

**Table S1.** Details of spring bread wheat cultivars used for heat treatment in the study (Pedigree information: Plant Breeder Rights Database ([http://pericles.ipaustralia.gov.au/pbr\\_db/](http://pericles.ipaustralia.gov.au/pbr_db/), accessed on 29 March 2022) and Genetic Resources Information System for Wheat and Triticale of CIMMYT (<http://wheatpedigree.net>, accessed on 29 March 2022). Days to anthesis (DTA) and days to auricle distance 1 cm (DTAD) were measured in this study. Information on 'Tolerance and stage of growth' was from previous publications ('References') and abbreviated as follows: heat tolerant (HT) or heat sensitive (HS) at seedling stage (S), anthesis (A) or post-anthesis (PA). Cultivars were chosen to represent a diverse set of wheat cultivars from previous heat stress studies.

Cultivar	Origin	Year of Release	Seed Source <sup>1</sup>	Pedigree	DTAD	DTA	Tolerance and Stage of Growth	References
Young	Australia	2005	AGG	VPM1/3*BEULAH//SILVERSTAR	44	61	HT-PA	Shirdelmoghlanloo et al. [59]
Sunco	Australia	1986	AGG	SUN-9-E-27*4/3-AG-14//WW-15/3/3*COOK	44	60	HT-PA	Shirdelmoghlanloo et al. [59]
Waagan	Australia	2007	AGG	RL6043/4*NACOZARI F 76	54	67	HT-PA	Shirdelmoghlanloo et al. [59]
Millewa	Australia	1979	AGG	CC/8156	40	58	HT-PA	Shirdelmoghlanloo et al. [59]
Kukri	Australia	2000	AGG	DRP((FN-K58xN10B/Gb55)NAI60)/(TOB-CNO'S'xTOB-8156/CALxBb-CNO)/2/MDN/6*RAC177	41	58	HS-PA	Bennett et al. [66]
RAC875	Australia	-	AGG	RAC-655//SR21/4* LANCE/3/4*BAYONET	46	62	HT-PA	Bennett et al. [66]
Suntop	Australia	2011	AGG	SUNCO/2*PASTOR//SUN436E	50	65	HT-PA	Telfer et al. [67] 2018
Mace	Australia	2008	AGG	WYALKATCHEM/STYLET//WYALKATCHEM	56	69	HT-A, PA	Telfer et al. [67]
EGA Gregory	Australia	2004	AGG	PELSART/2*BATAVIA	61	76	HT-A	Telfer et al. [67]
Gladius	Australia	2007	AGG	(DH)RAC-875/ KRICHAUFF//EXCALIBUR/ KUKRI/3/RAC-875/ KRICHAUFF/4/RAC-875// EXCALIBUR/KUKRI	42	61	HT-PA	Telfer et al. [67]
Babax	Australia	1992	AGG	BOBWHITE/NACOZARI-76//VEERY/3/BLUEJAY/COCORAQUE-75	56	71	HT-PA	Pinto et al. [74]
Seri M82	CIMMYT	1982	AGG	KAVKAZ/(SIB)BUHO//KALYANSONA/BLUEBIRD	57	71	HT-PA	Pinto et al. [74]
Chinese Spring	China	1916	AGG	SICHUAN LANDRACE	68	80	HS-S	Qin et al. [75]
Cranbrook	CIMMYT	1984	AGG	WE-M//CNO/NO/3/ZBZ	55	71	HT-S	Mufti [76]
Sundor	Australia	1984	AGG	3-AG-14/4*CONDOR	45	67	HT-S	Mufti [76]
Reeves	Australia	1989	AGG	BODALLIN//GAMENYA/INIA-66	57	72	HS-PA	Maphosa et al. [77]
Drysdale	Australia	2001	AGG	HARTOG*3/QUARRION	44	60	HT-PA	Maphosa et al. [77]
Excalibur	Australia	1990	AGG	RAC-177(Sr26)/UNICULM-492//RAC-311-S[1326]	54	70	HT-PA	Tura et al. [78]
Halberd	Australia	1969	AGG	SCIMITAR/KENYA-C-60 42//BOBIN/3/INSIGNIA-49	63	79	HT-A	Mason et al. [79]
Mitre	Australia	2000	AGG	3AG3/2*CONDOR//COOK/3/COOK*2/MILLEWA//AUS10894/4* CONDOR	51	68	HT-S	Alsamadany [80]
Opata M85	CIMMYT	1985	AGG	BLUEJAY(SIB)/JUPATECO-73	51	66	HT-S	Alsamadany [80]
Perenjori	Australia	1996	AGG	BODALLIN/HYDEN	66	80	HT-S	Alsamadany [80]

W156	India	-	AGG	-		42	60	HT-S	Alsamadany [80]
Tevere	Italy	1955	AGG	RIETI/HATIF-INVERSABLE//ARDITO		54	70	HT-S	Alsamadany [80]
Devil	Australia	2019	IG	IGW3119 (unreleased line)/MACE		53	68	HT-A, PA	Thistlethwaite et al. [81]
Vixen	Australia	2019	IG	MACE/IGW3119 (unreleased line)		45	60	HT-A, PA	Thistlethwaite et al. [81]
Kinsei	Australia	2019	IG	00Y314-5(SR24LR24 DONOR/5*WESTONIA //WAHWT2074/3/SR24LR24 DONOR/5* WESTONIA) / 01RBC2093 (C80.1/3* SR2BATAVIA-DON#7//2*WAHWT2313)		69	85	-	
Hellfire	Australia	2019	AGG	EGA GREGORY AND LRPB SPITFIRE (DH BASED)		46	61	-	
Ninja	Australia	2016	IG	CALINGIRI/WYALKATCHEM		59	74	-	
Rockstar	Australia	2019	IG	-		63	77	-	

<sup>1</sup> AGG-Australian Grain Genebank; IG-InterGrain

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**Table S2.** Cultivar mean values for several yield-related and physiological traits. Percent reduction in traits is the relative value of the mean in the high temperature treatment (“Heat”) and the mean in the control temperature treatment (“Control”), and positive values indicate that the high temperature means are lower the control means.

