Evaluation of physiological traits and identification of QTLs for drought tolerance in hexaploid wheat (*Triticum aestivum L.*)

Ali Izanloo

Thesis submitted for the degree of

Doctor of Philosophy

School of Agriculture, Food and Wine

Discipline of plant and pest science

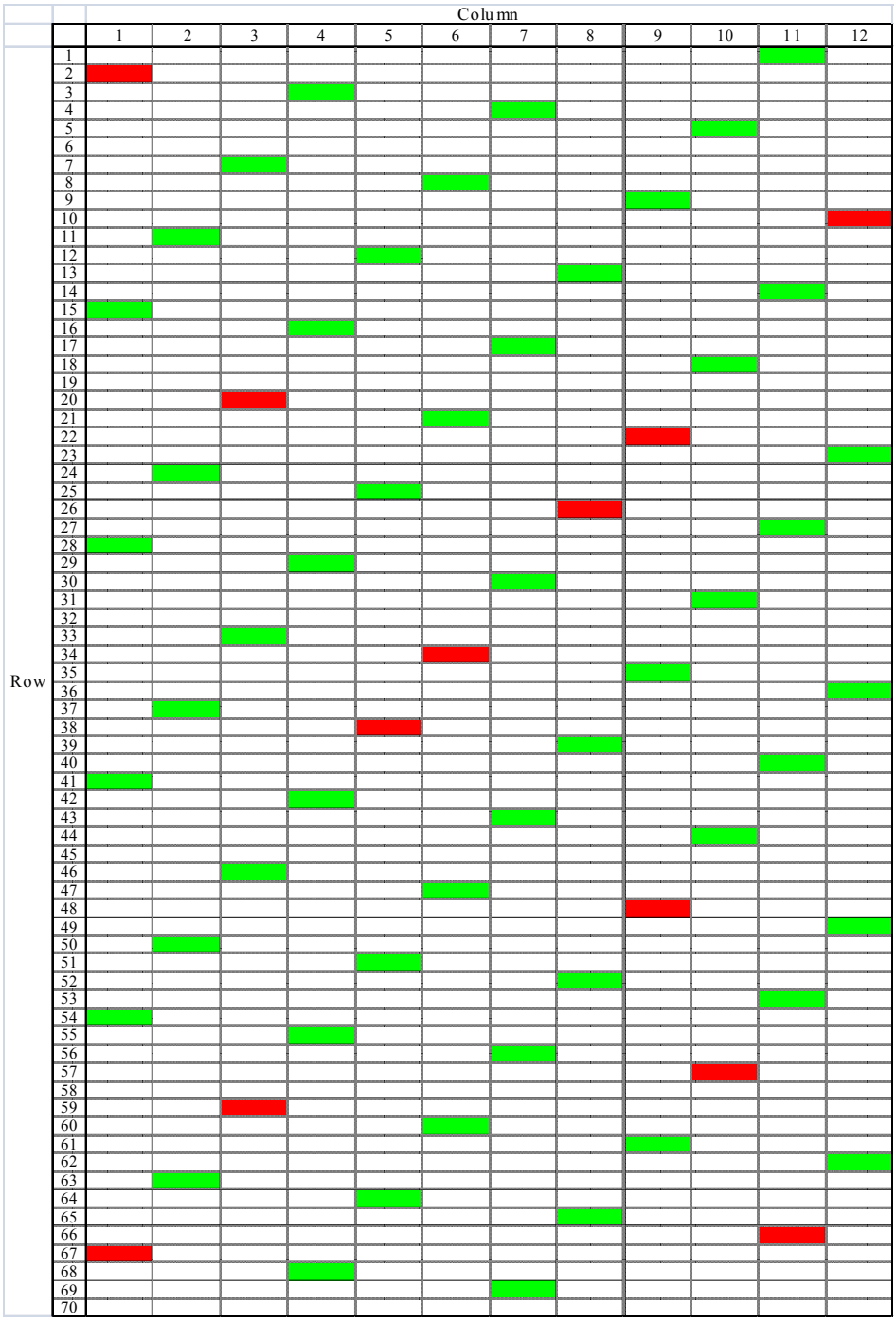
Australian centre for plant functional genomics (ACPFG)

March 2008

APPENDICES

Appendices

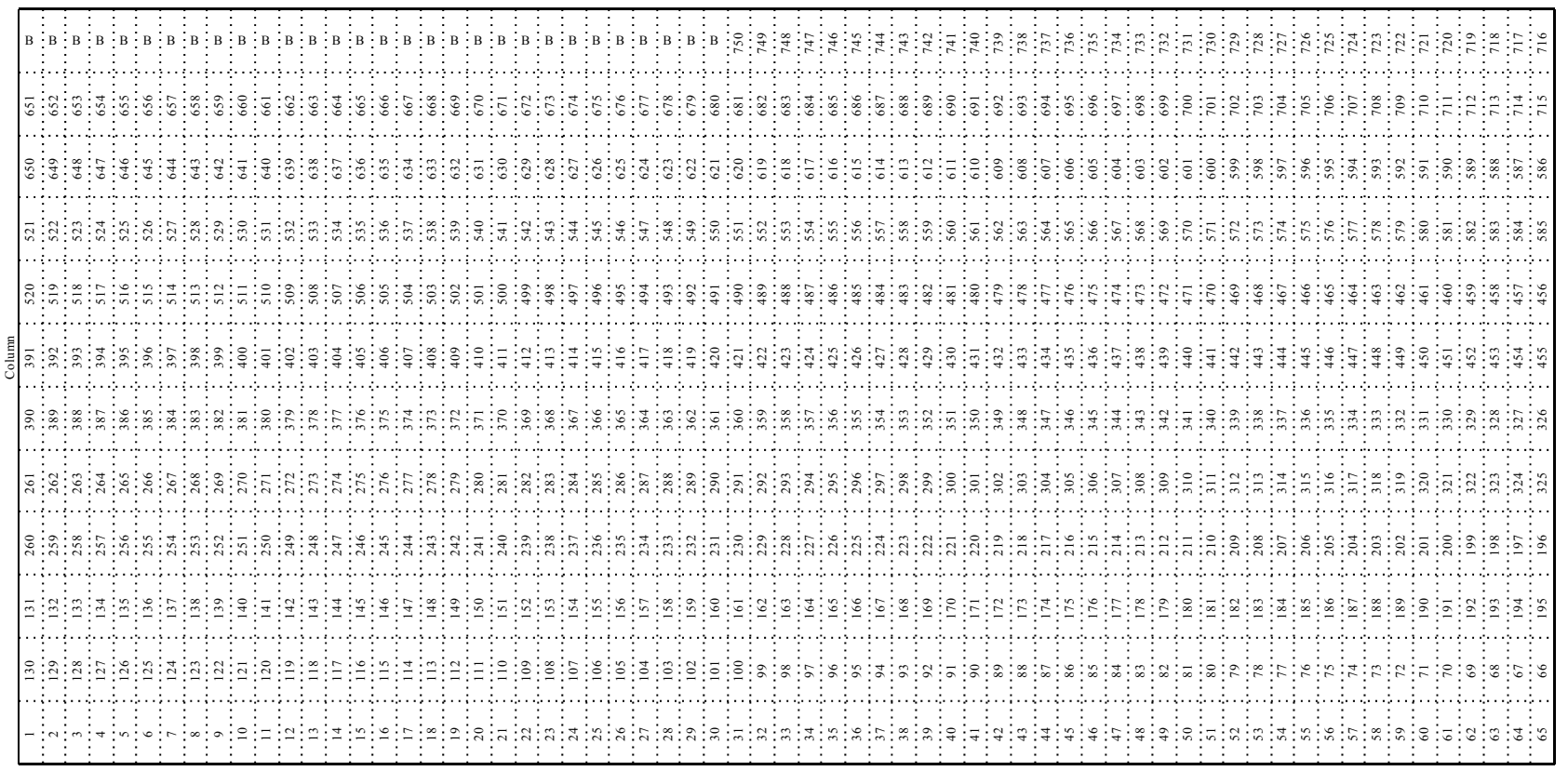
Appendix A. The experimental layout in the three sites across South Australia (Roseworthy, Minnipa and Booleroo). The highlighted plots are grid check and red plots are those soil samples were taken. The design was generated using the DiGGer software.



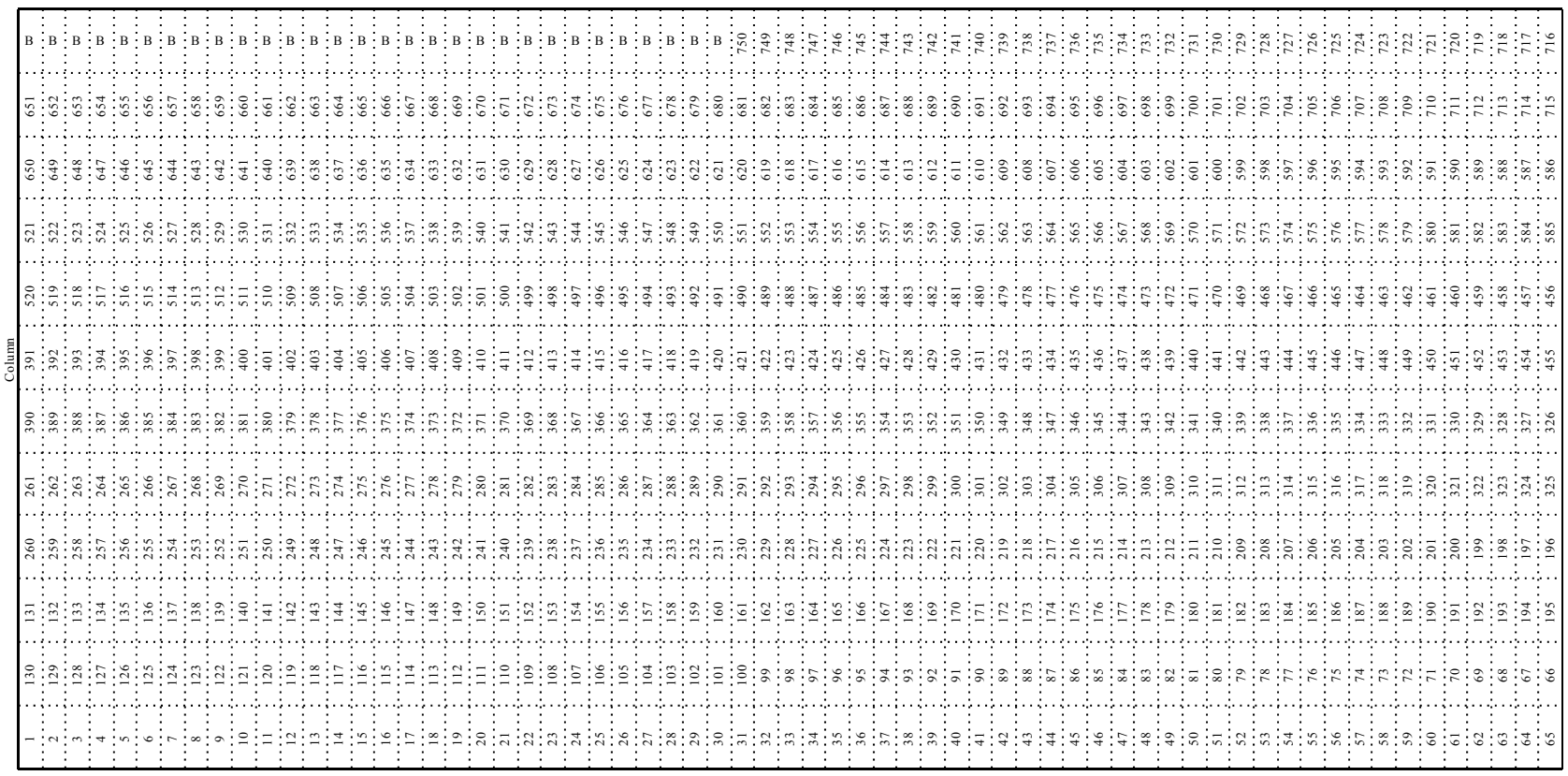
Appendix B. The check lines and their replications throughout the experiment in South Australian field experiments (RAC, Minn and Bool)

Check lines	Replications
Drysdale	2
Excalibur	8
Frame	2
Krichauff	2
Kukri	8
RAC1262	2
RAC875	8
Stylet	2
Tincurren	6
Westonia	2
Wyalkatchem	2
Yitpi	2
Carinya	64

Appendix C. The experimental layout of drought experiment in CIMMYT, Obregon, Mexico 2007.



Appendix D. The experimental layout of irrigated experiment in CIMMYT, Obregon, Mexico 2007.



Appendix E. Detected QTLs for heading time (Eet) for the early- and late-flowering subpopulations (EF and LF) in five environments. The most likely position, range, interval of flanking markers, allelic additive effect, heritability and LOD for each individual QTL is presented.

Sub	Site	QTL	Position (cM)	Range	Interval	Add	Parent	h^2 (%)	LOD
Early-flowering (EF)	RAC	***QEet.aww-2DS^{EF}***	60.7	48.7-92.2	*XwPt-6003–XwPt-0330*	-3.11	RAC875	15.1	9.9
		QEet.aww-5B^{EF}	75.9	59.4-92.6	*XwPt-4936–XwPt-3457*	-1.24	RAC875	5.2	4.3
		QEet.aww-7A^{EF}	90.1	58.6-98.1	*Xcfa2028–Xbarc1004*	1.19	Kukri	8.2	4.1
		QEet.aww-7B.1^{EF}	5.6	2.6-37.2	*XwPt-0745–Xgwm0297*	1.11	Kukri	5.2	4.9
	Minn	***QEet.aww-2DS^{EF}***	53.7	43.7-78.7	*XwPt-6003–XwPt-0330*	-4.34	RAC875	13.5	8.0
		QEet.aww-7A^{EF}	92.1	58.6-113.3	*Xcfa2028–Xbarc0259*	1.56	Kukri	7.8	4.9
	Bool	***QEet.aww-2D^{EF}***	63.7	51.7-91.2	*XwPt-6003–XwPt-0330*	-3.59	RAC875	14.9	12.9
		QEet.aww-3D^{EF}	95.1	67.9-105.1	*XwPt-7894–Xbarc0042*	-1.02	RAC875	3.6	3.0
		QEet.aww-5B^{EF}	64.4	54.3-83.6	*Xbarc0088–XwPt-4936*	-1.36	RAC875	3.5	5.0
		QEet.aww-7A^{EF}	92.1	62.6-98.1	*Xcfa2028–Xbarc1004*	1.95	Kukri	12.9	9.2
		QEet.aww-7B.2^{EF}	55.8	44.0-66.8	*XwPt-4230–Xwmc0517b*	1.84	Kukri	8.3	6.1
	MexI	***QEet.aww-2DS^{EF}***	80.2	79.7-81.2	*XwPt-0330–Xbarc0328b*	-1.86	RAC875	13.6	11.9
		QEet.aww-5B^{EF}	56.4	55.3-57.4	*Xbarc0088–XwPt-4936*	-0.93	RAC875	2.6	3.8
		QEet.aww-7A^{EF}	90.1	89.6-91.1	*Xcfa2028–Xbarc1004*	1.41	Kukri	10.5	6.3
		QEet.aww-7B.2^{EF}	48.8	48.0-49.8	*XwPt-4230–Xwmc0517b*	1.19	Kukri	6.8	5.5
	MexD	***QEet.aww-2D^{EF}***	86.2	79.7-81.2	*XwPt-0330–Xbarc0328b*	-2.17	RAC875	19.7	11.3
		QEet.aww-7B.1^{EF}	7.0	6.6-37.2	*Xbarc0338–Xgwm0297*	2.35	Kukri	7.5	4.8
Late-flowering (LF)	RAC	***QEet.aww-4A^{LF}***	107.0	101.8-111.7	*XwPt-0817–XwPt-5694*	-1.17	RAC875	7.2	5.2
		QEet.aww-5B^{LF}	63.4	56.4-70.4	*Xbarc0088–XwPt-4936*	-2.27	RAC875	20.2	8.8
		QEet.aww-7A^{LF}	92.1	58.6-98.1	*Xcfa2028–Xbarc1004*	2.11	Kukri	25.7	8.8
		QEet.aww-7B.2^{LF}	71.8	58.8-85.4	*XwPt-4230–Xwmc0517b*	1.29	Kukri	6.7	8.7
	Minn	***QEet.aww-5B^{LF}***	71.9	62.4-81.9	*XwPt-4936–XwPt-3457*	-1.61	RAC875	7.5	3.8
		QEet.aww-7A^{LF}	95.1	73.6-107.2	*Xcfa2028–Xbarc1004*	2.79	Kukri	31.9	3.9
		QEet.aww-7B.2^{LF}	63.8	46.0-79.8	*XwPt-4230–Xwmc0517b*	1.85	Kukri	9.3	8.3
	Bool	***QEet.aww-5B^{LF}***	77.9	63.4-87.6	*XwPt-4936–XwPt-3457*	-3.22	RAC875	13.9	3.3
		QEet.aww-7A^{LF}	93.1	68.6-99.1	*Xcfa2028–Xbarc1004*	4.05	Kukri	36.7	8.5
		QEet.aww-7B.2^{LF}	63.8	46.0-76.8	*XwPt-4230–Xwmc0517b*	2.79	Kukri	11.2	9.2
	MexI	***QEet.aww-7B.1^{LF}***	8.0	3.6-18.0	*Xbarc0338–Xstm0671acag*	2.02	Kukri	18.6	4.2

Appendix F. Detected QTLs for number of spikelets per spike (Spn) for the early-flowering subpopulation (EF) in RAC, Minn, Bool and MexD environments. The most likely position, range, interval of flanking markers, allelic additive effect, heritability and LOD for each individual QTL is presented.

Sub	Site	QTL	Position (cM)	Range	Interval	Add	Parent	h2 (%)	LOD
Early-flowering (EF)	RAC	***QSpn.aww-3A^{EF}***	51.1	41.1-58.9	*XwPt-0714–Xgwm0002*	0.29	Kukri	6.5	6.8
		QSpn.aww-4A^{EF}	37.9	28.9-48.9	*Xcfe0254–Xbarc0170*	-0.19	RAC875	5.6	3.4
		QSpn.aww-6A^{EF}	92.5	88.0-100.5	*Xwmc0256a–XwPt-7599*	-0.28	RAC875	8.0	7.2
		QSpn.aww-7A^{EF}	147.3	143.3-152.3	*Xbarc0292–Xgwm0746*	0.53	Kukri	23.1	20.6
		QSpn.aww-7B.2^{EF}	68.8	57.8-81.8	*XwPt-4230–Xwmc0517b*	0.29	Kukri	5.2	5.3
	Minn	***QSpn.aww-7A^{EF}***	146.3	140.3-151.3	*Xbarc0292–Xgwm0746*	0.48	Kukri	20.5	14.5
		QSpn.aww-7B.2^{EF}	69.8	57.8-85.4	*XwPt-4230–Xwmc0517b*	0.30	Kukri	6.0	4.2
	Bool	***QSpn.aww-2D^{EF}***	86.2	44.7-96.2	*XwPt-0330–Xbarc0328b*	-0.24	RAC875	2.6	3.6
		QSpn.aww-7A^{EF}	148.3	143.3-154.3	*Xbarc0292–Xgwm0746*	0.52	Kukri	20.6	13.8
		QSpn.aww-7B.2^{EF}	69.8	61.8-78.8	*XwPt-4230–Xwmc0517b*	0.44	Kukri	10.9	8.8
	MexD	***QSpn.aww-7A^{EF}***	159.9	149.3-166.4	*Xgwm0746–XwPt-5558*	0.92	Kukri	22.6	4.2
		QSpn.aww-7B.1^{EF}	33.6	28.4-39.2	*Xgwm0297–Xbarc0065*	0.52	Kukri	7.7	8.6

Appendix G. Detected QTLs for flag leaf (Fl) and spike length (El) for the early- and late-flowering subpopulations in RAC, Minn, Bool and MexD environments. The most likely position, range, interval of flanking markers, allelic additive effect, heritability and LOD for each individual QTL is presented.

Sub	Site	QTL	Position (cM)	Range	Interval	Add	Parent	h^2 (%)	LOD
Early-flowering	RAC	***QFl.aww-2BS^{EF}***	39.1	35.0-45.1	*Xbarc0013a–Xgwm0271a*	-0.54	RAC875	3.2	4.3
		QFl.aww-2DS^{EF}	89.2	83.2-96.2	*XwPt-0330–Xbarc0328b*	1.00	Kukri	16.9	11.7
		QFl.aww-5B^{EF}	89.6	73.9-97.6	*XwPt-3457–Xgwm0271b*	0.76	Kukri	11.9	7.8
		QFl.aww-7D^{EF}	104.2	83.2-116.9	*Xstm0535–Xstm0001tcac*	0.47	Kukri	5.4	3.8
	Minn	***QFl.aww-2BS^{EF}***	39.1	34.0-44.1	*Xbarc0013a–Xgwm0271a*	-0.66	RAC875	5.3	5.2
		QFl.aww-2DS^{EF}	56.7	44.7-91.2	*XwPt-6003–XwPt-0330*	1.50	Kukri	17.0	8.1
		QFl.aww-5B^{EF}	77.9	65.4-98.6	*XwPt-4936–XwPt-3457*	0.54	Kukri	6.1	3.8
	Bool	***QFl.aww-2DS^{EF}***	56.7	46.7-73.7	*XwPt-6003–XwPt-0330*	0.75	Kukri	19.5	13.7
		QFl.aww-5B^{EF}	90.6	74.9-101.3	*XwPt-3457–Xgwm0271b*	0.29	Kukri	6.9	5.2
	MexD	***QFl.aww-7A^{EF}***	90.1	89.6-91.1	*Xcfa2028–Xbarc1004*	0.74	Kukri	10.4	5.8
		QFl.aww-7B^{EF}	7.0	6.6-8.0	*Xbarc0338–Xstm0671acag*	0.59	Kukri	5.6	3.7
Late-flowering	RAC	***QFl.aww-5B^{LF}***	91.6	83.6-98.6	*XwPt-3457–Xgwm0271b*	0.80	Kukri	27.5	6.8
		QFl.aww-7A^{LF}	112.0	104.2-118.8	*Xbarc0174–Xbarc0259*	0.59	Kukri	15.4	5.6
	Minn	***QFl.aww-4A^{LF}***	103.8	83.3-111.7	*XwPt-7924–XwPt-0817*	-0.24	RAC875	8.5	3.3
		QFl.aww-6A^{LF}	83.0	74.7-91.1	*Xstm0519actc–Xbarc0118*	0.24	Kukri	14.3	3.8
		QFl.aww-7A^{LF}	118.3	105.2-121.8	*Xbarc0259–Xbarc0281*	0.28	Kukri	15.4	3.6
	Bool	***QFl.aww-5B^{LF}***	89.6	76.9-98.6	*XwPt-3457–Xgwm0271b*	0.28	Kukri	15.1	3.8
Early-flowering	RAC	***QEl.aww-3D^{EF}***	82.6	70.6-92.1	*Xwmc0533–XwPt-6262*	-0.182	RAC875	8.1	4.8
	Minn	***QEl.aww-7A.2^{EF}***	184.1	169.4-201.1	*Xgwm0984–XwPt-7763*	0.1008	Kukri	6.8	3.8
	Bool	***QEl.aww-3D^{EF}***	112.8	98.1-117.7	*Xbarc0042–Xgwm0664*	-0.108	RAC875	9.0	5.6
	MexD	***QEl.aww-2A^{EF}***	81.3	80.6-82.0	*Xgwm0558–Xbarc0010a*	-0.208	RAC875	5.5	4.8
		QEl.aww-3D^{EF}	59.9	59.7-60.9	*Xcfd0034–Xwmc0533*	-0.187	RAC875	4.8	3.8
		QEl.aww-4A^{EF}	14.2	13.9-15.2	*Xbarc0106–XDuPw0328*	0.233	Kukri	7.8	3.5
		QEl.aww-7A.1^{EF}	113.3	113.0-114.3	*Xbarc0259–Xbarc0281*	0.381	Kukri	17.5	14.6
Late	RAC	***QEl.aww-3A^{LF}***	50.1	37.1-74.6	*XwPt-0714–Xgwm0002*	0.272	Kukri	13.0	3.3

Appendix H. Detected QTLs for TGW for the early- and late-flowering subpopulations (EF and LF) in RAC, Minn, Bool and MexD environments. The most likely position, range, interval of flanking markers, allelic additive effect, heritability and LOD for each individual QTL is presented.

Sub	Site	QTL	Position	Range	Interval	Add	Parent	h^2 (%)	LOD
Early-flowering	RAC	***QTgw.aww-2B.2^{EF}***	131.0	109.6-139.3	*Xcfd0050a–XwPt-3378*	-0.59	RAC875	7.0	3.6
		QTgw.aww-4A^{EF}	80.3	62.3-124.7	*Xgwm0637a–XwPt-7924*	0.72	Kukri	3.3	3.1
		QTgw.aww-6A^{EF}	53.1	36.2-96.5	*Xgwm0169–Xbarc0353b*	-0.59	RAC875	4.0	2.9
		QTgw.aww-7A^{EF}	93.1	72.6-98.1	*Xcfa2028–Xbarc1004*	-0.98	RAC875	16.1	10.4
	Minn	***QTgw.aww-1A^{EF}***	200.1	192.1-201.6	*XwPt-6568–Xcfe0242b*	-0.82	RAC875	7.6	3.9
		QTgw.aww-3A^{EF}	65.3	51.1-71.1	*Xbarc0324–XwPt-4077*	-0.66	RAC875	4.6	2.5
		QTgw.aww-2B.2^{EF}	129.0	112.6-138.3	*Xcfd0050a–XwPt-3378*	-0.74	RAC875	5.0	4.6
		QTgw.aww-4A^{EF}	101.8	85.3-118.7	*XwPt-7924–XwPt-0817*	0.67	Kukri	4.1	3.5
		QTgw.aww-6A^{EF}	90.0	85.0-94.5	*Xstm0519actc–Xbarc0118*	-1.38	RAC875	19.4	14.5
		QTgw.aww-6B^{EF}	110.6	95.4-123.6	*Xbarc0247–Xbarc0134*	0.74	Kukri	4.9	3.5
		QTgw.aww-7A^{EF}	148.3	131.4-186.1	*Xbarc0292–Xgwm0746*	0.68	Kukri	3.6	2.7
	Bool	***QTgw.aww-2B.2^{EF}***	115.6	104.6-127.6	*XwPt-7004–Xcfd0050a*	-1.36	RAC875	9.1	7.9
		QTgw.aww-3A^{EF}	49.1	35.1-69.1	*XwPt-0714–Xgwm0002*	-0.77	RAC875	5.0	3.0
		QTgw.aww-6A^{EF}	91.5	86.0-95.5	*Xwmc0256a–XwPt-7599*	-1.05	RAC875	8.6	7.5
		QTgw.aww-7A^{EF}	166.4	165.5-172.2	*XwPt-6013–XwPt-0961*	-0.94	RAC875	4.8	3.8
	MexI	***QTgw.aww-2B.1^{EF}***	49.0	48.1-49.6	*Xgwm0271a–Xbarc0091*	-1.08	RAC875	9.4	5.4
		QTgw.aww-2D^{EF}	109.1	99.1-120.5	*Xbarc0328b–XwPt-6574*	0.89	Kukri	6.4	3.9
		QTgw.aww-4A^{EF}	14.2	13.9-15.2	*Xbarc0106–XDuPw0328*	-0.80	RAC875	4.5	4.4
		QTgw.aww-5A^{EF}	148.7	148.3-149.7	*Xcfa2141–XwPt-5231*	-0.75	RAC875	4.9	3.5
Late-flowering	RAC	***QTgw.aww-6A^{LF}***	96.5	83.0-107.5	*Xwmc0256a–XwPt-7599*	-1.22	RAC875	13.1	3.4
		QTgw.aww-7B^{LF}	38.2	28.4-63.8	*Xbarc0065–Xbarc0137b*	1.23	Kukri	16.7	6.5
	Minn	***QTgw.aww-2B^{LF}***	134.3	132.0-138.3	*XwPt-7360–XwPt-2135*	-1.27	RAC875	17.7	4.9
		QTgw.aww-3A^{LF}	65.3	48.1-81.6	*Xbarc0324–XwPt-4077*	-1.16	RAC875	7.8	3.2
		QTgw.aww-6A^{LF}	90.1	87.0-97.5	*Xbarc0118–Xwmc0256a*	-1.34	RAC875	13.6	4.2
		QTgw.aww-6B^{LF}	71.3	67.1-73.8	*XwPt-3060–Xcnl0064*	1.25	Kukri	10.6	3.4
	Bool	***QTgw.aww-7A^{LF}***	92.1	61.6-100.1	*Xcfa2028–Xbarc1004*	-2.24	RAC875	18.5	4.9
	MexI	***QTgw.aww-7A^{LF}***	92.1	63.6-98.1	*Xcfa2028–Xbarc1004*	-2.02	RAC875	25.2	7.2

Appendix I. Detected QTLs for average screening and screening fractions for the early- and late-flowering subpopulations in RAC, Minn, Bool and MexD environments. The most likely position, range, interval of flanking markers, allelic additive effect, heritability and LOD for each individual QTL are presented.

