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HETEROSIS FOR HEAT TOLERANCE, PROTEIN CONTENT, YIELD AND YIELD COMPONENTS IN BREAD WHEAT (*TRITICUM AESTIVUM* L.)

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ABSTRACT

Morpho-physiologically diverse seven varieties of wheat *Triticum aestivum* L. em. Thell) were grown alongwith their hybrid combinations in a randomised block design with the three replications. Significant heterosis over better parent was observed for grain yield, heat injury, chlorophyll content and stomatal frequency. There was significant positive heterosis for protein content, however such crosses having high protein content were relatively low grain yielders. The cross Hindi 62 × Ajantha exhibited significant heterosis over mid and better parent (Hindi 62) for heat injury and grain yield per plant.

Key words : *Triticum aestivum*, heat tolerance, heterosis.

The studies on heterosis in wheat for grain yield and its components [1] revealed that hybrids involving parents with dispersed allelic state had high grain weight as well as positive heterosis. Atale and Vikkare [2] reported substantial heterosis over better parent for grain yield in wheat where majority of crosses exhibited less than 80 percent standard heterosis except crosses NI 5439 × UP 215 and Sonalika × Mukta. However, heterosis for physiological characters like chlorophyll content, stomatal frequency and heat tolerance has not been reported so far in wheat crop, this paper deals with extent of heterosis for heat tolerance, protein content and yield and yield contributing characters in bread wheat.

MATERIALS AND METHODS

A set of 7 × 7 diallel (excluding reciprocals) crosses was achieved in bread wheat using 7 varieties, *viz.* Hindi 62, C 306, HD 2189, Ajantha, Kalyansona, NI 5439 and CC 464. Out of seven genotypes, first four were heat tolerant and remaining three were susceptible. The 21 F_1s along with their parents were sown in randomized block design with three replications with 30 cm row spacing. The material was sown by dibbling single seed per hill, followed by gap filling after 10 days. The usual

cultural operations for peninsular zone were followed. The data for different characters were collected on individual plant basis and subjected to statistical analysis. The stomatal frequency was computed with evaluation of number of stomata per square centimeter [3], whereas heat injury was calculated with the use of cellular membrane thermostability test [4]. Estimation of chlorophyll content was carried out using spectronic 20 apparatus. Heterosis over better parent (BP) was determined and its significance was tested by 't' test.

RESULTS AND DISCUSSION

DEVELOPMENTAL CHARACTERS

Moderate negative (desirable) heterosis over best parent was observed in crosses Hindi 62 × Ajantha (–1.1%), Hindi 62 × Kalyansona (–16.91) and Hindi 62 × CC 464 (–14.9%) for plant height. In *per se* performance the tall plants, *viz.*, Hindi 62, C 306 and Ajantha exhibited less heat injury (Table 1). Hoogendoor and Gale [5] reported that the shortest genotypes (Rht_1 + Rht_2 or Rht_3) of wheat were more sensitive to heat than tall genotypes (rht) and semidwarf genotypes (Rht_1 to Rht_2). The highest positive and significant heterobeltiosis for number of tillers was observed in crosses Hindi 62 × C 306 (58.1%) and Hindi 62 × NI 5439 (47.6%). The hybrid combination Ajantha × Kalyansona was the earliest in flowering (56 days) and maturity (101.7 days) among all crosses and parents except parent Ajantha (Table 2). Thus it may be possible to transfer genes for earliness alongwith yield components from this genetic material.

GRAIN AND PANICLE CHARACTERS

The highly significant and positive heterosis over best parent for panicle length was observed in C 306 × Kalyansona (8.5%), Hindi 62 × Ajantha (7.6%) and C 306 × NI 5439 (7.2%) while for number of grains per spike in Ajantha × CC 464 (37.4%) and Hindi 62 × Ajantha (20.2%). In the subsequent generations, derivatives with high number of grain per spike are possible.

For thousand grain weight significant heterosis was observed in hybrid combination Kalyansona × CC 464 (10.9%) (Table 2). It is interesting to note that for grain yield per plant, significant positive BP heterosis was observed in three hybrid combinations' the highest in C 306 × Kalyansona (28.6 per plant). It indicated that only these crosses have potential for further improvement in grain yield through panicle length, grains per spike, and grain yield per plant. Atale and Vitkare [3] reported standard/economic heterosis in bread wheat which was not very high in magnitude. Gupta *et. al.* [7] found highest heterosis of 32.2, 12.1, 22.3, 66.6, 52.9, 189.8 and 5.0% respectively for protein, tryptophan, seed weight, coleptile length, radical length, root spread and grain yield.