Cultivar	GN		GY (g)		GW (mg)		PV (%)		BM (g)		Reduction under heat stress (%)	
	Control	Heat	Reduction under heat stress (%)	Control	Heat	Reduction under heat stress (%)	Control	Heat	Reduction under heat stress (%)	Control	Heat	
RAC875	48.67	46.00	5.5	1.20	1.08	10.3	24.75	23.58	4.7	98.00	95.17	2.9
Sunco	45.67	40.67	10.9	0.82	0.89	-8.0	17.98	21.34	-18.7	99.33	97.67	1.7
Millewa	63.00	60.00	4.8	1.13	0.99	12.3	17.92	16.42	8.3	98.83	94.33	4.6
Suntop	52.67	44.67	15.2	1.18	1.30	-10.3	22.63	28.38	-25.4	98.83	94.67	4.2
Mace	59.67	46.67	21.8	1.05	0.81	22.6	17.70	17.47	1.3	98.50	93.67	4.9
Mitre	57.00	50.67	11.1	1.36	1.09	19.8	23.86	22.11	7.3	99.50	97.67	1.8
Perenjori	45.50	43.67	4.0	0.73	0.65	11.3	15.99	14.60	8.7	99.25	97.67	1.6
W156	56.33	43.33	23.1	1.48	1.02	31.1	26.21	23.27	11.2	96.00	93.17	2.9
OpataM-85	62.67	60.33	3.7	1.04	1.05	-0.8	16.70	17.41	-4.3	98.50	95.67	2.9
Tevere	54.33	53.00	2.5	1.50	1.42	5.1	27.78	26.89	3.2	99.33	97.17	2.2
Kukri	53.67	50.67	5.6	1.30	1.10	15.4	23.96	21.88	8.7	97.33	95.33	2.1
Halberd	50.00	48.33	3.3	1.12	1.09	3.1	22.40	22.29	0.5	98.00	95.67	2.4
Babax	67.33	62.67	6.9	1.17	1.12	4.5	17.35	17.74	-2.2	98.17	95.33	2.9
Cranbrook	77.67	68.00	12.4	1.27	1.13	11.0	16.45	16.12	2.0	98.83	96.17	2.7
Sundor	43.67	36.67	16.0	0.78	0.66	14.7	17.82	18.67	-4.8	99.00	96.33	2.7
Drysdale	62.00	56.33	9.1	1.37	1.16	15.3	22.08	20.66	6.4	97.67	94.67	3.1
Chinese Spring	47.00	44.33	5.7	1.05	0.77	26.8	22.29	18.20	18.4	98.83	96.00	2.9
Reeves	53.00	42.67	19.5	0.87	0.83	4.9	16.43	19.45	-18.4	99.50	95.50	4.0
Kinsei	54.00	41.67	22.8	0.62	0.37	39.5	11.57	8.54	26.2	99.50	98.00	1.5
SeriM-82	70.50	69.50	1.4	1.05	0.91	13.0	14.87	13.03	12.4	99.00	96.25	2.8
Rockstar	37.67	29.33	22.1	1.02	0.61	40.1	27.20	21.61	20.5	99.67	97.83	1.8
Ninja	45.50	37.33	17.9	0.86	0.70	18.3	18.84	19.61	-4.1	100.00	98.50	1.5
Devil	48.00	43.33	9.7	1.15	0.85	26.5	24.00	19.88	17.2	99.33	98.33	1.0
Vixen	50.67	45.67	9.9	1.03	1.14	-10.2	20.40	25.35	-24.3	98.00	96.17	1.9
Hellfire	49.00	48.33	1.4	1.15	1.14	0.6	24.02	24.81	-3.3	98.83	96.00	2.9
Waagan	61.00	58.67	3.8	1.26	1.01	20.3	21.09	17.23	18.3	98.83	97.50	1.3
Excalibur	56.00	42.00	25.0	0.91	0.68	25.0	16.14	15.81	2.1	98.17	95.83	2.4
EGA Gregory	58.00	39.67	31.6	0.90	0.77	13.5	15.67	19.33	-23.4	99.83	98.17	1.7
Gladius	54.67	43.33	20.7	1.35	0.98	27.6	25.01	22.63	9.5	98.67	96.17	2.5
ACT Young	54.67	49.33	9.8	1.04	0.83	20.3	19.29	16.74	13.2	98.33	95.67	2.7
Mean	54.65	48.23	11.75	1.09	0.94	14.07	20.28	19.70	2.85	98.72	96.21	2.54
LSD (P=0.05)	10.30	15.33		0.36	0.41		6.92	7.15		1.00	2.33	9.80
												10.13

