GENETIC LINKAGES

Unless otherwise indicated, estimates are for *T. aestivum*, *T. turgidum* {**tv**:} and *T. monococcum* {**dv**:}. All genetic recombination values and standard errors {S.E.} from the literature are presented as percentages with references. Where values were converted to map units by authors these values, S.E.s and references appear in appropriate columns. Recombination values of 15% or greater were converted to map units using the Kosambi function:

$$X=25 \log_e [(1+2y)/(1-2y)]$$

where X is the map distance in centimorgans {cM} and y is the recombination fraction. This function has little effect on values of less than 15%. Obviously, high values with large S.E.s should be treated with caution.

The S.E. for X was computed from the formula:

$$S.E._X = 100\ S.E._y/(1-2y^2).$$

As far as possible genes are listed in order from the distal end of the short (S) arm to the distal end of the long (L) arm. Close linkages are listed under m: in the gene lists.

I = genetically independent; cent = centromere.B56

Genes				% Recombination			cM		
				Value	S.E	Ref	Value	S.E.	Ref
Chromosome 1									
1AS									
	Rg3	-	*Hg*	0		{1406}			
tv:	*Hg*	-	*Bg*	1.17	1.4	{1103}			
	Hg	-	*Bg*	1.52	1.88	{1103}			
	Hg	-	*Bg*	1.32	1.15	{1103}			
tv:	*Hg*	-	*Bg*	2.4		{1519}			
	Hg	-	*Bg*	0		{631}			
	Hg	-	*Bg*	12.33	2.16	{1347}			
dv:	*Hg*	-	*Bg*	0-16.5		{1393}	0-17.4		
	Hg	-	*Pm3a*	4.81	0.52	{943}			
	Hg	-	*Pm3a*	0.82		{134}			
	Hg	-	*Gli-A1*	3.95	1.38	{559}			
	Hg	-	*Gli-A1*	0.30	0.31	{1406}			
	Hg	-	*Gli-A1*	0.79	0.81	{897}			
	Hg	-	*Gli-A1*	2.24	1.31	{1406}			
	Hg	-	*Gli-A1*	2.64	0.98	{1405}			
	Hg	-	*Gli-A1*	3.8	1	{1405}			
	Gli-A3	-	*Gli-A1*	25.17	4.27	{1406}			
	Gli-A3	-	*Gli-A1*	3.8	1	{009}			
tv:	*Hg*	-	*Gli-A1*	3.06	1.4	{1103}			
	Hg	-	*Gli-A1*	2.97	1.64	{1103}			
	Hg	-	*Gli-A1*	2.31	1.31	{1103}			
	Hg	-	*Gli-A1*	2.97	0.84	{1103}			
	Hg	-	*Lr10*	5.97	1.7	{559}			
	Hg	-	*Tin*	10	3	{1212}			
	Hg	-	*cent*	I		{947}			
	Rg3	-	*Hg*	0		{1406}			
	Pm3a	-	*Pm25*	21		{1343}			
	Pm3a	-	*cent*	I		{947}			
	Pm3a	-	*Glu-A1*	I		{1406}			
	H5	-	*H11*				4.4	1.8	{1422,1222}

	Gli-A1	-	*Gli-A5*			1.94	0.01	{350}
tv:	*Gli-A1*	-	*Bg*	<2.33	{1103}			
	Gli-A1	-	*Glu-A1*	42	{882}	61.1		
	Gli-A1	-	*Lr10*	2.95	1.18	{559}		
	Gli-A1	-	*Gli-A3*	31.9	2.27	{1407}	37.7	3.8
	Gli-A1	-	*Gli-A3*	22.73	4.07	{1406}		
	Gli-A1		*Gli-A3*			22.42	3.61	{1075}
	Gli-A1	-	*Glu-A3*			1.5	0.3	{1227}
	Gli-A1	-	*Tri-A1*	40.1	2.9	{1357}	55.2	8.1	{1358}
	Gli-A1	-	*Glu-A1*	I				
	Gli-A3	-	*Glu-A1*	27.3	2.7	{1407}	30.6	3.9	
	Gli-A3	-	*Glu-A1*	37.55	5.05	{1406}		
	Tri-A1	-	*cent*	11	1.8	{1355}		
	Tri-A2	-	*cent*	11	2	{1358}		
1AL								
	cent	-	*Glu-A1*			7.7	1.8	{1125}
	cent	-	*Glu-A2*			33.9	5.4	{1359}
	cent	-	*Glu-A3*			10.2	3.5	{1359}