Table 1. Mean performance of hybrids for developmental, physiological, yield and quality characters in bread wheat

Cross \ Character	Plant height (cm)	Tillers/ plant	Days to flowering	Days to maturity	Spike length	Spikelets/ spike	Grains/ spike	1000 grain weight (g)	Grain yield/plant(g)
Hindi 62	94.4	24.6	74.5	138.7	9.00	19.3	48.6	30.0	22.3
Hindi 62 × C 306	88.3	39.0	73.0	146.9	10.5	18.9	54.8	32.5	13.2
Hindi 62 × HD 2189	85.0	25.0	71.1	125.9	10.3	20.3	54.6	36.8	20.5
Hindi 62 × Ajantha	89.3	28.3	61.5	118.3	11.0	19.0	58.5	35.1	28.6
Hindi 62 × Kalyansona	81.6	35.0	62.1	116.1	10.6	20.1	62.9	34.2	16.0
Hindi 62 × NI 5439	90.7	51.6	69.0	127.2	10.1	18.6	46.3	31.1	13.4
Hindi 62 × CC 464	83.6	33.6	58.7	120.3	10.7	19.4	50.4	33.5	24.0
C 306	98.3	18.3	72.1	129.7	7.5	20.3	54.3	38.0	19.3
C 306 × HD 2189	92.9	28.3	66.4	125.6	9.7	18.1	59.1	39.3	25.3
C 306 × Ajantha	70.4	21.6	56.4	105.3	10.0	17.2	49.2	40.2	17.3
C 306 × Kalyansona	85.8	18.6	63.5	135.2	11.1	19.0	57.6	34.4	20.0
C 306 × NI 5439	95.1	32.3	72.1	133.5	9.4	19.4	57.6	36.4	16.7
C 306 × CC 464	89.0	22.0	70.4	125.1	10.2	20.3	56.5	39.6	22.6
HD 1289	87.0	24.6	62.6	123.2	10.1	18.0	54.3	40.9	15.8
HD 1289 × Ajantha	74.5	22.0	62.9	119.7	9.4	17.0	43.6	42.4	21.0
HD 2189 × Kalyansona	77.9	20.0	62.1	128.4	9.5	17.9	53.2	39.5	16.3
HD 2189 × NI 5439	77.7	22.6	63.7	126.6	8.6	16.3	43.5	36.7	12.7
HD 2189 × 464	74.6	24.3	66.8	118.9	9.0	18.3	57.3	39.8	19.3
Ajantha	82.3	24.3	66.8	94.3	9.0	17.3	41.6	39.8	19.3
Ajantha × Kalyansona	85.5	24.3	56.0	101.7	9.5	17.3	59.1	40.2	18.9
Ajantha × NI 5439	87.4	26.3	64.4	117.3	11.0	18.2	55.9	33.3	18.9
Ajantha × CC 464	76.1	25.6	59.4	108.2	10.3	18.5	59.1	37.5	17.4
Kalyansona	73.0	23.0	60.0	124.8	10.2	18.3	62.6	32.8	15.8
Kalyansona × NI 5439	66.6	18.3	63.6	128.3	8.1	17.0	64.5	32.9	16.1
Kalyansona × CC 464	69.3	22.6	57.4	119.6	7.5	19.0	63.3	36.5	17.0
NI 5439	73.5	35.0	65.9	128.4	8.1	18.3	53.0	34.7	10.1
NI 5439 × CC 464	76.4	22.6	60.9	118.1	8.3	18.3	46.5	36.4	19.1
CC 464	60.6	25.0	61.3	114.3	8.2	17.0	43.0	31.9	18.6
CD at 5%	5.4	6.7	4.0	5.5	0.7	1.5	8.4	2.6	4.0

Table 1. Contd.

