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Short Communication

Heat tolerant wheat genotypes for late sown conditions identified on the basis of physiological traits

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Wheat is one of the most vital cereals crop all over the world and cultivated since pre-historic times. Wheat production is hindered by various biotic, abiotic and management factors of which heat and moisture are important one. Heat stress causes some physiological changes like photosynthetic rate, transpiration rate, stomatal conductance, chlorophyll content, canopy temperature and many more in crop. Photosynthesis is the most sensitive physiological process in response to elevated temperature. According to Singh *et al*. (2017) under elevated temperature photosynthetic rates declined rapidly during grain filling period and the decline was significantly lower than ambient condition. Gupta *et al*. (2015) found that photosynthesis and stomatal conductance decreased significantly under late sown condition, heat tolerant genotype maintained higher rate of photosynthesis and stomatal conductance after anthesis under late sown condition. Transpiration rate is an important parameter, which is directly linked with temperature sensitivity vis a vis water availability for a plant. Transpiration rate was found higher in elevated temperature compared to that in ambient condition (Singh *et al*. 2017). The water use efficiency (WUE) followed a general increasing trend from vegetative phase to physiological maturity (Singh *et al*. 2017). Changes in chlorophyll content is an indicative of tolerant and susceptible nature of genotypes under strong light, high temperature and dry air environmental conditions in timely and late sowing cultivars. Heat stress declined chlorophyll contents in cool-season cereal species which leads to physiological changes and thereby leaf senescence (Almeselmani and Deshmukh 2012). Canopy temperature (CT) is a non destructive monitoring parameter of whole plant used to evaluate plant response to various environmental stresses including heat stress (Munjal and Rana, 2003). Canopy temperature depression is directly or indirectly affected by a number of physiological processes and is a good indicator of genotype fitness in a given environment (Munjal and Dhanda 2016; Saxena *et al*. 2016). Keeping in view this study was conducted to evaluate various physiological, trait like photosynthetic rate, tanspirational rate, stomatal conductance, chlorophyll content and canopy temperature and to identify a promising wheat genotype under late sown condition.

Twenty wheat genotypes genotypes viz. WH 730, WH 1124, WH 1021, HD 3059, DBW 90, PBW 373, Raj 3765, HD 2851, HD 2285, PBW 550 (Heat Tolerant Genotypes) HD 2967, DBW 621, WH 1105, DBW 88, HD 3086, HD 2733, WH 711, WH 1080, WH 1142 and K 0307 were sown at field of Wheat and Barley Section, Department of Genetics and Plant Breeding, CCSHAU, Hisar, during crop seasons of 2016- 2017 under late sown condition by sowing in December in Randomized Block Design with three replications. Each plot was consist of 4 rows of 3m length with a 20×5 cm spacing within rows and between plants, respectively Flag leaf per selected plant was randomly chosen and tagged (total of ten flag leaves per genotype was tagged). The tagged leaves was used to measure physiological traits at anthesis and 14 days after anthesis (14DAA). Photosynthetic rate (A), transpiration rate (E) and stomatal conductance (gs) of fully expended leaf was measured by infrared gas analyzer (IRGA LCi-SD, ADC Biosciences). Water use efficiency (WUE) was calculated as:

Water use efficiency = Photosynthetic rate/ stomatal conductance

Canopy temperature (CT) measurements were made using hand held infrared thermometer (IRT), model AG-42, Tele temp crop Fullerton.

Significant differences existed among wheat genotypes tested for A, E, gs, WUE, chlorophyll content and CT at anthesis and 14 DAA (Table 1). A declined with progressive grain filling stage condition under late sown condition. A was more in heat tolerant genotype as compare to heat sensitive genotype. Maximum A at anthesis stage was observed in PBW 550 (18.57) and genotype WH 1021(14.24) has maximum photosynthetic rate 14 DAA. Least A was observed in WH 1080 (9.81) and K 0307 (2.98) at anthesis and 14DAA. Among the twenty wheat genotypes,

