

**Table S1.** 303 inbred lines of the maize association analysis population used in this study.

Name	Pedigree	Origin	Subpopulation	K_Volume	EM_Volume	EN_Volume	C_Volume	EM_RatioRe mb	EN_Ratio	C_Ratio
XI502	Dan340×Huang ZaoSi	China	NSS	217.26344	29.50310	156.78649	5.72643	0.13579	0.72164	0.02636
CIMBL11 2	(MBR C6 AmF9-2-B-#-3- 1-BBBBB)-B	CIMM YT	TST	199.25430	20.71110	154.47302	3.29158	0.10394	0.77526	0.01652
5237	Dan340×Huang ZaoSi	China	NSS	172.18413	16.76755	130.44670	4.88629	0.09738	0.75760	0.02838
SI444	A619×HuangZ aoSi	China	NSS	153.29041	21.07933	114.43046	0.75964	0.13751	0.74649	0.00496
4019	G108×G172	China	NSS	168.62693	14.70888	131.49276	2.83811	0.08723	0.77979	0.01683
HZS	TangSiPingTou	China	Mixed	204.92370	21.48689	158.89825	2.73762	0.10485	0.77540	0.01336
SI273	American Hybrid	China	NSS	265.05102	34.92588	201.26654	3.83439	0.13177	0.75935	0.01447
HB	Huojiabaimaya	China	Mixed	194.43774	20.73894	150.67699	2.42564	0.10666	0.77494	0.01248
NMJT	Landrace	China	Mixed	197.12327	26.22301	145.13407	3.35583	0.13303	0.73626	0.01702
CIMBL54	([SAM4/BETA SYN]BC2FS21 -4-3-B)-B	CIMM YT	TST	250.52372	36.70031	181.96150	5.57610	0.14649	0.72632	0.02226
DSB	Landrace	China	Mixed	189.41066	18.46235	142.40347	5.15040	0.09747	0.75182	0.02719
GY237	AIHO	China	NSS	256.32726	27.94534	199.19015	2.69409	0.10902	0.77709	0.01051
A619	The University of Illinois, USA	USA	NSS	260.35712	32.65609	188.10132	5.68992	0.12543	0.72247	0.02185

EN25	Unkown	China	Mixed	217.98815	20.45475	148.34466	3.73735	0.09383	0.68052	0.01714
RY737	RYD	China	Mixed	230.04037	21.38838	171.32266	2.14007	0.09298	0.74475	0.00930
B114	Pool 41	China	NSS	236.98952	30.57108	171.32253	4.90977	0.12900	0.72291	0.02072
LIAO138	Improved from Dan340	China	NSS	239.76800	25.47641	156.33480	3.76332	0.10625	0.65203	0.01570
RY684	RYD*	China	NSS	209.36373	29.47160	139.03599	6.50309	0.14077	0.66409	0.03106
J153	Derived from Ji Synthetic C0-2	China	NSS	149.35601	13.64525	103.10563	4.87708	0.09136	0.69033	0.03265
TY10	TY30331-2-8-1 -1-3-2	China	Mixed	236.75646	22.09267	168.65523	5.30348	0.09331	0.71236	0.02240
WU109	XiDan7	China	Mixed	205.70728	27.44055	136.20897	4.65898	0.13340	0.66215	0.02265
GEMS44	CH05015:N12- 140-1-B-B	USA	Mixed	252.77519	24.35420	183.90513	2.50660	0.09635	0.72754	0.00992
TX5	Landrace	China	NSS	188.13204	38.46103	115.66264	2.21113	0.20444	0.61480	0.01175
YU87-1	American Hybrid	China	NSS	334.36905	67.45054	184.65361	5.97849	0.20172	0.55224	0.01788
ZHENG5 8	Variant plants from Ye478	China	NSS	196.16014	29.93310	130.03961	4.60763	0.15260	0.66293	0.02349
W138	Unknown	China	NSS	234.76159	45.68432	142.47038	4.77590	0.19460	0.60687	0.02034
975-12	78698×Dan904 6	China	Mixed	206.92355	39.22960	122.13739	7.56627	0.18958	0.59025	0.03657
CML422	G17TSRH5-2-4 -7-1-1-1-BBBB BBB	CIMM YT	TST	194.20022	43.39567	115.80649	1.51289	0.22346	0.59633	0.00779
CML423	G18C19H100#- 4-1-1-BBBBBB	CIMM YT	TST	162.56990	25.18361	105.73533	3.92267	0.15491	0.65040	0.02413

	BB									
GY462	AIHO	China	NSS	142.57671	24.56819	79.96443	7.02989	0.17232	0.56085	0.04931
ZHENG30	Zheng20×Ye478	China	NSS	184.88681	34.78742	107.52304	4.94734	0.18816	0.58156	0.02676
832	American Single-cross ([DTPYC9-F46 -1-2-1-1-B x	China	SS	197.72260	24.72080	111.61868	9.20988	0.12503	0.56452	0.04658
CIMBL48	DTPYC9-F74- 1-1-1-1-BB]-B- 4-1-B)-B	CIMM YT	TST	177.05755	19.43035	132.67739	2.83985	0.10974	0.74935	0.01604
SHEN135	Unknown	China	Mixed	233.77857	36.53819	170.93468	2.20979	0.15629	0.73118	0.00945
YAN414	HuangZaoSi	China	Mixed	169.95912	17.67631	129.28975	2.20143	0.10400	0.76071	0.01295
ZZ01	American Hybrid P78641	China	NSS	225.43291	20.24074	178.29140	2.49368	0.08979	0.79088	0.01106
GEMS58	ARI01150:N04 -696-1-B (PA91/LH98A)	USA	NSS	235.89392	29.67217	178.50418	2.98085	0.12579	0.75671	0.01264
IRF314	-6-420-64-2-1- 3-1-1-1	China	NSS	170.03009	20.36574	129.89829	1.20448	0.11978	0.76397	0.00708
CIMBL1	derived from BSCB1(R)C9	USA	NSS	125.34339	15.83683	91.63471	1.01838	0.12635	0.73107	0.00812
CML473	P31C4S5B-23- ###-4-BBBB	CIMM YT	TST	177.47866	21.11249	136.89167	1.13958	0.11896	0.77131	0.00642
RY732	RYD	China	NSS	195.95768	26.57982	150.73402	0.44400	0.13564	0.76922	0.00227
GEMS45	CH05015:N12-	USA	Mixed	200.08836	22.39312	148.47123	2.21201	0.11192	0.74203	0.01106

	20-1-B-B									
GEMS55	ARI16035:S02-443-1-B-B	USA	SS	227.92086	33.99118	164.78549	3.43224	0.14914	0.72299	0.01506
GEMS60	CHIS775:N1912-519-1-B-B	USA	NSS	236.07465	29.48031	176.06928	2.32768	0.12488	0.74582	0.00986
HTH-17	HuoTangBai42×Hai1917×Mo17Ht	China	NSS	229.44278	34.90372	167.29076	2.38608	0.15212	0.72912	0.01040
SY1052	Syn.D.O	China	NSS	244.40900	24.71773	189.92504	3.30862	0.10113	0.77708	0.01354
CIMBL153	(TX03-1037-3-B)-B	CIMM YT	TST	320.43790	42.98027	239.07679	2.89189	0.13413	0.74609	0.00902
DH29	American Hybrid P78599	China	Mixed	162.94254	21.30650	119.41298	2.48595	0.13076	0.73285	0.01526
XUN971	Landrace	China	Mixed	134.26464	18.47135	97.01356	1.37002	0.13757	0.72255	0.01020
CHANG7-2	HuangZaoSi×WeiChun	China	Mixed	160.55162	19.78711	120.71439	1.59746	0.12324	0.75187	0.00995
CIMBL146	(TX03-1008-6-B)-B	CIMM YT	Mixed	302.30277	33.72765	227.91693	5.71605	0.11157	0.75394	0.01891
CIMBL95	(Florida A plus Syn-FS2-2-1-B B)-B	CIMM YT	Mixed	222.35794	25.69621	173.86213	1.91242	0.11556	0.78190	0.00860
WH413	HuangZaoSi×WenQing1331	China	Mixed	166.24151	25.94828	120.94201	1.35108	0.15609	0.72751	0.00813
ZONG3	Synthetic	China	NSS	144.31230	20.77934	105.15740	1.53566	0.14399	0.72868	0.01064
GEMS29	2253-01_XL370A_S11_F2S4_	USA	Mixed	156.07883	20.81035	117.47478	1.56237	0.13333	0.75266	0.01001

