https://doi.org/10.17221/63/2020-CJGPB

Effect of terminal heat stress on physiological traits, grain zinc and iron content in wheat (*Triticum aestivum* L.)

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Electronic Supplementary Material (ESM)

The authors are fully responsible for both the content and the formal aspects of the electronic supplementary material. No editorial adjustments were made.

Table S1. Source of the genotypes used in the present study

Genotypes	Source	Genotypes	Source
BRW 3807	Bihar Agricultural University (BAU), Sabour	BRW3768	BAU, Sabour
BRW3797	BAU, Sabour	BRW967	BAU, Sabour
SW103	BAU, Sabour	BRW3723	BAU, Sabour
SW129	BAU, Sabour	HD2967	Indian Agricultural Research Institute (IARI), New Delhi
SW161	BAU, Sabour	HD2733	IARI, New Delhi
SW160	BAU, Sabour	HI1563	IARI, Indore
SW139	BAU, Sabour	CHIRYA 3	CIMMYT, Mexico
SW108	BAU, Sabour	HUW234	Banaras Hindu University (BHU), Varanasi
BRW3788	BAU, Sabour	DBW14	Indian Institute of Wheat and Barley Research (IIWBR), Karnal
BRW3790	BAU, Sabour	RAJ 3765	Rajasthan Agricultural University (RAU), Durgapura
BRW3794	BAU, Sabour	HD2643	IARI, New Delhi
BRW3762	BAU, Sabour	PBW343	Punjab Agricultural University (PAU), Ludhiana
BRW3759	BAU, Sabour	HUW468	BHU, Varanasi
BRW3800	BAU, Sabour	BAZ	CIMMYT, Mexico
BRW3804	BAU, Sabour	BRW934	BAU, Sabour

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Table S2. Number of rainy days and amount of rainfall during the crop growing period 2016–2017, 2017–2018

Year (2016–2017)	Rainfall (mm)	Year (2017–2018)	Rainfall (mm)
28th Jan, 2017	12.4	26th March, 2018	24.2
11th March, 2017	3.2	2nd April, 20118	6.2
18th March, 2017	0.6		
20th March, 2017	0.7		
25th March, 2017	5.2		

Table S3. Average soil moisture content (%) at different crop growth stage

Crop growth stage	Soil moisture in optimum environment (%)	Soil moisture in heat stress environment (%)
Crown root initiation	23.6	21.8
Grain filling stage	20.9	19.3
Physiological maturity	15.6	14.3

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Table S4. Mean performance of different genotypes under optimum temperature

