
Table S1 The primer sequences for KASP markers used in this study

Markes	Primer Seq Allele X	Primer Seq Allele Y	Primer Seq common	Reference
<i>KASP14803</i>	CAGACAACAAACACGTCCT CAG	GCAGACAACAAACACGTCCT CAA	CCAGTTCGGGATGTGAGAAACT GTA	Fan et al., 2022
<i>KASP6A-21</i> <i>21</i>	TGTGGTAGCAACACCTTTTC A	TGTGGTAGCAACACCTTTTCG	TCGAATGACCAAAGCATACTAT GT	Liue et al., 2022
<i>KASP3D32</i>	CGGCATTCGTATCGCGCA	CGGCCATTCGTATCGCGCG	TCCGTCTATGCCCATGGTATTG	Newly developed in this study
<i>KASP4B61</i>	CTTAACAACACTAGCCTAAT A	CTTAACAACACTAGCCTAATG	ACAAAAAGACTATTCATACGCC A	Newly developed in this study

Table S2 Phenotypic values for grain size related traits in the two parents and in the ZK-RIL population

Traits	Environments	Year	Location	Parents		ZK-RILs							
				ZKM138	KCM2	Min.	Max.	Mean	SD	CV (%)	Skewness	Kurtoneess	h_B^2 (%)
KL (mm)	E1	2017	Deyang	6.95**	6.72	6.25	7.31	6.78	0.23	3.35	-0.17	-0.25	61.63
	E2		Chengdu	6.97**	6.57	6.22	7.25	6.75	0.23	3.34	-0.19	-0.32	
	E3	2018	Deyang	7.41**	7.24	6.62	7.70	7.18	0.24	3.28	-0.11	-0.35	
	E4		Chengdu	7.19**	6.94	6.51	7.58	7.03	0.23	3.25	-0.09	-0.25	
	E5	2019	Deyang	7.39**	6.90	6.77	7.92	7.34	0.23	3.18	-0.30	-0.30	
	E6		Chengdu	7.24**	6.69	6.25	7.37	6.80	0.23	3.38	-0.18	-0.25	
	E7	2020	Deyang	7.22**	6.99	6.62	7.70	7.18	0.24	3.28	-0.11	-0.38	
	E8		Chengdu	7.18**	6.84	6.14	7.22	6.66	0.23	3.42	-0.17	-0.31	
KW (mm)	E1	2017	Deyang	3.25**	3.09	2.79	3.56	3.28	0.16	4.73	-0.58	-0.10	68.18
	E2		Chengdu	3.31***	2.99	2.66	3.51	3.14	0.16	4.96	-0.33	0.12	
	E3	2018	Deyang	3.66*	3.59	3.27	4.00	3.69	0.14	3.92	-0.30	-0.01	
	E4		Chengdu	3.35*	3.23	2.97	3.69	3.42	0.13	3.86	-0.63	0.81	
	E5	2019	Deyang	3.59**	3.24	3.11	3.82	3.56	0.13	3.66	-0.51	0.28	
	E6		Chengdu	3.57**	3.32	2.87	3.58	3.27	0.14	4.24	-0.39	0.06	
	E7	2020	Deyang	3.33**	3.12	3.27	4.00	3.69	0.15	3.93	-0.29	-0.07	
	E8		Chengdu	3.21**	3.01	2.86	3.60	3.29	0.14	4.39	-0.51	0.13	
KD (mm)	E1	2017	Deyang	4.78**	4.58	4.27	5.11	4.75	0.15	3.08	-0.35	0.05	63.97
	E2		Chengdu	4.84**	4.45	4.16	5.04	4.63	0.15	3.16	-0.26	0.35	
	E3	2018	Deyang	5.16*	5.11	4.77	5.51	5.17	0.15	2.85	0.06	-0.07	
	E4		Chengdu	4.85*	4.74	4.48	5.27	4.92	0.13	2.73	-0.24	0.44	
	E5	2019	Deyang	5.13***	4.70	4.69	5.44	5.11	0.14	2.66	-0.29	-0.09	
	E6		Chengdu	5.13**	4.72	4.33	5.08	4.73	0.14	2.90	-0.21	-0.03	
	E7	2020	Deyang	5.11**	4.69	4.77	5.51	5.17	0.15	2.85	0.05	-0.08	
	E8		Chengdu	5.09***	4.55	4.27	5.03	4.69	0.14	2.99	-0.26	-0.01	
KA (mm2)	E1	2017	Deyang	18.47***	16.73	14.60	20.73	17.93	1.08	6.02	-0.20	-0.02	61.73
	E2		Chengdu	18.69***	15.96	13.79	20.11	17.05	1.07	6.29	-0.14	0.21	
	E3	2018	Deyang	21.17***	20.82	18.40	24.03	21.32	1.12	5.28	0.15	-0.05	
	E4		Chengdu	19.03***	18.15	16.25	22.15	19.39	1.03	5.31	-0.07	0.36	
	E5	2019	Deyang	20.95***	17.63	17.79	23.45	20.85	1.04	4.98	-0.19	-0.14	
	E6		Chengdu	20.82***	17.57	14.86	20.46	17.77	1.03	5.82	-0.12	-0.05	
	E7	2020	Deyang	20.91***	17.01	18.40	24.03	21.32	1.12	5.27	0.15	-0.09	
	E8		Chengdu	20.23***	17.23	14.40	20.10	17.44	1.04	5.99	-0.16	-0.02	