	9220-Blk24/00									
GEMS53	CUBA164:S15-192-2-B	USA	SS	152.98306	20.49133	113.47495	1.61969	0.13395	0.74175	0.01059
K14	Shen5005×6917	China	NSS	131.74183	15.64573	100.59498	1.16938	0.11876	0.76358	0.00888
150	Unkown	China	Mixed	213.67366	21.19735	158.35426	10.02628	0.09920	0.74110	0.04692
B111	BSSS(R)C9	China	Mixed	188.27229	30.42623	133.84759	1.64103	0.16161	0.71093	0.00872
177	Unkown	China	Mixed	228.61614	31.65219	171.03416	1.84514	0.13845	0.74813	0.00807
	((Tx601XB104-B/B110XFR2128-B)-BB-4-B	CIMM		282.55473	30.82926	211.32237	8.34002	0.10911	0.74790	0.02952
	BB)-B	YT	Mixed							
CIMBL84	(DTPYC9-74-1-1-1-1-B)-B	CIMM		174.76752	15.58383	138.02725	2.53819	0.08917	0.78978	0.01452
		YT	TST							
TY9	TY30331-2-8-1-1-3-1	China	Mixed	226.39370	24.81464	174.06066	2.19772	0.10961	0.76884	0.00971
ZB648	ZhongBei648-1	China	NSS	149.80780	15.00116	108.89638	3.87630	0.10014	0.72691	0.02588
4F1	Improved from Mo17 by 2282-01_XL38	China	NSS	186.17040	21.79824	143.53260	2.16463	0.11709	0.77097	0.01163
GEMS31	0_S11_F2S4_9			221.65410	24.81262	172.44598	1.78420	0.11194	0.77800	0.00805
	226-Blk26/00	USA	TST							
8902	Ye107×81162	China	Mixed	257.24784	33.17592	190.63973	6.94774	0.12896	0.74107	0.02701
BT1	8085×Thai Hybrid	China	TST	239.71457	24.16775	183.15157	4.76000	0.10082	0.76404	0.01986
CML189	G34QH17-2-1-	CIMM	TST	178.49414	20.43902	138.00055	1.34120	0.11451	0.77314	0.00751

CML325	1-B P45C6F28-1-2-B*6	YT CIMM YT	TST	199.00076	30.18533	144.70949	3.04187	0.15168	0.72718	0.01529
DAN599	American Hybrid P78599	China	NSS	214.50551	39.14928	142.91156	4.89347	0.18251	0.66624	0.02281
RY713	RYD	China	NSS	188.11549	32.69108	129.80592	3.65193	0.17378	0.69003	0.01941
M165	Unknown	China	NSS	221.78996	26.26573	169.08872	3.68611	0.11843	0.76238	0.01662
LIAO526 2	Liao526-2-2-2-1-2-1	China	NSS	246.65592	28.05394	187.39338	5.60761	0.11374	0.75974	0.02273
BY4944	BHO	China	NSS	225.50001	24.38602	177.63341	1.80871	0.10814	0.78773	0.00802
GEMS11	2116-02_DK21 2T_S11_F2S4_9172-Blk28/00 (CML445/[BE	USA	SS	190.31908	23.47706	143.23801	3.74814	0.12336	0.75262	0.01969
CIMBL75	TASYN]BC1-9-2-3-1-1)-B	CIMM YT	TST	217.93058	21.00286	174.70667	1.88553	0.09637	0.80166	0.00865
CIMBL83	(DRPYC9-F13-2-1-1-1-B)-B	CIMM YT	TST	185.21707	24.11673	142.64992	0.78395	0.13021	0.77018	0.00423
CIMBL89	(DTPYC9-F14-3-5-4-1-2-B)-B	CIMM YT	Mixed	173.94199	24.42444	130.57178	1.00331	0.14042	0.75066	0.00577
LIAO159	Unkown	China	Mixed	231.37730	31.13355	177.74042	97.28874	0.13456	0.76818	0.42048
Q1261	Improved from K12	China	NSS	220.23750	29.99464	164.88278	2.64436	0.13619	0.74866	0.01201
SY1035	Syn.D.O	China	NSS	238.10236	24.51436	188.08981	2.82944	0.10296	0.78995	0.01188
TIE7922	American Hybrid 3382	China	SS	188.68750	19.76313	148.06281	2.12652	0.10474	0.78470	0.01127

CIMBL14 3	(TX03-1006-22 -B)-B ([SAM4/BETA	CIMM YT	Mixed	178.92713	26.93406	132.16469	1.19137	0.15053	0.73865	0.00666
CIMBL55	SYN]BC2FS36 -4-1-2-BB)-B ([[[NAW5867/ P30SR]-43-2/[ NAW5867/P30 SR]-114-1]-9-3	CIMM YT	TST	210.57084	27.03376	161.60036	1.08974	0.12838	0.76744	0.00518
CIMBL46	-3-B-1-B/CML 395-1]-B-13-1- B-4-#[BETAS YN]BC1-8-1-1- 1-1)-B P45C2F151(RI	CIMM YT	TST	199.82848	28.84069	148.64068	1.92928	0.14433	0.74384	0.00965
CML115	F)-#-5-1-2-BB B American	CIMM YT	Mixed	185.52095	23.42832	142.05772	1.65247	0.12628	0.76572	0.00891
R08	Hybrid P78641	China	NSS	232.86598	32.12165	173.19326	2.01137	0.13794	0.74375	0.00864
835B	U8112×Ye515	China	NSS	223.60823	31.86537	167.06682	2.34447	0.14251	0.74714	0.01048
BY4839	BHO (SAM4(Angola	China	NSS	202.37956	29.20943	151.44536	2.86921	0.14433	0.74832	0.01418
CIMBL13 4	)/[BETASYN] BC1-79-2-3-B B)-B	CIMM YT	TST	192.66380	24.64604	147.73022	1.81355	0.12792	0.76678	0.00941
JH96C	Synthetic	China	NSS	128.79840	7.38693	107.11352	0.82734	0.05735	0.83164	0.00642

LV28	LvDaHongGu	China	NSS	163.07225	18.37227	124.71010	1.91148	0.11266	0.76475	0.01172
TT16	TianTai16-1-3-1-2-2-2	China	Mixed	155.70883	19.61681	117.49374	1.61542	0.12598	0.75457	0.01037
YE52106	(Ye1075×Ye106)×AiJin525	China	NSS	192.56017	26.82097	143.94592	2.33103	0.13929	0.74754	0.01211
ZONG31	Synthetic	China	NSS	274.75380	33.11395	211.86061	2.78461	0.12052	0.77109	0.01013
B113	BS11(FR)C9	China	Mixed	158.47968	20.00992	120.34694	1.32685	0.12626	0.75938	0.00837
CIMBL147	(TX03-1013-186-B)-B	CIMM YT	TST	203.74190	26.83680	155.30993	1.24275	0.13172	0.76229	0.00610
CIMBL57	([ZM305/BETASYN]BC2-133-1-1-BB)-B	CIMM YT	TST	155.23985	22.35484	115.50154	0.98625	0.14400	0.74402	0.00635
DAN598	(Dan340×Danhuang11)×(Danhuang02×Dan599)	China	NSS	224.55690	27.97990	169.42474	4.95262	0.12460	0.75448	0.02206
M153	Unknown	China	NSS	205.83014	27.38285	152.30027	3.93138	0.13304	0.73993	0.01910
SY3073	Syn.D.O	China	NSS	182.31105	18.79567	145.65354	0.97084	0.10310	0.79893	0.00533
BY809	BHO	China	NSS	243.72081	34.16251	179.05420	6.58898	0.14017	0.73467	0.02703
GEMS24	2201-01_DK830_S11_F2S4_9208-Blk27/00	USA	TST	156.19238	16.52088	121.06988	1.68469	0.10577	0.77513	0.01079
GEMS25	2226-02_XL370A_S11_F2S4_9211-Blk25/00	USA	Mixed	195.21573	24.69915	143.78496	4.52175	0.12652	0.73654	0.02316
268	(shen5003×U81	China	NSS	140.96172	22.15102	94.55342	3.64745	0.15714	0.67077	0.02588

