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Research Note

Genetic variability, heritability and genetic advance in Wheat under different normal and heat stressed environments

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Abstract
Eighteen wheat genotypes raised in the Pusa farm, Bihar during during *Rabi* season of 2011-12 were evaluated for genetic variability, heritability and genetic advance for four yield attributing traits. Significant differences were observed among the genotypes for the traits namely, spikelet fertility, number of grains per spike, number of effective tillers per plant and pollen sterility. The PCV and GCV was found to be high for spikelet fertility, number of grains per spike and pollen sterility while, moderate for number of effective tillers per plant and spikelet fertility (field). Higher value of PCV was obtained in all the cases than the GCV for all the characters. The heritability for all the characters was found to be high with high GAM (Genetic advance over mean). Hence, these yield attributing traits could be considered as suitable selection criteria for the development of high yielding wheat cultivars in the breeding programs.

Keywords
Wheat, spikelet fertility, variability, genetic advance, genotypes.

Wheat (*Triticum aestivum* L.) is a second most important cereal crop after rice, grown successfully in wide range of environment. The global temperature has increased in last few decades and this trend may continue with an associated higher frequency of extremely hot days. In wheat producing countries, decreasing soil moisture and increasing temperature poses a major problem for grain filling to occur. Increasing temperatures in general accelerated phenological development resulting in a shorter growth period. Increasing mean temperatures during the growing season have been reported to reduce grain yields of irrigated wheat crops under field conditions as well as in temperature-tunnel experiments due to a shortening of the growing season and consequently lesser light interception (Choudhary *et al*., 2014). In India, temperatures during grain filling of wheat frequently rise above 30^0C and can reach upto 40^0C occasionally. The main objective of any breeding programs is to develope high yielding and better quality lines and release as cultivars to farmers (Ehdaie and Waines, 1989). To achieve this goal sufficient variability must be present to select the desired lines. For successful varietals improvement program, the identification of better genotypes with desirable traits is imperative.

The development of superior varieties with high yield and good adaptability requires a thorough knowledge of the existing genetic variation for yield and yield attributing components. For the establishment of breeding program and formation selection indexes, heritability is a widely used parameter (Falconer, 1985). Variability is the combined estimate of genetic and environmental causes of which genetic cause is heritable in nature. However, heritability estimates alone do not provide an idea about the expected gain in the future generation, but it has to be considered in conjunction with estimates of genetic advance and the change in mean value between generations (Shukla *et al*., 2006). In total observed variability, the heritable and non-heritable component is indispensable in adopting suitable breeding programs and the heritable component of the total observed variation can be ascertained by studying the components of variation such as GCV, PCV, heritability and predicted genetic advance.

The present study is therefore, aimed at assessing variation, heritability and expected genetic advance for yield attributing traits and a significant amount of variation for these traits.

Plant Materials: Eighteen promising hexaploid wheat genotypes from the Indian Agricultural Research Institute, New Delhi, Rajasthan Agricultural Research Institute, Jaipur and and Rajendra Agricultural University, Bihar were used in the present study. Genotypes namely, Sonalika, Raj 3765 and HD 2733 were included as checks (Table 1). Data were recorded on five randomly selected plants in each treatment over replication for four quantitative traits *viz.*, spikelet fertility, number of grains per spike, number of effective tillers per plant and pollen sterility.

Field Experimental Setup: The experiment was conducted during *Rabi* 2011-12 at Experimental

Research Farm of Rajendra Agricultural University, Pusa, Bihar (25.59° N, 85.40°E; 52.18 m elevation) in a clay type of soil. The experiments for morphological study of wheat genotypes were conducted in heat stressed and normal conditions to understand the basis of genotypic differences in fertility traits. Genotypes were grown in three rows of 3.0 m length spaced at 22.5 cm between row and 15 cm within row between plants. Genotypes were sown in plastic pots under open condition and allowed for proper development with protective irrigation until booting and heading stage.

Weather Conditions: Weekly meteorological data from the date of sowing to harvesting of crop in the year 2011-12 including temperature (max and min), relative humidity (max and min) and rainfall were recorded with 12 hr photoperiod at night (Table 2).

Estimation of genetic parameters: In order to assess and quantify the genetic variability among the genotypes for the characters under study, the following parameters were estimated.

