Genetic Dissection of the Developmental Behaviors of Plant Height in Wheat under Diverse Water Regimes

Xianshan Wu, Zhenghang Wang, Xiaoping Chang, and Ruilian Jing

Table S1. Correlation coefficients between stages for plant height of wheat grown in ten environments

Environment	Stage	S1	S2	S3	S4	S5
E1\E6	S1		0.84[***]	0.77[***]	0.71[***]	0.63[***]
	S2	0.93[***]		0.86[***]	0.80[***]	0.67[***]
	S3	0.91[***]	0.95[***]		0.87[***]	0.73[***]
	S4	0.87[***]	0.90[***]	0.92[***]		0.76[***]
	S5	0.80[***]	0.82[***]	0.85[***]	0.94[***]	
E2\E7	S1		0.83[***]	0.82[***]	0.79[***]	0.73[***]
	S2	0.88[***]		0.88[***]	0.90[***]	0.84[***]
	S3	0.84[***]	0.94[***]		0.93[***]	0.87[***]
	S4	0.83[***]	0.92[***]	0.97[***]		0.92[***]
	S5	0.77[***]	0.88[***]	0.94[***]	0.96[***]	
E3\E8	S1		0.89[***]	0.85[***]	0.84[***]	0.84[***]
	S2	0.94[***]		0.94[***]	0.93[***]	0.93[***]
	S3	0.91[***]	0.98[***]		0.98[***]	0.95[***]
	S4	0.91[***]	0.97[***]	0.98[***]		0.97[***]
	S5	0.87[***]	0.93[***]	0.95[***]	0.96[***]	
E4\E9	S1		0.85[***]	0.78[***]	0.74[***]	0.71[***]
	S2	0.93[***]		0.95[***]	0.93[***]	0.91[***]
	S3	0.90[***]	0.96[***]		0.98[***]	0.97[***]
	S4	0.87[***]	0.93[***]	0.99[***]		0.97[***]
	S5	0.83[***]	0.88[***]	0.95[***]	0.97[***]	
E5\E10	S1		0.94[***]	0.88[***]	0.87[***]	0.84[***]
	S2	0.97[***]		0.98[***]	0.96[***]	0.93[***]
	S3	0.93[***]	0.96[***]		0.97[***]	0.96[***]
	S4	0.92[***]	0.95[***]	0.97[***]		0.97[***]
	S5	0.88[***]	0.92[***]	0.95[***]	0.98[***]	

E1, Fenyang, Shanxi province in 2001 (F01) under drought-stressed conditions (DS); E2 and E4, Haidian, Beijing, 2005 (H05) and 2006 (H06) under DS; E3 and E5, Changping, Beijing, 2005 (Ch05) and 2006 (Ch06) under DS; E6, Fenyang, Shanxi, 2001 (F01) under well-watered conditions (WW); E7 and E9, Haidian, Beijing, 2005 (H05) and 2006 (H06), WW; E8 and E10, Changping, Beijing, 2005 (Ch05) and 2006 (Ch06), WW; S1, S2, S3, S4 and S5 indicate the first, second, third, fourth and fifth measuring stages; [*], [**], [***], [****] indicate significance at P=0.05, 0.01, 0.005 and 0.0001, respectively.

Values in the upper right and lower left segments are the correlation coefficients of stages for unconditional plant height in E1 and in E6, respectively, and so on.

Table S2. ANOVA for developmental behavior of plant height among different environmental components in wheat DHLs