Table 1: Physiological traits under late sown condition

Genotypes	Photosynthetic rate (A) (μmol $m^{-2}s^{-1}$)		Transpiration rate(E) (mmol $m^{-2}s^{-1}$)		Stomatal conductance (gs) (mol $m^{-2}s^{-1}$)		Water use efficiency (WUE) (μmol CO_2 mol^{-1} H_2O)		Chlorophyll content (Mg/g tissue)		Canopy temperature (° C)	
	Anthesis	14DAA	Anthesis	14DAA	Anthesis	14DAA	Anthesis	14DAA	Anthesis	14DAA	Anthesis	14DAA
DBW621	11.75±0.30	6.71±0.07	6.29±0.24	4.28±0.52	0.163±0.007	0.107±0.007	72.10±0.30	63.00±2.20	2.36±0.03	2.25±0.12	23.3±0.153	32.5±1.048
DBW88	12.42±0.29	7.36±0.18	7.14±0.26	4.57±0.19	0.170±0.006	0.117±0.003	72.30±0.30	62.00±0.10	2.33±0.23	1.69±0.40	22.9±0.857	32.4±0.617
DBW90	15.75±0.22	10.32±0.21	10.67±0.15	6.37±0.39	0.233±0.003	0.163±0.009	73.30±1.70	63.45±0.25	2.86±0.61	2.24±0.46	22.1±0.964	30.8±0.551
HD2285	14.53±0.22	9.19±0.12	8.60±0.00	5.77±0.36	0.213±0.003	0.140±0.012	67.50±0.90	63.60±0.50	2.75±0.52	2.00±0.07	22.6±0.876	31.4±0.328
HD2733	12.19±0.25	6.95±0.19	6.79±0.26	4.49±0.46	0.167±0.003	0.113±0.007	67.05±0.85	64.30±1.60	2.32±0.22	1.38±0.07	23.2±0.549	32.5±0.577
HD2851	14.28±0.19	8.51±0.43	10.42±0.18	5.76±0.59	0.210±0.001	0.133±0.007	69.20±1.70	65.50±0.80	2.58±0.03	1.95±0.20	22.2±1.229	31.6±0.145
HD2967	10.42±0.62	6.20±0.21	8.32±0.06	3.48±0.29	0.133±0.003	0.093±0.003	73.15±1.05	61.25±0.45	2.22±0.18	1.26±0.16	22.4±0.437	32.8±0.769
HD3059	17.28±0.50	13.01±0.61	9.83±0.24	7.33±0.31	0.260±0.006	0.177±0.012	70.35±2.35	63.15±1.05	2.96±0.21	2.21±0.22	22.7±0.755	30.5±0.736
HD3086	13.83±0.22	8.30±0.29	8.19±0.06	5.56±0.16	0.203±0.003	0.133±0.007	68.00±0.10	63.85±0.85	2.57±0.46	1.76±0.03	22.7±0.764	31.8±0.636
K0307	12.80±0.23	2.98±1.37	5.22±0.61	3.34±0.17	0.157±0.003	0.083±0.009	78.05±1.95	67.05±0.65	2.46±0.28	1.17±0.04	23.6±0.416	33.3±0.907
PBW373	14.68±0.25	9.86±0.16	8.73±0.02	7.58±0.57	0.227±0.007	0.147±0.009	72.85±6.05	64.25±1.65	2.97±0.16	1.98±0.33	22.3±0.379	30.2±0.321
PBW550	18.57±0.49	10.53±0.22	9.96±0.30	6.98±0.59	0.273±0.009	0.163±0.009	66.35±1.05	61.95±1.15	2.92±0.05	2.16±0.56	21.1±0.702	30.8±0.451
Raj3765	15.46±0.09	10.13±0.20	9.18±0.03	6.24±0.34	0.233±0.003	0.160±0.012	68.10±0.00	62.20±0.40	2.84±0.12	2.15±0.04	22.5±0.260	30.9±0.821
WH1021	15.95±0.23	14.24±0.49	9.26±0.04	6.00±0.34	0.247±0.003	0.200±0.015	76.35±8.15	49.55±13.35	2.90±0.62	2.18±0.38	22.3±0.379	31.3±0.318
WH1080	9.81±0.54	6.20±0.34	7.43±0.37	4.75±0.35	0.177±0.012	0.120±0.006	80.05±0.75	35.75±0.25	2.37±0.08	1.69±0.01	22.9±0.706	32.4±0.185
WH1105	12.99±0.23	7.65±0.07	8.06±0.05	5.32±0.55	0.105±0.006	0.120±0.006	67.00±0.50	65.15±0.25	2.40±0.15	1.47±0.21	22.8±0.829	32.3±0.606
WH1124	16.80±0.72	10.80±0.31	9.55±0.23	7.04±0.65	0.250±0.006	0.173±0.015	67.65±0.45	64.25±0.55	2.76±0.10	2.19±0.05	22.6±0.590	30.7±0.551
WH1142	13.39±0.09	8.10±0.36	8.10±0.05	5.46±0.53	0.193±0.009	0.130±0.006	68.00±0.30	64.45±0.85	2.19±0.06	1.76±0.18	22.8±0.757	32.1±0.611
WH711	11.53±0.26	6.59±0.11	9.26±0.04	4.28±0.52	0.183±0.009	0.097±0.003	66.05±0.45	63.10±1.40	2.27±0.09	1.30±0.01	23.3±0.348	32.7±0.546
WH730	15.29±0.08	11.73±0.47	9.00±0.03	6.02±0.18	0.233±0.003	0.147±0.009	67.55±0.65	64.30±0.60	2.78±0.30	2.03±0.18	22.6±0.586	31.0±0.153
Mean	13.99	8.83	8.50	5.53	0.204	0.136	70.47	61.61	2.59	1.84	22.8	31.7
Range	9.81 - 18.57	2.98 - 14.24	5.22 - 10.67	3.34 - 7.58	0.105 - 0.273	0.083 - 0.200	66.05-80.05	35.57- 67.05	2.19- 2.97	1.17- 2.25	22.1 - 23.6	30.2 - 33.3
CD(5%)	0.98	1.01	0.66	1.12	0.017	0.022			N/A	0.70	NS	1.6

