

Supplementary data:

QTL mapping for combining ability in different population-based NCII designs: a simulation study

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Table 1. Simulated and estimated QTL positions and effects for combining ability and heterosis under additive-dominance model with two alleles at each locus in BC-based NCII design.

n	h^2	Parameter values	Dataset	Trait mean	h^2	QTL1			QTL2			QTL3		
						Position	Effect	Power	Position	Effect	Power	Position	Effect	Power
200	0.8	BC	BC	100	0.633	192	1.2(1.5)	12	105	1.5(-1)	196	-1(2)	100	
				102.102	(0.034)	193.167	-1.001	(0.995)	4.133	(0.995)	190.08	-4.913	100	
				(0.079)	(14.684)	(0.196)	(0.312)	(0.995)	(0.262)	(0.995)	(1.002)	(0.262)	100	
				101.905	0.632	189.833	-0.599	99.98	2.079	190.08	-2.448	100		
				(0.041)	(0.036)	(1.03)	(0.157)	(1.005)	(0.176)	(1.002)	(0.166)	100		
				101.396	0.634	190.1	2.31	99.977	0.542	189.92	0.6	100		
				(0.024)	(0.04)	(1)	(0.157)	(1.389)	(0.23)	(1.489)	(0.173)	100		
				0	0.653	190.02	-1.313	99.98	0.78	190.1	-1.534	100		
				(0.031)	(0.036)	(1.005)	(0.116)	(1.005)	(0.19)	(1)	(0.162)	100		
				0	0.653	190.02	1.316	99.98	-0.779	190.1	1.533	100		
200	0.5	TCBCQQ	TCBCQQ	101.905	0.632	190.02	1.316	100	99.98	-0.779	190.1	1.533	100	
				(0.041)	(0.036)	(1.005)	(0.116)	(1.005)	(0.183)	(1)	(0.156)	100		
				101.405	0.399	190.18	1.017	100.1	1.294	190.02	-0.946	100		
				(0.05)	(0.045)	(0.976)	(0.208)	(1)	(0.096)	(1.005)	(0.098)	100		
				0	0.443	190.16	-1.369	86	0.614	109	-0.605	1		
				(0.043)	(0.044)	(0.992)	(0.216)	(7.071)	(0.105)	(0)	(0)	100		
				0	0.443	190.16	1.373	100.14	-1.566	190.16	3.044	100		
				(0.043)	(0.044)	(0.992)	(0.21)	(0.995)	(0.229)	(0.992)	(0.191)	100		
				0	0.402	190.01	1.093	100.14	-1.566	190.16	3.044	100		
				(0.035)	(0.049)	(1.351)	(0.169)	(1.005)	(0.167)	(4.648)	(0.184)	100		
200	0.5	ScaQQ	ScaQQ	-1.046	0.093	131	0.661	1	86	0.614	109	-0.605	1	
				(0.04)	(0.026)	(0)	(0)	(7.071)	(0.105)	(0)	(0)	100		
				-0.855	0.653	190.08	2.631	100.14	-1.566	190.16	3.044	100		
				(0.053)	(0.036)	(1.002)	(0.19)	(0.995)	(0.229)	(0.992)	(0.191)	100		
				102.108	0.407	166.333	-0.405	3	4.284	190.06	-4.956	100		
				(0.127)	(0.042)	(20.526)	(2.547)	100.1	(0.545)	(1.003)	(0.482)	100		
				101.905	0.414	187	-0.891	4	2.152	190.12	-2.504	100		
				(0.073)	(0.046)	(13.266)	(0.079)	100.08	(0.275)	(0.998)	(0.299)	100		
				101.405	0.399	190.24	2.41	104.222	0.736	185.424	0.749	33		
				(0.05)	(0.045)	(0.976)	(0.208)	(14.827)	(0.178)	(28.385)	(0.305)	100		
200	0.5	Hmpqq	Hmpqq	0	0.443	190.16	-1.369	100	100.106	0.867	189.94	-1.55	100	
				(0.043)	(0.044)	(0.992)	(0.216)	(2.807)	(0.149)	(1.003)	(0.226)	100		
				0	0.443	190.16	1.373	100.106	-0.862	189.94	1.549	100		
				(0.043)	(0.044)	(0.992)	(0.21)	(2.807)	(0.149)	(1.003)	(0.22)	100		
				0	0.402	190.01	1.093	100.02	1.322	189.9	-0.971	100		
				(0.035)	(0.049)	(1.351)	(0.169)	(1.005)	(0.167)	(4.648)	(0.184)	100		
				-1.049	0.064	119.667	1.267	-	-	159	-1.261	1		
				(0.077)	(0.008)	(63.256)	(0.079)	0	(0)	(0)	(0)	1		
				-0.849	0.439	190.18	2.702	100.462	-1.711	189.96	3.055	100		
				(0.078)	(0.047)	(0.989)	(0.366)	(2.936)	(0.332)	(1.004)	(0.29)	100		

Table 1 (contd)

n	h^2	Dataset	Trait mean	h^2	QTL1			QTL2			QTL3				
					Position	Effect	Power	Position	Effect	Power	Position	Effect	Power		
200	0.2	BC	102.127 (0.232)	0.166 (0.054)	–	–	0	100.529 (7.42)	4.623 (1.318)	68	188.011 (18.151)	–5.257 (0.881)	91		
		TCBCQQ	101.908 (0.118)	0.172 (0.052)	–	–	2	100.436 (1.984)	2.402 (0.399)	78	190.429 (2.093)	–2.658 (0.464)	91		
	TCBCqq	101.387 (0.081)	0.16 (0.043)	2.395 (0.38)	102	1.011 (1.264)	6	138.5 (60.759)	1.487 (0.139)	4	1.487 (0.139)	1.487 (0.139)	4		
		ScaQQ	0 (0.061)	0.173 (0.06)	–1.486 (0.215)	73	95.842 (19.279)	1.298 (0.18)	19	190.082 (1.399)	–1.64 (0.28)	85	–1.64 (0.28)	85	
	Scaqq	0 (0.061)	0.173 (0.06)	1.489 (0.215)	73	95.842 (19.279)	–1.291 (0.18)	19	190.082 (1.399)	1.638 (0.28)	85	1.638 (0.28)	85		
		Gca	0 (0.063)	0.137 (0.05)	1.381 (0.171)	46	100.233 (13.758)	1.468 (0.523)	73	188.152 (7.501)	–1.352 (0.168)	33	–1.352 (0.168)	33	
	HmpQQ	–1.056 (0.134)	0.072 (0.009)	0.213 (3.753)	2	69 (0)	1	41 (0)	0 (0)	1	0 (0)	1	0 (0)	1	
		Hmpqq	–0.876 (0.121)	0.161 (0.054)	3.015 (0.449)	68	96.143 (14.049)	–2.523 (0.404)	14	188.426 (18.809)	3.217 (0.53)	94	3.217 (0.53)	94	
	400	0.8	BC	102.1 (0.057)	0.628 (0.027)	–0.791 (0.174)	27	100.12 (0.998)	4.151 (0.215)	100	190.12 (0.998)	–4.875 (0.2)	100	–4.875 (0.2)	100
			TCBCQQ	101.9 (0.033)	0.626 (0.028)	–0.376 (0.079)	25	100.16 (0.992)	2.086 (0.123)	100	190.12 (0.998)	–2.442 (0.118)	100	–2.442 (0.118)	100
TCBCqq		101.397 (0.02)	0.633 (0.025)	2.348 (0.076)	100	100.08 (1.489)	0.521 (0.089)	100	189.84 (0.992)	0.6 (0.094)	100	0.6 (0.094)	100		
		ScaQQ	0 (0.021)	0.643 (0.024)	–1.295 (0.074)	100	100.16 (0.992)	0.796 (0.077)	100	190.1 (1)	–1.518 (0.083)	100	–1.518 (0.083)	100	
Scaqq		0 (0.021)	0.643 (0.024)	1.297 (0.074)	100	100.16 (0.992)	–0.794 (0.077)	100	190.1 (1)	1.518 (0.083)	100	1.518 (0.083)	100		
		Gca	0 (0.018)	0.617 (0.024)	1.059 (0.067)	100	100.06 (1.003)	1.3 (0.071)	100	190.2 (0.985)	–0.93 (0.073)	100	–0.93 (0.073)	100	
HmpQQ		–1.05 (0.027)	0.033 (0.002)	–0.486 (0)	1	21 (0)	0.441 (0)	1	121 (0)	0.49 (0)	1	0.49 (0)	1		
		Hmpqq	–0.854 (0.04)	0.646 (0.024)	2.62 (0.149)	100	100.08 (1.002)	–1.576 (0.142)	100	190.02 (1.005)	3.029 (0.137)	100	3.029 (0.137)	100	

Table 1 (contd)

n	h^2	Dataset	Trait mean	h^2	QTL1			QTL2			QTL3		
					Position	Effect	Power	Position	Effect	Power	Position	Effect	Power
400	0.5	BC	102.125	0.403	195	-1.322	4	100.12	4.237	100	190.06	-4.92	100
			(0.093)	(0.033)	(16.573)	(0.088)	(0.998)	(0.359)	(1.003)	(0.416)			
			101.914	0.403	194.25	-0.675	8	100.08	2.134	100	190.1	-2.444	100
		TCBCQQ	(0.044)	(0.033)	(7.778)	(0.062)	(1.002)	(0.19)	(1)	(0.176)			
			101.409	0.399	190.04	2.347	99.545	0.601	55	189.8	0.668	85	
			(0.032)	(0.036)	(1.004)	(0.138)	(2.595)	(0.089)	(2.586)	(0.131)			
		ScaQQ	0	0.434	190	-1.323	100	100.12	0.834	100	189.92	-1.53	100
			(0.027)	(0.033)	(1.005)	(0.12)	(0.998)	(0.114)	(0.119)				
			0	0.434	190	1.326	100	100.12	-0.831	100	189.92	1.53	100
		Scaqq	(0.027)	(0.033)	(1.005)	(0.12)	(0.998)	(0.114)	(0.119)				
			0	0.381	190.14	1.05	100	100.06	1.318	100	190.06	-0.931	100
			(0.024)	(0.034)	(0.995)	(0.123)	(1.003)	(0.117)	(0.112)				
		HmpQQ	-1.048	0.038	161	-1.004	1	106	0.874	2	209	1.294	1
			(0.047)	(0.011)	(0)	(0)	(148.492)	(0.089)	(0)	(0)			
			-0.854	0.43	190.08	2.593	100	100.14	-1.644	100	190.04	3.076	100
Hmpqq	(0.054)	(0.033)	(1.002)	(0.197)	(0.995)	(0.239)	(1.004)						
	102.141	0.167	191	-2.622	1	99.796	4.194	98	190.02	-5.04	100		
	(0.167)	(0.031)	(0)	(0)	(2.066)	(0.63)	(1.005)	(0.665)					
TCBCQQ	101.914	0.174	181	-0.826	6	100.354	2.189	99	190.1	-2.551	100		
	(0.091)	(0.031)	(63.435)	(1.238)	(1.586)	(0.345)	(1)	(0.309)					
	101.394	0.157	189.94	2.405	100	98.778	1.104	9	177.667	0.951	15		
TCBCqq	(0.059)	(0.034)	(1.003)	(0.291)	(7.71)	(0.149)	(44.089)	(0.601)					
	0	0.187	190.04	-1.337	100	98.968	0.964	62	190.26	-1.586	100		
	(0.052)	(0.032)	(1.348)	(0.235)	(5.72)	(0.259)	(0.97)	(0.2)					
ScaQQ	0	0.187	190.04	1.342	100	98.968	-0.958	62	190.26	1.585	100		
	(0.052)	(0.032)	(1.348)	(0.235)	(5.72)	(0.259)	(0.97)	(0.2)					
	0	0.156	189.138	1.187	87	100.071	1.368	99	188.896	-1.055	77		
Gca	(0.047)	(0.038)	(14.904)	(0.195)	(1.003)	(0.219)	(14.097)	(0.176)					
	-1.057	0.032	-	-	0	0.004	-	0					
	(0.109)	(0.001)	-	-	(69.296)	(2.709)	-	-					
HmpQQ	-0.877	0.182	189.84	2.69	100	98.925	-1.903	53	190.08	3.139	100		
	(0.095)	(0.034)	(1.953)	(0.475)	(3.373)	(0.289)	(1.002)	(0.434)					

n, Base population sample size; The first h^2 refers the set broad heritability and the second one refers the broad heritability calculated in simulations. The numbers in parentheses are standard deviation and the same is true for the later tables.

Table 2. Simulated and estimated QTL positions and effects for combining ability and heterosis under additive-dominance model with two alleles in F₂-based NCII design.

n	h^2	Dataset	Trait mean	h^2	QTL1			QTL2			QTL3					
					Position	A effect	D effect	Power	Position	A effect	D effect	Power	Position	A effect	D effect	Power
200	0.8	F ₂	101.223	0.812	189.91	1.461	1.426	100	100.08	1.814	-0.864	100	188.515	-0.884	1.591	101
			(0.124)	(0.02)	(0.965)	(0.111)	(0.148)	(0.918)	(0.103)	(0.152)	(13.25)	(0.173)				
		TCF2QQ	102.506	0.808	120.5	0.13	0.483	2	100.529	1.356	-0.018	102	188.891	-1.322	0.001	101
			(0.082)	(0.021)	(161.927)	(0.118)	(0.023)	(12.835)	(0.215)	(0.117)	(10.474)	(0.113)				
		TCF2qq	100.002	0.806	190.01	1.457	-0.004	100	100.703	0.447	-0.009	101	189.235	0.437	-0.001	102
			(0.058)	(0.023)	(0.87)	(0.063)	(0.082)	(19.682)	(0.082)	(0.095)	(19.682)	(0.104)				
	ScaQQ	0	0.805	188.627	-0.721	0.013	102	100.619	0.446	-0.005	105	187.961	-0.873	0.009	102	
		(0.047)	(0.022)	(18.927)	(0.131)	(0.07)	(14.604)	(0.105)	(0.088)	(15.655)	(0.07)					
	Scaqq	0	0.805	188.627	0.721	-0.013	102	100.619	-0.446	0.005	105	187.961	0.873	-0.009	102	
		(0.047)	(0.022)	(18.927)	(0.131)	(0.07)	(14.604)	(0.105)	(0.088)	(15.655)	(0.07)					
	Gca	0	0.812	188.725	0.711	0.01	102	101.475	0.911	-0.012	101	189.99	-0.446	-0.001	100	
		(0.059)	(0.025)	(18.741)	(0.105)	(0.072)	(13.85)	(0.105)	(0.066)	(2.307)	(0.077)					
HmpQQ	0.644	0.615	188.079	-0.741	-0.697	101	100.275	0.474	0.431	102	188.208	-0.881	-0.797	101		
	(0.074)	(0.05)	(18.343)	(0.133)	(0.165)	(6.978)	(0.115)	(0.143)	(17.746)	(0.154)						
Hmpqq	-0.609	0.656	190.13	0.732	-0.726	100	100.01	-0.45	0.414	102	190.12	0.894	-0.813	100		
	(0.06)	(0.041)	(1.284)	(0.077)	(0.103)	(12.352)	(0.095)	(0.14)	(1.192)	(0.12)						
200	0.5	F ₂	101.197	0.536	188.376	1.485	1.473	101	101.109	1.893	-0.837	101	190.22	-0.924	1.574	100
			(0.185)	(0.04)	(19.002)	(0.238)	(0.31)	(10.478)	(0.232)	(0.361)	(1.767)	(0.328)				
		TCF2QQ	102.507	0.507	-	-	0	100.11	1.365	0.012	100	190.08	-1.328	0.043	100	
			(0.127)	(0.048)	-	-	-	(1.497)	(0.145)	(0.202)	(1.668)	(0.141)	(0.188)			
		TCF2qq	100	0.492	190.04	1.474	0.004	100	99.82	0.514	-0.01	61	188.288	0.543	0.018	52
			(0.087)	(0.059)	(1.385)	(0.118)	(0.188)	(19.538)	(0.144)	(0.234)	(16.629)	(0.231)				
	ScaQQ	0	0.505	190.05	-0.746	0.005	100	99.929	0.473	0.007	85	190.26	-0.9	0.007	100	
		(0.065)	(0.046)	(2.451)	(0.085)	(0.151)	(7.421)	(0.085)	(0.138)	(1.661)	(0.09)	(0.138)				
	Scaqq	0	0.505	190.05	0.746	-0.005	100	99.929	-0.473	-0.007	85	190.26	0.9	-0.007	100	
		(0.065)	(0.046)	(2.451)	(0.085)	(0.151)	(7.421)	(0.085)	(0.138)	(1.661)	(0.09)	(0.138)				
	Gca	0	0.516	189.7	0.728	0.014	100	100.2	0.915	0.009	100	186.721	-0.454	0.034	86	
		(0.069)	(0.053)	(1.648)	(0.09)	(0.136)	(1.484)	(0.089)	(0.147)	(23.518)	(0.085)	(0.154)				
HmpQQ	0.658	0.253	188.318	-0.78	-0.781	88	105.263	0.538	0.688	19	188.604	-0.873	-0.755	96		
	(0.12)	(0.078)	(15.562)	(0.181)	(0.258)	(13.678)	(0.288)	(0.287)	(19.133)	(0.25)						
Hmpqq	-0.599	0.307	189.184	0.708	-0.757	98	104.182	-0.632	0.628	33	189.434	0.936	-0.774	99		
	(0.106)	(0.076)	(20.946)	(0.169)	(0.252)	(13.194)	(0.13)	(0.253)	(3.543)	(0.282)						

Table 2 (contd)

n	h^2	Dataset	Trait mean	h^2	QTL1			QTL2			QTL3					
					Position	A effect	D effect	Power	Position	A effect	D effect	Power	Position	A effect	D effect	Power
200	0.2	F ₂	101.217 (0.326)	0.189 (0.078)	189.717 (9.147)	1.742 (0.404)	1.528 (0.861)	60	97.909 (11.95)	2.087 (0.373)	-0.897 (1)	77	189.655 (9.348)	-1.199 (0.495)	2.281 (0.776)	29
		TCF2QQ	102.516 (0.226)	0.209 (0.065)	94.667 (105.368)	-0.609 (0.974)	0.42 (1.105)	3	101.447 (8.553)	1.443 (0.272)	0.045 (0.469)	85	189.228 (14.135)	-1.418 (0.385)	0.087 (0.556)	79
		TCF2qq	99.986 (0.156)	0.197 (0.055)	191.061 (3.796)	1.511 (0.261)	-0.074 (0.42)	98	99.8 (15.223)	0.907 (0.183)	0.1 (0.567)	10	188.429 (12.259)	0.874 (0.114)	-0.076 (0.478)	7
		ScaQQ	0 (0.104)	0.186 (0.069)	185.797 (25.825)	-0.807 (0.291)	-0.004 (0.333)	64	119.5 (41.997)	0.611 (0.235)	-0.033 (0.738)	12	190.916 (9.204)	-0.963 (0.169)	0.08 (0.317)	83
		Scaqq	0 (0.104)	0.186 (0.069)	185.797 (25.825)	0.807 (0.291)	0.004 (0.333)	64	119.5 (41.997)	-0.611 (0.235)	0.033 (0.738)	12	190.916 (9.204)	0.963 (0.169)	-0.08 (0.317)	83
		Gca	0 (0.12)	0.194 (0.07)	189.393 (8.275)	0.87 (0.152)	-0.031 (0.357)	61	101.506 (6.481)	0.97 (0.216)	0.031 (0.334)	87	187.417 (11.293)	-0.758 (0.148)	0.002 (0.516)	12
		HmpQQ	0.657 (0.233)	0.106 (0.042)	187.75 (22.576)	-1.283 (0.323)	-1.084 (0.638)	12	94 (0)	0.476 (0)	2.404 (0)	1	190.7 (9.852)	-1.278 (0.485)	-1.309 (0.688)	20
		Hmpqq	-0.623 (0.198)	0.116 (0.046)	188.682 (22.268)	1.068 (0.46)	-1.088 (0.701)	22	77.75 (31.245)	-0.83 (0.462)	1.747 (0.612)	4	189.758 (10.044)	1.194 (0.232)	-1.095 (0.566)	33
400	0.8	F ₂	101.236 (0.091)	0.807 (0.014)	187.755 (15.538)	1.43 (0.181)	1.381 (0.26)	102	101.069 (10.567)	1.81 (0.188)	-0.826 (0.105)	101	189.88 (0.769)	-0.886 (0.083)	1.595 (0.124)	100
		TCF2QQ	102.507 (0.055)	0.803 (0.014)	86.667 (54.93)	0.033 (0.18)	0.105 (0.196)	3	100.634 (6.994)	1.343 (0.147)	-0.006 (0.071)	101	190.04 (0.65)	-1.339 (0.046)	-0.003 (0.072)	100
		TCF2qq	100.004 (0.04)	0.802 (0.012)	188.307 (16.219)	1.434 (0.146)	0 (0.063)	101	100.12 (2.026)	0.458 (0.035)	-0.002 (0.06)	100	188.782 (12.818)	0.443 (0.055)	0 (0.055)	101
		ScaQQ	0 (0.031)	0.797 (0.016)	188.416 (15.637)	-0.719 (0.09)	0.002 (0.044)	101	99.98 (1.044)	0.455 (0.03)	0.001 (0.049)	100	189.98 (0.603)	-0.889 (0.032)	-0.002 (0.045)	100
		Scaqq	0 (0.031)	0.797 (0.016)	188.416 (15.637)	0.719 (0.09)	-0.002 (0.044)	101	99.98 (1.044)	-0.455 (0.03)	-0.001 (0.049)	100	189.98 (0.603)	0.889 (0.032)	0.002 (0.045)	100
		Gca	0 (0.032)	0.809 (0.015)	190 (0.739)	0.728 (0.032)	0.005 (0.048)	100	100.703 (6.984)	0.895 (0.095)	-0.004 (0.042)	101	190.09 (1.198)	-0.454 (0.029)	-0.001 (0.046)	100
		HmpQQ	0.639 (0.048)	0.596 (0.032)	189.119 (9.417)	-0.726 (0.081)	-0.701 (0.115)	101	100.09 (1.64)	0.453 (0.066)	0.426 (0.094)	100	190.05 (0.88)	-0.901 (0.057)	-0.802 (0.098)	100
		Hmpqq	-0.614 (0.05)	0.648 (0.029)	186.5 (24.69)	0.714 (0.133)	-0.692 (0.148)	102	100.01 (1.474)	-0.465 (0.054)	0.423 (0.079)	100	190.02 (0.864)	0.886 (0.058)	-0.797 (0.082)	100

Table 2 (contd)

n	h^2	Dataset	Trait mean	h^2	QTL1			QTL2			QTL3						
					Position	A effect	D effect	Power	Position	A effect	D effect	Power	Position	A effect	D effect	Power	
400	0.5	F ₂	101.228 (0.137)	0.51 (0.032)	188.158 (17.35)	1.461 (0.218)	1.427 (0.311)	101	100.01 (1.235)	1.814 (0.139)	-0.862 (0.193)	100	190.19 (1.308)	-0.902 (0.16)	1.583 (0.239)	100	
		TCF2QQ	102.493 (0.09)	0.508 (0.033)	137 (73.328)	-0.183 (0.236)	-0.324 (0.327)	3	101.088 (8.64)	1.345 (0.275)	0.008 (0.137)	102	188.218 (18.363)	-1.317 (0.203)	-0.02 (0.136)	101	
		TCF2qq	99.994 (0.059)	0.509 (0.033)	189.9 (1.04)	1.458 (0.076)	-0.006 (0.115)	100	99.837 (11.697)	0.467 (0.108)	-0.011 (0.13)	98	186.173 (19.712)	0.441 (0.092)	0.016 (0.152)	98	
	0	ScaQQ	0 (0.054)	0.502 (0.033)	188.911 (11.13)	-0.734 (0.085)	0.004 (0.084)	101	100.117 (4.751)	0.451 (0.115)	0.004 (0.115)	103	189 (10.625)	-0.879 (0.096)	-0.013 (0.1)	101	
		Scaqq	0 (0.054)	0.502 (0.033)	188.911 (11.13)	0.734 (0.085)	-0.004 (0.084)	101	100.117 (4.751)	-0.451 (0.115)	-0.004 (0.115)	103	189 (10.625)	0.879 (0.096)	0.013 (0.1)	101	
		Gca	0 (0.053)	0.519 (0.035)	189.74 (1.488)	0.731 (0.059)	-0.004 (0.09)	100	100.653 (7.976)	0.913 (0.102)	0.009 (0.091)	101	190.291 (13.582)	-0.438 (0.104)	-0.007 (0.107)	103	
	0	HmpQQ	0.629 (0.082)	0.286 (0.042)	186.559 (24.536)	-0.738 (0.176)	-0.718 (0.249)	102	99.56 (12.253)	0.489 (0.15)	0.473 (0.257)	84	187.892 (15.73)	-0.881 (0.18)	-0.816 (0.219)	102	
		Hmpqq	-0.62 (0.07)	0.32 (0.038)	189.198 (7.42)	0.728 (0.116)	-0.744 (0.181)	101	99.195 (7.992)	-0.478 (0.106)	0.437 (0.226)	87	189.139 (10.66)	0.882 (0.154)	-0.778 (0.157)	101	
		F ₂	101.238 (0.235)	0.217 (0.043)	190.122 (2.653)	1.514 (0.347)	1.529 (0.468)	98	101.275 (12.9)	1.855 (0.375)	-0.989 (0.431)	102	189.181 (5.644)	-0.943 (0.36)	1.742 (0.39)	83	
	400	0.2	TCF2QQ	102.516 (0.13)	0.213 (0.034)	-	-	-	0	100.01 (2.177)	1.406 (0.184)	-0.021 (0.282)	100	187.392 (19.543)	-1.346 (0.253)	0.038 (0.296)	102
			TCF2qq	99.993 (0.108)	0.191 (0.039)	189.85 (1.833)	1.503 (0.172)	0.028 (0.249)	100	108.75 (18.584)	0.643 (0.123)	0.005 (0.466)	20	177.933 (39.092)	0.655 (0.191)	-0.053 (0.446)	15
			ScaQQ	0 (0.082)	0.201 (0.042)	189.263 (5.612)	-0.753 (0.109)	-0.011 (0.191)	95	100.442 (7.487)	0.576 (0.076)	0.021 (0.215)	52	186.699 (22.509)	-0.882 (0.202)	0 (0.225)	103
		0	Scaqq	0 (0.082)	0.201 (0.042)	189.263 (5.612)	0.753 (0.109)	0.011 (0.191)	95	100.442 (7.487)	-0.576 (0.076)	-0.021 (0.215)	52	186.699 (22.509)	0.882 (0.202)	0 (0.225)	103
Gca			0 (0.082)	0.21 (0.044)	190.617 (4.962)	0.777 (0.123)	0.012 (0.203)	94	99.495 (8.242)	0.912 (0.187)	-0.021 (0.172)	101	182.978 (30.87)	-0.559 (0.177)	0.076 (0.271)	45	
HmpQQ			0.647 (0.151)	0.078 (0.032)	186.073 (19.287)	-0.903 (0.397)	-0.95 (0.476)	41	103.75 (17.363)	0.834 (0.174)	0.675 (0.556)	12	190.908 (7.986)	-1.053 (0.222)	-0.841 (0.428)	65	
0		Hmpqq	-0.626 (0.132)	0.096 (0.04)	189.61 (5.639)	0.9 (0.225)	-0.835 (0.388)	59	97.462 (12.073)	-0.831 (0.08)	0.497 (0.446)	13	188.363 (7.012)	0.977 (0.23)	-0.87 (0.278)	80	

A, additive effect; D, dominance effect.