**Table S2.** (Cont.)

Cultivar	MSL (cm)			SL (cm)			SN			ET (%)			ENT		
	Reduction		Under Heat Stress (%)												
	Control	Heat		Control	Heat		Control	Heat		Control	Heat		Control	Heat	
RAC875	45.67	51.20	-12.1	9.10	8.30	8.8	15.33	16.00	-4.3	82.20	90.30	-9.9	14.0	20.3	-45.2
Sunco	44.30	47.67	-7.6	8.30	8.40	-1.2	15.33	14.67	4.3	94.30	94.00	0.3	38.0	41.3	-8.8
Millewa	46.57	51.67	-11.0	7.90	8.30	-5.1	16.00	17.00	-6.3	87.80	82.00	6.6	22.0	26.7	-21.2
Suntop	55.50	49.10	11.5	11.40	10.10	11.4	17.33	14.33	17.3	88.20	94.20	-6.8	13.7	16.3	-19.5
Mace	49.77	51.70	-3.9	9.60	9.40	2.1	21.00	20.67	1.6	88.40	89.10	-0.8	20.0	17.7	11.7
Mitre	48.80	52.17	-6.9	8.60	8.20	4.7	19.00	19.33	-1.8	77.10	84.70	-9.9	20.3	18.0	11.5
Perenjori	51.85	49.17	5.2	10.30	9.90	3.9	19.00	18.00	5.3	62.20	78.30	-25.9	12.5	18.3	-46.7
W156	50.73	48.57	4.3	8.70	7.70	11.5	16.00	15.00	6.3	84.90	94.70	-11.5	19.3	16.0	17.2
OpataM-85	55.87	54.63	2.2	10.60	11.10	-4.7	20.00	19.67	1.7	90.20	92.90	-3.0	19.7	20.3	-3.4
Tevere	62.10	56.90	8.4	10.10	10.60	-5.0	18.67	19.00	-1.8	74.80	79.00	-5.6	13.3	13.7	-2.5
Kukri	54.17	50.33	7.1	8.90	9.40	-5.6	16.00	16.33	-2.1	89.20	92.60	-3.8	23.3	20.7	11.4
Halberd	53.50	56.50	-5.6	11.80	11.40	3.4	21.33	21.33	0.0	73.20	69.00	5.7	16.0	16.3	-2.1
Babax	59.27	61.57	-3.9	13.80	13.60	1.4	20.67	21.33	-3.2	86.40	84.20	2.5	13.3	10.7	20.0
Cranbrook	58.87	57.47	2.4	9.80	9.50	3.1	22.67	21.67	4.4	90.40	94.90	-5.0	15.0	17.7	-17.8
Sundor	46.33	46.27	0.1	7.90	7.60	3.8	17.67	16.33	7.5	82.00	90.90	-10.9	18.0	13.0	27.8
Drysdale	56.40	54.17	4.0	9.00	8.90	1.1	18.00	18.00	0.0	93.30	92.30	1.1	16.7	19.0	-14.0
Chinese Spring	77.63	77.50	0.2	10.00	9.80	2.0	18.33	18.33	0.0	73.50	67.50	8.2	15.3	16.7	-8.7
Reeves	61.63	60.50	1.8	8.80	8.10	8.0	17.33	16.67	3.8	94.70	84.90	10.3	17.3	15.7	9.6
Kinsei	51.50	48.47	5.9	9.40	9.20	2.1	19.00	18.00	5.3	52.80	53.20	-0.8	11.0	9.7	12.1
SeriM-82	42.50	54.70	-28.7	10.10	10.00	1.0	20.50	20.50	0.0	60.40	58.10	3.8	11.5	8.5	26.1
Rockstar	52.33	45.83	12.4	8.90	8.30	6.7	18.67	17.33	7.1	72.90	60.40	17.1	19.0	14.0	26.3
Ninja	47.65	46.07	3.3	9.90	9.30	6.1	21.00	20.67	1.6	89.40	77.00	13.9	21.5	19.0	11.6
Devil	50.30	50.00	0.6	9.30	9.20	1.1	18.00	17.67	1.9	82.70	92.40	-11.7	21.3	20.0	6.2
Vixen	45.80	43.93	4.1	8.40	8.50	-1.2	17.33	17.33	0.0	96.90	96.00	0.9	22.7	25.0	-10.3
Hellfire	48.23	50.20	-4.1	8.70	8.80	-1.1	17.00	16.67	2.0	96.30	93.20	3.2	25.0	28.7	-14.7
Waagan	54.53	54.53	0.0	9.40	9.40	0.0	20.33	20.00	1.6	92.80	90.80	2.2	24.0	20.3	15.3
Excalibur	45.83	50.73	-10.7	10.00	10.20	-2.0	22.00	22.00	0.0	87.30	79.90	8.5	23.0	16.0	30.4
EGA Gregory	50.47	54.90	-8.8	11.00	10.80	1.8	20.00	20.00	0.0	74.30	81.50	-9.7	14.3	13.7	4.7
Gladius	44.43	49.97	-12.5	8.30	8.30	0.0	14.33	13.33	7.0	73.10	76.40	-4.5	18.7	16.0	14.3
AGT Young	40.70	52.70	-29.5	8.30	8.90	-7.2	13.67	15.67	-14.6	93.70	95.10	-1.5	21.3	20.3	4.7
Mean	51.77	52.64	-1.67	9.54	9.37	1.78	18.38	18.09	1.57	82.85	83.65	-0.97	18.71	18.32	2.08
LSD (P=0.05)	8.17	7.73		1.40	1.23		2.33	2.67		18.90	18.96		7.33	8.33	

