

**Appendix A** Cluster of the 593 tropical and temperate maize inbreds using the Neighbor-Joining (NJ) tree constructed with genotypic data from Maize 55K SNP array. Iodent, Iowa Experiment Station Reid Yellow Dent; LAN, Lancaster group; PA, group A germplasm; Reid, Reid group; SPT, Sipingtou; PB, group B germplasm; Tropic, Tropical.

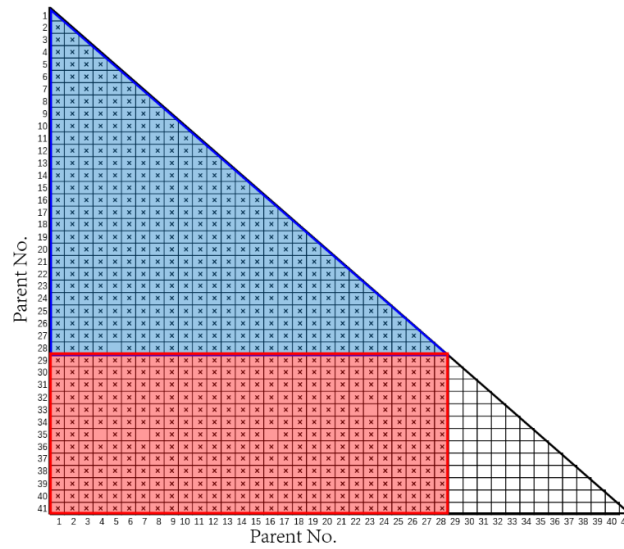
**Appendix B** Phenotypic traits<sup>1)</sup> of maize parental inbreds used in a diallel crossing system evaluated under well-watered (WW) and drought-stressed (DS) treatments