sub	Trait	QTL	Position	Range	Interval	Add		h^2 (%)	LOD
Early-flowering	Screening	***QScr.aww-2B^{EF}***	72.6	55.2-82.4	*XwPt-3132–XwPt-7200*	-0.39	RAC875	8.3	5.6
		QScr.aww-2D^{EF}	51.7	35.7-93.2	*XwPt-6003–XwPt-0330*	0.46	Kukri	2.5	3.3
		QScr.aww-3A^{EF}	56.9	51.1-63.3	*Xgwm0002–Xbarc0328a*	-0.35	RAC875	8.6	5.4
		QScr.aww-7A^{EF}	94.1	66.6-99.1	*Xcfa2028–Xbarc1004*	-0.45	RAC875	13.7	10.2
		QScr.aww-7D^{EF}	31.4	20.4-55.8	*Xbarc0184–Xbarc0092*	-0.33	RAC875	4.4	4.9
	N>2.8	***QN2.8.aww-2B^{EF}***	71.6	56.2-85.4	*XwPt-3132–XwPt-7200*	-4.48	RAC875	8.2	4.7
		QN2.8.aww-2D^{EF}	87.2	38.7-99.1	*XwPt-0330–Xbarc0328b*	3.47	Kukri	2.4	3.4
		QN2.8.aww-3A^{EF}	56.9	50.1-64.3	*Xgwm0002–Xbarc0328a*	-4.25	RAC875	8.5	5.2
		QN2.8.aww-6A^{EF}	56.1	43.2-79.7	*Xgwm0169–Xbarc0353b*	-3.91	RAC875	4.8	3.5
		QN2.8.aww-7A^{EF}	94.1	62.6-99.1	*Xcfa2028–Xbarc1004*	-5.52	RAC875	13.5	9.1
		QN2.8.aww-7D	49.8	19.4-57.8	*Xgwm295–XwPt-4115*	-2.84	RAC875	3.6	4.7
	N2.5	***QN2.5.aww-6A^{EF}***	131.0	122.2-135.0	*XwPt-7127–XwPt-3965*	1.27	Kukri	5.0	2.9
		QN2.2.aww-2B^{EF}	49.6	40.1-84.4	*Xbarc0091–XwPt-0335*	2.49	Kukri	6.5	4.1
		QN2.2.aww-3A^{EF}	56.9	50.1-64.3	*Xgwm0002–Xbarc0328a*	2.79	Kukri	7.7	5.9
		QN2.2.aww-7A^{EF}	94.1	69.6-99.1	*Xcfa2028–Xbarc1004*	3.81	Kukri	13.9	10.3
		QN2.2.aww-7D^{EF}	49.8	25.4-57.8	*Xgwm295–XwPt-4115*	2.08	Kukri	4.3	4.1
	N<2.2	***QN<2.2.aww-1B^{EF}***	79.0	77.8-82.8	*XwPt-3679–Xbarc1138b*	1.38	Kukri	5.4	4.4
		QN<2.2.aww-2B^{EF}	133.0	109.6-138.3	*Xcfd0050a–XwPt-3378*	1.61	Kukri	7.6	4.4
		QN<2.2.aww-2D^{EF}	83.2	52.7-93.2	*XwPt-0330–Xbarc0328b*	1.40	Kukri	3.9	4.4
		QN<2.2.aww-7A^{EF}	91.1	67.6-97.1	*Xcfa2028–Xbarc1004*	1.97	Kukri	12.4	8.3
		QN<2.2.aww-7B^{EF}	114.1	108.1-118.1	*XwPt-2356–Xwmc0311*	1.12	Kukri	3.8	3.0
Late-flowering	N>2.8	***QN2.8.aww-7B^{LF}***	42.6	29.4-48.0	*Xbarc0137b–Xwmc0396*	4.43	Kukri	17.9	4.4
	N2.5	***QN2.5.aww-1A^{LF}***	138.8	124.8-161.0	*Xwmc0093–XwPt-0128*	-2.66	RAC875	8.0	3.4
		QN2.5.aww-3A^{LF}	89.7	83.9-97.7	*Xwmc0264–Xcfa2193b*	-1.89	RAC875	14.8	3.8
		QN2.5.aww-4B^{LF}	8.9	3.9-11.9	*Xgwm0149–XwPt-7062*	-2.50	RAC875	15.2	4.4
		QN2.5.aww-7B^{LF}	29.4	21.0-35.6	*Xstm0671acag–Xgwm0297*	2.64	Kukri	13.3	5.2
	N2.2	***QN2.2.aww-3A^{LF}***	89.7	85.9-96.7	*Xwmc0264–Xcfa2193b*	3.27	Kukri	17.0	3.2
		QN2.2.aww-7B^{LF}	41.2	28.4-65.8	*Xbarc0065–Xbarc0137b*	-3.67	RAC875	13.9	4.2
	N<2.2	***QN<2.2.aww-1A^{LF}***	179.2	171.0-190.6	*XwPt-8644–XwPt-0864*	2.57	Kukri	24.2	4.6
		QN<2.2.aww-7B^{LF}	30.4	26.0-48.0	*Xstm0671acag–Xgwm0297*	-2.27	RAC875	14.5	5.1

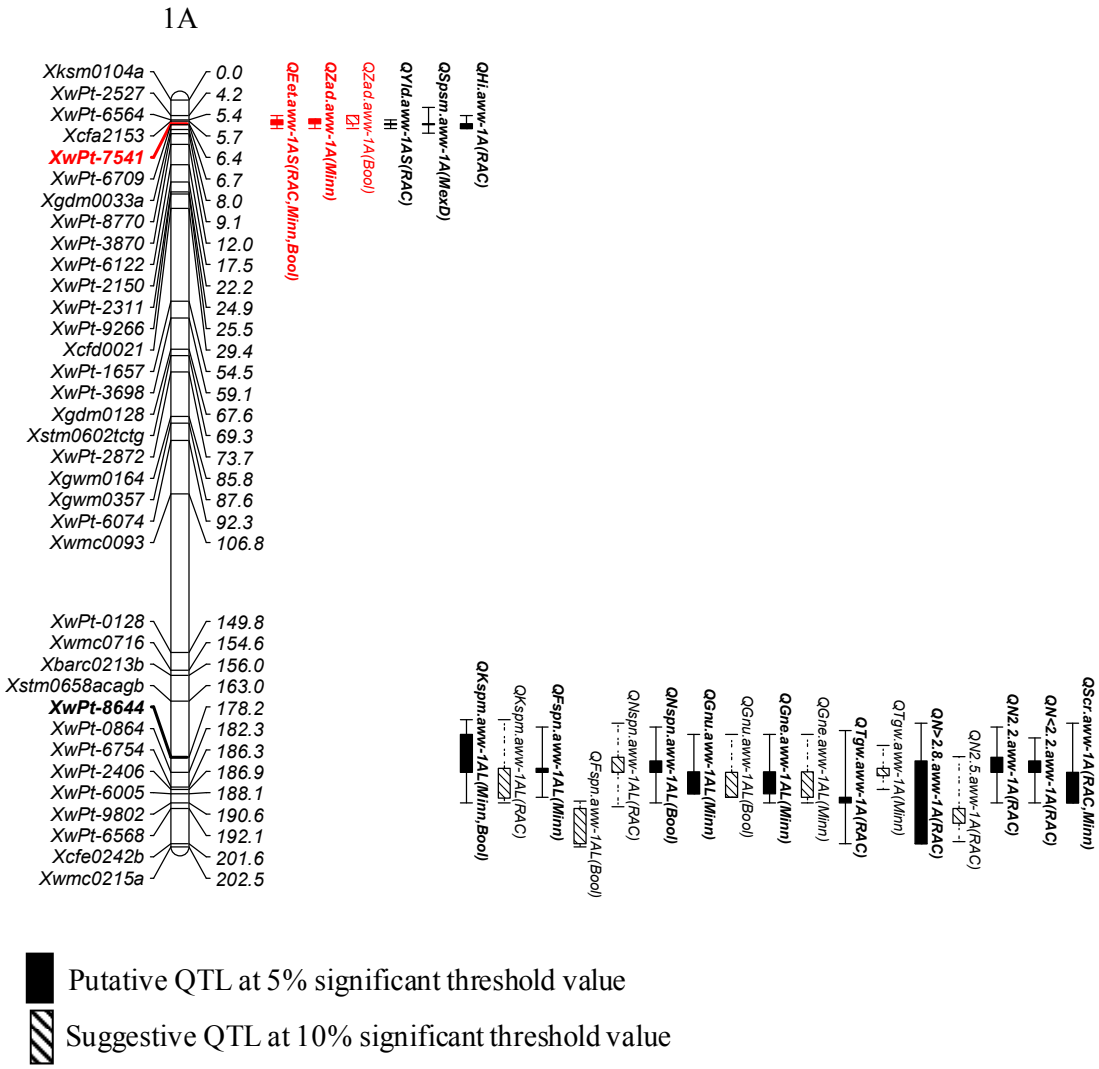
Appendix J. Detected QTLs for fertile and non-fertile spikelets for the early- and late-flowering subpopulations (EF and LF) in RAC, Minn, Bool and MexD environments. The most likely position, range, interval of flanking markers, allelic additive effect, heritability and LOD for each individual QTL is presented.

Trait	sub	Site	QTL	Position (cM)	Range	Interval	Add	Parent	h^2 (%)	LOD
Fertile spikelets	Early-flowering	RAC	***QFspn.aww-3A^{EF}***	56.1	42.1-63.3	*XwPt-0714–Xgwm0002*	0.24	Kukri	5.2	4.5
			QFspn.aww-4A^{EF}	109.7	107.0-124.7	*XwPt-5694–XwPt-7939*	-0.26	RAC875	7.5	4.1
			QFspn.aww-4D^{EF}	5.5	2.0-7.0	*Xwmc0457–Xbarc0288*	0.27	Kukri	10.3	5.1
			QFspn.aww-5B^{EF}	92.6	77.9-105.3	*XwPt-3457–Xgwm0271b*	0.26	Kukri	5.6	4.8
		Minn	***QFspn.aww-7D^{EF}***	122.9	105.6-143.9	*Xbarc0058–Xgwm0428*	0.64	Kukri	6.2	3.2
		Bool	***QFspn.aww-2D^{EF}***	54.7	42.7-84.2	*XwPt-6003–XwPt-0330*	0.80	Kukri	11.5	7.0
			QFspn.aww-5B^{EF}	92.6	62.4-110.3	*XwPt-3457–Xgwm0271b*	0.34	Kukri	5.4	3.6
			QFspn.aww-7B^{EF}	32.6	28.4-36.6	*Xgwm0297–Xbarc0065*	-0.23	RAC875	4.1	2.8
		MexD	***QFspn.aww-7A^{EF}***	126.3	125.3-127.3	*Xbarc0195–XDuPw0254*	0.64	Kukri	28.3	24.1
			QFspn.aww-7A^{EF}	165.5	164.9-166.4	*XwPt-5558–XwPt-6013*	0.35	Kukri	5.0	3.7
			QFspn.aww-7B^{EF}	37.2	36.6-38.2	*Xbarc0065–Xbarc0137b*	0.37	Kukri	6.5	5.5
	Late-flowering	RAC	***QFspn.aww-5B^{LF}***	75.9	64.4-86.6	*XwPt-4936–XwPt-3457*	0.82	Kukri	17.6	4.8
			QFspn.aww-7A^{LF}	94.1	63.6-125.3	*Xcfa2028–Xbarc1004*	-0.70	RAC875	17.1	6.3
		Minn	***QFspn.aww-7A^{LF}***	90.1	89.6-97.1	*Xcfa2028–Xbarc1004*	-0.65	RAC875	14. 9	4.0
			QFspn.aww-7B^{LF}	48	34.6-63.8	*Xwmc0396–XwPt-4230*	-0.75	RAC875	14.6	3.6
		Bool	***QFspn.aww-7A^{LF}***	104.2	89.6-118.3	*Xbarc1004–Xbarc0174*	-0.67	RAC875	19.1	5.4
			QFspn.aww-7B^{LF}	49.8	32.6-65.8	*XwPt-4230–Xwmc0517b*	-0.66	RAC875	16.3	4.2
Non-fertile spikelets	Early-flowering	RAC	***QNspn.aww-1B^{EF}***	78.8	76.0-90.8	*XwPt-6240–XwPt-3679*	0.31	Kukri	7.7	4.8
			QNspn.aww-4D^{EF}	5.5	1.0-8.0	*Xwmc0457–Xbarc0288*	0.28	Kukri	7.7	4.0
			QNspn.aww-5B^{EF}	78.9	71.4-100.6	*XwPt-4936–XwPt-3457*	-0.26	RAC875	5.0	3.7
			QNspn.aww-7A^{EF}	146.3	138.3-153.3	*Xbarc0292–Xgwm0746*	0.38	Kukri	8.7	8.5
			QNspn.aww-7B^{EF}	32.6	28.4-41.2	*Xgwm0297–Xbarc0065*	0.27	Kukri	5.9	4.9
		Minn	***QNspn.aww-2D^{EF}***	51.7	39.7-73.7	*XwPt-6003–XwPt-0330*	-1.17	RAC875	5.0	6.0
			QNspn.aww-5B^{EF}	79.9	65.4-98.6	*XwPt-4936–XwPt-3457*	-0.54	RAC875	4.4	3.7
			QNspn.aww-7A^{EF}	142.3	133.8-148.3	*Xbarc0292–Xgwm0746*	1.17	Kukri	23.7	12.3
			QNspn.aww-7B^{EF}	62.8	45.0-73.8	*XwPt-4230–Xwmc0517b*	0.65	Kukri	5.3	4.5
		Bool	***QNspn.aww-2D^{EF}***	50.7	40.7-66.7	*XwPt-6003–XwPt-0330*	-1.36	RAC875	8.3	8.5
			QNspn.aww-7A^{EF}	144.3	138.3-149.3	*Xbarc0292–Xgwm0746*	1.05	Kukri	22.4	14.8
			QNspn.aww-7B^{EF}	64.8	49.8-77.8	*XwPt-4230–Xwmc0517b*	0.59	Kukri	5.2	4.0
		MexI	***QNspn.aww-2B^{EF}***	67.9	67.2-68.9	*XwPt-0950–XwPt-3132*	0.19	Kukri	6.5	3.4
			QNspn.aww-6A^{EF}	90.1	90.0-91.1	*Xbarc0118–Xwmc0256a*	0.18	Kukri	6.2	3.4
			QNspn.aww-7A^{EF}	137.3	136.8-138.3	*Xbarc0292–Xgwm0746*	0.31	Kukri	13.4	10.9
	Late-flowering	RAC	***QNspn.aww-7A.2^{LF}***	145.3	137.3-153.3	*Xbarc0292–Xgwm0746*	0.97	Kukri	26.4	9.5
			QNspn.aww-7B^{LF}	26.4	17.0-30.4	*Xstm0671acag–Xgwm0297*	0.65	Kukri	14.5	4.8
		Minn	***QNspn.aww-7A.1^{LF}***	118.3	112.0-122.8	*Xbarc0259–Xbarc0281*	0.70	Kukri	19.0	5.0
			QNspn.aww-7B^{LF}	46	35.6-63.8	*Xwmc0396–XwPt-4230*	0.64	Kukri	11.4	3.2
		Bool	***QNspn.aww-7A.1^{LF}***	115.3	104.2-121.8	*Xbarc0259–Xbarc0281*	1.01	Kukri	32.1	10.2
			QNspn.aww-7B^{LF}	57.8	38.2-67.8	*XwPt-4230–Xwmc0517b*	1.06	Kukri	18.3	7.6

Appendix K. Detected QTLs for adjusted plant height (Ht) and peduncle length (Pdl) in five environments; RAC, Minn, Bool, MexI and MexD. The most likely QTL position, range, interval of flanking markers, allelic additive effect, heritability and LOD for each individual QTL is presented. The italic bold loci represent putative QTLs which were detected at a 5% significance threshold. Suggestive QTLs were detected at a 10% significance threshold. QTLs with largest trait effect are highlighted in light gray.

Trait	Site	QTL	Position (cM)	Range	Interval	Add	Parent	h2 (%)	LOD
Ht	RAC	*QHt.aww-1D^{Eet}*	90.5	79.6-94.5	*XwPt-8854–Xcfd0027*	0.57	Kukri	2.2	2.5
		QHt.aww-2A^{Eet}	79.6	76.3-82.0	*XwPt-7306–XwPt-4201*	-0.63	RAC875	2.7	2.5
		QHt.aww-2D^{Eet}	110.1	101.1-119.9	*Xbarc0328b–XwPt-6574*	-1.02	RAC875	4.9	5.1
		QHt.aww-3A^{Eet}	54.1	45.1-58.9	*XwPt-0714–Xgwm0002*	-1.32	RAC875	13.6	11.4
		QHt.aww-4A^{Eet}	27.9	13.9-33.9	*Xcfe0254–Xbarc0170*	0.76	Kukri	4.1	4.1
		QHt.aww-5A1^{Eet}	59.4	16.0-76.0	*Xgwm0304b–Xbarc0360*	-0.70	RAC875	3.2	3.4
		QHt.aww-5A2^{Eet}	173.7	157.7-192.5	*Xcfa2141–XwPt-5231*	0.83	Kukri	3.1	3.0
	Minn	*QHt.aww-2A^{Eet}*	65.3	47.4-70.3	*XwPt-7056–Xwmc0296*	0.18	Kukri	1.0	2.7
		QHt.aww-3A^{Eet}	42.1	32.1-54.1	*XwPt-0714–Xgwm0002*	-0.39	RAC875	4.9	5.8
		QHt.aww-5A^{Eet}	19.0	6.0-29.0	*XwPt-2768–Xbarc0358*	-0.55	RAC875	9.5	6.5
		QHt.aww-5B^{Eet}	45.7	39.3-51.7	*XwPt-5914–Xbarc0216*	0.25	Kukri	1.9	6.7
	Bool	*QHt.aww-3A^{Eet}*	50.1	40.1-57.9	*XwPt-0714–Xgwm0002*	-0.55	RAC875	2.3	2.8
		QHt.aww-5A.2^{Eet}	200.1	166.7-200.1	*Xgwm0126–Xstm0627acagb*	0.51	Kukri	4.6	2.8
		QHt.aww-7A^{Eet}	169.4	165.5-172.2	*XwPt-4553–Xcfa2019*	0.41	Kukri	2.3	2.6
	MexI	***QHt.aww-2D^{Eet}***	106.1	99.1-113.1	*Xbarc0328b–XwPt-6574*	1.74	Kukri	6.2	8.8
		QHt.aww-3A^{Eet}	52.1	42.1-58.9	*XwPt-0714–Xgwm0002*	-1.57	RAC875	8.0	7.2
		QHt.aww-5A^{Eet}	199.1	170.7-200.1	*Xgwm0126–Xstm0627acagb*	0.95	Kukri	3.8	3.4
		QHt.aww-6B^{Eet}	114.6	102.2-127.6	*Xbarc0247–Xbarc0134*	1.21	Kukri	3.6	3.3
		QHt.aww-7A^{Eet}	224.5	215.1-225.2	*XwPt-7763–XwPt-6495*	-1.09	RAC875	3.9	3.3
	MexD	***QHt.aww-2B^{Eet}***	36.0	32.3-42.1	*XwPt-7757–Xbarc0013a*	-1.82	RAC875	8.0	7.2
		QHt.aww-2D^{Eet}	52.7	45.7-61.7	*XwPt-6003–XwPt-0330*	4.90	Kukri	9.8	9.5
		QHt.aww-3A^{Eet}	50.1	40.1-57.9	*XwPt-0714–Xgwm0002*	-1.27	RAC875	3.8	3.7
		QHt.aww-5B^{Eet}	11.0	0.0-21.0	*Xgwm0234b–XwPt-8604*	1.45	Kukri	3.1	3.7
		QHt.aww-7A^{Eet}	94.1	89.6-100.1	*Xcfa2028–Xbarc1004*	-2.70	RAC875	5.0	5.3
PdL	RAC	*QPdl.aww-1D^{Eet}*	87.2	85.5-92.5	*Xbarc0210–XwPt-8854*	0.25	Kukri	0.9	2.1
		QPdl.aww-2D^{Eet}	107.1	94.2-117.1	*Xbarc0328b–XwPt-6574*	0.46	Kukri	4.5	4.2
		QPdl.aww-3A^{Eet}	48.1	40.1-70.1	*XwPt-0714–Xgwm0002*	0.77	Kukri	10.8	10.0
		QPdl.aww-5A^{Eet}	167.7	157.7-177.7	*Xcfa2141–XwPt-5231*	0.68	Kukri	7.6	8.0
		QPdl.aww-6D^{Eet}	71.9	65.5-79.1	*Xgwm0325b–Xcfd0287*	0.45	Kukri	5.8	3.8
	Minn	***QPdl.aww-2D^{Eet}***	89.2	63.7-98.2	*XwPt-0330–Xbarc0328b*	-0.31	Kukri	5.5	2.2
		QPdl.aww-5A^{Eet}	159.7	133.3-175.7	*Xcfa2141–XwPt-5231*	0.31	Kukri	3.6	2.8
		QPdl.aww-6D^{Eet}	66.9	33.1-72.9	*Xgwm0325b–Xcfd0287*	0.26	Kukri	3.8	2.9
	Bool	*QPdl.aww-2B^{Eet}*	9.6	1.0-19.6	*XwPt-1489–XwPt-9644*	0.21	Kukri	2.5	2.5
		QPdl.aww-5A^{Eet}	181.7	164.7-200.1	*Xcfa2141–XwPt-5231*	0.26	Kukri	3.7	3.0
	MexD	***QPdl.aww-2D^{Eet}***	104.1	82.2-115.1	*Xbarc0328b–XwPt-6574*	0.57	Kukri	2.8	3.2
		QPdl.aww-7A^{Eet}	94.1	57.6-108.2	*Xcfa2028–Xbarc1004*	-0.52	RAC875	2.4	2.9

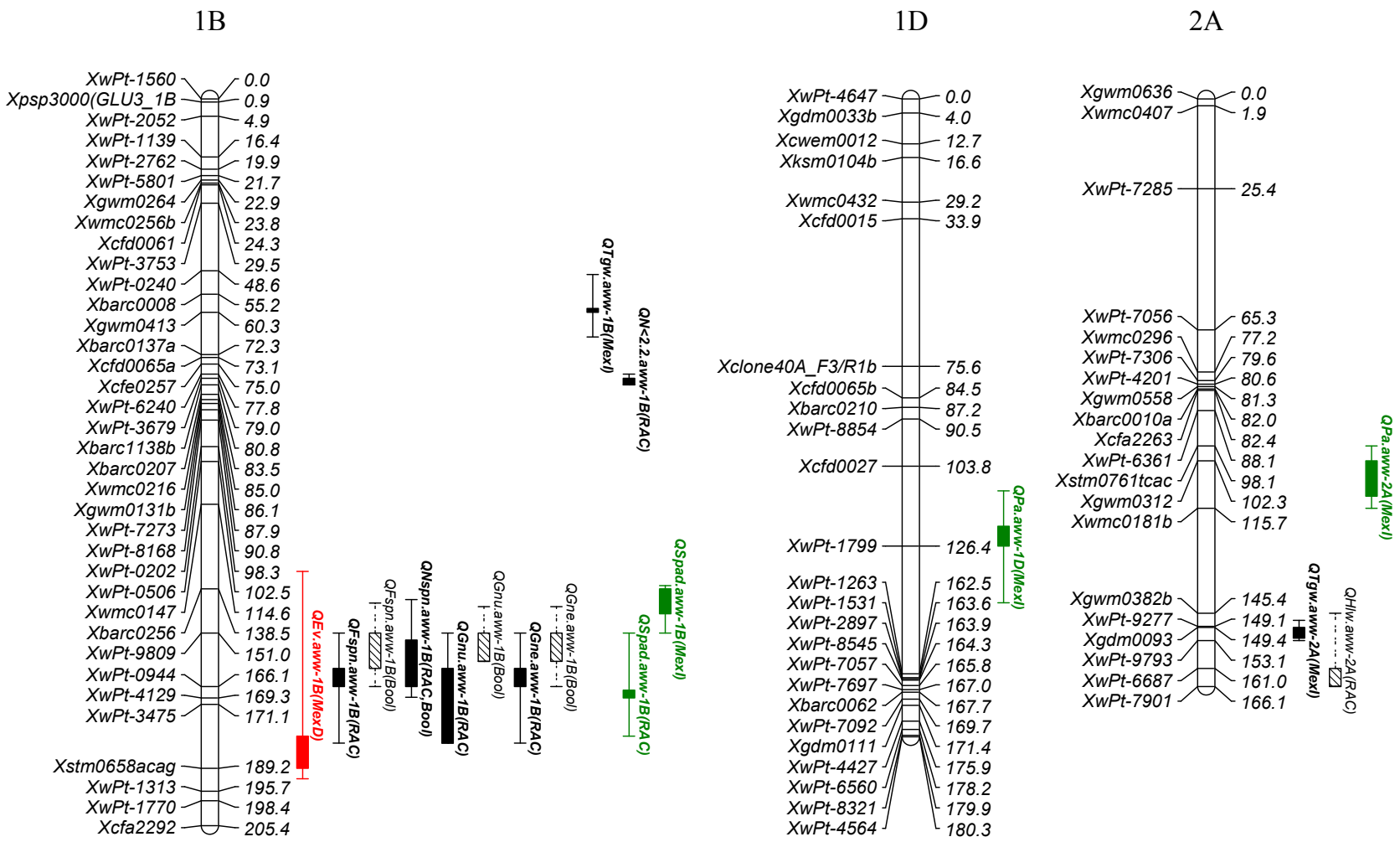
Appendix L. The estimated location of all detected QTLs for non-adjusted phenotypic data. QTLs for maturity related traits including; heading time (Eet), Zadok scale (Zad), anthesis (Anth) and maturity (Mat) are represented in red colour. QTLs for plant height (Ht), peduncle length (Pdl), spike length (El) and flag leaf length (Fl) are shown in blue colour. QTLs for grian yield (Yld) and yield components such as number of grains per m^2 (Gnm), number of spikelets per spike (Spn), the fertile spikelets (Fspn), the non-fertile spikelets (Nspn), grain weight per spike (Gwe), grain number per sampeled spikes (Gnu), harvest index (Hi), thousand grain weight (Tgw) and screening (scr) are shown in black colour. The dark green colour loci showing physiological traits such as leaf waxiness (W), chlorophyll content (Spad) and pubescence (pa). The putative QTLs (at $P < 0.05$) are shown in bold font and solid vertical bars, while the suggestive QTLs (at $P < 0.1$) are represented in non-bold and dashed lines adjacent to chromosomes.



