SCREENING OF WHEAT (*Triticum aestivum* L.) GENOTYPES FOR HIGH TEMPERATURE TOLERANCE

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ABSTRACT

In order to determine relative tolerance, the heat susceptibility index was estimated for 80 various genotypes. The results revealed that days to 50 per cent flowering, plant height, ear length, number of grains per main spike and harvest index were less affected by stress condition, while grain filling period, biological yield per plant, grain weight per main spike, number of productive tillers per plant and grain yield per plant were highly suffered. The genotypes, UAS 281, SAWYT 323, Kalyansona, GW 120, K 604, HD 2733, GW 496, PBN 4456, J-1-7, K 9006, VL 753, HW 2038, DL 1010-3 and DL 788-2 were found heat tolerant for grain yield. The heat susceptibility index could be taken as important criteria for breeding wheat genotypes suitable for high temperature stress environment.

KEY WORDS: Heat Susceptibility Index, temperature tolerance, wheat

INTRODUCTION

Heat stress is a major limitation to wheat productivity in arid, semi-arid, tropical and sub-tropical regions of world. During grain filling stage, this abiotic stresses reduces the yield considerably at the rate of 270 kg/ha/degree rise in temperature above 11^0C (Rane *et al*., 2000). In India, wheat growing regions of central and peninsular India experiencing high temperature stress during post anthesis stage. Hence, now breeding for heat tolerance has become an integral component of wheat improvement at both National and International level. However, the progress to breed for high temperature tolerance has been handicapped due to inadequate knowledge about the morpho-physiological parameters and their sophisticated measurement techniques. But in recent past, a few desirable heat tolerance parameters with high heritability have been identified for their use in breeding programme notably membrane thermostability, canopy temperature depression (CTD), seedling vigour index and heat susceptibility index. In present study, heat susceptibility index had been used for screening heat tolerance genotypes of wheat.

MATERIALS AND METHODS

Eighty genotypes of wheat were sown at normal (17^{th} November) and late (17^{th} December) sowing condition in a Randomized Block Design with three replications during *Rabi* 2011-2012. Each entry was

accommodated in a single row of 2.5 m length with a spacing of 22.5 cm. The recommended agronomical practices and plant protection measures were followed for the successful raising of the crop. The observations were recorded on five randomly selected plants in each entry and replication for days to 50 per cent flowering, days to maturity, grain filling period, plant height (cm), number of productive tillers per plant, ear length (cm), number of grains per main spike, grain weight per main spike (g), grain yield per plant (g), biological yield per plant (g), harvest index (%) and 100 grain weight (g). The mean values of selected plants were used for the statistical analysis. Heat susceptibility index (S) were calculated for grain yield and other attributes over high temperature stress and non-stress environments by using the formula as suggested by Fischer and Maurer (1978).

HSI = [1-YD/YP]/D,

Where,

YD= individual character mean of genotype in stress environment,

YP = individual character mean of genotype under non-stress environment, and

D=1-[mean YD of all genotypes/mean YP of all genotypes].

RESULTS AND DISCUSSION

Considering D-value i.e. heat stress intensity, it was revealed that days to 50 per cent flowering, plant height, ear length, number of grains per main spike and harvest index were less affected by late sown condition, while grain filling period, biological yield per plant, grain weight per main spike, number of productive tillers per plant and grain yield per plant highly suffered under late sown environment (Table 1). This clearly indicated that grain yield per plant depends upon number of productive tillers per plant, grain weight per main spike and biological yield per plant. Similar results had been also reported by Sharma *et al*. (2004), Ved (2007) and Pancholi *et al*. (2010). Shpiler and Blum (1990) emphasized that selection for high biological yield should bring about positive improvement in grain yield. Thus, biological yield could be improved by plant height. In the present study, plant height significantly contributed towards biological yield, because less reduction in plant height (D=0.0032) in late sown environment. Thus, selection for biological yield is one of the most important ways to improve the productivity under late sown conditions.