Table 3. Simulated and estimated QTL positions and effects for combining ability and heterosis under additive-dominance model with two alleles at each locus in DH-based NCII design.

n	h^2	Parameter values	Dataset	Trait mean	h^2	QTL1			QTL2			QTL3				
						Position	Effect	Power	Position	Effect	Power	Position	Effect	Power		
200	0.8	100 99.98 (0.111) 102.079 (0.089) 100.398 (0.058) 0 (0.057) 0 (0.057)	DH	192	1.2(1.5)	102	105	1.5(-1)	196	-1(2)	100	196	-0.908	100		
				186.873 (22.156)	1.156 (0.144)	102	99.94 (0.583)	1.367 (0.084)	190	-0.908 (0.076)	100	190	-0.908 (0.076)			
				182.417 (39.734)	-0.208 (0.153)	12	101.534 (19.632)	1.103 (0.242)	103	187.373 (19.411)	-1.309 (0.23)	102	187.373 (19.411)	-1.309 (0.23)		
		100.398 (0.058) 0 (0.057)	TCDHqq	187.147 (21.223)	1.286 (0.196)	102	100.913 (7.347)	0.251 (0.052)	80	187.735 (19.12)	0.453 (0.091)	102	187.735 (19.12)	0.453 (0.091)		
				189.426 (5.003)	-0.724 (0.097)	101	103.573 (20.898)	0.443 (0.111)	103	190.455 (4.524)	-0.889 (0.086)	101	190.455 (4.524)	-0.889 (0.086)		
				189.426 (5.003)	0.724 (0.097)	101	103.573 (20.898)	-0.443 (0.111)	103	190.455 (4.524)	0.889 (0.086)	101	190.455 (4.524)	0.889 (0.086)		
		0 (0.052) 1.039 (0.079) 0.208 (0.069)	Scaqq	187.863 (15.876)	0.58 (0.091)	102	98.245 (13.075)	0.669 (0.124)	102	188.218 (17.335)	-0.445 (0.074)	101	188.218 (17.335)	-0.445 (0.074)		
				190.155 (10.243)	-0.717 (0.132)	103	102.912 (18.3)	0.451 (0.147)	102	189.79 (0.902)	-0.905 (0.074)	100	189.79 (0.902)	-0.905 (0.074)		
				190.06 (0.983)	0.746 (0.061)	100	101.398 (9.259)	-0.454 (0.106)	103	189.99 (0.882)	0.907 (0.066)	100	189.99 (0.882)	0.907 (0.066)		
		200	0.5	100.02 (0.17) 102.089 (0.143) 100.41 (0.097)	DH	188.931 (12.048)	1.193 (0.212)	101	99.564 (5.147)	1.37 (0.244)	188.049 (13.815)	-0.933 (0.208)	102	188.049 (13.815)	-0.933 (0.208)	
						196 (0)	-0.571 (0)	1	100.485 (7.409)	1.173 (0.144)	101	190.17 (1.256)	-1.37 (0.139)	100	190.17 (1.256)	-1.37 (0.139)
						189.87 (1.098)	1.338 (0.117)	100	97.833 (12.35)	0.404 (0.034)	12	188.521 (16.159)	0.493 (0.104)	73	188.521 (16.159)	0.493 (0.104)
				0 (0.081) 0 (0.081)	TCDHqq	188.901 (9.438)	-0.744 (0.134)	101	100.85 (8.167)	0.483 (0.085)	100	190.11 (1.214)	-0.901 (0.092)	100	190.11 (1.214)	-0.901 (0.092)
						188.901 (9.438)	0.744 (0.134)	101	100.85 (8.167)	-0.482 (0.086)	100	190.11 (1.214)	0.901 (0.092)	100	190.11 (1.214)	0.901 (0.092)
						189.89 (1.717)	0.596 (0.088)	100	100.13 (1.412)	0.705 (0.075)	100	190.327 (3.716)	-0.483 (0.087)	98	190.327 (3.716)	-0.483 (0.087)
1.029 (0.138) 0.2 (0.111)	Hmpqq			188.766 (9.936)	-0.775 (0.199)	94	101.351 (12.228)	0.64 (0.103)	37	190.131 (2.16)	-0.929 (0.152)	99	190.131 (2.16)	-0.929 (0.152)		
				187.634 (17.574)	0.757 (0.131)	101	100.345 (4.664)	-0.572 (0.087)	55	187.564 (19.772)	0.918 (0.165)	101	187.564 (19.772)	0.918 (0.165)		
				0 (0.089)	0.46 (0.051)	100	100.13 (1.412)	0.705 (0.075)	100	190.327 (3.716)	-0.483 (0.087)	98	190.327 (3.716)	-0.483 (0.087)		

Table 3 (contd)

n	h^2	Dataset	Trait mean	h^2	QTL1			QTL2			QTL3			
					Position	Effect	Power	Position	Effect	Power	Position	Effect	Power	
200	0.2	DH	99.985 (0.262)	0.203 (0.065)	189.789 (4.688)	1.405 (0.236)	76	100.348 (2.331)	1.552 (0.265)	89	187.231 (16.48)	-1.259 (0.462)	39	
		TCDHQQ	102.086 (0.219)	0.202 (0.062)			0	99.802 (2.326)	1.321 (0.233)	81	186.583 (24.263)	-1.401 (0.27)	96	
	TCDHqq	100.378 (0.159)	0.199 (0.057)	188.267 (13.757)	1.377 (0.222)	101	87 (27.731)	0.926 (0.121)	3	183.067 (48.414)	0.852 (0.093)	15		
	ScaQQ	0 (0.133)	0.226 (0.066)	188.866 (15.716)	-0.811 (0.217)	82	96.643 (19.199)	0.707 (0.286)	28	188.489 (15.888)	-0.945 (0.163)	94		
	Scaqq	0 (0.133)	0.226 (0.066)	188.866 (15.716)	0.811 (0.217)	82	96.643 (19.199)	-0.707 (0.286)	28	188.489 (15.888)	0.945 (0.163)	94		
	Gca	0 (0.127)	0.158 (0.058)	190.164 (3.293)	0.754 (0.11)	55	99.921 (2.55)	0.805 (0.158)	76	186.143 (12.499)	-0.698 (0.084)	21		
	HmpQQ	1.043 (0.229)	0.097 (0.044)	192.667 (9.579)	-1.278 (0.153)	18	132.25 (53.444)	0.55 (1.037)	8	179.906 (38.683)	-1.167 (0.46)	32		
	Hmpqq	0.185 (0.19)	0.12 (0.052)	181.636 (33.1)	1.079 (0.149)	33	99 (4.123)	-1.106 (0.093)	7	187.052 (27.914)	1.158 (0.204)	58		
	400	0.8	DH	99.997 (0.074)	0.802 (0.014)	187.833 (15.906)	1.145 (0.145)	102	99.059 (9.563)	1.337 (0.163)	101	189.99 (0.595)	-0.891 (0.048)	100
			TCDHQQ	102.106 (0.058)	0.801 (0.015)	188.756 (7.481)	-0.198 (0.035)	45	99.549 (8.447)	1.109 (0.166)	102	188.238 (17.818)	-1.315 (0.157)	101
		TCDHqq	100.398 (0.039)	0.802 (0.014)	186.427 (22.507)	1.257 (0.24)	103	99.5 (9.506)	0.231 (0.053)	102	190 (1.11)	0.45 (0.037)	100	
		ScaQQ	0 (0.038)	0.83 (0.013)	188.733 (12.347)	-0.717 (0.09)	101	100.588 (15.557)	0.445 (0.082)	102	189.97 (0.437)	-0.884 (0.031)	100	
		Scaqq	0 (0.038)	0.83 (0.013)	188.733 (12.347)	0.717 (0.09)	101	100.588 (15.557)	-0.445 (0.082)	102	189.97 (0.437)	0.884 (0.031)	100	
		Gca	0 (0.036)	0.764 (0.02)	190.03 (0.54)	0.581 (0.029)	100	101.184 (12.468)	0.66 (0.126)	103	188.337 (17.737)	-0.443 (0.064)	101	
HmpQQ		1.058 (0.058)	0.605 (0.028)	190.08 (0.872)	-0.734 (0.06)	100	99.98 (1.206)	0.464 (0.05)	100	191.02 (6.853)	-0.879 (0.138)	102		
Hmpqq		0.199 (0.043)	0.672 (0.024)	189.277 (7.8)	0.722 (0.097)	101	99.93 (1.085)	-0.459 (0.042)	100	189.99 (0.643)	0.89 (0.044)	100		

Table 3 (contd)

n	h^2	Dataset	Trait mean	h^2	QTL1			QTL2			QTL3			
					Position	Effect	Power	Position	Effect	Power	Position	Effect	Power	
400	0.5	DH	99.983 (0.121)	0.507 (0.029)	189.99 (0.937)	1.171 (0.097)	100	100.08 (0.918)	1.393 (0.1)	100	188.584 (13.979)	-0.883 (0.168)	101	
		TCDHQQ	102.098 (0.096)	0.5 (0.031)	163 (61.482)	-0.372 (0.036)	6	101.05 (10.487)	1.133 (0.123)	101	190.08 (0.837)	-1.348 (0.087)	100	
	TCDHqq	100.388 (0.071)	0.496 (0.033)	187.505 (16.264)	1.272 (0.258)	103	101.196 (11.137)	0.314 (0.047)	46	190.253 (4.003)	0.458 (0.073)	99		
	ScaQQ	0 (0.055)	0.549 (0.031)	187.087 (17.154)	-0.708 (0.153)	103	100.297 (3.113)	0.456 (0.066)	101	187.598 (16.969)	-0.88 (0.109)	102		
	Scaqq	0 (0.055)	0.549 (0.031)	187.087 (17.154)	0.708 (0.153)	103	100.297 (3.113)	-0.456 (0.066)	101	187.598 (16.969)	0.88 (0.109)	102		
	Gca	0 (0.057)	0.448 (0.034)	190.13 (1.178)	0.594 (0.063)	100	100.99 (10.397)	0.685 (0.076)	101	189.95 (1.359)	-0.461 (0.059)	100		
	HmpQQ	1.057 (0.093)	0.275 (0.036)	189.82 (1.629)	-0.744 (0.111)	100	101.831 (12.485)	0.5 (0.084)	77	188.188 (17.959)	-0.913 (0.111)	101		
	Hmpqq	0.197 (0.07)	0.342 (0.041)	189.158 (9.468)	0.732 (0.143)	101	98.779 (8.714)	-0.481 (0.114)	95	189.495 (3.926)	0.885 (0.102)	101		
	400	0.2	DH	100.001 (0.08)	0.802 (0.013)	188.99 (11.139)	1.137 (0.222)	103	101.775 (12.972)	1.336 (0.198)	102	185.262 (28.674)	-0.872 (0.154)	103
			TCDHQQ	102.115 (0.071)	0.801 (0.016)	188.432 (14.562)	-0.193 (0.023)	44	99.66 (11.952)	1.111 (0.194)	103	190.01 (0.438)	-1.326 (0.047)	100
		TCDHqq	100.394 (0.042)	0.803 (0.014)	186.398 (22.995)	1.268 (0.23)	103	99.961 (5.464)	0.241 (0.045)	102	190.525 (4.258)	0.445 (0.07)	101	
		ScaQQ	0 (0.044)	0.83 (0.012)	189.139 (9.274)	-0.721 (0.066)	101	98.294 (10.818)	0.451 (0.059)	102	188.431 (19.079)	-0.866 (0.142)	102	
		Scaqq	0 (0.044)	0.83 (0.012)	189.139 (9.274)	0.721 (0.066)	101	98.294 (10.818)	-0.451 (0.059)	102	188.431 (19.079)	0.866 (0.142)	102	
		Gca	0 (0.042)	0.765 (0.02)	189.495 (4.312)	0.582 (0.054)	101	100.738 (13.454)	0.673 (0.116)	103	189.96 (0.828)	-0.447 (0.03)	100	
HmpQQ		1.064 (0.061)	0.606 (0.031)	189.05 (9.289)	-0.733 (0.073)	101	98.99 (7.57)	0.47 (0.063)	101	188.069 (18.713)	-0.879 (0.118)	101		
Hmpqq		0.193 (0.046)	0.677 (0.026)	187.48 (17.773)	0.719 (0.111)	102	99.78 (1.168)	-0.454 (0.051)	100	189.248 (7.982)	0.885 (0.085)	101		

Table 4. Simulated and estimated QTL positions and effects for combining ability and heterosis under additive-dominance model with two alleles at each locus in RIL (sib-mating)-based NCI design.

n	h^2	Parameter values	Dataset	Trait mean	h^2	QTL1			QTL2			QTL3		
						Position	Effect	Power	Position	Effect	Power	Position	Effect	Power
200	0.8	100 (0.098) 102.1 (0.071) 100.42 (0.052) 0 (0.048) 0 (0.048) 0 (0.046) 1.037 (0.061) 0.207 (0.061)	RIL	100	0.803	192	1.2(1.5)	104	105	1.5(-1)	101	196	-1(2)	101
				100.03 (0.098)	(0.022)	187.663 (13.528)	1.007 (0.218)	99.109 (7.986)	1.057 (0.104)	188.18 (18.039)	-0.649 (0.111)	101		
			TCRILQQ	102.1 (0.071)	0.799 (0.019)	185.636 (30.299)	-0.181 (0.093)	99.696 (7.698)	0.853 (0.157)	189.84 (0.545)	-0.982 (0.048)	100		
				100.42 (0.052)	0.803 (0.02)	189.99 (0.541)	1.176 (0.049)	101.17 (16.901)	0.209 (0.06)	189.34 (7.362)	0.331 (-0.069)	101		
			ScaQQ	0 (0.048)	0.831 (0.019)	190.11 (0.665)	-0.654 (0.03)	100.04 (1.024)	0.352 (0.034)	189.89 (0.695)	0.657 (0.032)	100		
				0 (0.048)	0.831 (-0.019)	190.11 (0.665)	0.654 (0.03)	100.04 (1.024)	0.352 (0.034)	189.89 (0.695)	0.657 (0.032)	100		
			Gca	0 (0.046)	0.768 (0.03)	188.812 (11.969)	0.524 (0.075)	99.971 (9.527)	0.514 (0.098)	189.95 (0.989)	-0.333 (0.033)	100		
				1.037 (0.061)	0.627 (0.041)	190.15 (1.114)	-0.661 (0.056)	98.13 (12.374)	0.339 (0.119)	188.41 (14.847)	-0.663 (0.075)	101		
			Hmpqq	0.207 (0.061)	0.649 (0.039)	188.676 (17.944)	0.655 (0.11)	100.84 (12.733)	-0.354 (0.065)	188.29 (13.454)	0.647 (0.11)	102		
				99.997 (0.13)	0.511 (0.047)	187.65 (19.375)	1.029 (0.246)	99.92 (1.316)	1.079 (0.134)	188.83 (10.812)	-0.675 (0.147)	100		
			TCRILQQ	102.12 (0.121)	0.506 (0.043)	135.4 (78.322)	-0.202 (0.333)	100.65 (5.44)	0.902 (0.164)	189.99 (1.096)	-1 (0.098)	100		
				100.4 (0.091)	0.496 (0.056)	188.98 (10.781)	1.18 (0.185)	156.5 (75.66)	0.361 (0.012)	190.35 (7.079)	0.394 (0.071)	66		
			ScaQQ	0 (0.077)	0.558 (0.044)	189.564 (4.629)	-0.658 (0.116)	100.49 (6.499)	0.375 (0.07)	188.97 (6.311)	-0.652 (0.142)	102		
				0 (0.077)	0.558 (0.044)	189.564 (4.629)	0.658 (0.116)	100.49 (6.499)	-0.375 (0.07)	188.97 (6.311)	0.652 (0.142)	102		
Gca	0 (0.068)	0.461 (0.051)	189.139 (8.676)	0.54 (0.081)	101.04 (10.564)	0.543 (0.072)	188.46 (18.357)	-0.345 (0.061)	97					
	1.07 (0.104)	0.29 (0.065)	188.67 (13.111)	-0.669 (0.171)	100.95 (3.22)	0.53 (0.085)	188.03 (16.476)	-0.674 (0.122)	102					
Hmpqq	0.199 (0.101)	0.316 (0.066)	190.54 (3.993)	0.683 (0.172)	102.74 (16.011)	-0.441 (0.139)	189.88 (1.966)	0.691 (0.105)	100					

Table 4 (contd)

n	h^2	Dataset	Trait mean	h^2	QTL1			QTL2			QTL3				
					Position	Effect	Power	Position	Effect	Power	Position	Effect	Power		
200	0.2	RIL	99.982 (0.203)	0.195 (0.064)	189.308 (3.875)	1.174 (0.311)	91	98.519 (8.953)	1.135 (0.35)	79	182.91 (24.791)	-0.967 (0.343)	35		
		TCRILQQ	102.09 (0.163)	0.205 (0.056)	-	-	0	100 (6.818)	0.94 (0.245)	87	187.72 (19.697)	-1.007 (0.311)	97		
		TCRILqq	100.4 (0.152)	0.196 (0.049)	189.515 (7.567)	1.233 (0.194)	101	149.5 (47.376)	0.826 (0.022)	2	194 (0)	0.744 (0.021)	2		
		SeaQQ	0 (0.11)	0.227 (0.062)	189.126 (12.731)	-0.689 (0.177)	95	103.04 (18.334)	0.498 (0.212)	23	189.51 (6.072)	-0.688 (0.114)	92		
		Scaqq	0 (0.11)	0.227 (0.062)	189.126 (12.731)	0.689 (0.177)	95	103.04 (18.334)	-0.498 (0.212)	23	189.51 (6.072)	0.688 (0.114)	92		
		Gca	0 (0.1)	0.16 (0.066)	188.711 (14.271)	0.639 (0.1)	76	99.857 (5.171)	0.624 (0.105)	63	185.32 (18.352)	-0.53 (0.06)	25		
		HmpQQ	1.048 (0.166)	0.095 (0.036)	182.353 (30.692)	-0.904 (0.372)	34	91.75 (33.31)	0.474 (0.913)	4	184.33 (33.08)	-0.903 (0.344)	30		
		Hmpqq	0.213 (0.179)	0.098 (0.037)	188.853 (17.5)	0.919 (0.125)	34	119.83 (30.603)	-0.566 (0.702)	6	188.29 (10.687)	0.943 (0.11)	38		
		400	0.8	RIL	99.989 (0.065)	0.802 (0.013)	190.03 (0.594)	1.053 (0.048)	100	99.451 (10.439)	1.034 (0.133)	102	190.08 (0.748)	-0.661 (0.045)	100
				TCRILQQ	102.09 (0.048)	0.804 (0.014)	190.274 (7.664)	-0.156 (0.025)	73	100.18 (2.758)	0.869 (0.082)	101	190.02 (0.492)	-0.987 (0.038)	100
				TCRILqq	100.39 (0.033)	0.802 (0.013)	189.277 (6.973)	1.155 (0.132)	101	100.14 (1.877)	0.186 (0.03)	95	190.06 (1.171)	0.34 (0.034)	100
				SeaQQ	0 (0.036)	0.832 (0.012)	188.861 (11.352)	-0.644 (0.078)	101	99.92 (0.918)	0.356 (0.025)	100	185.59 (25.221)	-0.641 (0.11)	103
Scaqq	0 (0.036)			0.832 (0.012)	188.861 (11.352)	0.644 (0.078)	101	99.92 (0.918)	-0.356 (0.025)	100	185.59 (25.221)	0.641 (0.11)	103		
Gca	0 (0.027)			0.765 (0.02)	189.93 (0.555)	0.522 (0.022)	100	99.94 (0.633)	0.529 (0.024)	100	189.97 (0.784)	-0.331 (0.024)	100		
HmpQQ	1.049 (0.049)			0.63 (0.028)	190.05 (0.702)	-0.664 (0.042)	100	99.416 (5.168)	0.36 (0.046)	101	186.84 (22.389)	-0.659 (0.084)	102		
Hmpqq	0.195 (0.041)			0.646 (0.024)	189.85 (0.757)	0.654 (0.036)	100	100.01 (1.243)	-0.36 (0.04)	100	190.03 (0.717)	0.665 (0.04)	100		

