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Estimation of heritability and genetic advance in 24 genotypes of bread wheat (*Triticum aestivum* L.)

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Abstract

The present study was conducted to estimate heritability and genetic advance in 24 genotypes of wheat for 12 quantitative characters. The mean sum of square for all 12 characters is found to be significant and PCV of all characters is slightly higher than GCV which shows little influence of environment for expression of all characters. Highest estimate of GCV and PCV were observed for character awn length, plant height and grain yield/plant. Character biological yield/plant exhibited highest heritability further followed by characters 100 grains/weight and days to flowering. Character plant height, biological yield/plant and no. of spike/plant shows high genetic advance.

Keywords: Wheat, variation, genotype, phenotype, genetic advance, heritability

Introduction

Wheat is the second most produced cereal in India after rice. Its importance can be measure as, it is the first crop which is improved for high production under green revolution. After the development of dwarf high yielding genotypes breeding programmes for development of high yielding genotypes took a boost in India. The main objective of breeding of wheat is to develop genotypes which produce high yield, can perform well in stressful conditions, resistant to diseases, have high protein content and can mature early.

Wheat is a staple crop in many countries and hence its consumption is directly proportional to the population growth. Consumption of wheat in rural India has increased apparently due to the availability of nutritious cereal. The share of wheat in total cereals consumption has increased from 25.43% (3.88 kg/month) in 1972-73 to 37.36 percent (4.24 kg/month) in 2009-10 (rural India) (Ramadas *et al.*, 2012) [1]. Such kind of change is also seen in urban India, a sharp rise in consumption of wheat in urban India also takes place. To meet up such rising demand of wheat and its end products there is a need to increase up the production to meet up the future demands. Since 2000, India has struggled to match that record production figure and thus faces a critical challenge in maintaining food security in the face of its growing population. The current major challenges facing future wheat production in India are increasing heat stress, dwindling water supplies for irrigation and growing threat of new virulence of disease such as wheat rusts (Joshi *et al.*, 2007) [2]. To tackle such challenges there is a need of new genotypes which are resisted to such stress and have high yielding capacity to meet up future demands.

The development of new and high potential genotype depends upon variability present among the germplasm, higher the variability more would be the chances of genetic improvement of crop.

Materials and Methods

The experiment was conducted at village Dhanauri, district Haridwar (Uttarakhand) to evaluate the 24 genotypes of wheat for 12 quantitative characters in rabi season of cropping year 2017-18. Characters viz. days to flowering, plant height (cm), no. of tillers/plant, spike length (cm), awn length (cm), no. of spikelet/spike, no. of grains/spike, 100 grains weight (gm), biological yield/plant (gm), harvest index (%), days to maturity and grain yield/plant (gm). The list of genotypes studied in the experiment is presented in form of table 1.

The genotypes in experiment were planted under randomized complete block design (RCBD) design plotting technique with genotypes planted in three replications under timely sown and irrigated conditions. In each replication two rows of a genotype is planted, length of each row was kept 2.5 metre. A sample of five plants from each replication of a genotype were taken on random basis to analyse the performance of selected traits, data for characters days to flowering and days to maturity was obtained on field only.

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Parameters viz. genotypic variance ($\sigma^2 g$), phenotypic variance ($\sigma^2 ph$), genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability percentage ($h^2 \%$) in a broad sense, genetic advance (GA) and genetic advance as percentage of mean were calculated. Analysis of variance and genetic advance was done by following (Johnson 1955)^[3].

Results and Discussions

The mean sum of square for twelve characters studied in the experiment are presented in table 2. The sum of square describes the relative deviation from the mean, thus it provide the measure of variability among genotypes used in the study for each character. Mean sum of square of twelve characters shows considerable amount of genetic variability present in all genotypes for all twelve characters studied. The mean sum of square for all twelve characters is significant. Therefore, variability among all genotypes selected in the experiment is present at genotypic level. Hence, selection of these genotypes for further breeding programme would be fruitful.