BY813	12)F3×32 BHO	China	NSS	147.81210	21.57702	109.03625	1.23854	0.14598	0.73767	0.00838
CIMBL42	((NC300/Tx772 ) -B-1-B2-BB)- B	CIMM YT	TST	211.83245	25.27033	163.29987	1.94892	0.11929	0.77089	0.00920
CIMBL98	(KUI carotenoid syn-FS25-3-2- BBB)-B	CIMM YT	TST	172.71044	15.91307	137.83542	0.95788	0.09214	0.79807	0.00555
R15	American Hybrid	China	NSS	232.95532	26.80965	173.33010	6.30027	0.11508	0.74405	0.02704
1462	Unkown	China	NSS	179.25069	25.01866	133.76470	1.84935	0.13957	0.74624	0.01032
526018	Unkown	China	NSS	232.60979	26.40495	180.99586	2.84845	0.11352	0.77811	0.01225
CIMBL14	(TX03-1007-36 -B)-B	CIMM YT	SS	223.58575	32.68965	165.88524	2.45149	0.14621	0.74193	0.01096
BEM	Landrace	China	NSS	187.15670	21.36883	142.65348	3.13019	0.11418	0.76221	0.01672
D863F	Unkown	China	NSS	163.36523	19.47309	124.21489	1.80603	0.11920	0.76035	0.01106
GY1032	AIHO	China	NSS	177.03600	20.13891	130.66490	5.38541	0.11376	0.73807	0.03042
ZHENG3										
5	Unkown	China	Mixed	264.31664	26.85314	201.93288	5.54221	0.10159	0.76398	0.02097
B73	BSSS	China	SS	175.34542	23.80416	126.54275	3.07330	0.13576	0.72168	0.01753
GEMS42	PE001n16F2S2 -705	USA	NSS	177.13799	22.07070	133.72704	2.66391	0.12460	0.75493	0.01504
GEMS50	DKB844:S1601 -517-1-B	USA	SS	201.74242	27.82045	150.61060	2.72204	0.13790	0.74655	0.01349
CIMBL15	(TX03-1034-63	CIMM	TST	181.70732	24.24382	136.63116	2.11768	0.13342	0.75193	0.01165

1	-B)-B	YT								
	([ZM305/BET									
CIMBL58	ASYN]BC2-13	CIMM		206.29572	31.32241	153.33105	1.25487	0.15183	0.74326	0.00608
	3-1-2-BBB)-B	YT	TST							
CIMBL69	(CL-G2609-B)-	CIMM		168.19462	22.43392	126.76670	0.88227	0.13338	0.75369	0.00525
	B	YT	TST							
CML114	P45C2F-B-88-#	CIMM		187.36802	20.18006	145.06541	2.93978	0.10770	0.77423	0.01569
	##1-1-2-BB	YT	TST							
CML116	P45(STE)C1F3	CIMM		197.99722	29.45026	147.90731	1.46370	0.14874	0.74702	0.00739
	6-5-1-3-1-BB	YT	Mixed							
	P45C2F151-1-2									
CML134	-5-3-1-2-4-B1-	CIMM		166.07645	24.25488	120.33633	1.77587	0.14605	0.72458	0.01069
	B1#B1	YT	TST							
TY2	TY30331-2-4-2			211.48441	31.21894	154.77343	2.64772	0.14762	0.73184	0.01252
	-2-1-1	China	Mixed							
YE478	U8112×Shen50			170.85392	16.64933	133.87061	1.29541	0.09745	0.78354	0.00758
	03	China	Mixed							
CIMBL15	(ZM305/[BET									
5	ASYN]BC1-29	CIMM		232.90255	28.55035	180.01293	1.94532	0.12258	0.77291	0.00835
	-1-1-B)-B	YT	TST							
JI853	(HuangZaoSi×			254.36941	33.00614	194.35707	1.73680	0.12976	0.76407	0.00683
	Zi330)×Zi330	China	Mixed							
TY7	TY30331-2-5-2			261.36065	30.52491	205.55269	2.03384	0.11679	0.78647	0.00778
	-1-1-3	China	Mixed							
CIMBL79	(CML489/[BE	CIMM		171.37774	19.46101	131.97384	1.66665	0.11356	0.77008	0.00972
	TASYN]BC1-7	YT	TST							

	-2-1-1-1)-B									
DAN360	Lv9×Wide Pod Corn	China	NSS	161.53495	20.36772	122.99290	1.03031	0.12609	0.76140	0.00638
JH59	American Hybrid P78599	China	NSS	150.12411	21.13253	112.82328	0.42394	0.14077	0.75153	0.00282
LIAO526 3	Liao526-2-2-2- 1-3-1	China	NSS	137.54159	19.03758	99.23641	2.15576	0.13841	0.72150	0.01567
SY999	Syn.D.O	China	NSS	178.34525	22.46927	134.69829	1.43038	0.12599	0.75527	0.00802
CML326	P45C6F6-2-1-1 -B*5	CIMM YT	TST	143.87734	18.04432	108.65595	1.42434	0.12541	0.75520	0.00990
ES40	Landrace	China	Mixed	135.16184	19.59411	98.74333	1.12473	0.14497	0.73056	0.00832
GEMS28	2250-02_XL37 0A_S11_F2S4_ 3363-Blk03/00	USA	Mixed	143.23530	25.82339	99.19299	1.86867	0.18029	0.69252	0.01305
GEMS51	CUBA164:S20 08a-83-1-B	USA	SS	215.11462	31.59917	159.09080	2.50859	0.14689	0.73956	0.01166
GEMS59	SCROI:N1310- 398-1-B	USA	NSS	196.60689	26.41725	145.00763	2.65294	0.13437	0.73755	0.01349
GEMS63	CUBA164:S15 11b-325-001	USA	SS	186.26941	29.45194	135.87470	2.06313	0.15811	0.72945	0.01108
501	Unknown	China	NSS	201.09482	27.15199	150.80831	2.79999	0.13502	0.74994	0.01392
BY4960	BHO	China	NSS	201.91095	28.47445	147.92641	3.08583	0.14102	0.73263	0.01528
LG001	Unknown	China	NSS	129.36375	20.33534	92.88848	1.20984	0.15720	0.71804	0.00935
TY6	TY30331-2-5-1 -2-3-2	China	Mixed	172.85470	20.57201	130.37745	2.74237	0.11901	0.75426	0.01587
SY998	Syn.D.O	China	NSS	298.41070	36.38199	228.50146	3.65927	0.12192	0.76573	0.01226

TY1	TY30331-2-4-2 -1-3-2	China	Mixed	176.89617	24.65267	127.40923	2.79592	0.13936	0.72025	0.01581
BY855	BHO	China	NSS	182.98923	17.43219	143.57138	3.23466	0.09526	0.78459	0.01768
QI205	(VeiAi141×ZhongXi017)×Population 70 (CML489/[BE	China	Mixed	166.89247	20.70639	125.26684	1.52324	0.12407	0.75058	0.00913
CIMBL78	TASYN]BC1-5 -2-1-2-1)-B	CIMM YT	TST	173.13379	20.46153	133.99335	1.10765	0.11818	0.77393	0.00640
S22	American Hybrid	China	NSS	168.41486	20.82119	123.62559	5.70285	0.12363	0.73405	0.03386
HU803	U8112×Shen5003	China	SS	227.11276	27.95713	170.80286	3.84027	0.12310	0.75206	0.01691
BY807	BHO	China	NSS	263.44500	25.71523	204.04628	5.32975	0.09761	0.77453	0.02023
CIMBL104	(LAMA2002-60-9-B)-B	CIMM YT	TST	146.32330	17.22244	109.75851	2.94061	0.11770	0.75011	0.02010
CIMBL149	(TX03-1013-1-B)-B ((KU1409/SC5	CIMM YT	TST	230.59953	27.76170	174.63493	2.70649	0.12039	0.75731	0.01174
CIMBL40	5/KU1409)-S2-12-1-BB)-B	CIMM YT	TST	196.90943	25.32303	145.39460	5.03352	0.12860	0.73838	0.02556
BY815	BHO	China	NSS	249.01010	29.58472	187.85236	3.95827	0.11881	0.75440	0.01590
GEMS17	2142-01_DK88 8_S11_F2S4_9			285.43260	32.26636	219.50827	4.65291	0.11304	0.76904	0.01630
GEMS27	190-Blk19/00 2250-01_XL37	USA USA	SS Mixed	230.90167	31.05354	172.78833	4.84306	0.13449	0.74832	0.02097