KP (mm)	E1	2017	Deyang	17.54*	16.86	15.96	18.51	17.25	0.50	2.91	-0.11	-0.14	60.92
	E2		Chengdu	17.63*	16.46	15.75	18.30	17.00	0.50	2.93	-0.11	-0.12	
	E3	2018	Deyang	18.51*	17.49	17.27	19.70	18.49	0.52	2.80	0.03	-0.18	
	E4		Chengdu	17.71*	17.02	16.65	19.10	17.86	0.50	2.78	-0.01	-0.06	
	E5	2019	Deyang	18.70**	17.27	17.43	19.76	18.59	0.50	2.71	-0.21	-0.25	
	E6		Chengdu	18.51***	16.97	16.12	18.44	17.24	0.50	2.89	-0.09	-0.19	
	E7	2020	Deyang	18.33*	17.63	17.27	19.70	18.49	0.52	2.80	0.03	-0.22	
	E8		Chengdu	17.99*	17.54	15.90	18.24	17.08	0.50	2.91	-0.11	-0.24	
LWR	E1	2017	Deyang	2.22	2.22	1.83	2.42	2.09	0.12	5.85	0.54	-0.16	87.87
	E2		Chengdu	2.15	2.25	1.93	2.50	2.18	0.12	5.68	0.26	-0.38	
	E3	2018	Deyang	1.99	2.04	1.79	2.29	1.97	0.10	5.12	0.68	0.46	
	E4		Chengdu	2.17	2.22	1.86	2.43	2.10	0.11	5.19	0.50	0.00	
	E5	2019	Deyang	2.10*	2.16	1.83	2.45	2.09	0.11	5.14	0.36	0.33	
	E6		Chengdu	2.03	2.03	1.79	2.42	2.11	0.12	5.67	0.33	0.08	
	E7	2020	Deyang	2.17	2.24	1.79	2.29	1.97	0.10	5.12	0.67	0.39	
	E8		Chengdu	2.24	2.27	1.78	2.41	2.07	0.12	5.89	0.48	-0.04	
KRD	E1	2017	Deyang	0.47	0.46	0.42	0.56	0.49	0.03	5.78	-0.24	-0.41	87.32
	E2		Chengdu	0.47	0.46	0.41	0.53	0.47	0.03	5.89	0.01	-0.47	
	E3	2018	Deyang	0.52	0.50	0.41	0.59	0.51	0.03	5.04	-0.05	0.04	
	E4		Chengdu	0.48	0.47	0.42	0.56	0.49	0.03	5.14	-0.22	-0.14	
	E5	2019	Deyang	0.48	0.47	0.45	0.57	0.52	0.03	4.85	-0.34	-0.08	
	E6		Chengdu	0.50	0.50	0.42	0.58	0.49	0.03	5.77	0.00	0.15	
	E7	2020	Deyang	0.49	0.48	0.41	0.59	0.51	0.03	5.95	-0.20	0.38	
	E8		Chengdu	0.49	0.49	0.42	0.58	0.50	0.03	5.78	-0.12	-0.18	
FFD	E1	2017	Deyang	2.16*	1.94	1.73	2.35	2.08	0.13	6.16	-0.79	0.34	68.33
	E2		Chengdu	2.13**	1.86	1.62	2.33	2.01	0.15	7.22	-0.42	-0.03	
	E3	2018	Deyang	2.05**	1.78	1.34	2.15	1.87	0.13	6.97	-0.66	0.21	
	E4		Chengdu	2.20**	2.00	1.88	2.34	2.14	0.09	4.04	-0.32	0.03	
	E5	2019	Deyang	2.07**	1.82	1.60	2.05	1.83	0.08	4.48	-0.13	0.00	
	E6		Chengdu	2.22*	2.06	1.62	2.67	2.10	0.13	6.28	0.32	0.92	
	E7	2020	Deyang	2.30***	1.93	1.34	2.15	1.87	0.13	6.98	-0.65	0.12	
	E8		Chengdu	2.31***	1.95	1.65	2.30	2.04	0.14	6.71	-0.58	-0.03	

Note:*, ** and *** indicates the significance at 0.05, 0.01 and 0.001 level, respectively.