Character / Cross	Chlorophyll content (mg/g)	Stomatal frequency	Heat injury (%)	Grain protein content (%)	Pelshenke value (min.)	Sedimentation value (ml.)
Hindi 62	2.8	47.3	25.3	14.0	127.3	25.6
Hindi 62 × C 306	2.5	51.0	23.0	13.4	132.0	23.8
Hindi 62 × HD 2189	2.6	46.6	31.3	13.6	100.7	27.5
Hindi 62 × Ajantha	2.7	57.0	14.6	12.7	115.9	30.8
Hindi 62 × Kalyansona	1.8	43.0	50.6	12.8	115.3	37.0
Hindi 62 × NI 5439	2.6	51.6	50.0	15.3	98.0	44.4
Hindi 62 × CC 464	2.6	47.3	57.0	12.9	116.0	36.3
C 306	2.8	47.3	27.3	12.0	120.0	26.3
C 306 × HD 2189	2.3	55.3	41.3	12.7	115.3	27.1
C 306 × Ajantha	3.3	47.6	49.66	13.6	129.2	39.0
C 306 × Kalyansona	2.0	47.6	49.66	12.8	118.9	40.7
C 306 × NI 5439	2.0	55.0	58.0	13.7	117.3	39.2
C 306 × CC 464	3.4	46.3	60.6	13.2	118.2	33.2
HD 2189	3.1	62.0	38.6	13.4	81.9	23.9
HD 2189 × Ajantha	1.8	54.0	47.3	13.7	90.9	34.2
HD 2189 × Kalyansona	2.5	50.6	54.6	12.3	118.4	35.6
HD 2189 × NI 5439	3.3	62.6	49.6	14.7	122.7	44.9
HD 2189 × CC 464	2.7	61.6	62.0	12.8	118.8	38.1
Ajantha	1.8	40.0	25.6	13.3	109.8	25.3
Ajantha × Kalyansona	1.7	49.3	45.6	12.5	118.2	39.7
Ajantha × NI 5439	2.9	53.3	43.3	12.8	108.2	404
Ajantha × CC 464	1.7	74.6	55.0	12.9	112.7	40.6
Kalyansona	2.9	43.3	60.0	11.7	106.0	31.1
Kalyansona × NI 5439	1.8	59.3	58.0	12.3	96.0	33.3
Kalyansona × CC 464	4.8	62.6	12.7	12.7	115.5	40.1
NI 5439	3.2	45.0	59.6	13.7	86.1	40.6
NI 5439 × CC 464	4.1	53.0	74.0	14.0	113.7	40.3
CC 464	4.8	44.6	75.3	12.5	105.4	35.9
CD at 5%	0.10	2.6	4.6	1.2	10.7	4.5

Table 2. Heterosis over better parent (BP) and mid parent (MP) for developmental and yield traits, yield components, heat tolerance and quality parameters in bread wheat

Character / Cross	Plant height		Tillers/plant		Days to flowering		Days to maturity		Spike length	
	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP
Hindi 62 × C 306	2.2	10.1*	81.4*	58.1*	-0.4	-2.0	9.3*	5.7*	27.4*	17.0*
Hindi 62 × HD 2189	8.6*	3.6	1.3	1.3	3.6	-4.6	-3.8*	-9.1*	8.1*	2.2
Hindi 62 × Ajantha	13.9*	8.5*	20.5	14.8	-2.1	-17.1*	1.5	-14.6*	14.7*	7.5*
Hindi 62 × Kalyansona	10.7*	9.6*	46.8*	41.8*	-7.6	-16.6*	-11.8*	-16.2*	10.0	3.2
Hindi 62 × NI 5439	22.6*	21.8*	73.1*	47.6*	-1.7	-7.4*	-4.7*	-8.2*	17.6*	12.3*
Hindi 62 × CC 464	23.8*	12.3*	35.5*	34.6*	-13.5*	-21.2*	-4.8*	-13.2*	74.6*	19.1*
C 306 × HD 2189	3.1	-5.4*	22.4	6.7	-1.3	-7.8	-0.6	-3.1	10.3*	-3.6
C 306 × Ajantha	-22.0*	-28.4*	6.5	-2.9	-8.8*	-21.7	-5.9*	-18.7*	12.9*	-2.1
C 306 × Kalyansona	0.26	-12.6*	-9.6	18.8	-3.8	-11.9*	6.2*	4.2*	25.4*	8.7*
C 306 × NI 5439	10.6*	-3.2	21.2*	-7.6	4.5	0.0	3.4	2.9	19.8*	15.0*
C 306 × CC 464	12.0*	-9.4*	15	-12.0	5.2	-2.6	2.5	-3.5	30.6*	25.3*
HD 2189 × Ajantha	-9.2*	-9.4*	-6.3*	-10.8	10.2*	0.5	10.0*	-2.8	-7.5*	-8.3*
HD 2189 × Kalyansona	-5.8*	-10.9*	-16.0	-18.9	1.3	-0.8	3.5	2.8	-6.2*	-6.9*
HD 2189 × NI 5439	0.0	-5.1	-24.0*	-35.2*	-0.8	-3.3	3.2	1.1	-5.3	-14.3*
HD 2189 × CC 464	4.6	-9.0*	-2.0	-2.6	7.8*	6.6*	0.1	-3.4	-1.6	-10.3*
Ajantha × Kalyansona	10.1*	3.8	7.3	5.8	0.3	-6.6	-7.1*	-18.4*	-7.4*	-7.5*
Ajantha NI 5439	12.2*	6.2*	-8.1	-24.7*	9.6*	-2.1	5.3*	-8.6	19.3*	7.1*
Ajantha × CC 464	6.4*	7.5*	8.4	2.6	5.3	-3.0	3.7	-5.3*	11.7*	0.4
Kalyansona × NI 5439	-8.9*	-9.3*	-36.7*	-47.6*	1.0	-3.4	1.3	-0.1	-11.4*	-20.4*
Kalyansona × CC 464	3.7	-5.0	-24.4*	-35.2*	-5.3	-6.3	0.0	-4.1	-18.7*	-26.9*
NI 5439 × CC 464	14.0*	3.9	-24.4*	-35.2*	-4.1	-7.5*	-2.6	-8.0*	1.6	1.5