Heritability (h^2) in broad sense was estimated as the ratio of genotypic to the phenotypic variance and was expressed in percentage Robinson *et al.* (1949).

Heritability (h^2) $= \frac{\sigma g^2}{\sigma p^2} X100$

Phenotypic and genotypic variances were estimated using the following formula as per Lush (1940).

$$\text{Genotypic variance}(\sigma_g^2) = \frac{\text{MSS (genotypes)} - \text{MSS (error)}}{\text{Number of replications}} = \frac{\text{MS g} - \text{MSe}}{\text{r}}$$

$$\text{Phenotypic variance}(\sigma_p^2) = \sigma g^2 + \sigma e^2$$

$$\text{Environmental variance } (\sigma_e^2) = \text{Error mean sum of square}$$

Both genotypic and phenotypic coefficients of variability were computed as per the method suggested by Burton (1953).

Genotypic coefficient of variability (GCV)

$$\text{GCV (\%)} = \frac{\sigma g}{\text{Mean}} \text{X } 100$$

Phenotypic coefficient of variability (PCV)

$$\text{PCV (\%)} = \frac{\sigma p}{\text{Mean}} \text{X } 100$$

Where,

σ_g= Genotypic standard deviation

σ_p= Phenotypic standard deviation

The extent of genetic advance to be expected from selecting five percent of the superior progeny was calculated by using the following formula.

Genetic Advance (GA) = $ih^2\sigma_p$

Where,

i = Intensity of selection

h^2 = Heritability in broad sense

σ_p = Phenotypic standard deviation

Genetic advance as percent of mean (GAM %) was estimated using the following formula Johnson *et al*. (1955)-

$$\text{GAM (\%)} = \frac{\text{GA}}{\overline{\text{X}}} \text{X100}$$

In the present investigation, 18 diverse genotypes of wheat were studied to assess their genetic potential. All the genotypes exhibited significant differences for all the traits (Table 3). Many earlier workers including Sharma *et al.* (1995) and Kamboj *et al.* (2000) reported high variability for different traits in wheat. This reasonably sufficient variability in the material used for their study, which provides ample scope for selecting superior and desired genotypes for further improvement.

Phenotypic and genotypic coefficient of variation was found to be high for spikelet fertility, number of grains per spike and pollen sterility while, moderate for number of effective tillers per plant and spikelet fertility under field condition. Similar observations were also reported earlier by Ali *et al,* (2008) and Zecevie *et al.* (2009) for high number of grains per spike and high for pollen sterility. There were no reports of moderate GCV and PCV for the character spikelet fertility. However, Pawar *et al.* (1989) reported low PCV and GCV for spikelet fertility. Moderate GCV for number of effective tillers per plant in this investigation was in accordance with Mahesh *et al.* (2001).

PCV was higher than GCV for all the characters. The result obtained in present study is in agreement with the earlier reports of Kumar *et al*. (2003) Ghimirary and Sarkar (2000), they reported higher PCV than GCV for all the characters under study.

Results obtained from present investigation has revealed moderate GCV and PCV for some characters like number of effective tillers per plant and spikelet fertility (field) indicating still there is possibility of improvement of genotypes through selection. It is interesting to note that the differences between GCV and PCV values were minimum implying influence of additive gene effects and least influence of environment. Hence selective could be effective for these traits. Heritability values for all the characters *viz.,* spikelet fertility, number of effective tillers per plant, number of grains per spike and pollen sterility were found to be high which indicated that the variations observed were less influenced by environment. These observations are in conformity with results of earlier workers *viz.,* Singh and Rai

(1987) and Bijendrapal and Garg (1992), who noticed higher heritability value for number of effective tillers per plant and number of grains per spike. Kamboj *et al.* (2000) reported high heritability values for number of grains per spike. High heritability with high genetic advance as percent of mean (GAM) for spikelet fertility was suggested by Firouzian *et al*. (2003) and Tahir *et al.* (1983) while for pollen sterility there were no such earlier reports.

Heritability estimate is useful in deciding the characters to be considered while making selection, but selection based on heritability alone may limit the progress, as it is prone for changes with change in environment, material *etc*. (Johanson *et al.*, 1955). In other words, estimate of heritability has role to play in determining the effectiveness of selection of a character, provided they are considered in conjunction with the predicted genetic advance as suggested by Panse (1942).

