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Estimation of genetic variability for different quantitative characters under heat stress condition in bread wheat (*tritium aestivum* L.) genotypes.

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Abstract:
The current investigation comprising of 108 various genotypes of bread wheat were assessed to detect appropriate and high yielding genotypes under heat stress situation. The experiment was conducted during Rabi 2014-15 and Rabi 2015-16 in RBD having three replications under heat stress condition. The data were noted on 16 quantitative and physiological characters to work out tolerant genotypes under heat stress condition. The analysis of variance revealed highly significant differences among 108 genotypes for all the sixteen quantitative and physiological characters under study, this point to the existence of adequate variation in the present gene pool. High heritability accompanied by high genetic advance will be more helpful to arrive at more reliable conclusion. It can be determined that the present research revealed that many traits have adequate genetic variability for the various agronomic characters among genotypes. Study showed effectiveness of germplasm for further use in breeding program. Lower genetic advance limits the greater scope of improvement but higher phenotypic and genotypic coefficient of variation and higher heritability provides good chance for its further improvement. Effective selection is dependent on a high heritability of a character. In the present study heritability was ranged from (0.30) to (0.95) which was recorded for harvest index and chlorophyll content respectively.

Key words: Genotypic coefficient of variance, phenotypic coefficient of variance. Heritability, Genetic advance

1- Introduction

Wheat (*Tritium aestivum* L.) is the staple food for a large part of the world population including India. The area under wheat in India is 28.42 mha, with a production 84.20 million tons and productivity of 2.6 t/ha. However, at Uttar Pradesh, it occupy an area of 10.42 mha, with production of 29.32 million tons and productivity of 2.8 t/ha (**DWR, 2016**). This is far below than that of most of the countries of the world like Germany (7.9 tons/ha), France (6.6 tons/ha) and Egypt (6.4 tons/ha). Wheat is the staple food in Afghanistan, contributing approximately 54 percent of average daily caloric intake. In 2008 due to a combination of international (increasing global food prices), regional (export bans in key trading partners like Pakistan), and domestic (drought) factors, domestic wheat grain and flour prices approximately doubled. These sharp price increases constituted a serious economic shock to Afghan households, who spend the majority of their budgets on food. **D'Souza and Jolliffe (2012)** find that the price shock had a measurable impact on household food security across Afghanistan. Unfortunately, heat stress is a major environmental factor that significantly reduces wheat grain yield worldwide especially in arid, semi-arid, tropical, and sub-tropical regions that are associated with higher temperature. **Wahid *et al.,* (2007)** defined heat stress as the rise in temperature beyond a threshold level for a period of time sufficient to cause irreversible damage to plant growth and development. Grain yield is a complex trait and highly influenced by many genetic factors and environmental fluctuations. In plant breeding programme, direct selection for yield as such could be misleading. A successful selection depends upon the information on the genetic variability and association of morpho-physiological traits with grain yield. The success of a breeding programme depends on the presence of genetic variability in a material in hand. To make the heritable improvement in characters, estimation of genetic parameters and index of their transmissibility is required. Heritability estimates provide information about the extent to which a particular character can be transmitted to the successive generations. Knowledge of heritability of a trait thus guides a plant breeder to predict behavior of succeeding generations and helps in making desirable selections. Conventional analysis of variance and statistical parameters like phenotypic and genotypic coefficients of variability, heritability and genetic advance have been used to assess the nature and magnitude of variation in wheat breeding material.