No	Name	Putative HG <sup>2)</sup>	GWPP		Drought Tolerance <sup>3)</sup>	DTI	DTS		ASI		KPR		Origin
			WW	DS			WW	DS	WW	DS	WW	DS	
1	Nan21-3	BSSS	87.3	66.9	S	23	65.5	65.5	4.5	6.5	26.4	23.7	China
2	H21	SPT	120.8	58.5	C	52	67.3	68.8	2.3	2.8	22.8	21.0	China
3	Zheng22	SPT	70.1	47.9	S	32	60.3	63.0	4.8	5.5	17.0	16.9	China
4	Si287	SPT	92.5	66.1	S	29	58.8	58.3	2.5	4.8	25.3	22.3	China
5	PHN47	SPT	118.5	83.7	S	29	63.3	62.8	1.5	2.0	19.0	17.8	USA
6	LX9801	SPT	84.2	67.6	D	20	68.0	68.0	2.3	4.3	28.0	25.6	China
7	HZ4	SPT	61.6	49.3	D	20	63.5	62.8	3.3	3.8	21.0	23.5	China
8	Chang7-2	SPT	71.8	57.8	D	20	69.3	71.8	3.0	3.1	24.8	22.8	China
9	LH132	NSS	86.8	62.5	S	28	58.3	58.5	5.0	6.0	24.2	23.6	USA
10	NK764	NSS	65.0	44.9	S	31	58.5	58.5	3.8	4.5	25.1	19.4	USA
11	PHG83	NSS	94.5	49.4	S	48	59.5	58.5	4.0	5.3	27.3	23.3	USA
12	PH6WC	BSSS	121.7	91.2	C	25	66.5	65.8	2.3	5.8	27.8	24.5	USA
13	Tie7922	BSSS	123.2	87.8	C	29	66.5	67.3	2.0	2.8	29.0	24.9	China
14	PH4CV	NSS	75.2	53.8	C	29	65.3	66.8	2.8	3.8	23.6	19.7	USA
15	LH51	NSS	72.0	48.4	C	33	60.5	61.5	4.0	6.5	23.1	16.0	USA
16	Dan598	PB	88.7	67.2	C	24	66.8	66.3	3.8	4.8	20.3	17.2	China
17	HuangC	BSSS	57.9	35.6	S	39	67.5	70.3	6.0	5.7	17.1	17.6	China
18	Ye478	BSSS	92.4	66.5	S	28	68.3	69.5	3.3	6.3	21.6	20.5	China
19	Dan340	NSS	77.4	64.3	C	17	68.0	68.0	5.0	9.0	22.8	19.7	China
20	NS701	NSS	92.9	66.1	C	29	64.8	65.3	2.0	3.0	27.0	23.5	USA
21	18-599	PB	25.3	27.6	C	-9	79.8	87.5	7.8	8.3	13.4	16.9	China
22	Qi319	PB	69.9	46.8	S	33	69.0	74.0	5.5	6.0	24.0	20.6	China
23	Mo17	NSS	108.5	73.8	C	32	62.0	63.8	5.5	6.0	34.9	28.2	USA
24	Zheng58	BSSS	104.0	76.2	S	27	64.0	62.5	1.8	3.5	25.1	20.5	China
25	AS6103	BSSS	79.2	67.3	D	15	59.8	58.5	2.5	5.3	23.2	21.7	USA
26	F42	BSSS	97.5	57.2	S	41	64.0	64.5	2.3	4.8	26.7	22.3	USA
27	FAPW	BSSS	96.3	73.4	C	24	66.5	67.3	1.5	4.5	26.6	19.7	USA
28	B73	BSSS	67.0	52.4	S	22	64.8	67.3	2.0	4.3	23.0	20.7	USA
29	Chuan29Female	PB	44.4	35.4	D	20	79.3	81.8	5.8	6.5	23.1	16.5	China
30	TR0501	Tropic	54.8	48.7	D	11	73.8	74.5	7.3	10.3	20.5	30.5	CIMMYT
31	Qi205	Tropic	111.2	64.4	C	42	68.3	69.8	3.0	5.3	26.6	18.2	China
32	622016-ZCN-2	Tropic	45.7	35.1	S	23	75.3	75.8	2.8	4.5	20.0	17.9	CIMMYT
33	CML84	Tropic	56.4	34.9	S	38	73.0	76.0	6.5	12.8	16.8	14.6	CIMMYT
34	DTMA227B	Tropic	45.2	30.1	S	33	73.8	75.0	1.0	2.0	14.2	13.1	CIMMYT
35	CML96	Tropic	36.0	36.3	D	-1	73.3	76.0	6.3	6.5	12.7	15.3	CIMMYT
36	CML312SR	Tropic	59.9	39.3	C	34	75.3	77.5	3.0	5.0	22.0	16.9	CIMMYT
37	CML312SRQ	Tropic	66.3	57.2	D	14	78.3	81.5	5.3	8.3	20.8	19.8	CIMMYT
38	CML418	Tropic	63.8	42.1	S	34	65.3	67.8	3.3	4.8	19.2	17.2	CIMMYT
39	TR0395	Tropic	36.6	28.6	S	22	70.3	71.8	5.3	8.0	24.3	15.6	CIMMYT
40	TR0403	Tropic	28.1	18.3	S	35	78.5	81.0	9.3	12.3	16.9	35.2	CIMMYT
41	CML206	Tropic	22.3	22.6	D	-1	81.5	84.8	6.0	7.0	11.8	13.5	CIMMYT

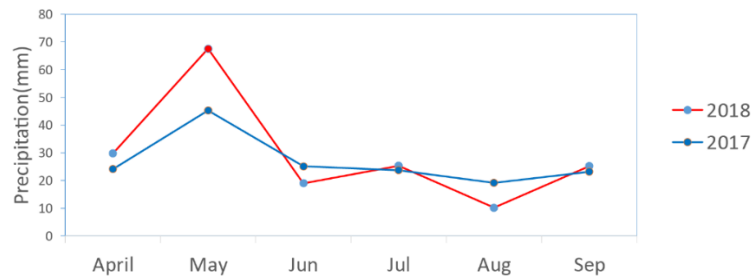
<sup>1)</sup> GWPP (g plant<sup>-1</sup>), grain weight per plant; DTS (day), days to silking; ASI (day), the anthesis-silking interval; KPR, kernel number per row.

<sup>2)</sup> Putative HG, heterotic group; BSSS, Iowa Stiff Stalk Synthetic; NSS, non-Stiff Stalk; PB, group B germplasm; Tropic, Tropical; SPT, Sipingtuo.