	0A_S11_F2S4_9214-Blk21/00									
GEMS49	DKB844:S1601-512-1-B	USA	SS	171.15534	23.31115	125.73359	2.11445	0.13620	0.73462	0.01235
GEMS61	ARI16026:S17-10-1-B-B	USA	TST	278.95571	37.88812	201.47546	6.95190	0.13582	0.72225	0.02492
CML113	P33C1F-B-129-B-###-2-B	CIMM YT	TST	197.13456	23.41482	137.85721	10.32277	0.11878	0.69931	0.05236
ZHENG653	(Shen5003×Zong31)×Shen5003	China	NSS	236.32800	29.32980	174.23069	6.30185	0.12411	0.73724	0.02667
CIMBL96	(KUI carotenoid syn-FS11-1-1-BBB)-B	CIMM YT	TST	282.15077	33.87462	217.68279	3.09981	0.12006	0.77151	0.01099
CML324	P33C2(STE)-12-1-B-2-B*4	CIMM YT	TST	212.52514	27.13199	156.39423	3.80465	0.12766	0.73589	0.01790
CML225	EV88SUWAN 1SR(BC5)-62-1-1-BB	CIMM YT	TST	221.85138	22.15901	174.50686	3.57509	0.09988	0.78659	0.01611
HUANGC	(HuangXiao162 ×Zi330/O2)×Tuxpenno	China	NSS	192.59526	29.80363	140.63305	1.74275	0.15475	0.73020	0.00905
LY	Unknown	China	TST	215.56659	26.05670	160.50034	4.75703	0.12088	0.74455	0.02207
647	Landrace	China	Mixed	149.47326	14.08461	112.60793	3.16519	0.09423	0.75337	0.02118
CIMBL97	(KUI	CIMM	TST	183.22435	22.32564	137.91489	2.52097	0.12185	0.75271	0.01376

	carotenoid syn-FS17-3-1- BBB)-B	YT								
CIMBL14 1	(TX03-1004-73 -B)-B	CIMM YT	Mixed	241.02084	31.45486	179.06301	3.82831	0.13051	0.74294	0.01588
DAN4245	Dan4245-1-3-1 -3-1-1	China	Mixed	253.42330	30.68963	193.42863	3.08203	0.12110	0.76326	0.01216
K12	HuangZaoSi× WeiChun	China	NSS	205.34727	21.67193	156.16813	5.43095	0.10554	0.76051	0.02645
C8605	Tie7922×Shen5 003	China	NSS	147.03508	17.80383	107.05777	3.28201	0.12109	0.72811	0.02232
	(PI218191/PI20 9135//PI226685 /P1317328/3/P4 7/MPSWCB4)									
CML121	6-3-1-5-1-B1-B 1#B1(MP704/ MP78:518)-8-3 -4-B1-4-2-3-B1 -B1-#B1	CIMM YT	TST	255.54387	29.36679	187.77344	7.20621	0.11492	0.73480	0.02820
SY1032	Syn.D.O	China	Mixed	240.78349	29.15912	163.48992	16.11811	0.12110	0.67899	0.06694
DAN340	Lv9×Wide Pod Corn	China	NSS	229.56258	28.53730	172.05400	3.88297	0.12431	0.74949	0.01691
	([DTPYC9-F65									
CIMBL49	-2-2-1-1-BB x DTPYC9-F65-	CIMM YT	TST	214.56655	24.91671	165.18706	2.22537	0.11613	0.76986	0.01037

	2-3-1-1-BB]-2-2-B)-B									
TY5	TY30331-2-4-2-2-3-1	China	Mixed	187.54826	21.92463	141.96008	2.92127	0.11690	0.75693	0.01558
Z2018F	Zheng2018F2*698-3-1-2-1-1	China	Mixed	228.52113	37.75996	158.71746	6.55723	0.16524	0.69454	0.02869
CHUAN48-2	Synthetic	China	Mixed	128.65443	14.76850	98.14197	1.53336	0.11479	0.76283	0.01192
CIMBL150	(TX03-1034-46-B)-B	CIMM YT	TST	190.99479	23.93890	141.76888	4.70842	0.12534	0.74227	0.02465
CIMBL93	(DTPYC9-F65-2-3-1-1-BBBB B)-B	CIMM YT	TST	190.73711	19.85455	148.69840	2.22376	0.10409	0.77960	0.01166
SY1077	Syn.D.O	China	Mixed	184.04256	25.54902	137.80457	1.06258	0.13882	0.74876	0.00577
CML118	SIYFS3#B1-7-B1-B1#B1	CIMM YT	Mixed	165.26962	23.36220	124.40326	0.96578	0.14136	0.75273	0.00584
CML411	P28C7-S4-#-B BBBB BBBB B	CIMM YT	TST	191.30647	27.70572	138.89690	3.47921	0.14482	0.72604	0.01819
7327	S37×3H-2	China	NSS	184.08263	23.90921	142.63941	0.81206	0.12988	0.77487	0.00441
B151	Unkown	China	Mixed	179.86627	20.53343	141.14657	0.89381	0.11416	0.78473	0.00497
CIMBL111	(MAS[MSR/312]-117-2-2-1-B BB/[BETASY N]BC1-11-5-2-1-1)-B	CIMM YT	TST	171.71447	23.03632	125.10560	4.84706	0.13415	0.72857	0.02823

	(P84c3BcxLine recycle LL									
CIMBL12 4	TpreAsi axMIR T			189.03468	25.12550	141.51576	1.64549	0.13291	0.74862	0.00870
	F59-2-1-1-1-B B)-B	CIMM YT	TST							
CIMBL13 6	(SRR-C1 SA3MH32-4-3- B-1-1-2-BB)-B	CIMM YT	TST	213.19402	25.33706	147.84234	9.17683	0.11885	0.69346	0.04304
	2258-03_XL38									
GEMS30	0_S11_F2S4_7 1/97-Blk/98	USA	TST	245.93893	33.33460	189.37284	1.52216	0.13554	0.77000	0.00619
GEMS37	PE001n16F2S2 -181	USA	NSS	200.27943	26.72451	148.87728	3.03986	0.13344	0.74335	0.01518
18-599	American Hybrid P78599	China	NSS	225.58859	22.51439	172.97619	4.65331	0.09980	0.76678	0.02063
	((CML454 x									
CIMBL24	CML451)-B-7- 3-2-BB)-B	CIMM YT	TST	142.48690	14.08826	109.84416	1.83258	0.09887	0.77091	0.01286
CIMBL3	Suwan 1	Thailan d	TST	177.64587	20.92688	134.48193	2.12317	0.11780	0.75702	0.01195
	([GQL5/[GQL5 /CML202]F2-1									
CIMBL52	sx]-3-1-2-B/[B ETASYN]BC1- 2-5-1-1-1)-B	CIMM YT	TST	147.25714	21.56959	100.77198	5.96984	0.14648	0.68433	0.04054

CIMBL88	(DTPYC9-F13 4-3-1-B)-B	CIMM YT	TST	150.02694	16.98395	114.28933	1.58869	0.11321	0.76179	0.01059
CML361	SA4C2F(21/26) -4-2-7-3-B	CIMM YT	TST	210.67054	30.31339	147.92768	6.25798	0.14389	0.70218	0.02971
BY843	BHO	China	NSS	172.22676	19.21977	129.65028	3.36325	0.11160	0.75279	0.01953
238	Unkown	China	NSS	214.63558	28.43560	161.46219	1.83784	0.13248	0.75226	0.00856
CIMBL14 0	(TX03-1004-20 -B)-B	CIMM YT	TST	197.33518	21.41026	151.02180	3.70179	0.10850	0.76531	0.01876
CIMBL14 8	(TX03-1013-19 8-B)-B	CIMM YT	TST	179.08971	18.02258	137.90071	2.46531	0.10063	0.77001	0.01377
CIMBL15 6	(ZM305/[BET ASYN]BC1-58 -2-3-B)-B	CIMM YT	TST	202.69601	20.75722	152.32024	5.43892	0.10241	0.75147	0.02683
CIMBL92	(DTPYC9-F46- 3-9-1-2-B)-B	CIMM YT	TST	189.09673	23.16619	143.25249	2.17856	0.12251	0.75756	0.01152
LXN	Landrace	China	NSS	184.61076	25.05039	135.09599	3.80691	0.13569	0.73179	0.02062
P178	American Hybrid P78599	China	NSS	207.44047	23.22181	159.02551	3.37095	0.11194	0.76661	0.01625
CIMBL11 6	(OBATANPA- SRc1F3(balbul k1)-#bal/[BET ASYN]BC1-54 -1-2-BBB)-B	CIMM YT	TST	244.59538	36.15684	178.35154	3.97769	0.14782	0.72917	0.01626
CIMBL2	Suwan 1	Thailan d	TST	237.49856	26.67359	183.77817	3.30085	0.11231	0.77381	0.01390
CML323	P33C2(STE)-1	CIMM	TST	267.40116	27.17735	206.10854	5.72321	0.10164	0.77078	0.02140

