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Genetic variability Analysis of Yield and its Attributes of Bread Wheat (*Triticum aestivum* L.) over the Environment

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ABSTRACT: A germplasm comprising 50 bread wheat (*Triticum aestivum* L.) cultivars was carried out to determine the genetic variability for yield and its attributes. The result showed that the analysis of variance revealed highly significant differences among the genotypes studied, emphasize the presence of genetic variation. A higher estimate of the phenotypic and genotypic coefficient of variation for the flag leaf area followed by flag leaf width, peduncle length, and days to maturity revealed the presence of exploitable genetic variation that can be improved through direct selection. Days to maturity, spike length, plant height, peduncle length, peniculated leaf distance, test weight, flag leaf length, number of grains/spike, flag leaf width, biological yield, grain yield/plot, and number of tillers/plant are examples of traits that have high heritability combined with high genetic advance over a percentage of mean reporting selection. Also, it provides information on genetic advancement and directional selection, which can be utilize indices to enhance selection efficiency. The experimental study find out the specific variable traits will be helpful for selection of desired traits under breeding for crop improvement programme.

Keywords: Genotype, genetic variability, environment, heritability, and genetic advance.

INTRODUCTION

Bread wheat or *Triticum aestivum* (L.) is a cereal grass belonging to the *Poaceae* family, genus *Triticum* and its origin is thought to be the South West Asia near East Region (Smith and Wayne 1995). The species is thought to have originated from the fertile crescent, from which it has travelled to every continent in the world. Wheat is one of the most important cultivated cereal crop and universally consumed crop in India as well as in the world, not only in terms of acreage but also in terms of adaptability for execution under a wide range of agro-climatic and crop growing conditions. The protein content of wheat grain provides about 8 - 20 percent of the total energy necessities in food for human body (Shehzad *et al*., 2014).

Wheat is grown in mild, humid to dry and cold environments with variations from irrigated to dry to high rainfall areas. This nutri-rich cereal has been under cultivation in 270.8 million hectares during 2021-22, in which wheat is grown in 222.21 million hectares of area and annual production of wheat is estimated at 779.03 million tons. In India, during 2021-22, Rabi season, wheat has been cultivated in 30.54 million hectares and the production of wheat is estimated at a record 106.84 million tons with national average productivity of 3484 kg/ha (Anonymous, 2022).

Wheat cultivation in Central India is unique wherein both the cultivated species *viz*., *Triticum aestivum* is grown in a typical hot tropical climate, characterized by the prevalence of high temperatures at the time of maturity. In India, wheat produced from the top six states *viz*., Uttar Pradesh, Punjab, Madhya Pradesh, Haryana, Rajasthan and Bihar together accounted for nearly 90 percent of the country's total wheat production (Anonymous, 2020).

Over the ages, wheat has established itself in a more complex range of environmental niches. Thus, wheat exhibits a broad spectrum of adaptability, conscious or unconscious selection pressures in the course of evolution has resulted in the establishment of specific genotypes adapted to different local environments.

MATERIALS AND METHODS

An experiment was conducted in a completely randomized block design with three replications at Zonal Agricultural Research Station, Powarkheda, Madhya Pradesh in black cotton soils during Rabi 2019-20 & 2020-21. Each plot comprised 2-rows of 2-meter length with 20 cm distance between rows and 10 cm between plants. All good agronomic practices for crop management are applied. 50 germplasm were used in the experiment (Table 1).

The data on nine morphological characters *viz*., days to heading, days to maturity, awns length, spike length, peduncle length, flag leaf length, flag leaf width, flag leaf area, canopy temperature at vegetative stage, canopy temperature at flowering stage, chlorophyll content, biological yield, harvest index, number of spikelets/spike, number of grains/spike, test weight, tillers, peniculated leaf distance, plant height and grain yield/plot were recorded. Analysis of variance, correlation coefficients and path coefficients for the observations were calculated by windostat version 9.2 form Indostat services, Hyderabad.

RESULTS AND DISCUSSIONS

Analysis of variance. The Analysis of variance for different quantitative traits of 50 entries along with the checks revealed that the component of variance with the genotypes was significant at 1% level of probability in all the traits namely days to heading followed by days to maturity, awns length, spike length, peduncle length, flag leaf length, flag leaf width, flag leaf area, canopy temperature at vegetative stage, canopy temperature at flowering stage, chlorophyll content, biological yield, harvest index, number of spikelets/spike, number of grains/spike, test weight, tillers, paniculated leaf distance, plant height and grain yield/plot (Table 2). In order to improve and select traits, the variation among these traits can be utilized in further breeding programs. Hence, the genes for such important traits may be derived from other sources, such as germplasm or other diverse germplasm. Similar results were reported by Barman *et al*. (2020).