Table 4 (contd)

n	h^2	Dataset	Trait mean	h^2	QTL1			QTL2			QTL3				
					Position	Effect	Power	Position	Effect	Power	Position	Effect	Power		
400	0.5	RIL	99.996 (0.092)	0.504 (0.029)	188.667 (17.477)	1.031 (0.176)	102	100	1.068 (0.088)	100	186.87 (21.676)	-0.667 (0.135)	102		
		TCRILQQ	102.1	0.501 (0.029)	170.364 (49.872)	-0.181 (0.214)	11	101.91 (14.408)	0.869 (0.148)	102	188.06 (17.708)	-0.986 (0.102)	101		
			100.39	0.502 (0.032)	189.94 (0.547)	1.177 (0.062)	100	98.548 (8.559)	0.282 (0.037)	31	188.61 (15.033)	0.34 (0.095)	97		
		SeaQQ	0	0.551 (0.031)	190.05 (0.757)	-0.66 (0.044)	100	101.74 (15.266)	0.346 (0.089)	103	188.48 (14.138)	-0.652 (0.098)	101		
			0	0.551 (0.031)	190.05 (0.757)	0.66 (0.044)	100	101.74 (15.266)	-0.346 (0.089)	103	188.48 (14.138)	0.652 (0.097)	101		
		Gea	0	0.455 (0.036)	188.465 (15.254)	0.528 (0.061)	101	99.94 (0.962)	0.537 (0.053)	100	189.78 (1.33)	-0.34 (0.05)	100		
			1.056	0.294 (0.042)	188.228 (17.552)	-0.656 (0.133)	101	102.36 (15.681)	0.383 (0.101)	87	189.27 (6.476)	-0.667 (0.085)	101		
		Hmpqq	0.188	0.317 (0.033)	189.396 (6.07)	0.663 (0.117)	101	100.08 (2.943)	-0.388 (0.064)	86	188.46 (14.572)	0.662 (0.128)	101		
			0.188	0.317 (0.033)	189.396 (6.07)	0.663 (0.117)	101	100.08 (2.943)	-0.388 (0.064)	86	188.46 (14.572)	0.662 (0.128)	101		
		400	0.2	RIL	100.03 (0.15)	0.198 (0.035)	189.922 (4.852)	1.031 (0.244)	102	100	1.085 (0.177)	101	189.26 (5.607)	-0.746 (0.115)	70
				TCRILQQ	102.11	0.203 (0.041)	82.333 (91.511)	-0.5 (0.063)	3	100.9 (9.14)	0.903 (0.2)	100	190.47 (4.582)	-0.982 (0.218)	101
					100.39	0.196 (0.036)	189.74 (1.011)	1.2 (0.129)	100	91 (40.15)	0.467 (0.012)	3	187.96 (4.811)	0.531 (0.089)	28
				SeaQQ	0	0.236 (0.04)	188.436 (12.996)	-0.671 (0.136)	101	99.261 (8.478)	0.427 (0.063)	69	189.84 (1.496)	-0.679 (0.096)	100
					0	0.236 (0.04)	188.436 (12.996)	0.671 (0.136)	101	99.261 (8.478)	-0.427 (0.063)	69	189.84 (1.496)	0.679 (0.096)	100
Gea	0			0.168 (0.042)	185.696 (24.987)	0.515 (0.173)	102	101.18 (12.516)	0.542 (0.137)	99	189.94 (3.507)	-0.427 (0.055)	50		
	1.041			0.09 (0.037)	189.9 (3.506)	-0.78 (0.122)	70	100 (37.676)	0.507 (0.506)	13	189.21 (11.595)	-0.761 (0.127)	76		
Hmpqq	0.172			0.101 (0.036)	189.671 (3.679)	0.756 (0.12)	85	103.83 (22.485)	-0.584 (0.104)	18	189.9 (5.757)	0.745 (0.136)	87		
	0.172			0.101 (0.036)	189.671 (3.679)	0.756 (0.12)	85	103.83 (22.485)	-0.584 (0.104)	18	189.9 (5.757)	0.745 (0.136)	87		

Table 5. Simulated and estimated QTL positions and effects for combining ability and heterosis under additive-dominance model with two alleles at each locus in RIL (selfs)-based NCI design.

n	h^2	Parameter values	Dataset	Trait mean	h^2	QTL1			QTL2			QTL3		
						Position	Effect	Power	Position	Effect	Power	Position	Effect	Power
200	0.8	RIL	100 99.969 (0.099)	0.806 (0.02)	192	1.2(1.5)	105	1.5(-1)	196	-1(2)	100			
					188.584	1.141	100.03	1.235	190.03	-0.802	100			
					(14.551)	(0.163)	(0.658)	(0.063)	(1.049)	(0.058)	101			
		TCRILQQ	102.085 (0.078)	0.803 (0.021)	177.172	-0.213	101.366	1.023	189.436	-1.209	101			
					(41.099)	(0.084)	(13.147)	(0.136)	(5.403)	(0.119)	100			
					187.204	1.223	99.944	0.23	189.99	0.408	100			
		TCRILqq	100.394 (0.052)	0.802 (0.021)	17.481	(0.215)	(9.331)	(0.064)	(1.915)	(0.057)	102			
					188.228	-0.7	100.12	0.417	187.863	-0.797	100			
					(18.731)	(0.068)	(0.82)	(0.038)	(17.378)	(0.103)	102			
		ScaQQ	0 (0.053)	0.834 (0.019)	188.228	0.7	100.12	-0.417	187.863	0.797	102			
					(18.731)	(0.068)	(0.82)	(0.038)	(17.378)	(0.103)	102			
					188.228	0.7	100.12	-0.417	187.863	0.797	102			
Scaqq	0 (0.053)	0.834 (0.019)	188.228	(0.068)	(0.82)	(0.038)	(17.378)	(0.103)	102					
			(18.731)	(0.068)	(0.82)	(0.038)	(17.378)	(0.103)	102					
			188.228	0.7	100.12	-0.417	187.863	0.797	102					
Gca	0 (0.048)	0.766 (0.027)	186.621	0.547	99.98	0.623	188.812	-0.414	101					
			(19.561)	(0.1)	(0.765)	(0.041)	(10.978)	(0.048)	101					
			188.902	-0.719	100.08	0.433	189.95	-0.836	100					
HmpQQ	1.05 (0.061)	0.626 (0.044)	16.168	(0.131)	(1.884)	(0.062)	(0.968)	(0.071)	100					
			(16.168)	(0.131)	(1.884)	(0.062)	(0.968)	(0.071)	100					
			187.049	0.682	100.12	-0.422	190.02	0.804	100					
Hmpqq	0.21 (0.067)	0.664 (0.036)	18.64	(0.102)	(1.506)	(0.064)	(0.995)	(0.064)	100					
			(18.64)	(0.102)	(1.506)	(0.064)	(0.995)	(0.064)	100					
			189.99	1.15	100.752	1.266	188.48	-0.829	100					
RIL	100.039 (0.142)	0.519 (0.046)	189.99	(1.337)	(6.798)	(0.228)	(10.926)	(0.186)	100					
			(1.337)	(0.135)	(6.798)	(0.228)	(10.926)	(0.186)	100					
			106	0.051	99.505	1.038	190.06	-1.209	100					
TCRILQQ	102.09 (0.087)	0.5 (0.042)	(121.622)	(0.691)	(18.982)	(0.204)	(1.127)	(0.117)	72					
			189.92	1.288	84.385	0.394	190.194	0.477	72					
			(0.981)	(0.107)	(29.742)	(0.045)	(2.243)	(0.077)	101					
TCRILqq	0 (0.073)	0.555 (0.048)	189.91	-0.725	98.97	0.432	188.574	-0.799	101					
			(1.464)	(0.077)	(7.803)	(0.104)	(15.167)	(0.137)	101					
			189.91	0.725	98.97	-0.432	188.574	0.799	101					
ScaQQ	0 (0.073)	0.555 (0.048)	(1.464)	(0.077)	(7.803)	(0.104)	(15.167)	(0.137)	94					
			188.32	0.584	100.535	0.635	188.67	-0.411	94					
			(17.057)	(0.075)	(5.649)	(0.087)	(10.302)	(0.1)	97					
Scaqq	0 (0.063)	0.555 (0.048)	188.105	-0.728	97.143	0.579	188.907	-0.829	97					
			(17.907)	(0.177)	(17.213)	(0.078)	(11.334)	(0.131)	101					
			188.539	0.725	103.018	-0.544	189.594	0.831	101					
Gca	0 (0.112)	0.341 (0.058)	(12.32)	(0.198)	(19.132)	(0.108)	(4.813)	(0.142)	101					
			(12.32)	(0.198)	(19.132)	(0.108)	(4.813)	(0.142)	101					
			188.539	0.725	103.018	-0.544	189.594	0.831	101					

Table 5 (contd)

n	h^2	Dataset	Trait mean	h^2	QTL1			QTL2			QTL3		
					Position	Effect	Power	Position	Effect	Power	Position	Effect	Power
200	0.2	RIL	100.012 (0.268)	0.181 (0.064)	191.28 (4.977)	1.326 (0.242)	100.762 (9.247)	1.393 (0.248)	84	183.84 (34.261)	-1.096 (0.423)	25	
		TCRILQQ	102.083 (0.21)	0.218 (0.06)	122.2 (66.744)	-0.225 (0.95)	99.18 (4.579)	1.168 (0.233)	89	188.357 (13.268)	-1.291 (0.318)	98	
		TCRILqq	100.393 (0.17)	0.198 (0.053)	188.388 (15.214)	1.262 (0.412)	211.333 (17.786)	-0.759 (0.061)	3	189.067 (15.98)	0.791 (0.082)	15	
		SeaQQ	0 (0.128)	0.23 (0.065)	189.069 (9.762)	-0.788 (0.147)	100.571 (8.004)	0.675 (0.121)	21	189.96 (3.908)	-0.881 (0.148)	100	
		Scaqq	0 (0.128)	0.23 (0.065)	189.069 (9.762)	0.788 (0.147)	100.571 (8.004)	-0.675 (0.121)	21	189.96 (3.908)	0.881 (0.148)	100	
		Gea	0 (0.114)	0.161 (0.063)	184.905 (25.299)	0.633 (0.302)	103.342 (23.447)	0.706 (0.248)	76	184.478 (21.637)	-0.665 (0.12)	23	
		HmpQQ	1.027 (0.227)	0.103 (0.04)	187.273 (7.51)	-1.176 (0.197)	93 (13.388)	1.092 (0.107)	9	185.529 (22.593)	-1.126 (0.428)	34	
		Hmpqq	0.187 (0.185)	0.114 (0.044)	189.452 (3.365)	1.045 (0.147)	113.857 (65.522)	-0.449 (0.973)	7	190.128 (2.551)	1.099 (0.177)	47	
		RIL	99.996 (0.073)	0.801 (0.017)	189.337 (7.088)	1.109 (0.139)	100.713 (7.182)	1.229 (0.151)	101	187.155 (17.15)	-0.783 (0.119)	103	
		TCRILQQ	102.103 (0.056)	0.802 (0.013)	183.929 (26.735)	-0.173 (0.026)	100.505 (4.597)	1.029 (0.098)	101	189.95 (0.479)	-1.19 (0.042)	100	
400	0.8	TCRILqq	100.399 (0.042)	0.802 (0.016)	188.901 (11.049)	1.236 (0.143)	101.248 (13.271)	0.213 (0.049)	101	189.495 (4.778)	0.4 (0.066)	101	
		SeaQQ	0 (0.04)	0.829 (0.013)	187.495 (21.144)	-0.677 (0.104)	100.535 (5.129)	0.417 (0.043)	101	189.96 (0.425)	-0.792 (0.027)	100	
		Scaqq	0 (0.04)	0.829 (0.013)	187.495 (21.144)	0.677 (0.104)	100.535 (5.129)	-0.417 (0.043)	101	189.96 (0.425)	0.792 (0.027)	100	
		Gea	0 (0.034)	0.767 (0.018)	189.95 (0.609)	0.565 (0.03)	100 (0.512)	0.624 (0.031)	100	190.06 (0.862)	-0.403 (0.025)	100	
		HmpQQ	1.055 (0.049)	0.609 (0.03)	187.775 (15.518)	-0.69 (0.095)	99.88 (1.289)	0.429 (0.051)	100	189.89 (0.737)	-0.805 (0.043)	100	
		Hmpqq	0.201 (0.047)	0.666 (0.028)	186.117 (22.54)	0.681 (0.134)	100.03 (1.058)	-0.422 (0.046)	100	189.96 (0.695)	0.799 (0.042)	100	

Table 5 (contd)

n	h^2	Dataset	Trait mean	h^2	QTL1			QTL2			QTL3		
					Position	Effect	Power	Position	Effect	Power	Position	Effect	Power
400	0.5	RIL	100.002 (0.106)	0.509 (0.032)	189.92 (0.918)	1.143 (0.11)	100	100.1 (0.847)	1.267 (0.099)	100	186.233 (21.381)	-0.785 (0.161)	103
		TCRILQQ	102.096 (0.084)	0.502 (0.029)	188 (8.767)	-0.31 (0.069)	8	100.08 (0.849)	1.047 (0.085)	100	187.657 (17.385)	-1.186 (0.14)	102
		TCRILqq	100.409 (0.068)	0.5 (0.037)	186.961 (22.075)	1.227 (0.223)	102	99.705 (11.978)	0.287 (0.043)	44	188.47 (15.837)	0.421 (0.069)	100
		SeaQQ	0 (0.056)	0.552 (0.029)	186.33 (21.62)	-0.687 (0.144)	103	99.88 (1.358)	0.422 (0.054)	100	187.873 (16.496)	-0.789 (0.126)	102
		Scaqq	0 (0.056)	0.552 (0.029)	186.33 (21.62)	0.687 (0.144)	103	99.88 (1.358)	-0.422 (0.054)	100	187.873 (16.496)	0.789 (0.126)	102
		Gca	0 (0.046)	0.45 (0.039)	189.89 (1.014)	0.563 (0.055)	100	102.412 (15.576)	0.622 (0.108)	102	185.24 (25.454)	-0.397 (0.084)	104
		HmpQQ	1.044 (0.076)	0.288 (0.042)	189.059 (12.746)	-0.72 (0.146)	102	100.325 (2.248)	0.459 (0.075)	83	188.515 (15.496)	-0.822 (0.093)	101
		Hmpqq	0.208 (0.075)	0.337 (0.031)	186.563 (22.792)	0.675 (0.192)	103	101.865 (13.815)	-0.432 (0.135)	96	187.049 (21.148)	0.803 (0.104)	102
		RIL	99.997 (0.188)	0.201 (0.037)	187.683 (19.783)	1.131 (0.322)	101	99.778 (1.718)	1.253 (0.19)	99	187.902 (18.906)	-0.872 (0.23)	82
		TCRILQQ	102.068 (0.155)	0.21 (0.037)	70 (0)	0.547 (0)	1	101.089 (9.503)	1.071 (0.152)	101	187.529 (18.692)	-1.267 (0.206)	102
400	0.2	TCRILqq	100.391 (0.103)	0.195 (0.041)	190.05 (1.351)	1.304 (0.14)	100	166.5 (85.56)	0.554 (0.057)	2	187.026 (22.666)	0.511 (0.316)	39
		SeaQQ	0 (0.104)	0.246 (0.045)	188.287 (16.499)	-0.731 (0.164)	101	102.868 (18.804)	0.483 (0.134)	76	190.17 (1.505)	-0.849 (0.127)	100
		Scaqq	0 (0.104)	0.246 (0.045)	188.287 (16.499)	0.731 (0.164)	101	102.868 (18.804)	-0.483 (0.134)	76	190.17 (1.505)	0.849 (0.127)	100
		Gca	0 (0.08)	0.169 (0.039)	188.74 (12.442)	0.584 (0.152)	96	100.51 (15.442)	0.636 (0.097)	102	187.027 (22.275)	-0.486 (0.081)	74
		HmpQQ	1.02 (0.154)	0.093 (0.035)	190.091 (2.265)	-0.885 (0.129)	66	98.727 (5.605)	0.777 (0.076)	11	187.583 (20.701)	-0.963 (0.181)	84
		Hmpqq	0.193 (0.126)	0.11 (0.04)	190.053 (2.673)	0.827 (0.135)	76	99.905 (8.689)	-0.692 (0.093)	21	189.903 (6.219)	0.863 (0.16)	93

Table 6. Simulated and estimated QTL positions and effects for combining ability and heterosis under additive-dominance model with four alleles at each locus in BC-based NCII design.

n	h^2	Dataset	Trait mean	h^2	QTL1			QTL2			QTL3					
					Position	Effect	Power	Position	Effect	Power	Position	Effect	Power			
200	0.8	BC	100		192	1.2(1.5)	2	105	1.5(-1)	196	-1(2)	99	190.051	-4.926	99	
			102.494 (0.073)	0.738 (0.032)	104 (120.208)	0.666 (0.033)	99.828 (0.99)	5.078 (0.271)	99	99.909 (1.001)	190.051 (0.999)	(0.257)	99	190.111	1.139	99
		TCBC1	102.388 (0.046)	0.733 (0.033)	190.071 (1.003)	-2.673 (0.161)	99.909 (1.001)	2.647 (0.164)	99	99.909 (1.001)	190.051 (1.004)	(0.181)	99	190.111	-2.148	99
			102.2 (0.037)	0.731 (0.035)	190 (1.414)	0.503 (0.019)	99.909 (1.001)	3.336 (0.143)	2	99.909 (1.001)	190.051 (1.004)	(0.172)	99	190.111	4.083	99
		TCBC3	102.596 (0.042)	0.737 (0.034)	190.131 (0.996)	1.939 (0.174)	98.917 (3.891)	0.565 (0.12)	99	98.917 (3.891)	190.131 (0.996)	(0.145)	48	190.131	4.083	99
			98.436 (0.04)	0.738 (0.026)	189.99 (1.005)	-1.322 (0.183)	100.051 (1.004)	-2.08 (0.145)	99	100.051 (1.004)	190.192 (0.986)	(-3.094)	99	190.192	-3.094	99
		Sca1	0 (0.036)	0.715 (0.033)	189.99 (1.005)	-2.206 (0.127)	99.889 (0.999)	1.581 (0.133)	99	99.889 (0.999)	190.111 (0.999)	1.146 (0.142)	99	190.111	1.146	99
			0 (0.033)	0.725 (0.035)	189.99 (1.005)	0.652 (0.142)	100.03 (1.005)	2.268 (0.129)	99	100.03 (1.005)	190.091 (1.001)	(-2.138)	99	190.091	-2.138	99
		Sca3	0 (0.044)	0.758 (0.031)	190.091 (1.001)	2.405 (0.177)	100.043 (1.004)	-0.705 (0.176)	99	100.043 (1.004)	190.131 (0.996)	4.082 (0.135)	99	190.131	4.082	99
			0 (0.043)	0.76 (0.027)	189.99 (1.005)	-0.839 (0.178)	100.051 (1.004)	-3.148 (0.141)	99	100.051 (1.004)	190.152 (0.993)	(-3.087)	99	190.152	-3.087	99
		gca	0 (0.013)	0.637 (0.041)	190.131 (0.996)	-0.476 (0.059)	99.929 (1.003)	1.077 (0.055)	99	99.929 (1.003)	79 (42.426)	(-0.081)	2	79	-0.081	99
			-1.258 (0.048)	0.712 (0.03)	189.99 (1.005)	-2.694 (0.198)	100.03 (1.003)	(0.055)	99	100.03 (1.003)	190.111 (0.999)	3.59 (0.179)	99	190.111	3.59	99
		Hmp2	-1.249 (0.025)	0.204 (0.057)	168 (52.449)	0.12 (0.48)	100.131 (1.345)	0.835 (0.126)	8	100.131 (1.345)	189.649 (7.587)	0.489 (0.077)	37	189.649	0.489	37
			-1.227 (0.057)	0.757 (0.035)	190.131 (0.996)	1.9 (0.253)	100.01 (1.005)	-2.156 (0.28)	99	100.01 (1.005)	190.051 (1.004)	6.552 (0.211)	99	190.051	6.552	99
		Hmp4	-1.26 (0.035)	0.727 (0.037)	189.97 (1.005)	-1.329 (0.197)	99.99 (1.005)	-4.591 (0.163)	99	99.99 (1.005)	188.707 (10.365)	(-0.725)	75	188.707	-0.725	75

Table 6 (contd)

n	h^2	Dataset	Trait mean	h^2	QTL1			QTL2			QTL3		
					Position	Effect	Power	Position	Effect	Power	Position	Effect	Power
200	0.5	BC	102.506 (0.099)	0.605 (0.037)	9 (0)	1.011 (0)	1	99.96 (1.004)	4.998 (0.376)	100	189.96 (1.004)	-4.871 (0.406)	100
		TCBC1	102.412 (0.061)	0.605 (0.034)	190.08 (1.002)	-2.681 (0.219)	100	99.94 (1.003)	2.686 (0.221)	100	189.788 (1.335)	1.152 (0.246)	99
		TCBC2	102.2 (0.059)	0.608 (0.035)	188 (4.761)	0.559 (0.079)	4	99.94 (1.003)	3.36 (0.189)	100	189.98 (1.005)	-2.139 (0.211)	100
		TCBC3	102.579 (0.065)	0.601 (0.04)	189.9 (1)	2.001 (0.254)	100	100.125 (21.565)	0.848 (0.119)	16	190.1 (1)	4.085 (0.248)	100
		TCBC4	98.458 (0.057)	0.61 (0.039)	190.06 (1.003)	-1.354 (0.208)	100	99.94 (1.003)	-2.108 (0.183)	100	190.14 (0.995)	-3.122 (0.208)	100
		Sea1	0 (0.046)	0.553 (0.038)	190.02 (1.005)	-2.211 (0.19)	100	99.98 (1.005)	1.604 (0.194)	100	189.94 (1.003)	1.164 (0.211)	100
		Sea2	0 (0.052)	0.578 (0.04)	188.139 (20.563)	0.694 (0.228)	72	99.92 (1.002)	2.274 (0.167)	100	189.94 (1.003)	-2.131 (0.183)	100
		Sea3	0 (0.061)	0.659 (0.039)	189.98 (1.005)	2.464 (0.197)	100	99.881 (3.935)	-0.816 (0.176)	59	190.08 (1.002)	4.084 (0.232)	100
		Sea4	0 (0.053)	0.672 (0.035)	189.99 (1.86)	-0.876 (0.218)	99	99.94 (1.003)	-3.179 (0.198)	100	190.06 (1.003)	-3.115 (0.215)	100
		gca	0 (0.018)	0.411 (0.049)	190.143 (1.664)	-0.5 (0.101)	91	99.96 (1.004)	1.096 (0.1)	100	-	-	0
		Hmp1	-1.241 (0.071)	0.539 (0.042)	190.02 (1.005)	-2.657 (0.244)	100	91 (0)	0.919 (0)	1	189.98 (1.005)	3.552 (0.306)	100
		Hmp2	-1.25 (0.051)	0.089 (0.03)	137.5 (83.704)	-0.067 (1.015)	4	98.869 (5.136)	1.05 (0.153)	61	190 (1.414)	0.937 (0.022)	2
		Hmp3	-1.253 (0.08)	0.661 (0.036)	189.78 (1.474)	2.012 (0.31)	100	100.16 (0.992)	-2.086 (0.394)	100	190.04 (1.004)	6.534 (0.309)	100
		Hmp4	-1.239 (0.061)	0.575 (0.043)	190.04 (1.348)	-1.356 (0.271)	100	99.94 (1.003)	-4.61 (0.283)	100	187.424 (23.301)	-0.93 (0.388)	33