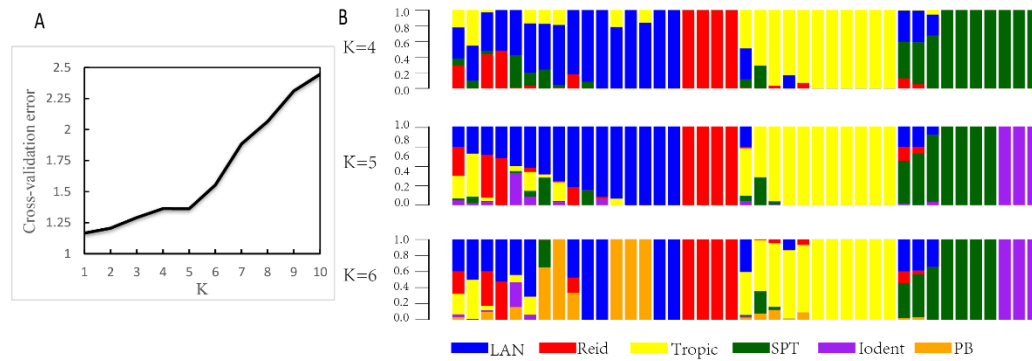
<sup>3)</sup> Selection criteria of the lines are high general combining ability for yield potential (C); drought tolerance (D); drought-sensitive (S); DTI, drought tolerance index (Derera *et al.* 2008).



**Appendix C** Development of a multi-hybrid population with an incomplete diallel design. The population developed in this study with two sets of hybrids, a set of diallel hybrids (blue triangle) from 28 temperate inbred lines (P1-28), and the other NC II hybrids (red rectangle) from 13 tropical inbred lines (P29-41) with 28 maize inbred lines.



**Appendix D** Precipitation data in Shihezi (China) for the growing seasons during 2017–2018.



**Appendix E** Population structure for 41 maize inbreds generated from 38,737 SNPs. (A) Plot of K was calculated for K = 1 to K = 10. (B) Population structure for the 41 lines from K = 4 to K = 5 and K = 6.

**Appendix F** Analysis of variance for 41 maize inbreds under well-watered (WW) and drought-stressed (DS) treatments in two years

Source of variation 1)	df	DTA <sup>2)</sup>	DTS	ASI	PH	EH	RN	KPR	GWPP
<b>Well-watered condition</b>									
Rep/Env	2	10.3*	10.3	0.0	492.7	18.3	0.7	2.0	281.7
Geno	40	158.3**	219.6**	14.8**	3142.2**	3070.8**	14.7**	93.1**	2962.8**
Env	1	2894.6**	2129.8**	58.6**	2896.7**	3.0	3.1	296.0**	2126.1**
Geno×Env	40	3.8**	4.8*	2.6	185.9	106.2	1.5*	31.1**	292.3*
Error	80	1.9	3.0	2.0	177.9	99.5	1.0	6.1	161.4
<b>Managed drought stress</b>									
Rep/Env	2	0.0	7.0	7.9	181.0	92.0	0.0	11.8	149.1
Geno	40	225.6**	306.8**	22.9**	2147.0**	2167.0**	13.3**	81.4**	1226.4**
Env	1	1404.9**	672.1**	133.6**	42764.0**	12456.0**	19.0**	599.2**	2089.2**
Geno×Env	40	7.1**	9.2**	7.2**	570.0	152.0*	1.5	44.0**	305.5**
Error	80	3.6	4.6	3.4	388.0	91.0	1.0	12.6	142.3

<sup>1)</sup> Rep, replication; Geno, genotype; Env, years.

<sup>2)</sup> DTA (day), days to anthesis; DTS (day), days to silking; ASI (day), anthesis-silking interval; PH (cm), plant height; EH (cm), ear height; RN, row number; KPR, kernel number per row; GWPP (g plant<sup>-1</sup>), grain weight per plant.

\*, \*\* Significant at P<0.05 and <0.01, respectively.

**Appendix G** Mean squares in a combined analysis of variance for 737 hybrids evaluated under well-watered (WW) and drought-stressed (DS) treatments