	02-2-B-2-B-1-B*3	YT								
GEMS19	2146-01_DK88 8_S11_F2S4_9			208.15217	19.30751	167.09559	2.17215	0.09276	0.80276	0.01044
	196-Blk29/00	USA	TST							
GEMS43	PE001n16F2S2 -857	USA	NSS	183.79481	22.35822	140.91591	1.58056	0.12165	0.76670	0.00860
CIMBL11 7	(OBATANPA-SRc1F3(balbul k1)-#bal/[BET ASYN]BC1-65	CIMM		195.86837	24.81645	147.44949	1.87322	0.12670	0.75280	0.00956
	-2-1-BB)-B	YT	TST							
CIMBL72	(CL-SCBY03)- B	CIMM YT	TST	280.97961	31.31131	221.45014	3.12849	0.11144	0.78814	0.01113
CIMBL91	(DTPYC9-F46- 1-7-1-1-BBBB) -B	CIMM YT	TST	257.71342	29.30054	194.76079	4.80248	0.11369	0.75573	0.01863
YE107	Foreign Hybrid XL80	China	Mixed	141.96559	15.33036	105.50223	4.17179	0.10799	0.74315	0.02939
CF3	Unknown	China	Mixed	142.14612	13.90685	110.64378	1.68033	0.09783	0.77838	0.01182
CIMBL13 8	(TX03-1004-16 8-B)-B	CIMM YT	TST	203.77759	24.32716	149.40267	5.21323	0.11938	0.73317	0.02558
CIMBL63	(Carotenoid Syn3-FS5-1-5- BB)-B	CIMM YT	TST	31.06447	3.80566	22.04834	0.36890	0.12251	0.70976	0.01188
CIMBL77	(CML489/[BE	CIMM	TST	253.94804	23.99244	193.93606	7.62335	0.09448	0.76368	0.03002

	TASYN]BC1-2	YT								
	-#-B)-B									
CIMBL86	(DTPYC9-F11	CIMM		231.89933	28.64345	175.39389	5.22547	0.12352	0.75634	0.02253
	6-2-1-1-1-B)-B	YT	TST							
	(((Ko326y x									
	Tx806)-6-1-1-1									
CIMBL14	-BB/CML161)			177.46898	21.33921	135.77007	2.52294	0.12024	0.76504	0.01422
	x									
	(Tx802/CML16	CIMM								
	1))-1-BBB)-B	YT	TST							
5311	GuiZhouQingL			218.81099	27.93836	169.61007	1.59726	0.12768	0.77514	0.00730
	ongWuSuiBai	China	NSS							
3411	Unknown	China	Mixed	166.55258	20.90381	127.55016	1.36646	0.12551	0.76583	0.00820
CIMBL13	(TX03-1004-17	CIMM		160.37997	17.38734	121.69426	3.30642	0.10841	0.75879	0.02062
9	9-B)-B	YT	TST							
	(MAS[206/312]									
CIMBL10	-23-2-1-1-BBB/			295.63135	56.04981	205.26827	4.92095	0.18959	0.69434	0.01665
6	[BETASYN]B									
	C1-10-2-1-#-B)	CIMM								
	-B	YT	TST							
	(HuangXiao162									
TIAN77	×Mei1865)×(18			198.84889	41.60775	137.89318	0.79423	0.20924	0.69346	0.00399
	7-2×Nan55)	China	Mixed							
ZHONG6	American			215.30872	51.49846	140.05088	1.89740	0.23918	0.65047	0.00881
9	Hybrid P78599	China	Mixed							
P138	American	China	NSS	161.81161	27.86019	112.55934	2.52592	0.17218	0.69562	0.01561

CIMBL5	Hybrid P78599 H5*PX105A/H 101	USA	TST	168.68844	36.37176	106.17510	4.93718	0.21562	0.62942	0.02927
CIMBL10	((CML408/B1 04)x(CML411/ B104))-1-1-BB )-B	CIMM YT	TST	276.52846	25.22619	220.00006	4.37787	0.09122	0.79558	0.01583
CML69	P36C5F37-2-1- 1-B1#B1-B1#B 1-B1	CIMM YT	TST	213.35671	52.12296	140.48762	1.23484	0.24430	0.65846	0.00579
SW92E11 4	Landrace	China	TST	119.78046	13.24655	91.58712	1.86013	0.11059	0.76462	0.01553
GEMS40	PE001n16F2S2 -431	USA	NSS	204.37958	23.55491	153.44477	5.12326	0.11525	0.75078	0.02507
CIMBL38	((KU1409/KU1 414-SR/SC213) -S2-10-1-BB)- B	CIMM YT	TST	242.17850	30.05632	176.10537	7.79526	0.12411	0.72717	0.03219
CML170	G26QC22H9-3 -1-5-1-BB	CIMM YT	TST	173.97810	16.55781	134.96237	3.03670	0.09517	0.77574	0.01745
CML304	SINTAMTSR- 76-1-2-3-2-BB- F	CIMM YT	TST	209.66086	22.51702	165.69246	1.86920	0.10740	0.79029	0.00892
XZ698	XinZhong698-3 -1-1-2-1-2-3	China	NSS	178.50807	26.19422	134.43682	1.26268	0.14674	0.75311	0.00707
07KS4	Unknown	China	NSS	170.87378	17.74856	129.16947	4.82765	0.10387	0.75594	0.02825

CIMBL101	(LAMA2002-4 6-2-B)-B	CIMM YT	TST	245.59240	22.71695	189.41691	5.71795	0.09250	0.77127	0.02328
CML168	G26QSINT-31- 1-2-2-BB	CIMM YT	TST	235.68146	28.12691	185.22454	1.96972	0.11934	0.78591	0.00836
CML360	SA4C2F(21/26) -1-2-2-2-B	CIMM YT	TST	226.84525	23.08642	169.15984	9.06369	0.10177	0.74571	0.03996
CML486	P45C8-76-1-2- 1-2-BBBB	CIMM YT	TST	151.25046	19.71851	110.40158	4.12121	0.13037	0.72993	0.02725
CIMBL105	(LAMA2002-6 1-1-B)-B	CIMM YT	TST	283.74220	26.28969	223.37213	4.77256	0.09265	0.78724	0.01682
CIMBL110	(MAS[206/312] -23-2-1-1-BBB/ [BETASYN]B C1-9-3-1-1-1)- B	CIMM YT	TST	284.51932	41.75296	203.57969	6.89094	0.14675	0.71552	0.02422
CIMBL71	(CL-RCY007= PIO3011F2-B)- B	CIMM YT	TST	184.70030	15.90400	144.80074	4.22109	0.08611	0.78398	0.02285
CIMBL82	(Cuba/Guad C3 F42-2-1-1-BBB ) -B	CIMM YT	TST	185.08562	24.98955	127.66354	10.32945	0.13502	0.68975	0.05581
CIMBL99	(LAMA2002-1 0-1-B)-B	CIMM YT	TST	243.61681	26.26515	183.73156	6.33660	0.10781	0.75418	0.02601
CML31	P27F117-1-4-B -####	CIMM YT	TST	220.95473	23.23717	170.14540	4.48689	0.10517	0.77005	0.02031
CIMBL51	([GQL5/[GQL5	CIMM	TST	211.24281	19.00660	166.39846	2.94756	0.08998	0.78771	0.01395

	/[MSRXPOOL	YT								
	9]C1F2-205-1(									
	OSU23i)-5-3-X									
	-X-1-B-B]F2-4									
	sx]-8-6-BB/[BE									
	TASYN]BC1-6									
	-5-1-1-1)-B									
	(CL-G2606									
CIMBL67	G26SeqC1-149			233.06629	27.92936	172.88580	7.24083	0.11983	0.74179	0.03107
	-1-1-2-1-2-1-B	CIMM								
	B)-B	YT	TST							
	(MAS[206/312]									
CIMBL10	-23-2-1-1-BBB/									
7	[BETASYN]B			256.35014	28.03699	193.18039	8.60646	0.10937	0.75358	0.03357
	C1-11-3-1-1-1)	CIMM								
	-B	YT	TST							
	(Nei									
CIMBL11	402025-BBB)-	CIMM		212.08033	18.89069	165.56470	5.27487	0.08907	0.78067	0.02487
4	B	YT	TST							
	2150-01_DK88									
GEMS20	8_S11_F2S4_9			137.46365	13.85455	102.19050	5.20474	0.10079	0.74340	0.03786
	199-Blk16/00	USA	SS							
	(P390Am/CML									
CIMBL11	c4F253-B-2-2-	CIMM		243.59101	22.92502	188.17451	6.38652	0.09411	0.77250	0.02622
9	4-1-BB)-B	YT	TST							
CIMBL21	((CML285/NC	CIMM	TST	143.09836	17.08218	106.69061	3.01839	0.11937	0.74558	0.02109