**Table S2.** (Cont.)

Cultivar	TNT			TGY (g)			SPAD_1D			SPAD_3D			SPAD_5D		
	Control	Heat	Reduction	Control	Heat	Reduction	Control	Heat	Reduction	Control	Heat	Reduction	Control	Heat	Reduction
			Under Heat Stress (%)			Under Heat Stress (%)			Under Heat Stress (%)			Under Heat Stress (%)			Under Heat Stress (%)
RAC875	17.3	22.7	-30.8	8.6	8.5	1.7	49.23	47.90	2.7	55.43	51.90	6.4	57.97	57.00	1.7
Sunco	40.3	43.7	-8.3	9.4	10.9	-15.7	45.40	44.87	1.2	47.70	49.40	-3.6	50.43	52.27	-3.6
Millewa	24.3	32.3	-32.9	10.9	9.6	12.4	44.10	43.30	1.8	47.20	49.23	-4.3	51.73	53.53	-3.5
Suntop	15.7	17.3	-10.6	7.7	12.9	-67.0	44.87	42.03	6.3	49.60	49.30	0.6	52.67	55.53	-5.4
Mace	22.7	20.0	11.8	12.9	7.5	41.4	46.40	49.87	-7.5	51.27	54.73	-6.8	54.27	56.50	-4.1
Mitre	26.0	21.3	17.9	11.6	8.9	23.7	42.77	45.23	-5.8	46.47	49.87	-7.3	49.13	53.10	-8.1
Perenjori	20.5	23.7	-15.4	3.8	4.8	-23.7	46.45	44.63	3.9	48.55	49.37	-1.7	52.60	50.37	4.2
W156	22.7	17.0	25.0	13.4	8.9	33.5	44.50	43.57	2.1	49.80	50.07	-0.5	52.70	54.73	-3.9
OpataM-85	22.0	22.0	0.0	12.6	12.3	2.8	46.20	45.60	1.3	50.30	51.23	-1.9	54.70	53.13	2.9
Tevere	18.3	17.3	5.5	8.9	8.4	6.1	46.33	47.03	-1.5	50.90	52.80	-3.7	53.90	56.27	-4.4
Kukri	26.0	22.3	14.1	13.5	10.4	22.5	45.70	46.17	-1.0	51.80	51.60	0.4	53.97	56.57	-4.8
Halberd	22.0	24.0	-9.1	8.8	7.6	13.7	50.00	52.40	-4.8	53.90	53.00	1.7	55.67	55.00	1.2
Babax	15.3	12.7	17.4	7.9	7.3	7.8	45.60	48.30	-5.9	50.00	52.37	-4.7	54.87	54.70	0.3
Cranbrook	16.7	19.0	-14.0	8.9	10.0	-12.0	46.50	47.80	-2.8	51.83	52.50	-1.3	53.90	54.47	-1.1
Sundor	23.3	14.0	40.0	6.6	5.3	20.3	45.43	46.80	-3.0	49.33	51.73	-4.9	52.20	56.17	-7.6
Drysdale	18.0	20.3	-13.0	11.7	10.5	9.7	44.57	44.10	1.0	50.97	48.93	4.0	55.17	52.40	5.0
Chinese Spring	21.0	24.7	-17.5	8.6	6.9	19.6	47.87	46.80	2.2	49.97	49.10	1.7	51.23	50.67	1.1
Reeves	18.3	18.7	-1.8	5.7	5.8	-0.9	46.40	47.30	-1.9	49.47	50.60	-2.3	53.63	52.93	1.3
Kinsei	21.3	17.3	18.8	2.9	2.8	0.7	41.73	44.50	-6.6	46.43	48.50	-4.5	48.13	50.83	-5.6
SeriM-82	20.0	14.5	27.5	4.7	4.0	15.2	45.05	47.65	-5.8	50.20	52.60	-4.8	56.30	55.00	2.3
Rockstar	26.0	24.0	7.7	7.4	4.6	38.8	49.67	50.60	-1.9	53.40	55.73	-4.4	56.53	56.83	-0.5
Ninja	24.0	24.3	-1.4	7.8	5.0	35.1	47.90	47.60	0.6	51.95	51.50	0.9	53.50	52.30	2.2
Devil	25.7	21.7	15.6	14.4	9.1	36.7	45.63	48.97	-7.3	48.90	53.57	-9.5	53.47	57.40	-7.4
Vixen	23.3	26.0	-11.4	10.0	13.2	-31.6	48.00	46.80	2.5	53.83	52.93	1.7	55.10	56.73	-3.0
Hellfire	26.0	30.7	-17.9	13.9	15.1	-8.3	46.43	44.70	3.7	51.73	48.43	6.4	53.77	54.03	-0.5
Waagan	25.7	22.3	13.0	12.0	10.2	15.2	41.17	40.37	1.9	45.67	45.03	1.4	49.13	49.73	-1.2
Excalibur	26.3	20.0	24.1	9.3	6.0	35.9	47.77	50.03	-4.7	52.23	54.47	-4.3	56.77	55.47	2.3
EGA Gregory	19.3	17.0	12.1	4.5	5.0	-9.5	45.40	44.57	1.8	48.93	48.27	1.4	51.33	50.83	1.0
Gladius	25.7	20.3	20.8	11.6	8.3	28.7	48.10	47.63	1.0	52.63	52.10	1.0	57.40	54.17	5.6
AGT Young	23.0	21.7	5.8	10.1	8.0	21.0	48.87	46.83	4.2	53.70	52.73	1.8	53.90	53.63	0.5
Mean	22.56	21.76	3.55	9.34	8.25	11.71	46.13	46.47	-0.72	50.47	51.12	-1.29	53.54	54.08	-1.01
LSD (P=0.05)	8.33	8.33		5.23	6.05		3.47	4.03		3.37	3.77		3.10	3.77	

