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Study of Percent contribution of line x tester components for morpho-physiological heat tolerance traits in bread wheat

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ABSTRACT
Wheat (Triticuma estivumEm.Thell), a cereal crop belongs to poaceae family widely consumed in the world. Thirteen genetically diverse heat tolerance wheat varieties viz. HD3091, DBW90, UP2843, WH1124,HPW211,WH1021, CBW12, MASC6272, JOB666, HD2329, WAXWING, HD2891, HD2961, and three testers HD2967, WH1105, HD3059 were crossed in line x tester mating design excluding reciprocals and evaluated. To estimate the level of heat tolerance for different genotypes with respect to morpho-physiological characters like days to 75% heading, days to maturity, plant height, spike length, peduncle length, awn length, flag leaf area, number of tillers per plant, number of spikelets per spike, 1000-grain weight, biological yield, grain yield per plant, harvest index, number of grains/ spike, grain weight/spike along with grain filling duration ,canopy temperature depression (CTD), relative Injury (%) ,chlorophyll content and heat susceptibility index (HSI) were recorded. The present study revealed that the percent contribution of lines was maximum for plant height (63.68%) and 75 % heading (62.57 %) in timely sown (E1) and late sown condition (E2) respectively. The line × tester interaction contributed higher for canopy temperature depression at anthesis (80.13 %) and biological yield per plant (81.89%) in timely sown (E1) and late sown condition (E2) respectively. The female parents contributed more than the male parents for different traits. The greatest contribution to the expression of most of the heat tolerance traits along with yield traits was found in the line ×tester interaction than due to lines or testers alone.
Keywords: *Percent contribution, line x tester, morpho-physiological traits, heat tolerance, wheat*

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INTRODUCTION

Wheat (*Triticum aesti*vum Em.Thell), a cereal crop is the most widely consumed worldwide belongs to poaceae family. Globally, demand for wheat by the year 2020 is forecast at around 950 million tonnes per year **[3]**. India has made tremendous progress in the production of food grains, especially wheat, and during 2002–03 the production was around 70 million tones still maintaining the second position in the world. It occupied around 29.8 million hectare area that produced 92.5 million tons of wheat during the year 2013 - 2014 (USDA Foreign Agricultural service, Grain Report 2014) which exhibited that in last 10 years 22.5 million tons production has been increased. At the same time biotic and abiotic stresses became more pronounced. Among abiotic stresses terminal heat adversely affects grain filling duration **[4]**that drastically reduces the production and productivity. Hence, heat tolerant varieties are urgent need to feed the ever increasing population of India and world. The existing yield gap in different parts of the country can be reduced to achieve the projected demand through diversification of wheat hybridization programs by using parental lines whose percent contribution for heat tolerance and yield contributing traits must be higher, therefore, a set of newclimate resilience varieties will develop to grow over a wide range of agro-climatic region in India. The main aim of the present investigation was to find out: to demonstrate a strong crossbreeding advantage of hybrid wheat by estimating the percent contribution of parents and their interaction for studied traits.

MATERIALS AND METHODS

The present investigation was carried out at Norman E. Borlaug, Crop Research Centre of Govind Ballabh Pant University of Agriculture and Technology, Pantnagar. India. The material was developed through line x tester mating during *Rabi* 2013-14.In *rabi* 2013-14, Thirteen genetically diverse heat tolerance wheat varieties viz. HD3091, DBW90, UP2843, WH1124,HPW211,WH1021, CBW12, MASC6272, JOB666, HD2329, WAXWING, HD2891, HD2961, and three testers HD2967, WH1105, HD3059 were crossed in line x tester mating design excluding reciprocals. During *rabi* 2014-15, complete set of 57 entries comprised of 39 F_1s, 13 lines and 3 testers along with 2 standard checks (DPW 621-50, UP 2338) were evaluated in the Randomized Block Design (RBD) with three replications under two different environment i.e. timely (E1) and late sown (E2). Each plot consisted of 2 rows of 1 m length with a row to row and plant to plant distance of 20 cm and 10 cm, respectively. To estimate the level of heat tolerance for different genotypes with respect to morphological characters like days to 75% heading, days to maturity, plant height, spike length, peduncle length, awn length, flag leaf area, number of tillers per plant, number of spikelets per spike, 1000-grain weight, biological yield, grain yield per plant, harvest index, number of grains/ spike, grain weight/spike along with grain filling duration (duration between the anthesis stage and the physiological maturity). However, Physiological attributes i.e. canopy temperature depression (CTD), relative Injury (%) ,chlorophyll content and heat susceptibility index (HSI) paying to heat tolerance for various genotypes of bread wheat. Canopy temperature depression (CTD) (with hand held infrared thermometer, model AG-42, Tele temp crop, Fullerton CA) was used for instantaneous measurement of canopy minus air temperature as canopy temperature depression at anthesis and 15 days after anthesis at an angle of 30^o with 50 cm above the canopy from horizontal and at one meter distance from the edge of the plot end. Data were recorded between 12:00 hrs.to 14:00 hrs. The relative injury (%) was estimated using the procedure of Blum and Ebercon(1981).