	300)-B-6-BBB	YT								
	B)-B									
	((CML479/CL									
CIMBL26	Q-RCYQ41)-B			182.19032	15.99778	140.16117	2.43179	0.08781	0.76931	0.01335
	-2-1-2-2-2-B)-	CIMM								
	B	YT	TST							
3H-2	(WeiDa202×Zi									
	330)×H84	China	Mixed	268.58366	30.12820	213.59808	1.81469	0.11217	0.79528	0.00676
	EV88SUWAN									
CML228	1SR(BC5)-201-	CIMM		199.09638	20.98276	149.13410	5.12933	0.10539	0.74905	0.02576
	1-1-BB	YT	TST							
CML26	P26F40-1-4-1-3	CIMM								
	-#-2-B-##	YT	TST	167.89828	22.14486	117.32029	6.11988	0.13189	0.69876	0.03645
CML327	P45C6F83-3-1-	CIMM								
	B*5	YT	Mixed	256.34506	34.47322	189.96576	4.73730	0.13448	0.74105	0.01848
	((KU1409/KU1									
CIMBL35	414-SR/KVI43)	CIMM		171.01795	18.76468	128.05448	4.87348	0.10972	0.74878	0.02850
	-S2-4-2-BB)-B	YT	TST							
	((KU1409/KU1									
CIMBL36	414-SR/M162									
	W)-S2-3-1-BB)	CIMM		246.39888	25.06136	191.87926	3.81807	0.10171	0.77873	0.01550
	-B	YT	TST							
	((KU1409/KU1									
CIMBL37	414-SR/NC350	CIMM		210.10779	28.28862	159.53526	2.27377	0.13464	0.75930	0.01082
	)-S2-1-2-BB)-B	YT	TST							
CIMBL14	(TX03-1007-18	CIMM	SS	228.45073	25.61424	176.11554	4.49152	0.11212	0.77091	0.01966

4	-B)-B	YT								
	((CL-RCY020									
	x									
CIMBL15	CL-02450)-B-4	CIMM		252.84075	31.26507	196.47456	1.72723	0.12366	0.77707	0.00683
	0-1-1-BB)-B	YT	TST							
CIMBL10	(LAMA2002-4	CIMM		129.21210	18.19574	93.96068	1.42620	0.14082	0.72718	0.01104
0	3-2-B)-B	YT	TST							
CML412	P36C5F279-1-1	CIMM		135.30303	16.69662	101.66300	2.22450	0.12340	0.75137	0.01644
	-B-F-##-B	YT	TST							
	((CML479/CL									
CIMBL25	Q-RCYQ41)-B			161.81696	23.45940	120.26097	1.85996	0.14497	0.74319	0.01149
	-2-1-2-2-1-B)-	CIMM								
	B	YT	TST							
YZ15	YuZong15BC-			179.06463	30.67750	122.57483	4.09698	0.17132	0.68453	0.02288
	2	China	NSS							
	((KU1409/KU1									
CIMBL33	414-SR/KVI11)			158.44602	29.72699	107.54785	2.19794	0.18762	0.67877	0.01387
	-S2-10-2-BB)-	CIMM								
	B	YT	TST							
SC55	The University			292.01836	29.55785	234.76645	2.71142	0.10122	0.80394	0.00929
	of Illinois, USA	USA	Mixed							
	EV88SUWAN									
CML226	1SR(BC5)-78-1	CIMM		173.31485	22.75554	120.67460	5.62883	0.13130	0.69627	0.03248
	-1-BB	YT	TST							
CML169	G26QC22H7-1	CIMM		216.95513	23.25456	171.75413	2.45093	0.10719	0.79166	0.01130
	-1-1-1-BB	YT	TST							

	G25QS4B-H35									
CML172	-2-B-1-1-2-B-4	CIMM		235.70214	20.25568	170.14512	15.22984	0.08594	0.72186	0.06461
	-BBBB	YT	TST							
	AMATLC0HS									
CML465	71-1-1-2-1-1-1-	CIMM		172.75817	20.84168	124.97200	4.09085	0.12064	0.72339	0.02368
	BBB	YT	TST							
CML32	P28(TSR)S2-11	CIMM		186.29040	31.80882	127.13800	5.54661	0.17075	0.68247	0.02977
	-2-4-B-1-##	YT	TST							
	((CML454 x									
CIMBL22	CL-02603)-B-2	CIMM		175.25105	38.75470	111.96804	3.87775	0.22114	0.63890	0.02213
	0-1-2-BB)-B	YT	TST							
	(CL-G2609									
CIMBL68	G26C23-75-1-1	CIMM		169.06939	27.70839	118.92655	3.18545	0.16389	0.70342	0.01884
	-2-1-B*5)-B	YT	TST							
CML165	P66C1F144-3-1	CIMM		162.75547	35.98836	109.17836	0.36084	0.22112	0.67081	0.00222
	-1-BB-1-BB-#	YT	TST							
	(pop.70									
CIMBL13	Templado			177.39337	17.79184	135.24009	3.82700	0.10030	0.76237	0.02157
0	Amarillo									
	QPM-BBB2-8-	CIMM								
	BBB)-B	YT	TST							
	(SAM4(Angola									
CIMBL13	)/[BETASYN]			168.62749	18.01398	129.47924	2.25288	0.10683	0.76784	0.01336
1	BC1-43-1-1-B)	CIMM								
	-B	YT	TST							
HUA83-2	Landrace	China	Mixed	189.68461	18.45108	150.72898	1.71167	0.09727	0.79463	0.00902

CIMBL18	((CML161 x CL-02603)-B-2 2-2-2-1-BBBB) -B	CIMM YT	TST	228.58138	20.33584	177.75462	5.92750	0.08897	0.77764	0.02593
CIMBL7	(AMATLC0HS 71-1-1-2-1-1-1- BBBBBBB)-B	CIMM YT	TST	188.01093	16.61465	148.68544	2.87933	0.08837	0.79083	0.01531
CIMBL31	((KU1409/KU1 414-SR/CI187) -S2-10-2-BB)- B	CIMM YT	TST	270.11424	26.55306	210.67279	5.37956	0.09830	0.77994	0.01992
JIAO51	Improved from Landrace	China	Mixed	266.26215	27.61157	202.51129	6.97651	0.10370	0.76057	0.02620
B11	Landrace	China	TST	202.97638	17.58973	160.34618	2.66145	0.08666	0.78997	0.01311
GEMS33	PE001n16F2S2 -44	USA	NSS	227.50305	26.56582	174.11304	3.06457	0.11677	0.76532	0.01347
CML29	P27F71-3-1-B- #*5-B	CIMM YT	TST	212.35277	30.60766	159.31074	1.58611	0.14414	0.75022	0.00747
CML451	[NPH28-1/G25 )NPH28]-1-2-1 -1-3-1-B*6	CIMM YT	TST	256.35370	25.96924	192.54920	9.89547	0.10130	0.75111	0.03860
CML305	SINTAMTSR- 23-2-2-1-3-BB- F	CIMM YT	TST	176.72479	19.76063	135.24372	3.05611	0.11182	0.76528	0.01729
CML497	[CL00331*v]-3 -B-3-2-1-B*5	CIMM YT	TST	168.52875	18.25694	128.36561	4.34086	0.10833	0.76168	0.02576

CML300	SINTAMTSR- 76-1-2-3-1-BB-F (CL-02841	CIMM YT	TST	282.28945	33.01332	210.03894	9.29902	0.11695	0.74406	0.03294
CIMBL65	Ac8928-40-1-1-1-1-B)-B	CIMM YT	TST	138.12428	15.77940	99.64391	5.13724	0.11424	0.72141	0.03719
CML28	P27F35-8-3-B-####-B (G22F128/G22	CIMM YT	TST	197.95978	22.81778	150.15957	3.67069	0.11526	0.75854	0.01854
CML282	F25)-2-2-3-1-B B-F	CIMM YT	TST	95.32038	10.63814	60.68118	8.29118	0.11160	0.63660	0.08698
CML285	P24C5F34-2-3-B-F-2#-BBB-F 2112-02_DK21	CIMM YT	TST	196.88363	20.47745	154.07145	2.15558	0.10401	0.78255	0.01095
GEMS10	2T_S11_F2S4_ 9169-Blk20/00 2120-01_DK88	USA	SS	276.58132	32.76940	192.16850	15.14251	0.11848	0.69480	0.05475
GEMS12	8_S11_F2S4_9 175-Blk28/00 2121-04_DK88	USA	SS	198.43249	21.20485	154.14241	2.42013	0.10686	0.77680	0.01220
GEMS13	8_S11_F2S4_9 178-Blk29/00 2127-01_DK88	USA	SS	189.02053	21.37837	145.38231	2.80620	0.11310	0.76913	0.01485
GEMS14	8_S11_F2S4_9 181-Blk21/00	USA	SS	255.35570	33.38814	190.82293	3.59613	0.13075	0.74728	0.01408