<u>Chromosome 1B</u>

1BS								
	Yr10	-	*Gli-B1*	5	2.2	{1121}		
	Yr10	-	*Glu-B1*	47	5	{1121}		
	Rg1	-	*Yr10*	2	0.3	{1002}		
	Rg1	-	*Bt4*	23		{1005}	24.9	
	Rg1	-	*Bt4*	14		{1000}		
	Rg1	-	*Gli-B1*	close		{504}		
	Rg1	-	*Gli-B1*	1.8	0.8	{1121}		
	Rg1	-	*Gli-B1*	2.84	1.39	{1405}		
	Rg1	-	*Gli-B1*	4.05	1.52	{1405}		
	Rg1	-	*Gli-B1*	0		{1405}		
	Rg1	-	*Sr14*	I		{933}		
	Rg1	-	*Bt5*	I		{1000}		
	Rg1	-	*Glu-B1*	44.3	3.1	{1121}		
tv:	*Rg1*	-	Gli band 42	7.87	2.39	{792}		
	Glu-B3	-	*Gli-B1*	1.7	0.8	{1358}		
tv:	*Glu-B3*	-	Gli band 45	10.32	2.44	{792}		
	Glu-B3	-	*Gli-B1*	2.8	1.3	{9922}		
	Glu-B3	-	*Gli-B5*	8.9	2.2	{9922}		
tv:	*Gli band 42*	-	Gli band 45	nil		{792}		
tv:	*Rg 1*	-	band 42/45	8.7	1.2	{500}		
	Rg1	-	(*Gli-B1)*	2	0.6	{500}		
tv:	*Rg 1*	-	*Gli-B1*	6.44	1.71	{1103}		
	Gli-B1	-	*Glu-B3*	1.7		{1355}		
tv:	*Gli-B1*	-	*Glu-B3*	2		{1144}		
	Gli-B1	-	*Gli-B5*	3.5	1.4	{9922}		
	Gli-B1	-	*Gli-B3*			22.4	6.3	{589}
	Gli-B1	-	*Gli-B3*			21.72	2.16	{1315}
	Gli-B1	-	*Gli-B3 (=Gli 1)*	25.5	4.3	{422}	28.1	5.8	{422}
	Gli-B1	-	*rf3*	22.1	6.4	{1399}	23.7	8	
	Gli-B1	-	*rf3*	18.6		{9934}		
	Gli-B1	-	*Nor-B1*	36.8	13.5	{1399}	47.1	29.5	
	Gli-B1	-	*Xgwm11/Xgwm*	20.7		{0321}		
	Gli-B1	-	cent				59.7	7.1	{1358}
	Gli-B1	-	cent				56.1	10.3	{1358}
	Gli-B1	-	cent	I		{223}		
tv:	*Gli-B1*	-	cent				46.4		{224}
	Gli-B1	-	*Glu-B1*	42	4.9	{1121}		

	Gli-B1	-	*Glu-B1*	42.5	3	{1121}	62.8	10.8	
	Gli-B1	-	*Glu-B1*	41		{882}	57.8		
	Gli-B1	-	*Glu-B1*				39.1		{589}
	Gli-B1	-	*Glu-B1*				66	5.7	{1125}
	Gli-B1	-	*Glu-B1*	37.5	1.9	{422}	48.6	4.3	{422}
	Gli-B1	-	*Glu-B1*	30.8	7.4	{1399}	35.9	11.9	
	Gli-B1	-	*Glu-B1*	I		{422}	53.6	7.9	{422}
	XGli-B3	-	*Glu-B2*				0		{277}
	Gli-B3	-	*Glu-B1*				16.7	5.2	{589}
	Gli-B3	-	*Glu-B1*				22.4	6.3	{589}
	Gli-B3	-	*Glu-B1*	23.5	4.2	{422}	25.5	5.4	{422}
	Glu-B3	-	*Glu-B1*	35.4	4.8	{1358}	44.2	9.6	
	Glu-B3	-	*Glu-B1*	29.9	6	{458}			
	rf3	-	*Nor-B1*	22.6	9.2	{1399}	24.4	11.6	
	rf3	-	*Glu-B1*	34.1	8.5	{1399}	41.6	15.9	
	Nor-B1	-	*Glu-B1*	22.5	9.3	{1399}	24.2	11.7	
	Nor-B1	-	*Glu-B1*				22		{1120}
	Nor-B1	-	*Rf3*	22.3		{9934}			
	Bt4	-	*Bt5*	30		{1000}	34.7		
	Bt4	-	*Bt6*	15.2	1.6	{1274}	15.7	1	
	Lr26	-	*Lr3*	2.6	0.8	{325}			
tv:	*Yr10*	-	*Yr15*				34.0	2	{969}
	Yr15	-	cent				7		{969}

Probable gene order: *Nor-B1* - *Gli-B3* - *Glu-B1* {589}.
Gene order: *Nor-B1* - *Hk-B1* - *Per-B1* - cent {012}.

Rg1 and *Gli-B1* are located on the satellite {1120}
Gene order: *Yr10/Rg1* - *Gli-B1* - *Rf3* - *Gli-B3* - *Nor-B1* - cent - *Glu-B1{* 1121}.