Stage	Source	DF	SS	Mean Square	F Value
S1/S1|S0	Geno	149/149	39991.6/39991.6	268.4/268.4	32.2****/32.2****
	Water	1/1	39270.4/39270.4	39270.4/39270.4	4708.5****/4708.5****
	YS	4/4	40420.4/40420.4	10105.1/10105.1	1211.6****/1211.6****
	Water×Geno	149/149	4275.5/4275.5	28.7/28.7	3.4****/3.4****
	YS×Geno	596/596	8153.8/8153.8	13.7/13.7	1.6****/1.6****
	YS×Water	4/4	5020.2/5020.2	1255.0/1255.0	150.5****/150.5****
	Error	596/596	4970.9/4970.9	8.3/8.3	
	Total	1499/1499	142102.8/142102.8		
S2/S2|S1	Geno	149/149	124172.4/5760.1	833.4/38.7	67.8****/4.4****
	Water	1/1	82085.2/81758.6	82085.2/81758.6	6678.7****/9348.0****
	YS	4/4	105415.3/464.0	26353.8/116.0	2144.2****/13.3****
	Water×Geno	149/149	9146.1/2383.0	61.4/16.0	5.0****/1.8****
	YS×Geno	596/596	22114.0/9635.2	37.1/16.2	3.0****/1.9****
	YS×Water	4/4	11167.2/7769.8	2791.8/1942.5	227.2****/222.1****
	Error	596/596	7325.2/5212.7	12.3/8.7	
	Total	1499/1499	361425.5/112983.4		
S3/S3|S2	Geno	149/149	238035.4/5813.5	1597.6/39.0	103.1****/3.2****
	Water	1/1	137974.2/135095.8	137974.2/135095.8	8903.5****/11097.8****
	YS	4/4	140014.4/5429.5	35003.6/1357.4	2258.8****/111.5****
	Water×Geno	149/149	8130.5/2389.6	54.6/16.0	3.5****/1.3*
	YS×Geno	596/596	40211.0/10976.9	67.5/18.4	4.4****/1.5****
	YS×Water	4/4	11395.8/4991.9	2849.0/1248.0	183.8****/102.5****
	Error	596/596	9236.0/7255.3	15.5/12.2	
	Total	1499/1499	584997.3/171952.6		
S4/S4|S3	Geno	149/149	318903.6/2771.6	2140.3/18.6	109.0****/1.4***
	Water	1/1	155493.4/148758.6	155493.4/148758.6	7917.5****/11319.9****
	YS	4/4	98080.6/6148.4	24520.2/1537.1	1248.5****/117.0****
	Water×Geno	149/149	5179.5/2031.0	34.8/13.6	1.8****/1
	YS×Geno	596/596	41716.3/10107.0	70.0/17.0	3.6****/1.3***
	YS×Water	4/4	18048.2/1909.4	4512.0/477.4	229.8****/36.3****
	Error	596/596	11705.0/7832.2	19.6/13.1	
	Total	1499/1499	649126.5/179558.3		
S5/S5|S4	Geno	149/149	313699.9/8614.5	2105.4/57.8	84.8****/4.9****
	Water	1/1	85733.4/85456.9	85733.4/85456.9	3452.0****/7217.9****
	YS	4/4	113188.0/15749.4	28297.0/3937.4	1139.4****/332.6****
	Water×Geno	149/149	3699.5/1965.6	24.8/13.2	1/1.1
	YS×Geno	596/596	40491.1/15371.4	67.9/25.8	2.7****/2.2****
	YS×Water	4/4	11972.7/2801.5	2993.2/700.4	120.5****/59.2****
	Error	596/596	14802.3/7056.4	24.8/11.8	
	Total	1499/1499	583586.8/137015.6		

Geno: Genotype; Water: Water regimes; YS: Year by site combination.

S1, S2, S3, S4 and S5 are as shown in Table S1; S1|S0, S2|S1, S3|S2, S4|S3, S5|S4 indicate the first, second, third, fourth and fifth measuring periods.

*, **, ***, **** are as shown in Table S1.

