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Evaluation of heat tolerance genotypes based on quantitative andphysiological parameters in breed wheat (*triticum aestivium*L.)

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Abstract

The present investigation consisting of 108 diverse genotypes of bread wheat were evaluated to identify suitable and high yielding genotypes under heat stress condition. The experiment was conducted during Rabi 2014-15 and Rabi 2015-16 in RBD having three replications under heat stress condition. The data were recorded on 16 quantitative and physiological characters to figure out lenient genotypes under heat stress condition. The analysis of variance showed highly significant differences among 108 genotypes for all the sixteen quantitative and physiological characters under study, this indicated the existence of sufficient variation in the present gene pool. Per se performance for seed yield depicted that genotypes SHIATS BW-1695(8.55 g) was found to be significantly higher in total set of genotypes, followed by SHIATS BW- 1702 (8.37 g) while SHIATS- BW 1629(8.18) was found to be the most consistent genotype for seed yield coupled with early maturity suited for late sown condition of Allahabad agro-climatic region.Test weight showed significant difference among the wheat genotypes and genotypes SHIATS BW-1606(48.25) was numerically found to have higher test weight, followed by K-8962 and SHIATS- BW-1629 (41.23) respectively.Whereas the genotype k-8962 recorded higher grain filling period (48.67 days), followed by Halna (43.333) and SHIATS BW-1702(40.00) respectively, but Halna (39.80), followed by SHIATS BW-1629 (39.53)and SHIATS BW-1695 (36.15) wheat genotype were found to be significantly higher for membrane stability. However wheat genotypes SHIATS BW-1702 (6.43), followed by SHIATS BW-1695 (5.67) and SHIATS BW-1629 (5.27) were depicted to have higher canopy temperature depression.

Key words: *wheat, heat stress, genotype, quantitative, tolerance*

I. Introduction

Wheat, (*Triticum aestivum* L.) the most important cereal crop occupies prominent position in Indian agriculture after rice. Wheat belongs to order poales and family Poaceae. Wheat is a grass, originated from the Fertile Crescent region of the Near East, but now cultivated worldwide. Wheat (*Tritium aestivum* L.) contributes significantly to the global food and food security **(Singh, 2001).** Climate change induced temperature increases are likely to reduce wheat production in developing countries including India (where around 66% of all wheat is produced) by 20-30% **(Hossain *et al.*, 2012).**In India, wheat is generally grown under timely sown and late sown conditions and best vegetative and reproduction growth of wheat plant is obtained at temperature 18-22^{o}C (Reynolds *et al*., 2010).Presently, in India, the wheat occupies 30 million ha area with 97.5 million tones production and productivity of 2935 kg/ha **(DWR, Annual Report, 2016).** Uttar Pradesh is countries topmost state for wheat producer. It produced 30.25 million tons from 9.96 million hectares area with a productivity of 3038kg/ha **(Agricultural Statistics at a Glance, 2016).**

Table.1wheat production and productivity in Indian and worldwide

Country /state	Area (mha)	Production (mt)	Yield (q/ha)
India	30.23	97.50	29.35
Uttar Pradesh	9.96	30.25	30.38
World	221.68	728.28	32.9

Source: Directorate of Economics and Statistics, Department of Agriculture and Cooperation, 2016

Wheat will continue to attract substantial research attentions in the face of the challenge of feeding a predictable population of 9 billion by 2050. Yield increases are essential to meet this demand, as expanding the wheat area is not possible (**Rajaram and Braun, 2008**).(**Gill *et al*., 2004**). Stated that in order to meet growing human needs; wheat grain production must increase at an annual rate of 2%. Unfortunately, heat stress is a major environmental factor that substantially reduces wheat grain yield globally 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. Global warming as a result of climate change negatively affects wheat grain yield, which potentially increases food insecurity and poverty **(Ortiz *et al*., 2008**).Each day delay in sowing of wheat after 20 November onward in decreases grain yield at the rate of 36 kg ha^{-1}day^{-1} (**Hussain *et al*., 1998**). Delayed sowing from normal to late and very late increased the canopy temperature depression significantly, whereas other parameters such as anthesis, maturity, spike length, and grain-filling period were reduced as sowing was delayed. **(Tripathi *et al*., 2005).** the optimum temperature range for attaining maximum grain weight is 18-22°C. Wheat grain weight is decreased from 4 to 8% per degree rise in mean temperature over the range of 12- 26°C during grain filling period (**Wiegand and Cuellar1981**). Stress due to high-temperature has emerged as a major constraint for the successful wheat production worldwide (**Hays *et al*., 2007**). Nearly 40 % of total irrigated area, where wheat is grown, is severely affected by heat stress (**Reynolds *et al*., 2001**).Yield loss of 29 % is expected by 2080 due to global \warming, in wheat. Annual yield loss in wheat due to global warming is expected to be 7.7 billion dollars, and by 2025, this would be around 18 billion dollars. Stress due to high-temperature has emerged as a major constraint for the successful wheat production worldwide (**Hays *et al*., 2007**). Nearly 40 % of total irrigated area, where wheat is grown, is severely affected by heat stress (**Reynolds *et al*., 2001**). Therefore information onheat tolerance genotypes based on quantitative and physiological parametersin bread wheat is important to identify outstanding genotypes with wide adaptation and desirable traits. Evidence on heat tolerance wheat genotypes in heat stress environment is less. Therefore the experiment was conducted to detect heat tolerance genotypes with appropriatecharacters for heat stress coupled with high yield and yield contributing traits.