**Table S2.** (Cont.)

Cultivar	FLTD_1D (°C)			FLTD_3D (°C)			FLTD_5D (°C)		
	Control	Heat	Reduction Under Heat Stress (%)	Control	Heat	Reduction Under Heat Stress (%)	Control	Heat	Reduction Under Heat Stress (%)
RAC875	1.90	2.83	-49.1	1.80	3.00	-66.7	1.83	2.53	-38.2
Sunco	2.10	3.27	-55.6	1.53	2.67	-73.9	1.43	2.67	-86.0
Millewa	1.50	3.00	-100.0	1.40	3.47	-147.6	2.17	2.83	-30.8
Suntop	1.80	3.27	-81.5	1.60	3.33	-108.3	1.97	3.30	-67.8
Mace	1.17	2.83	-142.9	1.87	2.60	-39.3	2.73	2.10	23.2
Mitre	1.60	2.67	-66.7	2.47	2.90	-17.6	2.20	2.60	-18.2
Perenjori	1.70	3.00	-76.5	2.00	2.77	-38.3	2.25	2.33	-3.7
W156	2.43	2.93	-20.5	1.73	2.90	-67.3	2.17	3.67	-69.2
OpataM-85	1.93	3.00	-55.2	2.10	2.93	-39.7	2.17	2.43	-12.3
Tevere	1.43	3.00	-109.3	1.93	3.13	-62.1	2.13	3.03	-42.2
Kukri	1.60	2.40	-50.0	1.60	2.93	-83.3	1.93	2.40	-24.1
Halberd	2.20	2.10	4.5	1.90	2.10	-10.5	2.13	2.90	-35.9
Babax	1.67	2.50	-50.0	2.53	2.33	7.9	2.47	2.27	8.1
Cranbrook	1.47	2.77	-88.6	1.60	2.33	-45.8	2.00	2.43	-21.7
Sundor	1.90	2.80	-47.4	2.33	3.47	-48.6	2.90	2.03	29.9
Drysdale	1.43	3.10	-116.3	1.63	3.67	-124.5	2.17	2.77	-27.7
Chinese Spring	1.43	2.47	-72.1	1.23	2.80	-127.0	1.73	3.27	-88.5
Reeves	1.67	2.63	-58.0	2.27	2.57	-13.2	2.30	2.40	-4.3
Kinsei	1.97	2.77	-40.7	1.93	3.10	-60.3	1.93	3.43	-77.6
SeriM-82	1.65	3.60	-118.2	2.75	2.90	-5.5	2.35	2.75	-17.0
Rockstar	2.27	2.63	-16.2	2.40	2.67	-11.1	2.43	3.07	-26.0
Ninja	1.90	2.30	-21.1	2.45	2.37	3.4	2.10	2.23	-6.3
Devil	1.47	3.03	-106.8	2.20	2.87	-30.3	2.90	2.50	13.8
Vixen	1.57	3.13	-100.0	2.43	2.63	-8.2	2.50	3.30	-32.0
Hellfire	1.73	2.73	-57.7	1.80	3.77	-109.3	2.13	2.73	-28.1
Waagan	1.97	2.33	-18.6	1.90	3.00	-57.9	2.03	2.97	-45.9
Excalibur	1.97	2.57	-30.5	1.87	2.30	-23.2	2.70	2.33	13.6
EGA Gregory	2.13	3.07	-43.8	1.83	2.77	-50.9	1.97	2.43	-23.7
Gladius	1.53	2.87	-87.0	1.87	3.57	-91.1	1.67	2.93	-76.0
AGT Young	1.43	2.53	-76.7	1.53	1.93	-26.1	1.57	2.73	-74.5
Mean	1.75	2.80	-60.20	1.95	2.86	-46.61	2.17	2.71	-25.27
LSD (P=0.05)	0.97	1.50		0.83	1.13		0.80	1.00	

