Table S1. Various Classification of Heat Tolerant Genotypes in Cowpea based on response to different temperature conditions and photoperiod behaviour

No	Grouping (Patel and Hall, 1990) [1]	Features	Representative genotypes	Grouping (Ehlers and Hall 1996) [2]	Features	Representative genotypes
1	I	Extremely heat-tolerant and exhibiting normal levels of flower and pod production under hot conditions	779 (UCR 204), and Prima	1a	Genotypes are day neutral, completely heat tolerant with no floral bud suppression and set high pod under hot conditions.	518-22, Prima, TVu4552, H8-9-3, H8-8-4, H8-14-13, H14-10-23, H14-10-27
2	II	Exhibit normal peduncle elongation and flower production, but they had only moderate levels of podding under hot conditions	25/3/2, 25/13/1, BBR-23, BBR-25, BBR-25A, BBR-75, 750 (UCR 193), 750-1 (UCR 194), 754 (UCR 240), Komal (UCR 206), 1552-1 (UCR 207), TVu 4552, IT82D-885, IT82D-889, IT84S-2208-7, IT84E-2231 – 15, IT84D-448, IT84D-449, IT84S-2127, IT83S-72002, IT83S-728-13, IT83S-742-2, IT83S-742-11, IT83S-880, IT82D-380-5, IT83S-899	1b	Similar to Group la except that pod set was lower under hot conditions. This group produced flowers but lacked a genetic factor present in Group la genotypes that allows pod set to proceed under hot temperatures.	IT82D-889, H8-8-30 H35-5-10,
3	III	Exhibit normal peduncle elongation and flower production, but they had low levels of podding.	7964, 8006, 8043, Magnolia, Queen Anne, P3-1, 24-1A, BBR-76, Charodi, Barsati Mutant, P46001-1, Rituraj, Red Seeded, 868 (UCR 205), Pusa Dofasli, TVx 3236-01G, IT82E-9, IT82E-18, IT82E-77, IT82D-789, IT83D-442, IT83D-666, IT82D-703, IT82D-716, IT82D-744, IT82D-709, IT82D-713, IT82D-752, IT82E-70, IT83S-725-18, IT83S-875, IT84D-368, IT84D-371, IT84D-552, IT84S-2081, IT83S-742-1, IT83S-742-13, IT83S-797, IT83S-898, Bambey 23, 66-54, 78-	1c	Group lc is distinguished from Groups la and lb by having an increased duration of the period from bud appearance to flowering under hot conditions but with no effect of photoperiod. Pod set is very low under long hot days and averaged about one pod	7964, Mouride Melakh, IT82D-375 IT85F-2614

			37, Cross I-6E-I, Cross 1-6E-2, Laura B, PI 293497, PI 339593, and PI 204647		per plant but was normal under moderate temperatures and long days	
4	IV	Showed suppressed floral bud growth, excessive bud abortion, and retarded peduncle elongation, and produced very few flowers or pods, but more normal development of floral buds on late nodes	CB3, CBS, CB46, CB77, Mississippi Silver, Hercules, Colossus 80, Purple Hull Pinkeye, Corona, Chino M~, Early Pinkeye, S 488, GC82-7, TVx 12-01E, IT82E-13, IT82E-16, IT82E-32, IT84E-116, IT82E-49, IT83D-320-10, IT83S-68009, IT84D-513, IT83S-728-5, IT82D-875, IT82D-872, IT81D-1228-10, IT83S-911, IT81D-1228-16, Bambey 26, Ndiambour, Sumbrizie, ICV-8, TKx 133-16D-1, TKx 133-16D-2, YLCC-784, Bush Sitao, CNCY 105-22E, PI 218123, P1 302457, PI 352830…	1d	Genotypes in Group ld were similar to Groups la to lc in terms of having a day neutral photoperiod response for floral bud initiation. However, genotypes in this group exhibited a strong photoperiod × temperature interaction for floral bud development. Development floral buds of Group ld genotypes was suppressed under hot long day conditions.	CB5, H8-8-31 Hg-14-18, H8-14-19, H35-5-6, H14-10-10
5	V	Similar to Group IV, except that they exhibit suppression of floral bud development at all nodes on the main stem.	Snapea, Frcezegreen, IT82E-41, IT82E-60, IT82E-25, Bambey 21	1e	Group le differed from Groups la to ld by producing first floral buds at branch nodes and had an intermediate, rather than a short, juvenile period. Group le genotypes were similar to Group lc in having an intermediate duration of floral bud	Ndiambour, IT86D-715 IT86D-719