Table S3. ANOVA for developmental behavior of plant height among different environmental combinations (year × site × water regime combination) in wheat DHLs

Stage	Source	DF	SS	MS	F Value
S1	Env	9	84711.0	9412.3	244.4****
	Error	1490	57391.8	38.5	
	Total	1499	142102.8		
S2	Env	9	198667.8	22074.2	202.1****
	Error	1490	162757.8	109.2	
	Total	1499	361425.5		
S3	Env	9	289384.5	32153.8	162.1****
	Error	1490	295612.8	198.4	
	Total	1499	584997.3		
S4	Env	9	271622.2	30180.2	119.1****
	Error	1490	377504.4	253.4	
	Total	1499	649126.5		
S5	Env	9	210894.1	23432.7	93.7****
	Error	1490	372692.7	250.1	
	Total	1499	583586.8		
S1|S0	Env	9	84711.0	9412.3	244.4****
	Error	1490	57391.8	38.5	
	Total	1499	142102.8		
S2|S1	Env	9	89992.4	9999.2	648.0****
	Error	1490	22991.0	15.4	
	Total	1499	112983.4		
S3|S2	Env	9	145517.3	16168.6	911.3****
	Error	1490	26435.3	17.7	
	Total	1499	171952.6		
S4|S3	Env	9	156816.4	17424.0	1141.6****
	Error	1490	22741.8	15.3	
	Total	1499	179558.3		
S5|S4	Env	9	104007.8	11556.4	521.7****
	Error	1490	33007.8	22.2	
	Total	1499	137015.6		

Notes as shown in Table S2.

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Table S4. Correlation coefficients between periods for plant height of wheat grown in ten environments

Environment	Period	S1|S0	S2|S1	S3|S2	S4|S3	S5|S4
E6\E1	S1|S0		-0.61***	-0.51***	-0.12	-0.15
	S2|S1	-0.72***		0.29***	0.26***	0.15
	S3|S2	-0.35***	0.17*		-0.01	0.15
	S4|S3	-0.12	0.09	-0.02		-0.14
	S5|S4	-0.08	0.01	0.08	0.17*	
E7\E2	S1|S0		-0.21**	-0.36***	-0.26***	0.19*
	S2|S1	-0.50***		-0.48***	0.12	0.12
	S3|S2	-0.09	-0.11		-0.28***	-0.09
	S4|S3	0.45***	-0.05	0.05		-0.07
	S5|S4	0.41***	-0.08	0.18*	0.23***	
E8\E3	S1|S0		-0.17*	0.29***	0.18*	-0.22**
	S2|S1	0.44***		-0.04	0.13	-0.13
	S3|S2	0.46***	0.59***		-0.08	-0.33***
	S4|S3	-0.45***	-0.53***	-0.44***		-0.18*
	S5|S4	-0.59***	-0.32***	-0.34***	0.27***	
E9\E4	S1|S0		0.13	0.07	0.22**	0.41***
	S2|S1	0.02		0.21**	0.50***	0.33***
	S3|S2	0.31***	-0.01		0.26***	0.42***
	S4|S3	0.54***	0.24***	0.53***		0.23**
	S5|S4	0.12	-0.13	0.40***	0.17*	
E10\E5	S1|S0		0.51***	0.24***	-0.15	-0.45***
	S2|S1	0.40***		0.58***	-0.12	-0.37***
	S3|S2	-0.35***	-0.12		-0.21**	-0.11
	S4|S3	-0.06	0.1	0.03		-0.17*
	S5|S4	-0.41***	-0.13	0.33***	0.34***	

E1 to E10 are as shown in Table S1; S1|S0 to S5|S4, *, ** and *** are as shown in Table S2.

Values in the upper right and lower left segments are the correlation coefficients of periods for conditional plant height in E1 and in E6, respectively, and so on.

Table S5. Unconditional epistatic QTLs affecting plant height of wheat at five growth stages in ten environments