Table 6 (contd)

n	h^2	Dataset	Trait mean	h^2	QTL1			QTL2			QTL3		
					Position	Effect	Power	Position	Effect	Power	Position	Effect	Power
200	0.2	BC	102.515 (0.166)	0.367 (0.043)	101 (28.284)	-0.759 (3.07)	2	100.138 (0.999)	5.181 (0.681)	58	189.724 (0.97)	-5.048 (0.646)	58
		TCBC1	102.396 (0.097)	0.353 (0.049)	190.207 (0.987)	-2.729 (0.382)	58	100.172 (0.994)	2.736 (0.385)	58	190.5 (3.079)	1.517 (0.317)	24
		TCBC2	102.21 (0.089)	0.354 (0.045)	-	-	0	100 (1.009)	3.401 (0.361)	58	190.207 (1.542)	-2.152 (0.338)	58
		TCBC3	102.578 (0.11)	0.344 (0.049)	190.164 (0.996)	2.095 (0.38)	55	99 (0)	1.565 (0)	1	190 (1.009)	4.063 (0.404)	58
		TCBC4	98.46 (0.091)	0.35 (0.066)	190.032 (3.61)	-1.643 (0.281)	31	100.193 (1.552)	-2.166 (0.359)	57	190.172 (0.994)	-3.189 (0.368)	58
		Sea1	0 (0.072)	0.289 (0.066)	190.31 (0.959)	-2.24 (0.321)	58	100.115 (2.22)	1.689 (0.318)	52	190.091 (4.003)	1.42 (0.267)	33
		Sea2	0 (0.071)	0.311 (0.043)	187.8 (5.02)	1.313 (0.151)	5	99.828 (0.994)	2.33 (0.307)	58	189.897 (1.003)	-2.136 (0.267)	58
		Sea3	0 (0.098)	0.436 (0.045)	190.207 (0.987)	2.501 (0.352)	58	103 (18.726)	-1.422 (0.323)	7	190.103 (1.003)	4.062 (0.33)	58
		Sea4	0 (0.087)	0.453 (0.046)	187.25 (8.851)	-1.347 (0.213)	16	100 (1.009)	-3.227 (0.352)	58	190.103 (1.003)	-3.152 (0.322)	58
		gca	0 (0.037)	0.158 (0.047)	184.385 (16.641)	-0.768 (0.095)	13	100.793 (5.2)	1.128 (0.177)	58	-	-	0
		Hmp1	-1.261 (0.104)	0.303 (0.045)	190.276 (1.531)	-2.823 (0.484)	58	-	-	0	189.862 (0.999)	3.725 (0.436)	58
		Hmp2	-1.243 (0.095)	0.069 (0.013)	-	-	0	105.667 (5.774)	1.801 (0.137)	3	119 (0)	-1.693 (0)	1
		Hmp3	-1.244 (0.139)	0.431 (0.057)	190.947 (4.299)	2.277 (0.413)	38	99.091 (6.484)	-2.415 (0.497)	44	190 (1.009)	6.558 (0.548)	58
		Hmp4	-1.242 (0.104)	0.309 (0.048)	184.6 (21.276)	-2.132 (0.38)	15	100.069 (1.006)	-4.742 (0.429)	58	199 (0)	-2.36 (0)	1

Table 6 (contd)

n	h^2	Dataset	Trait mean	h^2	QTL1			QTL2			QTL3		
					Position	Effect	Power	Position	Effect	Power	Position	Effect	Power
400	0.8	BC	102.508 (0.061)	0.724 (0.023)	61 (0)	-0.597 (0)	1	100 (1.005)	5 (0.183)	94	189.957 (1.004)	-4.865 (0.203)	94
		TCBC1	102.39 (0.032)	0.726 (0.021)	190.043 (1.004)	-2.655 (0.114)	94	99.915 (1.002)	2.665 (0.099)	94	189.83 (0.991)	1.141 (0.121)	94
		TCBC2	102.2 (0.029)	0.728 (0.022)	185.952 (18.107)	0.349 (0.076)	21	99.957 (1.004)	3.32 (0.084)	94	189.915 (1.002)	-2.118 (0.126)	94
		TCBC3	103.879 (0.014)	0.723 (0.025)	189.979 (1.005)	1.77 (0.047)	94	99.915 (1.002)	-0.423 (0.062)	94	189.894 (1)	0.818 (0.059)	94
		TCBC4	98.455 (0.033)	0.724 (0.022)	190.064 (1.003)	-1.335 (0.112)	94	100.021 (1.005)	-2.062 (0.108)	94	189.915 (1.002)	-3.075 (0.093)	94
		Sea1	0 (0.029)	0.729 (0.022)	190.064 (1.003)	-2.145 (0.111)	94	99.894 (1)	1.791 (0.083)	94	189.915 (1.002)	1.949 (0.09)	94
		Sea2	0 (0.022)	0.711 (0.023)	189.915 (1.002)	0.701 (0.102)	94	100.043 (1.004)	2.448 (0.068)	94	189.936 (1.003)	-1.312 (0.089)	94
		Sea3	0 (0.024)	0.751 (0.024)	190.021 (1.005)	2.28 (0.071)	94	99.979 (1.005)	-1.301 (0.083)	94	189.915 (1.002)	1.623 (0.08)	94
		Sea4	0 (0.03)	0.737 (0.021)	190.043 (1.004)	-0.83 (0.116)	94	99.957 (1.004)	-2.93 (0.097)	94	189.872 (0.997)	-2.265 (0.1)	94
		gca	0 (0.011)	0.685 (0.026)	190.128 (0.997)	-0.512 (0.044)	94	99.957 (1.004)	0.878 (0.036)	94	189.957 (1.004)	-0.811 (0.044)	94
		Hmp1	-1.264 (0.038)	0.702 (0.026)	190.043 (1.004)	-2.664 (0.166)	94	99.5 (1)	0.366 (0.108)	4	189.979 (1.005)	3.566 (0.11)	94
		Hmp2	-1.247 (0.018)	0.208 (0.036)	188.636 (20.373)	0.345 (0.063)	11	99.979 (1.005)	0.842 (0.09)	94	189.623 (2.491)	0.393 (0.069)	61
		Hmp3	0.055 (0.042)	0.742 (0.024)	189.915 (1.002)	1.773 (0.151)	94	100.043 (1.004)	-2.917 (0.129)	94	189.957 (1.004)	3.258 (0.122)	94
		Hmp4	-1.245 (0.029)	0.715 (0.025)	190.106 (1)	-1.35 (0.15)	94	100.021 (1.005)	-4.564 (0.117)	94	190 (1.005)	-0.658 (0.136)	94

Table 6 (contd)

n	h^2	Dataset	Trait mean	h^2	QTL1			QTL2			QTL3		
					Position	Effect	Power	Position	Effect	Power	Position	Effect	Power
400	0.5	BC	102.508 (0.08)	0.594 (0.024)	165 (93.338)	-0.719 (0.078)	2	99.99 (1.005)	4.982 (0.283)	97	190.134 (0.996)	-4.877 (0.251)	97
		TCBC1	102.404 (0.044)	0.597 (0.027)	190.031 (1.005)	-2.678 (0.154)	97	100.052 (1.004)	2.653 (0.154)	97	189.928 (1.003)	1.17 (0.179)	97
		TCBC2	102.202 (0.042)	0.596 (0.031)	190.143 (5.872)	0.484 (0.067)	7	99.948 (1.004)	3.359 (0.157)	97	190.072 (1.003)	-2.12 (0.165)	97
		TCBC3	103.877 (0.019)	0.598 (0.03)	190.113 (0.999)	1.787 (0.078)	97	99.969 (1.005)	-0.427 (0.086)	97	190.093 (1.001)	0.833 (0.079)	97
		TCBC4	98.448 (0.05)	0.596 (0.026)	189.948 (1.004)	-1.355 (0.156)	97	100.052 (1.004)	-2.082 (0.158)	97	189.887 (0.999)	-3.094 (0.153)	97
		Sca1	0 (0.037)	0.606 (0.027)	190.072 (1.003)	-2.167 (0.134)	97	100.052 (1.004)	1.772 (0.143)	97	189.907 (1.001)	1.969 (0.14)	97
		Sca2	0 (0.032)	0.554 (0.035)	189.99 (1.005)	0.699 (0.132)	97	99.948 (1.004)	2.484 (0.131)	97	190.093 (1.001)	-1.314 (0.123)	97
		Sca3	0 (0.028)	0.674 (0.027)	189.948 (1.004)	2.3 (0.102)	97	99.845 (0.993)	-1.304 (0.108)	97	190.01 (1.005)	1.631 (0.106)	97
		Sca4	0 (0.041)	0.632 (0.027)	190.01 (1.005)	-0.835 (0.145)	97	100.01 (1.005)	-2.949 (0.134)	97	189.907 (1.001)	-2.291 (0.144)	97
		gca	0 (0.015)	0.494 (0.033)	189.99 (1.005)	-0.52 (0.069)	97	99.907 (1.001)	0.885 (0.057)	97	190.072 (1.003)	-0.813 (0.066)	97
		Hmp1	-1.25 (0.043)	0.542 (0.033)	190.093 (1.001)	-2.689 (0.176)	97	39 (0)	0.684 (0)	1	189.928 (1.003)	3.59 (0.197)	97
		Hmp2	-1.247 (0.04)	0.073 (0.026)	122.5 (72.524)	0.024 (0.752)	4	99.946 (1.004)	0.915 (0.164)	93	194.273 (10.817)	0.663 (0.091)	11
		Hmp3	0.05 (0.041)	0.643 (0.027)	190.072 (1.003)	1.796 (0.202)	97	99.928 (1.003)	-2.919 (0.171)	97	190.01 (1.005)	3.296 (0.155)	97
		Hmp4	-1.256 (0.046)	0.563 (0.028)	189.928 (1.003)	-1.339 (0.208)	97	99.948 (1.004)	-4.569 (0.184)	97	188.031 (17.079)	-0.761 (0.235)	64

Table 6 (contd)

n	h^2	Dataset	Trait mean	h^2	QTL1			QTL2			QTL3		
					Position	Effect	Power	Position	Effect	Power	Position	Effect	Power
400	0.2	BC	102.508 (0.111)	0.349 (0.034)	90 (55.154)	2.037 (0.373)	2	99.938 (1.003)	5.071 (0.448)	96	190.125 (0.997)	-4.958 (0.462)	96
		TCBC1	102.392 (0.067)	0.357 (0.037)	189.854 (0.995)	-2.707 (0.287)	96	100.25 (0.973)	2.707 (0.248)	96	190.529 (3.75)	1.242 (0.222)	85
		TCBC2	102.197 (0.062)	0.348 (0.033)	141 (0)	0.994 (0)	1	100.167 (0.991)	3.345 (0.269)	96	190.063 (1.003)	-2.153 (0.262)	96
		TCBC3	103.872 (0.033)	0.346 (0.036)	189.917 (1.002)	1.792 (0.132)	96	104.174 (18.741)	-0.561 (0.095)	46	189.813 (1.348)	0.827 (0.131)	96
		TCBC4	98.459 (0.061)	0.353 (0.035)	190.255 (1.633)	-1.456 (0.281)	94	99.958 (1.004)	-2.133 (0.273)	96	189.958 (1.004)	-3.104 (0.275)	96
		Sea1	0 (0.057)	0.369 (0.036)	189.875 (0.997)	-2.172 (0.268)	96	100.146 (0.995)	1.836 (0.214)	96	190.063 (1.003)	1.984 (0.218)	96
		Sea2	0 (0.044)	0.291 (0.038)	190.277 (2.811)	0.894 (0.149)	47	100.063 (1.003)	2.487 (0.217)	96	189.872 (1.648)	-1.348 (0.215)	94
		Sea3	0 (0.038)	0.471 (0.036)	190.104 (1)	2.321 (0.152)	96	100.25 (0.973)	-1.3 (0.18)	96	189.875 (0.997)	1.622 (0.161)	96
		Sea4	0 (0.052)	0.405 (0.038)	189.261 (7.776)	-1.029 (0.205)	69	100.083 (1.002)	-2.978 (0.236)	96	189.979 (1.005)	-2.295 (0.229)	96
		gca	0 (0.024)	0.242 (0.034)	190.523 (2.845)	-0.574 (0.091)	88	100.333 (0.948)	0.888 (0.127)	96	189.958 (1.004)	-0.83 (0.109)	96
		Hmp1	-1.262 (0.066)	0.291 (0.034)	190 (1.005)	-2.73 (0.379)	96	- (1.003)	- (0.284)	0	190.063 (1.003)	3.633 (0.284)	96
		Hmp2	-1.252 (0.07)	0.042 (0.012)	83.667 (66.04)	-0.442 (1.391)	3	104.81 (14.925)	1.367 (0.188)	21	193.667 (6.429)	1.301 (0.008)	3
		Hmp3	0.042 (0.066)	0.41 (0.033)	189.896 (1)	1.841 (0.28)	96	100.042 (1.004)	-2.923 (0.269)	96	189.833 (0.991)	3.25 (0.245)	96
		Hmp4	-1.24 (0.071)	0.312 (0.037)	190.178 (2.329)	-1.591 (0.301)	73	100.125 (0.997)	-4.651 (0.33)	96	175.333 (46.074)	-0.943 (1.04)	12

Table 7. Simulated and estimated QTL positions and effects for combining ability and heterosis under additive-dominance model with four alleles at each locus in F₂-based NCII design.

n	h^2	Dataset	Trait mean	h^2	QTL1			QTL2			QTL3					
					Position	A effect	D effect	Power	Position	A effect	D effect	Power	Position	A effect	D effect	Power
200	0.8	F ₂	101.21	0.926	188.683	1.438	1.392	101	195	1.79	-0.829	101	196	-0.864	1.542	102
			(0.105)	(0.007)	(11.946)	(0.154)	(0.204)	(6.992)	(0.193)	(0.15)	(19.67)	(0.132)	(0.211)	(187.167)	(0.132)	(0.211)
		TCF21	101.996	0.925	189.545	-1.437	0.008	101	100.06	1.45	0.009	100	188.455	0.623	-0.003	101
			(0.081)	(0.007)	(5.025)	(0.163)	(0.069)	(0.694)	(0.052)	(0.061)	(15.667)	(0.063)	(0.069)	(188.455)	(0.063)	(0.069)
		TCF22	101.783	0.924	162.111	0.14	-0.013	9	99.91	1.815	-0.003	100	189.584	-1.145	0.001	101
			(0.079)	(0.009)	(67.936)	(0.067)	(0.152)	(0.494)	(0.05)	(0.059)	(4.733)	(0.109)	(0.067)	(189.584)	(0.109)	(0.067)
		TCF23	100.673	0.926	190.15	1.069	-0.002	100	99.413	0.255	0.006	80	190	2.208	0	100
			(0.094)	(0.009)	(0.857)	(0.053)	(0.084)	(10.543)	(0.054)	(0.095)	(0.449)	(0.053)	(0.062)	(190)	(0.053)	(0.062)
		TCF24	100.393	0.926	188.748	-0.707	0.011	103	99.624	-1.129	0.001	101	190	-1.677	-0.006	100
			(0.082)	(0.008)	(9.531)	(0.137)	(0.074)	(4.183)	(0.138)	(0.07)	(0.62)	(0.054)	(0.069)	(190)	(0.054)	(0.069)
		Sea1	0	0.9	188.96	-1.185	0.006	101	100.03	0.861	0.006	100	189.347	0.621	-0.002	101
			(0.062)	(0.009)	(10.968)	(0.126)	(0.059)	(0.846)	(0.044)	(0.057)	(8.131)	(0.058)	(0.064)	(189.347)	(0.058)	(0.064)
		Sea2	0	0.913	188.069	0.342	-0.01	102	98.314	1.205	-0.008	102	189.475	-1.145	0.004	101
			(0.064)	(0.01)	(18.903)	(0.052)	(0.064)	(11.406)	(0.166)	(0.052)	(5.414)	(0.111)	(0.061)	(189.475)	(0.111)	(0.061)
		Sea3	0	0.952	188.911	1.307	-0.005	101	100.466	-0.348	0.008	103	190.02	2.207	0.003	100
			(0.095)	(0.006)	(9.962)	(0.13)	(0.064)	(9.851)	(0.062)	(0.074)	(0.512)	(0.045)	(0.049)	(190.02)	(0.045)	(0.049)
		Sea4	0	0.954	189.01	-0.45	0.007	105	99.069	-1.713	-0.004	101	190.02	-1.678	-0.003	100
			(0.086)	(0.005)	(8.436)	(0.103)	(0.072)	(8.271)	(0.168)	(0.058)	(0.568)	(0.046)	(0.056)	(190.02)	(0.046)	(0.056)
		gca	0	0.804	190.03	-0.255	0.001	101	99.059	0.586	0.002	101	178	-0.096	-0.031	1
			(0.022)	(0.023)	(2.007)	(0.031)	(0.04)	(7.977)	(0.07)	(0.03)	(0)	(0)	(0)	(178)	(0)	(0)
		Hmp1	0.391	0.927	189.96	-2.174	-0.698	100	100.981	0.535	0.42	103	188.255	1.047	-0.771	102
			(0.09)	(0.008)	(0.602)	(0.058)	(0.082)	(17.285)	(0.1)	(0.118)	(6.026)	(0.157)	(0.159)	(188.255)	(0.157)	(0.159)
		Hmp2	0.274	0.81	189.245	-0.625	-0.701	102	100.644	0.905	0.405	101	189.515	-0.699	-0.783	101
			(0.064)	(0.024)	(7.176)	(0.114)	(0.172)	(8.124)	(0.094)	(0.093)	(6.026)	(0.104)	(0.123)	(189.515)	(0.104)	(0.123)
Hmp3	-0.258	0.925	189.8	0.337	-0.717	100	101.637	-0.658	0.428	102	190.04	2.654	-0.78	100		
	(0.09)	(0.009)	(1.435)	(0.063)	(0.107)	(11.211)	(0.096)	(0.1)	(0.602)	(0.065)	(0.084)	(190.04)	(0.065)	(0.084)	(190.04)	
Hmp4	-0.413	0.939	187.461	-1.429	-0.675	102	99.525	-2.014	0.408	101	188.941	-1.221	-0.785	101		
	(0.1)	(0.007)	(17.845)	(0.187)	(0.143)	(4.606)	(0.237)	(0.088)	(11.571)	(0.128)	(0.093)	(188.941)	(0.128)	(0.093)	(188.941)	

Table 7 (*contd*)

n	h^2	Dataset	Trait mean	h^2	QTL1			QTL2			QTL3					
					Position	A effect	D effect	Power	Position	A effect	D effect	Power	Position	A effect	D effect	Power
200	0.5	F ₂	101.203 (0.135)	0.76 (0.026)	190.11 (1.171)	1.47 (0.122)	1.423 (0.192)	100	99.178 (10.014)	1.803 (0.258)	-0.822 (0.199)	101	190.18 (1.617)	-0.894 (0.121)	1.619 (0.207)	100
		TCF21	101.99 (0.1)	0.761 (0.024)	188.515 (13.161)	-1.447 (0.151)	-0.007 (0.133)	101	100.515 (5.255)	1.435 (0.146)	0.02 (0.146)	101	187.183 (17.038)	0.61 (0.146)	0.002 (0.15)	104
		TCF22	101.796 (0.09)	0.757 (0.025)	180 (0)	0.315 (0)	-0.198 (0)	1	100.02 (0.752)	1.826 (0.089)	-0.006 (0.115)	100	190 (1.263)	-1.163 (0.091)	-0.004 (0.123)	100
		TCF23	100.628 (0.107)	0.753 (0.028)	189.94 (1.523)	1.106 (0.108)	-0.003 (0.166)	100	98.9 (21.184)	0.402 (0.111)	-0.094 (0.233)	10	188.693 (11.663)	2.209 (0.226)	-0.006 (0.165)	101
		TCF24	100.422 (0.11)	0.764 (0.025)	186.869 (22.17)	-0.695 (0.182)	0.014 (0.171)	107	101.149 (13.42)	-1.14 (0.168)	0.009 (0.136)	101	189.337 (6.939)	-1.664 (0.207)	-0.012 (0.155)	101
		Sca1	0 (0.077)	0.696 (0.028)	189.76 (1.129)	-1.207 (0.081)	-0.01 (0.111)	100	99.94 (1.523)	0.864 (0.084)	0.013 (0.128)	100	188.157 (17.65)	0.62 (0.086)	-0.001 (0.129)	102
		Sca2	0 (0.068)	0.723 (0.031)	185.985 (22.283)	0.386 (0.07)	0.004 (0.145)	68	100.792 (8.812)	1.224 (0.168)	-0.014 (0.11)	101	189.76 (1.207)	-1.165 (0.089)	-0.002 (0.121)	100
		Sca3	0 (0.104)	0.827 (0.019)	186.794 (21.856)	1.314 (0.219)	0.005 (0.158)	102	101.419 (11.881)	-0.404 (0.084)	-0.006 (0.173)	62	189.89 (0.737)	2.222 (0.092)	0.003 (0.126)	100
		Sca4	0 (0.099)	0.845 (0.016)	190.028 (13.01)	-0.463 (0.108)	0.018 (0.143)	106	98.157 (12.758)	-1.703 (0.249)	0.007 (0.122)	102	188.98 (9.987)	-1.666 (0.198)	-0.007 (0.131)	101
		gca	0 (0.029)	0.507 (0.051)	190.794 (7.317)	-0.259 (0.054)	0.006 (0.086)	97	99.99 (1.259)	0.593 (0.045)	0.004 (0.069)	100	127 (117.38)	-0.002 (0.177)	-0.008 (0.252)	2
		Hmp1	0.389 (0.116)	0.764 (0.027)	188.188 (17.324)	-2.166 (0.212)	-0.696 (0.175)	101	100.268 (8.27)	0.537 (0.11)	0.437 (0.216)	97	190.01 (1.567)	1.082 (0.099)	-0.821 (0.165)	100
		Hmp2	0.292 (0.082)	0.522 (0.047)	189.9 (2.564)	-0.647 (0.11)	-0.689 (0.168)	100	100.16 (1.587)	0.916 (0.122)	0.417 (0.144)	100	188.396 (15.294)	-0.707 (0.157)	-0.82 (0.192)	101
		Hmp3	-0.295 (0.121)	0.754 (0.033)	189.084 (5.867)	0.375 (0.119)	-0.749 (0.236)	83	100.34 (9.142)	-0.653 (0.157)	0.396 (0.226)	103	187.784 (15.999)	2.623 (0.401)	-0.779 (0.244)	102
		Hmp4	-0.379 (0.124)	0.801 (0.021)	188.99 (13.508)	-1.455 (0.15)	-0.703 (0.179)	101	99.94 (0.776)	-2.052 (0.112)	0.435 (0.158)	100	188.762 (12.893)	-1.239 (0.176)	-0.792 (0.217)	101

Table 7 (*contd*)

n	h^2	Dataset	Trait mean	h^2	QTL1			QTL2			QTL3					
					Position	A effect	D effect	Power	Position	A effect	D effect	Power	Position	A effect	D effect	Power
200	0.2	F ₂	101.237 (0.203)	0.45 (0.051)	190.333 (2.395)	1.468 (0.273)	1.455 (0.344)	99	100.111 (2.377)	1.817 (0.215)	-0.922 (0.353)	99	190.031 (2.17)	-0.931 (0.237)	1.766 (0.349)	98
		TCF21	101.987 (0.139)	0.435 (0.056)	190.33 (1.859)	-1.464 (0.202)	0.029 (0.284)	100	99.93 (2.051)	1.498 (0.176)	-0.007 (0.277)	100	186.396 (23.452)	0.739 (0.197)	-0.009 (0.346)	48
		TCF22	101.789 (0.143)	0.441 (0.05)	187 (0)	0.322 (0)	-1.101 (0)	1	99.297 (5.542)	1.791 (0.232)	-0.003 (0.277)	101	189.475 (7.05)	-1.207 (0.196)	0.028 (0.286)	99
		TCF23	100.648 (0.145)	0.442 (0.054)	190.286 (8.652)	1.133 (0.274)	-0.048 (0.355)	91	130 (0)	0.667 (0)	1.023 (0)	1	188.716 (10.275)	2.226 (0.358)	0.012 (0.316)	102
		TCF24	100.388 (0.142)	0.434 (0.061)	186.138 (24.996)	-0.817 (0.241)	0.051 (0.375)	58	98.564 (11.697)	-1.139 (0.256)	0.053 (0.366)	101	189.228 (9.218)	-1.68 (0.306)	-0.019 (0.298)	101
		Sca1	0 (0.105)	0.365 (0.061)	190.57 (2.021)	-1.213 (0.167)	0.038 (0.256)	100	100.253 (11.711)	0.899 (0.187)	-0.006 (0.287)	99	188.75 (18.677)	0.716 (0.146)	0.008 (0.271)	64
		Sca2	0 (0.119)	0.392 (0.055)	168.727 (60.078)	0.436 (0.468)	-0.034 (0.519)	11	98.59 (10.163)	1.222 (0.177)	-0.004 (0.234)	100	190.36 (2.452)	-1.199 (0.178)	0.031 (0.236)	100
		Sca3	0 (0.126)	0.551 (0.044)	189.28 (15.162)	1.338 (0.229)	-0.019 (0.304)	100	102 (10.1)	-0.75 (0.096)	-0.113 (0.313)	8	189.97 (1.167)	2.251 (0.172)	0.021 (0.218)	100
		Sca4	0 (0.128)	0.561 (0.051)	182.115 (36.799)	-0.646 (0.242)	0.044 (0.36)	26	98.204 (11.391)	-1.703 (0.3)	0.038 (0.302)	103	188.127 (14.468)	-1.663 (0.357)	-0.006 (0.24)	102
		gca	0 (0.055)	0.195 (0.059)	190.7 (13.099)	-0.397 (0.04)	0.002 (0.21)	20	99.242 (8.434)	0.603 (0.105)	0.006 (0.175)	99	137 (59.557)	-0.068 (0.296)	0.001 (0.552)	3
		Hmp1	0.369 (0.153)	0.432 (0.054)	190.426 (2.238)	-2.152 (0.287)	-0.699 (0.356)	101	99.885 (13.091)	0.734 (0.209)	0.6 (0.558)	26	189.464 (4.975)	1.113 (0.194)	-0.943 (0.327)	97
		Hmp2	0.274 (0.134)	0.194 (0.075)	183.913 (25.815)	-0.823 (0.254)	-0.938 (0.388)	46	100.932 (10.656)	0.999 (0.201)	0.57 (0.374)	59	188.339 (20.751)	-0.867 (0.24)	-1.011 (0.336)	62
		Hmp3	-0.293 (0.166)	0.416 (0.055)	196.692 (9.776)	0.47 (0.546)	-1.223 (0.354)	13	109.036 (28.227)	-0.922 (0.249)	0.687 (0.459)	28	189.465 (6.325)	2.667 (0.365)	-0.769 (0.414)	101
		Hmp4	-0.443 (0.167)	0.496 (0.057)	188.089 (18.583)	-1.472 (0.26)	-0.723 (0.341)	101	100.242 (1.642)	-2.057 (0.245)	0.431 (0.361)	99	188.188 (11.608)	-1.213 (0.316)	-0.791 (0.415)	101