Table 2. Contd.

Character / Cross	Spikelets/spike		Grains/spike		1000-grain wt.		Grain yield/plant		Chlorophyll content	
	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP
Hindi 62 × C 306	-4.3	-6.7*	6.5	0.9	-4.4	-14.5*	-36.4*	-40.4*	-10.9*	-11.4*
Hindi 62 × HD 2189	7.9*	5.1	6.1	0.6	4.3	-9.5**	7.4	-8.2	-11.9*	-15.5*
Hindi 62 × Ajantha	3.6	-1.7	29.5*	20.2*	3.3	-7.6*	50.8*	28.3*	16.6*	-3.2*
Hindi 62 × Kalyansona	7.2*	4.4	10.1	-4.1	8.9*	4.1	-15.9*	-28.1*	-37.3*	-38.2*
Hindi 62 × NI 5439	0.8	-3.4	-8.8	-12.5	-3.7	-10.3	-17.3	-39.8*	-12.5*	-17.9*
Hindi 62 × CC 464	7.0*	0.5	10.0	3.6	8.1*	4.7	17.0*	7.4	-31.0*	-45.4*
C 306 × HD 2189	-6.3*	-10.9*	8.9	8.9	-0.3	-3.8	44.0*	31.0*	-22.3*	-25.0*
C 306 × Ajantha	-8.6*	-15.4	7.6	-9.3	5.0	5.0	27.6*	15.5	40.8*	16.2*
C 306 × Kalyansona	-1.7	-6.5*	-3.8	-12.1*	-2.8	-9.4*	13.7	3.4	-28.8*	-2.4*
C 306 × 5439	0.5	-4.4	7.4	6.1	-0.0	-4.3	14.8	-12.4	-34.2*	-38.0*
C 306 × CC 464	8.9*	0.0	16.1*	3.9	13.2	4.2	19.3*	17.2	-11.0*	-29.2*
HD 2189 × Ajantha	-4.6	-7.2*	-9.0	-19.6*	7.4*	3.7	33.3*	32.6*	-26.3*	-40.9*
HD 2189 × Kalyanasona	-1.8	-1.8	-11.2*	-18.8*	7.1*	-3.3	3.0	3.0	-16.9	-19.1*
HD 2189 × NI 5439	-10.9*	10.9*	-18.9*	-19.9*	-2.9	-10.2*	-2.3	-19.7	4.6*	2.1
HD 2189 × CC 464	3.7	0.0	7.5	-3.6	9.1*	-2.7	12.0	3.5	-30.6	-43.2*
Ajantha ×Kalyanasona	-2.9	-5.2	10.2	-9.8	13.5*	5.8	20.1*	19.4	-27.5*	-40.5*
Ajantha × NI 5439	2.4	-0.3	18.1*	5.5	-8.3*	-12.2	45.3*	19.8*	13.1*	-10.8*
Ajantha × CC 464	7.7*	6.7	39.6*	37.4*	7.2*	-1.3	1.7	-6.4	-48.2*	-64.1*
Kalyanasona × 5439	-7.2*	-7.2*	8.7	-1.7	-2.6	-5.3	24.1*	1.8	-38.8*	-41.8*
Kalyanasona × CC 464	7.5*	3.6	16.5*	-3.5	12.5*	10.9*	-1.0	-8.5	24.8*	-0.0
NI 5439 × CC 464	3.7	0.0	-3.0	-12.1	9.1*	4.7	32.4*	2.3	1.3	-15.5*