QTL$_i$	Flanking marker$_i$	QTL$_j$	Flanking marker$_j$	Stage	aa	aae	h^2(aa)%	h^2(aae)%
QPh.cgb-1A.1	Xcwm517-Xwmc20	QPh.cgb-6B.2	P8444.1-P3454.2	S2	1.74***		0.11	
QPh.cgb-1A.3	Xwmc59-Xwmc254	QPh.cgb-2A.1	P3715.2-P1138.2	S3	1.30***		0.24	
QPh.cgb-1B.2	Xgwm273-Xgwm131	QPh.cgb-7D.3	Xwmc463-Xgwm295	S4	1.29***		0.01	
QPh.cgb-1B.3	Xgwm131-Xwmc156	QPh.cgb-3B.7	Xgwm644.2-Xwmc3	S3	-0.98***		0.00	
QPh.cgb-1B.4	Xwmc156-P3446.1	QPh.cgb-2D.6	P4233.2-P6411.4	S4	-2.10***		1.60	
				S5	-4.59***		1.50	
QPh.cgb-1B.4	Xwmc156-P3446.1	QPh.cgb-2D.4	Xgwm157-Xgwm539	S5	2.58***		1.57	
QPh.cgb-1B.6	P8222.3-Xcwm70	QPh.cgb-6B.3	P3454.2-P8466.1	S4	-1.25***		0.02	
QPh.cgb-1B.7	P3474.4-Xcwm548	QPh.cgb-3B.5	Xgwm72-Xgwm274	S3	0.99***		0.05	
QPh.cgb-1B.7	P3474.4-Xcwm548	QPh.cgb-3B.7	Xgwm644.2-Xwmc3	S3	-0.45*		0.00	
QPh.cgb-1B.7	P3474.4-Xcwm548	QPh.cgb-2D.3	Xwmc144-Xgwm157	S5	-0.78*		0.83	
QPh.cgb-1B.8	Xcwm548-Xcwm547	QPh.cgb-3B.6	Xpsp3030-Xwmc366	S2	1.54***	0.91*(aae10)	0.50	0.21
QPh.cgb-1B.9	Xcwm547-P5140.3	QPh.cgb-6B.5	Xgwm132-Xwmc104	S4	-2.79***		0.47	
QPh.cgb-1B.10	EST122-P6934.3	QPh.cgb-2D.5	Xgwm539-P4233.2	S5	-2.98***		1.41	
QPh.cgb-1B.11	P6934.3-P3446.6	QPh.cgb-1B.16	Xwmc269.2-Xcwm90	S1	0.88***	0.45*(aae10)	0.53	0.17
QPh.cgb-1B.12	P2043.3-P3622.3	QPh.cgb-3B.10	Xgwm108-Xwmc291	S4	1.50***		1.49	
QPh.cgb-1B.12	P2043.3-P3622.3	QPh.cgb-6B.5	Xgwm132-Xwmc104	S4	0.51*		0.07	
QPh.cgb-1B.12	P2043.3-P3622.3	QPh.cgb-2D.4	Xgwm157-Xgwm539	S5	-2.79***		0.21	
QPh.cgb-1B.12	P2043.3-P3622.3	QPh.cgb-2D.3	Xwmc144-Xgwm157	S5	0.71*		0.03	
QPh.cgb-1B.14	P1142.2-P3470.1	QPh.cgb-2D.6	P4233.2-P6411.4	S5	1.67***		0.01	
QPh.cgb-1B.15	P3470.1-P3622.2	QPh.cgb-3B.10	Xgwm108-Xwmc291	S4	2.58***		0.34	
QPh.cgb-1B.17	P8143.2-P3713	QPh.cgb-5A.7	Xgwm291-Xgwm410	S3	-3.39***		0.59	
QPh.cgb-1B.18	Xwmc44-Xgwm259	QPh.cgb-5B.5	P3516.1-P5140.2	S2	1.39***		0.25	
QPh.cgb-1B.18	Xwmc44-Xgwm259	QPh.cgb-5B.7	P4138-P5166.3	S2	-1.48***		0.33	
QPh.cgb-1B.18	Xwmc44-Xgwm259	QPh.cgb-5B.4	Xgwm371-Xgwm335	S2	-0.52***		0.00	
QPh.cgb-1B.19	Xgwm259-Xwmc367	QPh.cgb-7B.4	Xpsp3033-Xgwm297	S3	2.79***	-2.14**(aae1), 1.58*(aae8), 1.82*(aae10)	0.85	0.31
QPh.cgb-1B.19	Xgwm259-Xwmc367	QPh.cgb-4B.1	Xgwm368-Xgwm107	S4	-1.39***		0.37	
QPh.cgb-1B.20	Xwmc367-P8444.5	QPh.cgb-5B.5	P3516.1-P5140.2	S2	-1.37***		0.21	
QPh.cgb-1D.1	P3470.7-Xcwm170	QPh.cgb-4A.1	Xwmc420-Xgwm601	S2	0.82***		0.31	
QPh.cgb-1D.2	Xcwm1-Xwmc432	QPh.cgb-5B.3	Xgwm499-Xgwm371	S3	-2.09***		0.24	
QPh.cgb-1D.2	Xcwm1-Xwmc432	QPh.cgb-5D	Xgdm68-Xgdm3	S4	-1.26***		0.38	
QPh.cgb-2A.2	Xwmc264.2-P8966.2	QPh.cgb-7D.3	Xwmc463-Xgwm295	S1	0.84***		0.34	
QPh.cgb-2A.3	Xgwm328-Xwmc179.4	QPh.cgb-3A.3	Xgwm391-P8422	S2	0.55***		0.09	