Based upon the value and direction of desirability, ranking was done for different genotypes as highly heat tolerant (HSI<0.50), heat tolerant (HSI: 0.51-0.75), moderately heat tolerant (HSI: 0.76-1.00) and heat susceptible (HSI>1.00). According to estimation of HSI, the genotypes, UAS 281, SAWYT 323 and Kalyansona had been highly heat tolerant for grain yield followed by number of productive tillers per plant, days to flowering and biological yield per plant (Table 2). The genotype, GW 120 was heat tolerant for grain yield per plant followed by number of productive tillers per plant, grain filling period, days to maturity and highly heat tolerant for days to 50 per cent flowering and also moderately heat tolerant for biological yield per plant and 100 grain weight. CL 1575 was heat tolerant for grain yield per plant, biological yield per plant, 100 grain weight and number of productive tillers per plant, while highly heat tolerant for number of grains per main spike and grain weight per main spike. The genotype, K 604 was heat tolerant for grain yield per plant, biological yield per plant, grain yield per main

spike, days to 50 per cent flowering and number of productive tillers per plant, while highly heat tolerant for plant height, ear length and number of grains per main spike. HD 2733 was heat tolerant for grain yield per plant, number of productive tillers per plant, days to 50 per cent flowering, highly heat tolerant for plant height, number of grains per main spike and harvest index while moderately heat tolerant for biological yield per plant. The genotype, GW 496 was heat tolerant for grain yield per plant, days to 50% flowering and highly heat tolerant for number of productive tillers per plant, number of grains per main spike and ear length, while moderately heat tolerant for biological yield per plant, days to maturity and grain filling period. PBN 4456 was heat tolerant for grain yield per plant, while moderately heat tolerant for number of productive tillers per plant, number of grains per main spike and biological yield per plant. The genotype J-1-7 was heat tolerant for grain yield per plant followed by number of productive tillers per plant, while moderately heat tolerant for biological yield per plant, 100 grain weight, number of grains per main spike and grain weight per main spike. The genotypes K 9006, VL 753 and DL 788-2 were heat tolerant for grain yield per plant, biological yield per plant and number of productive tillers per plant and highly heat tolerant for number of grains per main spike, moderately heat tolerant for maturity. HW 2038 was heat tolerant for grain yield per plant, highly heat tolerant for number of grains per main spike, ear length, plant height, days to maturity and grain filling period, while moderately heat tolerant for biological yield per plant, number of productive tillers per plant, grain weight per main spike and days to 50% flowering. DL 1010-3 was heat tolerant for grain yield per plant followed by biological yield per plant, grain weight per main spike and days to 50% flowering, highly heat tolerant for plant height, harvest index and 100 grain weight, while moderately heat tolerant for number of productive tillers per plant, days to maturity and grain filling period.

An overall appraisal of the results revealed that the genotypes, UAS 281, SAWYT 323 and Kalyansona were highly heat tolerant, genotypes GW 120, K 604, HD 2733, GW 496, PBN 4456, J-1-7, K 9006, VL 753, HW 2038, DL 1010-3 and DL 788-2 were heat tolerant, while the genotypes AKW 1948, Raj 3077, GW 339, GW 345, HW 3070, Raj 4027, GW 387, GW 2004-18, KYZ 300, HD 2687, HI 1544, Raj 4038, GW 366, GW 322, J 24, HD 2932, K 0583, KRL 213, J 18, DL 1012, MP 1212, SAWYT 331, SAWYT 366, VL 611, NIAW 79, PBN 475, HP 1809 and WR 509 were moderately heat tolerant (Table 2).

CONCLUSION

The heat susceptibility index could be taken as important criteria for breeding wheat genotypes suitable for high temperature stress environment. The heat susceptibility index estimates indicates that the traits like days to 50% flowering, plant height, ear length, number of productive tillers per plant, number of grains per main spike and harvest index may be further exploited in wheat for breeding for high temperature stress environment. The genotypes screened out as tolerant to heat may be further exploited.