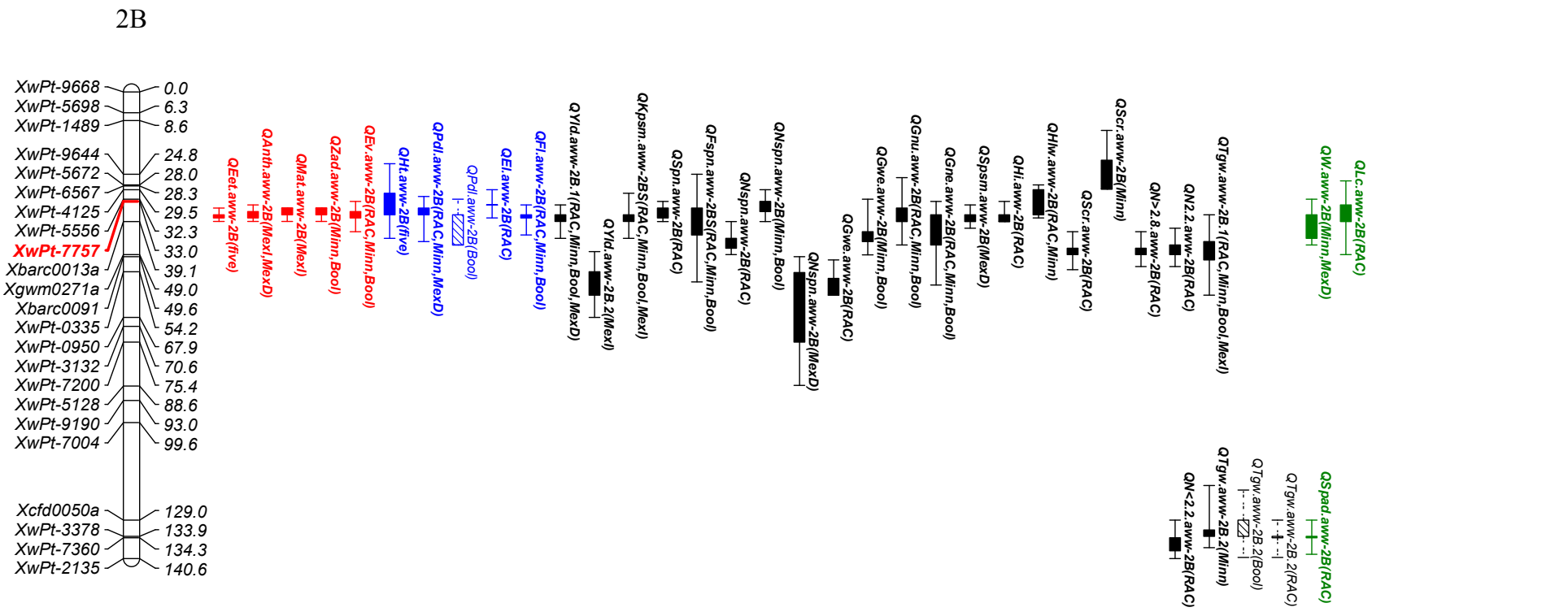
Putative QTL at 5% significant threshold value