Table S3 The loci detected by conditional QTL analysis in this study

Traits	Conditional Loci	Environments	Chromosome	Left Marker	Right Marker	LOD	PVE(%)	Add	Left CI	Right CI
KA KL	<i>Locus1</i>	E1,E2,E4,E6,E7,B	3D	<i>AX-110234451</i>	<i>AX-108754018</i>	4.54	8.64	0.25	0.00	6.50
	<i>Locus2</i>	E1,E2,E3,E4,E5,E8,B	4B	<i>AX-94790546</i>	<i>AX-111176263</i>	6.13	10.49	-0.28	13.50	20.50
	<i>Locus3</i>	E1,E2,E3,E4,E5,E8,B	4D	<i>AX-108905056</i>	<i>AX-111677925</i>	5.67	15.06	0.33	6.50	10.50
	<i>Locus4</i>	E1,E3,E4,E6,E8,B	6A	<i>AX-109932158</i>	<i>AX-110637693</i>	4.02	6.85	0.22	37.50	42.50
KA KW	<i>Locus5</i>	E6	1B	<i>AX-110378973</i>	<i>AX-110526568</i>	17.29	18.86	0.37	47.50	48.50
	<i>Locus6</i>	E2, E3, E6, B	3B	<i>AX-108855934</i>	<i>AX-109984220</i>	4.15	5.05	-0.17	79.50	81.00
	<i>Locus7</i>	E3,E4,E5,E6,B	3D	<i>AX-110950126</i>	<i>AX-109730385</i>	6.99	9.43	-0.23	8.50	16.50
	<i>Locus8</i>	E1	5A	<i>AX-110587222</i>	<i>AX-109375147</i>	3.44	3.07	0.15	0.00	6.50
	<i>Locus9</i>	E3	6A	<i>AX-94446180</i>	<i>AX-108734124</i>	30.41	22.00	-0.57	2.50	3.50
	<i>Locus10</i>	E6	6A	<i>AX-110955892</i>	<i>AX-111727948</i>	4.02	4.63	0.18	52.50	54.50
	<i>Locus11</i>	E2, E3, E5, E6, B	6D2	<i>AX-110261831</i>	<i>AX-109845133</i>	5.38	6.40	0.20	3.50	11.50
	<i>Locus12</i>	E2	4B	<i>AX-108828132</i>	<i>AX-110103911</i>	11.38	11.39	0.04	28.50	29.50
KA KD	<i>Locus13</i>	E2	4B	<i>AX-109368728</i>	<i>AX-111046577</i>	5.61	5.29	-0.03	34.50	40.50
	<i>Locus14</i>	E2,E3,E4,E5,E6,E7,E8,B	3D	<i>AX-110234451</i>	<i>AX-108891293</i>	4.06	6.18	0.05	0.00	3.50
KP KL	<i>Locus15</i>	E3,E4,E5,E6,E7,B	4A	<i>AX-110046592</i>	<i>AX-111045592</i>	3.67	5.04	0.04	31.50	32.50
	<i>Locus16</i>	E1,E2,E3,E4,E5,E6,E7,E8,B	4B	<i>AX-94790546</i>	<i>AX-109294476</i>	8.51	12.44	-0.07	13.50	17.50
	<i>Locus17</i>	E1,E2,E3,E4,E5,E6,E7,E8,B	4D	<i>AX-108905056</i>	<i>AX-111677925</i>	8.02	17.31	0.08	7.50	9.50
	<i>Locus18</i>	E1,E2,E3,E4,E5,E6,E7,E8,B	6A	<i>AX-109932158</i>	<i>AX-110637693</i>	5.23	7.36	0.05	37.50	42.50
	<i>Locus19</i>	E4, E7	7A	<i>AX-109892640</i>	<i>AX-111651884</i>	3.52	4.70	-0.04	63.50	69.50
	<i>Locus20</i>	E6,E7	2A	<i>AX-109434737</i>	<i>AX-111042596</i>	4.59	4.42	-0.12	0.00	5.50
KP KW	<i>Locus21</i>	E2, E3, E6, B	3B	<i>AX-108855934</i>	<i>AX-109984220</i>	4.07	2.93	-0.12	79.50	81.00
	<i>Locus22</i>	E1,E2,E3,E4,E5,E6,E7,B	3D	<i>AX-109431678</i>	<i>AX-110950126</i>	9.89	6.61	-0.19	12.50	15.50
	<i>Locus23</i>	E7,E8	4B	<i>AX-110925399</i>	<i>AX-109385774</i>	3.48	7.57	0.12	24.50	25.50