Table 2: Per cent decrease in various physiological traits in wheat genotypes from anthesis to 14DAA under late sown condition

Sr.no	Genotype	Photosynthetic rate	Transpiration rate	Stomatal conductance	water use efficiency	Chlorophyll content
1	DBW 621	42.9	32.0	34.4	12.6	4.7
2	DBW 88	40.7	36.0	31.2	14.2	27.5
3	DBW 90	34.5	40.3	30.0	13.4	21.7
4	HD 2285	36.8	32.9	34.3	5.8	27.3
5	HD 2733	43.0	33.9	32.3	4.1	40.5
6	HD 2851	40.4	44.7	36.7	5.3	24.4
7	HD 2967	40.5	58.2	30.1	16.3	43.2
8	HD 3059	24.7	25.4	31.9	10.2	25.3
9	HD 3086	40.0	32.1	34.5	6.1	31.5
10	K 0307	76.7	36.0	47.1	14.1	52.4
11	PBW 373	32.8	13.2	35.2	11.8	33.3
12	PBW 550	43.3	29.9	40.3	6.6	26.0
13	Raj 3765	34.5	32.0	31.3	8.7	24.3
14	WH 1021	10.4	35.2	19.0	35.1	24.8
15	WH 1080	36.8	36.1	42.4	55.3	28.7
16	WH 1105	41.1	34.0	33.3	2.8	38.8
17	WH 1124	35.7	26.3	30.8	5.0	20.7
18	WH 1142	39.5	32.6	32.6	5.2	19.6
19	WH 711	42.8	53.8	47.0	4.5	42.7
20	WH 730	23.3	33.1	36.9	4.8	27.0
	Range	76.6-10.4	58.2-13.2	47.1-19.0	55.3-2.8	52.4-4.7

maximum transpiration rate was found in heat tolerant genotypes DBW 90 (10.67) and PBW 373 (7.58) at anthesis and 14DAA whereas minimum transpiration rate (5.22 and3.34) was observed in K 0307 (heat sensitive genotype) at anthesis and 14 DAA. Stomatal conductance declined from anthesis to 14DAA. Among wheat genotypes, heat tolerant genotype PBW 550 (0.273) showed maximum gs at anthesis whereas maximum gs was found in WH 1021 (0.200) after 14DAA. WH 1105(0.105) showed minimum gs at anthesis. At 14 DAA minimum was shown by K 0307(0.083). WUE was found maximum in WH 1080 (80.05) at anthesis and genotype PBW 373 (72.85) showed maximum WUE 14 DAA whereas minimum was found in WH 711(30.75) and WH 1080 (35.75) at anthesis and 14DAA. Maximum chlorophyll content was found in heat tolerant genotypes PBW 373 (2.97) and DBW 621 (2.25) showed maximum chlorophyll content at anthesis and 14DAA whereas WH 1142 (2.19) and K 0307(1.17) showed minimum chlorophyll content at anthesis and 14DAA. CT increased with succeeding stage of grain filling. Among the twenty wheat genotypes, minimum CT was found in heat tolerant genotypes DBW 90 (22.1°C) at anthesis and PBW 373 (30.2°C) at 14 DAA. Maximum CT was observed in K 0307 (heat sensitive genotype) at both the stages. Percentage decrease in various physiological parameters after 14DAA was calculated (Table 2). WH 1021 (10.4 %) and PBW 373 (13.2 %) showed minimum decrease in A and E respectively whereas K 0307 (76.7 %) and HD 2967 (58.2%) showed maximum decrease for A and E respectively. K 0307 (47.1 %) and WH 1080 (55.3 %) showed maximum decrease for gs and WUE whereas WH 1021 (19.0 %) and WH 1105 (2.8%) showed minimum decrease for the same. Minimum and maximum increase for CT was found in DBW 621(4.7%) and K 0307 (52.4 %) respectively.

