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Genetic Parameters in Bread Wheat (*Triticum aestivum* L. em. Thell)

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Abstract: A field study was carried out to study genetic parameters for twelve traits in bread wheat genotypes including 10 parents and their 45 F_1's produced in half-diallel fashion. There was a highly significant difference among all the genotypes for all the traits under study. PCV was somewhat greater than their corresponding GCV for all characters studied. Traits *viz.,* number of productive tillers per plant, flag leaf area, biological yield per plant, grain yield per plant, thousand grain weight, harvest index and number of grains per spike were most selection approachable as they were having higher GCV, PCV, genetic gain and moderate to high heritability in broad sense indicating pervasiveness of additive gene action, therefore, these characters would be useful for further improvement of wheat.

Keywords: Wheat, Heritability, PCV, GCV, Genetic gain

Wheat (*Triticum aestivum* L. em. Thell.) is the major staple food consumed by billions of people in the world and for that reason it has tremendous importance in the state of world nutrition and in the general welfare and national security of many countries. In India, wheat is the second most important food crop after rice both in terms of area and production. The yield is a complex polygenic inherited trait and several factors affect yield directly or indirectly, therefore, yield production fluctuates widely as a result of its interaction with the environment (Akram et al 2008). The success of any crop improvement programme depends on genetic variability, heritability and genetic gain present in the base population, based on which, the breeders may enable to plan out suitable breeding methods for further crop improvement. Characters having high heritability could easily be set with simple selection resulting in speedy progress (Mallinath et al 2004). Nevertheless, heritability is as well affected by environment so information on heritability only could not help in recognizing characters enforcing selection. Thus, the estimates of both heritability and genetic gain would be extra trustworthy circumstance for selection Heritability provides information about the extent of inheritance of the characters whereas; genetic gain helps in preparation of appropriate breeding procedures (Ranjith et al 2017). Therefore, current experiment was carried out with the aim to assess the GCV, PCV, heritability and genetic gain for 12 traits in 10 bread wheat genotypes and their 45 F_1 hybrids.

MATERIAL AND METHODS

The present research work was conducted at Norman E. Borlaug Crop Research Centre, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, India, to estimate the level of genetic coefficient of variation, heritability and genetic gain for the purpose to ascertain and develop appropriate selection indices for the increased grain production with better quality. The material for this present investigation was produced during *Rabi* season 2017-18 and the progenies were evaluated in the next *Rabi* season 2018-19. Ten genetically diverse parents (CAL/NH//H567.71/3/SER1/4/CAL/NH//H567.71/5/2*KAU2/6/…, HD 3234, PBW 692, HUW 640, DBW 189, VORB/SOKOLL, UP 2762, UP 2901, QLD 73, QLD 65) were crossed in diallel fashion excluding the reciprocals and a total of 45 crosses were developed. The parental lines along with 45 F_1's and two checks (HD 3086 and UP 2628) were planted in randomized block design in 3 replications. The row to row spacing was 20 cm and plant to plant spacing was 10 cm. Each entry was planted in one plot having 2 rows of 1 m in each replication. The seeds were dibbled manually. The recommended package of practices and cultural operations were followed. The observations were recorded on 12 traits *viz.*, days to 75% heading, days to maturity, flag leaf area (cm), number of productive tillers per plant, plant height (cm), spike length (cm), number of spikelets per spike, number of grains per spike, 1000 grain weight (g), biological yield per plant (g), grain yield per plant (g) and harvest index (%). Five plants were selected randomly from each entry per replication for all the traits except days to 75% heading and days to maturity which were recorded on basis of whole plot observation. The data obtained were subjected to the biometrical analysis that included analysis of variance, heritability, genetic gain. genotypic variance (σ^2g), phenotypic variance (σ^2p), genotypic coefficient of variation (GCV %), phenotypic coefficient of variation (PCV %), broad sense heritability

(h^2(bs)%) and genetic advance in per cent mean (GAM) (Singh and Chaudhary 1985).