KP KD	<i>Locus24</i>	E2,E3,E4,E5,E7,B	6A	<i>AX-94446180</i>	AX-108734124	31.76	19.52	-0.40	2.50	3.50
	<i>Locus25</i>	E6	6A	<i>AX-110955892</i>	AX-111727948	4.76	7.33	0.13	51.50	54.50
	<i>Locus26</i>	E1,E2,E3,E4,E5,E6,E7,B	6D2	<i>AX-109447460</i>	AX-109845133	7.43	4.82	0.16	6.50	11.50
	<i>Locus27</i>	E1,E2	2A	<i>AX-110433540</i>	<i>AX-110904713</i>	4.43	9.20	-0.07	1.50	3.50
	<i>Locus28</i>	E5,E6,E7	2A	<i>AX-110433540</i>	<i>AX-110904713</i>	3.67	7.71	-0.06	0.00	3.50
	<i>Locus29</i>	E1,E2,E3,E4,E5,E6,E7,E8,B	3D	<i>AX-110234451</i>	<i>AX-111159927</i>	6.16	14.24	-0.08	0.00	10.50
LWR KD	<i>Locus30</i>	E1,E2,E3,E4,E5,E6,E7,E8,B	4B	<i>AX-109909153</i>	<i>AX-110938398</i>	4.08	9.05	0.07	20.50	24.50
	<i>Locus31</i>	E3,E4,E5,E6,E7,B	6A	<i>AX-94446180</i>	<i>AX-108734124</i>	3.91	8.35	-0.06	2.50	3.50
	<i>Locus32</i>	E7	2A	<i>AX-111042596</i>	<i>AX-110433540</i>	6.11	12.65	-0.04	1.50	3.50
	<i>Locus33</i>	E1,E2,E3,E4,E5,E6,E7,E8,B	3D	<i>AX-110234451</i>	<i>AX-110950126</i>	6.33	13.28	-0.04	0.00	15.50
	<i>Locus34</i>	E1,E2,E3,E4,E5,E6,E7,E8,B	4B	<i>AX-109909153</i>	<i>AX-110938398</i>	5.47	11.06	0.04	20.50	24.50
	<i>Locus35</i>	E3,36,B	5A	<i>AX-110587222</i>	<i>AX-109375147</i>	4.33	8.94	0.03	0.00	8.50
LWR KL	<i>Locus36</i>	E1	6D2	<i>AX-89564650</i>	<i>AX-108802393</i>	3.90	9.02	0.03	41.50	47.50
	<i>Locus37</i>	E2,E3,E4,E5,E6,B	3D	<i>AX-108894108</i>	<i>AX-108754018</i>	4.70	8.26	-0.03	0.00	6.50
	<i>Locus38</i>	E7	4A	<i>AX-110046592</i>	<i>AX-111045592</i>	3.48	3.84	-0.02	31.50	32.50
	<i>Locus39</i>	E1,E2,E3,E4,E6,E7,E8,B	4B	<i>AX-109294476</i>	<i>AX-111176263</i>	7.37	12.69	0.04	13.50	20.50
	<i>Locus40</i>	E1,E2,E4,E5,E6,E7,E8,B	4D	<i>Rht2</i>	<i>AX-108905056</i>	6.92	12.71	-0.04	30.50	47.50
	<i>Locus41</i>	E3	5D	<i>AX-89591395</i>	<i>AX-111019979</i>	4.35	8.07	-0.03	96.50	97.50
LWR KW	<i>Locus42</i>	E2,B	6A	<i>AX-110955892</i>	<i>AX-110396610</i>	3.78	5.99	-0.03	48.50	50.50
	<i>Locus43</i>	E7	2A	<i>AX-111042596</i>	<i>AX-110433540</i>	3.54	9.34	-0.03	0.00	3.50
	<i>Locus44</i>	E6	3A2	<i>AX-111083928</i>	<i>AX-109904743</i>	4.06	6.87	0.02	3.50	4.50
	<i>Locus45</i>	E1,E3	3B	<i>AX-108855934</i>	<i>AX-109984220</i>	4.43	7.27	-0.02	79.50	81.00
	<i>Locus46</i>	E1,E3,E5,E6	3D	<i>AX-110950126</i>	<i>AX-109730385</i>	5.49	11.00	-0.03	12.50	17.50
	<i>Locus47</i>	E2,E4,E6,E8,B	4B	<i>AX-110925399</i>	<i>AX-109385774</i>	4.66	8.57	0.03	23.50	25.50
	<i>Locus48</i>	E6	5A	<i>AX-110587222</i>	<i>AX-109375147</i>	3.86	6.41	0.02	0.00	6.50
	<i>Locus49</i>	E3	6A	<i>AX-110955892</i>	<i>AX-110396610</i>	3.57	4.91	0.02	48.50	50.50