Suggestive QTL at 10% significant threshold value

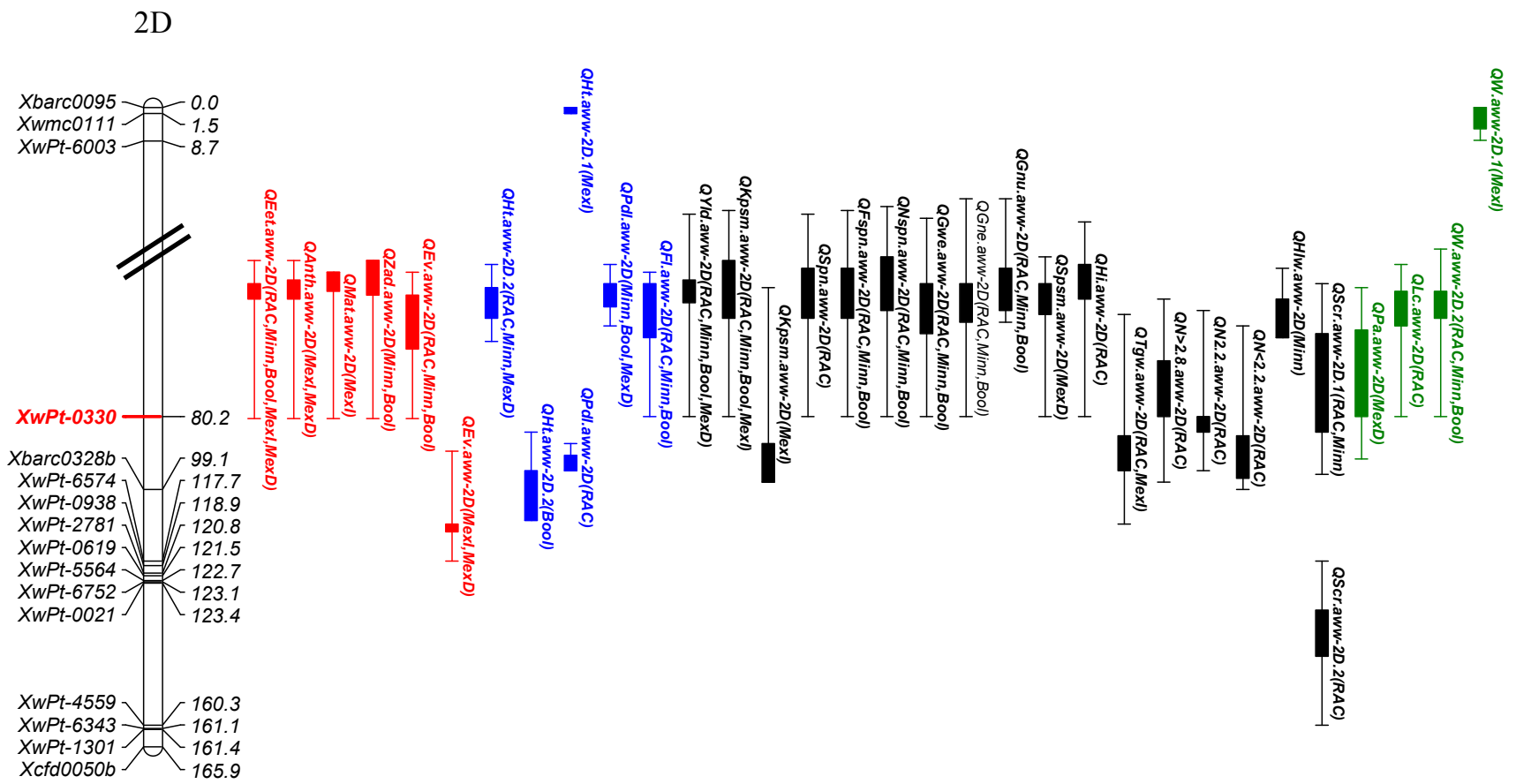
Appendix L. Continued



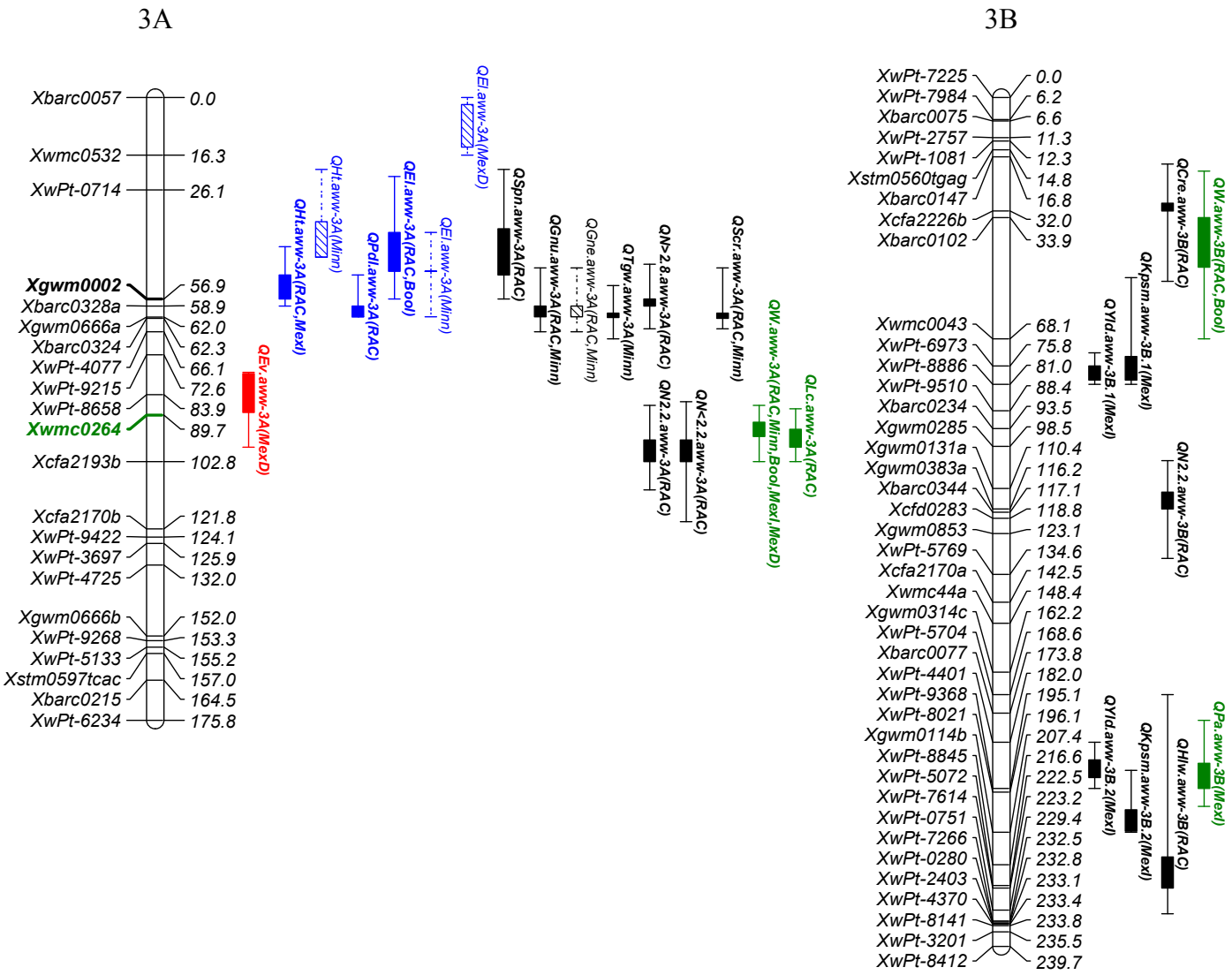
Appendix L. Continued



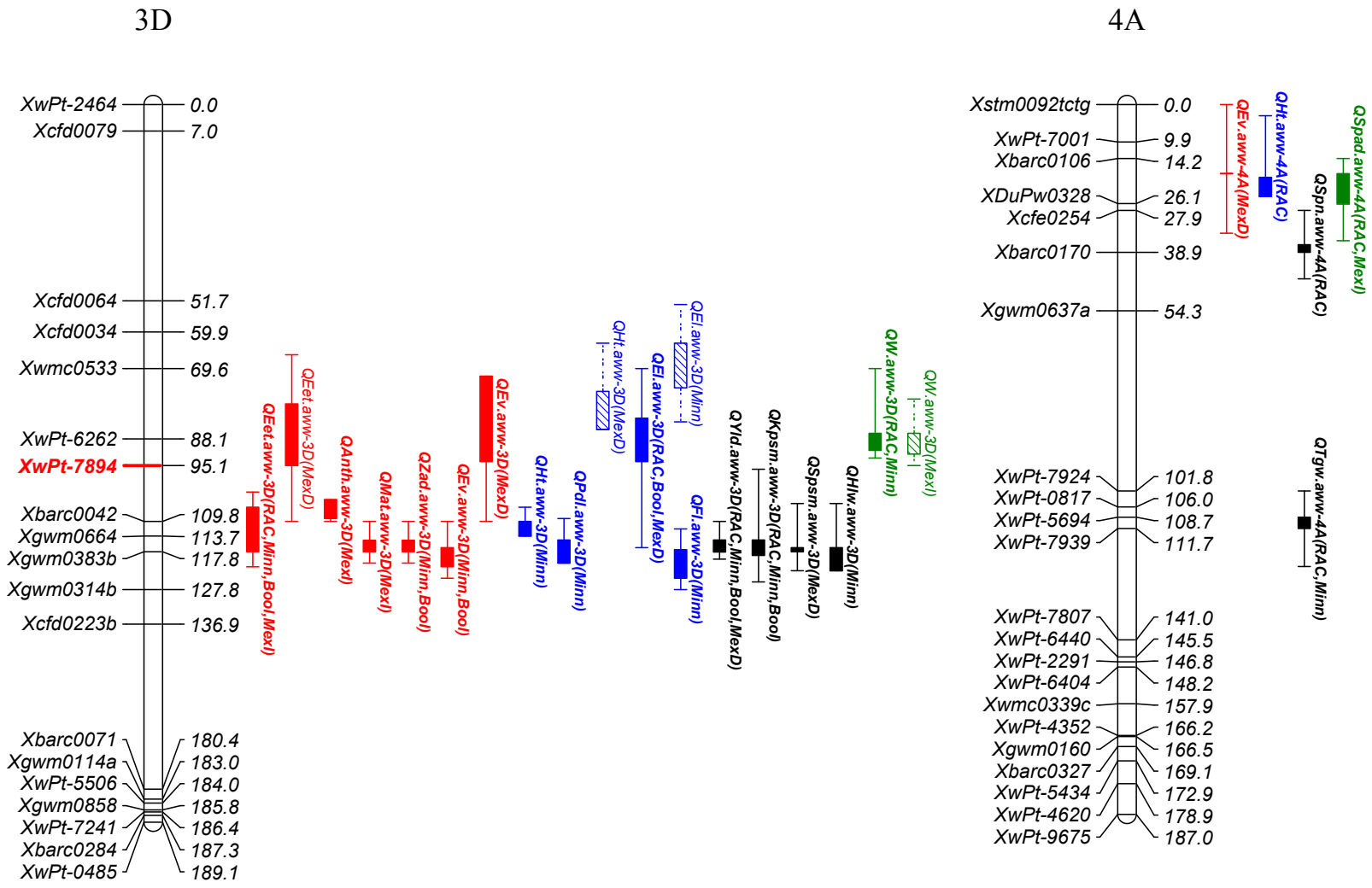
Appendix L. Continued



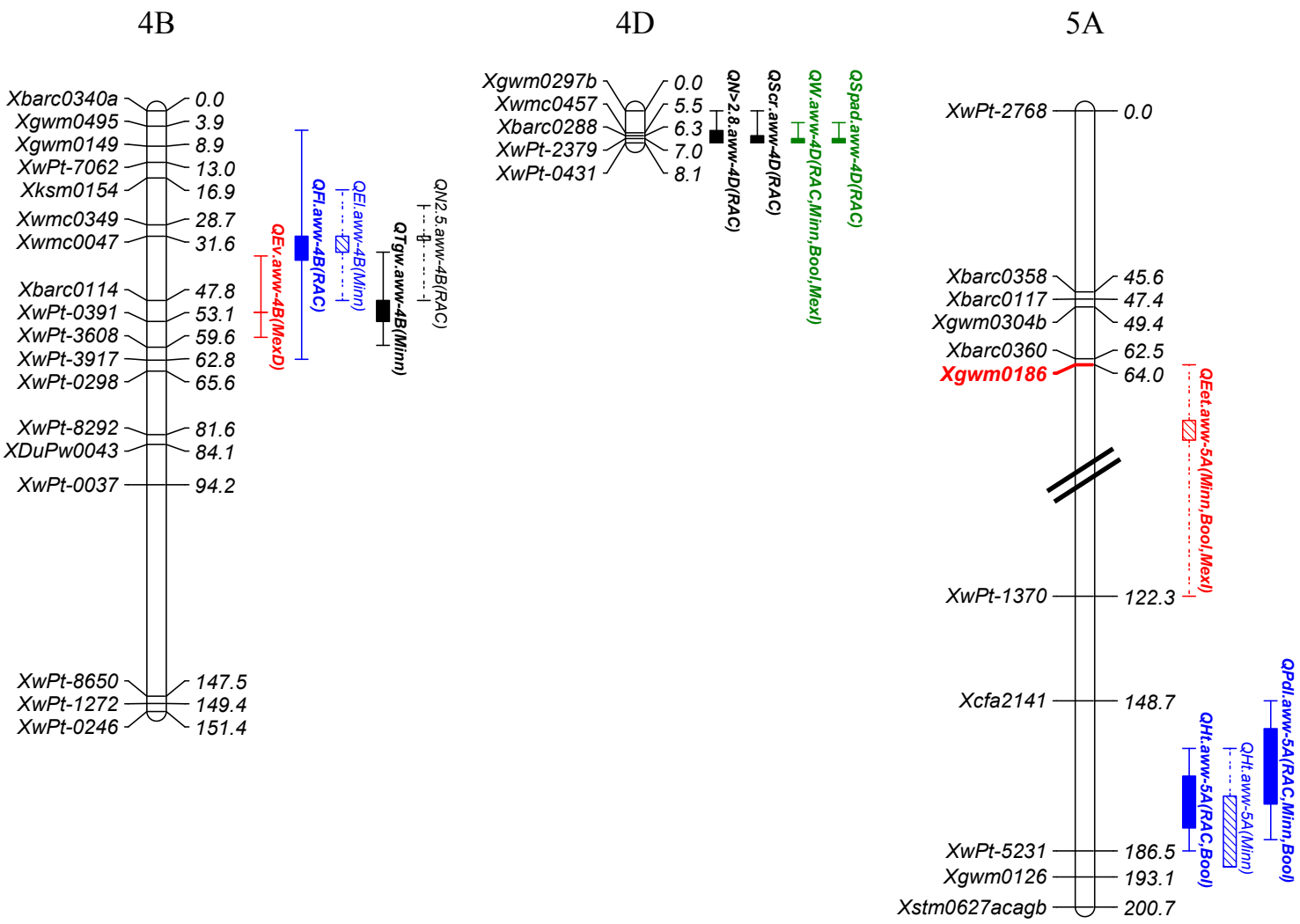
Appendix L. Continued



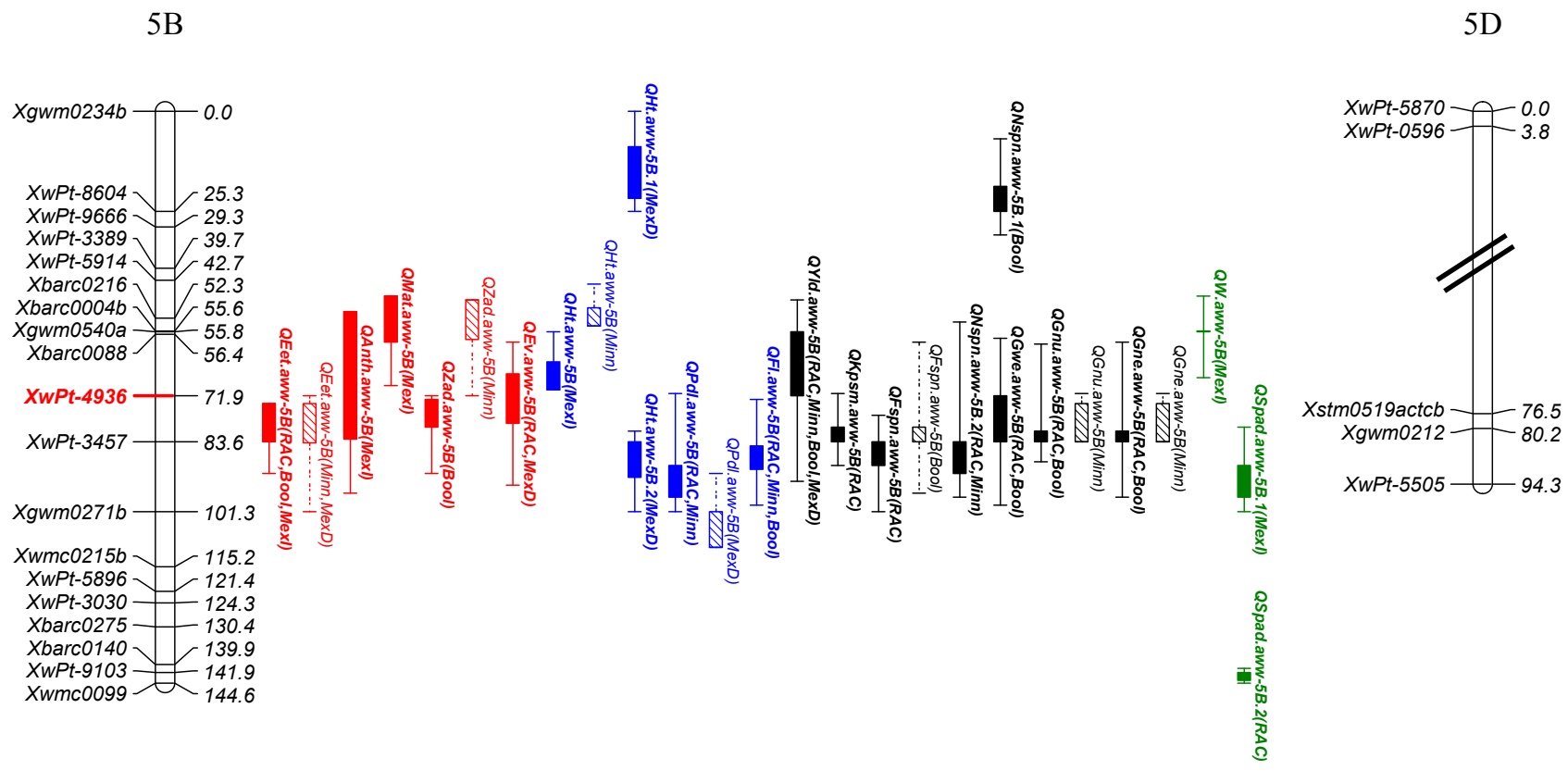
Appendix L. Continued



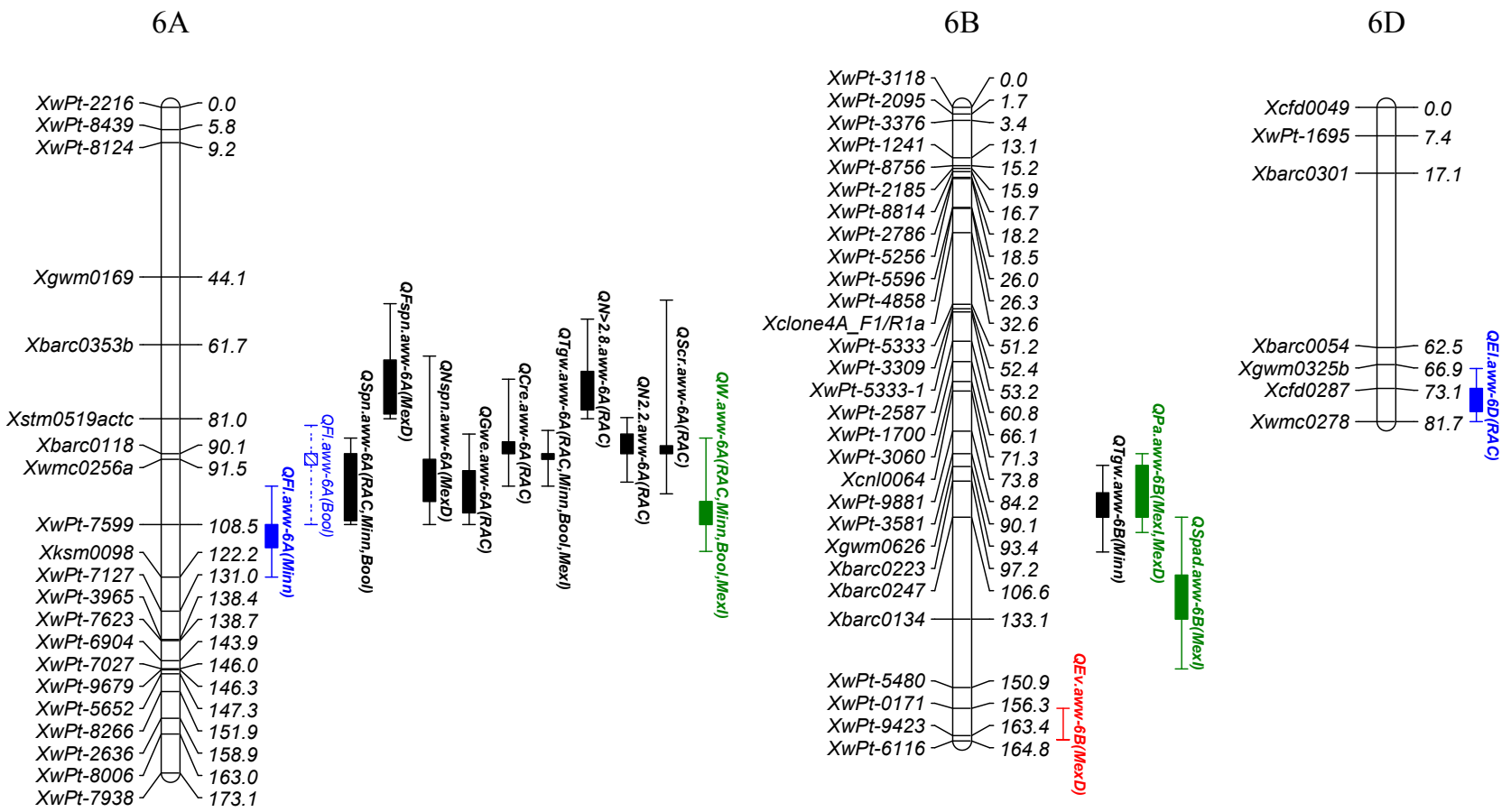
Appendix L. Continued



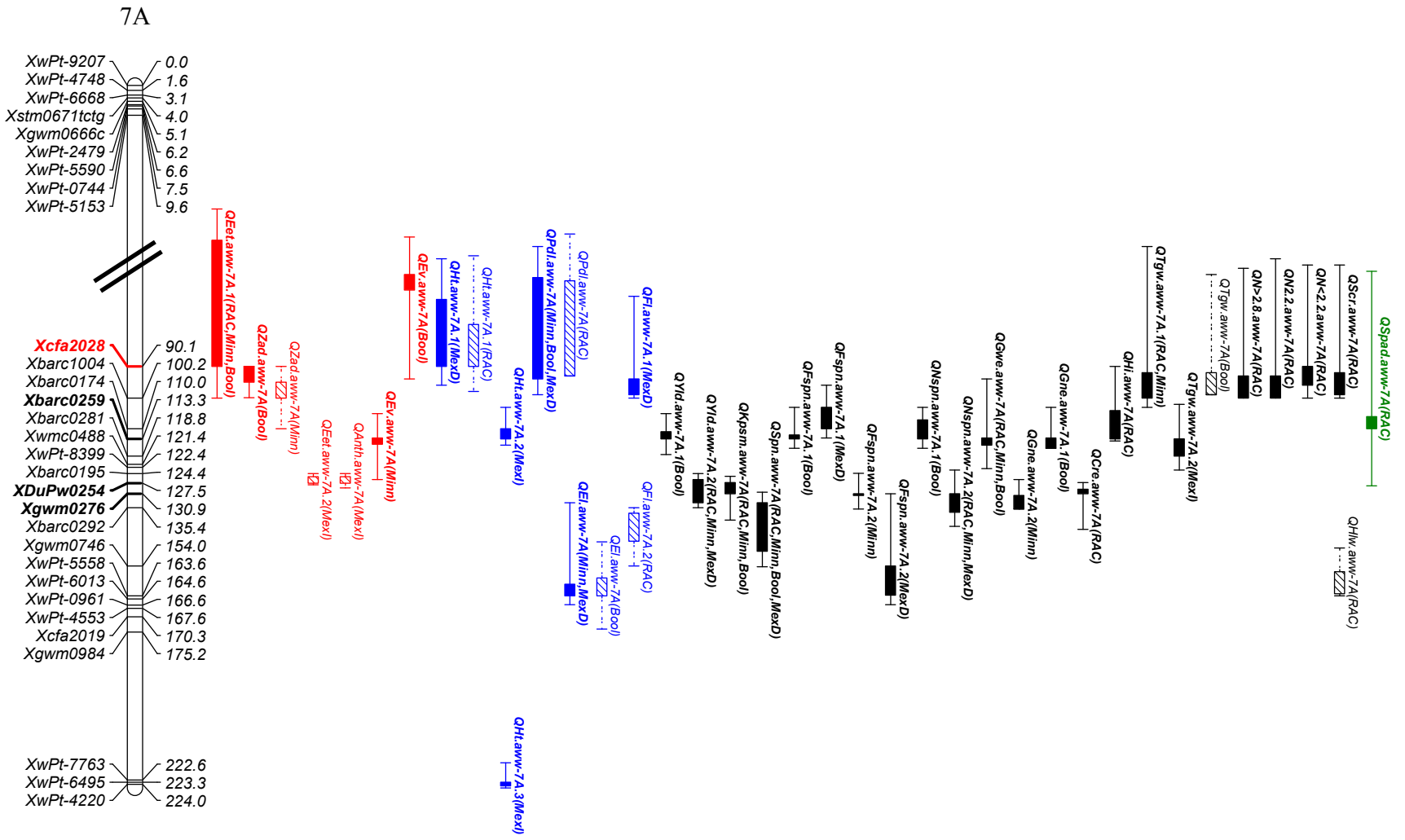
Appendix L. Continued



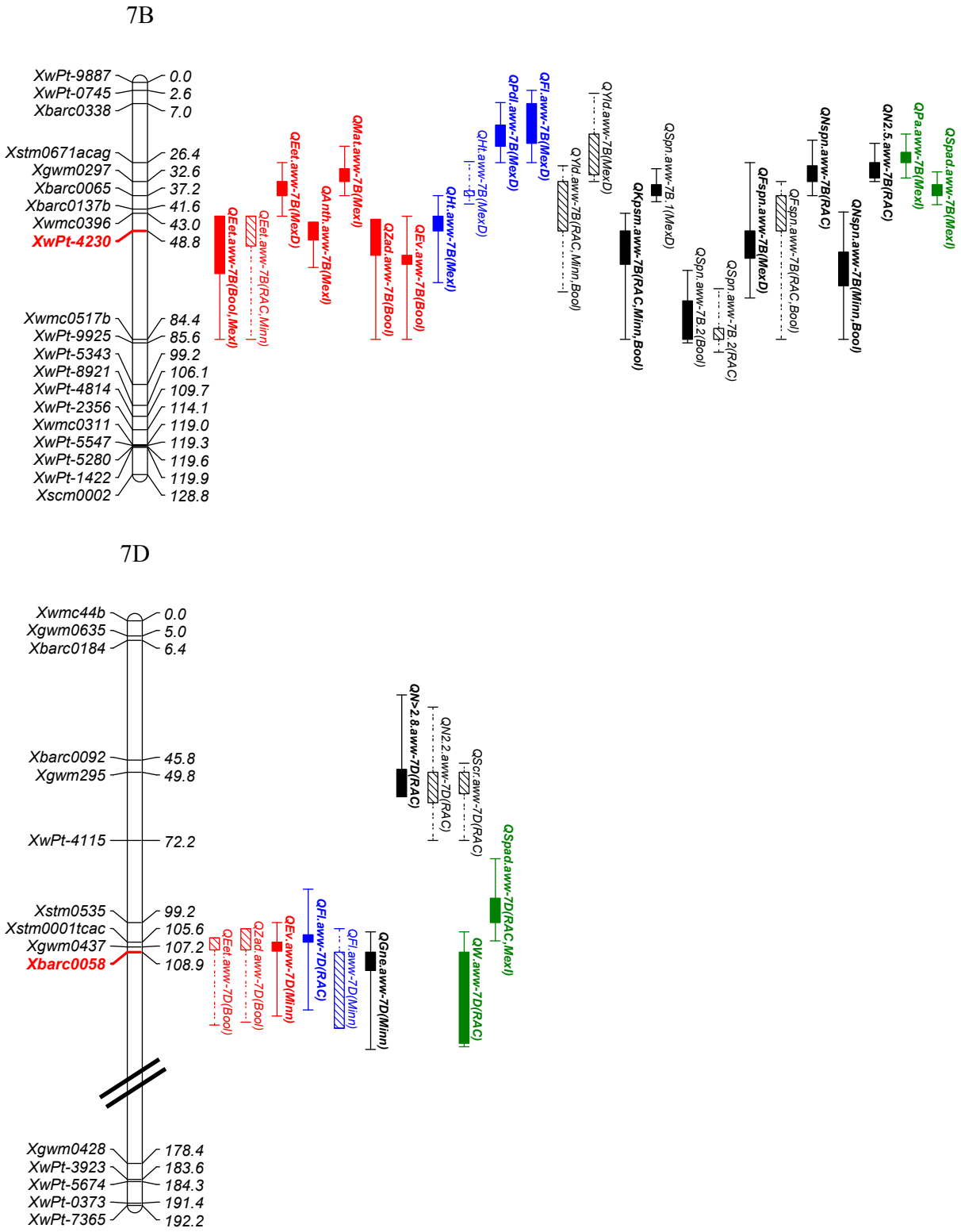
Appendix L. Continued



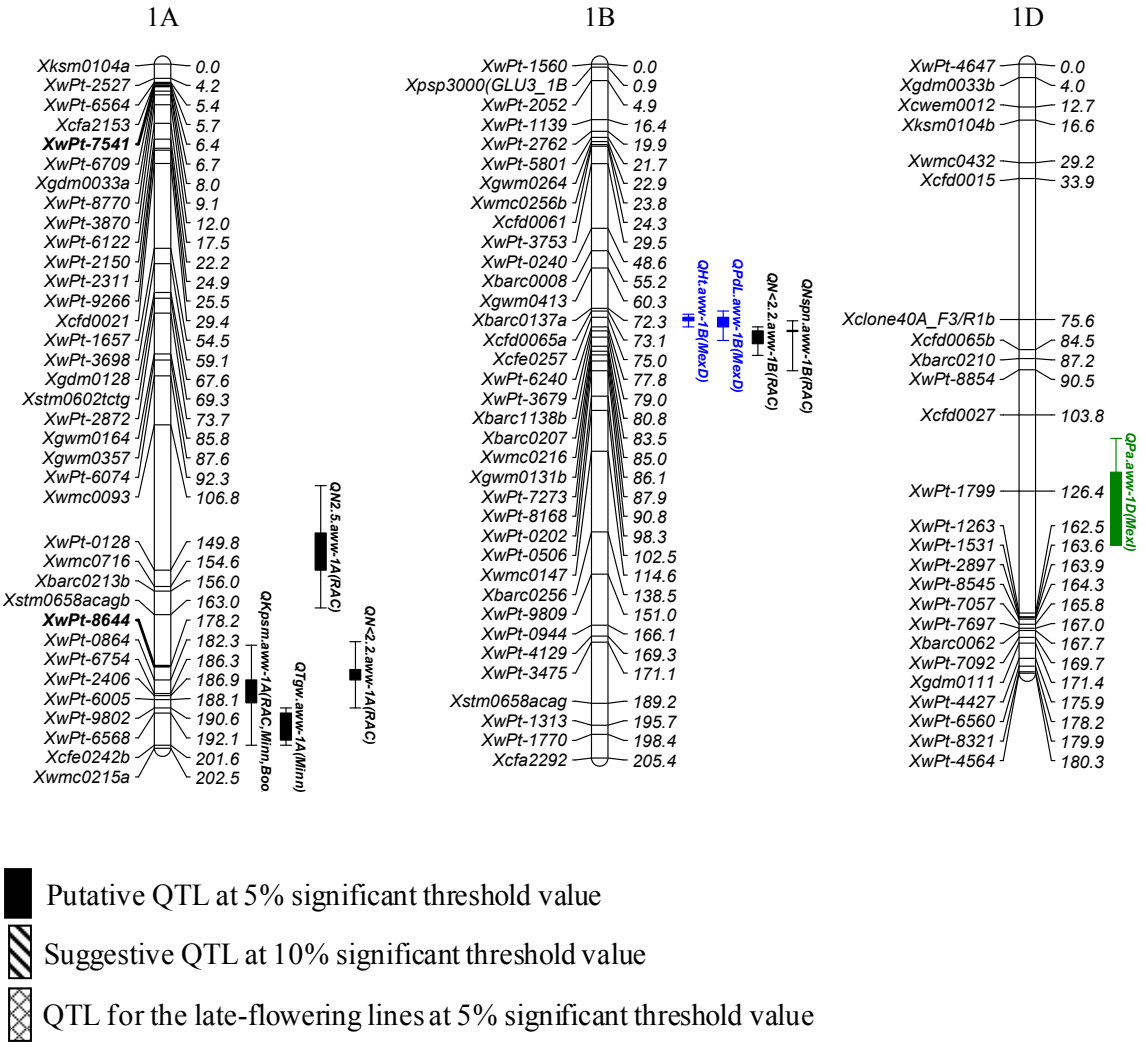
Appendix L. Continued



Appendix L. Continued



Appendix M. The estimated location of all detected QTLs for the early- and late-flowering subpopualtions. QTLs for maturity related traits including; heading time (Eet), Zadok scale (Zad), anthesis (Anth) and maturity (Mat) are represented in red colour. QTLs for plant height (Ht), peduncle length (Pdl), spike length (El) and flag leaf length (Fl) are shown in blue colour. QTLs for grian yield (Yld) and yield components such as number of grains per m^2 (Gnm), number of spikelets per spike (Spn), the fertile spikelets (Fspn), the non-fertile spikelets (Nspn), grain weight per spike (Gwe), grain number per sampeled spikes (Gnu), harvest index (Hi), thousand grain weight (Tgw) and screening (scr) are shown in black colour. The dark green colour loci showing physiological traits such as leaf waxiness (W), chlorophyll content (Spad) and pubescence (pa). The putative QTLs (at $P < 0.05$) are shown in bold font and solid vertical bars, while the suggestive QTLs (at $P < 0.1$) are represented in non-bold and dashed lines adjacent to chromosomes.

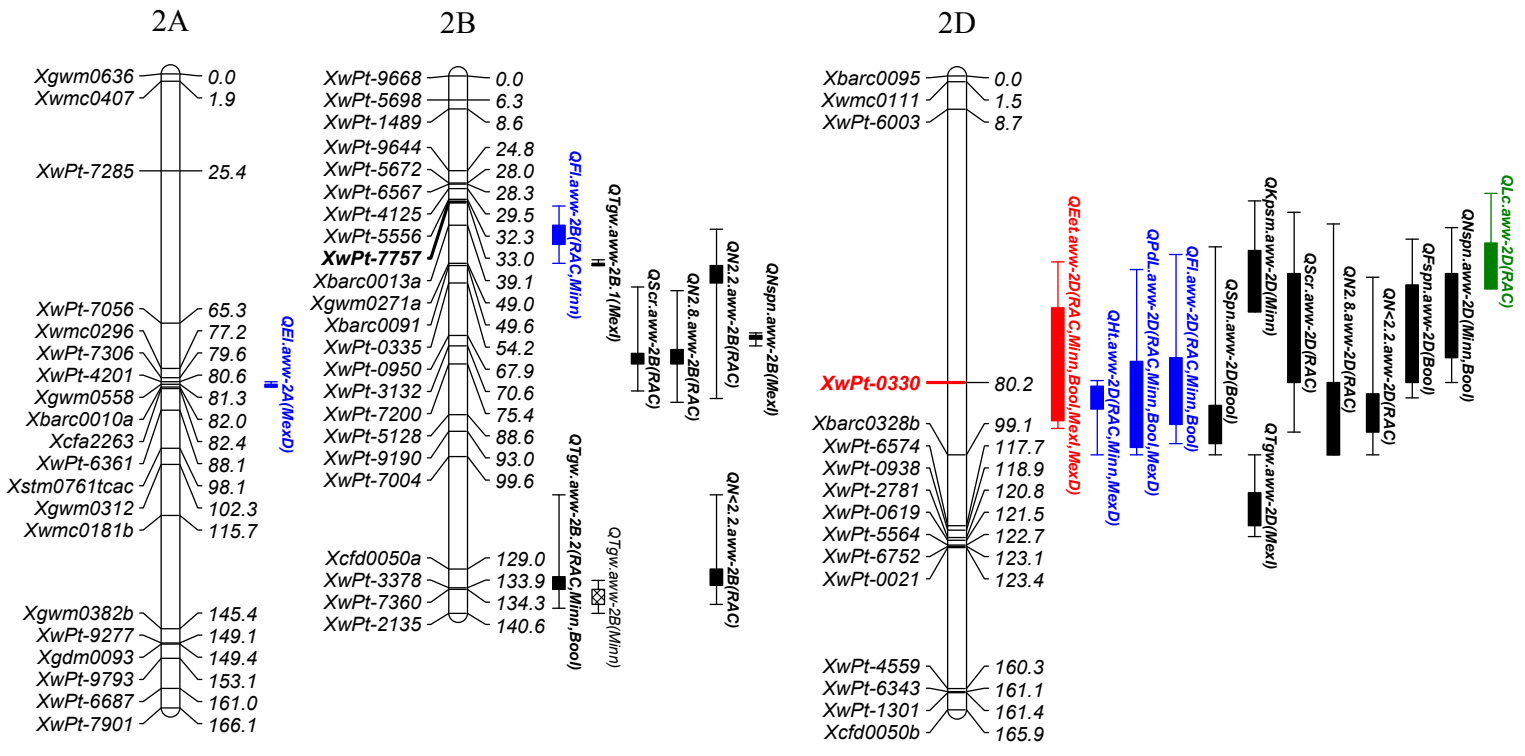


Putative QTL at 5% significant threshold value

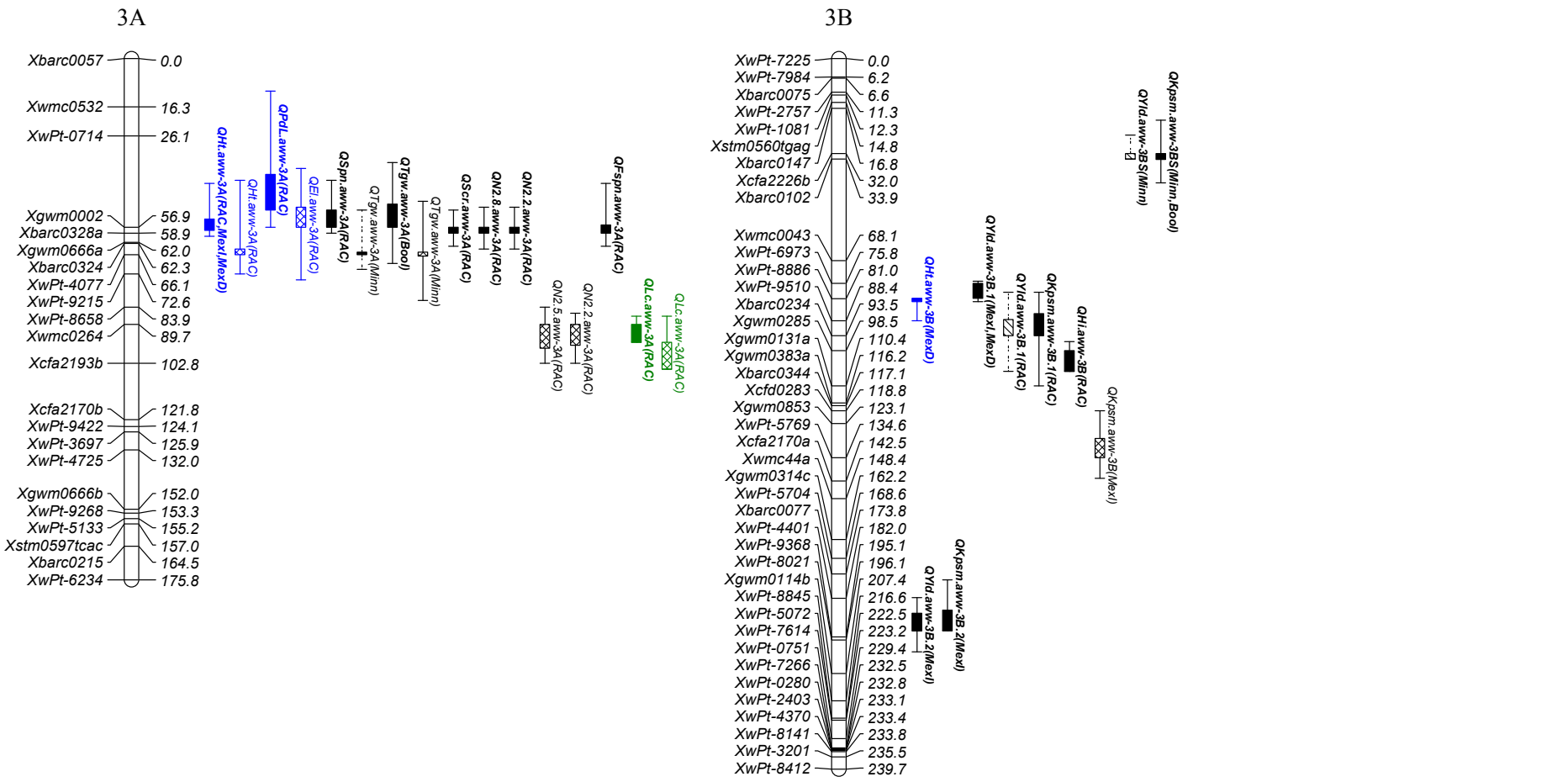
Suggestive QTL at 10% significant threshold value

