the 12 characters studied. Tufilar, NS 879/4, Bolal, Opal and Kavkaz, which recorded highest grain yield, were also found to combine certain other desirable traits. For instance, Tufilar combined high grains/spike, grain weight/spike, harvest index, 1000-grain weight and early flowering. Both NS 879/4 and Bolal had more grains/spike and high grain weight/spike. Opal and Kavkaz were superior for grain weight/spike and biological yield/plant, respectively. These genotypes can be used in hybridization for developing high yielding varieties.

Table 1. Estimates of mean squares, range and character mean of five best varieties identified from 50 winter wheat varieties

Character	Mean square	Range	Mean ± SE	Five best varieties and character mean
Days to 50% flower	240.7**	125.3–177.0	149.6 ± 0.9	Yorkwin (125.3), Tufilar (129.0), Gomod Local (138.3), Rescue (138.3), Maris-5-3 (138.7)
Days to maturity	204.2**	184.3–213.7	194.2 ± 1.3	Gomod Local (184.3), Yorkwin (186.3), Rescue (187.3), Favorit (187.3), Victor (190.3)
Plant height (cm)	968.2**	79.0–152.3	111.2 ± 1.2	Rossulka (79.0), GKF-2 (82.0), Dunav (82.3), Sappo (83.7), Burgas-2 (87.0)
Tillers per plant	19.9**	8.7–21.2	14.9 ± 0.5	Sentinal (21.2), EC 1774 (18.9), Stepoa (18.4), Agent (18.3), Likafen (18.3)
Spikes per plant	10.5**	7.5–15.1	10.8 ± 0.4	Sentinal (15.1), Rescue (14.5), Stepoa (14.4), Chinese 66 (14.0), EC 1774 (13.9)
Spikelets per spike	10.0**	17.0–25.4	21.2 ± 0.6	TW 238/62/7/9/3 (25.4), Opal (24.4), Flevina (24.3), Kitacome (23.7), Budifen (23.7)
Grains per spike	400.0**	21.9–75.8	46.2 ± 1.9	Tufilar (75.8), Sappo (72.9), NS 879/4 (69.8), Bolal (68.3), TW 238/62/7/9/3 (65.5)
Grain weight per spike (g)	1.08**	0.4–3.1	1.5 ± 0.1	Tufilar (3.1), NS 879/4 (2.6), Opal (2.6), Bolal (2.5), Strempalli (2.5)
Biological yield per plant (g)	230.8**	21.0–69.0	36.4 ± 1.8	Frondoso (69.0), Kavkaz (57.0), TW 238/62/7/9/3 (50.3), Burgas-2 (47.3), Flevina (46.3)
Harvest index	0.01**	0.09–0.37	0.26 ± 0.02	Tufilar (0.37), Strempalli (0.36), NS 879/4 (0.36), Rossulka (0.35), Mura (0.35)
1000-grain wt. (g)	210.5**	15.7–50.0	34.9 ± 1.0	Yorkwin (50.0), Holdfast (49.3), Martonvasur (48.3), Tufilar (47.7), Frondoso (45.0)
Grain yield per plant (g)	32.7**	4.0–16.7	9.5 ± 0.8	Tufilar (16.7), NS 879/4 (16.0), Kavkaz (15.0), Opal (14.7), Bolal (14.0)

**Significant at 1% level.

Mean values of different characters are given in parentheses after each variety.

Estimates of coefficients of variability, heritability and genetic advance are presented in Table 2. A close resemblance between the corresponding estimates of PCV and GCV suggests that the environment had little role in the expression of different characters. Highest PCV and GCV were recorded for grain weight/spike (39.4 and 37.1), followed by grain yield/plant (37.2 and 33.7), harvest index (28.2 and 24.7), grains/spike (25.7 and 24.6), biological yield/plant (25.0 and 23.5), 1000-grain weight (24.3 and 23.8), spikes/plant (18.3

and 16.7), tillers/plant (17.0 and 17.0), and plant height (16.2 and 16.1). High coefficient of variation for these characters is indicative of high magnitude of variability present in the experimental material. The remaining characters, viz., days of 50% flowering, days to maturity and spikelets/spike exhibited low PCV and GCV values.

Estimates of heritability varied from 49.8% (spikelets/spike) to 98.6% (plant height). By and large, all the characters excluding spikelets/spike showed more than 75% heritability (Table 2). High estimates of heritability for kernels/spike, plant height, number of spikes and earliness and intermediate to low estimates for grain yield and kernel weight have been

Table 2. Estimates of PCV, GCV, heritability (broad sense), and GA for twelve characters in winter wheat