II. Materials and Methods

A study was conducted taking 108 diverse genotypes including three checks (Halna, K-8962, and HD-2733). The experiment was planted 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 located 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 grown 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 practices were adopted to rise a good crop. Data were recorded on five randomly selected competitive plants from each plot on sixteen quantitative and physiological 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. Also data were subjected to non-hierarchical Euclidian cluster statistic.

III. Result and Discussion

The present investigation was carried out to assess heat tolerance genotypes based on quantitative and physiological parameters in breed wheat (*triticum aestivium* L.) among one hundred eight wheat genotypes procured from the Department of Genetics and Plant Breeding, Naini Agricultural Institute, SHUATS, Allahabad.

The mean sums of squares value for all the sixteen characters*viz*., days to 50% heading, days to 50% flowering, plant height(cm), spike length with awn (cm), spike weight(g), number of productive tillers per plant, grain filling period (days), number of grains per spike, grain yield per plant(g), test weight(g), days to maturity(days), biological yield per plant (g), harvest index (%), chlorophyll content (%), membrane stability (%), and canopy temperature depression, were subjected to analysis of variance for experimental design are presented. The mean sum of squares due to genotypes were significant for all the characters studied.

Table.2 Physiological and leaf type characters related to terminal heat tolerance in wheat

Rank	Genotypes	Leaf type	Leaf shape	Waxiness	Early vigor	Canopy temperature depression	Chlorophyll Content	Membrane stability	Grain yield per plant	Biological yield per plant	Cluster –N
1	SHIATS BW 1649	SE	N	P	92.5	3.97	42.57	25.18	7.62	21.85	VI
2	SHIATS BW 1648	SE	M	P	93	2.6	49.23	21.73	7.55	21.62	VIII
3	SHIATS BW 1655	SE	M	P	84	3.98	44.83	38.8	6.97	24.58	VIII
4	SHIATS BW 1661	SE	M	P	84	7.33	44.62	32.85	6.28	16.85	VI

5	SHIATS BW 1604	E	N	P	89	4.35	47.03	23.65	6.25	17.03	VI
Chk1	Halna	E	M	P	92.5	2.73	39.33	39.8	3.2	17.2	II
Chk2	K-8962	E	M	A	92.5	3.87	34.23	35.38	5.08	18.7	V
Chk3	HD- 2733	E	B	A	92	5.22	35.2	27.08	4.05	9.28	II

Table (2) shows that SHIATS BW 1649 followed by SHIATS BW 1648, SHIATS BW 1655, SHIATS BW 1661 and SHIATS BW 1604 had above average grain yield and biological yield per plant primarily due to their semi-erect leaf type, medium to narrow leaf shape, leaf waxiness, early vigor and high leaf chlorophyll content as compared to checks *viz.*, Halna, K-8962, HD- 2733 which are thought to be tolerant to terminal heat stress. These test varieties also belong to four distinct clusters *viz.*, SHIATS BW 1604, SHIATS BW 1649 and SHIATS BW 1661 belongs to cluster VI; SHIATS BW 1648 and SHIATS BW 1655 belongs to cluster VIII; while checks Halna and HD-2733 belong to cluster II and check K-8962 belongs to cluster V. This diversity of test genotypes (which are high yielding coupled with thermo-tolerant) and checks (which are thermo-tolerant) offers us with an opportunity to utilize these genotypes in a crossing program which may yield transgressive segregates which are high yielding and tolerant to terminal heat stress suggested by **Trethowan and Reynolds (2007)**.

Table (3) Mean performance of 5 top wheat genotypes against checks for grain yield and its components

Genotypes	Grain Yield (g/plant)	Test Weight (g)	GFP	Membrane Stability	CTD	Maturity
SHIATS-BW 1695	8.55	38.17	39.50	36.15	5.67	115.00
SHIATS- BW 1702	8.37	41.20	40.00	34.55	6.43	122.33
SHIATS- BW 1629	8.18	41.23	34.50	39.53	5.27	116.50
SHIATS- BW 1606	7.80	48.25	32.50	26.01	4.03	116.17
SHIATS- BW 1653	7.68	38.75	34.00	35.27	5.13	115.50
Halna (check-1)	3.20	37.63	43.33	39.80	2.73	132.00
K-8962 (check-2)	5.08	41.63	48.67	35.38	3.87	118.67
HD-2733 (check-3)	4.05	30.50	40.50	27.08	5.22	126.50
Mean	5.86	38.81	34.15	30.90	4.93	113.24
Range lowest	2.75	24.78	24.67	18.67	2.60	107.67