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Table 1: Heat Susceptibility Indices (S) for different 12 character of 80 wheat genotypes

Sr. No.	Genotypes	Days to 50 Per Cent Flowering	Days to Maturity	Grain Filling Period (Days)	Plant Height (cm)	Number of Productive Tillers Per Plant	Ear Length (cm)	Number of Grains Per Main Spike	Grain Weight Per Main Spike (g)	Grain Yield Per Plant (g)	Biological Yield Per Plant (g)	Harvest Index (%)	100-Grain Weight (g)
1	**HW 1045**	0.27	0.86	0.90	-7.52	1.00	2.74	0.63	1.62	1.05	0.96	-3.87	2.00
2	**AKW 1948**	0.28	0.92	0.98	7.28	0.87	2.58	-0.11	1.13	0.90	0.86	-0.33	1.52
3	**Raj 3077**	0.70	0.73	0.82	35.38	0.84	3.29	1.44	1.06	0.88	0.92	2.47	0.98
4	**NI 8622**	0.54	0.80	0.80	-8.87	1.29	-0.16	1.10	0.97	1.13	0.94	-5.00	1.35
5	**DWR 241**	0.59	0.63	0.56	11.11	1.01	0.82	0.89	2.35	1.23	1.10	-3.63	2.94
6	**GW 273**	0.13	0.64	0.81	-1.93	1.44	0.08	3.78	1.19	1.38	1.14	-10.59	0.38
7	**GW 190**	0.00	1.28	1.53	-22.48	1.23	3.25	1.90	1.24	1.20	1.16	-1.30	1.11
8	**GW 120**	0.15	0.63	0.70	10.92	0.58	1.05	4.26	1.69	0.73	0.77	1.61	0.99
9	**GW 503**	-0.01	0.85	0.92	7.64	0.82	0.46	2.46	2.15	1.04	1.00	-0.20	2.18
10	**Sonalika**	1.44	0.51	0.30	-2.68	1.34	0.03	1.24	0.61	1.20	1.08	-5.43	0.38
11	**UP 2495**	0.26	1.12	1.28	-2.06	0.92	4.76	-1.47	2.00	1.05	1.00	0.40	3.06
12	**MACS 2496**	1.15	0.96	0.95	-6.64	1.17	0.36	3.39	0.46	1.04	1.01	-0.30	-0.86
13	**GW 338**	0.62	1.24	1.39	-4.33	1.11	1.72	1.99	1.22	1.08	1.09	1.35	1.04
14	**GW 339**	0.13	1.19	1.32	-11.41	1.16	-0.09	5.05	-0.22	0.92	0.94	1.29	-2.23
15	**GW 348**	2.46	1.41	1.17	-18.75	1.19	0.75	3.93	1.53	1.27	1.11	-5.54	1.13
16	**GW 345**	1.69	1.55	1.50	8.63	1.03	1.87	1.72	0.76	0.87	0.51	-11.63	0.50
17	**GW 9715**	1.82	1.27	1.18	23.20	1.14	-1.86	0.16	0.80	1.05	1.07	2.62	1.00
18	**HW 3070**	1.58	0.68	0.51	-33.28	1.08	1.92	0.23	0.88	1.00	0.96	0.62	1.11
19	**HPW 241**	1.11	1.25	1.43	17.32	1.45	1.43	0.13	0.04	1.50	1.29	-7.44	0.03
20	**PBW 541**	3.11	1.02	0.52	-4.75	1.40	1.88	0.34	0.88	1.30	1.20	-5.00	1.08
21	**HW 5018**	0.96	1.21	1.35	4.21	1.48	1.66	1.25	0.30	1.25	1.23	1.05	-0.01
22	**Raj 4027**	0.97	0.78	0.72	-4.09	0.45	0.66	0.33	1.77	0.87	0.92	2.01	2.29
23	**Raj 4098**	1.81	1.04	0.91	3.36	1.33	-0.17	1.73	0.67	1.18	1.14	1.62	0.34