QPh.cgb-2A.5	Xgwm448-Xgwm558	QPh.cgb-3A.3	Xgwm391-P8422	S2	-1.43***		0.07	
QPh.cgb-2A.7	P5644.1-Xgwm122	QPh.cgb-6A.7	Xcwm487-P3465.4	S2	0.91***		0.45	
QPh.cgb-2A.8	Xcwm138.2-P2478.2	QPh.cgb-2D.7	Xwmc170-Xcwm96.2	S2	0.32*		0.00	
QPh.cgb-2A.9	P2478.2-Xwmc27.2	QPh.cgb-6A.7	Xcwm487-P3465.4	S2	1.85***	1.08*(aae10)	0.56	0.14
QPh.cgb-2A.10	Xwmc27.2-P5166.2	QPh.cgb-7D.4	Xwmc436-Xgwm44	S3	2.83***	-1.86***(aae1), 1.65**(aae8), 1.33*(aae10)	0.33	0.13
QPh.cgb-2B.1	Xcwm529-Xwmc317	QPh.cgb-7A.5	Xgwm635.1-P2454.4	S1	0.83***		0.79	
QPh.cgb-2B.2	Xwmc317-P6411.2	QPh.cgb-3D.3	Xgwm341-Xgwm456	S5	-1.00***		0.15	
QPh.cgb-2B.3	P3454.4-Xgwm501	QPh.cgb-3B.13	Xgwm181-Xgwm340	S2	-1.12***		0.85	
QPh.cgb-2B.3	P3454.4-Xgwm501	QPh.cgb-3B.14	Xgwm247-P2449.4	S2	-0.49*		0.00	
QPh.cgb-2B.4	P6901.1-Xwmc27.1	QPh.cgb-7D.1	Xgdm86-Xgdm88	S3	-1.61***		0.83	
QPh.cgb-2B.4	P6901.1-Xwmc27.1	QPh.cgb-7D.2	Xgdm88-Xwmc463	S4	1.32***		0.06	
QPh.cgb-2D.1	Xwmc453.1-Xwmc18	QPh.cgb-4A.5	P6431.1-Xgwm160	S1	-0.75***		0.72	
				S2	-1.61***		1.18	
				S3	-1.73***		1.00	
				S5	-0.76*		1.28	
QPh.cgb-2D.1	Xwmc453.1-Xwmc18	QPh.cgb-4D.1	Xgwm165.2-Xgwm192	S3	-1.24***		0.34	
QPh.cgb-2D.1	Xwmc453.1-Xwmc18	QPh.cgb-6B.7	Xwmc269.3-P4232.1	S4	-0.90***		0.09	
QPh.cgb-2D.2	Xwmc18-Xgwm30	QPh.cgb-2D.4	Xgwm157-Xgwm539	S5	3.82***		0.58	
QPh.cgb-2D.4	Xgwm157-Xgwm539	QPh.cgb-3B.12	Xgwm547-Xgwm181	S4	2.02***		0.65	
QPh.cgb-2D.5	Xgwm539-P4233.2	QPh.cgb-3B.14	Xgwm247-P2449.4	S5	-2.51***		0.73	