Transpiration rate had a negative correlation with CT and highly positive relationship with all other parameter whereas CT showed negative correlation with all parameter studied. Chlorophyll content had a positive relationship with grain yield biomass, thousand grain weight (TGW),

Table 3: Correlations coefficients between yield and physiological traits in wheat genotypes under late sown condition

	Transpiration rate	Canopy temperature	Water use efficiency	Photosynthetic rate	Chlorophyll	Grain content	Biomass	TGW yield	Harvest Index	Grain weight per spike
Canopy temperature	-0.971**									
Water use efficiency	0.080^{NS}	-0.085^{NS}								
Photosynthetic rate	0.825**	-0.852**	-0.063^{NS}							
Chlorophyll content	0.770**	-0.811**	-0.058^{NS}	0.780**						
Grain yield	0.796**	-0.797**	-0.179^{NS}	0.831**	0.770**					
Biomass	0.801**	-0.800**	-0.177^{NS}	0.829**	0.755**	0.896**				
TGW	0.892**	-0.892**	-0.104^{NS}	0.824**	0.849**	0.897**	0.878**			
Harvest Index	0.413^{NS}	-0.425^{NS}	-0.049^{NS}	0.406^{NS}	0.234^{NS}	0.393^{NS}	0.470*	0.239^{NS}		
Grain weight per spike	0.783**	-0.783**	-0.118^{NS}	0.842**	0.820**	0.858**	0.944**	0.870**	0.305^{NS}	

grain weight per spike and harvest index (HI). Biomass, TGW, weight per spike and HI were strongly corelated with grain yield. Biomass and HI were positively corelated with TWG, grain weight per spike (Table 3). The selection of wheat genotypes with better grain yield and heat tolerance at reproductive stage is the principal aim of wheat production. In this study, late sown condition caused significant changes in A, E, *WUE*, chlorophyll content and CT.

This study concludes that the wheat genotypes WH 1021 and PBW 373 was found to be most tolerant as these are least affected by late sown condition and found to differ in their ability to respond. WH 1021 showed high A and gs after 14DAA and less decrease in A and gs. Another genotype PBW 373 also performed well as it has high E, less CT at 14DAA and anthesis respectively. It also has high chlorophyll content at anthesis and least decrease in transpiration rate at 14DAA. These genotypes can be further used for future breeding program.

REFERENCES

Almeselmani, M. and Deshmukh, P.S. (2012). Effect of high temperature stress on physiological and yield parameters of some wheat genotypes recommended for irrigated and rainfed condition. *J.J.A.S.*, 8: 66-78.

Gupta, M., Chawla, V., Dhanda, S.S., Saharan, R.P. and Munjal, R. (2015). Effect of terminal heat stress on yield and yield components of bread wheat genotypes. *Research on Crops*.,16:42–52.

Munjal R. and Dhanda S. S., (2016). Assessment of drought resistance in Indian wheat cultivars for morpho-physiological traits. Ekin *J. Crop Breed. Genet.,* 2(1):74-81.

Munjal, R. and Rana, R.K. (2003). Evaluation of physiological traits in wheat (*Triticum aestivum* L.) for terminal high temperature tolerance. In: Proceedings of the Tenth International Wheat Genetics Symposium, Classical and Molecular Breeding, Poestum, Italy, 2, 804-805.

Saxena, D.C., Sai Prasad, S.V., Parashar, R. and Rathi, I. (2016). Phenotypic characterization of specific adaptive physiological traits for heat tolerance in wheat. *Indian J Plant Physiol*., 21:318–322.

Singh, H., Kumar, S.N., Ramawat, N. and Harit, R.C. (2017). Response of wheat varieties to heat stress under elevated temperature environments. *J. Agrometeorol.,* 19:17-22.

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