KRD KL	<i>Locus50</i>	E1,E3,E6	6D2	<i>AX-110261831</i>	<i>A014803</i>	5.06	8.50	0.02	3.50	12.50
	<i>Locus51</i>	E8	6D2	<i>AX-110425031</i>	<i>AX-89576368</i>	39.62	15.38	0.10	34.50	36.50
	<i>Locus52</i>	E2,E4,E7,E8,B	3D	<i>AX-110234451</i>	<i>AX-108754018</i>	4.78	8.35	0.01	0.00	6.50
	<i>Locus53</i>	E1,E2,E3,E4,E6,E7,E8,B	4B	<i>AX-109294476</i>	<i>AX-111176263</i>	6.78	11.92	-0.01	13.50	20.50
	<i>Locus54</i>	E1,E2,E4,E6,E7,E8,B	4D	<i>Rht2</i>	<i>AX-108905056</i>	7.29	13.66	0.01	30.50	45.50
KRD KW	<i>Locus55</i>	E,E2,B	6A	<i>AX-110955892</i>	<i>AX-110396610</i>	4.64	7.62	0.01	48.50	50.50
	<i>Locus56</i>	E4	1A	<i>AX-110963581</i>	<i>AX-108804089</i>	4.93	8.30	0.01	0.00	2.50
	<i>Locus57</i>	E4	2A	<i>AX-111041231</i>	<i>AX-109431101</i>	5.35	9.16	0.01	3.50	5.50
	<i>Locus58</i>	E6	3A2	<i>AX-111083928</i>	<i>AX-109904743</i>	3.64	5.68	-0.01	3.50	4.50
	<i>Locus59</i>	E5,E6,B	3D	<i>AX-110950126</i>	<i>AX-109730385</i>	6.17	9.85	0.01	12.50	16.50
KRD KD	<i>Locus60</i>	E2,E8	4B	<i>AX-109909153</i>	<i>AX-110938398</i>	4.03	10.67	-0.006	20.50	25.50
	<i>Locus61</i>	E4	4D	<i>AX-111494342</i>	<i>Rht2</i>	4.23	9.12	-0.01	24.50	35.50
	<i>Locus62</i>	E6	5A	<i>AX-110587222</i>	<i>AX-109375147</i>	4.48	7.16	-0.01	0.00	5.50
	<i>Locus63</i>	E5,E6,B	6D2	<i>AX-110261831</i>	<i>A014803</i>	4.99	8.00	-0.01	4.50	9.50
	<i>Locus64</i>	E4,B	2A	<i>AX-111042596</i>	<i>AX-110433540</i>	4.62	9.40	0.01	1.50	3.50
FFD KL	<i>Locus65</i>	E2	2D	<i>AX-86176809</i>	<i>AX-109998182</i>	4.71	7.05	-0.01	68.50	69.50
	<i>Locus66</i>	E1,E2,E3,E4,E5,E6,E7,E8,B	3D	<i>AX-110234451</i>	<i>AX-110950126</i>	7.57	14.00	0.01	0.00	14.50
	<i>Locus67</i>	E1,E2,E3,E4,E6,E7,E8,B	4B	<i>AX-109909153</i>	<i>AX-110938398</i>	5.60	10.32	-0.01	13.50	24.50
	<i>Locus68</i>	E7	4D	<i>Rht2</i>	<i>AX-108905056</i>	4.06	7.69	0.01	31.50	45.50
	<i>Locus69</i>	E6	4D	<i>AX-108852200</i>	<i>AX-108741322</i>	4.25	6.27	0.01	53.50	57.50
FFD KL	<i>Locus70</i>	E3,E6,E8,B	5A	<i>AX-110587222</i>	<i>AX-109375147</i>	4.29	8.18	-0.01	0.00	9.50
	<i>Locus71</i>	E2	5A	<i>AX-111275814</i>	<i>AX-109940010</i>	4.42	6.31	0.01	59.50	60.50
	<i>Locus72</i>	E7	6A	<i>AX-109905050</i>	<i>AX-109509808</i>	3.67	5.74	0.01	3.50	4.50
	<i>Locus73</i>	E6	6D2	<i>AX-109447460</i>	<i>AX-109845133</i>	4.23	5.90	-0.01	9.50	12.50
	<i>Locus74</i>	E2	7A	<i>AX-108744494</i>	<i>AX-110529210</i>	3.94	7.02	-0.01	84.50	93.50
	<i>Locus75</i>	E4	3B	<i>AX-109911340</i>	<i>AX-111536910</i>	4.00	9.36	0.03	75.50	77.50