					development under both hot short and hot long days and exhibiting strongly reduced grain yields under hot long days.	
6	VI	Longer durations to first macroscopic floral bud. Exhibit substantial floral bud abortion, and retarded peduncle elongation and produce virtually no flowers under high temperature conditons	C-152, CG-331, V-16, CG-566, Vita 1, Vita 3, Vita 4, Vita 5, TVx 1193-7D (Vita 6), TVx 1836-015J, TVx 309-1G, 4R-0267-01F (Vita 11), IT82E-56, IT82D-812, IT83D-356-1, IT83S-689-4, IT83S-818, IT82E-27, IT82D-786, ITglD-1069, IT81D-1205-174, TVx 1836-013J (Vita 10), TVx 1948-01F (Vita TVx 3627-012F, TVx 3871-02F, TVx 4654-44E, TVx 4659-02E, TVx 4661-07E, TVx 4677-010E, TVx 4677-088E, IT83S-871, IT84S-2137, IT84S-2212-1, ITglD-988, IT81D-994, ITglD-1007, ITglD-1020, IT81D-1032, IT81D-1064, ITglD-1137, ITglD-1151, ITglD-1157, IT84D-434, IT84D-453, IT84D-460, IT84S-2246-4, IT82D-812, FARV13, TVx 3442-027E, ITglD-1228-12, IT81D-1228-13, IT81D-1228-14, Bambey 4, Bambey 5, 58-57, Mougne, 58-74-L, 58-74-L39, Sumbrisogla, Vallenga, ICV-I, ICV-2, ICV-3, ICV-4, ICV-5, ICV-6, ICV-7, ICV-9, ICV-I 1, ICV-12, ICV-13, ICV-14, TKx 9-11D (Tumalni), Bots-17D, Bots-35, Bots-161, Bots-177, Bots-187, Bots-209, Bots-223, Bots-261E, Serido, Quarenta Dias, CNCx 24-015E, CNCx 24-	2a	Groups 2a were main stem first flowers types, and under long days, they exhibited an increase in first reproductive node of four nodes under moderate temperatures but an increase in first reproductive node of only 0.5 to 1 node under hot temperatures.	Bambey 23

			016E, CNCx 27-2E, CNCx 87-7E, CNCx 105-10E, CNCx 105-12E, CNCx 105-18E, CNCx 105-24E, CNC 77-1E, CNC 04-34,			
7	VII	Had longer durations to first macroscopic floral bud than Group VI, exhibited substantial floral bud abortion, and retarded peduncle elongation and produce virtually no flowers	Clay, NP-I, CO4, S 288, IHR-61-B, KBC-I, V-701, CG-108, V-240, V-105, V-385, UPC-126, UPC-125, KN-I (Vita 7), IT83D-235, IT83D-328-4, IT83D-326-2, IT82E-3, TVx 4659-03E, IT84S-2049, IT81D-985, TVu 21, 58-185, Suvita 2, KVu 69, TN 5-78, UCR 451, Bots-255, Bots-382, YPS1 1084, Frijol Toro, Frijol Sarabando, Frijol Torito, XPelon blanco, Frijol Soya, Frijol Pelon, Frijol Carilla, Frijol Chino, Pittiuba, CNCx 105-5E, CNCx 77-1E, CNC 39-3E	2b	Groups 2a and 2b both had short juvenile periods but differed in that 2b exhibited floral bud suppression under hot long days, while 2a exhibited normal floral bud development under these conditions.	Bambey 21, IT84S-2049, IT87D-590-5
8	VIII	Produce no apparent floral buds at least during the 100 days of observation	N'Dout, TN 88-63, UCR 449, UCR 450, UCR 278, UCR 279, UCR 280, UCR 281,	2c	Groups 2c produced their first floral buds on branches and exhibited photoperiod-induced delays in bud appearance under hot conditions. Group 2c genotypes had an intermediate juvenility period and little bud suppression and produced flowers.	Vita 5, B89-600 Suvita 2,
9		NA		2d	Groups 2d produced first floral buds on branches and exhibited photoperiod-induced delays in bud appearance under hot	IT81D-1007, Sumbrisogle, IT89KD-355

					conditions. These genotypes had a long juvenility period and exhibit complete abortion of floral buds.	
10		NA		3a	Group 3 genotypes did not initiate floral buds under the long days of atleasts 100 days. They have a longer juvenile period.	IT89KD-107-5, IT89KD-260, IT89KD-288, IT89KD-245, IT89KD-252
11		NA		3b	Under short days, these genotypes required between 35 and 42 d for bud appearance under hot and moderate temperatures, respectively.	Vita 3, KN-l (Vita 7), TN88-63, N'dout

NA = grouping not made by Patel and Hall 1990.