QPh.cgb-2D.6	P4233.2-P6411.4	QPh.cgb-4B.1	Xgwm368-Xgwm107	S4	1.80***		0.76	
QPh.cgb-2D.6	P4233.2-P6411.4	QPh.cgb-4D.1	Xgwm165.2-Xgwm192	S4	2.31***		1.58	
QPh.cgb-2D.7	Xwmc170-Xcwm96.2	QPh.cgb-5A.3	P2470-Xgwm154	S1	0.72***		0.30	
QPh.cgb-2D.7	Xwmc170-Xcwm96.2	QPh.cgb-7B.3	Xcwm96.1-Xwmc311	S3	3.93***	-1.62***(aae1), -1.19*(aae2), -1.07*(aae6), 1.67***(aae8)	1.21	0.25
QPh.cgb-2D.8	Xcwm96.2-Xwmc181	QPh.cgb-3B.4	Xwmc231-Xgwm284	S5	1.53***		0.46	
QPh.cgb-2D.8	Xcwm96.2-Xwmc181	QPh.cgb-3B.6	Xpsp3030-Xwmc366	S5	1.65***		0.11	
QPh.cgb-2D.10	P3470.3-P3176.1	QPh.cgb-3A.3	Xgwm391-P8422	S2	0.93***		0.03	
QPh.cgb-2D.11	P3176.1-P1123.1	QPh.cgb-7B.2	Xwmc526-Xwmc273	S3	1.46***		0.13	
QPh.cgb-2D.11	P3176.1-P1123.1	QPh.cgb-7B.3	Xcwm96.1-Xwmc311	S3	-0.60***		0.01	
QPh.cgb-3A.1	Xcwm48.1-Xwmc532	QPh.cgb-6A.6	Xgwm617-Xcwm487	S5	-2.15***	1.57*(aae1)	0.66	0.21
QPh.cgb-3A.2	Xwmc21-Xwmc505.2	QPh.cgb-3B.5	Xgwm72-Xgwm274	S5	3.08***		1.87	
QPh.cgb-3B.1	P2478.1-Xwmc505.1	QPh.cgb-6A.6	Xgwm617-Xcwm487	S1	-0.82***		0.24	
QPh.cgb-3B.3	P2449.2-Xwmc231	QPh.cgb-6B.1	P3516.2-P8966.1	S4	-1.48***		0.47	
QPh.cgb-3B.5	Xgwm72-Xgwm274	QPh.cgb-7B.4	Xpsp3033-Xgwm297	S3	-1.16***		0.83	
QPh.cgb-3B.5	Xgwm72-Xgwm274	QPh.cgb-6B.1	P3516.2-P8966.1	S4	-0.76***		0.05	
QPh.cgb-3B.5	Xgwm72-Xgwm274	QPh.cgb-6A.5	Xwmc417.1-P1832	S4	-2.02***		1.31	
QPh.cgb-3B.8	Xwmc3-P6934.7	QPh.cgb-7B.4	Xpsp3033-Xgwm297	S3	-2.41***		0.26	