1BL

	cent	-	*Sr14*	0		{933}			
	cent	-	*Lr33*				3.1	1.2	{325}
	cent	-	*Glu-B1*				10.2	2.4	{1125}
	Lr33	-	*Lr44*	5.4	1.1	{322}			
tv:	cent	-	*Glu-B1*	32.6		{224}	38.9		
	cent	-	*Glu-B1*	28.1	2.8	{1359}	31.8	4.1	
	cent	-	*Glu-B1*	14.1		{223}			
	Cent - *Lr51*	-	*Glu-B1*	0.41		{0307}	50-86		{0308}

<u>Chromosome 1D</u>

1DS

Gli-D1	-	*Gpi-D1*	36.2	4.5	{196}	45.8	9.5	
Gli-D1	-	*Tri-D1*	36.5	3.6	{1357}	46.4	7.7	
Gli-D1	-	*Tri-D1*	56	7	{478}			
Gli-D1	-	*Tri-D1*	I		{477}			
Gli-D1	-	cent	I		{477}			
Gli-D1	-	*Glu-D1*				63.5		{754}
Gli-D1	-	*Glu-D1*	48.3	2.4	{196}			
Gli-D1	-	*Glu-D1*	42		{882}	61.1		
Gli-D1	-	*Sr33*	5.6	2.4	{620}			
Gli-D1	-	*Sr33*	7.6	2.8	{620}			
Gli-D1	-	cent	37.3	5.1	{620}			
Gli-D1	-	*Glu-D1*	44.3	5.2	{620}			
Gli-D1	-	*Glu-D1*	47.2	5.2	{620}			
Gli-D1/Glu-D3	-	*Tri-D1*	55.8	7.4	{1358}			
Sr45	-	Cent.	21	3.4	{894}			
Sr45	-	*Sr33*				9	1.9	{894}

Most likely order: Cent - *Sr45* - *Sr33* - *Lr21* {894}.

Tri-D1	-	cent				15.4	2.1	{1358}
Tri-D1	-	cent	14.1	2.5	{477}			
Gpi-D1	-	*Glu-D1*	34.5	4.4	{196}	42.4	8.6	
Tri-D1	-	cent	10.1	2.2	{1355}			
Sr33	-	cent	29.6	4.8	{620}			
Sr33	-	*Glu-D1*	40.9	5.2	{620}			
Sr33	-	*Glu-D1*	39.5	5.1	{620}			

Gene order: *Gli-D1* - *Gpi-D1* - *Per-D1* - *Tri-D1* {709}. Last 3 agree with {012} for 1B.

Sr33	-	*Gli-D1*				9	3.2	{226}
Lr21	-	*Gli-D1*				5.6	2.7	{619}
Lr21	-	*Gli-D1*	18		{448}			
Lr21	-	*Rg2*				4.2	2.4	{619}
Lr21	-	*Glu-D1*	I		{619}			
Lr21	-	*Lr42*	28.6	2.3	{218}	32.5	3.4	
Lr21	-	*Lr41*	I		{218}			
Rg2	-	*Gli-D1*				1.4	1.4	{619}
Rg2	-	*Glu-D1*	I		{619}			
Gli-D1	-	*Glu-D1*	I		{619}			
Pm22	-	*Pm24*	I		{0150}			

Gene order: *Gli-D1* - *Rg2* - *Lr21* {619}.

1DL

cent	-	*Sr18*	1.2	0.8	{1175}	10.2	2.4	{1125}
cent	-	*Glu-D1*				30.9	2.7	{1359}
cent	-	*Glu-D1*				22	3.5	{1359}
cent	-	*Glu-D1*				7.7	9.7	{754}
cent	-	*Glu-D1*	16.5	3.8	{620}			
Rg2	-	*Lr21*	10.1	2.2	{1241}			
Rg2	-	*Lr21*	3.1	1.1	{1241}			
Rg2	-	*Lr21*	1.7	1	{1241}			
Rg2	-	*Sr33*	35	5.2	{650}	43.4	10.2	
Rg2	-	*Sr33*						

1D *Rg2* - *Sr33*

Lr41	-	*Lr24*	I		{218}			

<u>Chromosome 1R</u>

1RS

Tel (C-band)	-	*SrR*				16	4.8	{9919}
Sec 1	-	Cent				26.1	4.3	{9919}
Sec 1	-	*Sec 3*	36.0	4.6	{779}	45.4	9.6	
Sec 1	-	*Sec 3*	40.8	3.76	{1336}	57.2	11.3	
Sec 1	-	*Sec 3*	36.0	4.12	{163}	45.4	8.6	
Dn7	-	*Lr26*				14.5	3.9	{894}
Dn7	-	*Lr26*						
Sr31/Lr26/Yr9	-	Sec1				5.4	1.7	{9919}

1RL

cent	-	*Glu-R1*				4.7	1.0	{1356}

<u>Chromosome 2A</u>

2AS

bh	-	cent				8.5	2.1	{665}
Lr17a	-	cent	I		{314}			
Lr17a	-	*Lr11*	I		{314}			

Sr38, *Lr37* and *Yr17* were closely linked in coupling and showed close repulsion linkage with *Lr17a* {062}.