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24	**K 9507**	0.88	1.46	1.55	0.61	1.13	0.02	-0.74	0.68	1.08	1.07	1.28	1.15
25	**HP 1744**	0.97	0.88	0.93	-38.94	1.20	-0.26	0.65	0.38	1.02	0.90	-2.81	0.30
26	**GW 379**	1.13	1.42	1.48	17.40	1.03	-0.46	1.99	1.19	1.01	1.06	3.66	0.79
27	**GW 387**	0.13	0.99	1.21	-5.46	0.83	1.09	-1.11	1.09	0.85	0.81	-0.96	2.24
28	**GW 388**	1.01	0.89	0.88	-7.01	1.57	1.41	2.68	-0.64	1.28	1.40	7.07	-1.85
29	**GW 2004-18**	1.59	0.90	0.73	25.48	0.83	1.02	2.00	1.19	0.92	0.80	-3.15	0.75
30	**CL 1575**	2.97	1.41	1.03	1.41	0.69	1.15	-0.18	0.44	0.57	0.69	5.67	0.66
31	**KYZ 300**	1.13	1.29	1.29	4.27	0.97	-0.35	-1.53	-0.06	0.80	0.78	0.67	0.39
32	**WH 1023**	0.73	0.56	0.53	-7.63	1.05	0.56	-2.51	1.47	1.11	1.13	2.41	2.63
33	**K 7223**	0.61	1.15	1.34	-13.57	0.95	2.36	4.20	1.79	1.07	1.10	2.12	0.44
34	**K 604**	0.60	1.22	1.44	-8.57	0.64	0.50	-0.74	0.64	0.65	0.70	2.19	1.10
35	**KYP 522**	1.66	1.36	1.29	-6.72	1.04	2.23	0.59	1.04	1.03	1.20	10.64	1.22
36	**COW (W-1)**	1.14	1.40	1.47	-5.69	1.11	-0.70	-0.11	0.84	1.03	1.01	0.03	1.18
37	**HD 2687**	0.92	1.04	1.09	-0.98	1.10	0.16	0.64	0.97	0.96	0.97	0.79	1.43
38	**HD 2733**	0.67	1.38	1.63	-3.32	0.66	2.62	-2.66	1.33	0.74	0.80	0.16	2.53
39	**Raj 4037**	1.09	0.92	0.83	-18.62	1.51	0.19	-0.26	0.72	1.36	1.35	1.00	1.31
40	**HI 1544**	0.40	0.88	0.98	0.12	0.83	-0.45	0.63	1.43	0.82	0.67	-5.95	1.75
41	**Raj 4038**	0.56	1.31	1.58	-10.82	0.86	1.92	3.75	0.43	0.84	0.84	-3.99	-0.78
42	**GW 366**	0.56	0.72	0.71	-8.15	0.82	4.14	4.45	1.10	0.77	0.76	-0.65	-0.51
43	**GW 322**	1.75	1.19	1.03	20.36	0.85	2.35	0.90	1.88	1.00	1.09	11.35	2.09
44	**GW 496**	0.56	0.81	0.88	4.78	-0.06	0.27	-1.70	3.27	0.74	0.92	4.96	4.73
45	**GW 173**	0.93	0.56	0.43	-46.13	0.88	1.21	3.00	2.02	1.07	0.84	-8.64	1.84
46	**J 24**	-0.27	1.11	1.39	30.06	1.00	-0.31	2.34	0.66	0.88	0.93	3.17	0.37
47	**HD 2932**	0.13	1.04	1.18	17.30	1.02	0.88	3.11	-0.16	0.93	0.97	3.48	-1.64
48	**K 0583**	0.85	1.26	1.37	8.86	0.88	0.72	0.37	0.75	0.84	0.91	3.09	0.91
49	**GW 242**	0.66	0.65	0.64	-3.41	1.15	0.95	-0.50	0.71	1.04	1.13	6.72	1.08
50	**PBN 4456**	1.61	1.14	1.04	-1.47	0.85	1.27	1.77	0.94	0.73	0.92	8.85	1.06
51	**UAS 281**	0.15	0.77	0.85	7.94	0.21	2.10	0.83	0.46	0.19	0.48	12.35	0.35
52	**LBPY 06-3**	0.37	0.98	1.15	12.82	1.24	1.92	0.62	0.91	1.19	1.38	14.74	1.00