Parameter	Days to 50% flower	Days to maturity	Plant height	Tillers per plant	Spikes per plant	Spikelets per plant	Grains per spike	Grains weight per spike	Biological yield per plant	Harvest index	1000-grain wt.	Grain yield per plant
PCV (%)	6.0	4.3	16.2	17.0	18.3	9.5	25.7	39.4	25.0	28.2	24.3	37.2
GCV (%)	5.9	4.1	16.1	17.0	16.7	8.1	24.6	37.1	23.5	24.7	23.8	33.7
Heritability (%)	96.7	92.3	98.6	90.3	83.5	49.8	92.1	89.2	88.3	77.1	95.9	82.2
GA (% of mean)	12.0	8.3	32.9	33.4	31.5	14.3	48.7	72.2	45.5	44.7	47.9	62.2,

reported in winter wheat [10]. High heritability estimates coupled with high GA were observed for grain weight/spike, grain yield/plant, grains/spike, 1000-grain weight, biological yield/plant, harvest index, tillers/plant, spikes/plant and plant height (Table 2). High heritability of these characters may be due to additive gene effects, hence these characters are likely to respond to direct selection. Published results on this aspect in spring wheat are similar for certain characters, while for other characters they are at variance. For instance, high estimates of heritability and genetic advance for spikes/plant, 1000-grain weight and grain yield/plant and low for grains/spike, plant height, spikelets/spike and days to flowering have been reported in Indian spring wheat [11]. This encouraging situation leads to suggest that the negative points of both winter and spring wheats can be mutually compensated by their positive attributes through hybridization.

Correlation studies and path coefficient analysis revealed that grain yield/plant has significantly positive correlation with spikes/plant, grains/spike, grain weight/spike, biological yield/plant, harvest index and 1000-grain weight and significantly negative association with days to 50% flower and maturity. The association of grain yield/plant with the remaining characters was positive but nonsignificant (Table 3). In winter wheat, grain

Table 3. Direct (diagonal in bold) and indirect effects of different plant characters on grain yield in winter wheat

Character	Days to 50% flower	Days to maturity	Plant height	Tillers per plant	Spikes per plant	Spikelets per spike	Grains per spike	Grain weight per spike	Bio-logical yield per plant	Harvest index	1000-grain weight	Correlation coefficient with grain yield/plant	
												pheno-typic	geno-typic
Days to 50% flower	**−0.023**	−0.031	0.000	−0.031	0.130	−0.002	0.070	−0.122	−0.269	−0.270	0.013	−0.479**	−0.536
Days to maturity	−0.019	**−0.039**	−0.001	−0.056	0.138	0.000	0.039	−0.070	−0.208	−0.234	0.002	−0.406**	−0.448
Plant height	−0.000	0.005	**0.008**	0.190	−0.226	−0.017	0.054	−0.044	0.236	−0.129	−0.000	0.084	0.076
Tillers per plant	0.002	0.006	0.004	**0.380**	−0.390	−0.002	0.035	−0.076	0.223	−0.074	0.017	0.127	0.125
Spikes per plant	0.007	0.013	0.004	0.357	**−0.415**	−0.000	0.000	−0.014	0.348	0.050	0.007	0.349*	0.359
Spikelets per spike	0.001	−0.001	−0.003	−0.021	0.002	**0.045**	−0.098	0.058	0.209	−0.056	0.010	0.190	0.148
Grains per spike	0.010	0.009	−0.002	−0.078	0.001	0.027	**−0.167**	0.224	0.311	0.331	−0.026	0.596**	0.638
Grain weight per spike	0.011	0.010	−0.001	−0.109	0.021	0.010	−0.142	**0.263**	0.350	0.416	−0.051	0.724**	0.778
Biological yield per plant	0.010	0.013	0.003	0.133	−0.227	0.015	−0.082	0.145	**0.635**	0.137	−0.025	0.671**	0.758
Harvest index	0.009	0.014	−0.001	−0.043	−0.032	−0.004	−0.085	0.167	0.133	**0.654**	−0.034	0.708**	0.779
1000-grain weight	0.004	0.001	0.000	−0.096	0.043	−0.007	−0.065	0.204	0.235	0.339	**−0.066**	0.500**	0.592

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

yield has been reported to be positively associated with spikes/plant, grains/ear, 1000-grain weight and grain weight/spike [12–15]. Highly negative association has also been reported between grain yield and days to heading [14]. High positive direct effects of biological yield/plant, harvest index and grain weight/spike were revealed by path coefficient analysis (Table 3). Indirect effects of 1000-grain weight and grains/spike on grain yield were also high via these characters. Although tillers/plant did not show significant correlation with grain yield, its direct effect on grain yield was positively high. This trait not only contributed directly but some other characters like plant height and spikes/plant also influenced yield positively via this attribute. High direct effects of number of spikes, kernel weight and kernels/spike were reported by Fonseca and Patterson [10] in winter wheat. In spring wheat, the importance of effective tillers/plant and grain weight/ear was reported by Jatasra and Paroda [6].

Considering the results obtained from path coefficient analysis, it is concluded that due emphasis should be given during selection on traits like grain weight/spike, harvest index, biological yield/plant and tillers/plant for effective improvement in a complex character like grain yield.

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