2AL

cent	-	*Sr21*	2.4	0.9	{1464}			
cent	-	*Pm4b*	I		{1464}			
Sr21	-	*Pm4b*	37.5	1.7	{1464}	48.6	3.9	
Yr1	-	*Pm4a*				2	0.6	{940}

<u>Chromosome 2B</u>

2BS

Lr16	-	*Sr23*	< 0.7		{950}			
Lr16	-	*Sr36*	I		{939}			
Lr16	-	*Sr40*	34.4	4.1	{302}	42.2	7.8	
W1I	-	cent	42-50		{267}	>61.6		
Ne2	-	cent	9.4	1.5	{1085}			
Ne2	-	*D2*	34		{536}	41.5		
Sr40	-	*Sr36*	21.9	2.4	{302}	23.5	3	
Sr40	-	*Lr13*	1	0.6	{302}			
Sr40	-	*Lr23*	4.7	1.2	{302}			
Sr40	-	*Sr9*	28	3.3	{302}	31.6	4.8	
Sr19	-	cent	7.7		{1582}			
Lr23	-	*Lr13*	close		{939}			
Lr23	-	cent	4		{948}			
Lr23	-	cent				20		{1058}
Lr23	-	*Sr9b*	22	2	{948}	23.6	2.5	
Lr23	-	*Sr9b*	22.3	2.4	{932}	24	3	
Lr23	-	*Sr9b*	24.1	2.2	{932}	26.3	2.9	
Lr23	-	*Sr9b*	30.6	4.2	{965}	35.6	6.7	
Lr23	-	*Sr28*	28.5	2.8	{932}	32.4	4.1	
Lr23/Sr36	-	*Sr9b/Sr9e*	19.6	1.9	{951}	20.7	2.2	
Lr13	-	*Sr9b*	17.6	3.1	{1370}	18.4	3.5	
Lr13	-	*Lr39*	I		{647}			
Sr36	-	*Sr9d*	24	8	{827}	26.1	10.4	
ppd2	-	*Sr9g*	I		{1269}			
ppd2	-	*Dfq1*	I		{789}			
Hst2a-B1	-	cent				20		{909}

2BL

cent	-	*Sr9a*	10.6		{1307}			
cent	-	*Sr9b*	18.2	6.7	{944}	19.1	7.7	
cent	-	*Yr5*				21		{034}
cent	-	*Dfq1*				30		{789}
cent	-	*Sr28*	34.6	2.8	{932}	42.6	5.4	
cent	-	*D2*	48.5		{944}			
cent	-	*Sr16*	I		{932,1307}			
Sr9g/Yr7	-	*Dfq1*				6		{789}
Sr9a	-	*Sr19*	24	3	{636}	26.2	3.9	
Sr9a	-	*Sr19*	24.5	3.2	{1582}	26.8	4.2	
Sr9a	-	*Sr16*	I		{830}			
Sr9b	-	*Sr28*	16.8	2.1	{932}	17.5	2.4	
Sr9b	-	*D2*	42.2		{944}	61.1		
Sr9b	-	*Sr16*	I		{932}			
Sr9g	-	*Yr7*	<1.6		{965}			
Sr9g	-	*Sr16*	35.4	2.3	{965}	44.2	4.6	
Yr7	-	*Yr5*	allelic		{034}			
Yr7	-	*Yr5*	not allelic		{605}			
Dfq1	-	*Sr16*	I		{789}			
Sr20	-	*Sr19*	I		{029}			

Sr20	-	*Sr16*	I		{029}		
Sr28	-	Sr16	29.2	4.2	{932}	33.4	6.4
Sr28	-	Sr16	38.2	1.9	{932}	50.3	4.6

2B

Sr39	-	*Lr35*	3	1.1	{651}		
Sr39	-	*Sr32*	I		{647}		
Sr39	-	*Lr13*	I		{647}		

<u>Chromosome 2D</u>

2DS

Lr22a	-	cent	63.6	4.8	{1241}		
Lr22a	-	*Tg*	33	4	{1240}	39.7	7.1
Lr22	-	*Tg*	41.6	4.4	{1240}	59.7	14.3
Lr22	-	*Tg*	20.8	3.6	{1241}	22.1	4.4
Lr22	-	*Tg*	6	1.5	{311}		
Lr22b	-	*W2I*	10.6	2.9	{298}		
Lr22b	-	*W2I*	18.3	2.9	{1240}	19.2	3.3
Lr22b	-	*W2I*	41.6	4.4	{1240}	59.7	14.3
Lr22b	-	*W2I*	15.6	2.5	{311}	16.1	2.8
Lr22b	-	*Tg*	11.6	3.1	{298}		
W2I	-	cent	52.5	5	{1241}		
W2I	-	cent	58.9	4.6	{1241}		
W2I	-	*Tg*	21.9	4.2	{298}	23.5	5.2
W2I	-	*Tg*	22.3	3.9	{1240}	24	4.9
W2I	-	*Tg*	28.2	2.7	{1240}	31.9	4
W2I	-	*Tg*	21.6	2.7	{1240}	23	3.3
W2I	-	*Tg*	20.8	3.6	{1241}	22.1	4.4
W2I	-	*Tg*	15.1	2.6	{648}		
Tg	-	cent	39.4	4.9	{1241}	53.3	12.9
Tg	-	cent	42.9	4.6	{1241}	64.3	17.4
Tg	-	cent	38.7	4	{652}	51.5	10
Tg	-	cent	45	4.7	{652}		
Lr15	-	cent	32	5.1	{942}	37.9	8.6
Lr15	-	*Lr2a*	allelic		{939,942}		
Lr15	-	*Sr6*	0.75	0.34	{942}		
Lr2a	-	*C*	10	1.2	{843}		
Lr2a	-	*Sr6*	1.16	0.82	{942}		
Sr6	-	*C*	33.1, 18.9		{436}	39.8,19.9	9.9
Sr6	-	*C*	18.1		{671}	19	
Sr6	-	cent	28.7	4.8	{942}	32.7	7.2
Sr6	-	cent	15.5	3.6	{942}	16	4
Sr6	-	cent	33.1		{436}	39.8	
Sr6	-	cent	18.9		{436}	19.9	
Sr6	-	cent	18.1		{671}	18.8	
Sr6	-	cent	18.69	2.36	{942}	19.6	2.7
Sr6	-	*Ra*	0		{1645}		
D1	-	cent	3.2	2.4	{942}		