Range highest	8.55	53.67	48.67	40.63	7.33	132.00
C.V	20.45	6.78	5.46	6.8	11.41	2.05
C.D 5 %	1.36	2.98	2.11	2.38	0.64	3.46

Mean results revealed that grain yield of wheat genotypes SHIATS BW-1695(8.55 g) was found to be significantly higher in total set of genotypes, followed by SHIATS BW- 1702 (8.37 g) while SHIATS-BW 1629(8.18) was found to be the most consistent genotype for seed yield coupled with early maturity suited for late sown condition of Allahabad agro-climatic region.Test weight showed significant difference among the wheat genotypes and genotypes SHIATS BW-1606(48.25) was numerically found to have higher test weight, followed byK-8962 and SHIATS- BW-1629(41.23) respectively.Whereas the genotype k-8962 recorded higher grain filling period (48.67 days), followed by Halna (43.333) and SHIATS BW-1702(40.00) respectively,but Halna (39.80), followed by SHIATS BW-1629 (39.53)and SHIATS BW-1695 (36.15)wheat genotype were found to be significantly higher for membrane stability. However wheat genotypes SHIATS BW- 1702 (6.43), followed by SHIATS BW-1695 (5.67) and SHIATS BW-1629 (5.27) were depicted to have higher canopy temperature depression.

IV. Conclusion

The mean sum of square due to genotypes were significant for all the character studied, grain yield of wheat genotypes SHIATS BW-1695(8.55 g) was found to be significantly higher in total set of genotypes, while SHIATS- BW 1629(8.18) was found to be the most consistent genotype for seed yield coupled with early maturity suited for late sown condition of Allahabad agro-climatic region.Test weight showed significant difference among the wheat genotypes and genotypes SHIATS BW-1606(48.25) was numerically found to have higher test weight. Whereas the genotype k-8962 recorded higher grain filling period (48.67 days), followed by Halna (43.333). SHIATS BW 1649 also depicted higher grain yield and biological yield per plant due to their semi-erect leaf type, medium to narrow leaf shape, leaf waxiness, early vigor and high leaf chlorophyll content which are tolerant to terminal heat stress.

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References

Agricultural Statistics at a Glance, 2016)

[1] **DWR, (2016).** Proceedings, Recommendations & Plan of Work (2011-12).***In***: 49th All India Wheat and Barley Research Workers' Meet, August 27-30.

[2] **Gill, B., R. Appels, A., Botha-Oberholster, C., Buell, J., Bennetzen, B., Chalhoub, (2004)**. Workshop report on wheat genome sequencing: International genome research on wheat consortium. *Genetics*, 168:1087-1096.

[3] **Hays, D., Mason, E., Hwa, Do, J., Menz, M., Reynolds, M. (2007).**Expression quantitative trait loci mapping heat tolerance during reproductive development in wheat (*Triticum aestivum* L.). Wheat production in stressed environments. Springer, Amsterdam, 373-382.

[4] **Hossain, A., Lozovskaya, M.V., Zvolinsky, V.P. and Teixeira da Silva, J.A. (2012).**Effect of soil and climatic conditions on yield-related components performance of spring wheat (*Triticum aestivum* L.) varieties in the northern Bangladesh. Natural Science: *Journal of Fundamental AppliedResearch*, 2(**39**): 77-86.

[5] **Hussain, A.M., Maqsood, A., Ahmad, S., Aftab and Ahmad, Z. (1998).** Effect of irrigation during various development stages on yield, component of yield and harvest index of different wheat cultivars. *Pakistan Journal of Agricultural Sciences*, 34**:** 104-106.

[6] **Ortiz, R. Sayre, K.D., Govaerts, B., Gupta, R., Subbarao, G.V., Ban, T., Hodson, D., Dixon, J.M., Ortiz-Monasterio, J.I. and Reynolds, M. (2008)**. Climate change: can wheat beat the heat? *Agriculture, Ecosystems & Environment*126: 46-58.

[7] **Rajaram, S., and H. Braun. (2008).** Wheat yield potential International Symposium on Wheat Yield Potential: Challenges to International Wheat Breeding. CIMMYT, Mexico, D 103- 107

[8] **Reynolds, M.P, Nagarajan, S., Razzaque, M.A, Ageeb, O.A.A. (2001).** Heat tolerance Application of physiology in wheat breeding. CIMMYT, Mexico, DF

[9] **Singh, M. (2001)**. Sustainability of rice-wheat system in eastern Uttar Pradesh: An economic perspective. *Ph. D. dissertation, Indian Agricultural Research Institute, New Delhi*

[10] **Tripathi, D., Dessalegn, T., Dessalegn, Y. and Share, G. (2005).** Genetic variability, correlation and path analysis in durum wheat germplasm (*Triticum durum Desf*).*Agriculture Research and Reveals* 107-112.

[11] **Wahid, A., S., Gelani, M. Ashraf, and Foolad, M.R. (2007)**. Heat tolerance in plants: an overview Environmental and Experimental Botany 61(**3**):199-223.

[12] **Wiegand, C.L, and Cuellar, J.A. (1981).** Duration of grain filling and kernel weight of wheat as affected by temperature. *Crop Science*21: 95-101.