**Table S2.** SNP loci significantly correlated with kernel structure phenotype.

SNP	Chr	Position	P Value	$-\log_{10}(p)$	Trait
chr1.S_60149609	1	60149609	1.50E-12	11.8245	C_Ratio
chr3.S_197249810	3	197249810	6.41E-10	9.1929	C_Ratio
chr5.S_211071030	5	211071030	1.74E-12	11.7588	C_Ratio
chr10.S_147015065	10	147015065	1.15E-09	8.9399	C_Ratio
chr2.S_213580400	2	213580400	1.14E-08	7.9449	C_Volume
chr2.S_21418262	2	21418262	1.64E-08	7.78454	C_Volume
chr3.S_197249810	3	197249810	6.10E-13	12.2144	C_Volume
chr4.S_188408094	4	188408094	4.48E-12	11.3484	C_Volume
chr5.S_211071030	5	211071030	5.47E-15	14.2623	C_Volume
chr8.S_16442611	8	16442611	2.46E-09	8.6096	C_Volume
chr8.S_24721281	8	24721281	2.79E-08	7.55396	C_Volume
chr8.S_21821145	8	21821145	7.95E-12	11.0998	EM_Ratio
chr4.S_198117618	4	198117618	3.96E-08	7.4021	EM_Volume
chr5.S_56985039	5	56985039	3.23E-08	7.4907	EM_Volume
chr6.S_109294053	6	109294053	1.85E-09	8.7317	EM_Volume
chr7.S_160100654	7	160100654	3.21E-12	11.4938	EM_Volume
chr7.S_5125482	7	5125482	1.84E-11	10.7354	EM_Volume
chr8.S_80791521	8	80791521	2.91E-13	12.5361	EM_Volume
chr9.S_127215116	9	127215116	9.40E-09	8.0268	EM_Volume
chr9.S_146712300	9	146712300	2.04E-08	7.6910	EM_Volume
chr3.S_169053802	3	169053802	4.04E-12	11.3931	EN_Ratio

chr3.S_178136006	3	178136006	2.01E-08	7.6978	EN_Ratio
chr5.S_175465159	5	175465159	3.71E-10	9.4309	EN_Ratio
chr7.S_3009101	7	3009101	2.23E-08	7.6517	EN_Ratio
chr8.S_100960678	8	100960678	3.54E-09	8.4509	EN_Ratio
chr9.S_116898313	9	116898313	2.99E-10	9.5236	EN_Ratio

**Table S3.** Candidate genes and functional annotation of kernel structure phenotype.

SNP	Gene	Trait	Chromosome	Position	Description
chr1.S_60149609	GRMZM5G896731	C_Ratio	1	59566657..59572158	Peptidyl-tRNA hydrolase, mitochondrial [23]
chr1.S_60149609	LOC100273678	C_Ratio	1	59571440..59574375	Tau-cadinol synthase-like
chr1.S_60149609	LOC103634817	C_Ratio	1	59497066..59500831	uncharacterized LOC103634817
chr3.S_197249810	GRMZM2G156377	C_Ratio	3	199358050..199359053	probable calcium-binding protein CML41
chr10.S_147015065	GRMZM2G058588	C_Ratio	10	148507629..148511269	sbp28, protein LIGULELESS 1-like SBP-transcription factor 28 squamosa promoter-binding protein-like (SBP domain) transcription factor family protein
chr10.S_147015065	LOC109943010	C_Ratio	10	148436056..148438965	uncharacterized LOC109943010
chr2.S_213580400	GRMZM2G011236	C_Volume	2	213545900..213547143	EREB62,ethylene-responsive transcription factor ERN1 putative AP2/EREBP transcription factor superfamily protein [20]
chr2.S_21418262	LOC109943973	C_Volume	8	58263776..58264560	uncharacterized protein LOC109943973
chr2.S_21418262	GRMZM2G02896	C_Volume	2	21534202..21535454	putative AP2/EREBP transcription factor

	9				superfamily protein [27]
chr3.S_197249810	GRMZM2G15637 7	C_Volume	3	199358050..199359053	probable calcium-binding protein CML41
chr4.S_188408094	GRMZM2G11548 1	C_Volume	4	190338881..190340598	Protein LURP-one-related 8-like, pco085810 [28]
chr4.S_188408094	GRMZM2G11549 9	C_Volume	4	190329215..190332474	uncharacterized protein LOC100279842
chr4.S_188408094	LOC103654295	C_Volume	4	190344398..190345630	protein LURP-one-related 8 [26]
chr8.S_16442611	GRMZM2G04880 4	C_Volume	8	16412788..16432302	pco129760
chr8.S_24721281	GRMZM2G09948 3	C_Volume	8	24573314..24575605	Peptide-N4-(N-acetyl-beta-glucosaminyl)asparagi ne amidase A protein
chr8.S_24721281	GRMZM2G06981 6	C_Volume	8	24595938..24599986	CID11 Polyadenylate-binding protein-interacting protein 9 [22]
chr8.S_24721281	GRMZM2G06968 7	C_Volume	8	24587592..24594912	SCAR-like protein 2 Protein SCAR3 [24]
chr8.S_16442611	GRMZM2G08332 8, GRMZM2G08339 4	C_Volume	8	16439998..16441924	uncharacterized protein LOC100192776
chr8.S_16442611	LOC100286109	C_Volume	8	16437969..16440069	dehydration-responsive element-binding protein 2A [25]
chr8.S_16442611	LOC113687179	C_Volume	8	16442846..16449298	DCD (Development and Cell Death) domain protein [26]
chr8.S_16442611	LOC103634845	C_Volume	8	16492579..16496168	uncharacterized LOC103634845

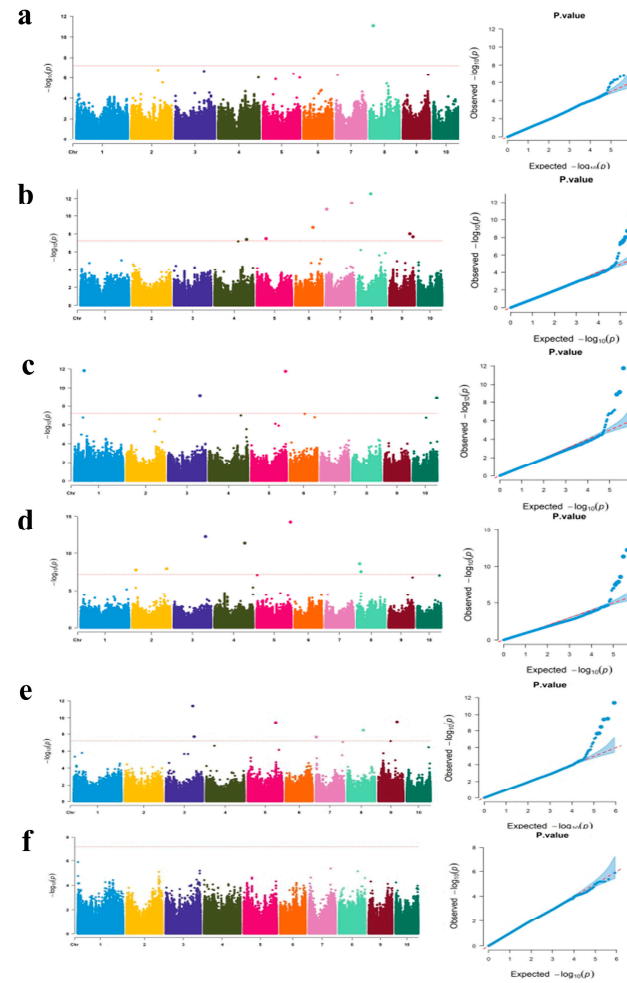
chr8.S_16442611	GRMZM2G04876 C_Volume 3	8	16435685..16438132	Ann11, annexin-like protein RJ4 [29]
chr8.S_21821145	GRMZM2G10710 EM_Ratio 1	8	21695212..21703434	gigantea like1a Protein [30]
chr8.S_21821145	GRMZM2G08714 EM_Ratio 6	8	21742679..21746640	si605019d10, Probable choline kinase 2 choline/ethanolamine kinas
chr8.S_21821145	LOC109942052 EM_Ratio	8	21747542..21747612	transfer RNA glycine (anticodon GCC)
chr4.S_198117618	GRMZM2G17368 EM_Volume 4	4	199925825..199929356	Anthocyanin-related membrane protein 1 (Anm1)-like
chr6.S_109294053	GRMZM2G04125 EM_Volume 8,	6	116263075..116263909	umc1105, DUF538 family protein [17]
chr6.S_109294053	GRMZM2G40488 EM_Volume 8	6	116225505..116228544	cationic amino acid transporter 8, vacuolar Cationic amino acid transporter 5
chr7.S_160100654	GRMZM2G02162 EM_Volume 4	7	163786225..163794137	Cysteine-rich receptor-like protein kinase 6 putative DUF26-domain receptor-like protein kinase family protein [31]
chr7.S_5125482	GRMZM2G16789 EM_Volume 2	7	4991574..4993761	seed maturation protein [18]
chr7.S_5125482	gpm680 EM_Volume	7	5026783..5027669	gnp_QCK3e03 verprolin
chr7.S_160100654	GRMZM2G37430 EM_Volume 9	7	163725783..163730342	Cysteine-rich receptor-like protein kinase 6 putative DUF26-domain receptor-like protein kinase family protein
chr7.S_160100654	GRMZM2G07698 EM_Volume 7	7	163712884..163717302	Cysteine-rich receptor-like protein kinase 6 putative DUF26-domain receptor-like protein