Gene order: *Tg* - *W2I* - *Lr22* {1240}; *Tg* - *Lr22* - *W2I* {311}. The *D1* - cent linkage was not supported by other genetic data {1000}.

2DL

cent	-	C	2.26		{1192}		
C	-	*D1*	36.7		{1000}	46.9	
C	-	*D4*	I		[1000}		
Rht8	-	*Ppd1*	17	4.9	{1598}	17.7	4.5
Rht8	-	*Ppd1*	25		{1601}	27.5	
Rht8	-	*Ppd1*	16.6		{1601}		17.3

Rht8	-	*Yr16*	44	5	{1598}	68.8	22.2	
Rht8	-	*Yr16*	38		{1601}	49.8		
Rht8	-	*Ppdl*				20.9		{00106}
Rht8	-	*D4*	I		{1598}			
Ppd1	-	*Yr16*	36	5	{1598}	45.4	10.4	
Ppd1	-	*D4*	I		{1598}			
Yr16	-	*D4*	25	1	{1598}	27.5	1.3	
Yr16	-	*D54*	26	8	{1598}	28.8	11	
D4	-	*Su-D*	I		{1598}			

C gave no recombination with the centromere in tests involving either arm {939}. Probable gene order: Rht8 - Ppd1 - Yr16 - D4/Su-D.

Chromosome 3A

3AS

3AL

cent	-	*Sr35*	34	4	{957}	41.5	7.4	
Br2	-	*R-Alb*				44.2		{0130}
Sr35	-	*R2*	1	1	{957}			

Chromosome 3B

3BS

Lr27	-	cent	33.6	4.1	{1367}	40.7	7.5	
Lr27	-	cent	I		{1367}			
Lr27	-	*Sr12*	I		{1372}			
vla	-	cent	0.28		{1297}			
Sr12	-	cent	0		{968}			

3BL

Br3	-	*R-Blb*				47		{0130}

Chromosome 3D

3DS

Lr32	-	cent	26.8	4	{645}	29.9	5.6	
s1	-	cent	5.7		{1194}			

3DL

cent	-	*Got-D3*	4.3		{521}			
cent	-	*S1*	5	2	{692}			
cent	-	*Ch2*	36.1	4	{692}	45.6	8.4	
cent	-	*R-Alb*	I		{1193}			

In Agent and Sears' translocations 3*Ag#1* and 3*Ag#2, Lr24, Sr24* and red grain colour assumed to be determined by RAg, are completely linked. In translocations 3Ag#3 and 3Ag#14, R1 recombined with Lr24/Sr24 {930} with linkage of about 20% {939}. This led to the release of white seeded *R-Dlb* derivatives in Australia.

Chromosome 4A

4AS

Adh-B1	-	cent	20	3.5	{1197}	21.2	4.2	
Hd	-	cent	7.7	3.7	{1195}			

4AL

cent	-	*Lr30*	2.9	1.3	{315}			
cent	-	*Lr28*	39.2	2.7	{967}	52.8	7	
Sr7a	-	*Hd*	I		{671}			

Chromosome 4B

4BS

ms1b	-	cent	I		{064}			
ms1b	-	*Lr25*	34		{064}	41.5		
ms1c	-	cent	I		{064}			
ms1c	-	*Lr25*	20		{064}	21		
Adh-Ala	-	*Gai/Rht-B1*	23.1	4.0	{1442}	25.0	5.1	
Gai1	-	*Gai3*	0		{406}			
Rht-B1/Gai1	-	cent	15	3	{698}			
Rht-B1	-	*b-Amy-B1*	I		{008}			
b-Amy-B1	-	cent	>35		{008}	43.4		
pa	-	*Hl*				29	2.6	{921}
pa	-	*Hl*				30		{042}

Gene order: *Adh* - *Rht-B1* - cent {1442}.