Table S2. Representative list of heat-tolerant cowpea genotypes, traits assessed, screening environments, and temperature regimes from various studies

No.	Tolerant lines	Susceptible lines	Traits assessed	Screening Environments	Photoperiod	Temperature regimes/Remarks	Studies Objectives	References
1	Prima	IT84S-2246	DTF, DTM, NOB, PB, FP, NPP, PS, PP, and PDW	Controlled reach-in growth cabinets	Short days	30/24 °C and 36/27 °C day/night temp.	Testing heat tolerance under hot, short-day conditions	[3]
2	TVu 4552, PI 204647, and 'Prima'. **P1339593, PI 293497, Bambey 23, Magnolia, PI 307558 (genotypes in italics are classified as moderate to high heat tolerance)*	CB5, CB7, Bambey 12, 13, 14,15, 21, 22, 26, 27, 28, 29, 30 & 32, Vita 4, Vita5, TVu 984, TVu 401, TVu 3046 plus 31 others	DTF, NFA, pollen viability, ovule viability, NPP, SPP and other yield components	Hot long-day field conditions and reach-in growth chambers	Long days	33/22 °C and 33°/30 °C day/night temp. *58 diverse genotypes were assessed in this study	Heat tolerance in cowpeas at the flowering stage	[4]
3	NA	CB5	DTF, NP, NF, pollen viability, ovule viability, NOB, PHT, number of	Growth chambers and hot field conditions	Long days	33/22°C and 33/30°C day /night temp. **CB3, CB5, Chino, Chino-E1, CB5-E1, and 7964* were	Responses of cowpea to night temperatures	[5]

			leaflets, leaf area, area per leaflet, number and length of internode, specific leaf weight, SDW, percentage indehiscent anthers, percentage of flowers with no pollen on stylar brush, number of pollen grain per anther, and yield components			tested under hot field conditions.		
4	NA	CB5	Seedling emergence count, mineral contents of leaves, PHT, number and length of internode, NOB, leaflets, leaf area, SDW, days to emergence of floral bud, first flower, anthesis to maturity, and yield components	Reach-in Growth chambers	Long days	27/19°C and 33/19°C day/night temp.	Effect of air and soil temperatures on cowpea seed yield	[6]
5	Prima, TVu 4552, 779 (UCR 204), PI 204647, 750-1, IT84D-448, IT84D-449, IT84S-2127, 7964 etc	CB5, 8006, 8043, IT82E-18, PI 218123, TVx 12-01E, IT82E-60, T82E-25, 58-57, Vita 3,	Days to first macroscopic floral bud, flowering, extent of floral bud abortion, peduncle	Hot field environments and Growth chambers	Long days	35/17 °C to 41/24 °C daily max/min temp. *The list here is representative of	Response of diverse cowpea genotypes to reproductive heat tolerance	[1]

		Magnolia, Queen Anee, CB3, CBS, CB46, CB77, Mississippi, silver, Hercules, Colossus 80, KN-1, Suvita2, TN88-63, N'Dout etc	elongation, and pod set			the 268 accessions studied.		
6	IT93K-452-1, IT98K-1111-1, IT93K-693-2, IT97K-472-12, IT97K-472-25, IT97K-81943, IT97K-499-38	NA	High yield-trait advantage	NA		NA	Screening for heat	[7]
7	Epace 10 and Marataoã	Pujante	Germination, length of shoot, and root, seedling dry weight	Biochemical Oxygen Demand Germination chamber		20, 25, 30 and 35°C	Evaluate the tolerance to salt stress at different temperatures	[8]
8	TVu4552 and Prima	CB5	Percentage flower abscission, NP, seed weight, SPP, and seed yield	Field environment supplemented with thermostats		34.0/15-25.5 °C daily max/min temp.	Responses to different levels of night air temperature during flowering	[9]
9	Itaim	Carijó, Pujante, Rouxinol, and Tapahium	Phenological, physiological, biochemical, and yield aspects	Growth chambers		Two temperature regimes as 20–26–33 °C and 24.8–30.8–37.8 °C for night, morning, and afternoon periods	Screen cowpea cultivars tolerant to high-temperature stress using	[10]

							multiple parameters	
10	Tapaihum	Pujante, and Canapu,	NPP, number of grains per pod, seed weight, shoot fresh and dry matter weight	Growth chambers		26-32 /20-29 ºC day/night temp.	Impact of the increased temperature and CO2 concentration on the development of cowpeas	[11]
11	IT96D-610	NA	Heat shock proteins, and other stress-protective proteins	Controlled Glasshouse, and field environments		26–28°C (warm temperatures) to 30–32°C (hot temperatures) field environments	Expression of heat shock proteins and other stress-protective proteins against heat stress in cowpea	[12]
12	Genotype H36	CB5	Leaf electrolyte leakage, NPP, NP, PHT, harvest index, GYD, vegetative dry weight	Growth chambers, glasshouse, and Hot field environment	Lond days	33/20 °C day/night temp.	Glasshouse has 37/26 °C day/night temperatures.	[13]
13	IT97K-472-12, IT97K-472-25, IT97K-819-43, & IT97K-499-38	IT97K-461-2 & IT97K-461-4	Number of flowers, pod set, and GYD	Field environment in Kano, Nigeria	Short days	40/25.5 °C day/night temp.	102 cowpea breeding lines were grown at IITA Kano Station from March to May	[14].