2- Material and methods

A study was conducted compelling 108 varied genotypes comprising three checks (Halna, K-8962, and HD-2733). The experiment was established during *Rabi* 2014-15 and *Rabi* 2015-16 at the Experimentation Centre of Department of Genetics and Plant Breeding, NAI. School of Agriculture, SHUATS, Allahabad (U.P.), which is situated at 25^0 24' 42" N latitude, 81^0 50' 56" E longitude and at altitude of 98 m above the mean sea level. The experimental material was grownup in Randomized Block Design (RBD) replicated thrice. Each genotype was grown in one row plot of 5 meters with 25 centimeter distance between rows. The recommended cultural observes were take on to rise a good crop. Data were note down on five randomly selected competitive plants from each plot on sixteen quantitative characters namely, days to 50 % heading, days to 50 % flowering, plant height (cm), spike length (cm), spike weight (cm), number of productive tillers per plant, grain filling period, grain per spike, test weight (g), chlorophyll content (%), membrane thermo-stability (%), harvest index, canopy temperature depression, days to 50 % maturity, biological yield per plant (g), and grain yield per plant (g). the estimate genetic parameters, broad sense heritability (h^2), genetic advance (GA % of mean), genotypic coefficient of variance (GCV), and phenotypic coefficient of variance (PCV), work out.

3- Results and Discussions

The analysis of variance indicated that there was significant differences between all the traits under heat stress condition. The mean sum of square due to genotypes were significant for all the character studied, suggesting the existence of high genetic variability among the genotypes for all the traits. The presence large amount of variability might be due to diverse source of materials as well as environmental influence affecting the phenotypes.

Table 1. Analysis of variance for different quantitative and physiological characters in wheat genotypes.

Characters	Mean Sum of Square		
	Replication (d.f= 2)	Treatments (d.f= 107)	Error (d.f= 214)
Days to 50% heading	0.20	33.39**	1.21
Days to 50% flowering	2.63	32.15**	1.68
Plant height	2.42	532.32**	1.97
Number of tillers per plant	1.00	3.33**	1.14
Spike length	1.34	21.05**	0.95
Spike weight	0.14	1.04**	0.13
Days to 50% maturity	3.17	32.55**	2.03
Grain filling period	4.16	34.84**	4.04
Number of grains per spike	2.30	336.52**	2.80
Test weight	2.43	90.46**	0.95
Biological yield per plant	4.31	64.75**	2.69
Chlorophyll content	0.66	99.21**	1.07
Membrane stability	1.97	145.99**	1.19

Harvest index	19.63	140.38**	29.04
Canopy temperature depression	0.35	5.54**	0.24
Grain yield per plant	0.75	9.40**	0.49