QPh.cgb-3B.14	Xgwm247-P2449.4	QPh.cgb-3D.1	Xwmc437-Xwmc529.1	S4	-4.07*** 2.18*(aae1)	1.97	0.33
QPh.cgb-3D.2	Xgdm72-Xgwm341	QPh.cgb-6A.2	Xgdm36-P3474.2	S4	-1.46***	0.27	
QPh.cgb-4A.2	Xgwm601-Xgwm610	QPh.cgb-6A.2	Xgdm36-P3474.2	S3	-0.83***	0.21	
QPh.cgb-4A.3	P8222.2-P5611.1	QPh.cgb-6B.6	Xcwm29-P3476.2	S5	1.04***	0.71	
QPh.cgb-4A.4	P2454.3-P3465.1	QPh.cgb-6B.6	Xcwm29-P3476.2	S5	1.49***	0.07	
QPh.cgb-4A.5	P6431.1-Xgwm160	QPh.cgb-7B.4	Xpsp3033-Xgwm297	S3	1.49***	1.11	
QPh.cgb-4B.1	Xgwm368-Xgwm107	QPh.cgb-5A.7	Xgwm291-Xgwm410	S3	1.93***	0.76	
QPh.cgb-4B.3	Xgwm149-Xwmc349	QPh.cgb-5B.4	Xgwm371-Xgwm335	S2	-1.95*** 1.05*(aae1), -1.14*(aae10)	0.91	0.32
QPh.cgb-5A.1	Xgwm415-Xgwm304	QPh.cgb-7A.8	P1111-P3622.1	S2	-2.29*** -1.47***(aae10)	1.14	0.36
QPh.cgb-5A.2	Xgwm304-P2470	QPh.cgb-5A.4	Xgwm205.1-Xgwm443	S5	-4.69*** 2.54***(aae1), -1.62*(aae4), 1.50*(aae6), -1.51*(aae9)	2.49	0.39
QPh.cgb-5A.2	Xgwm304-P2470	QPh.cgb-5A.5	Xgwm443-P3616.5	S5	-1.00***	0.09	
QPh.cgb-5B.8	P2454.2-Xgwm408	QPh.cgb-6A.2	Xgdm36-P3474.2	S4	-1.98***	0.37	
QPh.cgb-6A.4	Xpsp3071-Xgwm570	QPh.cgb-7B.4	Xpsp3033-Xgwm297	S1	-0.76*** -0.69*(aae10)	0.27	0.21
QPh.cgb-6B.5	Xgwm132-Xwmc104	QPh.cgb-6B.7	Xwmc269.3-P4232.1	S5	-2.37***	0.79	
QPh.cgb-7A.6	P6934.2-P3446.5	QPh.cgb-7B.1	Xwmc269.4-P3446.7	S4	-1.01***	0.00	
QPh.cgb-7A.7	P8443.2-Xgwm282	QPh.cgb-7B.1	Xwmc269.4-P3446.7	S4	1.24***	0.04	