QTL for the late-flowering lines at 5% significant threshold value

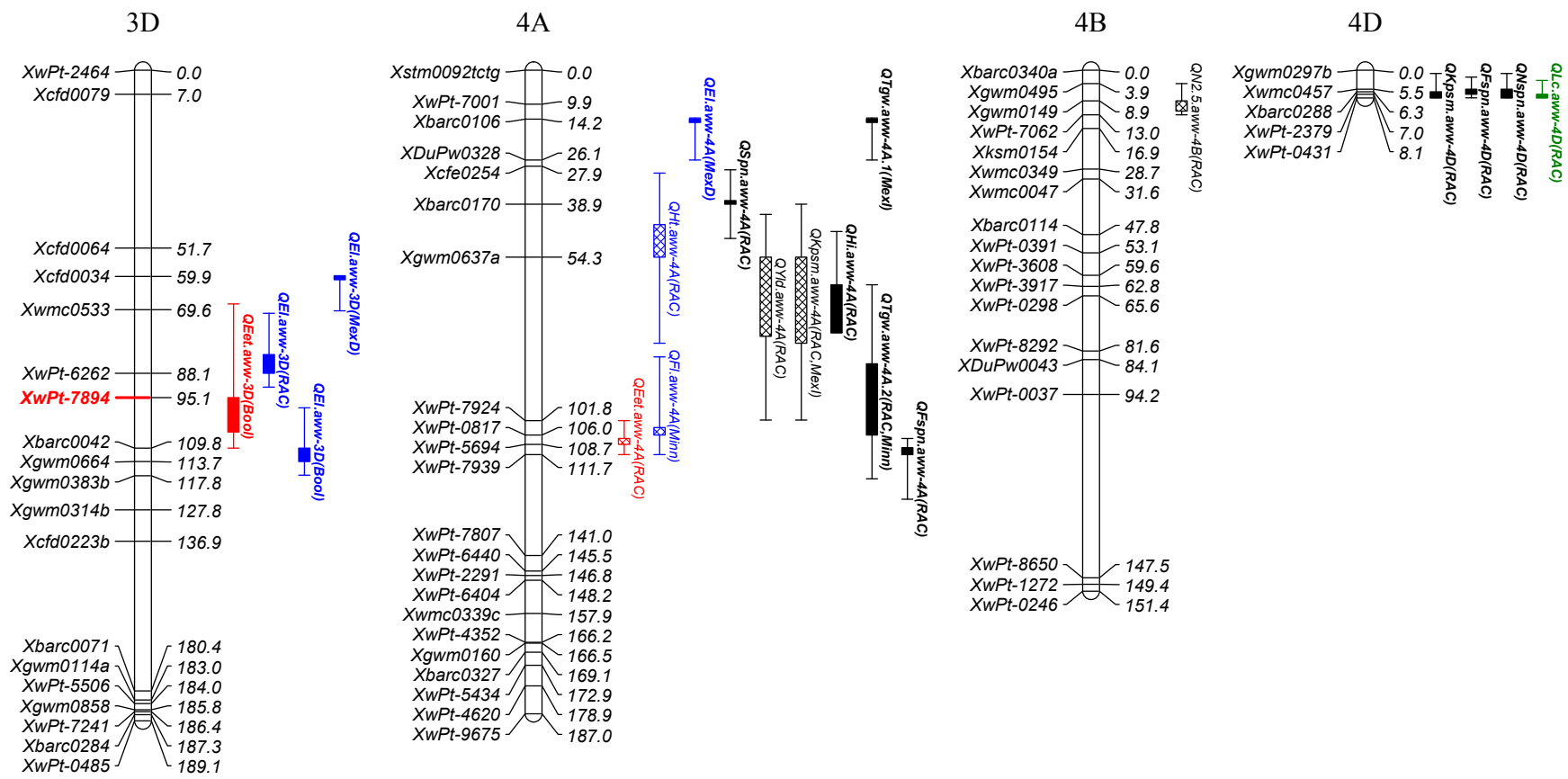
Appendix M. Continued



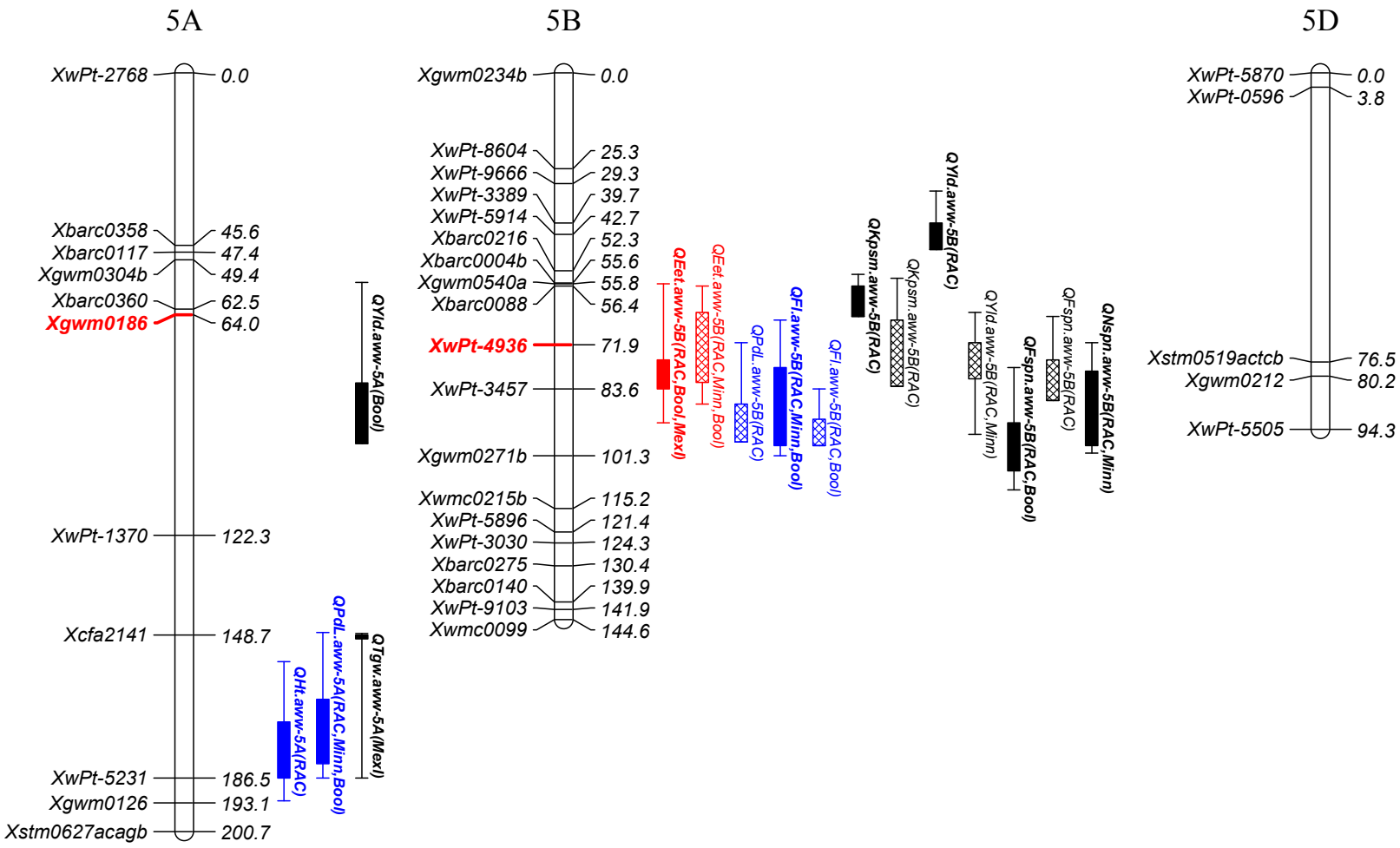
Appendix M. Continued



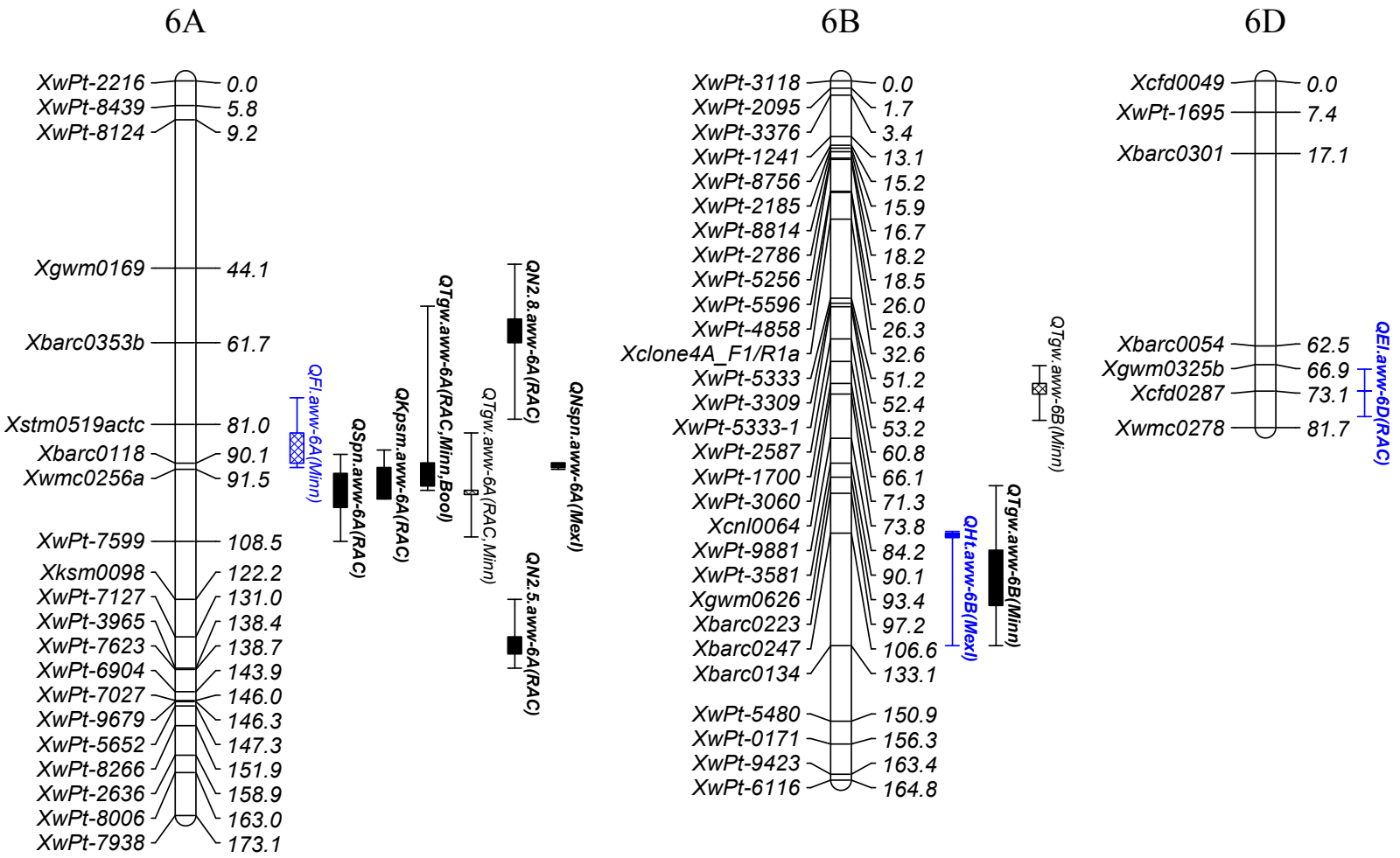
Appendix M. Continued



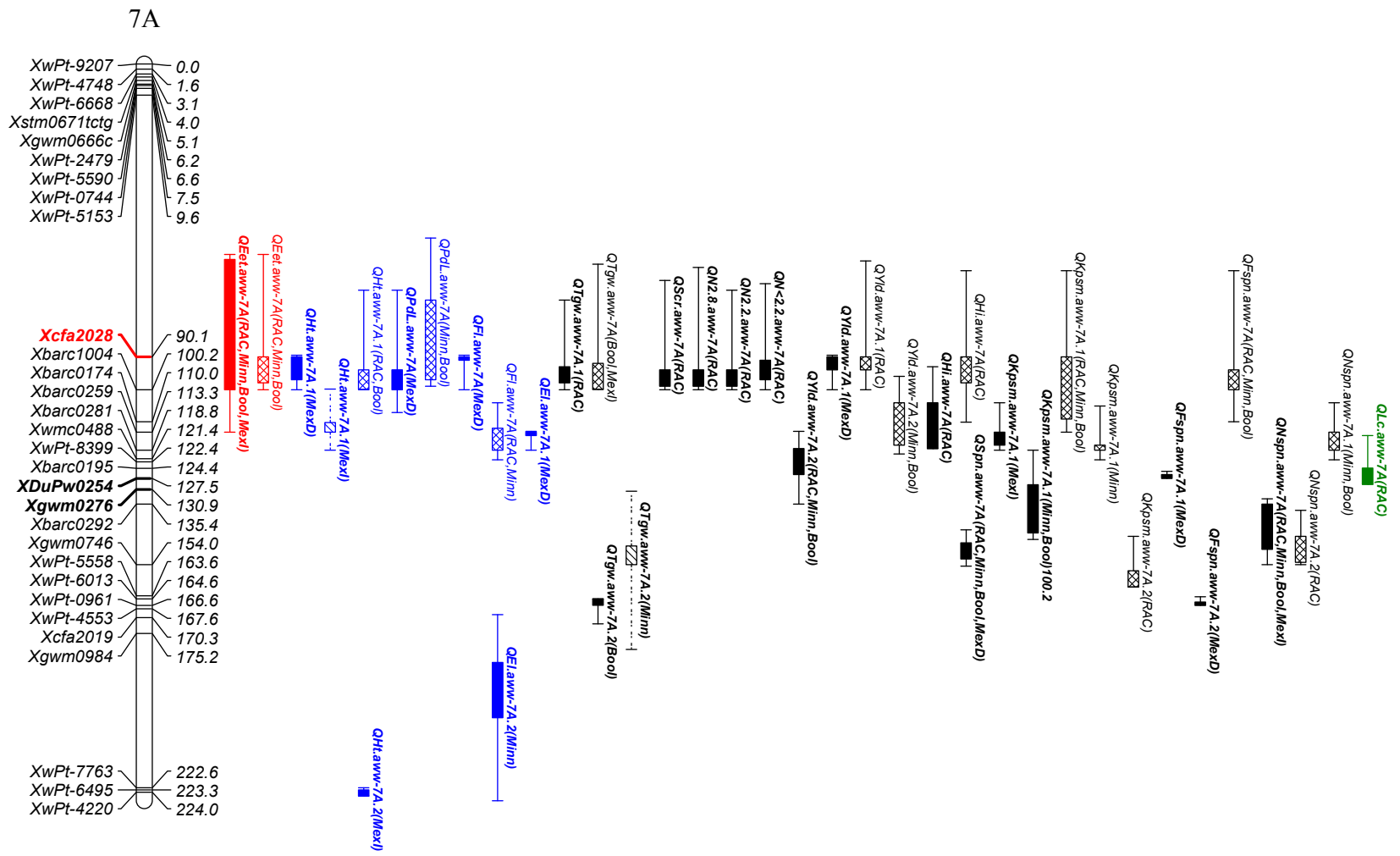
Appendix M. Continued



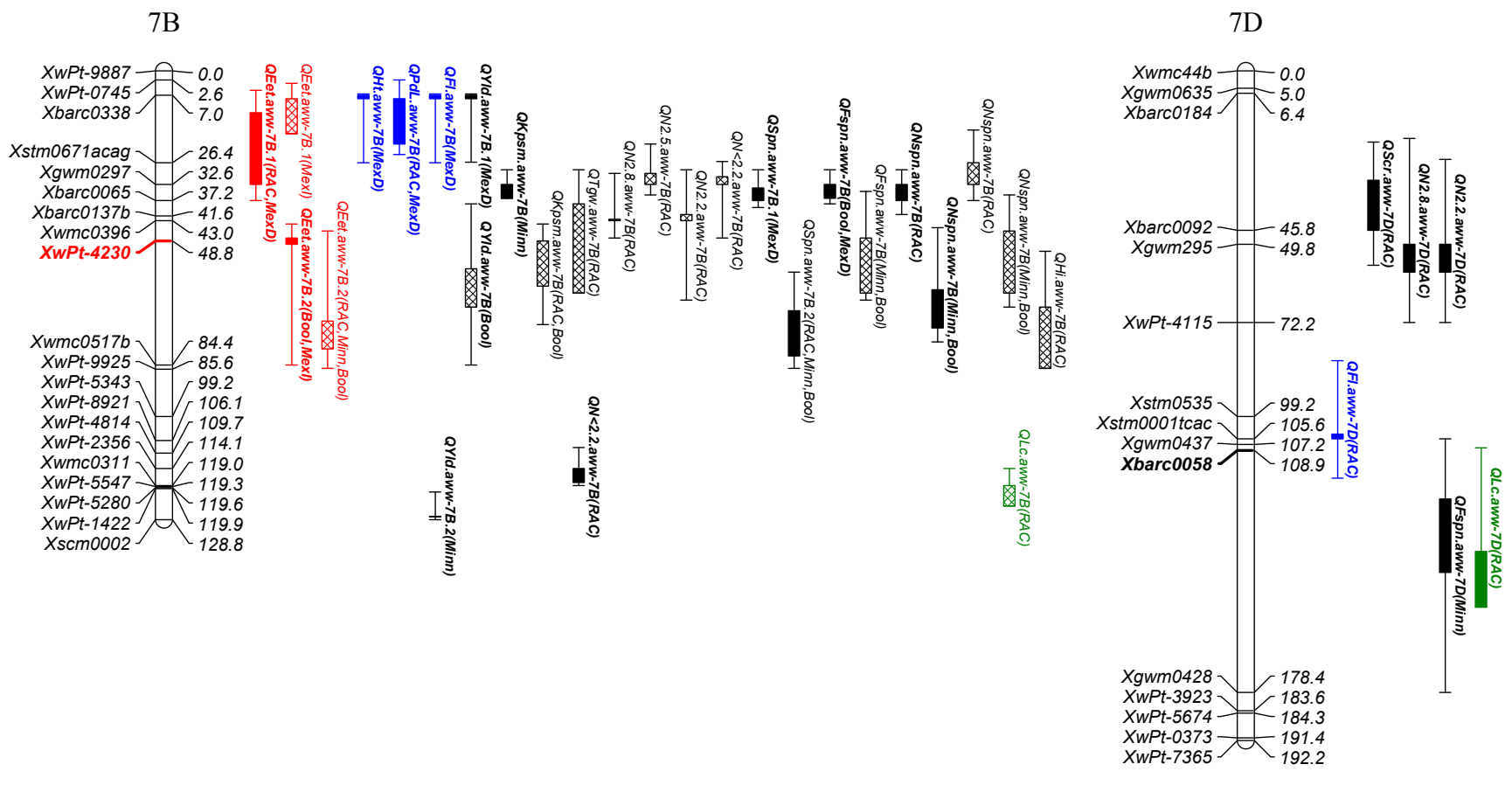
Appendix M. Continued



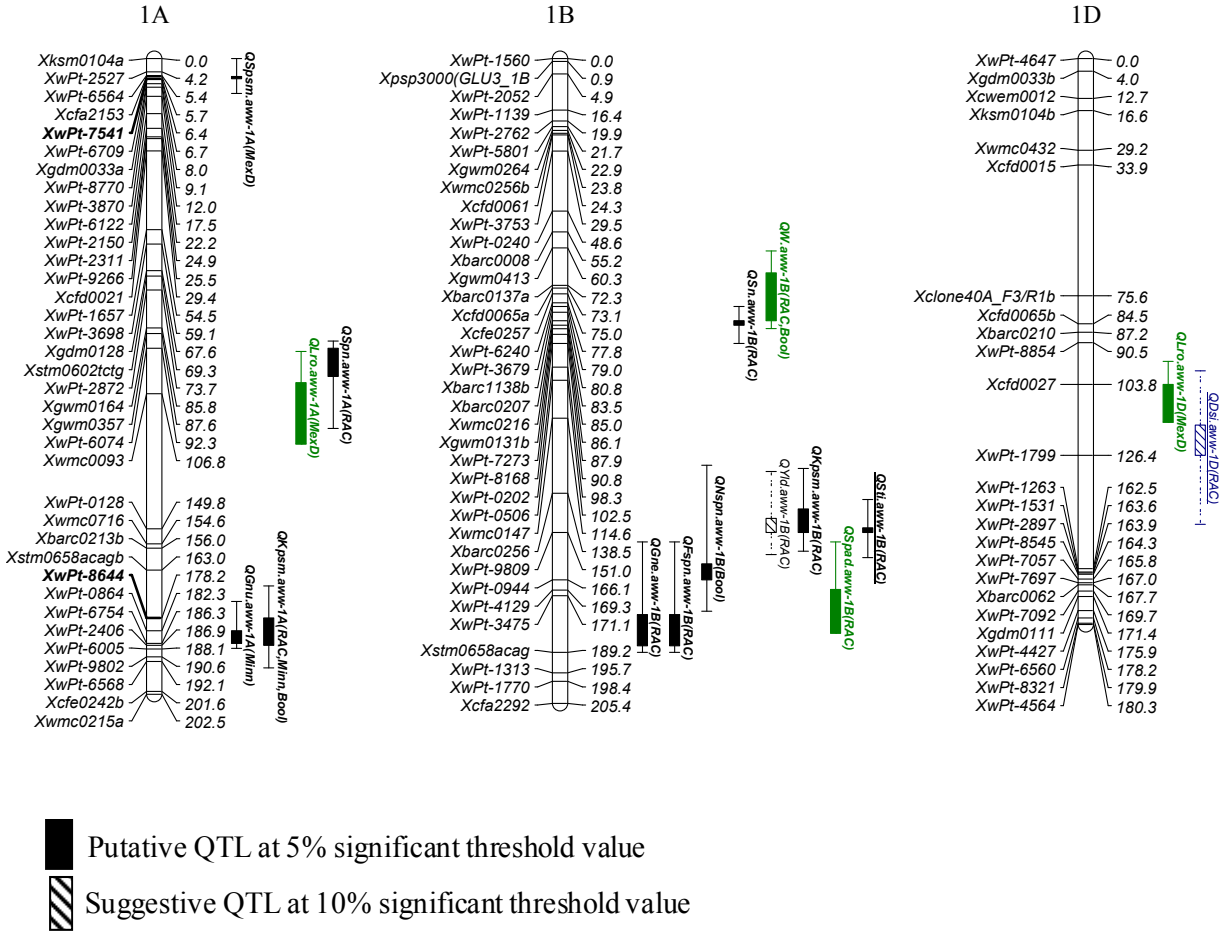
Appendix M. Continued



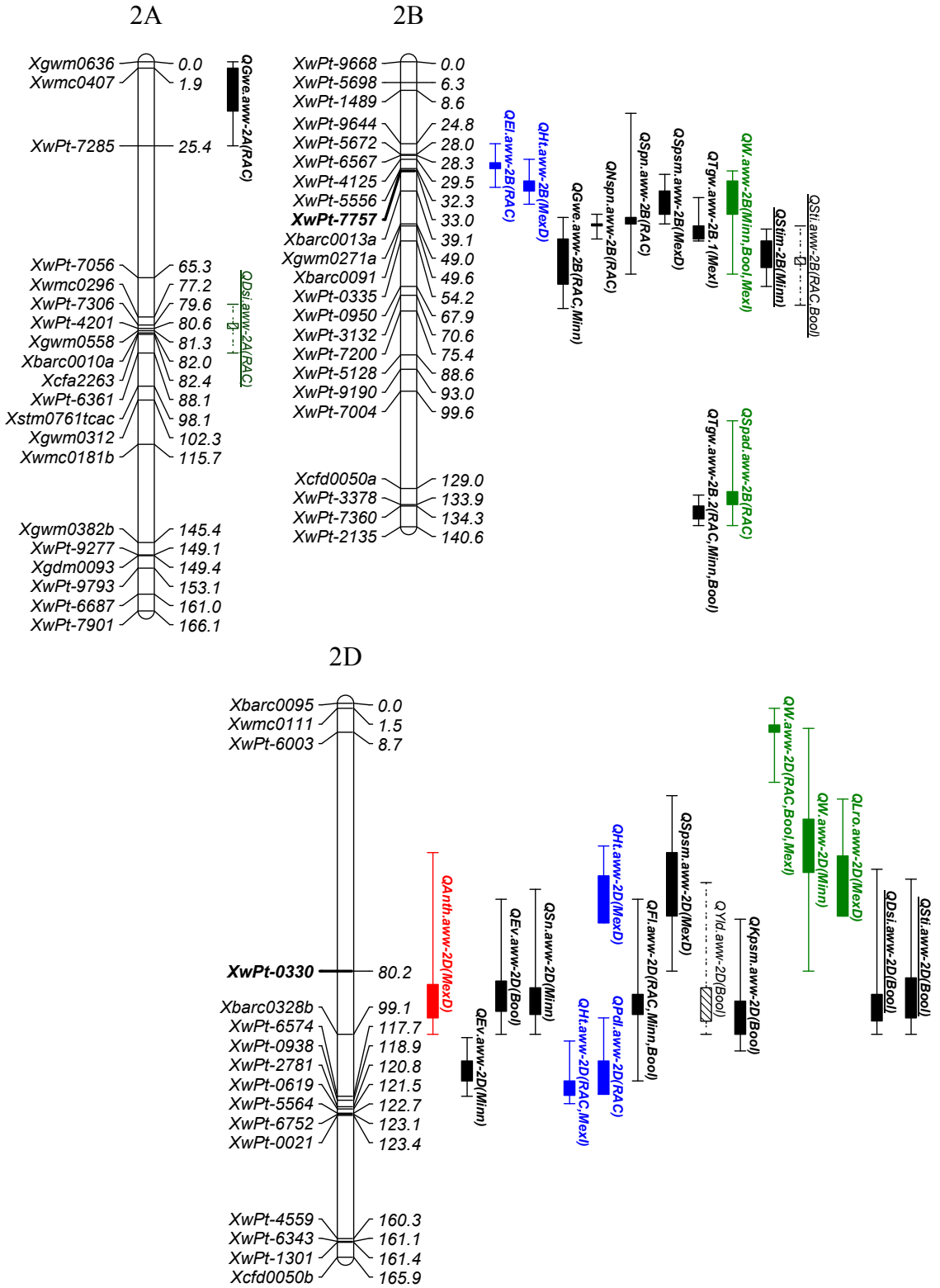
Appendix M. Continued



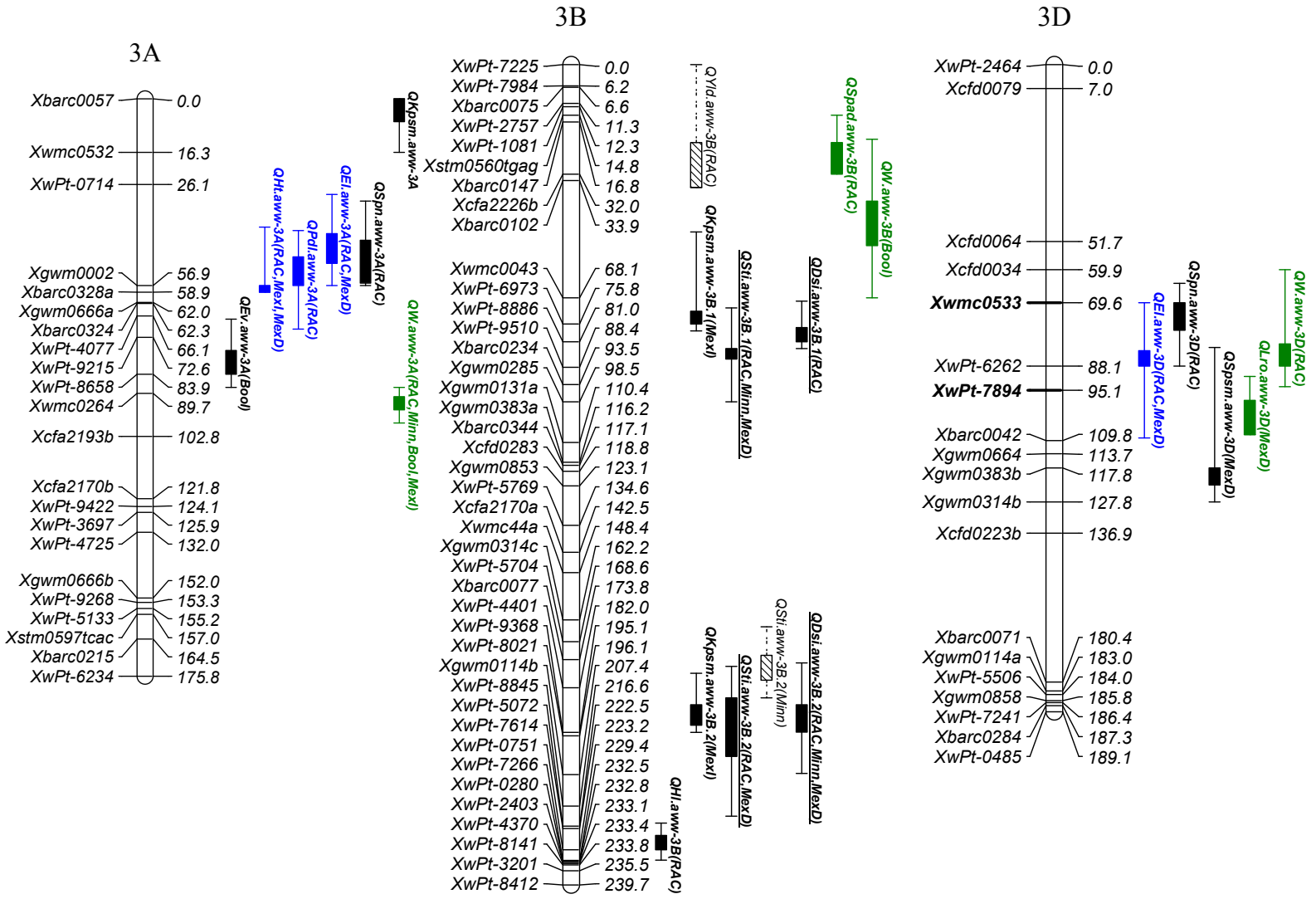
Appendix N. Location of all detected QTLs for the adjusted data for heading time. QTLs for plant height (Ht), peduncle length (Pdl), spike length (El) and flag leaf length (Fl) are shown in blue colour. QTLs for grian yield (Yld) and yield components such as number of grains per m^2 (Gnm), number of spikelets per spike (Spn), the fertile spikelets (Fspn), the non-fertile spikelets (Nspn), grain weight per spike (Gwe), grain number per sampeled spikes (Gnu), harvest index (Hi), thousand grain weight (Tgw) and screening (scr) are shown in black colour. The dark green colour loci showing physiological traits such as leaf waxiness (W), chlorophyll content (Spad) and pubescence (pa). The underlined loci are drought indices QTLs (DRI, DSI and STI). The putative QTLs (at $P < 0.05$) are shown in bold font and solid vertical bars, while the suggestive QTLs (at $P < 0.1$) are represented in non-bold and dashed lines adjacent to chromosomes.



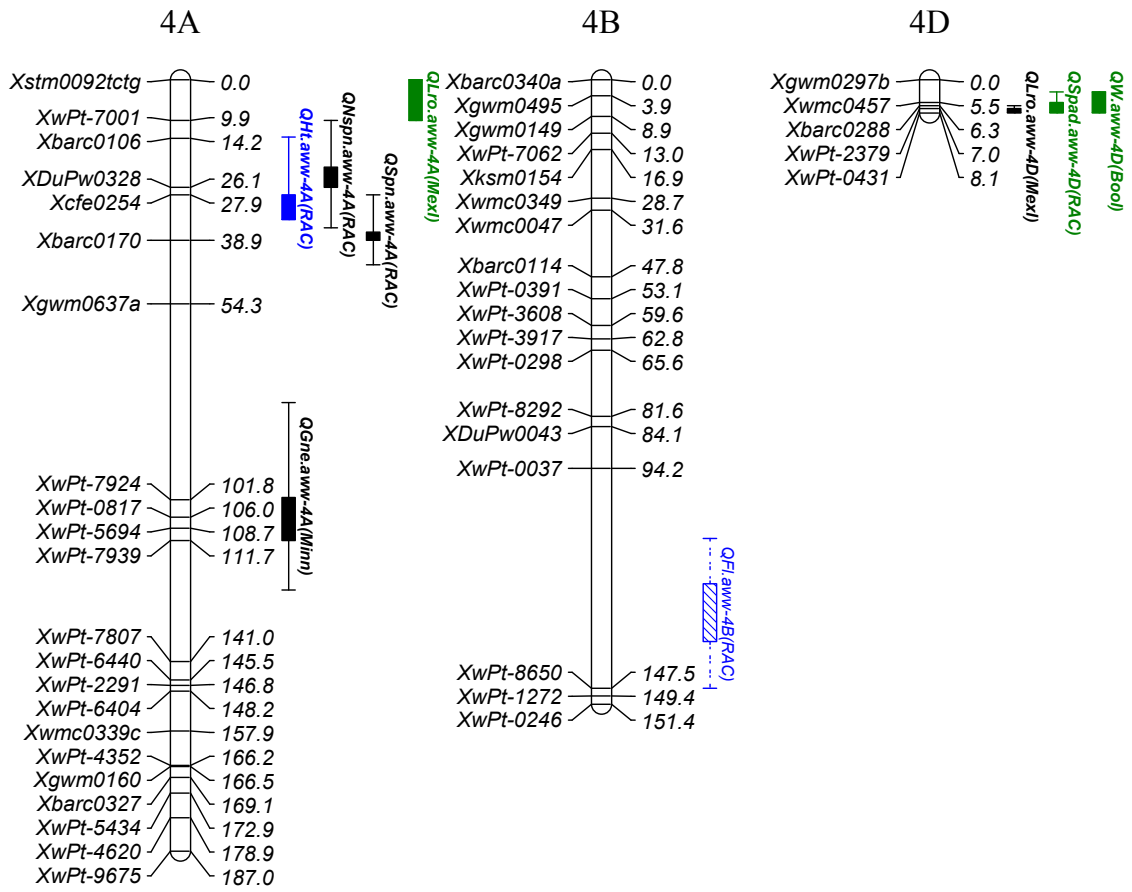
Appendix N. Continued



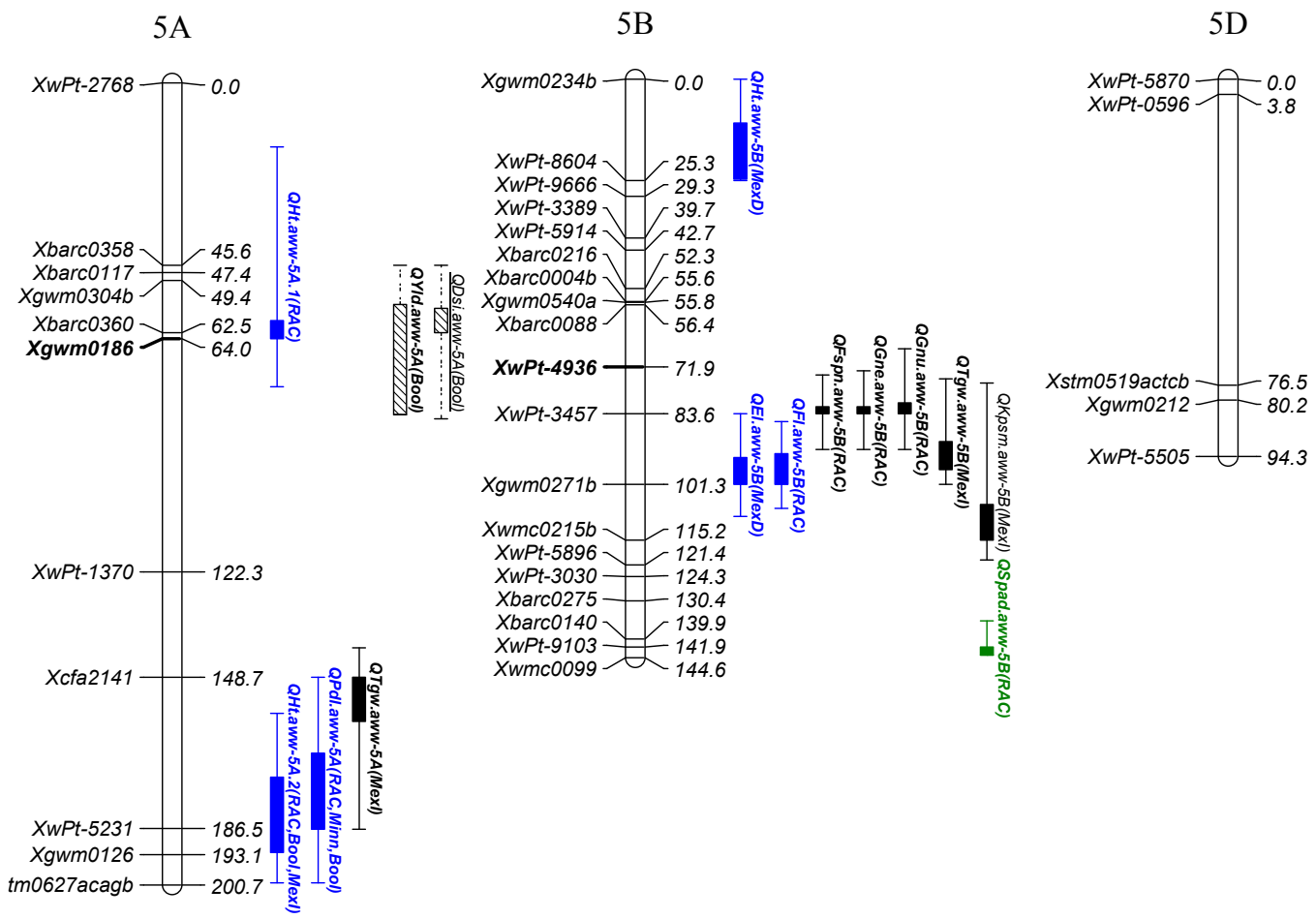
Appendix N. Continued.



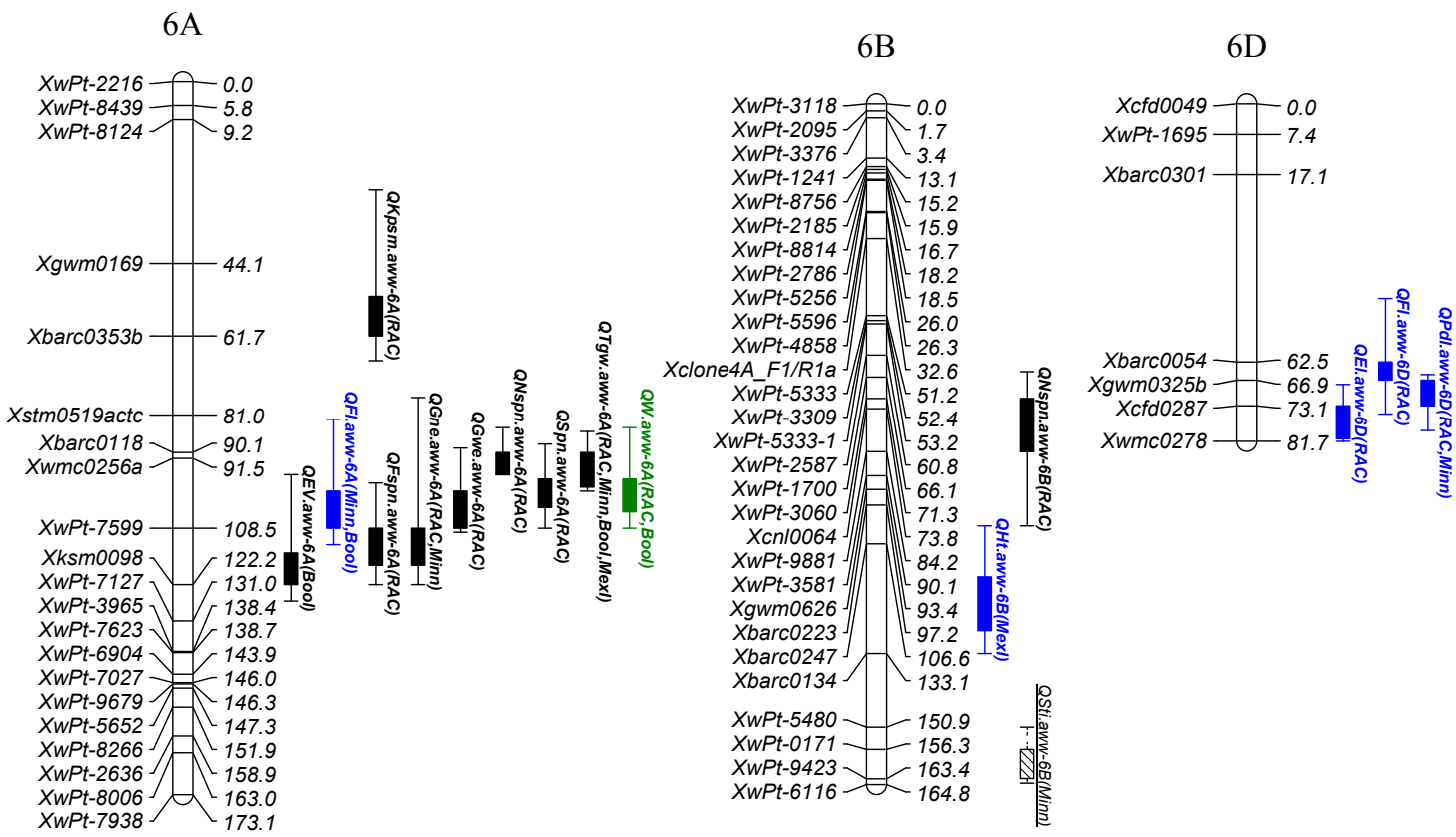
Appendix N. Continued.