4BL

cent	-	*Lr25/Pm7*	1		{271}			
cent	-	*Hp*		30	{275}	34.7		
cent	-	*b-Amy-B1*	35		{008}	43		
Lr25	-	*Pm7*		0	{271}			
Rht-B1	-	*b-Amy-B1*	I		{008}			

Chromosome 4D

4DS

ms4	-	cent	I		{0293}			
Ms2	-	*Rht-D1c*	0.005		{805}			
Ms2	-	cent	31.2		{807,806}	36.5		
Rht-D1/Gai2	-	cent	13	4	{698}			

According to {805}, *Ms2* and *Rht-D1c* were closely linked. However, a translocated recombinant male sterile dwarf was isolated.
Gibberellic insensitivity in Ai-Bian 1 possessing *Rht-DIC* was allelic with *Rht-D* 1{ 114}.

4DL

Rht2	-	*b-Amy-D1*	I		{008}			
cent	-	*b-Amy-D1*	>35		{008}	>43.4		
Alt2	-	*Kna1*				12.5		{848}

Chromosome 5A

5AS

Ms3	-	cent	3.1		{622}			

5AL

cent	-	*a -Amy-A1*				3.8		{1081}
cent	-	*a-Amy-A1*				8		{599}
B1	-	*Rht12*		<2.5	{1605}			
B1	-	*Xpsr164-5A*				57		{9903}
cent	-	*Vrn-A1*	I		{775}			
cent	-	*q*	I		{1196}			
Kr2	-	*Vrn-A1*	4.8	4.66	{1387}			
Kr2	-	*q*	38.1	10.6	{1387}	50	25.3	
Vrn-A1	-	*q*				34		{1400}
Vrn-A1	-	*B1*				31	3.3	{925}
Vrn-A1	-	*B1*				45	4.1	{925}
Vrn-A1	-	*B1*				47	4.4	{925}
Vrn-A1	-	*B1*				50	4.3	{925}
Vrn-A1	-	*b-Amy-A1*	37		{008}		47.5	

q (S)	-	*Hn*	36.2			45.8		
q	-	*B1* (n)	30		{913}	34.7		
q (S)	-	*B1* (N)	32.7		{1136}	39		
q (S)	-	*B1* (B)	37.3		{193}	48.2		
q (K)	-	*B1*	41		{1550}	57.8		
q	-	*B1*				25		{1400}
Hn	-	*B1*	5		{396}			
Hn	-	close			{837}			
B1	-	*b-Amy-A1*	2.3	2.3	{008}			
B1	-	*Ibf-A1*	0		{1605}			

Gene order: *b-Amy-A1 - B1 - Hn - Q - Vrn-A1 - Kr2* {008,1387,1400}.
: cent - *Vrn-A1 - Q - B1* {9903}.

Chromosome 5A

H3	-	*H6*	9		{1105}			
H3	-	*H9*	15.5	4.8	{1420}	16	5.3	
H6	-	*H9*	2	2.01	{1421}			
H9	-	*H10*	36		{162}	45.4		
	-		I		{1421}			
H9	-	*H15*	close		{625}			
H28	-	*H9*				22		{171}
H10	-	*H14*	I		{625}			
H10	-	*H17*				20		{1098}
H16	-	*H12*				25		{1098}
H16	-	*H29*	close		{1097}			
H17	-	*H16*				25		{1098}

Gene order: *H3 - H6 - H9* .
Gene order: *H9/H15 - H17 - H16 - H12* {1098}

Chromosome 5B

5BS

5BL

cent	-	*Ne1*				6		{1021}
cent	-	*Ne1*				10.5	2	{1085}
Ne1	-	*Vg*				11		{1021}
Vg	-	*Ibf-B1*				35		{1021}
cent	-	*Kr1*	11.5	3	{762}			
cent	-	*Kr1*	44.8	3.3	{1387}	72.6	16.6	
cent	-	*Crr*	42.9	3.4	{765}	64.3	12.9	
cent	-	*Crr*	36.1	3.3	{765}	45.6	6.9	
cent	-	*Ph1*	50.7	4.1	{1537}			
cent	-	*Lr18*	I		{939,935}			
Xbcd103	-	*tsn1*				5.7		{346}
tsn1	-	*Xwg583*				16.5		{346}

Chromosome 5D

5DS

Pm2	-	*Lr1*	I		{945}			
Pm2	-	*Sr30*	I		{688}			

5DL

cent	-	*Lr1*	36.7	5.3	{688}	46.9	11.5	
cent	-	*Lr1*	I		{945}			
cent	-	*Sr30*	I		{688}			
cent	-	*Vrn3*	I		{775}			
Lr1	-	*Sr30*	I		{688}			

Chromosome 6A

6AS

	Xbcd342-6U	-	*(Rf6)* cent				31.4	{865}
	Sr8a	-	cent	44	5	{929}		
	Sr8a	-	*Sr13*	I		{929}		
	Bza3-A1	-	cent				30	{909}
	Gli-A2	-	cent				26.2	{599}