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53	**ESWYT 134**	0.60	1.22	1.39	-13.27	1.11	1.78	0.68	0.83	1.01	0.95	-1.24	0.91
54	**KRL 213**	2.71	1.43	1.21	-9.61	0.88	-0.70	1.10	0.37	0.81	0.97	4.26	-0.36
55	**J 1-7**	1.12	1.30	1.39	4.31	0.59	1.35	0.76	0.91	0.67	0.80	5.79	0.94
56	**J 18**	0.84	0.88	0.89	26.60	0.97	-0.30	1.56	0.16	0.79	1.05	13.41	-0.34
57	**PHR 1021**	1.15	0.78	0.80	-5.27	1.02	-0.33	1.88	1.01	1.09	1.19	7.19	0.79
58	**KLP 401**	0.61	1.13	1.25	-0.92	0.86	0.79	-0.42	2.44	1.16	1.22	5.72	3.37
59	**DL 1012**	2.32	1.25	1.00	36.26	0.74	1.40	0.87	0.86	0.76	0.79	1.35	0.82
60	**MP 1212**	1.00	1.04	1.07	-0.71	0.91	1.90	2.06	0.76	0.85	0.93	3.69	-0.03
61	**HUW 609**	0.49	0.92	1.02	-7.85	1.43	1.37	0.23	0.84	1.27	1.24	-0.62	1.06
62	**SAWYT 323**	0.49	1.01	1.11	-39.02	-0.07	0.75	2.21	1.43	0.17	0.11	-0.61	1.25
63	**SAWYT 331**	1.06	1.08	1.17	25.90	0.76	1.46	1.13	1.20	0.85	0.91	3.82	1.29
64	**SAWYT 355**	0.61	0.92	0.98	-10.49	1.42	1.57	1.41	0.62	1.31	1.35	6.06	0.37
65	**SAWYT 366**	2.46	1.09	0.81	3.50	0.63	0.71	1.72	1.79	0.84	0.75	-3.12	1.67
66	**SAWYT 379**	0.41	0.81	0.86	-1.02	1.17	0.64	2.33	1.51	1.07	1.09	2.35	0.89
67	**K 9006**	1.12	0.93	1.02	9.66	0.51	1.87	-0.07	1.20	0.63	0.60	-0.73	1.15
68	**VL 611**	0.88	0.69	0.54	9.86	0.91	-0.78	-1.08	0.80	0.89	0.68	-9.16	1.38
69	**VL 753**	0.96	0.77	0.80	27.89	0.59	1.60	-0.49	0.49	0.58	0.57	-2.21	0.81
70	**WR 775**	0.14	0.56	0.61	21.36	1.46	0.49	0.00	0.92	1.32	1.29	-1.16	1.22
71	**NI 747-19**	0.61	0.88	0.97	0.55	1.07	0.71	1.93	1.16	1.10	1.12	3.20	0.95
72	**NIAW 79**	1.40	0.60	0.42	20.76	1.10	1.26	0.80	0.52	0.96	1.06	5.13	0.40
73	**PBW 475**	0.33	0.72	0.91	-5.34	0.65	1.56	-1.81	1.65	0.82	1.06	14.18	2.67
74	**HP 1809**	1.46	0.84	0.73	10.81	0.92	-0.59	0.89	0.71	0.87	0.77	0.05	0.35
75	**HW 2038**	0.82	0.30	0.18	-1.14	0.77	-0.24	0.00	0.84	0.75	1.00	11.07	1.04
76	**DL 1010-3**	0.72	0.96	0.91	-26.85	0.80	1.33	1.82	0.57	0.74	0.60	-2.54	0.16
77	**WR 509**	0.88	1.11	1.15	1.08	0.66	2.37	0.62	1.63	0.87	0.83	-0.90	1.96
78	**J 40**	2.67	1.32	1.00	12.19	0.95	0.69	0.51	2.03	1.15	1.23	6.08	2.56
79	**DL 788-2**	1.91	0.59	0.30	-33.90	0.61	-0.65	-1.02	0.82	0.63	0.68	2.08	1.41
80	**Kalyansona**	1.42	0.68	0.51	7.21	0.44	-0.10	2.53	0.95	0.45	0.56	4.70	0.42
	D-value	0.04	0.13	0.24	0.003	0.35	0.013	0.025	0.10	0.40	0.41	-0.023	0.075