In table 3, genotypic variance ($\sigma^2 g$), phenotypic variance ($\sigma^2 ph$), genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability percentage (at a broad sense) genetic advance and genetic advance as percent of mean is presented. There are two kinds of variability found in expression of a character viz. genotypic variability and environmental variability, both genotypic and environmental variability sums up phenotypic variability, that is why phenotypic variability remains higher than genotypic variability. Greater the difference between genotypic and phenotypic variability greater would be the influence of environment on the expression of particular character. The highest variability (genotypic or $\sigma^2 g$ and phenotypic or $\sigma^2 ph$) was recorded in plant height (371.72 and 374.3) followed by harvest index and no. of grains/spike. While the lowest amount of variability (genotypic or $\sigma^2 g$ and phenotypic or $\sigma^2 ph$) was recorded in case of character 100 grains weight (0.24 and 0.25) (Tsegaye, D. *et al.*, 2012)^[4] and (Tripathi, S. N. *et al.*, 2011)^[5].

A wide range of genotypic coefficient of variation was found among all characters. Highest GCV % was recorded in case of awn length (27.017) followed by plant height (20.962), grain yield/plant (19.497), biological yield/plant (16.330), no. of tillers/plant (14.168), spike length (12.735), harvest index (%) (11.845), 100 grains weight (10.844), no. of grains/spike (9.383), no. of spikelet/spike (7.165), days to flowering (3.114) and days to maturity (1.885). Highest phenotypic coefficient of variation (PCV) was recorded in case of awn length (28.212) further followed by grain yield/plant (24.415), plant height (21.020), biological yield/plant (18.424), harvest index (%) (17.261), no. of tillers/plant (16.950), spike length (13.135), no. of grains/spike (11.787), 100 grains weight (11.146), no. of spikelet/spike (8.238), days to flowering (3.217) and days to maturity (1.999) (Bergale, S. *et al.*, 2001)^[6] and (Dhakar, M. R. *et al.*, 2012)^[7].

Heritability in a broad sense is a genotypic portion of total variability existed. Heritability in a broad sense is also described as ratio of genotypic variance to the total variance. Heritability is a key for any breeding programme to establish desired characters in genotype to develop, it decides the

suitability and strategy for the selection of character. It is a measure of the extent of phenotypic variation caused by the action of genes (Navin K. *et al* 2014)^[8]. In this study heritability ranges from 47.090 to 99.455 percent. In this study the highest heritability percentage was shown by character plant height (99.455) followed by 100 grains weight (94.652), spike length (93.997), days to flowering (93.695), awn length (91.704), days to maturity (88.943), biological yield/plant (78.567), no. of spikelet/spike (75.658), no. of tillers/plant (69.870), grain yield/plant (63.766), no. of grains/spike (63.369) and harvest index (%) (47.090) (Rathwa, H.K. *et al.*, 2018)^[9].

For selection of individual genotype knowing heritability alone is not sufficient but knowledge of genetic advance is also compulsory. Heritability coupled with genetic advance provides indication of amount of genetic improvement for the selection of individual genotype. In the present study highest genetic advance was found in case of plant height (39.618) further followed by biological yield/plant (9.254), number of grains/spike (9.170), harvest index (7.448), days to flowering (5.393), days to maturity (4.940), grain yield/plant (4.445), awn length (3.857), spike length (2.597), no. of spikelet/spike (2.521), no. of tillers/plant (1.522) and 100 grains weight (0.980) (Dabi, A., 2016)^[10].

In the end the most prominent parameter of genotype which is checked, is the economic yield of a genotype. In this experiment the five highest grain yield producing genotypes are WP-710/1, TALL-2, WP-705/1, HD-3189 & PBW-343. The mean performance of grain yield/plant and some other characters of these five genotypes is shown in table 4. Genotype WP-710/1 produces highest amount of grain yield in his experiment with grain yield/plant (21.10), days to flowering (87.0), no. of tillers/plant (7.3), spike length (10.02) and number of grains/spike (62.33) which is further followed by genotype TALL-2 with grain yield/plant (20.77), days to flowering (83.3), no. of tillers/plant (6.6), spike length (10.1) and number of grains/spike (64.33) further followed by fourth highest grain producing genotype in this study HD-3189 with grain yield/plant (16.03), days to flowering (85.0), no. of tillers/plant (6.1), spike length (10.4) and number of grains/spike (57.33). Fifth highest grain yield producing genotype in this study is PBW-343 with grain yield/plant (15.79), days to flowering (87.0), no. of tillers/plant (6.9), spike length (8.8) and no. of grains/spike (59.67).

