Table S1. Information of primer pairs and χ2 tests of the markers showing segregation distortion in the test cross progeny for polymorphic flowering-related gene markers.

Name	Gene	Possition (phytozome)	Target	Forward primer	Reverse primer	Marker type[a]	Enzyme for CAPS/dCAPS	χ2 test for segregation distortion (skewness)[b]
PvALC	*Phvul.001G023200*	Chr01:1931951..1935673	*ALCATRAZ (ALC)*	CCCAGCAGGTCGGAAATAGT	CAGTCCAACGCAGCATTAAA	CAPS	*DraI*	ns
PvFTc	*Phvul.001G097200*	Chr01:18585107..18586231	*FLOWERING LOCUS T (FT)*	AGAGGGGACTCAAAACACATATT	TTGCGGTGGAAGGAGATATT	SSRs		ns
PvFTa1	*Phvul.001G097300*	Chr01:18602292..18604694	*FLOWERING LOCUS T (FT)*	AATTCTCTGCTTATGGAATTGTCA	AGGCTTAAAAGAATCCACACCA	CAPS	*DraI*	ns
PvFin	*Phvul.001G189200*	Chr01:44856139..44857862	*TERMINAL FLOWER1 (TFL1)*	CATCGAATGTGTACCTTCTCCAT	AAGGAAGCGAAACCCTAAACTATTA	dCAPS	*BccI*	** (PHA1037)
PvPHYA3	*Phvul.001G221100*	Chr01:47642033..47647745	*PHYTOCHROME A (PHYA)*	TGCAACACAACTTTTCAAGGA	ATCACCATCACGTCCAAACA	CAPS	*MnlI*	** (PHA1037)
PvAG2a	*Phvul.002G243200*	Chr02:41516308..41521518	*AGAMOUS-like 2 (AGL2)*	AAGAGTTTAAGGTTGCGAAGGA	GAAAATCAAGAACATGGTGCAA	dCAPS	*MseI*	** (PHA1037)
PvAG2b	*Phvul.002G243200*	Chr02:41516308..41521518	*AGAMOUS-like 2 (AGL2)*	CAGAAACTGAATAGGTGGAATTCACT	AAGAACATGGTGCAATCTCTGTATT	dCAPS	*AflI*	** (PHA1037)
PvLATE1a	*Phvul.004G088300*	Chr04:14679773..14697707	*GIGANTEA (GI)*	GTACGCTGGTCTATGACAAGAATA	TGTTTGCATTTCACAAACTAGAAA	dCAPS	*SspI*	** (Bolita)
PvSHP1	*Phvul.006G034300*	Chr06:12907811..12911918	*AGAMOUS-like 1 (AGL1)*	CCCAAGGATGTGCCTACAAG	GGTTGGGATACCCCTGAAGT	CAPS	*HpyCH4V*	** (Bolita)
PvAG1a	*Phvul.006G169600*	Chr06:27307945..27315783	*AGAMOUS (AG)*	TTCCCCTTTCAAAACCATTC	GAGTACATGCAGAAGAGGGTAAATA	SSRs		ns
PvAG1b	*Phvul.006G169600*	Chr06:27307945..27315783	*AGAMOUS (AG)*	AGGGGAAGATCAACCAAACA	GGGTTTTATTAGCAATAGCGTGAG	SSRs		ns
PvFTb3	*Phvul.008G003700*	Chr08:337345..340888	*FLOWERING LOCUS T-RELATED*	ACGCATGCAGAAGCAATACA	AGTTGTCGTTTGCAGGTGAAG	CAPS	*AvaII*	ns
PvFDc	*Phvul.009G018700*	Chr09:3564501..3568643	*FLOWERING LOCUS D (FD)*	GCAAATGGATCAAGATGTTT	TAGAATAGAAGGTGAGAAGAATAATTTA	dCAPS	*DraI*	ns
PvCOL3	*Phvul.009G085300*	Chr09:13956611..13957992	*CONSTANS-like (COL)*	CAAACAAAACAAACACAAAAACTGAT	ACCTTGGAGTCGCATGCTC	dCAPS	*BclI*	ns
PvFUL1	*Phvul.009G203400*	Chr09:30856875..30865960	*AGAMOUS-like 8 (AGL8)*	CAATTTTTTTACTTTTTTATTTGGATATT	CCAATGGTTGAGGTACAAGGA	dCAPS	*MseI*	ns

[a] CAPS: Cleaved Amplified Polymorphic Sequences; SSRs: Simple Sequence Repeats; dCAPS: Derived Cleaved Amplified Polymorphic Sequences.

[b] Skewed marker segregation towards Bolita or PHA1037 parental; ns,** not significant and significant at 0.01 probability level, respectively.