Table 2: Classification of 80 genotypes of wheat in highly heat tolerance (HHT), heat tolerance (HT), moderately heat tolerance (MHT) and heat susceptible (HS) based on heat susceptibility indices (S).

Sr. No.	Genotypes	Days to 50 Per Cent Flowering	Days to Maturity	Grain Filling Period (Days)	Plant Height (cm)	Number of Productive Tillers / Plant	Ear Length (cm)	No. of Grains Per Main Spike	Grain Wt. /Main Spike (g)	Grain Yield /Plant (g)	Biological Yield / Plant (g)	Harvest Index (%)	100-Grain Weight (g)
1	**HW 1045**	HHT	MHT	MHT	HHT	MHT	HS	HT	HS	HS	MHT	HHT	HS
2	**AKW 1948**	HHT	MHT	MHT	HS	MHT	HS	HHT	HS	MHT	MHT	HHT	HS
3	**Raj 3077**	MHT	HT	MHT	HS	MHT	HS	HS	HS	MHT	MHT	HS	MHT
4	**NI 8622**	HT	MHT	MHT	HHT	HS	HHT	HS	MHT	HS	MHT	HHT	HS
5	**DWR 241**	HT	HT	HT	HS	HS	MHT	MHT	HS	HS	HS	HHT	HS
6	**GW 273**	HHT	HT	MHT	HHT	HS	HHT	HS	HS	HS	HS	HHT	HHT
7	**GW 190**	HHT	HS	HS	HHT	HS	HS	HS	HS	HS	HS	HHT	HS
8	**GW 120**	HHT	HT	HT	HS	HT	HS	HS	HS	HT	MHT	HS	MHT
9	**GW 503**	HHT	MHT	MHT	HS	MHT	HHT	HS	HS	HS	MHT	HHT	HS
10	**Sonalika**	HS	HT	HHT	HHT	HS	HHT	HS	HT	HS	HS	HHT	HHT
11	**UP 2495**	HHT	HS	HS	HHT	MHT	HS	HHT	HS	HS	MHT	HHT	HS
12	**MACS 2496**	HS	MHT	MHT	HHT	HS	HHT	HS	HHT	HS	HS	HHT	HHT
13	**GW 338**	HT	HS	HS	HHT	HS	HS	HS	HS	HS	HS	HS	HS
14	**GW 339**	HHT	HS	HS	HHT	HS	HHT	HS	HHT	MHT	MHT	HS	HHT
15	**GW 348**	HS	HS	HS	HHT	HS	HT	HS	HS	HS	HS	HHT	HS
16	**GW 345**	HS	HS	HS	HS	HS	HS	HS	MHT	MHT	HT	HHT	HHT
17	**GW 9715**	HS	HS	HS	HS	HS	HHT	HHT	MHT	HS	HS	HS	MHT
18	**HW 3070**	HS	HT	HT	HHT	HS	HS	HHT	MHT	MHT	MHT	HT	HS
19	**HPW 241**	HS	HS	HS	HS	HS	HS	HHT	HHT	HS	HS	HHT	HHT
20	**PBW 541**	HS	HS	HT	HHT	HS	HS	HHT	MHT	HS	HS	HHT	HS
21	**HW 5018**	MHT	HS	HS	HS	HS	HS	HS	HHT	HS	HS	HS	HHT
22	**Raj 4027**	MHT	MHT	HT	HHT	HHT	HT	HHT	HS	MHT	MHT	HS	HS
23	**Raj 4098**	HS	HS	MHT	HS	HS	HHT	HS	HT	HS	HS	HS	HHT
24	**K 9507**	MHT	HS	HS	HT	HS	HHT	HHT	HT	HS	HS	HS	HS