Table 7 (contd)

n	h^2	Dataset	Trait mean	h^2	QTL1			QTL2			QTL3					
					Position	A effect	D effect	Power	Position	A effect	D effect	Power	Position	A effect	D effect	Power
400	0.8	F ₂	101.239 (0.076)	0.924 (0.005)	188.861 (10.948)	1.43 (0.153)	1.38 (0.13)	101	100.02 (0.426)	1.803 (0.046)	-0.814 (0.061)	100	190.07 (0.477)	-0.876 (0.042)	1.565 (0.067)	100
		TCF21	102.003 (0.058)	0.924 (0.007)	185.942 (25.248)	-1.402 (0.235)	-0.006 (0.05)	103	101.327 (13.443)	1.436 (0.148)	-0.008 (0.045)	101	188.426 (16.979)	0.616 (0.077)	-0.003 (0.052)	101
		TCF22	101.816 (0.055)	0.924 (0.005)	175.645 (39.693)	0.126 (0.044)	0.002 (0.077)	31	99.099 (8.661)	1.787 (0.177)	-0.003 (0.041)	101	188.238 (17.918)	-1.138 (0.13)	0.003 (0.05)	101
		TCF23	100.63 (0.056)	0.924 (0.005)	190.09 (6.605)	1.056 (0.04)	0.006 (0.054)	100	100.667 (12.701)	0.221 (0.053)	0.008 (0.069)	105	188.96 (10.351)	2.182 (0.237)	-0.001 (0.045)	101
		TCF24	100.41 (0.054)	0.924 (0.005)	189.545 (5.629)	-0.721 (0.089)	0.006 (0.044)	101	100 (0.569)	-1.128 (0.033)	0.009 (0.042)	100	189.099 (8.862)	-1.654 (0.173)	0.007 (0.043)	101
		Sca1	0 (0.045)	0.898 (0.008)	189.95 (0.458)	-1.189 (0.029)	-0.005 (0.039)	100	100.06 (0.565)	0.864 (0.031)	-0.008 (0.038)	100	190 (0.682)	0.62 (0.027)	-0.005 (0.041)	100
		Sca2	0 (0.044)	0.912 (0.007)	184.895 (24.388)	0.339 (0.08)	-0.005 (0.045)	105	99.88 (0.518)	1.217 (0.029)	-0.004 (0.035)	100	190.04 (0.425)	-1.151 (0.033)	0.002 (0.041)	100
		Sca3	0 (0.057)	0.951 (0.003)	190.01 (0.46)	1.308 (0.034)	0.006 (0.045)	100	97.298 (13.229)	-0.356 (0.06)	0.006 (0.047)	104	190 (0.142)	2.201 (0.027)	-0.002 (0.035)	100
		Sca4	0 (0.059)	0.953 (0.004)	188.505 (13.606)	-0.458 (0.076)	0.004 (0.039)	103	99.95 (0.435)	-1.713 (0.03)	0.007 (0.036)	100	189.109 (8.96)	-1.654 (0.171)	0.006 (0.04)	101
		gca	0 (0.017)	0.799 (0.015)	190.03 (1.058)	-0.257 (0.016)	0.001 (0.022)	100	100.05 (0.52)	0.59 (0.018)	0.002 (0.022)	100	214 (0)	0.058 (0)	-0.083 (0)	1
		Hmp1	0.384 (0.063)	0.924 (0.006)	186.529 (24.666)	-2.121 (0.291)	-0.688 (0.081)	102	100.657 (14.883)	0.542 (0.09)	0.4 (0.085)	102	188.716 (10.658)	1.04 (0.146)	-0.772 (0.149)	102
		Hmp2	0.298 (0.044)	0.807 (0.017)	188.465 (15.238)	-0.62 (0.067)	-0.702 (0.108)	101	100.392 (15.353)	0.889 (0.129)	0.402 (0.084)	102	190.455 (3.554)	-0.706 (0.086)	-0.782 (0.125)	101
		Hmp3	-0.315 (0.067)	0.923 (0.006)	189.317 (6.415)	0.329 (0.048)	-0.696 (0.092)	101	99.376 (7.023)	-0.674 (0.065)	0.411 (0.083)	101	188.95 (10.251)	2.619 (0.283)	-0.772 (0.095)	101
		Hmp4	-0.41 (0.065)	0.938 (0.004)	188.198 (18.919)	-1.433 (0.162)	-0.687 (0.094)	101	100.05 (0.386)	-2.022 (0.042)	0.42 (0.049)	100	189.98 (0.492)	-1.231 (0.042)	-0.78 (0.055)	100

Table 7 (contd)

n	h^2	Dataset	Trait mean	h^2	QTL1			QTL2			QTL3					
					Position	A effect	D effect	Power	Position	A effect	D effect	Power	Position	A effect	D effect	Power
400	0.5	F ₂	101.219 (0.093)	0.753 (0.018)	190.06 (0.722)	1.447 (0.096)	1.402 (0.123)	100	101.228 (12.659)	1.8 (0.182)	-0.814 (0.112)	101	190.02 (0.724)	-0.884 (0.087)	1.564 (0.126)	100
		TCF21	101.998 (0.058)	0.756 (0.016)	189.792 (2.422)	-1.438 (0.153)	0.001 (0.093)	101	99.9 (0.628)	1.453 (0.058)	0.009 (0.085)	100	190 (5.749)	0.609 (0.106)	-0.005 (0.096)	102
		TCF22	101.782 (0.058)	0.752 (0.016)	212 (25.456)	0.183 (0.084)	-0.262 (0.085)	2	101.297 (12.946)	1.797 (0.214)	0 (0.079)	101	186.951 (22.398)	-1.129 (0.179)	0.009 (0.11)	102
		TCF23	100.657 (0.074)	0.747 (0.018)	188.337 (18.966)	1.056 (0.118)	-0.006 (0.116)	101	100.838 (25.804)	0.299 (0.057)	-0.018 (0.162)	37	187.755 (16.767)	2.159 (0.333)	-0.011 (0.115)	102
		TCF24	100.401 (0.066)	0.757 (0.016)	190.13 (1.978)	-0.736 (0.067)	-0.007 (0.1)	100	100.03 (0.771)	-1.148 (0.064)	-0.012 (0.081)	100	189.92 (0.677)	-1.685 (0.067)	0.003 (0.081)	100
		Scal	0 (0.046)	0.689 (0.022)	190.06 (0.736)	-1.194 (0.057)	0.005 (0.075)	100	101.149 (12.986)	0.859 (0.114)	0.004 (0.075)	101	189.9 (1.573)	0.624 (0.058)	-0.005 (0.081)	100
		Sca2	0 (0.045)	0.721 (0.019)	186.99 (24.651)	0.347 (0.082)	0.003 (0.091)	105	99.385 (17.01)	1.181 (0.247)	-0.003 (0.087)	104	183.476 (30.818)	-1.09 (0.277)	0.004 (0.095)	105
		Sca3	0 (0.071)	0.825 (0.012)	189.314 (11.654)	1.287 (0.181)	0 (0.101)	102	99.566 (15.778)	-0.346 (0.091)	0.022 (0.104)	106	184.41 (26.093)	2.1 (0.483)	-0.019 (0.107)	105
		Sca4	0 (0.062)	0.839 (0.011)	189.812 (7.011)	-0.477 (0.069)	0 (0.086)	101	99.96 (0.511)	-1.728 (0.058)	-0.013 (0.071)	100	189.95 (0.657)	-1.681 (0.059)	0.003 (0.071)	100
		gca	0 (0.022)	0.501 (0.036)	189.81 (2.214)	-0.263 (0.032)	-0.007 (0.053)	100	99.129 (9.999)	0.584 (0.075)	0.003 (0.044)	101	83.667 (109.546)	-0.022 (0.091)	-0.009 (0.211)	3
		Hmp1	0.388 (0.073)	0.756 (0.02)	189.97 (0.627)	-2.17 (0.081)	-0.7 (0.109)	100	100.644 (8.41)	0.551 (0.086)	0.431 (0.132)	101	190.03 (1)	1.058 (0.084)	-0.792 (0.105)	100
		Hmp2	0.271 (0.054)	0.511 (0.033)	188.564 (15.989)	-0.625 (0.119)	-0.721 (0.128)	101	101.238 (12.988)	0.903 (0.147)	0.417 (0.115)	101	186.824 (22.517)	-0.693 (0.133)	-0.781 (0.166)	102
		Hmp3	-0.274 (0.078)	0.75 (0.02)	189.627 (6.753)	0.324 (0.108)	-0.731 (0.143)	102	98.183 (10.201)	-0.666 (0.15)	0.421 (0.141)	104	189.545 (5.308)	2.617 (0.271)	-0.784 (0.125)	101
		Hmp4	-0.408 (0.077)	0.795 (0.015)	187.99 (18.908)	-1.444 (0.167)	-0.706 (0.164)	101	99.784 (12.389)	-2.005 (0.315)	0.387 (0.111)	102	190.277 (3.98)	-1.226 (0.155)	-0.774 (0.103)	101

Table 7 (contd)

n	h^2	Dataset	Trait mean	h^2	QTL1			QTL2			QTL3					
					Position	A effect	D effect	Power	Position	A effect	D effect	Power	Position	A effect	D effect	Power
400	0.2	F ₂	101.215 (0.155)	0.438 (0.031)	189.798 (1.525)	1.47 (0.164)	1.455 (0.262)	99	100.69 (9.114)	1.819 (0.215)	-0.835 (0.296)	100	189.99 (1.898)	-0.896 (0.168)	1.639 (0.261)	99
		TCF21	101.988 (0.104)	0.44 (0.034)	190.051 (1.366)	-1.466 (0.116)	-0.004 (0.211)	99	100.03 (1.396)	1.468 (0.129)	-0.01 (0.189)	99	187.785 (18.1)	0.656 (0.127)	0.03 (0.2)	93
		TCF22	101.785 (0.106)	0.434 (0.035)	113 (103.238)	-0.041 (0.441)	-0.598 (0.119)	2	100.071 (1.003)	1.816 (0.13)	0.042 (0.186)	99	189.919 (1.893)	-1.189 (0.136)	-0.007 (0.209)	99
		TCF23	100.665 (0.118)	0.434 (0.032)	189.959 (2.487)	1.096 (0.158)	-0.011 (0.205)	98	116.833 (39.082)	0.562 (0.094)	-0.188 (0.325)	6	189.98 (0.979)	2.231 (0.132)	0.003 (0.183)	99
		TCF24	100.397 (0.104)	0.437 (0.037)	190.446 (4.98)	-0.758 (0.121)	0.017 (0.239)	92	99.755 (1.943)	-1.148 (0.138)	-0.018 (0.201)	98	190.02 (1.262)	-1.688 (0.131)	-0.012 (0.177)	99
		Sca1	0 (0.079)	0.365 (0.034)	190.901 (5.852)	-1.194 (0.153)	0 (0.194)	101	101.45 (12.258)	0.877 (0.155)	-0.028 (0.171)	100	187.616 (13.341)	0.64 (0.127)	0.027 (0.178)	99
		Sca2	0 (0.077)	0.39 (0.036)	192.03 (9.002)	0.464 (0.051)	-0.002 (0.21)	33	99.869 (1.33)	1.234 (0.117)	0.035 (0.18)	99	189.869 (1.447)	-1.187 (0.119)	-0.011 (0.178)	99
		Sca3	0 (0.104)	0.542 (0.031)	187.525 (18.636)	1.302 (0.203)	0.009 (0.199)	101	101.731 (7.175)	-0.553 (0.084)	0.004 (0.219)	26	189.919 (0.865)	2.224 (0.113)	-0.005 (0.156)	99
		Sca4	0 (0.09)	0.562 (0.034)	187.779 (15.64)	-0.503 (0.134)	0.022 (0.248)	77	99.51 (4.145)	-1.703 (0.243)	-0.019 (0.17)	100	188.96 (11.061)	-1.673 (0.183)	-0.009 (0.172)	100
		gca	0 (0.043)	0.196 (0.045)	187.714 (26.173)	-0.309 (0.066)	-0.008 (0.127)	56	100.173 (1.979)	0.598 (0.075)	0.008 (0.091)	98	-	-	-	0
		Hmp1	0.38 (0.111)	0.437 (0.034)	189.939 (1.018)	-2.184 (0.144)	-0.721 (0.238)	99	104.548 (23.447)	0.611 (0.19)	0.429 (0.333)	73	188.356 (12.25)	1.072 (0.23)	-0.766 (0.26)	101
		Hmp2	0.281 (0.105)	0.217 (0.04)	189.447 (2.71)	-0.655 (0.14)	-0.76 (0.198)	94	100.361 (3.474)	0.923 (0.153)	0.479 (0.231)	97	189.959 (2.926)	-0.761 (0.165)	-0.844 (0.261)	97
		Hmp3	-0.271 (0.126)	0.426 (0.037)	190.872 (4.826)	0.419 (0.193)	-0.949 (0.206)	47	101.234 (13.022)	-0.776 (0.224)	0.472 (0.264)	77	189.08 (8.237)	2.642 (0.28)	-0.794 (0.232)	100
		Hmp4	-0.421 (0.133)	0.491 (0.033)	189.838 (1.543)	-1.456 (0.17)	-0.721 (0.256)	99	99.929 (1.288)	-2.063 (0.175)	0.412 (0.224)	99	190.02 (1.778)	-1.246 (0.148)	-0.855 (0.251)	99

Table 8. Simulated and estimated QTL positions and effects for combining ability and heterosis under additive-dominance model with four alleles in DH-based NCII design.

n	h^2	Dataset	Trait mean	h^2	QTL1			QTL2			QTL3						
					Position	Effect	Power	Position	Effect	Power	Position	Effect	Power				
200	0.8	DH	100	0.515	192	1.2(1.5)	105	105	105	196	-1(2)	101	101	101	196	-1(2)	
			102.016	(0.049)	188.307	-1.497	100.782	1.507	100.782	1.507	190.632	0.728	101	101	101	190.632	0.728
		TCDH1	100.037	0.511	190.12	1.493	100.02	1.87	100.02	1.87	189.49	-0.963	100	100	100	189.49	-0.963
			(0.223)	(0.047)	(1.552)	(0.181)	(1.172)	(0.186)	(1.172)	(0.186)	(4.602)	(0.172)	100	100	100	(4.602)	(0.172)
		TCDH2	100.007	0.497	189.98	1.473	99.8	1.833	99.8	1.833	189.543	-0.936	100	100	100	189.543	-0.936
			(0.204)	(0.047)	(1.531)	(0.217)	(1.326)	(0.161)	(1.326)	(0.161)	(4.229)	(0.17)	100	100	100	(4.229)	(0.17)
		TCDH3	100.023	0.515	188	1.476	99.91	1.835	99.91	1.835	189.094	-0.926	100	100	100	189.094	-0.926
			(0.211)	(0.043)	(17.082)	(0.313)	(1.065)	(0.191)	(1.065)	(0.191)	(12.834)	(0.233)	100	100	100	(12.834)	(0.233)
		TCDH4	100.006	0.511	190.15	1.502	99.525	1.833	99.525	1.833	188.642	-0.971	101	101	101	188.642	-0.971
			(0.225)	(0.043)	(1.493)	(0.204)	(4.527)	(0.322)	(4.527)	(0.322)	(11.666)	(0.154)	101	101	101	(11.666)	(0.154)
		Sca1	0	0.069	163	-0.629	36	0.562	36	0.562	210	-0.574	1	1	1	210	-0.574
			(0.157)	(0.001)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	1	1	1	(0)	(0)
		Sca2	0	0.075	133	-0.626	76	0.747	76	0.747	-	-	1	1	1	-	-
			(0.14)	(0.01)	(4.243)	(0.068)	(0)	(0)	(0)	(0)	-	-	1	1	1	-	-
		Sca3	0	0.076	28	-0.699	-	-	-	-	223	0.706	0	0	0	223	0.706
			(0.148)	(0.012)	(39.598)	(0.022)	-	-	-	-	(0)	(0)	0	0	0	(0)	(0)
		Sca4	0	0.073	-	-	100	-0.57	100	-0.57	84	-0.037	1	1	1	84	-0.037
			(0.143)	(0.006)	-	-	(0)	(0)	(0)	(0)	(8.485)	(0.862)	1	1	1	(8.485)	(0.862)
		Gca	0	0.804	188.029	1.43	100.03	1.822	100.03	1.822	190.1	-0.917	100	100	100	190.1	-0.917
			(0.152)	(0.018)	(14.592)	(0.238)	(0.703)	(0.101)	(0.703)	(0.101)	(1.337)	(0.086)	100	100	100	(1.337)	(0.086)
Hmp1	-1.971	0.512	188.208	2.206	99.408	1.149	99.408	1.149	190.262	-1.255	98	98	98	190.262	-1.255		
	(0.212)	(0.05)	(18.853)	(0.352)	(6.975)	(0.188)	(6.975)	(0.188)	(5.132)	(0.235)	98	98	98	(5.132)	(0.235)		
Hmp2	-1.804	0.267	188.157	1.398	99.345	0.979	99.345	0.979	189.333	-0.789	84	84	84	189.333	-0.789		
	(0.198)	(0.061)	(13.6)	(0.333)	(5.194)	(0.139)	(5.194)	(0.139)	(4.933)	(0.068)	84	84	84	(4.933)	(0.068)		
Hmp3	-0.653	0.511	188.946	1.015	100.06	1.727	100.06	1.727	189.97	-2.025	100	100	100	189.97	-2.025		
	(0.216)	(0.042)	(10.889)	(0.173)	(1.179)	(0.194)	(1.179)	(0.194)	(1.21)	(0.189)	100	100	100	(1.21)	(0.189)		
Hmp4	-0.376	0.559	190.09	1.857	100.09	2.435	100.09	2.435	102.5	-0.013	100	100	100	102.5	-0.013		
	(0.229)	(0.039)	(1.24)	(0.212)	(0.954)	(0.225)	(0.954)	(0.225)	(34.648)	(1.158)	100	100	100	(34.648)	(1.158)		

Table 8 (contd)

n	h^2	Dataset	Trait mean	h^2	QTL1			QTL2			QTL3		
					Position	Effect	Power	Position	Effect	Power	Position	Effect	Power
200	0.5	DH	101.97 (0.169)	0.498 (0.045)	189.98 (1.239)	-1.479 (0.148)	100	100.676 (11.846)	1.423 (0.187)	102	189.429 (2.976)	0.726 (0.114)	70
		TCDH1	99.956 (0.183)	0.51 (0.041)	189.676 (8.527)	1.485 (0.196)	102	99.178 (9.247)	1.797 (0.292)	101	190.17 (2.927)	-0.956 (0.199)	100
		TCDH2	99.957 (0.19)	0.512 (0.047)	186.816 (19.322)	1.441 (0.234)	103	101.05 (11.023)	1.843 (0.3)	101	188.432 (17.136)	-0.947 (0.225)	95
		TCDH3	99.983 (0.19)	0.509 (0.046)	188.149 (18.863)	1.496 (0.215)	101	100.16 (1.187)	1.859 (0.199)	100	190.436 (3.211)	-0.946 (0.167)	94
		TCDH4	99.966 (0.193)	0.513 (0.042)	189.297 (7.395)	1.489 (0.2)	101	100.693 (8.648)	1.837 (0.21)	101	188.917 (4.445)	-0.962 (0.153)	96
		Sea1	0 (0.116)	0.073 (0.013)	-	-	0	94 (0)	-0.614 (0)	1	6 (0)	0.565 (0)	1
		Sea2	0 (0.127)	0.077 (0.019)	30 (0)	0.579 (0)	1	163 (0)	-0.663 (0)	1	27 (0)	0.602 (0)	1
		Sea3	0 (0.133)	0.068 (0.005)	60.5 (85.56)	-0.018 (0.78)	2	80.333 (41.501)	0.163 (0.639)	3	93.5 (79.903)	-0.056 (0.797)	2
		Sea4	0 (0.129)	-	-	-	0	-	-	0	-	-	0
		gca	0 (0.127)	0.803 (0.021)	189.337 (6.61)	1.454 (0.145)	101	101.228 (11.953)	1.799 (0.168)	101	190.03 (1.329)	-0.916 (0.088)	100
		Hmp1	-2.029 (0.201)	0.512 (0.046)	188.772 (11.376)	2.197 (0.252)	101	100.263 (2.538)	1.133 (0.184)	99	189.96 (1.979)	-1.265 (0.203)	100
		Hmp2	-1.848 (0.176)	0.284 (0.055)	189.376 (6.337)	1.432 (0.204)	101	101.726 (13.04)	0.97 (0.301)	95	25 (0)	0.75 (0)	1
		Hmp3	-0.662 (0.202)	0.51 (0.046)	187.588 (20.868)	1.02 (0.184)	85	100.04 (1.377)	1.756 (0.212)	100	190.17 (1.457)	-2.059 (0.205)	100
		Hmp4	-0.455 (0.201)	0.554 (0.041)	189.94 (1.332)	1.86 (0.201)	100	99.76 (1.074)	2.41 (0.179)	100	10 (0)	-0.64 (0)	1