QTL$_i$ and QTL$_j$ are a pair of QTL involved in epistasis; *aa*, the epistatic main effect; *aae1*, the epistasis × environment interaction effects in E1, *aae2*, the epistasis × environment interaction effects in E2, and so on; A positive value means that the parent-type effect is greater than the recombinant-type effect, and the negative value means that the parent-type effect is less than the recombinant-type effect; *h^2(aa)%* , Phenotypic variation explained (PVE) by *aa* effects; *h^2(aae)%*, PVE by *aae* effects; S1, S2, S3, S4, S5 are as shown in Table S1.

*, **, ***, significant at P= 0.05, 0.01 and 0.005, respectively.

Table S6. Conditional epistatic QTLs affecting plant height of wheat in five periods in ten environments

QTL$_i$	Flanking marker$_i$	QTL$_j$	Flanking markers$_j$	Period	aa	aae	$h^2(aa)\%$	$h^2(aae)\%$
QPh.cgb-1A.2	P3156.2-Xwmc59	QPh.cgb-5B.2	Xwmc363-Xwmc376	S4|S3		-0.93***(aae2), 0.70*(aae4), -0.62*(aae6), 0.61*(aae7), -0.82**(aae8), 1.25***(aae9)		0.49
QPh.cgb-1B.1	Xgwm582-Xgwm273	QPh.cgb-3B.11	Xwmc291-P3156.1	S2|S1	0.38***		0.28	
QPh.cgb-1B.1	Xgwm582-Xgwm273	QPh.cgb-3B.2	Xwmc505.1-Xwmc529.2	S2|S1	-0.50***	0.73*(aae2), -0.85***(aae10)	0.25	0.48
QPh.cgb-1B.4	Xwmc156-P3446.1	QPh.cgb-3B.11	Xwmc291-P3156.1	S2|S1	0.30***	-0.48*(aae1), -0.48*(aae6)	0.03	0.12
QPh.cgb-1B.9	Xcwm547-P5140.3	QPh.cgb-2D.6	P4233.2-P6411.4	S5|S4		-1.34***(aae4), 0.83*(aae8)		0.37
QPh.cgb-1B.11	P6934.3-P3446.6	QPh.cgb-1B.16	Xwmc269.2-Xcwm90	S1|S0	0.88***	0.45*(aae10)	0.53	0.17
QPh.cgb-1B.13	P3622.3-P1133	QPh.cgb-2D.6	P4233.2-P6411.4	S5|S4	-0.50***		0.05	
QPh.cgb-2A.2	Xwmc264.2-P8966.2	QPh.cgb-7D.3	Xwmc463-Xgwm295	S1|S0	0.84***		0.34	
QPh.cgb-2A.4	Xwmc51-Xgwm68.2	QPh.cgb-2D.9	Xwmc181-P3470.3	S3|S2	0.26**		0.04	
QPh.cgb-2A.6	Xgwm275-Xgwm339	QPh.cgb-2D.10	P3470.3-P3176.1	S3|S2		-0.90***(aae2), 0.59*(aae8)		0.18
QPh.cgb-2B.1	Xcwm529-Xwmc317	QPh.cgb-7A.5	Xgwm635.1-P2454.4	S1|S0	0.83***		0.79	
QPh.cgb-2D.1	Xwmc453.1-Xwmc18	QPh.cgb-4A.5	P6431.1-Xgwm160	S1|S0	-0.75***		0.72	
QPh.cgb-2D.1	Xwmc453.1-Xwmc18	QPh.cgb-7A.9	P3461.2-P6411.1	S2|S1	-0.63***	0.55*(aae4)	0.31	0.22
QPh.cgb-2D.7	Xwmc170-Xcwm96.2	QPh.cgb-5A.3	P2470-Xgwm154	S1|S0	0.72***		0.30	
QPh.cgb-3B.1	P2478.1-Xwmc505.1	QPh.cgb-6A.6	Xgwm617-Xcwm487	S1|S0	-0.82***		0.24	
QPh.cgb-3B.11	Xwmc291-P3156.1	QPh.cgb-6B.8	Xgwm644.1-Xwmc417.2	S5|S4		-1.38***(aae7)		0.46
QPh.cgb-4B.1	Xgwm368-Xgwm107	QPh.cgb-7D.4	Xwmc436-Xgwm44	S4|S3		0.62*(aae4), -1.06***(aae6), -0.67*(aae8)		0.42
QPh.cgb-4B.2	Xgwm107-Xgwm513	QPh.cgb-7D.4	Xwmc436-Xgwm44	S4|S3	-0.24*		0.02	
QPh.cgb-4B.2	Xgwm107-Xgwm513	QPh.cgb-7A.4	Xcwm462.2-Xgwm635.2	S5|S4	-0.50***	-0.87*(aae2), -0.90*(aae4), 0.71*(aae5), -1.55***(aae7), 1.43***(aae8), 0.97**(aae10)	0.16	0.79
QPh.cgb-5A.6	Xgwm595-Xwmc410	QPh.cgb-5B.6	P5140.2-P4138	S3|S2	-0.43***	0.80*(aae1), 0.88***(aae2), -0.86*(aae5), 1.22***(aae6), -0.94***(aae8)	0.12	0.47
QPh.cgb-5B.1	Xgwm234-Xwmc363	QPh.cgb-7A.1	P3465.2-Xcwm48.2	S3|S2		0.63*(aae2), -0.74*(aae4), -0.77*(aae5), 0.88*(aae6), -0.63*(aae8), 0.78*(aae10)		0.39
QPh.cgb-6A.4	Xpsp3071-Xgwm570	QPh.cgb-7B.4	Xpsp3033-Xgwm297	S1|S0	-0.76***	-0.69*(aae10)	0.27	0.21
QPh.cgb-6B.4	P8444.2-Xgwm132	QPh.cgb-7A.2	Xcwm48.2-Xcwm462.1	S5|S4	-0.64***		0.32	

All the other notes are the same as shown in Table S5 except that S1|S0, S2|S1, S3|S2, S4|S3, S5|S4 are the same as in Table S2.