Table S2. DNA sequence of primer pairs used for candidate genes sequencing**.**

Gene	Primer name	Forward primer	Reverse primer	Tª	Size band
PHYA3	PvPHYAb-1F/1R	GCACCAGAAAGAGGGAGAGA	CCAGAAGAAGCAACAATCAGG	58	366
	PvPHYAb-2F/2R	GAGCATGGACACTCTGTGTGAC	ATGCTTCCCAATAGCTTGCTC	60	1339
	PvPHYAb-3F/R4	TCTGGAAGCAGTGACTAGTGAGA	TCTTGTTGATGCCTAACACCAC	60	1356
	PvPHYAb-4F/3R	CTCCCGGAAATTGTTAGAAGG	TGCACCCTTCACTTTCTGAT	58	1429
ARP5	PvRP5-1F/1R	TTGGCAAGATTGCAGAGTTAGA	CCAACATTTTCGACAAACACA	60	654
	PvRP5-2F/2R	GGCAGGAGAGACTCAACCAC	CCAATTTGGACAAATCAACAA	58	838
	PvRP5-3F/3R	TTGCTTTATGAAGACTGATGAGAT	TTGTCAAAGTTCAAAAAGAGAAAAA	56	885
	PvRP5-4F/4R	CCTAGCAATTCCTTGACTTGATG	TGCAACTGTTACTTGACAAAAGG	58	848
	PvRP5-5F/5R	TTCTCTTGTTTTTGCGGACA	TTTTTCTTTAGCCTCATTAGATTTTT	56	896
	PvRP5-6F/6R	TGAAGCTCGACTGTTTCAGG	AAAACTGAATAAACTGACTCGCATA	58	887
	PvRP5-7F/7R	CGACAACGATTGAAGCAGAA	GTGATGCCTCAGCAGATTGA	60	886
	PvRP5-8F/8R	TGTGCCCAAGTCAGAAACTG	TGCAATGTAAAAGAAACTCGTGA	60	709
RPK2	PvRPK2-1F/1R	CATCGTTTCCATCATCGTCTT	ACAAAACCAGGCACAGAACC	60	876
	PvRPK2-2F/2R	ATTGGGGAGGTGCCTAGTTC	GCATATGGCGAGGAAACATT	60	875
	PvRPK2-3F/3R	CCCTGTATGAGCGTGTTTGA	GTACGGATTCCCAACAGCAC	60	897
	PvRPK2-4F/4R	CCTTCCAACAGTGGCTTGTT	GAAGTCTGGCCAATCCAAAA	60	820
	PvRPK2-5F/5R	ATCAGTGTGTTCCCCGTGTT	TTGAATTTAACTGGCACTCTCG	60	994
	PvRPK2-6F/6R	ACGCAAGACTTGGACAAAGA	TAGGCCAACCTTGTCACCAT	58	994
	PvRPK2-7F/7R	GGAAAACTTTGACGTAGTGATGC	GCTTAACATTTTTGCCAATC	58	993
	PvRPK2-8F/8R	TGAAGATTTCAGTCATTTCAAACA	TTGTGGTTCATTTGCAAAGATTA	60	961
	PvRPK2-9F/9R	CGCTGAATAACCAAAAGATGC	AAACTCTAATATGAAAGGAGAAATGGA	60	972
	PvRPK2-10F/10R	TTTTGTTGTGAAAGTGAAAAATGA	AAGCACGAAGACGAGGAAGA	58	924
	PvRPK2-11F/11R	AGATGTTTTCTTCTTCTGCTCATTG	CTCACCAGGAATACCCTCTTCTAGT	60	908
	PvRPK2-12F/12R	TGTTAATGAATTGAATGGTTCTGTG	TTGTTTTGACCAAAGTTGTGAACTA	60	909
	PvRPK2-13F/13R	GTTCAGGAGAATTCACTTTTCACAG	TATTTCAATAGAGCTCAAGCCATTC	60	879
	PvRPK2-14F/14R	GCTCAATAACAACAATCTTTCTGGT	TCTTGTGAAGAATCCTCCAATCTAC	60	779
	PvRPK2-15F/15R	AATCTTGAAAAGTTCATCCAGGAG	CAGAACAGCACAAAAGATATTGAAA	60	897
COL2	PvCOL-1F/1R	TCTCCCCCAACACTACTTGG	GAATCTGTGTTCCGGTTCGT	60	563
	PvCOL-2F/2R	CTCATCTTGGGTCCCCTCTT	TTTTCATGACCAAACCTAAACTTG	60	667
	PvCOL-3F/3R	TGCTGTCGCAATCTTTATGG	GGGTGAAAAGAAGCAGAAAAA	58	695
	PvCOL-4F/4R	TTCTCTTTTGCATCTCCTCTTTTT	GTGCCTTCCAATGATGTGGT	60	698
AP3	PvAP3-1F/1R	CCCCACCTTCCCTTTCTATTT	TGTATATAGGTAATTGGGGCATATAAA	60	899
	PvAP3-2F/2R	TTGTTCGTGAGCGTAAGGTG	GGTAGATTTCAAAAATTAATGAGCAA	58	827
	PvAP3-3F/3R	TATCCTTGGTGGGAATGGAG	TCAAACAATTTCTTGTGTGTCCTT	60	879
	PvAP3-4F/4R	TCCTTTCAACAAATCTTCTCAGG	TCCAAGCTCAAACCAAAGTT	58	900
	PvAP3-5F/5R	TTGATCTTGATCTTCTAATGTCCA	TCAATGGGAGATGATAGGTTAATG	58	895
FDc	PvFDc-1F/1R	GTGTCAATGTCCGTGTGCAT	CTCCGTCAAACGAGCAATTT	60	874
	PvFDc-2F/2R	CTCTGAACATGTCTGGAACGA	AAAATCGATGCCAATCTGTG	58	701
	PvFDc-3F/3R	AGCCCTTTGAGTAATGTAATCTCC	GCGATTACATGGAAAAGTGTGA	58	871
	PvFDc-4F/4R	CTTTTCCATGTAATCGCTCCTT	TGAACCTACAGTGGAACAACTAGG	60	790
	PvFDc-5F/5R	CAACGTTTTCCTTCAATTCG	GGCGTAATCAGACCGTAATG	58	720
	PvFDc-6F/6R	TGCATGTAGGTGTCCCAAAC	TTTTCCCCTTTCCATCCTCT	60	756
	PvFDc-7F/7R	TGGAGTAATCCGATAGCACACA	TTAGGTTGGAGGAAGGAAGTAGC	60	890
E1	PvE1-1F/1R	AACCTTGGCTGCGAGTTTAC	TGTTTGTGATTCCCTCAACG	58	643
	PvE1-2F/2R	CACTTCCATTTCACAAATTCCA	AAGGATGTGGATGTGAAGCAC	60	832
FUL1	PvFUL1-1F/1R	GCCAATGATATTTGCTCTTTTAATTT	GCGACTTCAGCATCACAAAG	60	537
	PvFUL1-2F/2R	GGTGCAGTTGAAGAGGATCG	AGGGTTGAAGGTACGTGAGG	58	204
	PvFUL1-3F/3R	GCATGAAGCTAACTTGTATGGTGT	AGGGATCAAAATTGAAGATTGG	58	360
	PvFUL1-4F/4R	TTGCCCTTCTACACAGATCATT	TTGAAACTATATCAGGAAAATGCAC	58	356
	PvFUL1-5F/5R	GCAGTAGTAGTGCATTTTCCTGA	CCACCCTTTGTTGATTCGTT	58	214
	PvFUL1-6F/6R	CACATGGATGGAGTTAACTTTGTT	GCTTGTTGTGCTGCTAGTGC	60	207
	PvFUL1-7F/7R	AAAAACCAGATAAAGGAAAAAGAGA	TCAACGTCAATTAAATGAATGGTA	58	215
	PvFUL1-8F/8R	TGAGTAGGGTTATTAAAACATTGTGC	GGCCATATTCATATTTAATTTTTATGC	60	214