Table 8 (contd)

n	h^2	Dataset	Trait mean	h^2	QTL1			QTL2			QTL3		
					Position	Effect	Power	Position	Effect	Power	Position	Effect	Power
200	0.2	DH	102.019 (0.289)	0.198 (0.06)	186.543 (22.459)	-1.54 (0.389)	94	100.14 (8.369)	1.576 (0.282)	93	178.556 (31.926)	0.973 (0.824)	9
		TCDH1	100.023 (0.326)	0.202 (0.065)	187.944 (17.814)	1.747 (0.328)	71	98.978 (10.629)	2.005 (0.503)	93	183.095 (31.973)	-1.38 (0.645)	21
		TCDH2	99.969 (0.305)	0.189 (0.061)	186.929 (18.556)	1.692 (0.281)	70	99.564 (4.136)	1.997 (0.322)	94	187.765 (7.146)	-1.522 (0.159)	17
		TCDH3	100.065 (0.366)	0.185 (0.071)	184.101 (26.793)	1.681 (0.583)	69	100.824 (8.655)	1.961 (0.347)	91	190.2 (2.624)	-1.621 (0.215)	15
		TCDH4	100.005 (0.338)	0.183 (0.054)	188.773 (7.613)	1.709 (0.448)	75	99.88 (2.163)	1.965 (0.369)	92	192 (3.162)	-1.632 (0.164)	7
		Sca1	0 (0.228)	0.074 (0.007)	146 (0)	1.401 (0)	1	104.5 (59.051)	-0.668 (1.255)	4	-	-	0
		Sca2	0 (0.234)	0.071 (0.013)	168 (0)	1.518 (0)	1	57 (0)	1.143 (0)	1	191 (43.841)	1.161 (0.13)	2
		Sca3	0 (0.259)	0.065 (0.012)	-	-	0	-	-	0	154.667 (20.008)	1.312 (0.059)	3
		Sca4	0 (0.287)	0.073 (0.004)	-	-	0	-	-	0	172 (16.971)	1.136 (0.029)	2
		gca	0 (0.215)	0.514 (0.044)	189.99 (1.322)	1.509 (0.182)	100	99.95 (1.201)	1.864 (0.185)	100	190.387 (4.561)	-0.953 (0.168)	93
		Hmp1	-1.986 (0.325)	0.199 (0.056)	190.186 (2.152)	2.336 (0.41)	97	95.788 (20.143)	1.659 (0.621)	33	187.936 (13.168)	-1.637 (0.518)	47
		Hmp2	-1.839 (0.34)	0.104 (0.037)	189.522 (4.598)	1.773 (0.274)	46	102.25 (4.973)	1.663 (0.168)	16	60 (0)	-1.376 (0)	1
		Hmp3	-0.591 (0.36)	0.194 (0.064)	167.938 (55.764)	1.329 (1.09)	16	100.547 (10.356)	1.916 (0.549)	75	190.602 (2.794)	-2.185 (0.43)	88
		Hmp4	-0.358 (0.358)	0.238 (0.056)	189.697 (2.652)	2.004 (0.35)	89	100.051 (1.923)	2.496 (0.402)	98	-	-	0

Table 8 (contd)

n	h^2	Dataset	Trait mean	h^2	QTL1			QTL2			QTL3		
					Position	Effect	Power	Position	Effect	Power	Position	Effect	Power
400	0.8	DH	102.025 (0.088)	0.8 (0.014)	187.588 (19.086)	-1.426 (0.216)	102	100.347 (3.82)	1.43 (0.174)	101	189.03 (8.709)	0.624 (0.069)	101
		TCDH1	100.019 (0.097)	0.801 (0.015)	188.772 (11.95)	1.445 (0.137)	101	101.456 (18.139)	1.761 (0.304)	103	190.18 (0.925)	-0.904 (0.074)	100
		TCDH2	100.014 (0.102)	0.8 (0.014)	190.02 (0.568)	1.461 (0.073)	100	100.598 (12.197)	1.769 (0.295)	102	190.06 (0.827)	-0.896 (0.067)	100
		TCDH3	100.015 (0.096)	0.803 (0.014)	190.03 (0.611)	1.458 (0.068)	100	99.98 (0.402)	1.818 (0.063)	100	190.01 (0.916)	-0.901 (0.058)	100
		TCDH4	100.012 (0.095)	0.804 (0.013)	188.426 (16.237)	1.447 (0.183)	101	99.817 (13.853)	1.752 (0.336)	104	187.912 (19.167)	-0.894 (0.174)	102
		Sca1	0 (0.044)	0.04 (0.004)	209 (0)	0.234 (0)	1	-	-	0	94.5 (23.335)	-0.216 (0.02)	2
		Sca2	0 (0.046)	0.035 (0.004)	124 (0)	-0.201 (0)	1	214 (0)	-0.223 (0)	1	-	-	0
		Sca3	0 (0.049)	0.038 (0.006)	-	-	0	189 (0)	-0.205 (0)	1	-	-	0
		Sca4	0 (0.053)	0.036 (0.001)	194 (0)	-0.229 (0)	1	155 (7.071)	-0.204 (0.004)	2	50 (0)	0.208 (0)	1
		gca	0 (0.079)	0.942 (0.004)	190.01 (0.301)	1.445 (0.036)	100	100.02 (0.141)	1.802 (0.029)	100	190.04 (0.47)	-0.893 (0.038)	100
		Hmp1	-1.994 (0.09)	0.802 (0.015)	188.206 (13.324)	2.136 (0.277)	102	101.689 (17.047)	1.074 (0.194)	103	190.13 (0.787)	-1.212 (0.08)	100
		Hmp2	-1.794 (0.088)	0.613 (0.03)	188.475 (15.64)	1.403 (0.14)	101	100.647 (12.494)	0.891 (0.179)	102	190.089 (17.646)	-0.335 (0.061)	90
		Hmp3	-0.63 (0.098)	0.803 (0.014)	190.06 (1.003)	0.939 (0.074)	100	99.99 (0.559)	1.715 (0.066)	100	188.248 (17.218)	-1.984 (0.181)	101
		Hmp4	-0.387 (0.099)	0.831 (0.011)	190.07 (0.624)	1.824 (0.078)	100	100.294 (8.783)	2.334 (0.299)	102	200 (14.142)	-0.257 (0.036)	2

Table 8 (*contd*)

n	h^2	Dataset	Trait mean	h^2	QTL1			QTL2			QTL3		
					Position	Effect	Power	Position	Effect	Power	Position	Effect	Power
400	0.5	DH	101.996 (0.12)	0.504 (0.03)	189.228 (7.609)	-1.463 (0.233)	101	99.93 (0.998)	1.479 (0.111)	100	190.186 (4.874)	0.642 (0.112)	102
		TCDH1	100.009 (0.128)	0.505 (0.033)	189.039 (7.281)	1.448 (0.189)	102	99.93 (0.868)	1.862 (0.139)	100	188.693 (4.519)	-0.905 (0.195)	101
		TCDH2	100.039 (0.13)	0.506 (0.035)	189.287 (7.849)	1.468 (0.242)	101	100.881 (8.496)	1.829 (0.185)	101	188.653 (17.438)	-0.917 (0.139)	101
		TCDH3	100.007 (0.144)	0.502 (0.033)	188.178 (18.636)	1.47 (0.168)	101	100.04 (0.84)	1.829 (0.135)	100	190.04 (1.53)	-0.893 (0.143)	100
		TCDH4	100.014 (0.136)	0.5 (0.032)	188.794 (10.475)	1.445 (0.257)	102	100 (0.816)	1.817 (0.13)	100	188.01 (16.583)	-0.891 (0.242)	101
		Sca1	0 (0.086)	0.041 (0.003)	-	-	0	-	-	0	217 (0)	0.482 (0)	1
		Sca2	0 (0.081)	0.033 (0.003)	-	-	0	136.5 (67.175)	0.434 (0.065)	2	-	-	0
		Sca3	0 (0.096)	0.046 (0.02)	112 (0)	-0.424 (0)	1	129 (131.522)	-0.45 (0.041)	2	69 (49.497)	0.019 (0.638)	2
		Sca4	0 (0.088)	0.04 (0.005)	72.6 (47.815)	-0.251 (0.44)	5	82.5 (13.435)	0.015 (0.605)	2	60.667 (38.837)	0.34 (0.081)	3
		gca	0 (0.087)	0.799 (0.014)	187.476 (16.25)	1.407 (0.271)	103	100.07 (0.383)	1.808 (0.072)	100	190.17 (0.853)	-0.891 (0.069)	100
		Hmp1	-1.989 (0.13)	0.505 (0.032)	189.108 (6.175)	2.161 (0.272)	102	99.87 (1.433)	1.149 (0.152)	100	190.03 (1.193)	-1.231 (0.135)	100
		Hmp2	-1.766 (0.123)	0.287 (0.04)	187.814 (16.454)	1.412 (0.256)	102	102.097 (14.462)	0.924 (0.22)	103	173 (49.423)	-0.509 (0.257)	18
		Hmp3	-0.637 (0.146)	0.5 (0.033)	189.683 (4.289)	0.95 (0.211)	101	101.208 (11.783)	1.7 (0.275)	101	189.069 (9.88)	-1.957 (0.297)	101
		Hmp4	-0.389 (0.154)	0.547 (0.029)	187.451 (19.316)	1.809 (0.246)	102	102.157 (15.216)	2.332 (0.378)	102	-	-	0

Table 8 (contd)

n	h^2	Dataset	Trait mean	h^2	QTL1			QTL2			QTL3		
					Position	Effect	Power	Position	Effect	Power	Position	Effect	Power
400	0.2	DH	102.015 (0.205)	0.202 (0.033)	190.13 (1.824)	-1.492 (0.232)	100	100.921 (9.002)	1.498 (0.336)	101	190.656 (6.276)	0.938 (0.133)	32
		TCDH1	100.039 (0.237)	0.21 (0.039)	190.09 (2.094)	1.568 (0.23)	100	99.05 (10.09)	1.881 (0.385)	101	191.357 (5.571)	-1.133 (0.228)	56
		TCDH2	99.959 (0.202)	0.212 (0.042)	189.949 (1.886)	1.545 (0.267)	99	99.87 (1.79)	1.927 (0.264)	100	185.345 (25.729)	-1.084 (0.417)	58
		TCDH3	100.023 (0.235)	0.203 (0.033)	189.68 (4.422)	1.505 (0.36)	100	100.564 (4.203)	1.87 (0.227)	101	189.589 (3.426)	-1.154 (0.14)	56
		TCDH4	99.981 (0.224)	0.2 (0.041)	189.653 (5.523)	1.479 (0.261)	101	100.535 (3.695)	1.889 (0.282)	101	190.553 (2.788)	-1.173 (0.17)	47
		Sea1	0 (0.185)	0.034 (0)	2 (0)	0.862 (0)	1	-	-	0	74 (0)	0.846 (0)	1
		Sea2	0 (0.186)	0.035 (0.002)	200.5 (47.376)	0.037 (1.219)	2	81 (0)	-0.751 (0)	1	186 (0)	0.944 (0)	1
		Sea3	0 (0.187)	0.042 (0.013)	146.5 (6.364)	-0.818 (0.184)	2	140 (0)	1.024 (0)	1	-	-	0
		Sea4	0 (0.182)	0.04 (0.006)	-	-	0	133 (0)	1.015 (0)	1	-	-	0
		gca	0 (0.12)	0.511 (0.033)	190.02 (1.035)	1.485 (0.128)	100	99.99 (0.916)	1.858 (0.139)	100	186.865 (23.799)	-0.879 (0.245)	104
		Hmp1	-1.969 (0.243)	0.205 (0.044)	190.12 (1.458)	2.271 (0.287)	100	100.352 (7.434)	1.318 (0.231)	71	190.519 (2.868)	-1.383 (0.227)	77
		Hmp2	-1.845 (0.222)	0.096 (0.037)	187.854 (19.476)	1.524 (0.288)	96	101.632 (9.857)	1.239 (0.18)	57	169.6 (80.426)	-0.669 (0.98)	5
		Hmp3	-0.64 (0.224)	0.202 (0.037)	184.089 (30.787)	1.145 (0.521)	45	100.333 (1.616)	1.784 (0.27)	99	190.05 (1.772)	-2.092 (0.298)	100
		Hmp4	-0.402 (0.215)	0.239 (0.035)	190.1 (1.673)	1.872 (0.284)	100	100.416 (3.427)	2.427 (0.333)	101	150 (0)	-1.016 (0)	1

Table 9. Simulated and estimated QTL positions and effects for combining ability and heterosis under additive-dominance model with four alleles in RIL (sib-mating)-based NCII design.

n	h^2	Parameter values	Dataset	Trait mean	h^2	QTL1			QTL2			QTL3			
						Position	Effect	Power	Position	Effect	Power	Position	Effect	Power	
200	0.8	100	RIL	100.012	0.805	192	1.2(1.5)	105	1.5(-1)	196	-1(2)	100	196	-1(2)	100
		100.016		(0.021)	187.108	1.266	99.485	1.399	190.03	-0.679	190.03	-0.679	100	190.03	-0.679
		102.005	0.806	(20.159)	(-0.236)	(5.027)	(0.142)	(1.259)	(0.078)	(1.259)	(0.078)	101	(1.259)	(0.078)	101
		(0.095)	(0.022)	187.563	-1.284	100.812	1.121	189.337	0.473	189.337	0.473	101	189.337	0.473	101
		101.804	0.803	(22.228)	(0.195)	(7.986)	(0.112)	(4.574)	(0.08)	(4.574)	(0.08)	100	(4.574)	(0.08)	100
		(0.089)	(0.019)	151.667	0.218	100.08	1.403	190.03	-0.866	190.03	-0.866	100	190.03	-0.866	100
		100.659	0.798	(64.183)	-0.013	(0.486)	(0.063)	(0.81)	(0.063)	(0.81)	(0.063)	100	(0.81)	(0.063)	100
		(0.08)	(0.019)	188.713	0.956	107.071	0.246	190.07	1.632	190.07	1.632	100	190.07	1.632	100
		100.377	0.808	(12.765)	(0.143)	(25.315)	(0.153)	(0.537)	(0.08)	(0.537)	(0.08)	100	(0.537)	(0.08)	100
		(0.089)	(0.017)	189.61	-0.669	99.822	-0.887	189.94	-1.251	189.94	-1.251	100	189.94	-1.251	100
		0	0.763	(1.171)	(0.065)	(2.402)	(0.089)	(0.6)	(0.059)	(0.6)	(0.059)	101	(0.6)	(0.059)	101
		(0.072)	(0.03)	189.559	-1.064	100.762	0.677	188.723	0.475	188.723	0.475	101	188.723	0.475	101
		0	0.771	(10.646)	(0.13)	(7.818)	(0.078)	(12.797)	(0.068)	(12.797)	(0.068)	100	(12.797)	(0.068)	100
		(0.073)	(0.025)	190.26	0.316	100.16	0.959	190.02	-0.86	190.02	-0.86	100	190.02	-0.86	100
		0	0.867	(5.836)	(0.063)	(0.662)	(0.056)	(0.752)	(0.052)	(0.752)	(0.052)	100	(0.752)	(0.052)	100
		(0.089)	(0.013)	189.96	1.194	99.844	-0.302	190.06	1.632	190.06	1.632	100	190.06	1.632	100
		0	0.874	(0.71)	(0.068)	(3.462)	(0.051)	(0.528)	(0.062)	(0.528)	(0.062)	100	(0.528)	(0.062)	100
		(0.081)	(0.012)	189.66	-0.435	101.971	-1.313	189.9	-1.249	189.9	-1.249	100	189.9	-1.249	100
		0	0.583	(1.683)	(0.058)	(14.017)	(0.199)	(0.595)	(0.056)	(0.595)	(0.056)	0	(0.595)	(0.056)	0
		(0.027)	(0.041)	188.248	-0.239	101.127	0.451	-	-	-	-	103	-	-	103
0.999	0.822	(18.971)	(0.034)	(8.795)	(0.056)	187.573	0.779	187.573	0.779	100	187.573	0.779	100		
(0.089)	(0.018)	187.284	-1.917	99.963	0.418	(14.565)	(0.179)	(14.565)	(0.179)	100	(14.565)	(0.179)	100		
0.901	0.551	(19.872)	(0.249)	(15.786)	(0.111)	189.93	-0.54	189.93	-0.54	100	189.93	-0.54	100		
(0.08)	(0.045)	188.089	-0.581	100.26	0.721	(1.451)	(0.073)	(1.451)	(0.073)	100	(1.451)	(0.073)	100		
0.332	0.785	(18.547)	(0.079)	(1.05)	(0.068)	190.05	1.959	190.05	1.959	100	190.05	1.959	100		
(0.079)	(0.026)	189.97	0.365	101.376	-0.547	(0.575)	(0.089)	(0.575)	(0.089)	100	(0.575)	(0.089)	100		
0.175	0.849	(3.899)	(0.062)	(13.922)	(0.107)	188.782	-0.921	188.782	-0.921	101	188.782	-0.921	101		
(0.114)	(0.015)	189.287	-1.3	100.06	-1.587	(11.967)	(0.135)	(11.967)	(0.135)	100	(11.967)	(0.135)	100		
		(5.703)	(0.129)	(0.565)	(0.074)										

Table 9 (contd)

n	h^2	Dataset	Trait mean	h^2	QTL1			QTL2			QTL3		
					Position	Effect	Power	Position	Effect	Power	Position	Effect	Power
200	0.5	RIL	100.009 (0.152)	0.514 (0.05)	189.93 (1.233)	1.334 (0.148)	100	100.1 (1.115)	1.443 (0.179)	100	188.236 (16.104)	-0.727 (0.201)	89
		TCRIL1	101.986 (0.126)	0.507 (0.047)	189.9 (1.176)	-1.33 (0.123)	100	100.05 (1.175)	1.176 (0.122)	100	187.368 (21.145)	0.568 (0.178)	57
		TCRIL2	101.814 (0.131)	0.508 (0.046)	132 (53.339)	0.26 (0.415)	5	100.5 (10.443)	1.401 (0.179)	102	188.52 (10.415)	-0.861 (0.14)	102
		TCRIL3	100.658 (0.124)	0.504 (0.048)	189.95 (1.366)	1.013 (0.147)	100	143 (62.426)	0.558 (0.06)	3	188.794 (17.73)	1.646 (0.285)	102
		TCRIL4	100.396 (0.132)	0.52 (0.043)	190.214 (2.102)	-0.701 (0.119)	98	99.644 (3.205)	-0.911 (0.129)	101	190.14 (1.164)	-1.282 (0.132)	100
		Sca1	0 (0.091)	0.445 (0.052)	188.297 (15.95)	-1.094 (0.127)	101	100.091 (1.768)	0.723 (0.113)	99	188.342 (18.876)	0.528 (0.152)	73
		Sca2	0 (0.106)	0.443 (0.056)	190.703 (5.502)	0.454 (0.069)	37	100.901 (8.734)	0.959 (0.117)	101	189.188 (7.592)	-0.862 (0.127)	101
		Sca3	0 (0.112)	0.618 (0.042)	188.95 (11.002)	1.219 (0.14)	101	104.857 (13.507)	-0.491 (0.114)	14	190.564 (3.846)	1.645 (0.25)	101
		Sca4	0 (0.12)	0.632 (0.04)	189.816 (3.776)	-0.506 (0.105)	76	100.644 (6.725)	-1.348 (0.208)	101	188.792 (14.684)	-1.27 (0.149)	101
		gca	0 (0.047)	0.254 (0.056)	189.262 (3.75)	-0.279 (0.04)	61	101.139 (10.941)	0.467 (0.092)	101	128 (74.746)	0.268 (0.018)	3
		Hmp1	0.982 (0.133)	0.527 (0.044)	188.723 (12.977)	-1.971 (0.206)	101	103.917 (21.114)	0.609 (0.23)	36	188.643 (13.644)	0.826 (0.215)	98
		Hmp2	0.905 (0.124)	0.223 (0.075)	186.27 (21.178)	-0.65 (0.176)	74	99.6 (6.131)	0.765 (0.144)	90	188.441 (11.812)	-0.662 (0.101)	59
		Hmp3	0.325 (0.133)	0.462 (0.054)	180.167 (41.111)	0.547 (0.366)	12	101.182 (4.082)	-0.688 (0.101)	44	188.842 (13.083)	1.997 (0.213)	101
		Hmp4	0.195 (0.14)	0.588 (0.037)	189.822 (3.008)	-1.351 (0.17)	101	99.594 (3.128)	-1.602 (0.181)	101	190.43 (1.849)	-0.966 (0.161)	100

Table 9 (contd)

n	h^2	Dataset	Trait mean	h^2	QTL1			QTL2			QTL3			
					Position	Effect	Power	Position	Effect	Power	Position	Effect	Power	
200	0.2	RIL	100.015 (0.244)	0.186 (0.063)	189.57 (7.527)	1.492 (0.247)	100.344 (2.121)	1.529 (0.292)	175.786 (43.274)	90	1.529 (0.292)	175.786 (43.274)	-1.02 (0.646)	14
		TCRIL1	102.009 (0.252)	0.2 (0.055)	189 (14.101)	-1.405 (0.257)	101.072 (8.44)	1.286 (0.214)	181 (34.871)	83	1.286 (0.214)	181 (34.871)	0.393 (1.229)	3
		TCRIL2	101.832 (0.216)	0.205 (0.054)	155.5 (7.778)	0.037 (1.197)	99.566 (1.939)	1.481 (0.243)	191.076 (6.386)	99	1.481 (0.243)	191.076 (6.386)	-1.094 (0.186)	66
		TCRIL3	100.643 (0.248)	0.196 (0.063)	187.368 (20.233)	1.206 (0.389)	30 (0)	0.974 (0)	189.245 (8.638)	1	0.974 (0)	189.245 (8.638)	1.673 (0.312)	102
		TCRIL4	100.356 (0.226)	0.179 (0.056)	189.929 (9.002)	-1.045 (0.174)	99.469 (4.704)	-1.13 (0.186)	190.031 (7.419)	49	-1.13 (0.186)	190.031 (7.419)	-1.295 (0.31)	98
		Sca1	0 (0.196)	0.145 (0.051)	189.143 (14.602)	-1.166 (0.213)	106.647 (23.296)	0.957 (0.118)	169.111 (54.278)	34	0.957 (0.118)	169.111 (54.278)	0.483 (0.791)	9
		Sca2	0 (0.165)	0.171 (0.056)	140.167 (71.962)	0.505 (0.702)	101.024 (10.717)	1.027 (0.332)	188.833 (16.451)	83	1.027 (0.332)	188.833 (16.451)	-1.023 (0.174)	78
		Sca3	0 (0.207)	0.297 (0.056)	188.717 (15.234)	1.254 (0.307)	165.5 (92.631)	0.003 (1.129)	188.287 (15.993)	2	0.003 (1.129)	188.287 (15.993)	1.679 (0.264)	101
		Sca4	0 (0.185)	0.288 (0.053)	156.429 (70.413)	-0.615 (0.591)	100.02 (1.928)	-1.366 (0.242)	188.069 (15.128)	100	-1.366 (0.242)	188.069 (15.128)	-1.249 (0.371)	102
		gca	0 (0.094)	0.1 (0.034)	167 (44.654)	-0.232 (0.536)	100.78 (13.724)	0.59 (0.102)	- (-)	59	0.59 (0.102)	- (-)	- (-)	0
		Hmp1	1.001 (0.244)	0.203 (0.057)	186.767 (20.395)	-1.952 (0.469)	111.667 (28.598)	1.132 (0.144)	187.12 (11.62)	6	1.132 (0.144)	187.12 (11.62)	1.153 (0.501)	25
		Hmp2	0.923 (0.218)	0.083 (0.021)	162.692 (65.934)	-0.813 (0.805)	103.571 (13.449)	1.162 (0.181)	191.727 (18.45)	14	1.162 (0.181)	191.727 (18.45)	-1.174 (0.122)	11
		Hmp3	0.335 (0.23)	0.178 (0.058)	141.667 (88.081)	0.406 (1.472)	82.5 (27.38)	-1.162 (0.123)	188.98 (7.35)	4	-1.162 (0.123)	188.98 (7.35)	1.982 (0.54)	102
		Hmp4	0.11 (0.243)	0.236 (0.059)	189.69 (4.233)	-1.442 (0.267)	100.305 (2.932)	-1.641 (0.323)	190.361 (4.923)	95	-1.641 (0.323)	190.361 (4.923)	-1.248 (0.198)	36