**Table S2.** (Cont.)

Cultivar	Fv/Fm_1D			Fv/Fm_3D			Fv/Fm_5D			SC (mmol m <sup>-2</sup> s <sup>-1</sup> )		
	Control	Heat	Reduction Under Heat Stress (%)	Control	Heat	Reduction Under Heat Stress (%)	Control	Heat	Reduction Under Heat Stress (%)	Control	Heat	Reduction Under Heat Stress (%)
RAC875	0.810	0.798	1.44	0.818	0.802	2.04	0.823	0.808	1.82	284.36	355.38	-24.9
Sunco	0.822	0.802	2.43	0.817	0.808	1.02	0.823	0.810	1.62	203.23	277.90	-36.7
Millewa	0.813	0.803	1.23	0.822	0.808	1.62	0.822	0.808	1.62	-	-	-
Suntop	0.827	0.803	2.82	0.820	0.807	1.63	0.825	0.813	1.41	-	-	-
Mace	0.820	0.805	1.83	0.825	0.810	1.82	0.823	0.808	1.92	-	-	-
Mitre	0.810	0.797	1.65	0.818	0.800	2.14	0.810	0.803	0.82	253.18	305.83	-20.8
Perenjori	0.815	0.795	2.45	0.820	0.802	2.24	0.820	0.807	1.63	-	-	-
W156	0.817	0.802	1.84	0.822	0.808	1.62	0.822	0.813	1.01	314.50	415.43	-32.1
OpataM-85	0.817	0.800	2.04	0.818	0.805	1.53	0.818	0.810	1.02	252.46	357.8	-41.7
Tevere	0.810	0.798	1.54	0.817	0.807	1.22	0.817	0.810	0.82	-	-	-
Kukri	0.820	0.808	1.42	0.823	0.810	1.62	0.827	0.813	1.61	234.58	290.1	-23.7
Halberd	0.825	0.815	1.21	0.820	0.810	1.22	0.825	0.808	2.02	-	-	-
Babax	0.820	0.800	2.44	0.815	0.810	0.61	0.820	0.803	2.03	-	-	-
Cranbrook	0.808	0.798	1.24	0.820	0.800	2.44	0.818	0.812	0.71	-	-	-
Sundor	0.818	0.800	2.24	0.817	0.805	1.43	0.825	0.808	2.02	-	-	-
Drysdale	0.815	0.795	2.45	0.820	0.800	2.44	0.822	0.807	1.83	-	-	-
Chinese Spring	0.820	0.810	1.22	0.820	0.808	1.42	0.818	0.810	1.02	-	-	-
Reeves	0.825	0.802	2.83	0.820	0.805	1.83	0.823	0.810	1.52	-	-	-
Kinsei	0.815	0.805	1.23	0.820	0.808	1.42	0.817	0.810	0.82	-	-	-
SeriM-82	0.805	0.810	-0.62	0.815	0.810	0.61	0.810	0.810	0.00	-	-	-
Rockstar	0.820	0.808	1.52	0.820	0.803	2.03	0.822	0.807	1.83	-	-	-
Ninja	0.813	0.803	1.23	-	-	-	0.830	0.793	4.42	-	-	-
Devil	0.828	0.810	2.21	0.820	0.810	1.22	-	0.810	-	-	-	-
Vixen	0.825	0.802	2.83	0.817	0.805	1.43	0.825	0.810	1.82	282.76	344.95	-21.99
Hellfire	0.807	0.802	0.62	0.817	0.805	1.43	0.822	0.813	1.01	250.78	320.46	-27.79
Waagan	0.805	0.783	2.80	0.808	0.797	1.44	0.815	0.807	1.02	-	-	-
Excalibur	0.820	0.803	2.13	0.820	0.800	2.44	0.820	0.805	1.83	-	-	-
EGA Gregory	0.815	0.795	2.45	0.818	0.810	0.92	0.820	0.810	1.22	-	-	-
Gladius	0.815	0.805	1.23	0.817	0.802	1.84	0.825	0.810	1.82	-	-	-
AGT Young	0.820	0.800	2.44	0.820	0.808	1.52	0.823	0.808	1.82	-	-	-
Mean	0.817	0.802	1.82	0.819	0.806	1.59	0.821	0.809	1.52	259.48	333.48	-28.72
LSD (P=0.05)	0.023	0.013		0.010	0.007		0.008	0.008		136.41	136.51	

GN, grain number (main stem); GY, grain yield (main stem); GW, average individual grain weight (main stem); PV, pollen viability (main stem); BM, above-ground biomass; SL, spike length (main stem); SN, spikelet number (main stem); MSL, main stem length; TGY, total plant grain yield; TNT, total number of tillers; ENT, effective number of

tillers; ET, percentage effective tillers; SPAD\_1D, flag leaf chlorophyll content day 1; SPAD\_3D, flag leaf chlorophyll content day 3; SPAD\_5D, flag leaf chlorophyll content day 5; Fv/Fm\_1D, quantum yield of photosynthesis day 1; Fv/Fm 3D, quantum yield of photosynthesis day 3; Fv/Fm\_5D, quantum yield of photosynthesis day 5; FLTD\_1D, flag leaf temperature depression day 1; FLTD\_3D, flag leaf temperature depression day 3; FLTD\_5D, flag leaf temperature depression day 5, SC; flag leaf stomatal conductance

**Table S3.** Eigen values for the corresponding principal components (PCs) and PC loadings for target traits (average percent reduction under high temperature treatment relative to the control).

PCs	Eigen Value	Variance (%)	Cumulative Variance (%)	GN	GY	GW	PV	BM	SL	MSL	SN	ET	FLTD _1D	FLTD _3D	FLTD _5D	DTAD
PC1	2.82	21.75	21.75	0.40	0.32	0.08	-0.23	0.32	0.36	0.28	0.34	-0.02	0.26	0.22	0.11	0.35
PC2	2.21	17.00	38.75	0.07	-0.45	-0.52	0.27	-0.09	0.31	0.30	0.43	-0.11	-0.06	-0.14	0.02	-0.14
PC3	1.69	12.97	51.72	-0.03	0.24	0.32	0.04	-0.27	0.11	0.21	0.20	0.06	0.10	-0.55	-0.59	-0.01
PC4	1.43	11.04	62.76	0.12	0.23	0.16	0.28	0.42	-0.04	-0.07	0.09	-0.44	-0.58	-0.30	0.14	-0.03
PC5	1.25	9.60	72.36	0.40	0.19	-0.06	0.58	-0.04	0.12	-0.26	-0.08	0.60	-0.03	-0.01	0.05	-0.01
PC6	1.03	7.93	80.29	0.37	0.03	-0.20	-0.16	0.25	0.04	-0.40	-0.06	-0.26	0.33	-0.03	-0.32	-0.52

GN, grain number (main stem); GY, grain yield (main stem; g); GW, average individual grain weight (main stem; mg); SL, spike length (main stem; cm); SN, spikelet number (main stem); MSL, main stem length (cm); PV, pollen viability (%); BM, above-ground biomass (g); ET, percentage effective tillers; FLTD\_1D, flag leaf temperature depression day 1 (°C); FLTD\_3D, flag leaf temperature depression day 3 (°C); FLTD\_5D, flag leaf temperature depression day 5 (°C); DTAD, days to auricle distance (cm).

**Table S4.** Pairwise correlations for traits (average percent reduction under high temperature treatment relative to the control).