14	Genotype 7964	CB5	Floral bud weight and length, DTF, flowers per plant, pod set, anther dehiscence, pollen viability, number of first reproductive nodes, days to macroscopic buds	Greenhouses and growth chambers	Long days	33/20 and 33/30 °C day/night temp.	Impact of high temperature on floral development	[15]
15	NA	CB5	Nodal position of the first reproductive node, days after germination to first macroscopic bud and first flower, number of flowering peduncles, and peduncle length	Reach-in growth chambers supplemented lighting system	Long days	33/20 and 33/30 °C day/night temp.	Knowing the effect of heat stress on specific developmental stages causing abortion of floral buds	[16]
16	Genotypes 518 and 7964	CB5	Position of the first reproductive node, days to first macroscopic bud, first flower, number of flowers and pod set, carbohydrate contents of the peduncle, starch in leaves, stems and peduncles,	Reach-in growth chambers	Long days	33/20 or 33/30 °C, day/night	Responses of cowpea lines to ambient and elevated CO2, under heat stress and optimal temperature	[17]

			Photosynthesis rate, leaf area and SDW					
17	TN88-63, A73-2-1 and TVx 3236	TN5 78, TN27 80, Danila, Tera local, Sadore local, 58 57, B99 21, Suvita 2, Kvx 61 74, Kvx100 2, IT83D 328-4-1, IT84E1-108	NF, PS and GYD	Hot field environment near Niamey, Niger Republic	Short days	41.4/26.5 °C day/night	Variability for reproductive efficiency under high-temperature conditions	[18]
18	H36, 1393-2-1, H8-8-27, H8-14-12, H14-10-1N, and H35-5-10	CB5, 1393-1-11, H35-5-6, H8-8-1N, H8-14-18, and H14-10-10	PHT, SDW, NPP, SPP, SDWi = individual seed weight and HI = harvest index	Field environments	Long days	17-28 °C night temperatures	Positive and potential negative effects of the heat-tolerance genes on reproductive development	[19]
19	CB27	CB5	Flower production, NPP	Hot field conditions	Long days	NA	Performance trials under hot field conditions	[20]
20	TVu4552, Prima, H14-10-27, H14-10-23, H8-14-13, H8-8-4, H8-9-3, 518-2, B89-600, TN88-63 etc	CB5, H8-8-31, IT82E-60, Bambey 21, IT84S-2049 and wide range of accessions	DTF, NPP, NP, and GYD	Greenhouses	Short-day conditions	32/18 °C, and 36/27 °C day and night temp.	Testing lines are known to be heat-tolerant in long-photoperiod under hot, short-day conditions.	[21]

21	Prima and TVu4552	Bambey 23, 'Magnolia' and 7964	NPP	Field environment	Hot long-days	43/24 °C day and night temp.	Genetics of heat tolerance during reproductive development	[22]
22	518-22, Prima, TVu4552, H8-9-3, H8-8-4, H8-14-13, H14-10-23, H14-10-27 etc	CB5, H8-8-31, H8-14-18, H8-14-19, H35-5-6 etc	Photoperiod response, DTF, PS and GYDP = grain yield per plant	Field and glasshouses conditions	Long and short days	31.5-38/16.5-22.5 °C and 32-35/18-26°C day/night temp. field and glasshouse, respectively	Classification of cowpeas based on responses to heat and photoperiod	[2]
23	IAR-48, GEC, IT98K-277-2, Yacine, and IT98K-1092-1	Big John, IT98K-589-2, It98K-476-8, CB-46, and White Acre	DTF, visual heat ratings, seed weight, pod number, pod weight, and weight of 100 seeds	Field environments and Glasshouse	Long days	32 to 37/ 20 to 26 °C day/night temp.	Variability for heat tolerance	[23]

NA = not applicable because no information is available from the study. DTF = days to flowering, DTM = days to maturity, NOB = number of branches, PB = peduncles per branch, FP = flowers per peduncle, NF = number of flowers, NP = total number of pods, NPP = number of pods per peduncle, PHT = plant height, PS = pod set (%), PP = pods plant, PDW = pod weight per plant, SDW = shoot dry weight and SPP = number of seeds per pod.

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