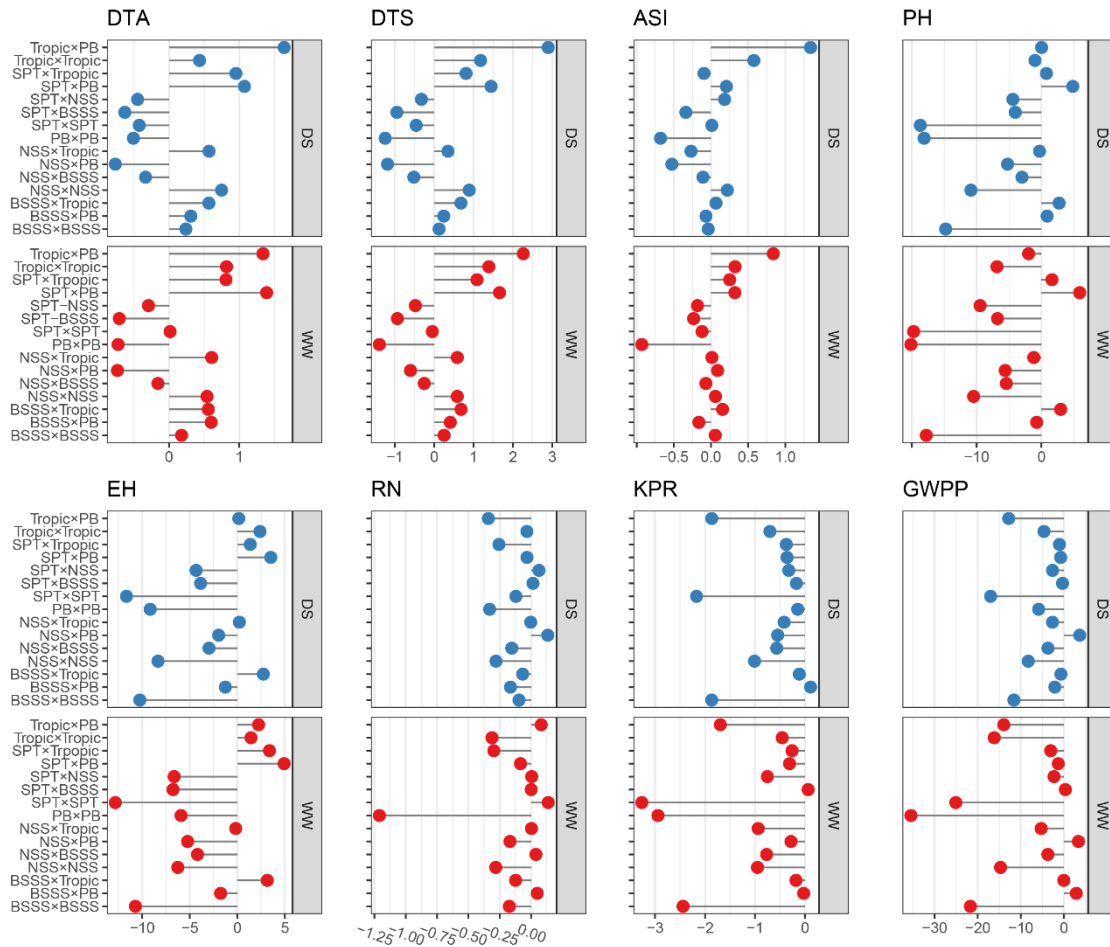
Source of variation <sup>1)</sup>	df	DTA <sup>2)</sup>	DTS	ASI	PH	EH	RN	KPR	GWPP
Well-watered condition									
Block/Rep×Env	36	325.27**	759.45**	1.42**	461.00**	1.51	0.06**	46.52**	1775.15**
Env	1	20696.32**	18466.04**	65.21**	104014.82**	83.43	1.37**	10153.94**	296573.24**
Rep/Env	2	337.24**	323.46**	0.13**	2174.11**	0.39	10.50**	122.61**	13360.54**
Geno	736	33.14**	42.95**	4.85**	2337.14**	1506.17**	9.34**	74.80	2659.84**
GCA	40	371.07**	474.92**	42.8**	24407.06**	17025.13**	94.85**	435.48**	17238.93**
SCA	696	7.08**	9.63**	1.92**	634.61**	309.00**	2.74**	46.97**	1535.16**
Geno×Env	736	3.92**	4.85**	1.63**	318.13**	171.44**	1.97**	27.28**	1090.95**
GCA×Env	40	5.44**	10.99**	4.35**	787.42**	301.01**	5.12**	43.97**	3178.85**
SCA×Env	696	3.81**	4.38**	1.42**	281.93**	161.45**	1.73**	25.99	929.88**
Error	1408	1.52**	2.00**	1.01**	206.24**	104.90**	1.22**	24.51**	604.52**
GCA-SCA ratio		0.90	0.87	0.85	0.84	0.90	0.87	0.58	0.63
Managed-drought stress									
Block/Rep×Env	36	244.53**	8.52**	11.25**	18862.45**	730.10*	12.01**	8.92**	202.43**
Env	1	9221.40**	123.43**	7198.02**	957486.48**	241454.35*	683.95**	55900.25**	853624.09**
Rep/Env	2	45.76**	148.48**	57.82**	9471.72**	748.87*	5.17**	309.05**	3561.23**
Geno	736	40.18**	58.97**	14.45**	1859.69**	1089.87**	5.78**	48.23**	856.54**
GCA	40	419.75**	585.42**	78.50**	12499.39**	10767.16**	49.01**	173.05**	3143.70**
SCA	696	10.90**	18.36**	9.50**	1038.92**	343.33	2.45**	38.60**	680.10**
Geno×Env	736	9.68**	15.58**	9.18**	1089.17**	285.42**	2.73**	42.91**	633.89**
GCA×Env	40	22.36**	53.58**	32.27**	2484.50**	700.51**	8.55**	63.96**	1647.99**
SCA×Env	696	8.70**	12.64**	7.40**	981.53**	253.40*	2.28*	41.28**	555.66**
Error	1403	4.17**	4.48**	2.89**	629.69**	201.90**	1.97**	30.13**	337.16**
GCA-SCA ratio		0.93	0.88	0.62	0.93	0.90	0.95	0.48	0.46