	<i>Locus76</i>	E1,E2,B	4B	<i>AX-109294476</i>	<i>AX-111176263</i>	6.29	11.33	-0.04	15.50	22.50
	<i>Locus77</i>	E1,E2,E7,B	4D	<i>Rht2</i>	<i>AX-108905056</i>	5.09	11.18	0.05	31.50	48.50
	<i>Locus78</i>	B	5D	<i>AX-108760983</i>	<i>AX-111723433</i>	3.73	8.68	-0.03	93.50	94.50
	<i>Locus79</i>	E2,B	6A	<i>AX-110955892</i>	<i>AX-110396610</i>	4.62	7.47	0.04	48.50	50.50
FFD KW	<i>Locus80</i>	E1	2A	<i>AX-111042596</i>	<i>AX-110433540</i>	8.53	21.64	0.03	2.50	3.50
	<i>Locus81</i>	B	2D	<i>AX-109449257</i>	<i>AX-110411457</i>	4.35	8.16	-0.02	74.50	76.50
	<i>Locus82</i>	E2	4B	<i>AX-109909153</i>	<i>AX-110938398</i>	3.67	7.47	-0.03	20.50	24.50
	<i>Locus83</i>	B	5D	<i>AX-108760983</i>	<i>AX-111723433</i>	4.84	13.69	-0.02	93.50	94.50
FFD KD	<i>Locus84</i>	E1,E8,B	2A	<i>AX-111042596</i>	<i>AX-110433540</i>	4.95	9.38	0.03	1.50	3.50
	<i>Locus85</i>	B	3B	<i>AX-108855934</i>	<i>AX-109984220</i>	3.78	10.03	0.02	79.50	81.00
	<i>Locus86</i>	E2	3D	<i>AX-110234451</i>	<i>AX-108891293</i>	3.63	6.48	0.03	0.00	2.50
	<i>Locus87</i>	E1,E2	4B	<i>AX-109909153</i>	<i>AX-110938398</i>	11.23	20.07	-0.07	20.50	24.50
	<i>Locus88</i>	E2	4D	<i>Rht2</i>	<i>AX-108905056</i>	3.54	6.62	0.03	29.50	43.50
	<i>Locus89</i>	E8	7B	<i>AX-94611818</i>	<i>AX-109976283</i>	5.34	11.17	0.05	76.50	80.50

Table S4 Genotypes for R3D, R4B and R6D2 using KASP marker in global cultivars

Varieties	Countries	R3D	R4B.1	R6D2
Xiaoyan315	China	A	B	A
Pubing151	China	A	A	A
Pubing04-1	China	B	X	A
Pubing04-2	China	X	X	A
Pubing3504	China	A	B	B
Yunhan102	China	A	B	A
Changhang1	China	A	X	A
Pubing2011	China	X	B	B
Hangyangmai	China	B	A	A
Xiaoyan22	China	A	B	B

Zhongyu1428	China	A	B	A
Xinmai8171	China	A	A	B
Xinong360	China	B	X	A
Zheng9023	China	B	A	A
Zheng7698	China	A	B	A
Jimai36	China	A	A	A
Guojiamai15	China	B	B	A
Jimai22	China	A	A	A
Xinong979	China	B	X	A
Xinong589	China	A	X	A
Zhoumai40	China	B	X	B
Hemai1301	China	A	A	A
Jindi166	China	A	A	A
Xinong622	China	B	X	X
Xianmai99	China	B	B	A
Zhongyu9331	China	A	A	A
Zhumai328	China	A	X	A
Hua2132	China	B	B	A
Hua2667	China	B	B	A
Xinong189	China	A	A	A
Zimai12	China	A	X	A
Bainong207	China	A	X	A
Ronghua188	China	B	X	B
Xinong285	China	B	A	A
Huamai0981	China	X	A	B
Hua1315	China	B	X	A
Tainong2987	China	A	A	A
Zhengmai119	China	A	X	A

JiyanmaiC6047	China	B	A	B
Xinong733	China	A	X	A
Fannong6	China	A	A	A
Xinnong23	China	B	X	A
Zhengmai103	China	A	X	B
Zhengmai004	China	A	A	B
Jimai52	China	A	A	A
Yannong1212	China	A	A	A
Xianmai10	China	A	B	A
Hua2820	China	A	A	A
Nongda5738	China	A	A	A
Nongda5758	China	X	B	B
Xinmai29	China	A	X	A
Zhoumai22	China	B	B	A
Deyan0516	China	B	B	A
Hefeng3	China	A	A	A
Chuangmai58	China	B	X	A
Zhengpinmai25	China	B	B	A
Saidemai601	China	B	B	A
Tianmin366	China	A	A	A
Xuyan5	China	X	B	A
Zhengmai16	China	A	X	A
Jimai44	China	B	X	A
Jimai55	China	A	A	A
Saidemai17	China	B	B	A
Pumai1165	China	B	X	B
Xinong592	China	B	A	B
Zheng9405	China	A	X	A

Xinong916	China	A	X	A
Xinong235	China	X	B	A
Keda109	China	B	A	A
Xinong113	China	B	A	A
Xinong66	China	A	A	A
Zhongmai698	China	A	X	A
Xinong162	China	A	A	A
Zhengmai162	China	A	B	A
Xinong511	China	A	X	A
Annong1124	China	A	X	B
Luomai33	China	A	X	A
Zhoumai32	China	A	A	A
Fengdecunmai5	China	B	B	A
Zhoumai30	China	A	A	A
Yuanfeng175	China	B	B	B
Zhoumai28	China	B	X	B
Yumai34	China	A	A	A
Neimai11	China	A	B	B
Yangmai2	China	B	X	A
Yangmai1	China	B	B	A
Yunmai53	China	A	B	A
Yangfumai2	China	A	B	A
Yunmai57	China	X	X	B
Zhongmai166	China	B	X	A
Yangmai22	China	A	A	A
Tianshui08-3	China	A	B	A
Chuannong29	China	B	B	B
Chuanfu8	China	B	B	B