RESULTS AND DISCUSSION

Highly significant mean squares due to genotypes for all the characters in all wheat genotypes revealed the presence of enough genetic variability in the material under study (Table 1). The mean sum of squares of the treatments were significant for all the traits studied being highest for biological yield per plant followed by harvest index, plant height, flag leaf area, thousand grain weight, number of productive tillers per plant, grain yield per plant, number of grains per spike, days to maturity, days to 75% heading, number of spikelets per spike and spike length. The highest mean performance for grain yield per plant is of parent UP 2901 and among crosses is of CAL/NH//H567.71/3/SER1/4/CAL/NH//H567 .71/5/2*KAU2/6/ × PBW 692 (Table 2). Similarly, the lowest mean performance for grain yield per plant for parent is VORB/SOKOLL and among crosses is for UP 2762 × QLD 73. The values of genotypic coefficient of variation were lower than phenotypic coefficient of variation for all characters studied reflecting the influence of environment on the expression of traits and the values of phenotypic coefficient of variation was higher than environmental coefficient of variation for all traits studied (Table 3). However, the genotypic coefficient of variation was higher than environmental coefficient of variation for all traits showing the preponderance of heritable variation except for days to maturity, spike length, number of spikelets per spike, number of grains per spike and harvest index. The highest phenotypic coefficient of variation was observed for number of productive tillers per plant (26.04%) followed by flag leaf area, biological yield per plant, harvest index, thousand grain weight and grain yield per plant while was lowest for days to maturity (1.61%). The highest genotypic coefficient of variation was observed for number of productive tillers per plant (20.27%) followed by flag leaf area, biological yield per plant, grain yield per plant and harvest index while it was lowest for days to maturity (0.97%). The amount of environmental coefficient of variation was highest for number of productive tillers per plant (16.34) followed by flag leaf area and harvest index while the lowest environmental coefficient of variation was observed for days to 75% heading (1.07%). High phenotypic and genotypic coefficient of variation was observed for traits such as number of productive tillers per plant, flag leaf area, biological yield per plant, grain yield per plant, thousand grain weight, harvest index and number of grains per spike. These results agree with the findings of Kumar et al (2014), Khan et al (2015), Fikre et al (2015) and Arya et al (2017). High heritability estimates were for traits as grain yield (91.30%) followed by thousand grain weight, biological yield per plant and days to 75% heading while lowest heritability was for number of spikelets per spike (15.00%). High heritability estimates for plant height (Tripathi et al 2011), days to 50% heading (Baranwal et al 2012), thousand kernel weight (Ashraf et al 2002), number of grains per spike (Abinasa et al 2011) are also reported by earlier researchers. Highest value genetic advance was observed for biological yield per plant (17.60%) followed by grain yield per plant, plant height, thousand grain weight, number of productive tillers per plant, harvest index, flag leaf area, number of grains per spikelet, days to 75% heading, days to maturity and number of spikelets per spike while lowest value was for spike length. High heritability coupled with high genetic advance was observed for some of the important characters such as grain yield per plant, thousand grain

Table 1. Analysis of variance for different characters in wheat

Source of variation	Mean sum of squares						
	d.f.	Days to 75 % heading	Days to maturity	Flag leaf area (cm^2)	Number of productive tillers per plant	Plant height (cm)	Spike length (cm)
Replication	2	5.99**	8.23	27.82	27.67*	12.50	3.72**
Treatments	56	6.08**	7.85**	46.34**	43.19**	54.83**	0.52**
Error	112	0.96	2.93	11.20	7.69	9.62	0.32

Source of variation	Mean sum of squares						
	d.f.	Number of spikelets per spike	Number of grains per spike	1000 grain weight (g)	Biological yield per plant (g)	Grain yield per plant (g)	Harvest index (%)
Replication	2	5.10*	66.92**	2.33	28.86	0.37	13.83
Treatments	56	2.22*	35.28**	43.49**	379.15**	41.67**	56.82**
Error	112	1.45	10.42	5.88	53.09	1.29	16.29

*, ** Significant at 5% and 1% level of significance, respectively

weight and biological yield per plant. High heritability coupled with moderate genetic advance was observed for plant height, days to 75% heading, number of productive tillers per plant, flag leaf area and harvest index while high heritability with low genetic advance was observed for rest of the characters. Selection for the traits having high genetic advance coupled with high heritability will be highly effective and have greater scope for improvement while high

Table 2. Mean performance of parents and crosses for different characters in wheat