Whereas, chlorophyll content was recorded in the flag leaves, using a self-calibrating SPAD chlorophyll meter (Minolta) and data were recorded at anthesis and 15 days after anthesis and heat susceptibility index (HSI) for yield which was calculated using the formula as described by Fischer and Maurer (1978). The contribution due to parents and F_1s was calculated as percent of sum of square due to hybrids and following formulae was used in both the environments i.e. timely sown condition(E1) and late sown condition(E2) along with pooled conditions.

$$\text{Contribution of lines} = \frac{SS(L) \times 100}{SS(\text{Crosses})}$$

$$\text{Contribution of testers} = \frac{SS(T) \times 100}{SS(\text{Crosses})}$$

$$\text{Contribution of lines and testers } (1 \times t) = \frac{SS(1 \times t) \times 100}{SS(\text{Crosses})}$$

Where,SS(L)= Sum of square due tolines,SS(T) = Sum of square due totesters,SS(l ×t) = Sum of square due to lines × tester

RESULTS AND DISCUSSION

The perusal of the results of analysis of variance reflected that genotypic differences were significant for all the morpho-physiological traits investigated, indicating that lines used in the study possessed good amount of genetic variability for different heat tolerance traits. The present study revealed that the percent contribution of lines was maximum for plant height (63.68%) followed by harvest index(62.62%) and chlorophyll content at anthesis (59.28%) the minimum contribution was observed for canopy temperature depression at anthesis (15.48 %) followed by tillers per plant(27.84%)in timely sown condition.In late sown condition , the highest percent contribution of lines was recorded for 75 % heading (62.57 %) followed by peduncle length (58.58 %) and awn length (58.50 %) and the lowest value was exhibited by biological yield per plant (15.52 %) followed by harvest index (20.38%). However, the maximum contribution of lines exhibited by chlorophyll content at 15 days after anthesis (25.71%) followed by flag leaf area (25.16%) and minimum contribution of lines reflected by tillers per plant (0.40%) followed by spikelets per spike (0.68%) in pooled condition.

The line× tester interaction contributed higher for Canopy temperature depression at anthesis (80.13 %) followed by heat susceptibility index (68.11%) and lowest value (28.15 %) for peduncle length followed by chlorophyll content at anthesis (29.96 %) in timely sown condition (E1). Whereas, in late sown condition (E2), the maximum contribution of line × tester by biological yield per plant (81.89%) followed by canopy temperature depression at 15 days after anthesis (76.03%), while lower contribution was observed by peduncle length (18.73 %) followed by 75% days to heading(29.70%).However, in pooled condition the contribution of line × tester interaction was showed maximum by tillers per plant (71.66%) followed by biological yield per plant(70.23%) and minimum contribution was observed by peduncle length (23.44%) followed by 75% days to heading(32.97%). In the hybridization program the genomic contribution for the expression of a trait is most important. The present findings are in close confirmation with the work of earlier worker**[6,5]**. None of the trait was found where the male parent i.e. Tester contributed maximum. The greatest contribution to the expression of most of the heat tolerance traits along with yield traits was found in the line ×tester interaction than due to lines or testers alone.

Conclusion

The present investigation suggest that the selection of parents with high percent contribution for high heat tolerance traits and yield enhancing traits for development of potential wheat hybrids by involving such parents in the hybridization program.

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Table1: Percent contribution of different component of hybrid sum of square

Character	Environment (E1)			Environment (E2)			Pooled		
	Due to lines	Due to testers	Due to line×tester	Due to lines	Due to testers	Due to line×tester	Due to lines	Due to testers	Due to line×tester
Days to 75% heading	48.60	15.15	36.24	62.57	7.72	29.70	14.02	26.11	32.97
Days to maturity	51.97	2.36	45.65	57.30	2.66	40.02	3.39	34.64	42.84
plant height (cm)	63.68	1.16	35.14	48.62	7.65	43.72	4.94	35.22	39.43
Spike length (cm)	38.64	0.89	60.45	37.18	7.37	55.43	4.84	45.63	57.94
Peduncle length (cm)	54.53	17.41	28.15	58.58	22.67	18.73	22.44	18.86	23.44
Awn length (cm)	47.48	3.88	48.62	58.50	4.86	36.62	5.55	34.95	42.62
Tillers/ plant	27.84	0.39	71.75	22.94	5.49	71.56	0.40	74.82	71.66
Spikelets/ spike	38.87	0.75	60.36	26.63	17.57	55.78	0.68	59.84	58.07
Flag leaf area cm^2	38.86	18.89	42.24	24.51	17.60	57.88	25.16	46.58	50.06
1000 grain weight	37.48	6.95	55.56	57.45	2.52	40.01	3.60	40.95	47.79
Grain weight/ spike	55.24	5.84	38.90	37.18	2.46	60.34	5.89	47.47	49.62
Grain yield/ plant	39.55	5.73	54.71	23.57	0.82	75.60	6.94	55.07	65.16
Biological yield/ plant	39.51	1.92	58.56	15.52	2.58	81.89	2.65	62.34	70.23
Harvest index	62.62	2.23	35.14	20.38	10.61	69.00	12.58	58.75	52.07
Grains/ spike	33.25	2.93	63.81	26.65	17.54	55.80	15.99	57.78	59.81
Relative injury (%)	38.22	4.41	57.36	36.68	6.09	57.22	5.25	57.31	57.29
Chlorophyll content at anthesis	59.28	10.75	29.96	42.48	6.46	51.04	8.98	29.54	40.50
Chlorophyll content At	30.69	16.69	52.61	43.85	15.29	40.85	25.71	30.48	46.73

15DAA									
CTD at anthesis	15.48	4.38	80.13	42.38	0.54	57.06	3.82	73.55	68.60
CTD at 15 DAA	29.48	10.66	59.85	22.17	1.78	76.03	5.39	73.09	67.94
Grain filling duration	49.88	11.55	38.55	58.33	2.84	38.82	13.70	37.28	38.69
Heat susceptibility index	28.04	3.83	68.11						

DAA = Days after anthesis, CTD = Canopy temperature depression

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