					kinase family protein receptor-like serine-threonine protein kinase [32]
chr7.S_160100654	LOC103633259	EM_Volume	7	163732309..163733057	uncharacterized LOC103633259
chr7.S_160100654	GRMZM2G07700 8	EM_Volume	7	163717835..163721463	ethylene receptor 4 Protein EIN4 [20]
chr8.S_80791521	LOC103635448	EM_Volume	8	80975720..80977109	uncharacterized LOC103635448
chr8.S_80791521	LOC103635447	EM_Volume	8	80935377..80936464	uncharacterized LOC103635447
chr9.S_127215116	GRMZM2G12714 1	EM_Volume	9	130844359..130849006	MAPK1, simk1, salt-induced MAP kinase 1 MPK4 - putative MAPK osmotic and salt stimulation MAPK1
chr9.S_146712300	GRMZM2G03991 9	EM_Volume	9	150088874..150092324	Probable xyloglucan endotransglucosylase/hydrolase protein 28 [33]
chr9.S_127215116	GRMZM2G12722 4	EM_Volume	9	130856611..130858463	Alpha/beta hydrolase related protein
chr9.S_127215116	GRMZM2G06569 6	EM_Volume	9	130888159..130892631	TIDP3699, PLAC8 family protein domain of unknown function DUF614 containing protein [19]
chr9.S_127215116	LOC114711034	EM_Volume	9	130853056..130856516	uncharacterized protein LOC114711034
chr9.S_146712300	GRMZM2G17827 9	EM_Volume	9	150158524..150162120	type IV inositol polyphosphate 5-phosphatase 9 putative inositol polyphosphate phosphatase (synaptogenin-like) family protein
chr9.S_146712300	GRMZM2G04016 1	EM_Volume	9	150094750..150100732	2-oxoglutarate (2OG) and Fe(II)-dependent oxygenase superfamily protein [21]
chr3.S_169053802	GRMZM2G11487 3	EN_Ratio	3	171118828..171122047	CL62634_1 bHLH-transcription factor 123helix-loop-helix DNA-binding domain

chr3.S_169053802	GRMZM2G35939 7	EN_Ratio	3	171052369..171054972	containing protein [34] VTC2, si946084h12, GDP-L-galactose phosphorylase 2-like [17]
chr3.S_169053802	GRMZM2G05895 4	EN_Ratio	3	171055355..171061910	putative recA DNA recombination family protein DNA repair protein recA homolog 3 mitochondrial
chr3.S_169053802	GRMZM2G41195 6	EN_Ratio	3	171116650..171118569	OTU domain-containing protein [35]
chr3.S_169053802	GRMZM2G11500 0	EN_Ratio	3	171101705..171106423	U-box domain-containing protein 45 U-box domain-containing protein 7 [36]
chr3.S_169053802	LOC109945391	EN_Ratio	3	171052009..171052082	transfer RNA isoleucine (anticodon AAU)
chr3.S_178136006	GRMZM2G14966 2	EN_Ratio	3	180339702..180346058	COV1-like protein Protein LIKE COV 2
chr3.S_178136006	GRMZM2G14963 9	EN_Ratio	3	180349288..180352545	cl38374_1a, Integral membrane Yip1 family protein cl38374_1(258) protein YIPF6 homolog yip1 domain family member 6
chr3.S_178136006	GRMZM2G14961 7	EN_Ratio	3	180354340..180372205	Sterol 3-beta-glucosyltransferase UGT80B1 sterol 3-beta-glucosyltransferase
chr3.S_178136006	GRMZM2G14975 6	EN_Ratio	3	180331931..180335139	ethylene-responsive transcription factor ERF115 Ethylene-responsive transcription factor ABR1
chr7.S_3009101	GRMZM2G47001 0	EN_Ratio	7	2988281..2990471	probable fucosyltransferase 8 Galactoside 2-alpha-L-fucosyltransferase
chr7.S_3009101	LOC109940926	EN_Ratio	7	2958480..2960864	uncharacterized LOC109940926
chr7.S_3009101	LOC103631912	EN_Ratio	7	2946797..2958364	uncharacterized protein LOC103631912

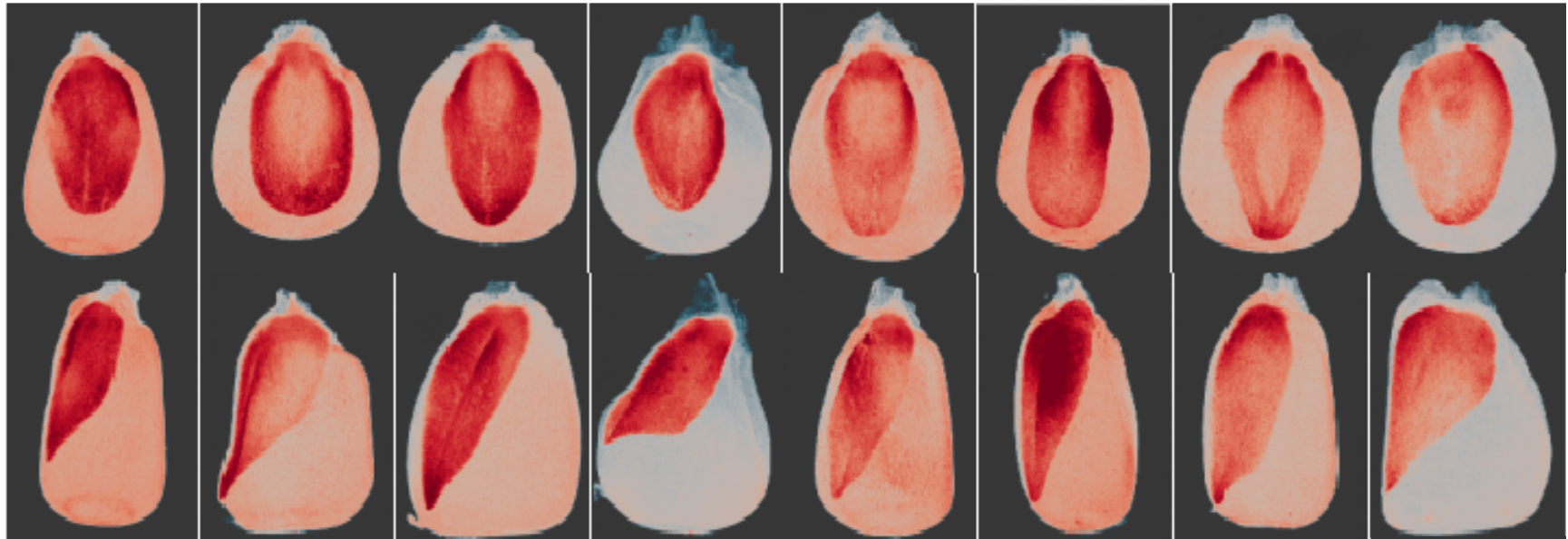
chr8.S_100960678	LOC103635604	EN_Ratio	8	100880219..100886759	cell division protein FtsZ homolog 2-1, chloroplastic
chr8.S_100960678	LOC100281226	EN_Ratio	8	100889483..100890208	ferredoxin-6 putative ferredoxin-4 chloroplastic
chr9.S_116898313	GRMZM2G13842 9	EN_Ratio	9	118664828..118667413	Tobamovirus multiplication protein 2A-like
chr9.S_116898313	LOC100275376	EN_Ratio	9	118749105..118750992	uncharacterized protein LOC100275376
chr9.S_116898313	LOC103645209	EN_Ratio	9	118739737..118740773	protein ALP1-like

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**Figure S1.** GWAS analysis of six key kernel traits. Note: a GWAS analysis of EM\_Volume. b GWAS analysis of EM\_Ratio. c GWAS analysis of C\_Volume. d GWAS analysis of C\_Ratio. e GWAS analysis of EN\_Volume. f GWAS analysis of EN\_Ratio.





**Figure S3.** Variation of kernels and embryos of different inbred lines. Note: For the kernels visualized by the ray casting algorithm, the shades with heavier colors represent the embryos; the first row is the front view of the embryo surface, and the second row is the side view of the embryo surface; the kernel varieties from left to right are cuan48-2, LXN, CF3, Zhi41, Dan4245, TY1, Dan340 and Jing725.