6AL

	cent	-	*Sr26*	0		{1154}		
	cent	-	*Ep-A1*				1	{599}
	cent	-	*Sr13*	I		{929}		

Chromosome 6B

	Amp-B2	-	*B2*		0.9	{0176}		
	Amp-B2	-	*B2*		2.1	{0176}		

6BS

	telomere	-	*Lr36*	<9.9		{292}		
	Lr36	-	cent				46.3	4 {292}
	Lr36	-	cent				26	7.9 {292}
	Amp-B1	-	cent	<0.6		{1244}		
	co	-	cent	I		{1304}		
	Gli-B2	-	*C* band				10.2	4.3 {289}
	Gli-B2	-	*Nor-B2*	16.7		{289}	17.4	
	Gli-B2	-	cent				20	5.3 {289}
	C band	-	cent				12.2	4.6 {289}
	Nor-B2	-	cent				<6.1	{289}
	Nor-B2	-	cent				4.1	{599}
	Lr9	-	cent	0		{1299}		
	Pm11	-	cent				1	{1480}
	Pm12	-	*a -Amy-S1*				1.1	{598}
	XCxp3-6B	-	cent				30.1	{599}
	Ep-B2	-	cent				33.1	{599}
tv:	*Nor-B2*	-	*Xpsr312*				24.8	{799,735}
tv:	*Xpsr312-6B*	-	*Su1*				5.5	{735}
tv:	*Su1*	-	*a -Amy-1*	9			84	{735}
	Su1	-	*Xpsr141(Pgk-2)*				6.8	{799}
	Su1	-	*Xpsr312*				5.3	{799}

Lr36 is distal to *Gli-B2* {292}.

6BL

	cent	-	*a -Amy-B1*	13.8	2.6	{1083}		
	cent	-	*a -Amy-B1*				4.5	{598}
	cent	-	*a-Amy-B3*	5.5	1.7	{1083}		
	a-Amy-B1	-	*a-Amy-B3*	9.3	2.2	{1083}		
tv:	*a-Amy-B1*	-	*a-Amy-B5*	<1.0		{1083}		
tv:	*a-Amy-B1*	-	*a-Amy-B4*	22.3	3.5	{1083}		
tv:	cent	-	*a-Amy-B5*	2.1	1.1	{1083}		
tv:	cent	-	*a-Amy-B1*	13.2	3.5	{1083}		
tv:	cent	-	*a-Amy-B4*	26.1	5	{1083}		
	X-Amy-1	-	*Xpsr149*	4.2	2.9	{663}		
	cent	-	*a-Amy-B3*				5.5	{1081}
	cent	-	*a-Amy-B1*				13.8	{1081}
	cent	-	*a-Amy-B1*				4.5	{599}
	cent	-	*B2*	0.44		{1297}		

	cent	-	*B3*	0.87		{394}			
	cent	-	*a -Amy-B1*	19.4	3.8	{398}	20		
	Xcdo772 /cent	-	*Xbcd1-6B*				41.2 cM		{9921}
	Xbcd-6B/Lr3	-	*Xmwg798*				32.1 cM		{9921}
	cent	-	*Sr11*	45.1		{1297}		74.1	
	cent	-	*Lr3*	I		{1244}			
	B2	-	*Lr9*	3.5		{1299}			
	B2	-	*Sr11*	43.3		{1297}		65.8	
	B2	-	*Sr11*	46.9 (or 43.8)		{1299}	86.1 (or 67.9)		
	a -Amy-B3	-	*a-Amy-B1*				9.3		{1081}
	Sr11	-	*Ki*	9		{829}			
	Sr11	-	*Ki*	10.5		{1306}			
	Sr11	-	*Lr9*	close		{1297}			
	Sr11	-	*Lr3*	21.7	7.8	{548}	23.2	9.6	
	Sr11	-	*Lr3*	0		{839,842}			
	Lr3	-	*Ki*	11.5		{1306}			

An *Sr11 Lr9* coupling stock was isolated by ER Sears.

<u>Chromosome 6D</u>

6DS

	Sr5	-	*Sr29*	I		{313}			
	Cmc1	-	cent	I		{1468}			

6DL

	cent	-	*a -Amy-D1*	11.9	2.8	{398}			
	cent	-	*a -Amy-D1*				11.3		{1081}
	cent	-	*H13*	35	8	{441}	43.4	15.7	
	cent	-	*Sr29*	I		{313}			
	H13	-	*H23*				25	5	{1199}

<u>Chromosome 7A</u>

7AS

	XNra	-	*Per-A4*				23.3	6.4	{816}
	XNra	-	*Per-A4*				20.1	6.5	{816}
	Amp-A1	-	*XPepc*				24		{179}
	Xpsr119-7A	-	*or*				13		{1031}