<sup>1)</sup> Rep, replication; Geno, genotype; Env, years; SCA, specific combining ability; GCA, general combining ability; GCA-SCA ratio, the relative importance of GCA and SCA was calculated as:

$$\frac{2\delta_{GCA}^2}{(2\delta_{GCA}^2 + \delta_{SCA}^2)} \text{ (Makumbi et al. 2011).}$$

<sup>2)</sup> DTA (day), days to anthesis; DTS (day), days to silking; ASI (day), anthesis-silking interval; PH (cm), plant height; EH (cm), ear height; RN, row number; KPR, kernel number per row; GWPP (g plant<sup>-1</sup>), grain weight per plant.

\*, \*\* Significant at P<0.05 and <0.01, respectively.



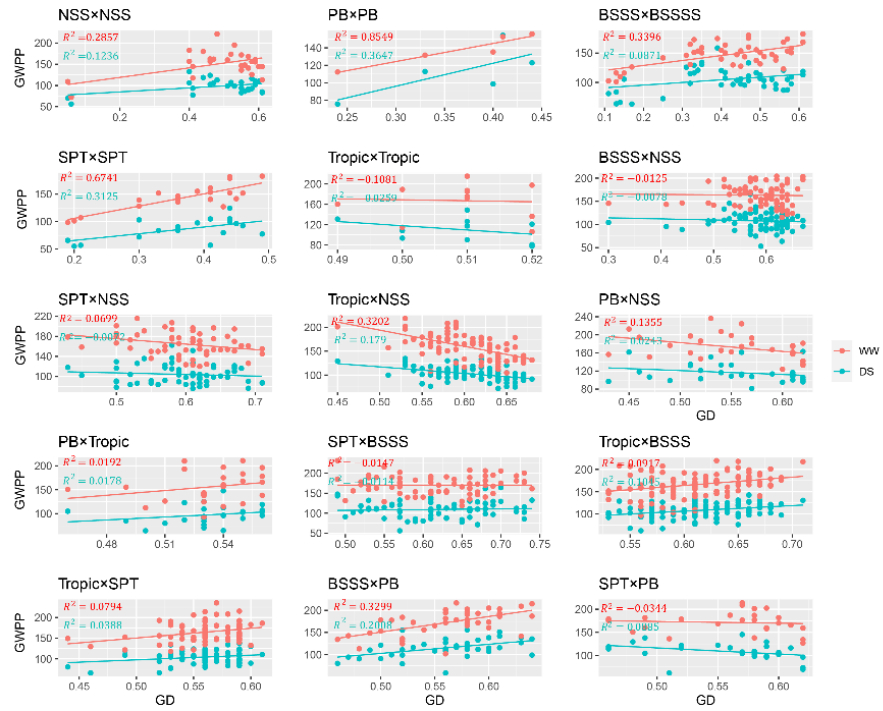
**Appendix H** Specific combining ability (SCA) between heterotic groups under well-watered (WW) and drought-stressed (DS) treatments. DTA (day), days to anthesis; DTS (day), days to silking; ASI (day), anthesis-silking interval; PH (cm), plant height; EH (cm), ear height; RN, row number; KPR, kernel number per row; GWPP (g plant<sup>-1</sup>), grain weight per plant; BSSS, Iowa Stiff Stalk Synthetic; NSS, non-Stiff Stalk; PB, group B germplasm; Tropic, Tropical; SPT, Spingtout.