Estimates of genetic parameter

Mean and range. Days to flowering was ranged from 62.17 days (RBW-594) to 77.83 days (PKD-1112) with a mean value of 69.06 days (Table 3). Days to maturity ranged from 92.20 days (RBW-594) to 110.0 days (UP-2572) with a grand mean value of 101.7 days. Awn length was ranged from 5.65 (MPO-1215) to 9.35 (UP-2462) with a grand mean value of 7.22. Spike length ranged from 7.25 cm (MP-0422) to 13.60 cm (IBWSN-156). with a grand mean value of 9.93. Peduncle length was ranged from 8.45 (MP-1370) to 27.67 (PKD-1226) with a grand mean value of 17.28. Flag leaf length was ranged from 16.58 (C-306) to 31.85 (HPW-157) with a grand mean value of 23.09. Flag leaf width was fluctuated from 0.88 (C-306) to 2.50 (PKD-1203) with a mean value of 1.73. Flag leaf area was ranged from 9.38 (C-306) to 39.94 (UP-2572) with a grand mean value of 25.77 cm. Canopy temperature at vegetative stage was ranged from 18.3 (HD-2004) to 23.6 ^oC (UP-2572) with a mean canopy temperature of 19.46 ^oC. Canopy temperature at flowering stage was ranged from 26.0 (GW-322) to 30.8 ^oC (MP-120), with a mean canopy temperature of 18.5 ^oC. Chlorophyll content ranges from 23.25 (CPAN-6220) to 38.87 (%) (HI-2240) with a mean value of 29.2. The range for biological yield was 612.8 g (PKD-1203) to 1172.5 g (PKD-1024), the estimated mean value was 831.2 (g). The harvest index (%) ranged from 30.4 (HI-1500) to 43.2 (%) (H-62), with a mean value of 36.0 (%). The number of spikelets/spike was ranged from 13.2 (PKD-1201) to 22.8 (HPW-157) with a mean value of 16.1. The number of grains/spike was ranged from 27.3 (MP-9676) to 56.6 (NIAW-231) with a mean value of 40.7. Test weight ranged from 29.8 g (PKD-1018) to 51.0 g (IBWSN-156) with a grand mean value of 38.8 g. Tillers/plant was ranged from 2.8 (NGSN-35) to 6.3 (CPAN-6220) with a mean of 4.35. Peniculated leaf length varied from 19.2 (MP-1070) to 33.8 (CPAN-6220) with a mean value of 24.5. Plant height for pooled was varied from 78.9 (MP-1370) to 127.0 cm (HI-1500) with a mean value of 100.2 cm. Grain yield/plot plant was ranged from 211.5 (PKD-1203) to 422.8 g (NIAW-231) with a grand mean value of 300.1 g Raza *et al.* (2018); Kumar and Payasi (2016).

Phenotypic and genotypic coefficient of variation. Phenotypic and genotypic coefficient of variation generally, the phenotypic coefficients of variance were higher than the corresponding genotypic coefficients of variance for the observed traits which indicate the impact of environment upon the traits (Table 3). The higher estimate of phenotypic and genotypic coefficient of variation (PCV and GCV *i.e*., more than 20%) were observed for flag leaf area followed by flag leaf width, peduncle length and days to maturity with less difference between observed PCV and GCV estimates, indicating the presence of exploitable genetic variance for these traits and suggested possible improvement through direct selection. Moderate phenotypic and genotypic coefficient of variance (10 to 19%) was observed for grain yield/plot, number of spikelets/spike, number of grains/spike, biological yield, awns length, spike length, chlorophyll content, flag leaf length, peniculated leaf distance, plant height and test weight, which suggested that there is considerable scope of improvement in these traits in the desired direction through a selection processes. The Low estimates of phenotypic and genotypic coefficient of variation were observed for the parameters harvest index (9.5%), canopy temperature at vegetative stage (6.1%), canopy temperature at flowering stage (5.8%) and days to heading indicating the major role of genetic factors changing the expression of these traits. The above findings were in accordance with the findings of Kumar *et al.* (2016); Kumar *et al*. (2022).