** Significant at 5% & 1% level of significance

The data (Table. 2 and Fig.1) showed that the phenotypic and genotypic variability (V_P or σ^2P and V_G or σ^2g) ranged from (142.93 and 172.86) to (0.28 and 0.46) which were recorded for plant height and the lowest was for spike weight (g) respectively. Traits such as plant height, grain per spike, membrane stability, chlorophyll content, harvest index, test weight, showed higher phenotypic as well as genotypic variance. A wide range of variance was observed for all the characters. The highest genotypic variance (V_g) was recorded for plant height (142.93 cm), The highest phenotypic variance was recorded for plant height (172.96 cm), Phenotypic variance was higher than genotypic for all yield and yield contributing characters, indicating the influence of environmental factors on these traits. Similar findings were reported by **Arya *et al.* (2005), Sharma *et al.* (2007), and Kaur *et al*. (2015)** and **Fikre *et al*. (2015)** in wheat. Phenotypic coefficient of variation (PCV) ranged from (4.01) days to maturity to (29.68) harvest index. High degree of PCV was recorded for spike weight (25.75), canopy temperature (25.17), grain spike^{-1} (23.75), grain yieldplant^{-1} (24.73), biological yieldplant^{-1} (22.90), and membrane stability (21.28). Genotypic coefficient of variation GCV ranged from (2.95) days to 50 % maturity to (22.76) canopy temperature depression. High magnitude GCV was recorded for CTD (22.76), grain per spike (21.83), spike weight(20.13), grain yieldplant^{-1} (20.43), biological yieldplant^{-1} (19.88) and membrane stability (19.50), whereas, the lower GCV was recorded for the traits such as days to maturity (2.95), days to heading (3.99) days to 50% flowering (4.05) and grain filling period (8.92). Effective selection is dependent on a high heritability of a character. In the present study heritability was ranged from (0.30) to (0.95) which was recorded for harvest index and chlorophyll content respectively. Plant traits days to flowering (0.89), grain yield per plant (0.86), membrane stability (0.84), and plant height showed higher heritability, while tiller plant^{-1} (0.57), days to maturity (0.54), and harvest index (0.30) showed medium heritability. The high heritability and low genetic advance under control of non-additive (dominant and/or epistasis) genes which limits the scope for improvement through selection. **Fellahi *et al.* (2013)** found high heritability and genetic coefficient of variation for plant characters like plant height, number of spikes plant^{-1} and thousand grain weight. According to (**Panse (1957)** such characters are governed predominantly by non-additive gene action and could be improved through individual plant selection. However, **Khan *et al.*, (2011) and Degewione *et al*. (2013)** found high heritability coupled with moderate genetic advance for plant height.in the present study, many traits recorded higher to moderate heritability coupled with lower genetic advance, which may be attributed to non-additive gene action governing these traits, and characters could be improved through the use of cross hybridization. However, characters exhibiting high heritability may not necessarily give high genetic advance. High heritability and high genetic advance indicates prevalence of additive gene effect, therefore, characters can be better exploited through selection. High heritability accompanied by high genetic advance will be more helpful to arrive at more reliable conclusion. It can be determined that the present research revealed that many traits have adequate genetic variability for the various agronomic characters among genotypes. Study showed effectiveness of germplasm for further use in breeding program. Lower genetic advance limits the greater scope of improvement but higher phenotypic and genotypic coefficient of variation and higher heritability provides good chance for its further improvement. The estimate of genetic advance ranged from (0.85) spike weight to (22.39) plant height cm, followed by grain spike^{-1}(16.04), membrane stability (11.51), whereas the lower genetic advance was depicted by tillers per plant (1.60). Low genetic advance is due to controlling of these traits by non-additive genes. Genetic advance as percent of mean ranged from (4.48) days to 50% maturity to (42.39) canopy temperature depression), followed by grain yield (41.33%), membrane stability (38.81%) high genetic advance as percent of mean were recorded for CTD (42.39%), followed by grain spike^{-1} (41.33%), membrane thermo-stability (38.81%), biological yield(35.54) chlorophyll content (26.73%).

Table. 2 Estimation of components of variance and genetic parameters for quantitative and physiological characters in wheat genotypes.

Characters	σ^2g	σ^2p	GCV	PCV	Heritability (h^2bs)	Genetic advance	Genetic advance as % of mean
Days to 50% heading	8.47	10.70	3.99	4.49	0.79	5.33	7.32
Days to 50% flowering	10.19	11.49	4.05	4.30	0.89	6.19	7.85
Plant height	142.93	172.96	13.19	14.51	0.83	22.39	24.69
Number of tiller per plant	1.06	1.85	16.36	21.64	0.57	1.60	25.48
Spike length	6.46	8.29	15.24	17.27	0.78	4.62	27.71
Spike weight	0.28	0.46	20.13	25.75	0.61	0.85	32.41
Days to 50% maturity	11.20	20.63	2.93	4.01	0.54	5.08	4.48
Grain filling period	9.35	13.23	8.92	10.61	0.71	5.29	15.45
Number of grain per spike	71.80	85.01	21.83	23.75	0.84	16.04	41.33
Test weight	28.96	39.62	14.09	16.48	0.73	9.48	24.82
Biological yield per plant	15.88	21.08	19.88	22.90	0.75	7.13	35.54
Chlorophyll content	29.49	31.16	13.34	13.71	0.95	10.88	26.73
Membrane stability	37.16	44.25	19.50	21.28	0.84	11.51	38.81
Harvest index	24.12	80.76	16.22	29.68	0.30	5.55	18.25
Canopy temperature depression	1.36	1.67	22.76	25.17	0.82	2.17	42.39
Grain yield per plant	1.49	2.18	20.43	24.73	0.86	2.08	34.77

Where, Vg = Genotypic variance
VP = Phenotypic variance
GCV = Genotypic coefficient of variance
PCV = Phenotypic coefficient of variance
h^2 (bs) = Heritability (broad sense)
GA = Genetic advance

Graphical representation of mean genetic parameters data.