**Appendix I** General combining ability effects estimated under well-watered (WW) and drought-stressed (DS) conditions

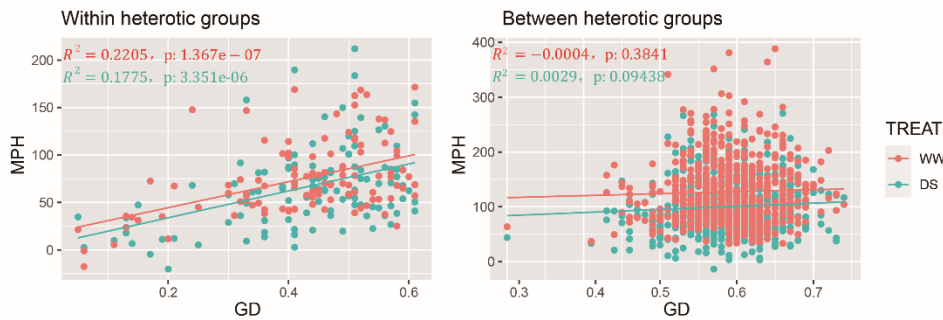
Line	DTA <sup>1)</sup>		ASI		PH		KPR		GWPP	
	WW	DS	WW	DS	WW	DS	WW	DS	WW	DS
NK764	-5.23	-6.08	-0.28	-1.21	-31.93	-10.11	-2.22	-3.63	-25.12	-16.21
AS6103	-3.35	-3.35	-0.83	-1.04	-24.18	-10.29	-0.92	-0.66	-2.36	3.63
F42	-1.64	-1.75	-0.68	-1.21	-10.66	-1.87	1.20	0.93	3.53	7.36
FAPW	-0.72	-0.81	-0.82	-1.37	-5.58	-2.22	2.51	1.53	7.83	2.77
LH51	-2.24	-2.12	-0.22	-0.17	-4.54	2.38	4.35	3.09	6.87	3.57
LX9801	0.80	1.65	-0.48	-1.33	11.12	7.54	1.21	1.14	6.19	4.14
NS701	-1.68	-1.69	-0.69	-0.98	2.11	4.13	2.33	1.17	11.63	6.99
PHG83	-4.07	-4.42	-0.31	-1.15	-25.20	-11.10	-2.30	-1.93	-20.93	-10.20
PHN47	-2.72	-3.36	-1.27	-1.53	-14.36	-3.09	-1.68	-2.12	-2.38	-1.89
Dan340	0.03	-0.32	0.50	1.65	-4.98	-3.69	0.23	1.28	16.14	4.76
H21	0.61	0.73	-1.13	-0.46	26.15	12.74	0.60	-0.10	21.30	7.03
HZ4	-1.90	-2.04	-0.09	-0.16	-11.86	-3.07	-0.67	-0.52	1.12	-4.80
Nan21-3	-1.27	-1.87	0.70	1.09	-14.90	-4.78	-2.16	1.61	-11.45	-3.20
Qi205	0.94	1.33	0.13	0.55	1.11	1.88	0.71	-0.60	22.80	8.05
Ye478	0.19	-0.34	0.02	0.89	-26.09	-6.39	-0.67	-0.44	-7.80	-6.63
B73	-1.55	-1.77	-0.34	0.27	-9.53	-6.10	2.39	1.77	5.58	3.46
LH132	-4.22	-4.82	-0.02	0.24	-20.50	-6.99	-3.80	-1.40	-21.85	-5.48
Mo17	-1.35	-2.37	0.29	0.67	-3.11	3.09	4.02	1.16	10.91	4.22
PH4CV	-1.81	-1.88	-1.56	-1.39	-6.97	-1.01	0.43	1.38	9.59	5.42
PH6WC	-1.36	-1.42	-1.55	-1.27	0.31	3.05	-1.01	0.13	13.02	12.22
Chang7-2	0.00	-0.52	-0.51	0.05	-11.43	-6.48	0.81	0.43	-3.97	-5.29
Qi319	2.63	3.24	1.33	1.76	3.47	1.94	-1.26	0.80	-4.03	3.93
Si287	-4.70	-4.67	-0.83	0.38	-16.92	-3.64	-2.66	-3.52	-6.16	-10.40
Tie7922	0.57	0.52	-0.41	0.00	20.94	8.97	2.48	2.63	13.22	12.30
Zheng22	-4.03	-3.99	-1.12	-1.05	-29.64	-11.15	1.37	-0.12	-7.25	-6.26
Zheng58	-1.75	-2.14	-0.63	-0.35	-31.09	-8.82	-0.23	-0.38	-5.01	-1.94
Dan598	1.78	1.67	1.17	1.69	0.69	2.21	-0.54	0.93	10.81	11.32
HuangC	1.43	1.25	-1.07	-1.13	-27.59	-10.69	-3.40	-3.18	-11.76	-3.66