Table S4. Estimates of means, standard errors, range of variation, variance analysis results and heritability for days to flowering (DTF) of the two common bean parents, Bolita and PHA1037, and the RI population, grown in twelve environments under Short (SD) and Long-Day (LD) conditions.

Environment	Block effect	Parents			RILs			
		PMB0225	PHA-1037	P_{PAR}	Mean	Range	P_{RIL}	h^2
LD1		46.5 ± 1.50	200.0 ± 0.00	***	67.9 ± 3.48	35 - 200	**	0.98 ± 0.001
LD2		46.5 ± 1.50	200.0 ± 0.00	***	53.1 ± 0.96	41 - 200	**	0.96 ± 0.006
LD3		55.7 ± 1.20	200.0 ± 0.00	***	83.4 ± 1.76	53 - 200	***	0.98 ± 0.002
LD4		51.5 ± 0.50	200.0 ± 0.00	***	75.9 ± 2.02	43 - 200	***	0.98 ± 0.003
LD5	***	49.0 ± 1.15	200.0 ± 0.00	***	79.9 ± 2.29	40 - 200	***	0.98 ± 0.002
LD6		41.0 ± 0.15	91.5 ± 1.50	**	52.9 ± 0.52	37 - 85	***	0.85 ± 0.022
SD1	***	48.0 ± 0.30	64.0 ± 0.00	**	60.3 ± 0.30	44 - 78	***	0.48 ± 0.059
SD2	***	46.0 ± 0.40	66.0 ± 0.02	**	51.5 ± 0.22	41 - 61	***	0.43 ± 0.057
SD3	*	44.0 ± 0.02	61.0 ± 0.58	***	50.4 ± 0.23	34 - 62	***	0.68 ± 0.068
SD4		46.3 ± 0.33	64.7 ± 0.33	*	50.3 ± 0.19	41 - 65	***	0.86 ± 0.017
SD5		49.0 ± 0.71	57.5 ± 0.50	*	51.0 ± 0.17	42 - 65	***	0.47 ± 0.06
SD6		47.5 ± 2.50	68.0 ± 3.00	*	56.8 ± 0.41	45 - 83	***	0.74 ± 0.028