Traits	Mean performance of parents		Mean performance of hybrids	
	Highest	Lowest	Highest	Lowest
Days to 75% heading	93.3 (UP 2628)	88.7 (UP 2726, UP 2901)	93(CAL/NH//H567.71/3/SER1/4/CAL/NH//H567.71/5/2*KAU2/6/… × HD 3234)	88.3 (QLD 73 × QLD 65, UP 2901 × QLD 65)
Days to maturity	136.7 (UP 2628)	130 (UP 2726)	136.7(CAL/NH//H567.71/3/SER1/4/CAL/NH//H567.71/5/2*KAU2/6/…x VORB/SOKOLL)	129.7 (UP 2901 × QLD 65)
Flag leaf area (cm^2)	32.8 (HD 3234)	22.7 (HD 3086)	39.7(CAL/NH//H567.71/3/SER1/4/CAL/NH//H567.71/5/2*KAU2/6/…x VORB/SOKOLL)	23.7 (UP 2901 × QLD 65)
Number of productive tillers per plant	21.3 (UP 2628, HD 3086)	9.6 (QLD 73)	23.3(VORB/SOKOLL × UP 2762)	10 (UP 2762 × QLD 73)
Plant height (cm)	101.2 (VORB/SOKOLL)	87 (QLD 65)	107.3 (DBW 189 × VORB/SOKOLL)	88.4 (HUW 640 × QLD 73)
Spike length (cm)	12.3 (DBW 189)	10.7(VORB/SOKOLL, HD 3086)	12.5 (PBW 692 × QLD 73)	10.8 (HUW 640 × QLD 73)
Number of spikelets per spike	21.3 (QLD 65)	18.4 (HD 3086)	22.7(VORB/SOKOLL × UP 2901)	19.2 (UP 2762 × QLD 73)
Number of grains per spike	72.7 (DBW 189)	60 (QLD 65)	71.3 (PBW 692 × UP 2901)	60 (DBW 189 × UP 2901)
1000 grain weight (g)	50.2 (DBW 189)	39.3 (QLD 65)	51.7 (UP 2901 × QLD 65)	36.2 (PBW 692 × QLD 65)
Biological yield per plant (g)	128.4(CAL/NH//H567.71/3/SER1/4/CAL/NH//H567.71/5/2*KAU2/6/…)	89.1(VORB/SOKOLL)	125.5 (DBW 189 × QLD 65)	81.1(CAL/NH//H567.71/3/SER1/4/CAL/NH//H567.71/5/2*KAU2/6/… × UP 2901)
Grain yield per plant (g)	48.1 (UP 2901)	31.3(VORB/SOKOLL)	49.6 (DBW 189 × QLD 65)	34.5 (PBW 692 × UP 2901)
Harvest index (%)	44.3 (HD 3234)	35.3 (UP 2762)	52.3 (UP 2901 × QLD 65)	35.5 (HUW 640 × QLD 65)

Table 3. Mean, range, coefficient of variance, heritability and genetic gain for various characters in wheat

Character	Mean	Range	PCV (%)	GCV (%)	ECV (%)	Heritability (%)	Genetic advance	Genetic value as % mean
Days to 75 % heading	91.22	88.33-93.33	1.79	1.43	1.07	64.00	2.15	2.36
Days to maturity	132.61	129.67-136.67	1.61	0.97	1.29	35.90	1.58	1.19
Flag leaf area (cm^2)	30.06	22.68-39.69	15.92	11.39	11.13	51.10	5.04	16.77
Number of productive tillers per plant	16.97	9.55-23.33	26.04	20.27	16.34	60.60	5.52	32.51
Plant height (cm)	96.94	87.0-107.26	5.13	4.01	3.20	61.10	6.25	6.45
Spike length (cm)	11.64	10.65-12.5	5.37	2.21	4.90	16.90	0.22	1.87
Number of spikelets per spike	20.43	18.44-22.67	6.40	2.48	5.90	15.00	0.41	1.98
No. of grains per spike	66.64	60.0-72.67	6.49	4.32	4.85	44.30	3.95	5.92
1000 grain weight (g)	44.92	36.17-51.67	9.55	7.88	5.40	68.10	6.02	13.40
Biological yield per plant (g)	100.15	81.13-125.49	12.70	10.41	7.28	67.20	17.60	17.58
Grain yield per plant (g)	40.85	31.30-49.62	9.40	8.98	2.78	91.30	7.22	17.68
Harvest index (%)	43.35	35.29-52.29	12.59	8.48	9.31	45.30	5.10	11.76

heritability with low genetic advance showed the preponderance of non-additive type of gene action due to high influence of the environment.

CONCLUSION

Adequate extent of variability was found in genetic material for all the traits under study. The traits *viz.,* flag leaf area, number of productive tillers per plant, plant height, thousand grain weight, biological yield per plant, grain yield per plant and harvest index showed high genetic advance in conjunction with high heritability and genotypic coefficient of variation. Therefore, these traits are the most important quantitative traits to be taken into consideration for effective selection in wheat. Low genotypic coefficient of variation, heritability and genetic advance manifested by days to maturity, spike length and number of spikelets per spike suggested that these traits cannot be relied upon for the purpose of selection.

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