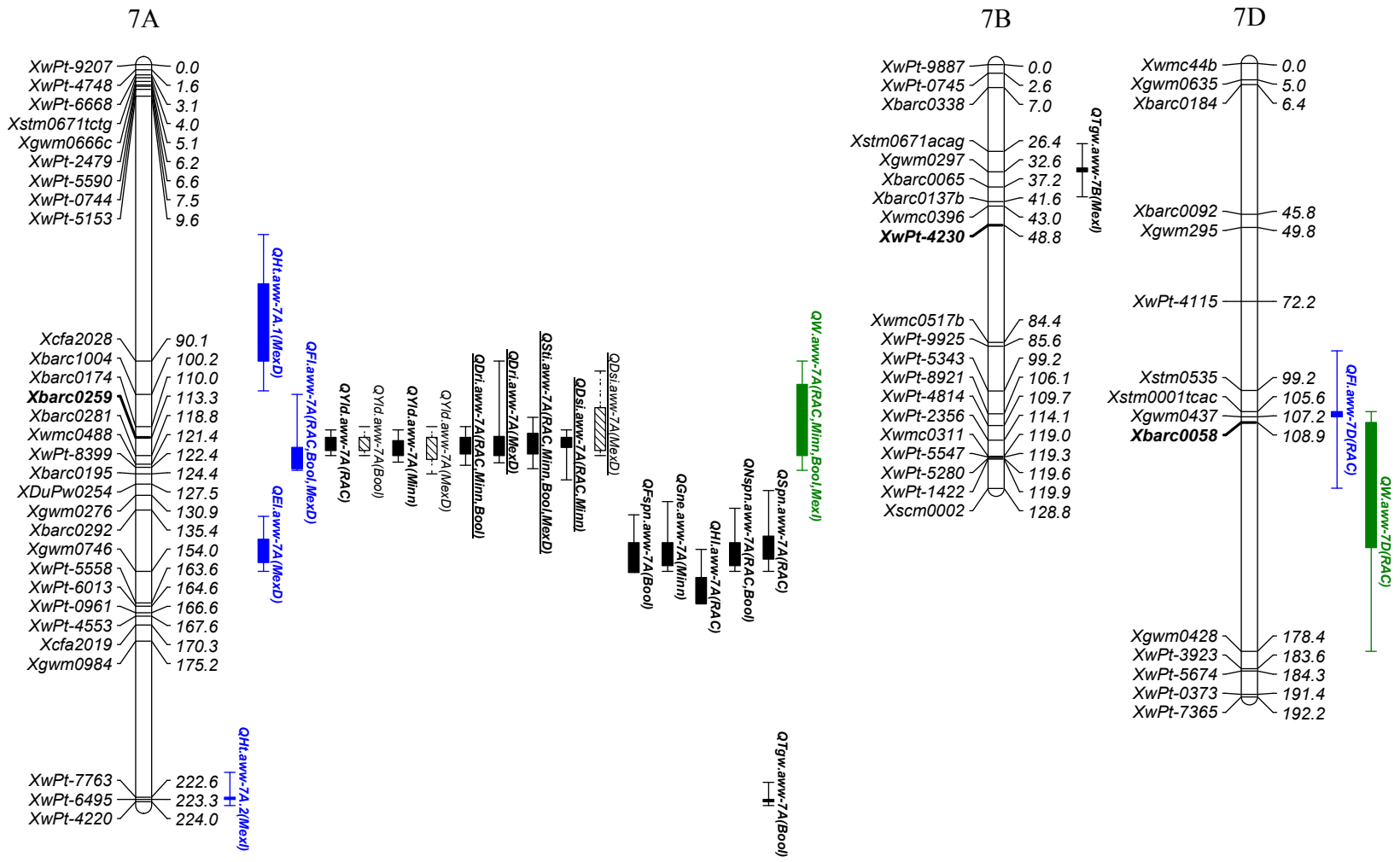
Appendix N. Continued



Appendix N. Continued



Appendix N. Continued



References:

Abebe A, Brick MA, Kirkby RA (1998) Comparison of selection indices to identify productive dry bean lines under diverse environmental conditions. Field Crops Research **58:** 15-23

Adcock D, McNeill AM, McDonald GK, Armstrong RD (2007) Subsoil constraints to crop production on neutral and alkaline soils in south-eastern Australia: a review of current knowledge and management strategies. Aust. J. Exp. Agri. **47:** 1245-1261

Akbari M, Wenzl P, Caig V, Carling J, Xia L, Yang S, Uszynski G, Mohler V, Lehmensiek A, Kuchel H, Hayden M, Howes N, Sharp P, Vaughan P, Rathmell B, Huttner E, Kilian A (2006) Diversity arrays technology (DArT) for high-throughput profiling of the hexaploid wheat genome. Theor. Appl. Genet. **113:** 1409-1420

Ali DT, Monneveux P, Acevedo E, Nachit M (1994) Evaluation of proline analysis and chlorophyll fluorescence quenching measurements as drought tolerance indicators in durum wheat (Triticum turgidum L. var. durum). Euphytica **79:** 65-73

Ali M, Jensen CR, Mogensen VO, Andersen MN, Henson IE (1999) Root signalling and osmotic adjustment during intermittent soil drying sustain grain yield of field grown wheat. Field Crops Research **62:** 35-52

Amani I, Fischer RA, Reynolds MP (1996) Canopy temperature depression association with yield of irrigated spring wheat cultivars in a hot climate. J. Agron. Crop Sci. **176:** 119-129

Angus JF (2001) Nitrogen supply and demand in Australian agriculture. Aust. J. Exp. Agri. **41:** 277-288

Angus JF, van Herwaarden AF (2001) Increasing water use and water use efficiency in dryland wheat. Agron J **93:** 290-298

Araus JL, Alegre L, Tapia L, Calafell R (1986) Relationship between leaf structure and gas exchange in wheat leaves at different insertion levels. J. Exp. Bot. **37:** 1323-1333

Araus JL, Amaro T, Voltas J, Nakkoul H, Nachit MM (1998) Chlorophyll fluorescence as a selection criterion for grain yield in durum wheat under Mediterranean conditions. Field Crops Research **55:** 209

Araus JL, Bort J, Steduto P, Villegas D, Royo C (2003) Breeding cereals for Mediterranean conditions: ecophysiological clues for biotechnology application. Annals of Applied Biology **142:** 129-141

Araus JL, Slafer GA, Reynolds MP, Royo C (2002) Plant breeding and drought in C-3 cereals: What should we breed for? Annals of Botany **89:** 925-940

Araus JL, Slafer GA, Reynolds MP, Royo C (2004) Physiology of yield and adaptation in wheat and barley breeding. *In* HT Nguyen, A Blum, eds, Physiology and Biotechnology Integration for Plant Breeding. Marcel Dekker, Inc., New York. Basel, pp 1-49

Austin RB (1989) Maximizing crop production in water-limited environments. *In* FWG Baker, ed, Drought resistance in cereals. CAB International, pp 13-25

Babu RC, Pathan MS, Blum A, Nguyen HT (1999) Comparison of measurement methods of osmotic adjustment in rice cultivars. Crop Sci. **39:** 150-158

Bacon MA (2004) Water use efficiency in plant biology. *In* MA Bacon, ed, Water use efficiency in plant biology. Blackwell, pp 1-26

Baker N, Rosenqvist E (2004) Applications of chlorophyll fluorescence can improve crop production strategies: an examination of future possibilities. J. Exp. Bot. **55:** 1607-1621

Balota M, Lichtenthaler HK (1999) Red chlorophyll fluorescence as an ecophysiological method to assess the behaviour of wheat genotypes under drought and heat. Cereal Res. Commun. **27:** 179-187

Barr HD, Weatherley PE (1962) A re-examination of the relative turgidity technique for estimating water deficit in leaves. Aust. J. Biol. Sci **15:** 413-428

Baum M, Grando S, Backes G, Jahoor A, Sabbagh A, Ceccarelli S (2003) QTLs for agronomic traits in the Mediterranean environment identified in recombinant inbred lines of the cross 'Arta' x H-spontaneum 41-1. Theor. Appl. Genet. **107:** 1215-1225

Beales J, Turner A, Griffiths S, Snape J, Laurie D (2007) A Pseudo-Response Regulator is misexpressed in the photoperiod insensitive Ppd-D1a mutant of wheat (Triticum aestivum L.). Theor. Appl. Genet. **115:** 721-733

Bennett MD, Smith JB (1976) Nuclear DNA Amounts in Angiosperms. Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences (1934-1990) **274:** 227-274

Bennetzen J (2000) Genetic fine-mapping technology. *In* BIG Haussmann, HH Geiger, DE Hess, CT Hash, P Bramel-Cox, eds, Application of molecular markers in plant breeding. Training manual for a seminar held at IITA. ICRISA, Andhra Pradesh, India, Ibadan, Nigeria

Bernier J, Kumar A, Ramaiah V, Spaner D, Atlin G (2007) A large effect QTL for grain yield under reproductive-stage drought stress in upland rice. Crop Sci. **47:** 507-516

Betran FJ, Beck D, Banziger M, Edmeades GO (2003) Secondary traits in parental inbreds and hybrids under stress and non-stress environments in tropical maize. Field Crops Research **83:** 51-65

Bewley JD, Black M (1994) Seeds: Physilogy of development and germination, Ed 2. Plenum Press, New York

Bianchi G, Figini ML (1986) Epicuticular waxes of glaucous and nonglaucous durum wheat lines. J. Agric. Food Chem. **34:** 429-433

Bianchi G, Scole F, Borghi B, Corbellini M (1982) Epicuticular waxes of hexaploid and octaploid triticales. Phytochemistry **21:** 639-642

Bidinger FR, Mahalakshmi V, Rao GDP (1987) Assessment of drought resistance in pearl millet (*Pennisetum americanum* (L.) Leeke). II. Estimation of genotype response to stress. Aust. J. Agric. Res. **38:** 49-59

Bidinger FR, Witcombe JR (1989) Evaluation of specific drought avoidance traits as selection criteria for improvement of drought resistance. *In* FWG Baker, ed, Drought resistance in cereals. CAB International, pp 151-164

Blum A http://www.plantstress.com. *In*,

Blum A (1986) The effect of heat stress on wheat leaf and ear photosynthesis. J. Exp. Bot. **37:** 111-118

Blum A (1988) Plant breeding for stress environments. CRC Press, Boca Raton, Florida

Blum A (1996) Crop responses to drought and the interpretation of adaptation. Plant Growth Regulation **20:** 135-148

Blum A (1998) Improving wheat grain filling under stress by stem reserve mobilisation. Euphytica **100:** 77

Blum A (1999) Towards standard assays of drought resistance in crop plants. *In* JM Ribaut, D Poland, eds, Molecular approaches for the genetic improvement of cereals for stable production in water-limited environments. CIMMYT, El Batan, Mexico, pp 29-35

Blum A (2002) Drought tolerance – is it a complex trait? *In* NP Saxena, JC O'Toole, eds, Proceedings of an international workshop on field screening for drought tolerance in rice. ICRISAT, Patancheru, India, pp 17-22

Blum A (2004) Plant stress. *In*. http://www.plantstress.com/

Blum A (2006) Drought adaptation in cereal crops: A prologue. *In* J-M Ribaut, ed, Drought adaptation in cereals. Food Products Press, New York pp 3-17

Blum A, Pnuel Y (1990) Physiological attributes associated with drought resistance of wheat cultivars in a Mediterranean environment. Aust. J. Agric. Res. **41:** 799-810

Blum A, Ramaiah S, Kanemasu ET, Paulsen GM (1990) Wheat recovery from drought stress at the tillering stage of development. Field Crops Research **24:** 67-85

Blum A, Sinmena B, Mayer J, Golan G, Shpiler L (1994) Stem reserve mobilisation supports wheat-grain filling under heat stress. Aust. J. Plant Physiol. **21:** 771-781

Blum A, Zhang J, Nguyen HT (1999) Consistent differences among wheat cultivars in osmotic adjustment and their relationship to plant production. Field Crops Research **64:** 287-291

Boer MP, Wright D, Feng L, Podlich DW, Luo L, Cooper M, van Eeuwijk FA (2007) A Mixed-Model Quantitative Trait Loci (QTL) Analysis for Multiple-Environment Trial Data Using Environmental Covariables for QTL-by-Environment Interactions, With an Example in Maize. Genetics **177:** 1801-1813

Bolaños J, Edmeades GO (1996) The importance of the anthesis-silking interval in breeding for drought tolerance in tropical maize. Field Crops Research **48:** 65-80

Bonnin I, Rousset M, Madur D, Sourdille P, Dupuits C, Brunel D, Goldringer I (2008) FT genome A and D polymorphisms are associated with the variation of earliness components in hexaploid wheat. Theor. Appl. Genet. **116:** 383-394

Borlaug NE, Dowswell CR (2003) Feeding a world of ten billion peapole: A 21st century challenge *In* R Tuberosa, RL Phillips, G M., eds, In the wake of double helix: from the green revolution to the gene revolution Avenue media, Bologna, Italy

Börner A, Röder M, Korzun V (1997) Comparative molecular mapping of GA insensitive Rht loci on chromosomes 4B and 4D of common wheat (Triticum aestivum L.). Theor. Appl. Genet. **95:** 1133-1137

Börner A, Schumann E, Fürste A, Cöster H, Leithold B, Röder M, Weber W (2002) Mapping of quantitative trait loci determining agronomic important characters in hexaploid wheat (*Triticum aestivum* L.). Theor. Appl. Genet. **105:** 921

Borojevic K, Borojevic K (2005) The transfer and history of "reduced height genes" (Rht) in wheat from Japan to Europe. Journal of Heredity **96:** 455-459

Borras L, Slafer GA, Otegui ME (2004) Seed dry weight response to source-sink manipulations in wheat, maize and soybean: a quantitative reappraisal. Field Crops Research **86:** 131-146

Borrell AK, Hammer GL (2000) Nitrogen dynamics and the physiological basis of stay-green in sorghum. Crop Sci. **40:** 1295-1307

Borrell AK, Hammer GL, Douglas ACL (2000a) Does maintaining green leaf area in sorghum improve yield under drought? I. Leaf growth and senescence. Crop Sci. **40:** 1026-1037

Borrell AK, Hammer GL, Henzell RG (2000b) Does maintaining green leaf area in sorghum improve yield under drought? II. Dry matter production and yield. Crop Sci. **40:** 1037-1048

Borrell AK, Jordan D, Mullet J, Klein P, Klein R, Nguyen H, Rosenow D, Hammer G, Douglas A, Henzell B (2004) Discovering stay-green drought tolerance genes in sorghum: a multidisciplinary approach. *In* 4th International Crop Science Congress, Brisbane, Australia

Botstein D, White RL, Skolnick M, Davis RW (1980) Construction of a Genetic Linkage Map in Man Using Restriction Fragment Length Polymorphisms. Am J Hum Genet **32:** 314-331

Botwright TL, Condon AG, Rebetzke GJ, Richards RA (2002) Field evaluation of early vigour for genetic improvement of grain yield in wheat. Aust. J. Agric. Res. **53:** 1137-1145

Boyer JS (1967) Leaf water potentials measured with a pressure chamber. Plant Physiol. **42:** 133-137

Boyer JS, Westgate ME (2004) Grain yields with limited water. J. Exp. Bot. **55:** 2385-2394

Briggs KG, Aytenfisu A (1980) Relationships between Morphological Characters above the Flag Leaf Node and Grain Yield in Spring Wheats. Crop Sci. **20:** 350-354

Brown DG, Vision TJ, Tanksley SD (2000) Selective Mapping: A discrete optimization approach to selecting a population subset for use in a high-density genetic mapping project. *In* Proceedings of the 11th Annual (ACM-SIAM) Symposium on Discrete Algorithms pp 419-428

Bruce WB, Edmeades GO, Barker TC (2002) Molecular and physiological approaches to maize improvement for drought tolerance. J. Exp. Bot. **53:** 13-25

Bullrich L, Appendino ML, Tranquilli G, Lewis S, Dubcovsky J (2002) Mapping of a thermo-sensitive earliness per se gene on Triticum monococcum chromosome 1A(m). Theor. Appl. Genet. **105:** 585-593

C.T.C. Members (2003) The nature and identification of quantitative trait loci: a community's view. Nat Rev Genet **4:** 911-916

Cadalen T, Sourdille P, Charmet G, Tixier MH, Gay G, Boeuf C, Bernard S, Leroy P, Bernard M (1998) Molecular markers linked to genes affecting plant height in wheat using a doubled-haploid population. Theor. Appl. Genet. **96:** 933-940

Campbell GS (1985) Soil Physics with BASIC: Transport models for soil-plant systems, Vol 14. Elsevier, New York

Campbell KG, Bergman CJ, Gualberto DG, Anderson JA, Giroux MJ, Hareland G, Fulcher RG, Sorrells ME, Finney PL (1999) Quantitative Trait Loci Associated with Kernel Traits in a Soft X Hard Wheat Cross.(Statistical Data Included). Crop Sci. **39:** 1184

Carlborg O, Haley CS (2004) Epistasis: too often neglected in complex trait studies? Nat Rev Genet **5:** 618-625

Carlborg O, Jacobsson L, Ahgren P, Siegel P, Andersson L (2006) Epistasis and the release of genetic variation during long-term selection. Nat Genet **38:** 418-420

Carollo V, Matthews DE, Lazo GR, Blake TK, Hummel DD, Lui N, Hane DL, Anderson OD (2005) GrainGenes 2.0. An improved resource for the small-grains community. Plant Physiol. **139:** 643–651

Chalmers KJ, Campbell AW, Kretschmer J, Karakousis A, Henschke PH, Pierens S, Harker N, Pallotta M, Cornish GB, Shariflou MR, Rampling LR, McLauchlan A, Daggard G, Sharp PJ, Holton TA, Sutherland MW, Appels R, Langridge P (2001) Construction of three linkage maps in bread wheat, (Triticum aestivum). Aust. J. Agric. Res. **52:** 1089-1119

Champoux MC, Wang G, Sarkarung S, Mackill DJ, Otoole JC, Huang N, McCouch SR (1995) Locating genes associated with root morphology and drought avoidance in rice via linkage to molecular markers. Theor. Appl. Genet. **90:** 969-981

Chapman SC, Barreto HJ (1997) Using a chlorophyll meter to estimate specific leaf nitrogen of tropical maize during vegetative growth. Agron J **89:** 557-562

Chaves MM, Maroco JP, Pereira JS (2003) Understanding plant responses to drought- from genes to the whole plant. Functional Plant Biology **30:** 239-264

Chaves MM, Pereira JS, Maroco J, Rodrigues ML, Ricardo CPP, Osorio ML, Carvalho I, Faria T, Pinheiro C (2002) How plants cope with water stress in the field? Photosynthesis and growth. Annals of Botany **89:** 907-916

Churchill GA, Doerge RW (1994) Empirical threshold values for quantitative triat mapping. Genetics **138:** 963-971

Clarke JM, Depauw RM, Townley-Smith (1992) Evaluation of methods for quantification of drought tolerance in wheat. Crop Sci. **32:** 723-728

Clarke JM, McCaig TN (1982) Excised-leaf water retention capability as an indicator of drought resistance of *Triticum* genotypes. Canadian Journal of Plant Science **62:** 571-578

Clarke JM, McCaig TN, Depauw RM (1993) Relationship of glaucousness and epicuticular wax quantity of wheat. Canadian Journal of Plant Science **73:** 961-967

Clarke JM, McCaig TN, Depauw RM (1994) Inheritance of glaucousness and epicuticular wax in durum wheat. Crop Sci. **34:** 327-330

Clarke JM, Richards RA (1988) The effects of glaucousness, epicuticular wax, leaf age, plant height, and growth environment on water-loss rates of excised wheat leaves. Canadian Journal of Plant Science **68:** 975-982

Clarke JM, Romagosa I, Depauw RM (1991) Screening durum-wheat germplasm for dry growing conditions - Morphological and physiological criteria. Crop Sci. **31:** 770-775

Cockram J, Jones H, Leigh FJ, O'Sullivan D, Powell W, Laurie DA, Greenland AJ (2007) Control of flowering time in temperate cereals: genes, domestication, and sustainable productivity. J. Exp. Bot.**:** erm042

Colin M, Leanne L, Walter S, Nilufar J (2007) Australian GRAINS 07.1 *In*. The Australian Bureau of Agricultural and Resource Economics (ABARE), http://abareconomics.com, Canberra

Condon AG, Farquhar GD, Rebetzke GJ, Richards RA (2006) The application of carbon isotope discrimination in cereal improvement for water-limmited environments. *In* JM Ribaut, ed, Drought adaptation in cereals. Food products press, New York

Condon AG, Farquhar GD, Richards RA (1990) Genotypic variation in carbon isotope discrimination and transpiration efficiency in wheat - leaf gas-exchange and whole plant studies. Aust. J. Plant Physiol. **17:** 9-22

Condon AG, Richards RA (1992) Broad sense heritability and genotype × environment interaction for carbon isotope discrimination in field-grown wheat. Aust. J. Agric. Res. **43:** 921-934

Condon AG, Richards RA, Farquhar GD (1987) Carbon isotope discrimination is positively correlated with grain yield and dry matter production in field-grown wheat. Crop Sci. **27:** 996-1001

Condon AG, Richards RA, Farquhar GD (1992) The effect of variation in soil water availability, vapour pressure deficit and nitrogen nutrition on carbon isotope discrimination in wheat. Aust. J. Agric. Res. **43:** 935-947

Condon AG, Richards RA, Farquhar GD (1993) Relationships between carbon-isotope discrimination, water-use efficiency and transpiration efficiency for dryland wheat. Aust. J. Agric. Res. **44:** 1693-1711

Condon AG, Richards RA, Rebetzke GJ, Farquhar GD (2002) Improving Intrinsic Water-Use Efficiency and Crop Yield. Crop Sci. **42:** 122-131

Condon AG, Richards RA, Rebetzke GJ, Farquhar GD (2004) Breeding for high water-use efficiency. J. Exp. Bot. **55:** 2447-2460

Cook MG, Evans LT (1978) Effect of relative size and distance of competing sinks on the distribution of photosynthetic assimilates in wheat. Aust. J. Plant Physiol. **5:** 495-509

Coombes NE (2002) The reactive tabu search for efficient correlated experimental designs. Ph.D. thesis. John Moores University, Liverpool, U.K.

Courtois B, McLaren G, Sinha PK, Prasad K, Yadav R, Shen L (2000) Mapping QTLs associated with drought avoidance in upland rice. Molecular Breeding **6:** 55-66

Cullis BR, Smith AB, Coombes NE (2006) On the design of early generation variety trials with correlated data. Journal of Agricultural, Biological, and Environmental Statistics **11:** 381-393

Curtis BC (2002) Wheat in the world. *In* BC Curtis, S Rajaram, HG Macpherson, eds, Bread wheat Improvement and b89oillProduction, Vol http://www.fao.org/. FAO, p 567

Davies W, Kudoyarova G, Hartung W (2005) Long-distance ABA signaling and its relation to other signaling pathways in the detection of soil drying and the mediation of the plant's response to drought. J Plant Growth Regul **24:** 285

Davies WJ, Wilkinson S, Loveys B (2002) Stomatal control by chemical signalling and the exploitation of this mechanism to increase water use efficiency in agriculture. New Phytologist **153:** 449-460

Dembinska O, Lalonde S, Saini HS (1992) Evidence against the regulation of grain set by spikelet abscisic acid levels in water-stressed wheat. Plant Physiol. **100:** 1599-1602

Dodd IC (2003) Hormonal interactions and stomatal responses. J Plant Growth Regul **22:** 32-46

Doerge RW (2002) Mapping and analysis of quantitative trait loci in experimental populations. Nat Rev Genet **3:** 43-52

Driscoll CJ (1966) Gene-centromere distances in wheat by aneuploid F2 observations. Genetics **54:** 131-135

Dubcovsky J, Loukoianov A, Bonafede M (2007) Regulation of Flowering Time in Wheat. *In* Wheat Production in Stressed Environments, pp 659-665

Dubcovsky J, Loukoianov A, Fu DL, Valarik M, Sanchez A, Yan LL (2006) Effect of photoperiod on the regulation of wheat vernalization genes VRN1 and VRN2. Plant Molecular Biology **60:** 469-480

Dubois D, Winzeler M, Nosberger J (1990) Fructan accumulation and sucrose:sucrose fructosyltransferase activity in stems of spring wheat genotypes. Crop Sci. **30:** 315-319

Edmeades GO, Bolanos J, Lafitte HR, Rajaram S (1989) Traditional approaches to breeding for drought resistance in cereals. *In* FWG Baker, ed, Drought resistance in cereals. CAB International, pp 27-52

Ehdaie B, Alloush GA, Madore MA, Waines JG (2006a) Genotypic variation for stem reserves and mobilization in wheat: I. Postanthesis changes in internode dry matter. Crop Sci. **46:** 735-746

Ehdaie B, Alloush GA, Madore MA, Waines JG (2006b) Genotypic variation for stem reserves and mobilization in wheat: II. Postanthesis changes in internode water-soluble carbohydrates. Crop Sci. **46:** 2093-2103

Ehdaie B, Alloush GA, Waines JG (2008) Genotypic variation in linear rate of grain growth and contribution of stem reserves to grain yield in wheat. Field Crops Research **106:** 34-43

Ehdaie B, Whitkus RW, Waines JG (2003) Root Biomass, Water-Use Efficiency, and Performance of Wheat-Rye Translocations of Chromosomes 1 and 2 in Spring Bread Wheat 'Pavon'. Crop Sci. **43:** 710-717

Ellis M, Bonnett D, Rebetzke G (2007) A 192bp allele at the Xgwm261 locus is not always associated with the Rht8 dwarfing gene in wheat (Triticum aestivum L.). Euphytica **157:** 209-214

Ellis MH, Rebetzke GJ, Azanza F, Richards RA, Spielmeyer W (2005) Molecular mapping of gibberellin-responsive dwarfing genes in bread wheat. Theor. Appl. Genet. **111:** 423-430

Ellis MH, Rebetzke GJ, Chandler P, Bonnett D, Spielmeyer W, Richards RA (2004) The effect of different height reducing genes on the early growth of wheat. Functional Plant Biology **31:** 7

Ellis MH, Spielmeyer W, Gale KR, Rebetzke GJ, Richards RA (2002) "Perfect" markers for the Rht-B1b and Rht-D1b dwarfing genes in wheat. Theor. Appl. Genet. **105:** 1038-1042

Elmi AA, West CP (1995) Endophyte Infection Effects on Stomatal Conductance, Osmotic Adjustment and Drought Recovery of Tall Fescue. New Phytologist **131:** 61-67

Eriksen L, Borum F, Jahoor A (2003) Inheritance and localisation of resistance to *Mycosphaerella graminicola* causing septoria tritici blotch and plant height in the wheat (Triticum aestivum L.) genome with DNA markers. Theor. Appl. Genet. **107:** 515-527

Fageria NK, Baligar VC, Clark RB (2006) Physiology of crop production. Food Production Press, New Yourk

FAOSTAT (2006) http://faostat.fao.org. *In*,

Faris JD, Haen KM, Gill BS (2000) Saturation Mapping of a Gene-Rich Recombination Hot Spot Region in Wheat. Genetics **154:** 823-835

Faris JD, Laddomada B, Gill BS (1998) Molecular Mapping of Segregation Distortion Loci in Aegilops tauschii. Genetics **149:** 319-327

Farquhar GD, Ehleringer JR, Hubick KT (1989) Carbon isotope discrimination and photosynthesis. Annual Review of Plant Physiology and Plant Molecular Biology **40:** 503-537

Farquhar GD, O'Leary MH, Berry JA (1982) On the Relationship Between Carbon Isotope Discrimination and the Intercellular Carbon Dioxide Concentration in Leaves. Functional Plant Biology **9:** 121-137

Farquhar GD, Richards RA (1984) Isotopic composition of plant carbon correlates with water-use efficiency of wheat genotypes. Aust. J. Plant Physiol. **11:** 539-552

Febrero A, Ferna´ndez S, Molina-Cano JL, Araus JL (1998) Yield, carbon isotope discrimination, canopy reflectance and cuticular conductance of barley isolines of differing glaucousness. J. Exp. Bot. **49:** 1575-1581

Feil B (1992) Breeding progress in small grain cereals: A comparison of old and modern cultivars. Plant Breeding **108:** 1-11

Fernandez GCJ (1992) Effective selection criteria for assessing stress tolerance. *In* CG Kuo, ed, Proceedings of the International Symposium on Adaptation of Vegetables and Other Food Crops in Temperature and Water Stress, Tainan, Taiwan

Fischer R, Rees D, Sayre K, Lu Z-M, Condon A, Saavedra A (1998) Wheat yield progress associated with higher stomatal conductance and photosynthetic rate, and cooler canopies. Crop Sci. **38:** 1467-1475

Fischer RA, Maurer R (1978) Drought Resistance in Spring Wheat Cultivars. I Grain Yield Responses. Aust. J. Agric. Res. **29:** 897-912

Fischer RA, Turner NC (1978) Plant productivity in the arid and semiarid zones. Annual Review of Plant Physiology **29:** 277-317

Flint-Garcia SA, McMullen MD, Darrah LL (2003) Genetic Relationship of Stalk Strength and Ear Height in Maize. Crop Sci. **43:** 23-31

Fukai S, Cooper M (1995) Development of Drought-Resistant Cultivars Using Physio-Morphological Traits in Rice. Field Crops Research **40:** 67-86

Fukai S, Pantuwan G, Jongdee B, Cooper M (1999) Screening for drought resistance in rainfed lowland rice. Field Crops Research **64:** 61-74

Gardner KM, Latta RG (2007) Shared quantitative trait loci underlying the genetic correlation between continuous traits. Molecular Ecology **16:** 4195-4209

Garrity DP, O'Toole JC (1994) Screening rice for drought resistance at the reproductive phase. Field Crops Research **39:** 99-110

Garrity DP, O'Toole JCA (1995) Selection for reproductive stage drought avoidance in rice, using infrared thermometry. Agron J **87:** 773-779

Gilmour AR, Cullis BR, Verbyla AP (1997) Accounting for natural and extraneous variation in the analysis of field experiments. Journal of Agricultural, Biological, and Environmental Statistics **2:** 269-293

Gleadow RM, Dalling MJ, Halloran GM (1982) Variation in endosperm characteristics and nitrogen content in six wheat lines. Aust. J. Plant Physiol. **9:** 539-551

Goggin DE, Setter TL (2004) Fructosyltransferase activity and fructan accumulation during development in wheat exposed to terminal drought. Functional Plant Biology **31:** 11-21

Golabadi M, Arzani A, Mirmohammadi-Maibody SAM (2006) Assessment of Drought Tolerance in Segregating Populations in Durum Wheat. African Journal of Agricultural Research **1:** 162-171

Goodger JQD, Sharp RE, Marsh EL, Schachtman DP (2005) Relationships between xylem sap constituents and leaf conductance of well-watered and water-stressed maize across three xylem sap sampling techniques. J. Exp. Bot. **56:** 2389-2400

Gunasekera D, Ford M, Tulloh C (2007) Climate change: Issues and challenges for Australian agriculture and forestry. *In* www.abareconomics.com, ed,

Gupta P, Balyan H, Edwards K, Isaac P, Korzun V, Röder M, Gautier MF, Joudrier P, Schlatter A, Dubcovsky J, Pena RDl, Khairallah M, Penner G, Hayden M, Sharp P, Keller B, Wang R, Hardouin J, Jack P, Leroy P (2002) Genetic mapping of 66 new microsatellite (SSR) loci in bread wheat. Theor. Appl. Genet. **105:** 413

Gupta PK, Rustgi S, Kumar N (2006) Genetic and molecular basis of grain size and grain number and its relevance to grain productivity in higher plants. Genome **49:** 565-571

Gutierrez-Rodriguez M, Reynolds MP, Escalante-Estrada JA, Rodriguez-Gonzales MT (2004) Association between canopy reflectance indices and yield and physiological traits in bread wheat under drought and well-irrigated conditions. Aust. J. Agric. Res. **55:** 1139-1147

Hackett CA, Broadfoot LB (2003) Effects of genotyping errors, missing values and segregation distortion in molecular marker data on the construction of linkage maps Heredity **90:** 33-38

Haldane JBS (1919) The combination of Linkage values and the calculation of distances between the loci of linked factors. J. Genet. **8:** 299-309

Hanocq E, Laperche A, Jaminon O, Laine AL, Le Gouis J (2007) Most significant genome regions involved in the control of earliness traits in bread wheat, as revealed by QTL meta-analysis. Theor. Appl. Genet. **114:** 569-584

Hanocq E, Niarquin M, Heumez E, Rousset M, Le Gouis J (2004) Detection and mapping of QTL for earliness components in a bread wheat recombinant inbred lines population. Theor. Appl. Genet. **110:** 106-115

Haque MM, Mackill DJ, Ingram KT (1992) Inheritance of leaf epicuticular wax content In rice. Crop Sci. **32:** 865-868