Genotypes	Days to heading		Days to maturity		Thousand kernel weight		SPAD value		Canopy tem depression		Catalase		Peroxidase	
	2016–17	2017–18	2016–17	2017–18	2016–17	2017–18	2016–17	2017–18	2016–17	2017–18	2016–17	2017–18	2016–17	2017–18
BRW 3807	90.33	83	120.33	116.33	28.8	37.23	59.82	52.64	4.01	5.17	96.67	110.85	199.67	57.88
BRW 3797	89	83.33	115	117.33	29.87	38.32	59.24	55.03	3.85	6.48	67.14	75.03	112.5	59.42
SW 103	87.33	83.67	112.33	118.67	30.16	37.5	58.05	58.3	3.12	4.26	86.11	112.22	199.17	54.42
SW 129	81.33	82.67	113	118.67	33.26	39.9	58.69	57.56	2.59	4.43	65.83	86.54	63.33	47.07
SW 161	67.67	81.33	116.67	120	29.24	36.68	58.68	56.58	2.03	5.02	89.45	123.13	190.67	50
SW 160	81	83.33	109.33	118.33	27.96	39.68	58.56	56.75	4.33	5.8	77.76	102.72	166.67	56.43
SW 139	80.67	81	117	115.33	27.53	38.08	58.56	52.66	5.67	4.97	83.03	103.29	199.67	56.32
SW 108	89	89	117.33	122	31.58	40.11	58.26	56.01	6.26	5.48	90.83	98.83	149.17	68.1
BRW 3788	80.67	80.67	119	114	26.38	35.72	54.48	54.7	3.38	4.53	90.28	117.24	67.33	54.32
BRW 3790	89	82.67	117.67	116	27.77	36.81	57.86	51.03	4.37	4.8	85.56	117.91	130.83	49.17
BRW 3794	66.67	74	118	115	29.63	40.03	58.88	50.08	5.74	4.48	66.17	112.12	40	58.47
BRW 3762	80.33	79.33	115.33	115	31.93	43.81	59.18	54.69	2.78	4.37	94.17	113.42	66.67	63.55
BRW 3759	78	79.67	114	114.33	28.87	40.44	59.84	55.69	3.42	4.12	105	77.61	109.83	64.37
BRW 3800	90	80.33	114.33	114	30.59	34.04	58.02	55.47	2.64	5.25	80.83	96.88	199.17	55.97
BRW 3804	86.33	83.33	114.33	118.33	28.87	37.56	57.05	54.6	4.5	5.78	88.34	91.83	146.5	57
BRW 3768	75	77	116.33	112.33	32.55	43.2	57.6	52.89	2.63	5.1	87.11	89.5	185.17	58.42
BRW 967	66.67	75	107	113	32.11	38.12	58.07	55.63	3.45	4.6	96.66	95.51	46.67	66.37
BRW 3723	90	88.67	121	122.67	31.21	38.4	57.66	48.48	2.47	6.71	80.83	117.41	138.33	48.17
HD 2967	88.67	86.67	116.67	120	28.67	34.74	57.52	53.51	2.86	4.7	75.78	106.78	193.33	54.87
HD 2733	83	81.67	112	118	34.29	41.48	58.87	54.86	4.14	4.58	89.17	104.03	69.17	68.78
HI 1563	70.67	73.67	117.67	115.67	29.85	36.37	58.21	54.28	2.58	4.43	86.39	125.62	197.5	57.38
CHIRYA 3	82	79	116.67	115.33	32.43	38.74	59.23	48.53	1.48	3.67	97.4	99.63	49.17	55.83
HUW 234	68.67	72	120	114.67	30.15	36.34	58.57	56.58	2.15	4.75	83.34	104.01	165.83	69.37
DBW 14	67	71	120.33	118.67	31.15	33.9	58.7	52.95	1.84	5.3	79.17	104.16	168.33	61.87
RAJ 3765	69.33	75	122	115	29.65	34.63	57.06	51.12	2.95	5.71	82.22	114.62	71.67	59.77
HD 2643	82.67	81.33	121.33	118.67	27.19	48.08	58.1	53.89	1.75	4.95	101.1	93.22	131.67	56.08
PBW 343	87.67	83	121.67	118.33	28.76	40.02	59.31	52.92	1.25	6.77	86.11	87.79	149.17	59.32
HUW 468	81.33	82	117.33	117.33	37.22	35.73	58.45	51.53	3.58	6.08	78.32	108.56	159.17	63.08
BAZ	77.33	74.33	116.33	113.33	33.43	38.72	59.81	51.1	2.04	4.69	84.33	105.03	195	73.32
BRW 934	81.33	80.33	107.67	115.67	30.81	43.78	61	50.23	1.43	5.72	88.06	109.78	155	62.53
Mean	80.29	80.27	116.26	116.73	30.4	38.61	58.44	53.68	1.34	4.76	85.44	103.7	137.21	58.92
CD (0.05)	2.71	2.87	5.59	3.98	5.04	4.01	2.38	3.99	0.86	0.8	6.87	3.87	11	3.38
SEM (±)	0.96	1.01	1.97	1.41	1.78	1.42	0.84	1.41	0.6	0.38	2.43	1.37	3.89	1.19

SPAD – soil plant analysis development; CD – critical difference; SEM – standard error of the mean

Original Paper Czech Journal of Genetics and Plant Breeding, 57, 2021 (2) https://doi.org/10.17221/63/2020-CJGPB