Continue…

Table: 2 Continue

25	**HP 1744**	MHT	MHT	MHT	HHT	HS	HHT	HT	MHT	HS	MHT	HHT	HHT
26	**GW 379**	HS	HS	HS	HS	HS	HHT	HS	HS	HS	HS	HS	HT
27	**GW 387**	HHT	MHT	HS	HHT	MHT	HS	HHT	HS	MHT	MHT	HHT	HS
28	**GW 388**	HS	MHT	MHT	HHT	HS	HS	HS	HHT	HS	HS	HS	HHT
29	**GW 2004-18**	HS	MHT	HT	HS	MHT	HS	HS	HS	MHT	MHT	HHT	HT
30	**CL 1575**	HS	HS	HS	HS	HT	HS	HHT	HHT	HT	HT	HS	HT
31	**KYZ 300**	HS	HS	HS	HS	MHT	HHT	HHT	HHT	MHT	MHT	HT	HHT
32	**WH 1023**	HT	HT	HT	HHT	HS	HT	HHT	HS	HS	HS	HS	HS
33	**K 7223**	HT	HS	HS	HHT	MHT	HS	HS	HS	HS	HS	HS	HHT
34	**K 604**	HT	HS	HS	HHT	HT	HHT	HHT	HT	HT	HT	HS	HS
35	**KYP 522**	HS	HS	HS	HHT	HS	HS	HT	HS	HS	HS	HS	HS
36	**COW (W-1)**	HS	HS	HS	HHT	HS	HHT	HHT	MHT	HS	HS	HHT	HS
37	**HD 2687**	MHT	HS	HS	HHT	HS	HHT	HT	MHT	MHT	MHT	MHT	HS
38	**HD 2733**	HT	HS	HS	HHT	HT	HS	HHT	HS	HT	MHT	HHT	HS
39	**Raj 4037**	HS	MHT	MHT	HHT	HS	HHT	HHT	HT	HS	HS	MHT	HS
40	**HI 1544**	HHT	MHT	MHT	HHT	MHT	HHT	HT	HS	MHT	HT	HHT	HS
41	**Raj 4038**	HT	HS	HS	HHT	MHT	HS	HS	HHT	MHT	MHT	HHT	HHT
42	**GW 366**	HT	HT	HT	HHT	MHT	HS	HS	HS	MHT	MHT	HHT	HHT
43	**GW 322**	HS	HS	HS	HS	MHT	HS	MHT	HS	MHT	HS	HS	HS
44	**GW 496**	HT	MHT	MHT	HS	HHT	HHT	HHT	HS	HT	MHT	HS	HS
45	**GW 173**	MHT	HT	HHT	HHT	MHT	HS	HS	HS	HS	MHT	HHT	HS
46	**J 24**	HHT	HS	HS	HS	MHT	HHT	HS	HT	MHT	MHT	HS	HHT
47	**HD 2932**	HHT	HS	HS	HS	HS	MHT	HS	HHT	MHT	MHT	HS	HHT
48	**K 0583**	MHT	HS	HS	HS	MHT	HT	HHT	HT	MHT	MHT	HS	MHT
49	**GW 242**	HT	HT	HT	HHT	HS	MHT	HHT	HT	HS	HS	HS	HS
50	**PBN 4456**	HS	HS	HS	HHT	MHT	HS	HS	MHT	HT	MHT	HS	HS
51	**UAS 281**	HHT	MHT	MHT	HS	HHT	HS	MHT	HHT	HHT	HHT	HS	HHT
52	**LBPY 06-3**	HHT	MHT	HS	HS	HS	HS	HT	MHT	HS	HS	HS	HS
53	**ESWYT 134**	HT	HS	HS	HHT	HS	HS	HT	MHT	HS	MHT	HHT	MHT
54	**KRL 213**	HS	HS	HS	HHT	MHT	HHT	HS	HHT	MHT	MHT	HS	HHT
55	**J 1-7**	HS	HS	HS	HS	HT	HS	MHT	MHT	HT	MHT	HS	MHT