Table 9 (contd)

n	h^2	Dataset	Trait mean	h^2	QTL1			QTL2			QTL3		
					Position	Effect	Power	Position	Effect	Power	Position	Effect	Power
400	0.8	RIL	99.988 (0.085)	0.804 (0.014)	189.96 (0.47)	1.3 (0.049)	100	101.941 (14.228)	1.376 (0.206)	102	189.87 (0.906)	-0.668 (0.051)	100
		TCRIL1	101.996 (0.066)	0.801 (0.014)	188.644 (12.737)	-1.278 (0.152)	101	99.05 (9.969)	1.106 (0.135)	101	188.912 (8.854)	0.46 (0.061)	102
		TCRIL2	101.79 (0.056)	0.803 (0.013)	183.167 (12.54)	0.153 (0.099)	12	100 (7.679)	1.366 (0.2)	102	189.426 (6.207)	-0.852 (0.082)	101
		TCRIL3	100.666 (0.059)	0.8 (0.014)	186.437 (20.854)	0.922 (0.174)	103	100.596 (6.571)	0.22 (0.039)	57	187.461 (18.938)	1.59 (0.233)	102
		TCRIL4	100.389 (0.064)	0.803 (0.013)	188.366 (16.737)	-0.647 (0.093)	101	100.525 (4.906)	-0.876 (0.087)	101	190.05 (0.458)	-1.241 (0.05)	100
		Sea1	0 (0.049)	0.756 (0.017)	189.9 (0.503)	-1.067 (0.039)	100	101.386 (13.846)	0.663 (0.092)	101	188.129 (18.426)	0.461 (0.073)	101
		Sea2	0 (0.05)	0.772 (0.016)	188.843 (9.587)	0.317 (0.055)	102	99.465 (5.397)	0.94 (0.09)	101	189.426 (5.898)	-0.846 (0.08)	101
		Sea3	0 (0.062)	0.868 (0.01)	187.461 (18.913)	1.15 (0.148)	102	100.127 (5.616)	-0.288 (0.054)	102	187.814 (15.812)	1.588 (0.23)	102
		Sea4	0 (0.063)	0.869 (0.01)	188.881 (11.286)	-0.425 (0.047)	101	101.139 (11.752)	-1.313 (0.151)	101	189.99 (0.438)	-1.239 (0.045)	100
		Gca	0 (0.02)	0.575 (0.027)	186.637 (24.19)	-0.23 (0.029)	102	100.634 (6.092)	0.448 (0.059)	101	- -	- -	0
		Hmp1	1.002 (0.059)	0.816 (0.012)	188.386 (15.921)	-1.914 (0.181)	101	99.882 (7.356)	0.425 (0.069)	102	189.149 (8.891)	0.789 (0.075)	101
		Hmp2	0.89 (0.051)	0.548 (0.033)	190.28 (0.965)	-0.575 (0.057)	100	100.535 (5.531)	0.7 (0.109)	101	190.11 (1.136)	-0.541 (0.054)	100
		Hmp3	0.344 (0.052)	0.787 (0.017)	189.081 (9.615)	0.313 (0.053)	99	100.11 (1.23)	-0.543 (0.061)	100	190.01 (0.266)	1.946 (0.051)	100
		Hmp4	0.19 (0.08)	0.844 (0.011)	188.297 (16.32)	-1.291 (0.121)	101	100.03 (0.388)	-1.572 (0.064)	100	189.98 (0.635)	-0.926 (0.063)	100

Table 9 (contd)

n	h^2	Dataset	Trait mean	h^2	QTL1			QTL2			QTL3		
					Position	Effect	Power	Position	Effect	Power	Position	Effect	Power
400	0.5	RIL	100.014 (0.109)	0.501 (0.031)	184.971 (26.559)	1.277 (0.207)	104	101.218 (12.97)	1.401 (0.15)	101	189.99 (1.899)	-0.675 (0.105)	100
		TCRIL1	102.006 (0.104)	0.512 (0.028)	188.317 (16.933)	-1.306 (0.185)	101	100.206 (7.993)	1.114 (0.241)	102	188.49 (16.485)	0.488 (0.119)	96
		TCRIL2	101.802 (0.084)	0.502 (0.031)	42 (0)	0.336 (0)	1	99.416 (6.022)	1.407 (0.2)	101	188.039 (17.792)	-0.852 (0.183)	102
		TCRIL3	100.63 (0.103)	0.503 (0.032)	190.06 (1.144)	0.983 (0.114)	100	101.4 (7.834)	0.382 (0.008)	10	186.699 (19.458)	1.585 (0.282)	103
		TCRIL4	100.412 (0.092)	0.508 (0.031)	190.15 (1.184)	-0.672 (0.083)	100	99.723 (2.864)	-0.887 (0.151)	101	187.725 (16.416)	-1.23 (0.156)	102
		Sca1	0 (0.08)	0.449 (0.035)	189.059 (9.993)	-1.082 (0.157)	101	100.427 (8.383)	0.667 (0.166)	103	190.09 (1.965)	0.489 (0.077)	100
		Sca2	0 (0.067)	0.455 (0.033)	187.889 (16.458)	0.36 (0.06)	81	100.637 (13.278)	0.946 (0.192)	102	188.078 (15.992)	-0.846 (0.179)	102
		Sca3	0 (0.091)	0.62 (0.029)	190.04 (0.777)	1.198 (0.089)	100	99.365 (5.51)	-0.36 (0.056)	63	188.225 (12.326)	1.604 (0.206)	102
		Sca4	0 (0.076)	0.627 (0.026)	190.235 (4.727)	-0.437 (0.082)	102	99.97 (0.758)	-1.345 (0.075)	100	189.97 (0.643)	-1.247 (0.075)	100
		Gca	0 (0.038)	0.258 (0.035)	188.908 (11.477)	-0.242 (0.045)	98	100.422 (9.119)	0.456 (0.087)	102	10 (0)	0.164 (0)	1
		Hmp1	0.999 (0.101)	0.53 (0.031)	188.287 (17.025)	-1.941 (0.26)	101	99.253 (6.543)	0.491 (0.145)	75	190.446 (3.229)	0.81 (0.12)	101
		Hmp2	0.897 (0.085)	0.236 (0.034)	189.416 (6.529)	-0.575 (0.132)	101	99.74 (1.606)	0.738 (0.111)	100	185.71 (26.205)	-0.536 (0.183)	100
		Hmp3	0.291 (0.103)	0.476 (0.037)	189.379 (4.204)	0.466 (0.057)	29	99.774 (2.132)	-0.579 (0.096)	93	188.386 (15.629)	1.948 (0.27)	101
		Hmp4	0.205 (0.104)	0.582 (0.028)	190.01 (0.823)	-1.319 (0.109)	100	99.98 (0.804)	-1.595 (0.099)	100	186.931 (21.859)	-0.916 (0.173)	102

Table 9 (contd)

n	h^2	Dataset	Trait mean	h^2	QTL1			QTL2			QTL3		
					Position	Effect	Power	Position	Effect	Power	Position	Effect	Power
400	0.2	RIL	99.993 (0.23)	0.211 (0.037)	189.98 (8.873)	1.352 (0.222)	102	98.99 (9.578)	1.463 (0.304)	101	188.981 (6.045)	-0.9 (0.133)	54
		TCRIL1	102 (0.173)	0.198 (0.035)	186.657 (21.22)	-1.323 (0.214)	102	99.78 (1.691)	1.143 (0.173)	100	184.935 (30.942)	0.781 (0.119)	31
		TCRIL2	101.775 (0.151)	0.208 (0.035)	196.5 (51.619)	0.592 (0.067)	2	99.706 (12.339)	1.421 (0.281)	102	189.969 (2.255)	-0.913 (0.172)	96
		TCRIL3	100.643 (0.169)	0.207 (0.033)	191.041 (5.418)	0.998 (0.26)	98	130.75 (53.112)	0.45 (0.75)	4	189.8 (1.4)	1.712 (0.21)	100
		TCRIL4	100.373 (0.143)	0.21 (0.037)	189.211 (8.45)	-0.798 (0.135)	76	99.085 (9.098)	-0.953 (0.167)	94	188.683 (13.71)	-1.298 (0.275)	101
		Sea1	0 (0.135)	0.156 (0.037)	189.74 (1.9)	-1.095 (0.165)	100	100.974 (9.067)	0.751 (0.122)	78	188.523 (28.142)	0.692 (0.142)	44
		Sea2	0 (0.118)	0.171 (0.036)	167 (61.693)	0.65 (0.084)	9	99.228 (7.543)	0.988 (0.225)	101	189.837 (1.797)	-0.897 (0.162)	98
		Sea3	0 (0.135)	0.291 (0.033)	189.564 (7.402)	1.219 (0.17)	101	120.125 (32.516)	-0.713 (0.068)	8	190.287 (4.255)	1.67 (0.285)	101
		Sea4	0 (0.134)	0.297 (0.037)	187.97 (11.996)	-0.675 (0.098)	33	95.547 (17.15)	-1.296 (0.382)	106	189.95 (1.282)	-1.316 (0.15)	100
		Gca	0 (0.06)	0.075 (0.025)	189.444 (9.108)	-0.378 (0.039)	27	99.874 (2.651)	0.479 (0.078)	95	205 (0)	-0.359 (0)	1
		Hmp1	1.003 (0.169)	0.213 (0.038)	187.284 (19.032)	-1.968 (0.274)	102	104.375 (24.663)	0.827 (0.102)	8	186.333 (24.172)	0.986 (0.168)	72
		Hmp2	0.872 (0.161)	0.069 (0.033)	182.324 (36.432)	-0.759 (0.423)	34	98.483 (18.484)	0.879 (0.244)	58	187.846 (7.604)	-0.865 (0.107)	26
		Hmp3	0.333 (0.179)	0.183 (0.038)	176.667 (42.454)	0.832 (0.038)	3	105.353 (16.59)	-0.93 (0.132)	17	189.79 (1.336)	2.057 (0.25)	100
		Hmp4	0.176 (0.171)	0.262 (0.032)	190.13 (1.868)	-1.379 (0.212)	100	100.11 (1.355)	-1.635 (0.203)	100	190.099 (7.298)	-1.03 (0.199)	91

Table 10. Simulated and estimated QTL positions and effects for combining ability and heterosis under additive-dominance model with four alleles in RIL (selfs)-based NCII design.

n	h^2	Dataset	Trait mean	h^2	QTL1			QTL2			QTL3		
					Position	Effect	Power	Position	Effect	Power	Position	Effect	Power
200	0.8	RIL	100		192	1.2(1.5)	105	1.5(-1)	196	-1(2)	100	101	103
			100.019 (0.147)	0.803 (0.019)	189.96 (0.724)	1.418 (0.094)	100.861 (8.585)	1.653 (0.221)	187.039 (19.805)	-0.783 (0.159)			
		TCRIL1	101.991 (0.113)	0.808 (0.021)	187.971 (16.895)	-1.402 (0.183)	99.554 (4.84)	1.326 (0.128)	189.892 (5.795)	0.559 (0.115)			
			101.818 (0.101)	0.801 (0.018)	-	-	100.735 (14.9)	1.621 (0.245)	189.376 (7.014)	-1.037 (0.148)			
		TCRIL3	100.638 (0.104)	0.798 (0.019)	188.931 (10.18)	1.031 (0.158)	91.611 (34.748)	0.303 (0.147)	189.406 (5.788)	1.959 (0.184)			
			100.404 (0.106)	0.807 (0.022)	189.693 (2.537)	-0.71 (0.128)	99.97 (0.674)	-1.044 (0.069)	188.812 (11.956)	-1.5 (0.188)			
		Sca1	0 (0.084)	0.758 (0.028)	189.525 (4.533)	-1.168 (0.117)	100.06 (0.919)	0.798 (0.067)	189.802 (3.191)	0.567 (0.102)			
			0 (0.084)	0.773 (0.02)	190.586 (4.269)	0.37 (0.065)	98.412 (11.832)	1.103 (0.136)	190 (0.791)	-1.047 (0.071)			
		Sca3	0 (0.099)	0.865 (0.014)	189.97 (0.674)	1.281 (0.067)	100.763 (6.438)	-0.349 (0.092)	188.446 (14.825)	1.959 (0.188)			
			0 (0.104)	0.875 (0.013)	189.376 (4.576)	-0.468 (0.064)	101.02 (9.96)	-1.56 (0.149)	190.08 (0.563)	-1.512 (0.064)			
		Gca	0 (0.035)	0.578 (0.041)	189.95 (2.451)	-0.253 (0.041)	100.01 (0.732)	0.541 (0.035)	-	-			
			0.991 (0.111)	0.816 (0.021)	190.02 (0.568)	-2.122 (0.103)	99.106 (12.104)	0.494 (0.099)	188.735 (8.891)	0.942 (0.192)			
		Hmp1	0.92 (0.086)	0.536 (0.044)	188.317 (17.002)	-0.6 (0.125)	99.92 (1.134)	0.839 (0.079)	190.1 (1.396)	-0.657 (0.075)			
			0.311 (0.093)	0.793 (0.023)	189.413 (3.088)	0.409 (0.073)	99.038 (12.277)	-0.611 (0.175)	188.951 (15.241)	2.335 (0.304)			
		Hmp4	0.194 (0.13)	0.843 (0.018)	189.149 (7.99)	-1.405 (0.193)	99.97 (0.481)	-1.864 (0.085)	189.98 (0.853)	-1.131 (0.079)			

Table 10 (contd)

n	h^2	Dataset	Trait mean	h^2	QTL1			QTL2			QTL3		
					Position	Effect	Power	Position	Effect	Power	Position	Effect	Power
200	0.5	RIL	100.065 (0.181)	0.511 (0.045)	189.89 (1.483)	1.47 (0.163)	100	99.91 (1.364)	1.674 (0.178)	100	190.645 (5.61)	-0.868 (0.14)	93
		TCRIL1	101.989 (0.154)	0.512 (0.043)	189.505 (5.529)	-1.426 (0.265)	101	101.099 (10.824)	1.376 (0.176)	101	190.414 (5.134)	0.672 (0.104)	70
		TCRIL2	101.825 (0.139)	0.506 (0.042)	166 (16.971)	0.535 (0.027)	2	98.627 (9.557)	1.658 (0.201)	102	190.139 (4.55)	-1.059 (0.142)	101
		TCRIL3	100.674 (0.172)	0.509 (0.045)	187.235 (20.442)	1.034 (0.23)	102	112.571 (44.09)	0.642 (0.066)	7	189.91 (0.996)	2.061 (0.168)	100
		TCRIL4	100.357 (0.185)	0.515 (0.047)	189.867 (2.876)	-0.773 (0.131)	90	101.158 (12.649)	-1.078 (0.152)	101	188.343 (12.232)	-1.545 (0.214)	102
		Sea1	0 (0.128)	0.438 (0.047)	188.676 (8.979)	-1.18 (0.174)	102	99.91 (2.05)	0.838 (0.139)	100	189.857 (2.575)	0.631 (0.099)	84
		Sea2	0 (0.117)	0.454 (0.051)	188.405 (8.63)	0.535 (0.061)	37	100 (1.239)	1.141 (0.135)	100	188.376 (13.681)	-1.063 (0.137)	101
		Sea3	0 (0.151)	0.616 (0.039)	187.738 (20.058)	1.262 (0.244)	103	103.588 (15.748)	-0.584 (0.096)	17	188.386 (15.336)	2.018 (0.2)	101
		Sea4	0 (0.153)	0.638 (0.04)	189.387 (8.773)	-0.56 (0.071)	62	101.228 (12.478)	-1.603 (0.161)	101	190.08 (1.051)	-1.571 (0.137)	100
		Gca	0 (0.061)	0.248 (0.054)	187.458 (14.701)	-0.332 (0.046)	48	100 (1.484)	0.565 (0.067)	100	- -	- -	0
		Hmp1	0.959 (0.145)	0.514 (0.044)	188.843 (8.6)	-2.105 (0.37)	102	102.225 (10.805)	0.72 (0.127)	40	189.816 (2.501)	1.017 (0.16)	98
		Hmp2	0.901 (0.141)	0.2 (0.07)	186.208 (22.425)	-0.744 (0.221)	53	100.34 (3.092)	0.869 (0.146)	94	186.152 (25.433)	-0.728 (0.197)	66
		Hmp3	0.337 (0.157)	0.487 (0.044)	116.167 (82.563)	0.487 (0.645)	6	101.717 (10.767)	-0.8 (0.141)	53	187.245 (20.479)	2.405 (0.407)	102
		Hmp4	0.124 (0.212)	0.575 (0.039)	188.168 (18.769)	-1.44 (0.262)	101	101 (12.408)	-1.879 (0.21)	101	190 (1.735)	-1.174 (0.157)	100

Table 10 (cont'd)

n	h^2	Dataset	Trait mean	h^2	QTL1			QTL2			QTL3		
					Position	Effect	Power	Position	Effect	Power	Position	Effect	Power
200	0.2	RIL	100.007 (0.301)	0.189 (0.066)	190.471 (2.448)	1.677 (0.287)	70	100.065 (3.274)	1.768 (0.343)	92	180.313 (48.102)	-1.235 (0.668)	16
		TCRIL1	102.008 (0.304)	0.198 (0.062)	189.204 (13.01)	-1.512 (0.388)	93	101.233 (12.268)	1.483 (0.269)	86	152.571 (61.927)	1.225 (0.135)	7
		TCRIL2	101.817 (0.267)	0.21 (0.064)	183 (79.196)	-0.978 (0.152)	2	99.96 (12.738)	1.681 (0.487)	101	190.939 (7.005)	-1.302 (0.24)	66
		TCRIL3	100.7 (0.31)	0.203 (0.057)	188.744 (7.789)	1.437 (0.204)	43	-	-	0	189.119 (10.19)	2.073 (0.511)	101
		TCRIL4	100.402 (0.266)	0.189 (0.062)	187.85 (11.518)	-1.22 (0.162)	20	101.967 (19.965)	-1.302 (0.398)	60	189.905 (3.193)	-1.585 (0.296)	95
		Sca1	0 (0.233)	0.144 (0.057)	188.189 (12.772)	-1.289 (0.348)	90	100.086 (3.484)	1.136 (0.19)	35	178.727 (50.122)	0.876 (0.625)	11
		Sca2	0 (0.21)	0.176 (0.058)	184 (0)	0.973 (0)	1	99.368 (3.992)	1.251 (0.226)	87	187.747 (21.607)	-1.23 (0.198)	79
		Sca3	0 (0.27)	0.295 (0.056)	189.912 (3.285)	1.412 (0.252)	91	99.5 (2.121)	-0.99 (0.149)	2	190.05 (1.66)	2.099 (0.31)	100
		Sca4	0 (0.224)	0.299 (0.057)	189.857 (5.113)	-1.062 (0.151)	7	100.04 (1.823)	-1.668 (0.27)	99	189.83 (2.45)	-1.558 (0.295)	100
		Gca	0 (0.118)	0.096 (0.033)	217.5 (10.607)	-0.597 (0.016)	2	97.273 (10.21)	0.665 (0.208)	55	-	-	0
		Hmp1	0.979 (0.284)	0.195 (0.057)	189.99 (2.063)	-2.221 (0.395)	99	110.2 (26.176)	0.841 (1.268)	5	179.143 (33.389)	1.442 (0.185)	28
		Hmp2	0.928 (0.28)	0.087 (0.033)	159.2 (66.211)	-0.784 (1.074)	10	89.043 (26.367)	1.204 (0.812)	23	175.625 (45.947)	-1.068 (0.961)	8
		Hmp3	0.36 (0.294)	0.193 (0.054)	27 (0)	-1.465 (0)	1	113.857 (42.452)	-1.42 (0.24)	7	187.539 (19.436)	2.431 (0.668)	102
		Hmp4	0.198 (0.306)	0.232 (0.076)	187.813 (22.774)	-1.581 (0.463)	75	99.102 (7.961)	-2.01 (0.361)	98	190.841 (8.02)	-1.428 (0.206)	44

Table 10 (contd)

n	h^2	Dataset	Trait mean	h^2	QTL1			QTL2			QTL3		
					Position	Effect	Power	Position	Effect	Power	Position	Effect	Power
400	0.8	RIL	99.987 (0.096)	0.8 (0.012)	188.822 (11.452)	1.38 (0.132)	101	99.96 (0.47)	1.654 (0.062)	100	189.564 (5.039)	-0.785 (0.086)	101
		TCRIL1	102.001 (0.074)	0.801 (0.014)	187.32 (23.199)	-1.36 (0.276)	103	100 (0.512)	1.324 (0.056)	100	188.634 (13.973)	0.566 (0.068)	101
		TCRIL2	101.783 (0.068)	0.8 (0.014)	183.875 (14.197)	0.203 (0.024)	8	102.5 (17.801)	1.616 (0.237)	102	188.921 (11.866)	-1.034 (0.133)	101
		TCRIL3	100.671 (0.076)	0.803 (0.015)	190.535 (4.422)	1.032 (0.103)	101	102.371 (15.229)	0.26 (0.041)	62	189.505 (4.395)	1.959 (0.232)	101
		TCRIL4	100.385 (0.074)	0.804 (0.013)	190.07 (1.008)	-0.714 (0.047)	100	99.98 (0.586)	-1.045 (0.054)	100	187.696 (16.736)	-1.471 (0.217)	102
		Sea1	0 (0.058)	0.75 (0.02)	188.465 (15.431)	-1.148 (0.141)	101	100.05 (0.757)	0.795 (0.047)	100	187.825 (15.278)	0.551 (0.12)	103
		Sea2	0 (0.057)	0.77 (0.018)	189.559 (5.156)	0.346 (0.054)	102	101.317 (13.348)	1.113 (0.106)	101	190.05 (0.609)	-1.043 (0.047)	100
		Sea3	0 (0.075)	0.867 (0.01)	186.288 (24.779)	1.231 (0.257)	104	100.077 (4.869)	-0.33 (0.075)	104	189.95 (0.386)	1.978 (0.06)	100
		Sea4	0 (0.074)	0.872 (0.01)	190.27 (1.205)	-0.466 (0.042)	100	100.762 (7.671)	-1.555 (0.151)	101	188.802 (12.348)	-1.488 (0.142)	101
		Gca	0 (0.022)	0.575 (0.028)	189.73 (1.213)	-0.253 (0.026)	100	101.139 (11.153)	0.532 (0.05)	101	47 (28.284)	0.007 (0.149)	2
		Hmp1	1.009 (0.075)	0.807 (0.013)	188.347 (16.922)	-2.073 (0.237)	101	100.039 (4.403)	0.502 (0.081)	102	189.475 (6.018)	0.957 (0.095)	101
		Hmp2	0.892 (0.058)	0.537 (0.033)	188.842 (10.473)	-0.612 (0.102)	101	102.451 (17.767)	0.82 (0.135)	102	189.02 (11.706)	-0.65 (0.105)	101
		Hmp3	0.351 (0.076)	0.8 (0.015)	190.677 (4.271)	0.354 (0.068)	96	102.275 (15.754)	-0.62 (0.138)	102	189.594 (4.598)	2.348 (0.271)	101
		Hmp4	0.191 (0.087)	0.841 (0.011)	188.921 (10.659)	-1.384 (0.129)	101	99.95 (0.411)	-1.862 (0.065)	100	189.99 (0.659)	-1.126 (0.068)	100

Table 10 (*cont'd*)

n	h^2	Dataset	Trait mean	h^2	QTL1			QTL2			QTL3		
					Position	Effect	Power	Position	Effect	Power	Position	Effect	Power
400	0.5	RIL	99.998 (0.111)	0.504 (0.031)	190.02 (1.128)	1.424 (0.12)	100	99.94 (0.874)	1.68 (0.121)	100	188.333 (14.154)	-0.813 (0.132)	102
		TCRIL1	102.027 (0.107)	0.506 (0.028)	188.843 (14.926)	-1.368 (0.271)	102	99.109 (9.003)	1.344 (0.146)	101	190.48 (6.034)	0.566 (0.116)	100
		TCRIL2	101.817 (0.099)	0.503 (0.029)	192.333 (48.604)	0.176 (0.469)	3	100.08 (0.774)	1.664 (0.108)	100	190.03 (1.185)	-1.05 (0.101)	100
		TCRIL3	100.626 (0.124)	0.497 (0.031)	188.822 (14.511)	1.059 (0.131)	101	84.333 (64.632)	0.131 (0.521)	3	190.1 (0.745)	1.997 (0.136)	100
		TCRIL4	100.398 (0.104)	0.506 (0.031)	190.23 (1.413)	-0.742 (0.102)	100	98.931 (9.707)	-1.047 (0.123)	101	190.475 (4.927)	-1.5 (0.211)	101
		Sea1	0 (0.084)	0.433 (0.031)	189.98 (0.853)	-1.162 (0.085)	100	99.248 (6.691)	0.815 (0.113)	101	189.614 (9.895)	0.559 (0.131)	101
		Sea2	0 (0.076)	0.454 (0.034)	189.793 (4.048)	0.408 (0.073)	82	102.136 (12.17)	1.087 (0.243)	103	190.04 (1.072)	-1.043 (0.09)	100
		Sea3	0 (0.114)	0.613 (0.026)	190.06 (0.962)	1.29 (0.101)	100	101.017 (17.835)	-0.406 (0.118)	59	190.07 (0.59)	1.989 (0.114)	100
		Sea4	0 (0.096)	0.63 (0.022)	190.26 (3.868)	-0.5 (0.101)	100	97.641 (13.781)	-1.544 (0.226)	103	190.03 (0.731)	-1.514 (0.087)	100
		Gca	0 (0.04)	0.255 (0.037)	190.032 (4.367)	-0.259 (0.048)	93	100.14 (1.119)	0.55 (0.046)	100	198.667 (25.007)	-0.059 (0.228)	3
		Hmp1	1.024 (0.109)	0.512 (0.027)	188.078 (17.106)	-2.034 (0.405)	103	98.482 (11.656)	0.565 (0.16)	83	190.04 (1.497)	0.969 (0.113)	100
		Hmp2	0.916 (0.089)	0.228 (0.036)	190.568 (4.549)	-0.629 (0.102)	95	101.01 (17.344)	0.838 (0.177)	103	190.112 (2.06)	-0.67 (0.123)	98
		Hmp3	0.303 (0.129)	0.489 (0.032)	177.292 (34.239)	0.525 (0.233)	24	100.146 (8.742)	-0.659 (0.161)	96	190.1 (0.689)	2.397 (0.156)	100
		Hmp4	0.199 (0.133)	0.569 (0.029)	190.09 (0.996)	-1.443 (0.125)	100	98.911 (9.674)	-1.867 (0.19)	101	189.139 (8.129)	-1.129 (0.14)	101