CML418	-1.34	-1.70	0.81	0.42	15.00	0.86	-2.65	-1.12	-9.29	-2.85
CML84	1.48	1.89	0.71	0.88	18.89	3.11	-3.84	-2.95	-6.90	-9.20
CML96	0.65	0.81	0.34	0.17	20.77	5.53	0.01	-0.35	3.87	6.68
Chuan29Female	5.79	6.53	2.15	1.58	16.26	3.56	1.43	1.38	-7.91	-0.59
TR0395	1.42	1.58	0.88	0.59	23.74	8.79	0.62	0.08	-7.51	-3.96
TR0403	4.71	4.97	1.39	1.18	26.41	8.90	2.03	3.41	-1.55	0.82
18-599	4.81	5.95	2.52	2.44	27.45	9.63	1.60	-0.30	12.49	3.17
622016-ZCN-2	4.32	4.77	-0.21	-1.47	-1.91	-5.53	0.44	0.28	-20.20	-8.01
CML206	3.07	3.54	1.07	1.37	35.19	7.88	2.01	-0.25	1.49	-7.07
CML312SR	3.32	3.61	0.33	0.07	8.62	0.66	2.31	0.63	9.02	1.18
CML312SRQ	3.49	4.10	0.34	-0.14	27.88	7.55	-2.32	-1.46	-2.05	-3.35
DTMA227B	1.91	2.08	-0.65	-0.91	26.07	5.32	-1.24	-1.31	-6.40	-6.16
TR0501	2.96	3.19	1.01	0.37	20.78	7.28	-1.49	0.59	4.51	4.12
Summarized by parental group involved in hybrids										
PB <sup>2)</sup>	3.75	4.35	1.79	1.87	11.97	4.34	0.31	0.70	2.84	4.46
SPT	-1.71	-1.74	-0.78	-0.59	-6.71	-1.02	-0.15	-0.69	1.26	-2.50
BSSS	-0.95	-1.17	-0.56	-0.41	-12.84	-3.91	0.02	0.39	0.48	2.63
Tropic	2.24	2.51	0.51	0.26	18.55	4.35	-0.28	-0.25	-1.02	-1.65
NSS	-2.57	-2.96	-0.29	-0.29	-11.89	-2.91	0.38	0.14	-1.60	-0.87

<sup>1)</sup> DTA (day), days to anthesis; ASI (day), anthesis-silking interval; PH (cm), plant height; KPR, kernel number per row; GWPP (g plant<sup>-1</sup>), grain weight per plant.

<sup>2)</sup> BSSS, Iowa Stiff Stalk Synthetic; NSS, non-Stiff Stalk; PB, group B germplasm; Tropic, Tropical; SPT, Sipingtou.



**Appendix J** Relationship between GWPP and GD between heterotic groups under well-watered (WW) and drought-stressed (DS) conditions. GWPP (g plant<sup>-1</sup>), grain weight per plant; GD, genetic distance between parents; BSSS, Iowa Stiff Stalk Synthetic; NSS, non-Stiff Stalk; PB, group B germplasm; Tropic, Tropical; SPT, Sipingtou.



**Appendix K** Relationship between MPH and GD under well-watered (WW) and drought-stressed (DS) conditions. MPH (%), mid-parent heterosis; GD, genetic distance between parents.