Hartung W, Schraut D, Jiang F (2005) Physiology of abscisic acid (ABA) in roots under stress - a review of the relationship between root ABA and radial water and ABA flows. Aust. J. Agric. Res. **56:** 1253-1259

Hayden M, Nguyen T, Waterman A, McMichael G, Chalmers K (2007) Application of multiplex-ready PCR for fluorescence-based SSR genotyping in barley and wheat. Molecular Breeding **21:** 271-281

Hayden MJ, Stephenson P, Logojan AM, Khatkar D, Rogers C, Koebner RMD, Snape JW, Sharp PJ (2004) A new approach to extending the wheat marker pool by anchored PCR amplification of compound SSRs. Theor. Appl. Genet. **108:** 733-742

Hedden P (2003) The genes of the green revolution. Trends in Genetics **19:** 5-9

Hillers KJ (2004) Crossover interference. Current Biology **14:** R1036-R1037

Hong SS, Hong T, Jiang H, Xu DQ (1999) Changes in the non-photochemical quenching of chlorophyll fluorescence during aging of wheat flag leaves. Photosynthetica **36:** 621-625

Huang S, Sirikhachornkit A, Su X, Faris J, Gill B, Haselkorn R, Gornicki P (2002) Genes encoding plastid acetyl-CoA carboxylase and 3-phosphoglycerate kinase of the Triticum/Aegilops complex and the evolutionary history of polyploid wheat. PNAS. **99:** 8133-8138

Impa SM, Nadaradjan S, Boominathan P, Shashidhar G, Bindumadhava H, Sheshshayee MS (2005) Carbon isotope discrimination accurately reflects variability in WUE measured at a whole plant level in Rice. Crop Sci. **45:** 2517-2522

Innes P, Blackwell R (1983) Some effects of leaf posture on the yield and water economy of winter wheat. J. Agric. Sci. **101:** 367-376

Isidore E, van Os H, Andrzejewski S, Bakker J, Barrena I, Bryan GJ, Caromel B, van Eck H, Ghareeb B, de Jong W, van Koert P, Lefebvre V, Milbourne D, Ritter E, van der Voort JR, Rousselle-Bourgeois F, van Vliet J, Waugh R (2003) Toward a Marker-Dense Meiotic Map of the Potato Genome: Lessons From Linkage Group I. Genetics **165:** 2107-2116

Jaccoud D, Peng K, Feinstein D, Kilian A (2001) Diversity Arrays: a solid state technology for sequence information independent genotyping. Nucl. Acids Res. **29:** e25

Jackson P, Robertson M, Cooper M, Hammer G (1996) The role of physiological understanding in plant breeding; from a breeding perspective. Field Crops Research **49:** 11-37

Jansen J, Jong AGd, Ooijen JWv (2001) Constructing dense genetic linkage maps. Theor. Appl. Genet. **102:** 1113-1122

Jansen RC (1993) Interval Mapping of Multiple Quantitative Trait Loci. Genetics **135:** 205-211

Jansen RC (1994) Mapping quantitative trait loci using genetic markers overview biometrical models used. *In* JW van Ooijen, J Jansen, eds, Biometrics in Plant Breeding: Applications of Molecular Markers. CPRO-DLO, Wageningen, The Netherlands, pp 116-124

Jansen RC, Stam P (1994) High resolution of quantitative traits into multiple loci via interval mapping. Genetics **136:** 1447-1455

Jefferies SP, Kuchel H, Hollamby G, Howes N (2007) Paragmatic approch to breeding for drought tolerance. *In* The Genomics of Drought. ACPFG, Adelaide

Ji X, Raveendran M, Oane R, Ismail A, Lafitte R, Bruskiewich R, Cheng S, Bennett J (2005) Tissue-Specific Expression and Drought Responsiveness of Cell-Wall Invertase Genes of Rice at Flowering. Plant Molecular Biology **59:** 945-964

Jiang C, Zeng ZB (1995) Multiple Trait Analysis of Genetic Mapping for Quantitative Trait Loci. Genetics **140:** 1111-1127

Jiang GH, He YQ, Xu CG, Li XH, Zhang Q (2004) The genetic basis of stay-green in rice analyzed in a population of doubled haploid lines derived from an indica by japonica cross. Theor. Appl. Genet. **108:** 688-698

Johnson D, Richards R, Turner N (1983) Yield, water relations, gas exchange, and surface reflectances of near-isogenic wheat lines differing in glaucousness. Crop Sci. **23:** 318-325

Jones HG (2004) What is water use efficiency? *In* MA Bacon, ed, Water use efficiency in plant biology. Blackwell, pp 27-41

Jones HG (1992) Plants and microclimate: A quantitative approach to environmental plant physiology. Cambridge University press, Cambridge

Jones HG (2007) Monitoring plant and soil water status: established and novel methods revisited and their relevance to studies of drought tolerance. J. Exp. Bot. **58:** 119-130

Jones MM, Turner NC, Osmond CB (1981) Mechanisms of drought resistance. *In* LG Paleg, D Aspinall, eds, The physiology and biochemistry of drought resistance in plants. Academic Press, pp 15-35

Kammholz SJ, Campbell AW, Sutherland MW, Hollamby GJ, Martin PJ, Eastwood RF, Barclay I, Wilson RE, Brennan PS, Sheppard JA (2001) Establishment and characterisation of wheat genetic mapping populations. Aust. J. Agric. Res. **52:** 1079-1088

Kao C-H, Zeng Z-B (1997) General Formulas for Obtaining the MLEs and the Asymptotic Variance- Covariance Matrix in Mapping Quantitative Trait Loci When Using the EM Algorithm. Biometrics **53:** 653-665

Kao C-H, Zeng Z-B, Teasdale RD (1999) Multiple interval mapping for quantitative trait loci. Genetics **152:** 1203-1216

Kato K, Miura H, Sawada S (1999) Detection of an earliness per se quantitative trait locus in the proximal region of wheat chromosome 5AL. Plant Breeding **118:** 391-394

Kato K, Miura H, Sawada S (2000) Mapping QTLs controlling grain yield and its components on chromosome 5A of wheat. Theor. Appl. Genet. **101:** 1114-1121

Kilian A, Huttner E, Wenzl P, Jaccoud D, Carling J, Caig V, Evers, M, Heller-Uszynska K, Cayla C, Patarapuwadol S, Xia L, Yang S, Thomson B (2005) The fast and the cheap: SNP and DArT-based whole genome profiling for crop improvement. *In* R Tuberosa, RL Phillips, M Gale, eds, Proceedings of the International Congress In the Wake of the Double Helix: From the Green Revolution to the Gene Revolution. Avenue Media, Bologna, Italy, pp 443-461

Kimber G, Sears ER (1987) Evolution in the genus *Triticum* and the origin of cultivated wheat. *In* EG Heyne, ed, Wheat and wheat improvement Ed 2. Madison, Wisconsin, USA, p 765

King RW, von Wettstein-Knowles P (2000) Epicuticular waxes and regulation of ear wetting and pre-harvest sprouting in barley and wheat. Euphytica **112:** 157-166

Kirby EJM (1974) Ear development in spring wheat. J. Agric. Sci. **82:** 437-447

Kirigwi F, Van Ginkel M, Brown-Guedira G, Gill B, Paulsen G, Fritz A (2007) Markers associated with a QTL for grain yield in wheat under drought. Molecular Breeding **20:** 401-413

Klute A (1986) Water retention: laboratory methods. *In* A Klute, ed, Methods of soil analysis. Part 1. Physical and mineralogical methods, Ed 2, pp 635-662

Knox MR, Ellis THN (2002) Excess Heterozygosity Contributes to Genetic Map Expansion in Pea Recombinant Inbred Populations. Genetics **162:** 861-873

Korzun V, Röder MS, Ganal MW, Worland AJ, Law CN (1998) Genetic analysis of the dwarfing gene (Rht8) in wheat. Part I. Molecular mapping of Rht8 on the short arm of chromosome 2D of bread wheat (Triticum aestivum L.). Theor. Appl. Genet. **96:** 1104-1109

Kosambi DD (1944) The estimation of map distances from recombination values. Annals of Eugenics **12:** 172-175

Kuchel H, Hollamby G, Langridge P, Williams K, Jefferies SP (2006) Identification of genetic loci associated with ear-emergence in bread wheat. Theor. Appl. Genet. **V113:** 1103-1112

Kuchel H, Williams KJ, Langridge P, Eagles HA, Jefferies SP (2007a) Genetic dissection of grain yield in bread wheat. I. QTL analysis. Theor. Appl. Genet. **115**. 1029-1041

Kuchel H, Williams KJ, Langridge P, Eagles HA, Jefferies SP (2007b) Genetic dissection of grain yield in bread wheat. II. QTL-by-environment interaction. Theor. Appl. Genet. **115:** 1015-1027

Kulwal PL, Roy JK, Balyan HS, Gupta PK (2003) QTL mapping for growth and leaf characters in bread wheat. Plant Science **164:** 267-277

Kumar LS (1999) DNA markers in plant improvement: An overview. Biotechnology Advances **17:** 143-182

Kumar S, Gill B, Faris J (2007) Identification and characterization of segregation distortion loci along chromosome 5B in tetraploid wheat. Molecular Genetics and Genomics **278:** 187-196

Lagercrantz E, Ellegren H, Andersson L (1993) The abundance of various polymorphic microsatellite motifs differs between plants and vertebrates. Nucl. Acids Res. **21:** 1111-1115

Lanceras JC, Pantuwan G, Jongdee B, Toojinda T (2004) Quantitative trait loci associated with drought tolerance at reproductive stage in rice. Plant Physiology **135:** 384-399

Lander ES, Botstein D (1989) Mapping mendelian factors underlying quantitative traits using RFLP linkage maps. Genetics **121:** 185-199

Lander ES, Green P, Abrahamson J, Barlow A, Daly MJ, Lincoln SE, Newburg L (1987) MAPMAKER: An interactive computer package for constructing primary genetic linkage maps of experimental and natural populations. Genomics **1:** 174-181

Langridge P, Lagudah ES, Holton TA, Appels R, Sharp PJ, Chalmers KJ (2001) Trends in genetic and genome analyses in wheat: a review. Aust. J. Agric. Res. **52:** 1043-1077.

Laurie DA (1997) Comparative genetics of flowering time. Plant Molecular Biology **35:** 167-177

Laurie DA, Griffiths S, Dunford RP, Christodoulou V, Taylor SA, Cockram J, Beales J, Turner A (2004) Comparative genetic approaches to the identification of flowering time genes in temperate cereals. Field Crops Research **90:** 87-99

Laurie DA, Pratchett N, Bezant JH, Snape JW (1995) RFLP mapping of 5 major genes and 8 quantitative trait loci controlling flowering time in a winterxspring barley (*Hordeum vulgare* L) cross. Genome **38:** 575-585

Law CN, Suarez E, Miller TE, Worland AJ (1998) The influence of the group 1 chromosomes of wheat on ear-emergence times and their involvement with vernalization and day length. Heredity **80:** 83-91

Law CN, Sutka J, Worland AJ (1978) A genetic study of day-length response in wheat. Heredity **41:** 575–585

Law CN, Worland AJ (1997) Genetic analysis of some flowering time and adaptive traits in wheat. New Phytologist **137:** 19-28

Laza MR, Kondo M, Ideta O, Barlaan E, Imbe T (2006) Identification of quantitative trait loci for $\Delta^{13}C$ and productivity in Irrigated lowland rice. Crop Sci. **46:** 763-773

Lebreton CM, Visscher PM, Haley CS, Semikhodskii A, Quarrie SA (1998) A Nonparametric Bootstrap Method for Testing Close Linkage vs. Pleiotropy of Coincident Quantitative Trait Loci. Genetics **150:** 931-943

Leonova I, Pestsova E, Salina E, Efremova T, Roder M, Borner A (2003) Mapping of the Vrn-B1 gene in Triticum aestivum using microsatellite markers. Plant Breeding **122:** 209-212

Leung J, Giraudat J (1998) Abscisic acid signal transduction. Annual Review of Plant Physiology and Plant Molecular Biology **49:** 199-222

Levitt J (1980) Stress terminology. *In* NC Turner, PJ Kramer, eds, Adaptation of plants to water and high temperature stress. Wiley, New York, pp 473-439

Li XH, Liu XD, Li MS, Zhang SH (2003) Identification of quantitative trait loci for anthesis-silking interval and yield components under drought stress in maize. Acta Botanica Sinica **45:** 852-857

Lilley JM, Ludlow MM (1996) Expression of osmotic adjustment and dehydration tolerance in diverse rice lines. Field Crops Research **48:** 185-197

Lilley JM, Ludlow MM, McCouch SR, O'Toole JC (1996) Locating QTL for osmotic adjustment and dehydration tolerance in rice. J. Exp. Bot. **47:** 1427-1436

Liu FL, Jensen CR, Andersen MN (2005a) A review of drought adaptation in crop plants: changes in vegetative and reproductive physiology induced by ABA-based chemical signals. Aust. J. Agric. Res. **56:** 1245-1252

Liu FL, Jensen CR, Shahanzari A, Andersen MN, Jacobsen SE (2005b) ABA regulated stomatal control and photosynthetic water use efficiency of potato (Solanum tuberosum L.) during progressive soil drying. Plant Science **168:** 831-836

Liu Q, Ni Z, Peng H, Song W, Liu Z, Sun Q (2007) Molecular mapping of a dominant non-glaucousness gene from synthetic hexaploid wheat (Triticum aestivum L.). Euphytica **155:** 71-78

Liu ZH, Anderson JA, Hu J, Friesen TL, Rasmussen JB, Faris JD (2005c) A wheat intervarietal genetic linkage map based on microsatellite and target region amplified polymorphism markers and its utility for detecting quantitative trait loci. Theor. Appl. Genet. **111:** 782-794

Loss SP, Siddique KHM (1994) Morphological and physiological traits associated with wheat yield increases in mediterranean environments. Adv. Agron. **52** 229-276

Lu CM, Zhang JH (1999) Effects of water stress on photosystem II photochemistry and its thermostability in wheat plants. J. Exp. Bot. **50:** 1199-1206

Lu CM, Zhang JH (1998) Changes in photosystem II function during senescence of wheat leaves. Physiologia Plantarum **104:** 239-247

Lu Q, Lu C, Zhang J, Kuang T (2002) Photosynthesis and chlorophyllafluorescence during flag leaf senescence of field-grown wheat plants. Journal of Plant Physiology **159:** 1173-1178

Lu Z, Percy R, Qualset C, Zeiger E (1998) Stomatal conductance predicts yields in irrigated Pima cotton and bread wheat grown at high temperatures. J. Exp. Bot. **49:** 453-460

Ludlow MM, Muchow RC (1990) A critical evaluation of traits for improving crop yields in water-limited environments. Adv. Agron. **43:** 107-153

Maccaferri M, Sanguineti MC, Corneti S, Araus JL, Salern MB, Bort J, DeAmbrogio E, Moral LGd, Demontis A, El-Ahmed A, Maalouf F, Machlab H, Martos V, Moragues M, Motawaj J, Nachit M, Nserallah N, Ouabbou H, Royo C, Slama A, Tuberosa R (2008) Quantitative trait loci for grain yield and adaptation of durum wheat (Triticum durum Desf.) across a wide range of water availability Genetics **178**

Mackay TFC (2001) The genetic architecture of quantitative traits. Annual Review of Genetics **35:** 303-339

Madhava HB, Sheshshayee MS, Shankar AG, Prasad TG, Udayakumar M (2002) Use of SPAD Chlorophyll Meter to Assess Transpiration Efficiency of Peanut *In* AW Cruickshank, NC Rachaputi, GC Wright, SN Nigam, eds, Breeding of Drought-resistant Peanuts. Australian Centre for International Agricultural Research, Hyderabad, Andhra Pradesh India

Malosetti M, Ribaut J, Vargas M, Crossa J, van Eeuwijk F (2008) A multi-trait multi-environment QTL mixed model with an application to drought and nitrogen stress trials in maize (Zea mays L.). Euphytica

Manly KF, Robert H. Cudmore, Jr., Jane MM (2001) Map Manager QTX, cross-platform software for genetic mapping. Mammalian Genome **12:** 930-932

Marquez-Cedillo LA, Hayes PM, Kleinhofs A, Legge WG, Rossnagel BG, Sato K, Ullrich SE, Wesenberg DM (2001) QTL analysis of agronomic traits in barley based on the doubled haploid progeny of two elite North American varieties representing different germplasm groups. Theor. Appl. Genet. **103:** 625-637

Marshall TJ, Holmes JW (1979) Soil Physics. Cambridde University press, Cambridge

Mathews KL, Malosetti M, Chapman S, McIntyre L, Reynolds M, Shorter R, Eeuwijk Fv (2008) Multi-environment QTL mixed models for drought stress adaptation in wheat. Theor. Appl. Genet. (Accepted)

Maxwell K, Johnson GN (2000) Chlorophyll fluorescence--a practical guide. J. Exp. Bot. **51:** 659-668

McIntosh RA, Yamazaki Y, Devos KM, Dubcovsky J, Rogers WJ, Appels R (2003) Catalogue of Gene Symbols for Wheat. *In* Tenth International Wheat Genetics Symposium, Vol 4, Paestum, Italy

McMaster GS, Wilhelm WW, Frank AB (2005) Developmental sequences for simulating crop phenology for water-limiting conditions. Aust. J. Agric. Res. **56:** 1277-1288

McWilliam JR (1989) The dimensions of drought. *In* FwG Baker, ed, Drought resistance in cereals. CAB International, pp 1-11

Merah O, Deleens E, Monneveux P (1999) Grain yield, carbon isotope discrimination, mineral and silicon content in durum wheat under different precipitation regimes. Physiologia Plantarum **107:** 387-394

Merah O, Deleens E, Souyris I, Monneveux P (2000) Effect of glaucousness on carbon isotope discrimination and grain yield in durum wheat. J. Agron. Crop Sci. **185:** 259-265

Merah O, Deleens E, Souyris I, Nachit M, Monneveux P (2001) Stability of Carbon Isotope Discrimination and Grain Yield in Durum Wheat. Crop Sci. **41:** 677-681

Messmer MM, Keller M, Zanetti S, Keller B (1999) Genetic linkage map of a wheat×spelt cross. Theor. Appl. Genet. **98:** 1163-1170

Miralles DJ, Slafer GA (1999) Wheat development. *In* EH Satorre, GA Slafer, eds, Wheat: Ecology and physiology of yield determination. Food produts press, New York pp 13-44

Mitra J (2001) Genetics and genetic improvement of drought resistance in crop plants. Current Sci. **80:** 758-763

Monforte AJ, Tanksley SD (2000) Fine mapping of a quantitative trait locus (QTL) from Lycopersicon hirsutum chromosome 1 affecting fruit characteristics and

agronomic traits: breaking linkage among QTLs affecting different traits and dissection of heterosis for yield. Theor. Appl. Genet. **100:** 471-479

Monneveux P, Belhassen E (1996) The diversity of drought adaptation in the wide. Plant Growth Regulation **20:** 85-92

Morgan JM (1980a) Osmotic adjustment in the spikelets and leaves of wheat. J. Exp. Bot. **31:** 655-665

Morgan JM (1980b) Possible role of abscisic acid in reducing seed set in water-stressed wheat plants. Nature **285:** 655-657

Morgan JM (1984) Osmoregulation and water stress in higher plants. Annual Review of Plant Physiology **35:** 299-319

Morgan JM (1992) Osmotic components and properties associated with genotypic differences in osmoregulation in wheat. Aust. J. Plant Physiol. **19:** 67-76

Morgan JM, Condon AG (1986) Water use, grain yield, and osmoregulation in wheat. Aust. J. Plant Physiol. **13:** 523-532

Morgan JM, Tan MK (1996) Chromosomal location of a wheat osmoregulation gene using RFLP analysis. Aust. J. Plant Physiol. **23:** 803-806

Mrva K, Mares DJ (2001) Quantitative trait locus analysis of late maturity α-amylase in wheat using the doubled haploid population Cranbrook x Halberd. Aust. J. Agric. Res. **52:** 1267-1273

Mu P, Li ZC, Li CP, Zhang HL, Wu CM, Li C, Wang XK (2003) QTL mapping of the root traits and their correlation analysis with drought resistance using DH lines from paddy and upland rice cross. Chinese Science Bulletin **48:** 2718-2724

Mugo SN, Bänziger M, Edmeades GO (1999) Prospects of Using ABA in Selection for Drought Tolerance in Cereal Crops. *In* J-M Ribaut, D Poland, eds, Molecular Approaches for the Genetic Improvement of Cereals for Stable Production in Water-Limited Environments. CIMMYT, El Batan, Mexico

Muller HJ (1916) The Mechanism of Crossing-Over. The American Naturalist **50:** 193

Munne-Bosch S, Alegre L (2000) Changes in carotenoids, tocopherols and diterpenes during drought and recovery, and the biological significance of chlorophyll loss in *Rosmarinus officinalis* plants. Planta **210:** 925

Munne-Bosch S, Alegre L (2004) Die and let live: leaf senescence contributes to plant survival under drought stress. Functional Plant Biology **31:** 203-216

Narasimhamoorthy B, Gill BS, Fritz AK, Nelson JC, Brown-Guedira GL (2006) Advanced backcross QTL analysis of a hard winter wheat × synthetic wheat population. Theor. Appl. Genet. **112:** 787-796

Nelson JC, Vandeynze AE, Autrique E, Sorrells ME, Lu YH, Merlino M, Atkinson M, Leroy P (1995) Molecular Mapping of Wheat - Homoeologous Group-2. Genome **38:** 516-524

Nguyen HT, Babu RC, Blum A (1997) Breeding for drought resistance in rice: Physiology and molecular genetics considerations. Crop Sci. **37:** 1426-1434

Nguyen TTT, Klueva N, Chamareck V, Aarti A, Magpantay G, Millena ACM, Pathan MS, Nguyen HT (2004) Saturation mapping of QTL regions and identification of putative candidate genes for drought tolerance in rice. Molecular Genetics and Genomics **272:** 35-46

Nicolas ME, Gleadow RM, Dalling MJ (1984) Effects of drought and high temperature on grain growth in wheat Aust. J. Plant Physiol. **11:** 553-566

Nicolas ME, Turner NC (1993) Use of chemical desiccants and senescing agents to select wheat lines maintaining stable grain size during post-anthesis drought. Field Crops Research **31:** 155-171

Nobel PS (1999) Physicochemical and environmental plant physiology. Academic Press, San Diego, USA

Nogués S, Alegre L, Araus J, Perez-Aranda L, Lannoye R (1994) Modulated chlorophyll fluorescence and photosynthetic gas exchange as rapid screening methods for drought tolerance in barley genotypes. Photosynthetica **30:** 465-474

Nyquist WE (1991) Estimation of heritability and prediction of selection response in plant populations. Critical reviews in plant sciences **10:** 235-322

O'Brien L, Moller M, Wrigley C, Appels R (2001) Genetic pool of Australian wheats. *In* AP Bonjean, WJ Angus, eds, The World wheat book : a history of wheat breeding Tec & Doc/Intercept Ltd, London pp 611-648

O'Toole JC, Cruz RT (1980) Responses of leaf water potential, stomatal resistance, and leaf rolling to water stress. Plant Physiol. **65:** 428-432

Olivares-Villegas JJ, Reynolds MP, McDonald GK (2007) Drought-adaptive attributes in the Seri/Babax hexaploid wheat population. Functional Plant Biology **34:** 189-203

Ouk M, Basnayake J, Tsubo M, Fukai S, Fischer KS, Cooper M, Nesbitt H (2006) Use of drought response index for identification of drought tolerant genotypes in rainfed lowland rice. Field Crops Research **99:** 48-58

Paillard S, Schnurbusch T, Tiwari R, Messmer M, Winzeler M, Keller B, Schachermayr G (2004) QTL analysis of resistance to Fusarium head blight in Swiss winter wheat (Triticum aestivum L.). Theor. Appl. Genet. **109:** 323-332

Paillard S, Schnurbusch T, Winzeler M, Messmer M, Sourdille P, Abderhalden O, Keller B, Schachermayr G (2003) An integrative genetic linkage map of winter wheat (Triticum aestivum L.). Theor. Appl. Genet. **107:** 1235-1242

Pantuwan G, Fukai S, Cooper M, Rajatasereekul S, O'Toole JC (2002) Yield response of rice (Oryza sativa L.) genotypes to drought under rainfed lowlands: 2. Selection of drought resistant genotypes. Field Crops Research **73:** 169-180

Passioura JB (1996) Drought and drought tolerance. Plant Growth Regulation **20:** 79-83

Passioura JB (2002) Environmental biology and crop improvement. Functional Plant Biology **29:** 537-546

Passioura JB (2006) Increasing crop productivity when water is scarce - from breeding to field management. Agricultural Water Management **80:** 176-196

Passioura JB (2006) The perils of pot experiments. Functional Plant Biology **33:** 1075-1079

Passioura JB (2007) The drought environment: physical, biological and agricultural perspectives. J. Exp. Bot. **58:** 113-117

Payne RW, D.B. Baird, M. Cherry, A.R. Gilmour, S.A. Harding, A.F. Kane, P.W. Lane, D.A. Murray, D.M. Soutar, R. Thompson, A.D. Todd, G. Tunnicliffe Wilson, R. Webster, Welham. SJ (2002) GenStat. *In*, Ed 6.1. VSN International, Wilkinson House, Jordan Hill Road, Oxford, UK

Peña RJ (2002) Wheat for bread and other foods. *In* BC Curtis, S Rajaram, HG Macpherson, eds, Bread wheat: Improvement and Production. FAO, Rome

Peng S, Garcia FV, Laza RC, Cassman KG (1993) Adjustment for specific leaf weight improves chlorophyll meter's estimate of rice leaf nitrogen concentration. Agron J **85:** 987-990

Peng J, Korol AB, Fahima T, Roder MS, Ronin YI, Li YC, Nevo E (2000) Molecular Genetic Maps in Wild Emmer Wheat, Triticum dicoccoides: Genome-Wide Coverage, Massive Negative Interference, and Putative Quasi-Linkage. Genome Res. **10:** 1509-1531

Peng J, Richards DE, Hartley NM, Murphy GP, Devos KM, Flintham JE, Beales J, Fish LJ, Worland AJ, Pelica F, Sudhakar D, Christou P, Snape JW, Gale MD, Harberd NP (1999) 'Green revolution' genes encode mutant gibberellin response modulators. Nature **400:** 256-261

Pestsova E, Ganal MW, Röder MS (2000) Isolation and mapping of microsatellite markers specific for the D genome of bread wheat. Genome **43:** 689-697

Powell JB, Schlehuber AM (1967) Components of Height Inheritance of the Semidwarf Straw Character in Wheat Triticum aestivum L. Crop Sci. **7:** 511-516

Price A, Courtois B (1999) Mapping QTLs associated with drought resistance in rice: Progress, problems and prospects. Plant Growth Regulation **29:** 123-133

Price AH, Cairns JE, Horton P, Jones HG, Griffiths H (2002) Linking drought-resistance mechanisms to drought avoidance in upland rice using a QTL approach: progress and new opportunities to integrate stomatal and mesophyll responses. J. Exp. Bot. **53:** 989-1004

Qariani L, Jaafari SE, Dekkaki M, Araus JL (2000) Cuticular conductance, water use efficiency and drought tolerance of durum wheat isolines of differing glaucousness. *In* C Royo, MM Nachit, N Di Fonzo, JL Araus, eds, Durum wheat improvement in the Mediterranean region, Zaragoza (Spain) p620

Quarrie SA, Gulli M, Calestani C, Steed A, Marmiroli N (1994) Location of a gene regulating drought-induced abscisic acid production on the long arm of chromosome 5A of wheat. Theor. Appl. Genet. **89:** 794-800

Quarrie SA, Laurie DA, Zhu J, Lebreton C, Semikhodskii A, Steed A, Witsenboer H, Calestani C (1997) QTL analysis to study the association between leaf size and abscisic acid accumulation in droughted rice leaves and comparisons across cereals. Plant Molecular Biology **35:** 155-165

Quarrie SA, Lebreton C, Gulli M, Calestani C, Marmiroli N (1994) QTL analysis of ABA production in wheat and maize and associated physiological traits. Russian Journal of Plant Physiology **41:** 565-571

Quarrie SA, Quarrie SP, Radosevic R, Rancic D, Kaminska A, Barnes JD, Leverington M, Ceoloni C, Dodig D (2006) Dissecting a wheat QTL for yield present in a range of environments: from the QTL to candidate genes. J. Exp. Bot. **57:** 2627-2637

Quarrie SA, Steed A, Calestani C, Semikhodskii A, Lebreton C, Chinoy C, Steele N, Pljevljakusic D, Waterman E, Weyen J, Schondelmaier J, Habash DZ, Farmer P, Saker L, Clarkson DT, Abugalieva A, Yessimbekova M, Turuspekov Y, Abugalieva S, Tuberosa R, Sanguineti MC, Hollington PA, Aragues R, Royo A, Dodig D (2005) A high-density genetic map of hexaploid wheat (Triticum aestivum L.) from the cross Chinese Spring x SQ1 and its use to compare QTLs for grain yield across a range of environments. Theor. Appl. Genet. **110:** 865-880

Quarrie SA, Stojanovic J, Pekic S (1999) Improving drought resistance in small-grained cereals: A case study, progress and prospects. Plant Growth Regulation **29:** 1-21

Rawson HM, Clarke JM (1988) Nocturnal transpiration in wheat. Functional Plant Biology **15:** 397-406

Ray JD, Yu L, McCouch SR, Champoux MC, Wang G, Nguyen HT (1996) Mapping quantitative trait loci associated with root penetration ability in rice (Oryza sativa L). Theor. Appl. Genet. **92:** 627-636

Rebetzke GJ, Condon AG, Richards RA, Farquhar GD (2002) Selection for reduced carbon isotope discrimination increases aerial biomass and grain yield of rainfed bread wheat. Crop Sci. **42:** 739-745

Rebetzke GJ, Richards RA (2000) Gibberellic acid-sensitive dwarfing genes reduce plant height to increase kernel number and grain yield of wheat. Aust. J. Agric. Res. **51:** 235-245

Rebetzke GJ, Richards RA, Fischer VM, Mickelson BJ (1999) Breeding long coleoptile, reduced height wheats. Euphytica **106:** 159-168

Rebetzke GJ, Van Herwaarden AF, Jenkins C, Ruuska S, Tabe L, Fettell N, Lewis D, Weiss M, Richards RA (2007) Genetic control of water-soluble carbohydrate reserves in bread wheat. *In* Developments in Plant Breeding, pp 349-356

Remington DL, Ungerer MC, Purugganan MD (2001) Map-based cloning of quantitative trait loci: progress and prospects. Genetical Research **78** 213-218

Rengasamy P (2002) Transient salinity and subsoil constraints to dryland farming in Australian sodic soils: an overview. Aust. J. Exp. Agri. **42:** 351-361

Rengasamy P, Chittleborough D, Helyar K (2003) Root-zone constraints and plant-based solutions for dryland salinity. Plant and Soil **257:** 249-260

Reynolds MP (2002) Physiological approaches to wheat breeding. *In* BC Curtis, S Rajaram, HG Macpherson, eds, Bread wheat. FAO, Rome

Reynolds MP, Mujeeb-Kazi A, Sawkins M (2005) Prospects for utilising plant-adaptive mechanisms to improve wheat and other crops in drought- and salinity-prone environments. Annals of Applied Biology **146:** 239-259

Reynolds MP, Singh RP, Ibrahim A, Ageeb OAA, Larque-Saavedra A, Quick JS (1998) Evaluating physiological traits to complement empirical selection for wheat in warm environments. Euphytica **100:** 85-94

Reynolds MP, Trethowan RM, Ginkel Mv, Rajaram S (2001) Application of physiology in wheat breeding. *In* MP Reynolds, JI Ortiz-Monasterio, A McNab, eds, Application of Physiology in Wheat Breeding. CIMMYT, pp 2-10

Reynolds MP, Tuberosa R (2008) Translational Research Impacting on Crop Productivity in Drought Prone Environments. Current Opinion in Plant Biology **11:** 171-179

Reynolds MP, van Ginkel M, Ribaut J-M (2000) Avenues for genetic modification of radiation use efficiency in wheat. J. Exp. Bot. **51:** 459-473

Ribaut J-M, William HM, M. Khairallah, Worland AJ, Hoisington D (2001) Genetic Basis of Physiological Traits. *In* MP Reynolds, JI Ortiz-Monasterio, A McNab, eds, Application of Physiology in Wheat Breeding. CIMMYT, pp 29-47

Richards RA (1989) Breeding for drought resistance - physiological approaches. *In* FwG Baker, ed, Drought resistance in cereals. CAB International, pp 65-80

Richards RA (1991) Crop improvement for temperate Australia: future opportunities. Field Crops Research **26:** 141-169

Richards RA (1992a) The effect of dwarfing genes in spring wheat in dry environments. I. Agronomic characteristics. Aust. J. Agric. Res. **43:** 517-527

Richards RA (1992b) The effect of dwarfing genes in spring wheat in dry environments. II. Growth, water use and water-use efficiency. Aust. J. Agric. Res. **43:** 529-539

Richards RA (1996) Defining selection criteria to improve yield under drought. Plant Growth Regulation **20:** 157-166

Richards RA (2004) Physiological traits used in the breeding of new cultivars for water-scarce environments. *In* T Fischer, N Turner, J Angus, L McIntyre, M Robertson, A Borrell, D Lloyd, eds, Proceedings of the 4th International Crop Science Congress, Brisbane, Australia

Richards RA (2006) Physiological traits used in the breeding of new cultivars for water-scarce environments. Agricultural Water Management **80:** 197–211

Richards RA, Condon AG, Rebetzke GJ (2001) Traits to improve yield in dry environments. *In* MP Reynolds, JI Ortiz-Monasterio, A McNab, eds, Application of Physiology in Wheat Breeding. CIMMYT, Mexico, D.F. pp. 88–100.