Chuanlanmai1	China	A	X	A
Chuanmai104	China	A	X	B
Chuanmai42	China	A	B	B
Chuanmai43	China	A	X	X
Chuanmai64	China	A	A	B
Chuanmai82	China	A	B	B
Neimai8	China	A	B	B
Mianyang24	China	A	B	A
Mianyang30	China	A	B	A
Shumai830	China	B	X	B
Shumai114	China	A	X	B
Shumai133	China	B	A	B
Kechengmai1	China	B	B	B
Lantian22	China	A	B	A
Lantian26	China	B	A	A
Maimai367	China	A	A	B
Chuanmai93	China	B	B	B
Chuannong12	China	B	A	B
Chuannong19	China	B	X	A
Chuannong21	China	A	A	A
Chuanyu20	China	A	A	A
Chuanyu23	China	B	A	B
Chuanyu29	China	B	X	B
Fan6	China	B	X	B
Mianmai1403	China	B	B	B
Mianmai315	China	A	B	A
Xikemai4	China	B	X	A
Shumai969	China	A	X	A

Shumai1609	China	B	A	B
Chuanmai98	China	B	A	A
Chuanmai901	China	A	B	B
CD015-1237-2	China	A	A	A
CD015-1264-1	China	A	A	A
Kemai2939	China	A	X	B
Chuanmai36	China	A	X	A
Shumai3	China	X	B	A
Chuannong32	China	B	X	A
Yumai1	China	B	B	B
Shumai1661	China	X	X	X
Chuanyu26	China	B	B	B
Shumai580	China	A	B	A
Kechengmai4	China	B	B	A
Guixie4	China	A	A	A
Mianmai905	China	A	X	A
Zhongmai578	China	A	X	A
Chuannong16	China	A	A	B
Mianmai51	China	A	A	A
CS	China	B	B	B
Chuannong33	China	B	A	B
Zimai1	China	A	B	B
Zimai2	China	A	A	A
Lantian34	China	X	X	A
Lantian35	China	A	A	A
Lantian19	China	A	B	A
Zhongkemai169	China	B	X	B
Zhongkemai10	China	A	A	B

Shumai691	China	A	B	B
Neimai101	China	A	A	B
Mianzimai830	China	X	B	A
Mianyangnong	China	X	A	A
Chuanyu38	China	A	A	A
Xikemai518	China	A	B	B
Chengshixinmai3	China	B	B	B
Mianmai45	China	X	X	A
Mianyang11	China	X	X	A
Mianmai185	China	A	X	A
Chuanyu16	China	A	A	A
Chongzu104	China	A	X	B
Zhongkemai17	China	A	B	A
Zhongkemai18	China	A	B	A
Zhongkemai36	China	A	X	X
Chuanyu12	China	A	X	B
Zhongkemai138	China	A	A	A
Mianmai37	China	A	X	B
Chuanmai30	China	A	X	A
Chuanmai107	China	B	X	B
Chuanmai28	China	B	B	B
Chuannong27	China	B	X	B
Chuanmai44	China	B	B	A
Chuanyu42	China	A	A	B
Xiaobingmai33	China	B	X	A
Xichang18	China	B	A	A
Zhongmai133	China	B	X	A
Tianxuan43	China	A	X	A

Xiaoguan54	China	B	X	A
Changbai251	China	A	X	A
Mangmai1	China	A	X	A
12Z37	China	X	B	A
Xinggang1958	China	A	X	A
Zhongyou206	China	A	B	A
Luokang2	China	A	A	A
Shicaomai4071	China	A	B	A
Mahon	Algeria	A	A	A
Improved Steinwedel	Australia	A	X	A
Aussie	Australia	A	A	A
Sultan	Australia	A	B	A
Sunset	Australia	A	A	A
Ford	Australia	A	A	A
Fife	Australia	B	A	A
Early Bird	Australia	B	A	A
Majestic	Australia	A	A	A
Rajah	Australia	A	X	A
Cedar	Australia	X	A	B
Union	Australia	A	X	A
Waratah	Australia	A	X	A
Canberra	Australia	A	B	A
Exquisite	Australia	A	A	A
Duchess	Australia	A	A	A
Bebrovo	Bulgaria	A	A	A
Constantin	Bulgaria	A	A	A
Golema Franga	Bulgaria	A	A	A
Shan wheat	Burma	A	B	A