Table 1: List of genotypes used in present study

Sr. No.	Name of genotypes	Sr. No.	Name of genotypes
1.	HACS-3949	13.	PBW-530
2.	TALL-3	14.	TALL-2
3.	UP-2572	15.	DBW-6250
4.	RAJ-4422	16.	WP-710/17
5.	WP-709/17	17.	HD-3128
6.	DBW-60	18.	RAJ-4037
7.	WP-703/17	19.	PBW-660
8.	TALL-1	20.	WP-705/17
9.	PBW-590	21.	DBW-62-150
10.	DBW-730	22.	PBW-343
11.	HD-3189	23.	HD-3123
12.	C-306	24.	HD-3086 (check)

Table 2: Analysis of variance for twelve characters studied in present study

Sr. No.	Mean sum of square			
	Characters	Replications (df=2)	Treatments (df=23)	Error (df=46)
1.	Days to Flowering	0.347	22.343*	0.492
2.	Plant height(cm)	3.190	1117.752*	2.037
3.	No. of tillers/ plant	0.850	2.680*	0.337
4.	Spike length(cm)	0.229	5.182*	0.108
5.	Awn length(cm)	0.121	11.811*	0.346
6.	No. of spikelet/spike	1.014	6.577*	0.637
7.	No. of grains/spike	1.264	111.883*	18.075
8.	100 grains weight(gm)	0.087	0.731	0.014
9.	Biological yield/plant (gm)	7.227	84.054*	7.006
10.	Harvest index (%)	89.321	114.466*	31.190
11.	Days to maturity	1.514	20.200*	0.804
12.	Grain yield/plant (gm)	6.993	26.056*	4.149

* Significant at 5% level of significance.

Table 3: Estimation of coefficient of variance, coefficient of variation, heritability percentage in a broad sense and genetic advance in present study

Sr. No.	characters	$\sigma^2 g$	$\sigma^2 ph$	GCV %	PCV %	h^2 % (at broad sense)	GA	GA as % of mean
1.	Days to Flowering	7.29	7.78	3.114	3.217	93.695	5.393	6.209
2.	Plant height(cm)	371.72	374.3	20.962	21.020	99.455	39.618	43.065
3.	No. of tillers/ plant	0.77	1.12	14.168	16.950	69.870	1.522	24.397
4.	Spike length(cm)	1.69	1.80	12.735	13.135	93.997	2.597	25.434
5.	Awn length(cm)	3.80	4.16	27.017	28.212	91.704	3.857	53.296
6.	No. of spikelet/spike	1.99	2.62	7.165	8.238	75.658	2.521	12.839
7.	No. of grains/spike	31.25	49.28	9.383	11.787	63.369	9.170	15.386
8.	100 grains weight(gm)	0.24	0.25	10.844	11.146	94.652	0.980	21.732
9.	Biological yield/plant (gm)	25.68	32.72	16.330	18.424	78.567	9.254	29.818
10.	Harvest index (%)	27.77	58.98	11.845	17.261	47.090	7.448	16.744
11.	Days to maturity	6.45	7.24	1.885	1.999	88.943	4.940	3.663
12.	Grain yield/plant (gm)	7.29	11.42	19.497	24.415	63.766	4.445	32.072

Table 4: List of five most high yielding genotypes in present study

Genotype	Days to flowering	No. of tillers/plant	Spike length (cm)	No. of grains/spike	Grain yield/plant (gm)
WP-710/1	87.0	7.3	10.2	62.33	21.10
TALL-2	89.7	6.9	11.8	67.67	20.77
WP-705/1	83.3	6.6	10.1	64.33	17.16
HD-3189	85.0	6.1	10.4	57.33	16.03
PBW-343	87.0	6.9	8.8	59.67	15.79

Conclusion

From the findings of present study it is concluded that all genotypes used has adequate amount of variability for most of the traits. Characters namely plant height, biological yield/plant and no. of grains/spike showed high heritability with high genetic advance. Therefore, for future breeding programmes these traits should be kept at high priorities.

These are the results of only one year experiment to observe better results further testing should be done. Trials at multiple locations and different agro-ecological zones should be conducted to evaluate further results.

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