Table S5. Mean performance of different genotypes under heat stress

Genotypes	Days to heading		Days to maturity		Thousand kernel weight		SPAD value		Canopy tem. depression		Catalase		Peroxidase	
	2016–17	2017–18	2016–17	2017–18	2016–17	2017–18	2016–17	2017–18	2016–17	2017–18	2016–17	2017–18	2016–17	2017–18
BRW 3807	69.33	67	93.67	94.67	20.81	19.22	56.83	51.67	2.75	4.75	93.89	109.78	350.57	109.46
BRW 3797	67	69	89	98.67	18.39	30.8	57.5	57.23	5.88	7.12	85.56	71.3	198.5	119.56
SW 103	66.33	68.67	90	98	22.68	31.39	58.49	59.06	2.49	6.4	82.22	113.03	335.37	95.26
SW 129	68	68.67	96.67	98	21.9	31.93	59.32	56.33	3.71	7.93	92.5	108.18	155.2	123.96
SW 161	67	70	94.67	99.67	15.28	31.12	58.91	57.24	2.25	6.98	69.6	115.35	491.07	126.95
SW 160	62.67	67.67	87	98.33	22.47	18.25	56.82	56.49	4.23	7	81.94	95.96	364.1	110.82
SW 139	66.67	67	92.67	97.33	18.65	29.27	58.18	48.88	3.78	7.98	79.17	98.12	404.3	124.94
SW 108	64.67	72.67	84.33	99.33	22.55	27.09	56.69	55.02	3.67	4.88	86.5	99.9	249.27	100.28
BRW 3788	67.33	66.67	91.33	97	18.46	30.78	56.26	49.19	4.72	7.23	89.45	114.19	156.97	125.57
BRW 3790	65	66.33	85.67	96.33	23.32	17.58	54.17	52.77	5.54	3.83	82.11	115.29	303.17	108.26
BRW 3794	64.67	62.33	90.33	96.33	16.55	26.84	57.47	51.8	4.53	7.27	88.89	110.33	100.57	95.89
BRW 3762	69.33	67.67	91.67	97	21.09	31.98	57.56	54.46	4.48	5.12	90.11	104.16	140.27	86.34
BRW 3759	68.67	67.33	92	95.33	20.76	30.53	56.31	55.16	2.5	7.03	98.37	74.51	157.07	79.61
BRW 3800	65	66.33	88	88	25.61	20.22	58.23	53.98	5.8	3.87	77.78	87.74	296.23	77.26
BRW 3804	67.33	68.33	90.33	97.67	19.99	29.91	58.7	54.47	3.43	5.27	83.61	96.21	286.27	91.6
BRW 3768	67.33	63.67	94.33	88.33	19.23	23.33	61.33	53.08	3.13	1.3	97.78	81.97	326.47	101.68
BRW 967	69.67	62.67	95.67	90.33	24.99	25.7	58.86	51.05	2.39	2.8	94.45	93.06	122.8	78.44
BRW 3723	67	72.67	89	104.67	17.45	38.48	57.78	50.64	1.53	7.83	79.45	115.95	289.27	88.57
HD 2967	63.33	70.67	89	99.33	27.52	33.79	57.59	56.94	4.49	8.13	99.06	105.01	325.3	96.41
HD 2733	66.67	66.67	92	98	22.36	24.69	56.95	55.05	5.14	6.8	94.45	107.91	108.83	97.1
HI 1563	73	62.33	91.33	92.67	22.53	29.54	55.84	47.93	2.93	2.25	99.27	127.28	408.57	104.57
CHIRYA 3	63.67	67	92	96.33	22.79	27.08	56.57	50.57	3.27	3.43	95.28	116.72	132.97	92.62
HUW 234	68	62.67	94	90.33	18.49	24.88	56.68	54.75	4.84	3.18	77.5	125.81	253.47	93.54
DBW 14	66	62.33	88	94.67	17.71	30.08	55.99	49.55	1.98	6.32	76.56	101.9	312.03	94.56
RAJ 3765	67.33	63.33	91.67	94.33	21.75	25.11	54.57	49.36	3.83	7.05	84.72	117.71	150.47	103.87
HD 2643	65	65.33	88.67	96	17.97	31.52	53.15	55.23	5.73	7.83	97.33	134.16	162.83	63.76
PBW 343	65	68.67	92	96	24.4	28.29	55.15	53.58	4.68	8.38	97.5	109.81	213.7	83.62
HUW 468	66	66.33	90	96	18.89	26.35	54.3	50.38	5.57	6.43	74.56	104.55	236	91.27
BAZ	68	61.67	93.67	89	15.12	26.3	54.83	53.21	1.95	4.43	107.78	107.36	246.57	72.38
BRW 934	66.33	67	89.67	97	19.27	30.66	56.8	50.87	1.75	3.37	85.56	116.81	243.93	87.69
Mean	66.71	66.62	90.94	95.82	20.63	27.76	56.93	53.2	3.78	4.17	87.98	106	250.74	97.53
CD (0.05)	3	2.68	6	3.42	5.07	3.43	3.6	4.06	0.73	0.74	6.39	4.2	11.29	4.1
SEM (±)	1.06	0.95	2.12	1.21	1.79	1.21	1.27	1.43	0.73	0.26	2.26	1.49	3.99	1.45

SPAD – soil plant analysis development; CD – critical difference; SEM – standard error of the mean

https://doi.org/10.17221/63/2020-CJGPB

Table S6. Grain yield (GY, in g) in optimum and heat stress condition and heat susceptibility index (HSI)