Table 2. Contd.

Cross	Stomatal frequency		Heat injury (%)		Protein content (%)		Pelshenke value		Sedimentation value (ml)	
	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP
Hindi 62 × C 306	7.7*	7.7*	-12.6	-15.8*	3.4	-4.0	6.7*	3.6	-8.2	-9.4
Hindi 62 × HD 2189	-14.6*	-24.7*	-2.0	-18.9*	-1.10	-3.3	-9.0*	-19.2	11.2	7.6
Hindi 62 × Ajantha	19.0*	9.8*	-42.4*	-24.8*	-7.4	-9.5*	-2.2	-8.9*	20.8*	20.2*
Hindi 62 × Kalyansona	-5.1*	-9.1*	18.7*	18.7	0.0	-8.7*	-1.1	-9.4*	30.6*	19.0*
Hindi 62 × NI 5439	11.9*	9.1*	29.4*	-7.8*	10.1*	8.9*	-8.1*	-22.9*	38.5*	15.3*
Hindi 62 × CC 464	2.9	0.0	13.2*	-24.3*	-2.8	-7.9	-0.3	-8.9*	18.1*	1.2
C 306 × HD 2189	1.2	-10.7*	25.2*	6.9	-0.1	-5.4	5.5*	-3.8	7.7	2.9
C 306 × Ajantha	-2.2	-9.8*	58.4*	53.6*	7.1	1.5	12.4*	7.7*	50.8*	48.1*
C 306 × Kalyanasona	5.1*	0.7	13.7*	-17.2*	8.5	6.6	5.2*	-0.9	41.7*	30.8*
C 306 × NI 5439	19.1*	16.2*	33.3*	-2.7	6.9	0.1	13.8*	-2.2	21.0*	1.8
C 306 × CC 464	0.7	-2.1	19.1*	-19.4*	7.6	5.2	4.8*	-1.4	7.1	-7.1
HD 2189 × Ajantha	5.8*	-12.9*	47.1*	22.4*	2.3	2.1	-12.8*	-17.2*	38.9*	35.1*
HD 2189 × Kalyansona	-3.8*	-18.2*	10.8*	-8.8*	-1.5	-8.2	15.7*	11.7*	29.3*	14.4*
HD 2189 × NI 5439	17.1*	1.0	1.0	-16.7*	8.2*	6.9	32.8*	24.4*	43.7*	16.5*
HD 2189 × CC 464	15.6*	-0.5	8.7*	-17.7	-1.2	-4.4	16.4*	12.6*	27.3*	6.2
Ajantha × Kalyanasona	18.4*	13.8*	6.6	-23.8*	0.3	-6.4	9.5*	7.6*	40.2*	27.2*
Ajantha × NI 5439	27.8*	20.7*	1.5	-27.3*	-5.2	-6.4	10.3*	-1.5	26.5*	4.9
Ajantha × CC 464	76.3*	-67.1*	8.9*	-28.9*	0.1	-2.9	4.7	2.6	45.7*	24.4*
Kalyansona - NI 5439	34.3*	31.8*	-3.3	-3.3	-2.6	-10.3*	0.0	-9.3*	-4.2	-13.4*
Kalyansona × CC 464	42.4*	40.3*	7.3*	-3.5	5.4	1.3	5.4*	5.2	19.7*	11.8
NI 5439 × CC 464	18.7*	9.6*	9.6*	-1.7	6.5	1.9	18.6*	7.8	8.4	4.7

*Significant at P = 0.5

HEAT TOLERANCE

Heterosis for chlorophyll content, heat injury, and stomatal frequency have been studied for the first time in wheat. The highest mean total chlorophyll content 3.8 mg/g was observed in Kalyansona × CC 464 and NI 5439 × CC 464 (Table 1). Highly significant positive BP heterosis (16.3%) was obtained in the cross C 306 × Kalyansona for chlorophyll content. This indicates that the hybrid vigour in the cross C 306 × Kalyansona was due to the broad leaves of both the parents. Hence, it may lead to segregates containing high chlorophyll content, which ultimately may reflect for more biological yield.