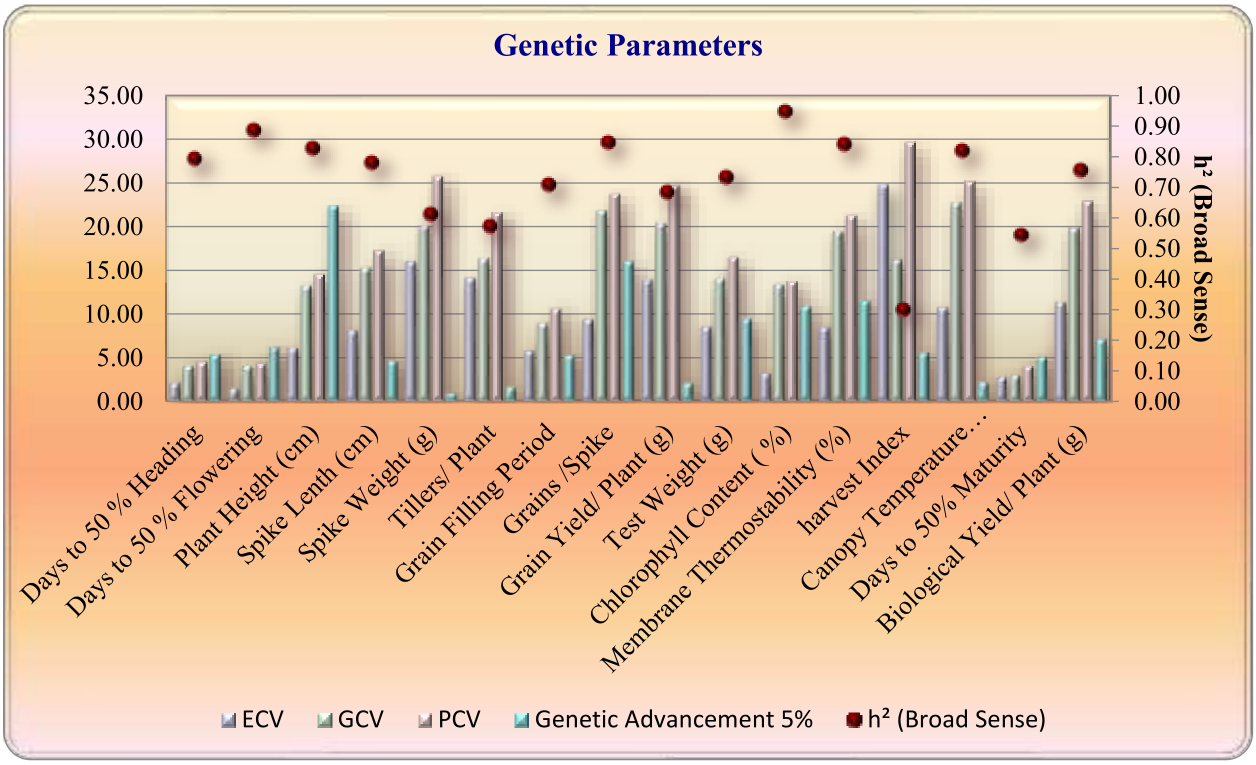

Fig. 1 Histogram depicting genotypic and phenotypic coefficient of variation for different characters in wheat

4- Conclusion

The mean sum of square due to genotypes were significant for all the character studied, High heritability accompanied by high genetic advance will be more helpful to arrive at more reliable conclusion. It can be determined that the present research revealed that many traits have adequate genetic variability for the various agronomic characters among genotypes. Study showed effectiveness of germplasm for further use in breeding program. Lower genetic advance limits the greater scope of improvement but higher phenotypic and genotypic coefficient of variation and higher heritability provides good chance for its further improvement.

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