Heritability and Genetic advance as a % of mean. Heritability estimates along with genetic advance were more helpful than heritability alone in predicting the resultant gain under a selection of best individual. Heritability and genetic advance as percent of mean were estimated to get a clear picture of improvement in various traits through selection. In the results of the present investigation, high heritability was observed for the traits (>70%) days to maturity (99.5%) followed by spike length, plant height, peduncle length, peniculated leaf distance, days to heading, test weight, flag leaf length, number of grains/spike, flag leaf width, flag leaf area, biological yield, grain yield/plot and number of tillers/plant, moderate for awns length (69.60%), canopy temperature at vegetative stage and chlorophyll content, whereas low for number of spikelets/spike (48.4%), harvest index and canopy temperature at flowering stage(Table 3). The high value of heritability indicates that though the trait is least influenced by environmental effect, the selection for such character may not be useful because heritability is the estimate of both fixable and non-fixable variances. This reveals that character is highly influenced by environmental effects and genetic improvement through selection will be difficult due to the masking effect of the environment (Raha and Ramgiri 1998).

Higher estimates of Genetic Advance as a % over mean (i.e., >15%) were observed in flag leaf area (62.1%) followed by peduncle length (55.9%), days to maturity (53.0%), flag leaf width (49.9%), number of tillers/plant (42.3%), spike length (39.1%), grain yield/plot (36.9%), number of grains/spike (36.7%), biological yield (33.6%), peniculated leaf distance (32.8%), flag leaf length (31.2%), plant height (29.0%), awns length (29.0%), test weight (25.9, chlorophyll content (23.5%) and number of spikelets/spike (22.4%), this showed that character is governed by additive genes and selection will be rewarding. Moderate values of genetic advance as % over mean (10-15%) were observed in days to heading (12.5%), harvest index (11.9%) and canopy temperature at vegetative stage (10.6%), the lowest value were observed in canopy temperature at flowering stage (5.6%), this suggestion utilization heterosis breeding for improvement of this trait as it is governed by non-additive genes. Hence, the high heritability and along with higher estimates of genetic advance over percentage of mean will be rewarding as likely it is governed by additive genes and selection will be effective for such observed traits *viz*., days to maturity, spike length, plant height, peduncle length, peniculated leaf distance, test weight, flag leaf length, number of grains/spike, flag leaf width, biological yield, grain yield/plot and number of tillers/plant. Although high estimates heritability and medium genetic advance over percentage of mean of were observed for days to heading indicates that selection will be ineffective as the trait is under high influence of environment (Table 3). The results were in accordance with Fellahi *et al.* (2014); Kumar *et al*. (2013); Singh *et al.* (2018); Laala *et al*. (2021).

Table 1: List of genotypes.

Sr. No.	Varieties	Test weight (cm) (g)	Sr. No.	Varieties	Test weight (cm) (g)
1.	CPAN-6220	42.17	26.	MP-1370	41.33
2.	C-591	37.67	27.	NIAW-231	36.50
3.	CPAN-1532	39.83	28.	MP-9676	42.17
4.	C-306	38.67	29.	MP-3288	39.17
5.	H-951	39.17	30.	PNB-1018	38.33
6.	DBW-504	40.83	31.	PBW-9022	41.33
7.	EIGN-I-41	40.00	32.	RBW-594	37.00
8.	HPW-157	36.83	33.	PKD-153	36.00
9.	HD-2864	34.00	34.	PKD-1018	34.17
10.	GW-322	33.50	35.	PKD-1024	33.50
11.	H-62	35.83	36.	PKD-1112	35.33
12.	H-965	39.67	37.	SONALIKA	40.83
13.	GW-253	40.83	38.	PKD-1201	42.33
14.	NDSN-35	39.67	39.	PKD-1203	37.83
15.	HI-2240	36.83	40.	PKD-1226	37.50
16.	HI-1544	37.17	41.	IBWSN-156	37.67
17.	HD-2004	36.83	42.	IDSN-7059	37.83
18.	HD-2756	37.17	43.	IDSN-7211	36.67
19.	HY-2026	37.83	44.	NGSN-35	37.00
20.	J-260	39.50	45.	HI-1500	39.67
21.	JW-322	48.50	46.	SAWYT-328(B)	45.50
22.	MP-1070	39.67	47.	UP-2462	38.33
23.	MP-120	39.50	48.	HI-1531	41.50
24.	MP-0422	41.00	49.	VL-908	41.00
25.	MP-1116	40.00	50.	UP-2572	39.50

Table 2: Analysis of variance of 20 bread wheat genotypes of yield and its attributes traits.