The mean low heat injury *14.6%) has been observed in Hindi 62 × Ajantha (Table 1). Low heat injury is desirable and therefore, negative heterosis is a positive feature for this trait. Highest negative BP heterosis was recorded in the cross Hindi 62 × Ajantha (–42.1%). In the cross where heat tolerant parent Hindi 62 is involved, more chances of recovery of high tolerance derivatives are expected. But these parents are susceptible to black and brown rusts. In this situation there is necessity to adopt gene deployment for rust tolerance from known sources of *Sr* and *Lr* lines.

Significant and positive heterosis over best parent was recorded in cross Hindi 62 × NI 5439 (8.9%) for protein per cent. However, high protein crosses [6] were reported with as high as 33.3% heterosis for protein content. According to Adsule and Lowande [9] the pelshenke value for good chapati making quality should ranged from 100 to 150 minutes. In the present studies positive but non-significant heterosis over BP for pelshenke value was observed in crosses Hindi 62 × C 306 (3.6%) and C 306 × Ajantha (1.5%).

The cross combination Hindi 61 × Ajantha exhibited significant heterosis for grain yield and stomatal frequencies and its parents exhibited significant gca effects for heat injury, number of tillers, grain yield and protein content (Table 3).

Significant and positive heterosis over BP for sedimentation value was recorded in crosses HD 2189 × NI 5439, Ajantha × CC 464 and Hindi 62 × NI 5439. These cross combinations were found suitable for high sedimentation value which had negative correlation with grain weight and positive correlation with heat injury. However, low sedimentation is not desirable for chapati making. Crosses with moderate sedimentation value (30-40 ml) are desirable [8]. The cross Ajantha × CC464 exhibited optimum sedimentation value and high heterosis over best parent. Hence, it is possible to get segregates with desirable sedimentation value, at the same time care should be taken for incorporating rust tolerance.

Table 3. Superior crosses and characters exhibiting significant heterosis and desirable gca.

Best crosses	Grain yield per plant	Heterosis over BP for	Significant gca effects of parents	
			female	male
Hindi 62 × Ajantha	28.6	Heat injury, stomatal frequency and grain yield	Protein content, No. of tillers, grain yield per plant, heat injury	Heat injury, day to flower, test weight
C 306 × HD 2189	25.3	Grain yield	Heat injury, test weight, grain yield per plant	Heat injury, stomatal frequency, test weight
Hindi 62 × CC 464	24.0	Number of tillers	Heat injury, protein content, No.of tillers/grain yield/plant	Chlorophyll contant, stomatal frequency
C 306 × CC 464	22.6	Nil	Heat injury, test weight and grain yield/plant	Chlorophyll content, stomatal frequency, days to flower and
HD 2189 × Ajantha	21.0	Grain yield	Heat injury, stomatal frequency & test weight	Heat injury, days to flower, test weight
Hindi 62 × HD 2189	20.5	—	Heat injury, protein content, No. of tillers and grain yield/plant	Heat injury, stomatal frequency and test weight
C 306 × Kalyansona	20.0	—	Heat injury, test weight and grain yield/plant	Days to flower
HD 2189 × CC 464	19.3	—	Heat injury, stomatal frequency, test weight	Chlorophyll content, stomatal frequency and days to flower
NI 5439 × CC 464	19.1	Stomatal frequency	Chlorophyll content, protein content, No. of tillers/plant	Chlorophyll content, stomatal frequency and days to flower
Ajantha × Kalyanasona	18.9	Stomatal frequency	Heat injury, days to flower and test weight	Days to flower
Ajantha × NI 5439	18.7	Stomatal frequency	Heat injury,days to flower and test weight	Chlorophyll contant, stomatal frequency, protein content and no. of tillers
C 306 × Ajantha	17.3	Chlorophyll content	Heat injury, test weight and grain yield/plant	Heat injury, days to flower and test weight

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