7AL

	cent	-	*Sr22*	27	4.2	{1460}	30.2	5.9	
	cent	-	*Cn-A1a*	I		{1304}			
	cent	-	*Cn-A1b*	34		{802}	41.5		
	cent	-	*cn-A1d*				46.6	3.8	{665}
	cent	-	*Pm1*	I		{1305}			
	Ep-A1b	-	*Xpsr121-7A*	3.8	2.1	{228}			
	Ep-A1b	-	*Pch2*	15	4	{228}			
	Rc1	-	*P*	20.3		{911}			
	Sr22	-	*Cn-A1*	2		{1462}			
	Sr22	-	*Pm1/Lr20/Sr15*	41		{1462}	57.8		
	Xpsr121-7A	-	*Pch2*	11.2	3.5	{228}			
dv:	*Sr22*	-	*Rc1*	42	2.8	{1461}	61.9	9.5	
	Sr22	-	*Rc1*	43	2.7	{1461}	64.7	10.4	
	cn-A1a	-	*Pm1/Lr20/Sr15*	40		{1462}	54.9		
	Pm1	-	*Pm9*	linked		{347}			
	Pm1	-	*Pm9*				8.5		{1287}
tv:	*P*	-	*cn-A1d* (CDd6)				37.9	3.2	{1547}

<u>Chromosome 7B</u>

7BS

cc	-	cent				33.5	4.1	{665}
Vrn5	-	*Pc*	26	5	{771}	28.8	5.6	
Vrn5	-	*Lr* mod	25.5	4.6	{412}	28.1	6.2	
Vrn5	-	*Pm5*	26	5	{771}	28.8	6.9	
Pc	-	*Lr14a*	44	6	{771}			
Pc	-	cent	22.8	5.3	{412}	24.6	6.7	
Pc	-	*P2*				29.6	7.3	{9990}
Pc (*Rc2*)	-	cent	16	5	{769}	16.6	5.6	
Pc	-	*Lr* mod	10.5	3.7	{412}			
Hl2	-	cent	14.3	3.5	{0316}			

Gene order: *Pc* - *Vrn5 (e1)* - cent {770}; revised to: *Vrn5* - *Pc* - cent {769}.

7BL

cent	-	*a -Amy-B2*	5.9	5.5	{412}			
cent	-	*cn-B1a*				42.6	4.3	{665}
cent	-	*Pm5*	37	9	{771}	47.5	19.9	
cent (5B.7B)	-	*Ep-B1*	I		{708}			
a-Amy-B2	-	*Pm5*	44.4	5.1	{412}	70.6	24.1	
a -Amy-B2	-	*Ep-B1*	I		{708}			
Xpsr129	-	*Ep-B1*				>50		{179}
Pm5	-	*Lr14a*	20.4	2.4	{1564}	21.7	2.9	
Pm5	-	*Lr14a*	28	5	{770}	31.6	7.3	
Pm5	-	*Lr14a*	30.1	4.5	{412}	34.8	7.1	
Pm5	-	*Sr17*	6	2	{964}			
Pm5	-	*Sr17*	2	1.1	{964}			
Lr14a	-	*Sr17*	18.2	4.5	{964}	19.1	5.2	
Lr14a	-	*Ep-B1*	9.6	3	{708}			
Xpsr121	-	*Ep-B1*				9		{179}
Xpsr121	-	*Wsp-B1*				16.6	6.9	{817}
Ep-B1	-	*WspB1*				31.6	12.1	{817}
P2	-	*cn-B1b*				36.5	5.6	{9990}

Gene order: cent - *Pm5* - *Lr14a* {770}.

<u>Chromosome 7D</u>

7DS

This chromosome arm is physically longer than the arm designated 7DL, but is homoeologous to those arms designated 7AS and 7BS {1571,388}.

Bdv1	-	*Lr34* /*Yr18* /*Ltn*	0		{1363}
Lr34	-	*Lr29*	0		{924}
Ltn	-	*Lr34* /*Yr18*	<0.013		{1361}
Lr34	-	*Yr18*	0		{1362,937}
Lr34	-	*Rc3*	30.25	2.88	{924}
Rc3	-	cent	10.3	2.8	{1241}
Rc3	-	cent	9.8	2.8	{1241}
Rc3	-	cent	16	4.2	{1444}

Rc3	-	*Adk-D1*				24.1	4.5	{1435}
a-Amy-D2	-	*Adk-D1*				0.24	5	{1603}
a-Amy-D2	-	*Pch*				37	5	{1603}
a-Amy-D2	-	*Pch/Ep-D1b*				I		{1603}
Pan1	-	*Pc2*				13.3	2.3	{921}
Pan1	-	*Pc2*				14.4	2.7	{921}
Pm15	-	cent	I		{1480}			

7DL

Physically shorter than 7DS; see note for 7DS above.

a-Amy-D2	-	*Lr*				42	6	{1603}
a-Amy-D2	-	*Pch*				I		{417,1603}
Xgwm111-7D	-	*Gb3*				22.5		{0319}
Cent	-	*Dn5*	I		{287}			
Lr	-	*Pch*				18	4	{1603}
Pch	-	*Ep-D1b*				0		{1603}
Lr19/Sr25	-	*cn-D1*	0		{939}			
Dn5	-	*Ep-D1*	32	4.67	{894}			
Dn5	-	*cn-D1*	37	6.3	{894}			
Gb3	-	*Xgwm428-7D*				33.1		{0319}
Pm29	-	*Pm19*			{0129}			

Gene order: cent - *Xgwm111-7D* - *Gb3* {0319}.