Richards RA, Lukacs Z (2002) Seedling vigor in wheat-sources of variation for genetic and agronomic improvement. Aust. J. Agric. Res. **53:** 41-50

Richards RA, Rawson HM, Johnson DA (1986) Glaucousness in wheat: Its development and effect on water-use efficiency gas exchange and photosynthetic tissue temperatures. Aust. J. Plant Physiol. **13:** 465-473

Richards RA, Rebetzke GJ, Condon AG, van Herwaarden AF (2002) Breeding opportunities for increasing the efficiency of water use and crop yield in temperate cereals. Crop Sci. **42:** 111-121

Richardson A, Franke R, Kerstiens G, Jarvis M, Schreiber L, Fricke W (2005) Cuticular wax deposition in growing barley (Hordeum vulgare) leaves commences in relation to the point of emergence of epidermal cells from the sheaths of older leaves. Planta **222:** 472

Rivero RM, Kojima M, Gepstein A, Sakakibara H, Mittler R, Gepstein S, Blumwald E (2007) Delayed leaf senescence induces extreme drought tolerance in a flowering plant. PNAS. **104:** 19631-19636

Robin S, Pathan MS, Courtois B, Lafitte R, Carandang S, Lanceras S, Amante M, Nguyen HT, Li Z (2003) Mapping osmotic adjustment in an advanced back-cross inbred population of rice. Theor. Appl. Genet. **107:** 1288-1296

Röder M, Huang X-Q, Börner A (2008) Fine mapping of the region on wheat chromosome 7D controlling grain weight. Functional & Integrative Genomics **8:** 79-86

Röder MS, Korzun V, Wendehake K, Plaschke J, Tixier M-H, Leroy P, Ganal MW (1998) A microsatellite map of wheat. Genetics **149:** 2007-2023

Röder MS, Plaschke J, König SU, Börner A, Sorrells ME, Tanksley SD, Ganal MW (1995) Abundance, variability and chromosomal location of microsatellites in wheat. Molecular Genetics and Genomics **246:** 327

Rodriguez D, Nuttall J, Sadras VO, Rees Hv, Armstrong R (2006) Impact of subsoil constraints on wheat yield and gross margin on fine-textured soils of the southern Victorian Mallee. Aust. J. Agric. Res. **57:** 355-365

Rogowsky PM, Guidet FLY, Langridge P, Shepherd KW, Koebner RMD (1991) Isolation and characterization of wheat-rye recombinants involving chromosome arm 1DS of wheat. Theor. Appl. Genet. **82:** 537-544

Ronin Y, Korol A, Shtemberg M, Nevo E, Soller M (2003) High-Resolution Mapping of Quantitative Trait Loci by Selective Recombinant Genotyping. Genetics **164:** 1657-1666

Rosielle AA, Hamblin J (1981) Theoretical Aspects of Selection for Yield in Stress and Non-Stress Environment. Crop Sci. **21:** 943-946

Ruuska SA, Rebetzke GJ, van Herwaarden AF, Richards RA, Fettell NA, Tabe L, Jenkins CLD (2006) Genotypic variation in water-soluble carbohydrate accumulation in wheat. Functional Plant Biology **33:** 799-809

Sadras VO, Angus JF (2006) Benchmarking water-use efficiency of rainfed wheat in dry environments. Aust. J. Agric. Res. **57:** 847-856

Saini HS, Aspinall D (1982) Sterility in wheat (Triticum aestivum L.) induced by water deficit or high temperature: Possible mediation by abscisic acid. Aust. J. Plant Physiol. **9:** 529-537

Saini HS, Westgate ME (2000) Reproductive development in grain crops during drought. Adv. Agron. **68:** 59-97

Sanchez AC, Subudhi PK, Rosenow DT, Nguyen HT (2002) Mapping QTLs associated with drought resistance in sorghum (Sorghum bicolor L. Moench). Plant Molecular Biology **48:** 713-726

Sanguineti MC, Tuberosa R, Stefanelli S, Noli E, Blake TK, Hayes PM (1994) Utilization of a recombinant inbred population to localize QTLs for abscisic-acid content in leaves of drought-stressed barley (Hordeum-Vulgare L). Russian Journal of Plant Physiology **41:** 572-576

Sax K (1923) The association of size differences with seed-coat pattern and pigmentation in *Phaseolus vulgaris*. Genetics **8:** 552-560

Sayed OH (2003) Chlorophyll fluorescence as a tool in cereal crop research. Photosynthetica **41:** 321-330

Sayre KD, Acevedo E, Austin RB (1995) Carbon isotope discrimination and grain yield for three bread wheat germplasm groups grown at different levels of water stress. Field Crops Research **41:** 45-54

Scartazza A, Lauteri M, Guido MC, Brugnoli E (1998) Carbon isotope discrimination in leaf and stem sugars, water-use efficiency and mesophyll conductance during different developmental stages in rice subjected to drought. Aust. J. Plant Physiol. **25:** 489-498

Schwinning S, Ehleringer JR (2001) Water use trade-offs and optimal adaptations to pulse-driven arid ecosystems. Journal of Ecology **89:** 464-480

Semagn K, Bjørnstad A, Skinnes H, Marøy AG, Tarkegne Y, William M (2006) Distribution of DArT, AFLP, and SSR markers in a genetic linkage map of a doubled-haploid hexaploid wheat population. Genome **49:** 545-555

Serraj R, Hash TC, Buhariwalla HK, Bidinger FR, Folkertsma RT, Chandra S, Guar PM, Kashiwagi J, Nigam SN, Rupakula A, Crouch JH (2005) Marker-assisted breeding from crop drought tolerance at ICRISAT: Achivements and

prospects. *In* R Tuberosa, RL Phillips, M Gale, eds, In the wake of the Double Helex: from the green revolution to the gene revolution. Avenue Media, Bologna, Italy

Sharp RE, Poroyko V, Hejlek LG, Spollen WG, Springer GK, Bohnert HJ, Nguyen HT (2004) Root growth maintenance during water deficits: physiology to functional genomics. J. Exp. Bot. **55:** 2343-2351

Shearman VJ, Sylvester-Bradley R, Scott RK, Foulkes MJ (2005) Physiological Processes Associated with Wheat Yield Progress in the UK. Crop Sci **45:** 175-185

Shindo C, Sasakuma T, Watanabe N, Noda K (2002) Two-gene systems of vernalization requirement and narrow-sense earliness in einkorn wheat. Genome **45:** 563-569

Shindo C, Tsujimoto H, Sasakuma T (2003) Segregation analysis of heading traits in hexaploid wheat utilizing recombinant inbred lines. Heredity **90:** 56-63

Shinozaki K, Yamaguchi-Shinozaki K (2007) Gene networks involved in drought stress response and tolerance. J. Exp. Bot. **58:** 221-227

Siddique KHM, Belford RK, Perry MW, Tennant D (1989) Growth, development and light interception of old and modern wheat cultivars in a Mediterranean-type environment. Aust. J. Agric. Res. **40:** 473-487

Simmonds J, Fish L, Leverington-Waite M, Wang Y, Howell P, Snape J (2008) Mapping of a gene (Vir) for a non-glaucous, viridescent phenotype in bread wheat derived from Triticum dicoccoides , and its association with yield variation. Euphytica **159:** 333-341

Slafer GA (2003) Genetic basis of yield as viewed from a crop physiologist's perspective. Annals of Applied Biology **142:** 117-128

Snape JW, Butterworth K, Whitechurch E, Worland AJ (2001a) Waiting for fine times: genetics of flowering time in wheat. Euphytica **119:** 185

Snape JW, Sarma R, Quarrie SA, Fish L, Galiba G, Sutka J (2001b) Mapping genes for flowering time and frost tolerance in cereals using precise genetic stocks. Euphytica **120:** 309-315

Snape JW, Foulkes MJ, Simmonds J, Michelle L, Lesley JF, Yingkun W, Matteo C (2007) Dissecting gene × environmental effects on wheat yields via QTL and physiological analysis. Euphytica **154:** 401-408

Soar CJ, Speirs J, Maffei SM, Loveys BR (2004) Gradients in stomatal conductance, xylem sap ABA and bulk leaf ABA along canes of Vitis vinifera cv. Shiraz: molecular and physiological studies investigating their source. Functional Plant Biology **31:** 659-669

Somers DJ, Isaac P, Edwards K (2004) A high-density microsatellite consensus map for bread wheat (Triticum aestivum L.). Theor. Appl. Genet. **109:** 1105-1114

Sourdille P, Singh S, Cadalen T, Brown-Guedira G, Gay G, Qi L, Gill B, Dufour P, Murigneux A, Bernard M (2004) Microsatellite-based deletion bin system for the establishment of genetic-physical map relationships in wheat (Triticum aestivum L.). Functional & Integrative Genomics **4:** 12-25

Spano G, Di Fonzo N, Perrotta C, Platani C, Ronga G, Lawlor DW, Napier JA, Shewry PR (2003) Physiological characterization of 'stay green' mutants in durum wheat. J. Exp. Bot. **54:** 1415-1420

Stam P (1993) Construction of integrated genetic linkage maps by means of a new computer package: Join Map. The Plant Journal **3:** 739-744

Stapper M, Fischer RA (1990) Genotype, sowing date and plant spacing influence on high-yielding irrigated wheat in southern New South Wales. I. Phasic development, canopy growth and spike production. Aust. J. Agric. Res. **41:** 997-1019

Steinmüller D, Tevini M (1985) Action of ultraviolet radiation (UV-B) upon cuticular waxes in some crop plants. Planta **164:** 557

Stephens DA, Fisch RD (1998) Bayesian analysis of quantitative trait locus data using reversible jump Markov Chain Monte Carlo. Biometrics **54:** 1334-1347

Swindale LD, Bidinger FR (1981) Introduction: The human consequences of drought and crop research priorities for their alleviation. *In* LG Paleg, D Aspinall, eds, The physiology and biochemistry of drought resistance in plants. Academic Press, pp 1-13

Taiz L, Zeiger E (2006) Plant Physiology. *In* 4, ed. Sinauer Associates Inc

Tambussi EA, Casadesus J, Munné-Bosch S, Araus JL (2002) Photoprotection in water-stressed plants of durum wheat (Triticum turgidum var. durum): changes in chlorophyll fluorescence, spectral signature and photosynthetic pigments. Functional Plant Biology **29:** 35-44

Tanksley SD, Young ND, Paterson AH, Bonierbale MW (1989) RFLP mapping in plant breeding: new tools for an old science. Biotechnology **7:** 257-264

Tardieu F (2005) Plant tolerance to water deficit: physical limits and possibilities for progress. Comptes Rendus Geoscience **337:** 57-67

Tardieu F (2006) Leaf ggrowth under water-limited conditions. *In* JM Ribaut, ed, Drought adaptation in cereals. Food products press, New York

Taylor DR, Ingvarsson PK (2003) Common Features of Segregation Distortion in Plants and Animals. Genetica **117:** 27-35

Teulat B, Borries C, This D (2001a) New QTLs identified for plant water status, water-soluble carbohydrate and osmotic adjustment in a barley population grown in a growth-chamber under two water regimes. Theor. Appl. Genet. **103:** 161-170

Teulat B, Merah O, This D (2001b) Carbon isotope discrimination and productivity in field-grown barley genotypes. J. Agron. Crop Sci. **187:** 33-39

Teulat B, Merah O, Sirault X, Borries C, Waugh R, This D (2002) QTLs for grain carbon isotope discrimination in field-grown barley. Theor. Appl. Genet. **106:** 118-126

Teulat B, This D, Khairallah M, Borries C, Ragot C, Sourdille P, Leroy P, Monneveux P, Charrier A (1998) Several QTLs involved in osmotic adjustment trait variation in barley (Hordeum vulgare L.). Theor. Appl. Genet. **96:** 688-698

Teulat B, Zoumarou-Wallis N, Rotter B, Ben Salem M, Bahri H, This D (2003) QTL for relative water content in field-grown barley and their stability across Mediterranean environments. Theor. Appl. Genet. **108:** 181-188

Tranquilli G, Dubcovsky J (2000) Epistatic interaction between vernalization genes Vrn-A(m)1 and Vrn-A(m)2 in diploid wheat. Journal of Heredity **91:** 304-306

Trethowan R, Pfeiffer WH (1999) Challenges and Future Strategies in Breeding Wheat for Adaptation to Drought Stressed Environments. *In* JM Ribaut, D Poland, eds, Molecular Approaches for the Genetic Improvement of Cereals for Stable Production in Water-Limited Environments. CIMMYT, pp 45-48

Tsunewaki K (1966) Comparative gene analysis of common wheat and its ancestral species. II. Waxiness, growth habit and awnedness. Japanese Journal of Botany **19:** 175-254

Tsunewaki K, Ebana K (1999) Production of near-isogenic lines of common wheat for glaucousness and genetic basis of this trait clarified by their use. Genes & Genetic Systems **74:** 33-41

Tuberosa R, Salvi S (2006) Genomics-based approaches to improve drought tolerance of crops. Trends in Plant Science **11:** 405-412

Tuberosa R, Salvi S, Sanguineti MC, Maccaferri M, Giuliani S, Landi P (2003) Searching for quantitative trait loci controlling root traits in maize: a critical appraisal. Plant and Soil **255:** 35-54

Tuberosa R, Sanguineti MC, Landi P, Michela Giuliani M, Salvi S, Conti S (2002) Identification of QTLs for root characteristics in maize grown in hydroponics and analysis of their overlap with QTLs for grain yield in the field at two water regimes. Plant Molecular Biology **48:** 697-712

Tuberosa R, Sanguineti MC, Landi P, Salvi S, Casarini E, Conti S (1998) RFLP mapping of quantitative trait loci controlling abscisic acid concentration in leaves of drought-stressed maize (Zea mays L.). Theor. Appl. Genet. **97:** 744-755

Tuinstra MR, Ejeta G, Goldsbrough P (1998) Evaluation of Near-Isogenic Sorghum Lines Contrasting for QTL Markers Associated with Drought Tolerance. Crop Sci. **38:** 835-842

Turner NC (1979) Drought resistance and adaptation to water deficits in crop plants. *In* H Mussell, R C.Staples, eds, Stress physiology in crop plants. John Wiley & Sons, New York, pp 343-372

Turner NC (1986) Adaptation to water deficits: A changing perspective. Aust. J. Plant Physiol. **13:** 175-190

Turner NC (1988) Measurement of plant water status by the pressure chamber technique. Irrigation Science **9:** 289

Turner NC (2003) Can we improve the drought tolerance of our crops? *In* Agribusiness Crop Updates,

Turner NC (2004a) Agronomic options for improving rainfall-use efficiency of crops in dryland farming systems. J. Exp. Bot. **55:** 2413-2425

Turner NC (2004b) Sustainable production of crops and pastures under drought in a Mediterranean environment. Annals of Applied Biology **144:** 139-147

van Herwaarden AF, Angus JF, Richards RA, Farquhar GD (1998) "Haying-off", the negative grain yield response of dryland wheat to nitrogen fertiliser II. Carbohydrate and protein dynamics. Aust. J. Agric. Res. **49:** 1083-1093

van Os H, Stam P, Visser RGF, Van Eck HJ (2005) RECORD: a novel method for ordering loci on a genetic linkage map. Theor. Appl. Genet. **112:** 30-40

Verma V, Foulkes MJ, Worland AJ, Sylvester-Bradley R, Caligari PDS, Snape JW (2004) Mapping quantitative trait loci for flag leaf senescence as a yield determinant in winter wheat under optimal and drought-stressed environments. Euphytica **135:** 255-263

Vile D, Garnier E, Shipley B, Laurent G, Navas M-L, Roumet C, Lavorel S, Diaz S, Hodgson JG, Lloret F, Midgley GF, Poorter H, Rutherford MC, Wilson PJ, Wright IJ (2005) Specific leaf area and dry matter content estimate thickness in laminar leaves. Annals of Botany **96:** 1129-1136

Villegas D, Garcia del Moral LF, Rharrabti Y, Martos V, Royo C (2007) Morphological Traits above the Flag Leaf Node as Indicators of Drought Susceptibility Index in Durum Wheat. J. Agron. Crop Sci. **193:** 103-116

Virgona JM, Barlow EWR (1991) Drought stress induces changes in the non-structural carbohydrate composition of wheat stems. Aust. J. Plant Physiol. **18:** 239-247

Vision TJ, Brown DG, Shmoys DB, Durrett RT, Tanksley SD (2000) Selective mapping: A strategy for optimizing the construction of high-density linkage maps. Genetics **155:** 407-420

Voorrips RE (2002) MapChart: Software for the graphical presentation of linkage maps and QTLs. Journal of Heredity **93:** 77-78

Wan X, Wan J, Jiang L, Wang J, Zhai H, Weng J, Wang H, Lei C, Wang J, Zhang X, Cheng Z, Guo X (2006) QTL analysis for rice grain length and fine mapping of an identified QTL with stable and major effects. Theor. Appl. Genet. **112:** 1258-1270

Wang S, Basten CJ, Gaffney P, Zeng. Z-B (2006) Windows QTL Cartographer. *In*, Ed 2.5

Watanabe N, Takesada N, Shibata Y, Ban T (2005) Genetic mapping of the genes for glaucous leaf and tough rachis in Aegilops tauschii, the D-genome progenitor of wheat. Euphytica **144:** 119-123

Welsh JR, Keim DL, Pirasteh B, Richards RD (1973) Genetic control of photoperiod response in wheat. *In* Proceedings of the 4th International Wheat Genetics Symposium. University of Missouri, Columbia, USA, p 879–884

Wenzl P, Carling J, Kudrna D, Jaccoud D, Huttner E, Kleinhofs A, Kilian A (2004) Diversity Arrays Technology (DArT) for whole-genome profiling of barley. PNAS **101:** 9915-9920

Westgate ME, Passioura JB, Munns R (1996) Water status and ABA content of floral organs in drought-stressed wheat. Aust. J. Plant Physiol. **23:** 763-772

Williams, Williams K, Taylor, Taylor S, Bogacki, Bogacki P, Pallotta, Pallotta M, Bariana, Bariana H, Wallwork, Wallwork H (2002) Mapping of the root lesion nematode (Pratylenchus neglectus) resistance gene Rlnn1 in wheat. Theor. Appl. Genet. **104:** 874-879

Worland AJ (1996) The influence of flowering time genes on environmental adaptability in European wheats. Euphytica **89:** 49-57

Worland AJ, Börner A, Korzun V, Li WM, Petrovíc S, Sayers EJ (1998a) The influence of photoperiod genes on the adaptability of European winter wheats. Euphytica **100:** 385-394

Worland AJ, Korzun V, Röder MS, Ganal MW, Law CN (1998b) Genetic analysis of the dwarfing gene Rht8 in wheat. Part II. The distribution and adaptive significance of allelic variants at the Rht8 locus of wheat as revealed by microsatellite screening. Theor. Appl. Genet. **96:** 1110-1120

Worland AJ, Sayers E (1996) The influence of flowering time genes on environmental adaptability in European wheats. Euphytica **89:** 49-57

Wright GC, Smith RCG, Morgan JM (1983) Differences between two grain sorghum genotypes in adaptation to drought stress. III. Physiological responses. Aust. J. Agric. Res. **34:** 637-651

Xia L, Peng KM, Yang SY, Wenzl P, de Vicente MC, Fregene M, Kilian A (2005) DArT for high-throughput genotyping of Cassava (Manihot esculenta) and its wild relatives. Theor. Appl. Genet. **110:** 1092-1098

Xu Z, Zou F, Vision TJ (2005) Improving Quantitative Trait Loci Mapping Resolution in Experimental Crosses by the Use of Genotypically Selected Samples. Genetics **170:** 401-408

Xue G-P, McIntyre CL, Jenkins CLD, Glassop D, van Herwaarden AF, Shorter R (2008) Molecular Dissection of Variation in Carbohydrate Metabolism Related to Water-Soluble Carbohydrate Accumulation in Stems of Wheat. Plant Physiol. **146:** 441-454

Yamamoto T, Kuboki Y, Lin SY, Sasaki T, Yano M (1998) Fine mapping of quantitative trait loci Hd-1, Hd-2 and Hd-3, controlling heading date of rice, as single Mendelian factors. Theor. Appl. Genet. **97:** 37-44

Yan L, Fu D, Li C, Blechl A, Tranquilli G, Bonafede M, Sanchez A, Valarik M, Yasuda S, Dubcovsky J (2006) The wheat and barley vernalization gene *VRN3* is an orthologue of *FT*. PNAS. **103:** 19581-19586

Yan L, Helguera M, Kato K, Fukuyama S, Sherman J, Dubcovsky J (2004) Allelic variation at the *VRN-1* promoter region in polyploid wheat. Theor. Appl. Genet. **109:** 1677-1686

Yan L, Loukoianov A, Tranquilli G, Helguera M, Fahima T, Dubcovsky J (2003) Positional cloning of the wheat vernalization gene *VRN1*. PNAS. **100:** 6263-6268

Yan LL, Loukoianov A, Blechl A, Tranquilli G, Ramakrishna W, SanMiguel P, Bennetzen JL, Echenique V, Dubcovsky J (2004) The wheat *VRN2* gene is a flowering repressor down-regulated by vernalization. Science **303:** 1640-1644

Yang D-L, Jing R-L, Chang X-P, Li W (2007) Identification of quantitative trait loci and environmental interactions for accumulation and remobilization of water-soluble carbohydrates in wheat (Triticum aestivum L.) stems. Genetics**:** genetics.106.068361

Yang D-L, Jing R-L, Chang X-P, Li W (2007) Quantitative trait loci mapping for chlorophyll fluorescence and associated traits in wheat (Triticum aestivum). Journal of Integrative Plant Biology **49:** 646-654

Yang J, Zhang J (2006) Grain filling of cereals under soil drying. New Phytologist **169:** 223-236

Yang J, Zhu J, Williams RW (2007) Mapping the genetic architecture of complex traits in experimental populations. Bioinformatics**:** btm143

Yang RC, Jana S, Clarke JM (1991) Phenotypic diversity and associations of some potentially drought-responsive characters in durum-wheat. Crop Sci. **31:** 1484-1491

Yemm EW, Willis AJ (1954) The estimation of carbohydrates in plant extracts by anthrone. Biochem J. **57:** 508-514

Yong W, Xu Y, Xu W, Wang X, Li N, Wu J, Liang T, Chong K, Xu Z, Tan K, Zhu Z (2003) Vernalization-induced flowering in wheat is mediated by a lectin-like gene *VER2*. Planta **217:** 261

Yoshida S, Hasegawa S (1982) The rice root system: its development and function. *In* Drought Resistance in Rice. JRRJ, Los Banos, Laguna, Philippines, pp 97-l 14

Yue B, Xiong L, Xue W, Xing Y, Luo L, Xu C (2005) Genetic analysis for drought resistance of rice at reproductive stage in field with different types of soil. Theor. Appl. Genet. **111:** 1127-1136

Yue B, Xue W, Xiong L, Yu X, Luo L, Cui K, Jin D, Xing Y, Zhang Q (2006) Genetic basis of drought resistance at reproductive stage in rice: Separation of drought tolerance from drought avoidance. Genetics **172:** 1213-1228

Zadoks J, Chang T, Konzak C (1974) A decimal code for the growth stages of cereals. Weed Res. **14:** 415-421

Zaharieva M, Gaulin E, Havaux M, Acevedo E, Monneveux P (2001) Drought and heat responses in the wild wheat relative Aegilops geniculata Roth: Potential interest for wheat improvement. Crop Sci. **41:** 1321-1329

Zamski E, Grunberger Y (1995) Short- and Long-eared High-yielding Hexaploid Wheat Cultivars: which has Unexpressed Potential for Higher Yield? Annals of Botany **75:** 501-506

Zeegers M, Rijsdijk F, Sham P (2004) Adjusting for covariates in variance components QTL linkage analysis. Behavior Genetics **34:** 127-133

Zeng ZB, Kao C-H, Basten CJ (1999) Estimating the genetic architecture of quantitative traits. Genetical Research **74:** 279-289

Zeng ZB (1993) Theoretical basis for separation of multiple linked gene effects in mapping Quantitative Trait Loci. PNAS. **90:** 10972-10976

Zeng ZB (1994) Precision mapping of Quantitative Trait Loci. Genetics **136:** 1457-1468

Zhang J, Nguyen HT, Blum A (1999) Genetic analysis of osmotic adjustment in crop plants. J. Exp. Bot. **50:** 291-302

Zhang J, Schurr U, Davies WJ (1987) Control of stomatal behaviour by abscisic acid which apparently originates in the roots. J. Exp. Bot. **38:** 1174-1181

Zhang JY, Broeckling CD, Blancaflor EB, Sledge MK, Sumner LW, Wang ZY (2005) Overexpression of WXP1, a putative Medicago truncatula AP2 domain-containing transcription factor gene, increases cuticular wax accumulation and enhances drought tolerance in transgenic alfalfa (Medicago sativa). Plant Journal **42:** 689-707

Zubaidi A, McDonald GK, Hollamby GJ (1999) Shoot growth, root growth and grain yield of bread and durum wheat in South Australia. Aust. J. Exp. Agri. **39:** 709-720