Table 10 (contd)

n	h^2	Dataset	Trait mean	h^2	QTL1			QTL2			QTL3		
					Position	Effect	Power	Position	Effect	Power	Position	Effect	Power
400	0.2	RIL	100.009 (0.253)	0.204 (0.038)	186.019 (22.818)	1.448 (0.397)	103	99.96 (1.576)	1.718 (0.258)	100	189.068 (10.851)	-1.029 (0.132)	44
		TCRIL1	102.005 (0.188)	0.205 (0.036)	189.86 (1.764)	-1.471 (0.208)	100	102.524 (15.003)	1.37 (0.383)	103	186.629 (17.795)	0.846 (0.096)	35
		TCRIL2	101.815 (0.171)	0.205 (0.038)	— —	— —	0	100.02 (1.239)	1.708 (0.217)	100	189.702 (2.026)	-1.077 (0.189)	94
		TCRIL3	100.68 (0.193)	0.198 (0.04)	190.43 (3.172)	1.182 (0.211)	86	115.8 (57.712)	0.524 (0.816)	5	189.03 (10.046)	1.991 (0.364)	101
		TCRIL4	100.378 (0.187)	0.198 (0.044)	189.038 (11.016)	-0.874 (0.259)	53	102.144 (14.179)	-1.092 (0.287)	97	188.644 (189.732)	-1.526 (0.225)	101
		Sea1	0 (0.147)	0.156 (0.036)	189.86 (1.944)	-1.226 (0.176)	100	101.655 (11.678)	0.885 (0.233)	87	189.732 (4.087)	0.757 (0.102)	41
		Sea2	0 (0.134)	0.169 (0.034)	192.143 (2.478)	0.72 (0.063)	7	100.15 (1.672)	1.156 (0.188)	100	189.79 (1.822)	-1.056 (0.184)	100
		Sea3	0 (0.173)	0.278 (0.04)	190 (1.595)	1.351 (0.183)	100	78.25 (81.7)	-0.353 (0.716)	4	188.228 (18.448)	1.97 (0.234)	101
		Sea4	0 (0.155)	0.295 (0.043)	186.952 (9.927)	-0.749 (0.079)	21	100.713 (8.064)	-1.622 (0.211)	101	187.598 (17.407)	-1.513 (0.249)	102
		Gca	0 (0.075)	0.08 (0.032)	186.2 (29.072)	-0.402 (0.255)	15	101.798 (14.216)	0.578 (0.152)	99	57 (22.627)	-0.008 (0.553)	2
		Hmp1	1.005 (0.196)	0.206 (0.036)	190 (2.307)	-2.151 (0.278)	101	111.733 (24.327)	0.869 (0.584)	15	186.965 (16.511)	1.114 (0.282)	85
		Hmp2	0.885 (0.201)	0.065 (0.03)	184.966 (25.715)	-0.978 (0.152)	29	100.118 (3.368)	1.097 (0.161)	51	185.36 (23.366)	-0.985 (0.169)	25
		Hmp3	0.365 (0.184)	0.181 (0.039)	182.4 (12.7)	1.032 (0.122)	5	109.5 (30.844)	-0.864 (0.576)	12	187.961 (15.919)	2.358 (0.438)	102
		Hmp4	0.174 (0.212)	0.253 (0.041)	189.396 (7.845)	-1.452 (0.332)	101	99.68 (1.262)	-1.912 (0.269)	100	187.319 (20.151)	-1.2 (0.229)	94

Table 11. Simulated and estimated QTL positions and effects for combining ability and heterosis under additive-dominance model with two alleles at each locus in RIL (sib-mating)-based NCII design ($p = 1/3$).

	QTL1			QTL2			QTL3			
	Trait mean	Trait std.	h^2 mean	h^2 std.	Pos. mean	Pos. std.	Effect	Pos. mean	Pos. std.	Effect
RIL	100.00	0.14	0.43	0.03	190.00	0.91	30	100.00	1.02	30
TCRIL1	101.87	0.08	0.44	0.04	184.29	8.46	7	99.97	0.67	30
TCRIL2	101.86	0.10	0.44	0.03	178.80	19.52	5	99.77	0.82	30
TCRIL3	99.36	0.06	0.43	0.04	190.10	0.80	30	99.00	8.97	11
ScaQQ1	0.00	0.07	0.21	0.04	189.97	1.71	30	99.83	1.70	30
ScaQQ2	0.00	0.06	0.20	0.04	189.97	1.50	30	99.67	1.79	30
Scaqq	0.00	0.07	0.57	0.03	190.23	0.86	30	99.87	0.82	30
Gca	0.00	0.05	0.55	0.04	190.00	2.61	26	99.93	0.52	30
HmpQQ1	0.82	0.08	0.16	0.05	190.18	2.44	22	99.90	2.11	29
HmpQQ2	0.80	0.07	0.15	0.05	190.62	4.25	26	99.38	2.14	26
Hmpqq	-0.82	0.07	0.21	0.05	187.46	15.03	28	101.13	19.82	31

Table 12. Simulated and estimated QTL positions and effects for combining ability and heterosis under additive-dominance model with two alleles at each locus in RIL (sib-mating)-based NCII design ($p = 1/4$).

	QTL1			QTL2			QTL3			
	Trait mean	Trait std.	h^2 mean	h^2 std.	Pos. mean	Pos. std.	Effect	Pos. mean	Pos. std.	Effect
RIL	99.99	0.10	0.43	0.04	190.47	0.90	30	100.00	0.87	30
TCRIL1	101.86	0.08	0.43	0.04	189.29	12.75	7	99.93	0.58	30
TCRIL2	101.86	0.09	0.44	0.03	191.63	7.48	8	103.19	18.16	31
TCRIL3	101.87	0.08	0.43	0.03	185.75	10.33	8	100.10	0.66	30
TCRIL4	99.34	0.06	0.42	0.04	189.90	0.71	30	101.30	2.50	10
ScaQQ1	0.00	0.06	0.10	0.03	189.81	6.38	26	97.19	11.82	26
ScaQQ2	0.00	0.06	0.11	0.04	190.42	1.79	24	99.79	1.93	29
ScaQQ3	0.00	0.06	0.10	0.04	189.52	1.90	25	98.81	7.98	27
Scaqq1	0.00	0.07	0.61	0.04	183.97	32.85	31	99.66	17.46	32
Gca	0.00	0.05	0.65	0.02	173.20	32.04	5	99.93	0.52	30
HmpQQ1	0.82	0.09	0.15	0.04	190.38	1.50	24	100.11	1.67	27
HmpQQ2	0.79	0.08	0.15	0.04	183.45	23.78	20	103.71	21.88	28
HmpQQ3	0.81	0.11	0.15	0.04	190.09	2.64	22	100.21	1.85	28
Hmpqq	-0.86	0.09	0.56	0.04	186.45	18.84	31	95.88	18.18	32

Table 13. Simulated and estimated QTL positions and effects for combining ability and heterosis under additive-dominance model with two alleles at each locus in RIL (sib-mating)-based NCII design ($p = 1/5$).

	QTL1			QTL2			QTL3			
	Trait mean	Trait std	h^2 mean	h^2 std.	Pos. mean	Pos. std	Effect	Pos. mean	Pos. std	Effect
RIL	100.02	0.13	0.44	0.03	190.10	0.99	30	100.07	0.83	30
TCRIL1	101.83	0.10	0.43	0.03	192.71	9.23	7	99.77	0.77	30
TCRIL2	101.83	0.10	0.43	0.04	192.00	3.16	6	103.84	23.43	31
TCRIL3	101.85	0.10	0.43	0.03	193.40	6.11	5	102.48	12.56	31
TCRIL4	101.84	0.09	0.45	0.03	189.56	3.32	9	99.90	1.06	30
TCRIL5	99.34	0.07	0.43	0.03	190.13	0.68	30	98.18	2.44	11
ScaQQ1	0.00	0.06	0.06	0.02	190.89	6.24	19	102.13	11.61	23
ScaQQ2	0.00	0.08	0.07	0.03	189.06	8.74	18	98.59	3.30	17
ScaQQ3	0.00	0.06	0.06	0.02	190.81	2.81	16	106.21	18.91	14
ScaQQ4	0.00	0.07	0.07	0.03	188.87	3.04	15	99.22	3.34	18
Scaqq	0.00	0.07	0.64	0.03	188.52	9.21	31	99.67	0.61	30
Gca	0.00	0.05	0.72	0.02	189.00	0.00	1	99.93	0.64	30
HmpQQ1	0.77	0.08	0.14	0.04	190.00	2.07	23	100.20	4.03	30
HmpQQ2	0.78	0.09	0.14	0.05	188.08	10.59	24	99.40	2.72	25
HmpQQ3	0.80	0.09	0.15	0.05	189.96	3.08	25	100.63	2.72	24
HmpQQ4	0.80	0.09	0.15	0.05	189.96	3.08	25	100.63	2.72	24
Hmpqq	1.65	0.09	0.16	0.04	184.64	32.70	25	99.04	5.54	27
								190.13	1.63	30
								182.84	30.69	32
								189.97	1.03	30
								189.60	1.38	30
								189.87	0.78	30
								183.88	35.15	16
								165.00	0.00	1
								187.00	5.66	2
								178.50	0.71	2
								188.00	2.83	2
								189.63	1.35	30
								190.10	0.66	30
								189.39	2.48	28
								190.00	2.04	27
								189.52	4.66	29
								189.52	4.66	29
								189.60	1.69	30

Table 14. Simulated and estimated QTL positions and effects for combining ability and heterosis under additive-dominance model with two alleles at each locus in RIL (sib-mating)-based NCII design ($p = 2/5$).

	Trait mean	Trait std	h^2 mean	h^2 std	QTL1			QTL2			QTL3		
					Pos mean	Pos std	Effect	Pos mean	Pos std	Effect	Pos mean	Pos std	Effect
RIL	99.99	0.16	0.43	0.02	189.83	1.34	30	100.03	1.07	30	187.33	11.77	30
TCRIL1	101.85	0.11	0.43	0.03	190.80	2.77	5	100.37	0.76	30	188.71	8.00	31
TCRIL2	101.83	0.10	0.43	0.04	153.20	81.89	5	100.10	0.76	30	190.17	1.32	30
TCRIL3	101.87	0.09	0.43	0.03	182.17	13.00	6	100.10	0.76	30	189.93	1.05	30
TCRIL4	99.33	0.06	0.41	0.03	190.00	0.87	30	100.56	1.74	9	189.90	2.96	10
TCRIL5	99.34	0.06	0.42	0.04	187.09	25.11	32	99.63	3.38	16	188.88	3.00	8
ScaQQ1	0.00	0.09	0.24	0.04	190.17	1.51	30	100.57	1.36	30	189.09	11.37	22
ScaQQ2	0.00	0.08	0.23	0.04	184.61	31.93	31	100.13	1.50	30	189.53	3.25	15
ScaQQ3	0.00	0.08	0.23	0.04	188.48	6.37	31	98.61	7.29	31	191.67	11.29	15
ScaQQ4	0.00	0.06	0.49	0.04	189.90	1.03	30	100.00	0.53	30	189.57	1.72	30
Scaqq	0.00	0.07	0.51	0.04	189.93	0.91	30	100.23	0.94	30	190.50	1.80	30
Gca	0.00	0.03	0.64	0.02	189.80	1.35	30	100.00	0.69	30	184.26	32.90	31
HmpQQ1	0.80	0.10	0.14	0.04	189.78	2.16	18	100.68	1.99	25	187.27	18.61	30
HmpQQ2	0.79	0.10	0.16	0.04	189.60	1.96	25	100.04	1.97	28	190.62	2.38	26
HmpQQ3	0.82	0.09	0.16	0.05	189.15	7.79	26	99.40	1.89	25	186.61	19.89	31
HmpQQ4	-0.87	0.09	0.56	0.03	190.03	0.72	30	100.13	1.07	30	-	-	0
Hmpqq	-0.87	0.09	0.56	0.03	190.03	0.72	30	100.13	1.07	30	-	-	0

Table 15. Simulated and estimated QTL positions and effects for combining ability and heterosis under additive-dominance model with two alleles at each locus in RIL (sib-mating)-based NCI design ($p = 1/6$).

	QTL1				QTL2				QTL3						
	Trait mean	Trait std	h^2 mean	h^2 std	Pos mean	Pos std	Effect	Effect	Pos mean	Pos std	Effect	Effect	Pos mean	Pos std	Effect
RIL	100.02	0.10	0.45	0.02	187.87	13.35	31	30	100.13	1.20	30	30	189.77	1.98	30
TCRIL1	101.86	0.08	0.42	0.03	162.83	65.10	6	30	99.77	0.90	30	30	190.10	1.30	30
TCRIL2	101.83	0.06	0.44	0.04	172.67	51.81	9	30	100.03	0.85	30	30	189.87	1.43	30
TCRIL3	101.88	0.09	0.43	0.04	180.25	46.42	12	30	100.03	0.67	30	30	190.27	1.31	30
TCRIL4	101.85	0.09	0.43	0.03	187.40	7.54	5	30	100.17	0.79	30	30	189.97	1.13	30
TCRIL5	101.83	0.09	0.43	0.03	187.80	4.44	5	30	99.97	1.07	30	30	189.77	1.30	30
TCRIL6	99.35	0.06	0.42	0.04	190.03	0.81	30	17	101.41	23.55	17	10	190.50	3.41	10
ScaQQ1	0.00	0.07	0.05	0.02	163.00	65.17	6	11	98.64	3.56	11	1	165.00	0.00	1
ScaQQ2	0.00	0.06	0.05	0.02	190.50	4.28	10	11	99.36	2.38	11	1	233.00	0.00	1
ScaQQ3	0.00	0.07	0.05	0.02	194.50	11.10	10	9	96.89	8.82	9	1	198.00	0.00	1
ScaQQ4	0.00	0.06	0.05	0.02	187.78	6.10	9	7	100.29	2.43	7	2	189.50	2.12	2
ScaQQ5	0.00	0.06	0.05	0.02	189.44	3.32	9	13	98.08	3.01	13	1	189.00	0.00	1
Scaqq	0.00	0.06	0.65	0.02	190.10	0.76	30	30	100.03	0.49	30	30	189.93	1.36	30
Gca	0.00	0.04	0.77	0.02	–	–	0	30	99.97	0.49	30	30	190.17	0.53	30
HmpQQ1	0.80	0.08	0.14	0.05	183.28	32.00	25	25	99.41	2.53	27	25	190.44	1.83	25
HmpQQ2	0.80	0.10	0.15	0.03	176.59	42.52	27	27	101.11	3.76	27	27	190.33	2.95	27
HmpQQ3	0.84	0.10	0.15	0.03	191.65	9.51	26	28	100.21	1.87	28	29	190.52	2.25	29
HmpQQ4	0.84	0.10	0.15	0.03	191.65	9.51	26	28	100.21	1.87	28	29	190.52	2.25	29
HmpQQ5	0.84	0.10	0.15	0.03	191.65	9.51	26	28	100.21	1.87	28	29	190.52	2.25	29
Hmpqq	1.64	0.08	0.15	0.04	191.00	2.38	24	30	100.47	2.56	30	30	190.65	1.87	26

Table 16. Simulated and estimated QTL positions and effects for combining ability and heterosis under additive-dominance model with two alleles at each locus in RIL (sib-mating)-based NCI design ($p = 1/8$).

	QTL1			QTL2			QTL3						
	Trait mean	Trait std	h^2 mean	h^2 std	Pos mean	Pos std	Effect	Pos mean	Pos std	Effect			
RIL	100.00	0.14	0.44	0.03	189.83	1.09	30	100.10	0.96	30	191.47	8.66	32
TCRIL1	101.82	0.09	0.44	0.03	189.57	4.65	7	99.90	1.06	30	190.03	1.19	30
TCRIL2	101.78	0.11	0.43	0.04	184.89	15.80	9	100.07	0.94	30	190.13	1.07	30
TCRIL3	101.81	0.10	0.44	0.04	187.00	9.77	5	104.65	24.95	31	189.90	1.18	30
TCRIL4	101.79	0.11	0.43	0.03	189.25	4.27	4	100.00	0.83	30	190.27	0.98	30
TCRIL5	101.82	0.10	0.42	0.03	160.20	51.57	5	100.07	0.87	30	189.87	1.11	30
TCRIL6	101.79	0.10	0.44	0.04	191.40	3.05	5	99.93	0.64	30	189.97	1.45	30
TCRIL7	101.81	0.10	0.43	0.03	176.14	22.16	7	100.03	0.85	30	189.87	1.17	30
TCRIL8	99.34	0.05	0.43	0.03	190.13	0.63	30	106.15	12.31	13	175.58	48.08	12
ScaQQ1	0.00	0.07	0.04	0.02	191.50	7.78	2	90.29	26.90	7	183.33	9.07	3
ScaQQ2	0.00	0.06	0.05	0.02	177.50	27.79	4	101.67	5.03	3	194.00	0.00	1
ScaQQ3	0.00	0.07	0.06	0.02	161.67	40.15	3	96.00	12.52	4	—	—	0
ScaQQ4	0.00	0.08	0.04	0.00	193.25	12.69	4	91.75	24.60	4	—	—	0
ScaQQ5	0.00	0.08	0.04	0.00	161.00	58.74	4	—	—	0	—	—	0
ScaQQ6	0.00	0.08	0.04	0.00	190.00	3.61	3	103.33	0.58	3	195.00	0.00	1
ScaQQ7	0.00	0.07	0.04	0.01	192.00	5.66	2	104.00	0.00	1	176.00	2.83	2
Scaqq	0.00	0.07	0.67	0.03	189.83	0.75	30	100.23	0.68	30	184.71	30.22	31
Gca	0.00	0.05	0.83	0.01	207.00	0.00	1	100.00	0.45	30	189.97	0.56	30
HmpQQ1	0.77	0.09	0.16	0.04	190.83	4.24	24	100.97	8.11	30	190.93	5.38	29
HmpQQ2	0.77	0.10	0.13	0.05	190.47	2.63	19	99.62	2.68	26	188.15	11.07	27
HmpQQ3	0.80	0.10	0.14	0.04	190.18	2.20	22	100.70	2.20	27	189.75	2.10	28
HmpQQ4	0.80	0.10	0.14	0.04	190.18	2.20	22	100.70	2.20	27	189.75	2.10	28
HmpQQ5	0.80	0.10	0.14	0.04	190.18	2.20	22	100.70	2.20	27	189.75	2.10	28
HmpQQ6	0.80	0.10	0.14	0.04	190.18	2.20	22	100.70	2.20	27	189.75	2.10	28
HmpQQ7	0.80	0.10	0.14	0.04	190.18	2.20	22	100.70	2.20	27	189.75	2.10	28
Hmpqq	1.60	0.10	0.15	0.04	190.64	6.06	22	99.27	1.96	30	190.38	1.80	29

Table 17. Simulated and estimated QTL positions and effects for combining ability and heterosis under additive-dominance model with two alleles at each locus in RIL (sib-mating)-based NCI design ($p = 3/8$).

	QTL1				QTL2				QTL3						
	Trait mean	Trait std	h^2 mean	h^2 std	Pos mean	Pos std	Effect	Effect	Pos mean	Pos std	Effect	Effect	Pos mean	Pos std	Effect
RIL	100.05	0.11	0.43	0.03	185.13	28.07	31	31	100.00	0.91	30	30	191.10	3.67	30
TCRIL1	101.86	0.09	0.44	0.03	156.25	64.21	4	4	100.07	0.69	30	30	191.16	7.12	31
TCRIL2	101.83	0.11	0.42	0.03	169.63	58.73	8	8	100.00	0.64	30	30	187.77	11.89	31
TCRIL3	101.89	0.08	0.42	0.04	190.00	2.12	5	5	100.00	0.83	30	30	190.03	1.25	30
TCRIL4	101.85	0.09	0.43	0.03	190.67	2.80	6	6	99.97	0.93	30	30	189.93	0.98	30
TCRIL5	101.86	0.08	0.43	0.03	189.25	2.22	4	4	100.07	0.78	30	30	188.26	10.50	31
TCRIL6	99.36	0.07	0.44	0.04	189.97	0.85	30	30	110.17	33.44	12	12	190.33	2.31	12
TCRIL7	99.33	0.06	0.42	0.03	190.03	0.72	30	30	100.25	2.45	12	12	172.00	47.54	13
TCRIL8	99.36	0.07	0.41	0.04	190.03	0.56	30	30	98.69	8.43	16	16	182.56	16.73	9
ScaQQ1	0.00	0.08	0.19	0.03	185.94	23.44	31	31	100.23	1.41	30	30	189.50	1.69	8
ScaQQ2	0.00	0.09	0.19	0.04	184.87	29.71	31	31	100.13	1.36	30	30	181.00	24.77	7
ScaQQ3	0.00	0.07	0.18	0.03	189.87	1.85	30	30	99.67	1.49	30	30	178.20	41.92	15
ScaQQ4	0.00	0.07	0.20	0.03	189.68	3.82	31	31	99.93	1.93	30	30	190.36	1.96	11
ScaQQ5	0.00	0.06	0.19	0.04	189.37	1.75	30	30	100.90	4.66	30	30	190.25	2.56	12
ScaQQ6	0.00	0.05	0.52	0.03	186.58	19.06	31	31	103.81	20.65	31	31	189.93	2.07	30
ScaQQ7	0.00	0.07	0.51	0.03	189.97	0.72	30	30	100.13	0.73	30	30	190.65	5.26	31
Scaqq	0.00	0.07	0.51	0.03	189.83	0.70	30	30	100.23	0.68	30	30	187.97	10.84	30
Gca	0.00	0.04	0.75	0.02	185.48	25.92	31	31	100.00	0.53	30	30	186.00	22.28	31
HmpQQ1	0.79	0.08	0.15	0.04	187.19	10.21	26	26	99.00	7.78	30	30	190.18	2.72	28
HmpQQ2	0.76	0.11	0.13	0.04	189.20	2.63	20	20	100.19	2.09	27	27	190.19	2.40	26
HmpQQ3	0.82	0.08	0.14	0.04	190.18	3.23	22	22	99.52	2.49	25	25	190.11	2.30	28
HmpQQ4	0.82	0.08	0.14	0.04	190.18	3.23	22	22	99.52	2.49	25	25	190.11	2.30	28
HmpQQ5	0.82	0.08	0.14	0.04	190.18	3.23	22	22	99.52	2.49	25	25	190.11	2.30	28
HmpQQ6	1.66	0.10	0.15	0.04	190.63	3.19	24	24	100.68	4.53	28	28	190.07	1.81	29
HmpQQ7	1.66	0.10	0.15	0.04	190.63	3.19	24	24	100.68	4.53	28	28	190.07	1.81	29
Hmpqq	1.66	0.10	0.15	0.04	190.63	3.19	24	24	100.68	4.53	28	28	190.07	1.81	29