Genotypes	GY in 2016–2017			GY in 2017–2018		
	optimum	heat stress	HSI	optimum	heat stress	HSI
BRW 3807	11.47	3.63	0.90	11.16	4.37	0.65
BRW3797	9.67	4.33	0.81	13.76	6.42	0.89
SW103	8.90	3.27	0.65	17.52	7.36	0.91
SW129	7.93	3.13	0.68	12.51	7.56	0.92
SW161	8.27	2.60	0.72	12.20	5.85	0.79
SW160	11.00	3.20	0.86	10.97	6.14	0.76
SW139	11.13	2.93	0.89	12.25	5.27	0.76
SW108	12.33	3.17	0.89	17.05	5.10	0.78
BRW3788	8.37	3.50	0.51	12.02	5.91	0.79
BRW3790	10.40	4.07	0.81	11.69	4.95	0.71
BRW3794	8.50	3.87	0.69	11.43	5.61	0.75
BRW3762	7.73	3.77	0.71	10.42	5.38	0.69
BRW3759	10.53	2.80	0.87	11.70	6.69	0.83
BRW3800	9.93	4.60	0.92	11.25	4.54	0.67
BRW3804	12.17	3.17	1.02	13.30	5.55	0.79
BRW3768	8.40	3.27	0.81	12.59	2.91	0.57
BRW967	10.73	3.13	1.01	11.34	4.19	0.64
BRW3723	9.17	3.00	0.80	14.12	6.45	0.86
HD2967	11.23	3.80	0.88	16.11	7.55	0.90
HD2733	10.13	3.53	0.58	11.32	5.65	0.75
HI1563	8.47	3.27	0.76	12.78	4.46	0.71
CHIRYA 3	11.53	3.60	0.95	11.64	4.72	0.69
HUW234	10.97	3.83	0.93	10.79	4.57	0.65
DBW14	10.70	2.67	0.93	9.75	6.50	0.73
RAJ3765	6.00	3.83	0.67	8.35	5.15	0.59
HD2643	7.00	3.93	0.76	12.36	5.67	0.79
PBW343	8.40	3.07	0.90	13.56	3.67	0.64
HUW468	8.03	3.50	0.81	11.67	5.43	0.75
BAZ	9.70	2.80	0.95	10.64	5.62	0.72
BRW934	9.93	2.10	0.97	13.38	5.62	0.74
$CD_{0.05}$	2.32	1.06		2.06	1.27	
SEM (±)	0.82	0.24		0.73	0.45	

CD – critical difference; SEM – standard error of the mean

https://doi.org/10.17221/63/2020-CJGPB

Table S7. Grain Zn and Fe content (in ppm) as average of 2016–2017 and 2017–2018 in optimum and heat stress conditions

Genotypes	Zn		Fe	
	optimum	heat stress	optimum	heat stress
BRW 3807	26.66	34.16	35.03	36.06
BRW3797	27.43	33.86	36.99	35.85
SW103	28.55	27.28	31.90	31.72
SW129	26.61	32.26	34.77	35.97
SW161	28.84	31.71	34.77	35.37
SW160	29.76	31.45	34.49	33.44
SW139	25.78	30.34*	34.87	34.65
SW108	29.78	28.79	33.30	34.01
BRW3788	28.31	35.20	36.76	36.46
BRW3790	25.68	31.68	34.03	33.39
BRW3794	26.11	30.32	34.11	31.99
BRW3762	26.94	30.02	33.83	33.53
BRW3759	25.46	30.71	32.37	33.93
BRW3800	27.78	30.22	32.60	33.80
BRW3804	26.59	35.50	33.06	33.69
BRW3768	29.43	33.26	35.17	34.52
BRW967	29.0	32.52	34.54	33.93
BRW3723	26.86	31.57	34.12	34.02
HD2967	29.66	31.35	35.02	33.75
HD2733	29.17	31.74	36.41	34.14
HI1563	29.78	31.35	34.25	32.99
CHIRYA 3	27.0	34.15	33.14	33.14
HUW234	29.6	29.40	33.54	33.50
DBW14	28.21	32.19	31.56	33.97
RAJ3765	28.93	29.86	34.54	34.23
HD2643	30.16	32.02	34.59	34.49
PBW343	23.57	31.21	28.74	32.96
HUW468	26.38	30.30*	32.11	32.23
BAZ	23.35	29.20	32.92	34.76**
BRW934	32.21	33.35	35.84	35.44
SD (±)	1.99	1.89	1.68	1.16

*, **indicates significance between optimum and stress condition at 0.05 and 0.01 level; SD – standard deviation