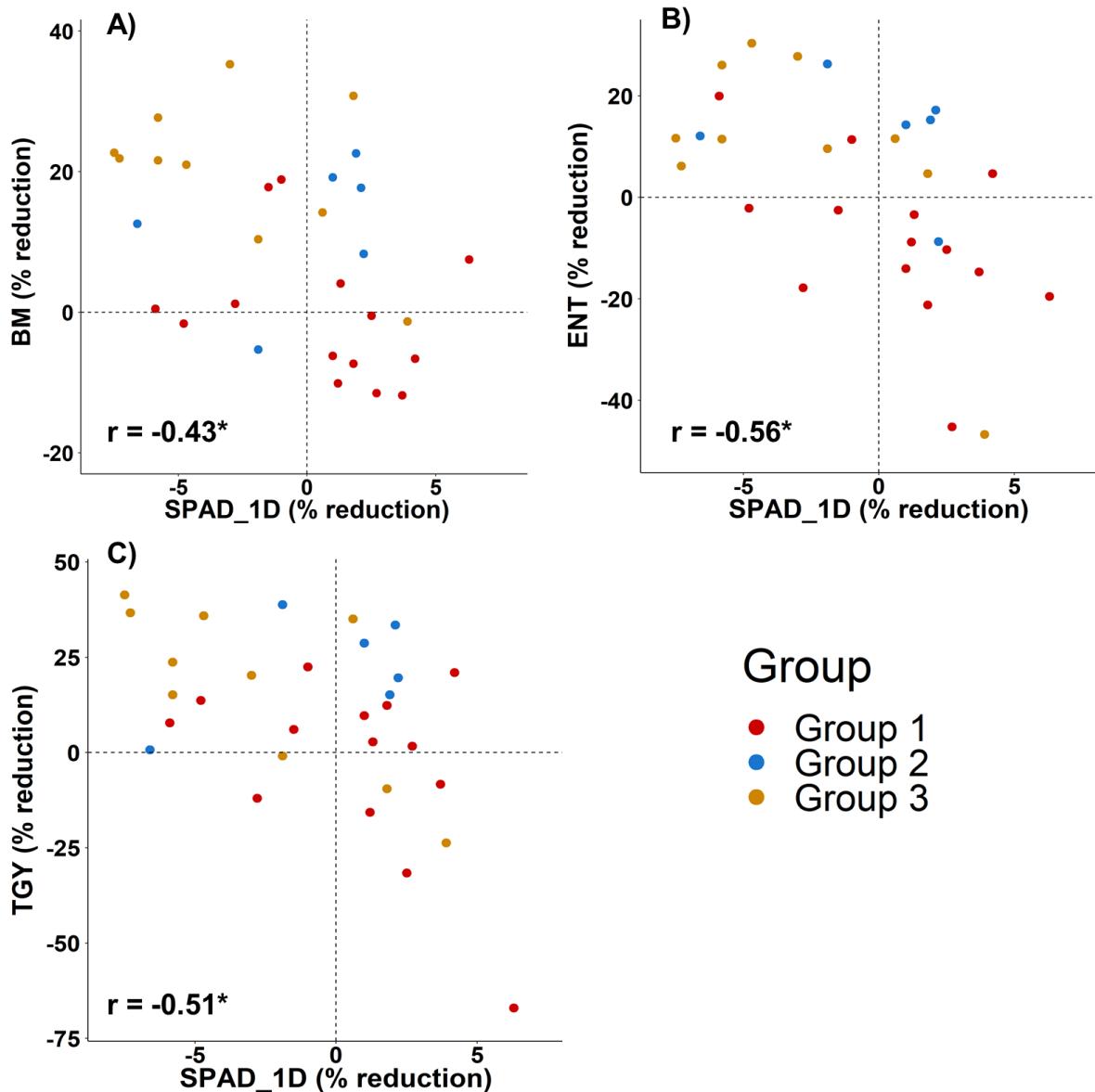
	GY	GW	PV	BM	MSL	SL	SN	ET	ENT	TNT	TGY	SPAD_1D	SPAD_3D	SPAD_5D	FLTD_1D	FLTD_3D	FLTD_5D	FV/FM_1D	FV/FM_3D	FV/FM_5D
GN	<b>0.44</b>	-0.17	0.00	<b>0.41</b>	0.12	<b>0.38</b>	0.35	0.07	<b>0.44</b>	<b>0.42</b>	0.19	-0.16	-0.20	-0.07	0.21	0.16	0.05	0.25	0.21	0.22
GY		<b>0.79</b>	-0.23	0.35	-0.02	0.11	-0.04	0.10	<b>0.46</b>	<b>0.45</b>	<b>0.73</b>	-0.36	-0.27	-0.02	0.16	0.03	-0.03	-0.25	0.26	0.00
GW			-0.24	0.06	-0.09	-0.14	-0.24	0.03	0.19	0.21	<b>0.62</b>	-0.30	-0.19	0.01	0.04	-0.09	-0.14	<b>-0.43</b>	0.16	-0.21
PV				-0.18	-0.13	0.11	0.01	0.17	-0.15	-0.27	-0.11	0.10	0.05	0.05	<b>-0.40</b>	-0.36	0.08	-0.05	0.14	-0.06
BM					0.02	0.08	0.21	-0.22	<b>0.63</b>	<b>0.78</b>	0.36	<b>-0.43</b>	<b>-0.45</b>	-0.34	-0.01	0.22	0.32	0.00	-0.15	-0.12
MSL						0.33	<b>0.59</b>	-0.05	-0.11	-0.11	-0.22	0.07	-0.04	-0.28	0.17	-0.12	0.06	0.32	0.25	0.12
SL							<b>0.61</b>	-0.10	-0.06	-0.01	-0.14	0.02	0.06	-0.05	0.28	0.14	0.02	0.08	0.21	0.13
SN								-0.14	0.04	0.15	-0.34	0.06	-0.11	-0.15	0.12	-0.11	-0.04	0.12	0.13	-0.05
ET									<b>0.39</b>	-0.10	0.29	-0.14	0.06	0.24	0.23	0.11	-0.05	-0.24	-0.09	0.29
ENT										<b>0.87</b>	<b>0.61</b>	<b>-0.56</b>	<b>-0.47</b>	-0.18	0.25	<b>0.43</b>	0.23	-0.11	-0.27	0.03
TNT											<b>0.48</b>	<b>-0.54</b>	<b>-0.52</b>	-0.27	0.14	<b>0.43</b>	0.26	-0.02	-0.25	-0.11
TGY												<b>-0.51</b>	-0.33	0.02	0.13	0.22	0.26	-0.32	0.09	0.23
SPAD_1D													<b>0.72</b>	0.30	0.08	<b>-0.50</b>	<b>-0.50</b>	0.28	0.12	0.10
SPAD_3D														<b>0.50</b>	0.23	<b>-0.36</b>	<b>-0.42</b>	0.00	0.13	0.16
SPAD_5D															0.09	0.04	-0.05	-0.10	0.18	0.20
FLTD_1D																0.25	-0.12	0.07	-0.04	0.27
FLTD_3D																	<b>0.47</b>	0.07	-0.17	0.23
FLTD_5D																		0.08	0.12	0.26
FV/FM_1D																			0.15	0.23
FV/FM_3D																				0.21
FV/FM_5D																				