Trait	DF	X_1	X_2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17	X18	X19	X20
Rep.	1	0.48	1.08	0.35	0.01	0.54	25.34	0.29	188.07	8.43	24.54	40.49	2160.08	71.05	1.58	1.61	138.72	2.61	0.08	2.39	0.37
Geno.	49	74.94	2203.52	5.81	13.55	88.41**	56.05**	0.84**	290.12**	6.02**	7.72**	76.99**	93454.79**	15510.36**	39.33**	27.52**	245.42**	105.43**	4.40**	65.15**	780.88**
Error	245	1.70	1.74	0.39	0.09	1.24	1.93	0.03	12.17	0.47	1.73	8.05	4784.98	928.33	6.13	4.15	9.05	3.08	0.28	1.46	8.07

X_1- Days to heading, X_2- Days to maturity, X_3- Awns length (cm), X_4- Spike length, X_5- Peduncle length (cm), X_6- Flag leaf length, X_7- Flag leaf width, X_8- Flag leaf area, X_9- Canopy temperature at vegetative stage (ºC), X_{10}- Canopy temperature at flowering stage (ºC), X_{11}- Chlorophyll content (SPAD), X_{12}- Biological yield (g), X_{13}- Grain yield/plot (g), X_{14}- Harvest index, X_{15}- Number of spikelets/spike, X_{16}- Number of grains/spike, X_{17}- Test weight (g), X_{18}- Tillers/plant, X_{19}- Peniculated leaf distance (cm), X_{20}- Plant height (cm).

Table 3: Estimates of parameters of genetic variability for 20 yield and its attributes of bread wheat.

Character	Mean	Range		PCV %	GCV %	Heritability %	Genetic Advance	GA % over mean
		Minimum	Maximum					
Days to heading	69.1	62.2	77.8	5.1	5.4	0.9	8.6	12.5
Days to maturity	101.7	34.5	110.0	20.1	20.2	1.0	50.5	53.0
Awns length (cm)	7.2	5.7	9.4	13.2	15.8	0.7	2.1	29.0
Spike length	9.9	7.3	13.6	15.1	15.4	1.0	3.9	39.1
Peduncle length (cm)	17.3	8.5	27.7	22.1	23.0	0.9	9.7	55.9
Flag leaf length	23.1	16.6	31.9	13.0	14.3	0.8	7.2	31.2
Flag leaf width	1.7	0.9	2.5	21.2	23.7	0.8	0.9	49.9
Flag Leaf Area	25.8	9.4	39.9	26.4	29.7	0.8	16.0	62.1
Canopy temperature at vegetative stage (ºC)	19.5	18.3	23.6	4.9	6.1	0.7	2.1	10.6
Canopy temperature at flowering stage (ºC)	28.6	26.0	30.8	3.5	5.8	0.4	1.6	5.6
Chlorophyll content (SPAD)	29.2	23.3	38.9	11.6	15.1	0.6	6.9	23.5
Biological yield (g)	831.2	612.8	1172.5	14.6	16.8	0.8	278.9	33.6
Harvest index	36.0	30.4	43.3	6.5	9.5	0.5	4.3	11.9
Number of spikelets/spike	16.2	8.8	22.8	12.2	17.6	0.5	3.6	22.4
Number of grains/spike	40.7	27.3	56.7	15.4	17.1	0.8	14.9	36.7
Test weight (cm) (g)	38.8	29.8	51.0	10.6	11.6	0.9	10.0	25.9
Tillers/plant	4.4	2.8	6.3	19.0	22.6	0.7	1.8	42.3
Peniculated leaf distance (cm)	24.6	19.1	33.8	13.3	14.1	0.9	8.1	32.8
Plant height (cm)	100.3	78.9	127.1	11.3	11.7	0.9	29.1	29.0
Grain yield/plot (g)	300.1	211.5	422.8	16.4	19.3	0.7	110.7	36.9

CONCLUSIONS

The above experimentation concludes that the higher estimate of phenotypic and genotypic coefficient of variation for flag leaf area followed by flag leaf width, peduncle length and days to maturity, revealed the presence of exploitable genetic variance which can be improved through direct selection. Such observed traits *viz*., days to maturity, spike length, plant height, peduncle length, peniculated leaf distance, test weight, flag leaf length, number of grains/spike, flag leaf width, biological yield, grain yield/plot and number of tillers/plant, reported high heritability coupled with high genetic advance over percentage of mean reporting selection will be rewarding and effective as traits were likely to be governed by additive genes. It also provides information on the correlated response to directional selection to predict genetic advancements and so on, which can be used as selection indices for the functioning of a more efficient selection program. Also, the above study was very useful for breeders in order to increase yield per se performance.

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Conflict of Interest. None.

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