Most of the characters *viz.*, spikelet fertility, number of grains per spike, number of effective tillers per plant and pollen sterility had shown high genetic advance as per cent mean. The results were in accordance with reports of earlier work done by Thakur *et al.* (1999) for number of effective tillers per plant, Singh *et al*. (1998) for number of grains per ear spike, Subhashandra *et al*. (2009) for number of effective tillers per plant and McMaster *et al.* (1992) for spikelet fertility while in case of pollen sterility there were no earlier reports. In these characters where high heritability was associated with high genetic advance, the variation might be mostly due to additive gene effects.

The present study showed the presence of considerable variations among wheat genotypes for all traits with high heritability and genetic advance which gives an opportunity to plant breeders for the improvement of these traits.

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Table 1: Wheat genotypes and their sources used in present investigation.

Sl. No.	Name of genotypes	Source	Species
1	Mons Ald's	IARI, New Delhi	*T.aestivum*
2	HD 2285	RARI, Jaipur	*T.aestivum*
3	Sonalika (C)	IARI, New Delhi	*T.aestivum*
4	Iepaca rabe	IARI, New Delhi	*T.aestivum*
5	AKAW 4008	IARI, New Delhi	*T.aestivum*
6	Halna	IARI, New Delhi	*T.aestivum*
7	Pusa gold	RAU, Pusa	*T.aestivum*
8	HD 2733 (C)	IARI, New Delhi	*T.aestivum*
9	PBW 343	RAU, Pusa	*T.aestivum*
10	C 306	RAU, Pusa	*T.aestivum*
11	Kauz/AA/Kauz	IARI, New Delhi	*T.aestivum*
12	Raj 3765 (C)	RAU, Pusa	*T.aestivum*
13	HD 2888	RAU, Pusa	*T.aestivum*
14	VL 914	IARI, New Delhi	*T.aestivum*
15	F5-995	RAU, Pusa	*T.aestivum*
16	K0583	RAU, Pusa	*T.aestivum*
17	SAWSN 3010	IARI, New Delhi	*T.aestivum*
18	Cuo/79/Prulla	IARI, New Delhi	*T.aestivum*

Table 2: Monthly minimum, maximum and average temperature, rainfall and relative humidity during winter season of 2011-12.

Months		Normal (field)			Stressed (polyhouse)	
		Temp. (^{0}C)	RH (%)	Rainfall (mm)	Temp. (^{0}C)	RH (%)
		2011-12	2011-12		2011-12	2011-12
December	Max	20.1	88.2	Nil	25.0	91.6
	Min	11.2			11.9	
	Avg	15.1			19.2	
January	Max	19.9	89.1	5.5	26.5	91.0
	Min	9.0			11.0	
	Avg	13.2			19.1	
February	Max	25.8	88.9	Nil	29.8	90.1
	Min	11.0			11.4	
	Avg	17.9			21.3	
March	Max	30.3	86.9	0.9	37.0	84.0
	Min	13.0			12.9	
	Avg	18.5			26.1	
April	Max	36.0	77.2	1.7	43.1	78.8
	Min	19.7			23.0	

Avg	27.0	33.1

Table 3: Estimates of heritability, genetic advance as percent of mean, genotypic and phenotypic coefficient of variation.

Sl. No.	Characters	Environment	Range	Mean ±SE(m)	PCV (%)	GCV (%)	h^2 (%)	GAM (%)
1.	Spikelet fertility	Normal	46.87-94.12	49.58±7.10	23.93	16.71	62.80	24.05
		Stressed	22.87-80.66	32.57±5.86	32.79	24.67	68.45	38.23
2.	No. of grains per spike	Normal	34.08-59.51	42.56±2.10	35.94	28.53	62.53	46.64
		Stressed	37.09-61.49	40.29±2.10	30.14	26.46	77.08	47.86
3.	No. of effective tillers per plant	Normal	2.99-9.66	3.73±0.70	15.14	12.75	70.92	22.13
		Stressed	2.44-8.21	3.38±0.45	14.74	12.14	67.82	20.59
4.	Pollen sterility	Normal	11.81-44.10	17.80±2.62	40.43	34.10	71.14	59.25
		Stressed	6.63-34.44	14.30±3.53	48.32	36.52	69.14	56.88