Correlation values in bold indicates significance at  $p < 0.05$ ; GN, grain number (main stem); GY, grain yield (main stem; g); GW, individual grain weight (main stem; mg); PV, pollen viability (%); BM, above-ground biomass (g); SL, spike length (main stem; cm); SN, spikelet number (main stem); MSL, main stem length (cm); TGY, total plant grain yield (g); TNT, total number of tillers; ENT, effective number of tillers; ET, percentage effective tillers (%); SPAD\_1D, flag leaf chlorophyll content day 1; SPAD\_3D, flag leaf chlorophyll content day 3; SPAD\_5D, flag leaf chlorophyll content day 5; FLTD\_1D, flag leaf temperature depression day 1 ( $^{\circ}$ C); FLTD\_3D, flag leaf temperature depression day 3 ( $^{\circ}$ C); FLTD\_5D, flag leaf temperature depression day 5 ( $^{\circ}$ C). Fv/Fm\_1D, quantum yield photosynthesis day 1; Fv/Fm\_3D, quantum yield photosynthesis day 3; Fv/Fm\_5D, quantum yield of photosynthesis day 5.

**Table S5:** Regression estimates for grain number per spikelet (GNs) and average individual grain weight per spikelet (GWs) against spikelet position on the main stem spike of heat-tolerant wheat cultivars Hellfire and Vixen, and heat-sensitive cultivars Gladius and W156. The effect of heat treatment (heat stress or control temperature at meiosis) on the intercept and slope was included in the analysis, and each cultivar was analysed separately.

Estimates	Grain Number per Spikelet (GNs)				Average Individual Grain Weight per Spikelet (GWs)			
	Hellfire	Vixen	Gladius	W156	Hellfire	Vixen	Gladius	W156
<b>Linear model</b>								
Intercept	3.11*	3.31	4.81	4.90	21.98*	19.88*	25.36*	24.26*
Slope (linear term)	0.04	0.006	-0.09	-0.09	0.29	0.005	0.02	0.37
Treatment (heat) effect on intercept	0.83	0.04	0.03	-0.70	1.29	4.08	-3.75	-3.13
Treatment effect on slope (linear term)	-0.13	-0.02	-0.06	-0.02	-0.04	0.30	0.21	0.03
Linear model (% variance accounted for by model; R <sup>2</sup> )	10%	1.3%	27.6%	28.6%	1.5%	26.3%	10.2%	21.5%
<b>Quadratic model</b>								
Intercept	3.43*	3.37*	4.03*	4.17*	24.43*	19.93*	25.55*	27.42*
Slope (linear term)	0.85	0.13	-2.02*	-1.93	6.44	0.11	0.48	8.25
Slope (quadratic term)	-2.2*	-2.7*	-2.13*	-3.13*	6.77	-0.82	0.03	-2.38
Treatment effect on intercept	-0.27	-0.13	-0.50*	-0.87*	0.93	6.66*	-1.96*	-2.89*
Treatment effect on slope (linear term)	-2.88	-0.45	-1.40	-0.45	-0.93	6.75	4.71	0.64
Treatment effect on slope (quadratic term)	0.71	1.06	-0.07	1.85	-6.73	-2.6	1.16	-7.81
Quadratic model (% variance accounted for by model; R <sup>2</sup> )	20.3%	21.6%	38.7%	38.9%	2.2%	26.5%	10.4%	27.5%
<b>Suitable model</b>	Quadratic	Quadratic	Quadratic	Quadratic	Linear	Linear	Linear	Linear

\* The value is significantly different from zero ( $p < 0.05$ )



**Figure S1.** Scatterplot of traits (average percent reduction in cultivar means under heat stress relative to control) for chlorophyll content on day 1 (SPAD<sub>1D</sub>) vs biomass (BM), effective number of tillers (ENT) and total plant grain yield (TGY). A) SPAD<sub>1D</sub> vs BM; B) SPAD<sub>1D</sub> vs ENT, and C) SPAD<sub>1D</sub> vs TGY. Group 1 refers to tolerant cultivars, whereas Groups 2 and 3 refers to sensitive cultivars as shown in Figure 4. (\* indicates significance at  $p < 0.05$ )