2193/20-12	Burma	B	X	A
2193/20-14	Burma	A	X	X
Blé mavratheri	Crete	A	B	A
Blé cheliostazo	Crete	A	B	A
Psathas	Cyprus	B	A	A
Asprokoutsoullon	Cyprus	B	X	A
Alliés	France	A	A	A
Vilmorin 29	France	A	A	A
P.M.L.1	France	A	A	A
Carré Géant blanc	France	A	B	A
Bladette de Besplas	France	A	A	A
Rouge de St-Laud	France	A	A	A
Roux de Presles	France	A	A	A
Rouge des Ardennes	France	B	X	A
Way	France	A	B	A
Wilson jaune	France	A	A	A
Rouge de Bordeaux	France	A	A	A
Parsel	France	A	X	A
Blé Seigle	France	A	X	A
Saissette de Maninet P	France	B	B	A
Maylin	France	A	A	A
Deve	Greece	A	X	A
Trigonostaro	Greece	A	A	A
Hokino	Greece	A	A	A
Vardarka Chervenaka	Greece	A	A	A
Asprotheri	Greece	A	B	A
Zulitsa	Greece	B	A	A
Arnaout	Greece	A	A	A

Karabash	Greece	X	A	B
Pusa 90	India	A	A	A
Gangajali	India	A	A	A
Dolatkhani (white)	India	A	A	A
Pusa 4	India	B	A	A
Rodi Garamseli	India	A	A	A
Pashmak	India	A	B	A
Federation	India	A	A	A
Thori (beardless)	India	A	A	A
Phundi	India	A	A	A
Ka	India	B	A	A
Bhawarwall	India	A	X	A
Boojri	India	A	A	A
Boojri (bearded)	India	A	X	A
Pusa 52	India	B	B	A
Lalia	India	A	X	A
White Murga	India	B	A	A
White Tikoria	India	B	B	A
Dehak	India	A	X	A
Lyallpur 14	India	A	A	A
Setwa	India	B	B	B
Sur	India	A	B	A
Soor Ghanum	India	A	B	B
Lyallpur 10	India	B	A	B
Desi White	India	A	A	A
Spin	India	B	X	A
Lalia Desi	India	B	A	B
Dandi	India	A	B	B

Sambhoria (Lalwali Wala)	India	B	X	A
Dehak Panjabi	India	A	B	A
Samna	India	A	B	B
Punjab 8A	India	A	A	A
Kaghzi Desi	India	B	A	A
Lyallpur 11	India	B	X	A
Lyallpur 8A	India	B	B	A
Walaiti (Mastung wheat)	India	A	X	A
C.	India	A	A	B
Thori	India	X	A	A
Sufed Panjabi	India	A	A	A
Desi	India	A	A	A
Gahu (Nepali) or Kyo (Sikkimese)	India	A	B	A
Pusa 6	India	B	B	A
Lalmi	India	A	X	B
Abi	India	A	A	A
Pusa 80-5	India	A	B	A
Malo	India	A	X	A
Mundia	India	B	X	A
Autumn wheat	Iran	A	A	B
Razan Ferahan	Iran	A	X	A
Kerbelai Ali Khani	Iran	B	A	A
Sarakhs	Iran	A	A	A
Sarakh	Iran	A	A	A
Kal	Iran	A	A	A
Sari Boghda	Iran	B	X	A
Serabend	Iran	A	A	A
Safid	Iran	A	X	A

Zardak-i-Harrami	Iran	B	A	A
Khal Kirmiz	Iran	A	X	A
Ab Mahi	Iran	B	X	A
Qizilqin Boghda	Iran	B	B	A
Khusheh Safid	Iran	A	X	A
Vilayati	Iran	A	B	A
Sukh Das	Iran	A	B	A
Ma'aunch	Iran	B	A	A
Gandum-i-Jiruft	Iran	B	B	B
Muganka x Belokoloska	Iran	A	B	A
Rustam Exp Farm 99	Iraq	B	X	B
Kandhari, Rustam Exp Farm 859	Iraq	A	A	A
Humairah, Rustam Exp Farm 595	Iraq	B	A	A
Rustam Exp Farm 79	Iraq	B	A	A
Rustam Exp Farm 171	Iraq	A	A	A
Mairca di Pali, Flaksberger 19341	Italy	A	B	A
Gentil Rossa, Flaksberger 19927	Italy	A	B	A
Decimomanna, Flaksberger 20119	Italy	A	A	A
Edda	Italy	A	A	A
Piccolo	Italy	A	B	A
Mahan	Morocco	A	A	A
Mughari	Palestine	B	A	A
Abu Fashi	Palestine	B	A	A
Wysololitewka Sobieszynska	Poland	A	A	A
Trigo preto rijo	Poland	B	A	A
Bialy Krzyz Ryxa	Poland	X	X	A
Kolben Heinego	Poland	A	A	A

Kujawianka Wieclawicka	Poland	A	B	A
Superelekta Kleszczynskich	Poland	A	A	A
Extra Kolben Heinego	Poland	X	A	A
Surka Cezostna	Poland	B	A	A
Ostka Wieclawicka	Poland	A	A	A
Ostka Skomoroska	Poland	B	B	A
Hors Concurs	Poland	A	A	A
Zlotka Miczynskiego	Poland	B	B	B