Continue…

Table: 2 Continue

56	**J 18**	MHT	MHT	MHT	HS	MHT	HHT	HS	HHT	MHT	HS	HS	HHT
57	**PHR 1021**	HS	MHT	MHT	HHT	HS	HHT	HS	HS	HS	HS	HS	MHT
58	**KLP 401**	HT	HS	HS	HHT	MHT	MHT	HHT	HS	HS	HS	HS	HS
59	**DL 1012**	HS	HS	MHT	HS	MHT	HS	MHT	MHT	MHT	MHT	HS	MHT
60	**MP 1212**	MHT	HS	HS	HHT	MHT	HS	HS	MHT	MHT	MHT	HS	HHT
61	**HUW 609**	HHT	MHT	HS	HHT	HS	HS	HHT	MHT	HS	HS	HHT	HS
62	**SAWYT 323**	HHT	HS	HS	HHT	HHT	HT	HS	HS	HHT	HHT	HHT	HS
63	**SAWYT 331**	HS	HS	HS	HS	MHT	HS	HS	HS	MHT	MHT	HS	HS
64	**SAWYT 355**	HT	MHT	MHT	HHT	HS	HS	HS	HT	HS	HS	HS	HHT
65	**SAWYT 366**	HS	HS	MHT	HS	HT	HT	HS	HS	MHT	HT	HHT	HS
66	**SAWYT 379**	HHT	MHT	MHT	HHT	HS	HT	HS	HS	HS	HS	HS	MHT
67	**K 9006**	HS	MHT	HS	HS	HT	HS	HHT	HS	HT	HT	HHT	HS
68	**VL 611**	MHT	HT	HT	HS	MHT	HHT	HHT	MHT	MHT	HT	HHT	HS
69	**VL 753**	MHT	MHT	MHT	HS	HT	HS	HHT	HHT	HT	HT	HHT	MHT
70	**WR 775**	HHT	HT	HT	HS	HS	HHT	HHT	MHT	HS	HS	HHT	HS
71	**NI 747-19**	HT	MHT	MHT	HT	HS	HT	HS	HS	HS	HS	HS	MHT
72	**NIAW 79**	HS	HT	HHT	HS	HS	HS	MHT	HT	MHT	HS	HS	HHT
73	**PBW 475**	HHT	HT	MHT	HHT	HT	HS	HHT	HS	MHT	HS	HS	HS
74	**HP 1809**	HS	MHT	HT	HS	MHT	HHT	MHT	HT	MHT	MHT	HHT	HS
75	**HW 2038**	MHT	HHT	HHT	HHT	MHT	HHT	HHT	MHT	HT	MHT	HS	HS
76	**DL 1010-3**	HT	MHT	MHT	HHT	MHT	HS	HS	HT	HT	HT	HHT	HHT
77	**WR 509**	MHT	HS	HS	HS	HT	HS	HT	HS	MHT	MHT	HHT	HS
78	**J 40**	HS	HS	MHT	HS	MHT	HT	HT	HS	HS	HS	HS	HS
79	**DL 788-2**	HS	HT	HHT	HHT	HT	HHT	HHT	MHT	HT	HT	HS	HS
80	**Kalyansona**	HS	HT	HT	HS	HHT	HHT	HS	MHT	HHT	HT	HS	HHT

Note: HHT = highly heat tolerance, HT = heat tolerance, MHT = moderately heat tolerance and HS = heat susceptible.

[MS received: April 7, 2015] *[MS accepted: June19, 2015]*