*, **, *** significant at the 0.05, 0.01 and 0.001 probability levels, respectively, for difference among parents (P_{PAR}; t_{test}), RILs (P_{RIL}), and block effect, h^2, heritability estimates and their s.e.

Table S5. The main QTL detected for flowering time (DTF and GDD) and photoperiod (PRI, RRP, PS and CLASS) traits using multiple-QTL model mapping for individual environment and year analysis.

Env.	QTL	Position in cM[a]	Position in Mb[a]	Chromosome	Marker interval	F (F threshold)	R^{2c}	A[d]	
Days to flowering (DTF)									
SD1	DTF-4.1	24.02-25.09	4.11-5.86	4	BMc155-Pv04G048200	23.52 (12.05)	8.77	3.05	***
	DTF-9.5	62.16-63.66	30.86-30.84	9	PvFUL1-Pv09G203300	16.52 (12.05)	9.20	1.43	***
SD2	DTF-1.3	80.86-90.91	44.85-47.64	1	PvFin-PvPHYA3	15.52 (9.89)	6.99	2.49	***
	DTF-7.2	83.24-95.79	50.69	7	E31M61-110-BMc216	14.96 (9.89)	7.90	-1.68	***
SD3	DTF-1.4	90.91-102.59	47.64-49.04	1	PvPHYA3-BMc324	14.77 (12.32)	10.25	3.93	***
	DTF-9.4	57.57-57.57	30.99-31.06	9	Pv09G204500-Pv09G204700	18.31 (12.32)	13.88	4.81	***
SD4	DTF-4.1	24.02-25.09	4.11-5.86	4	BMc155-Pv04G048200	12.52 (11.51)	1.67	1.30	**
	DTF-5.2	47.13-49.57	33.90	5	E32M60-263-PvCh05-33.9	13.85 (11.51)	4.65	0.82	**
	DTF-9.4	57.57-57.57	30.99-31.06	9	Pv09G204500-Pv09G204700	11.58 (11.51)	32.14	2.63	***
	DTF-10.1	0.00-12.24		10	E31M31-173-E31M50-168	22.33 (11.51)	5.04	0.65	*
SD5	Non significant	Non significant	Non significant						
SD6	DTF-9.1	10.15-13.24	1.86-3.56	9	BM154-PvFDc	28.05 (11.95)	16.43	3.10	***
	DTF-9.5	62.16-63.66	30.86-30.84	9	PvFUL1-Pv09G203300	20.55 (11.95)	14.10	2.73	***
LD1	DTF-4.1	24.02-25.09	4.11-5.86	4	BMc155-Pv04G048200	28.12 (10.38)	21.78	30.19	***
LD2	DTF-4.1	24.02-25.09	4.11-5.86	4	BMc155-Pv04G048200	35.08 (10.52)	19.26	11.76	**
LD3	Non significant	Non significant	Non significant						
LD4	DTF-4.1	24.02-25.09	4.11-5.86	4	BMc155-Pv04G048200	30.80 (11.43)	55.25	60.19	***
LD5	DTF-4.1	24.02-25.09	4.11-5.86	4	BMc155-Pv04G048200	74.71 (12.61)	62.42	77.45	***
	DTF-9.5	62.16-63.66	30.86-30.84	9	PvFUL1-Pv09G203300	20.68 (12.61)	1.80	9.14	***
LD6	DTF-1.4	90.91-102.59	47.64-49.04	1	PvPHYA3-BMc324	20.90 (12.12)	5.11	12.65	***
	DTF-4.1	24.02-25.09	4.11-5.86	4	BMc155-Pv04G048200	24.46 (12.12)	30.28	10.46	***
Growing degree days (GDD)									
SD1	GDD-4.1	24.02-25.09	4.11-5.86	4	BMc155-Pv04G048200	23.45 (13.72)	8.8	26.25	***
	GDD-9.4	57.57-57.57	30.99-31.06	9	Pv09G204500-Pv09G204700	16.61 (13.72)	9.06	13.72	***
SD2	GDD-1.4	90.91-102.59	47.64-49.04	1	PvPHYA3-BMc324	12.69 (12.01)	10.18	39.03	***
	GDD-7.2	83.24-95.79	50.69	7	E31M61-110-BMc216	14.06 (12.01)	7.37	-12.22	***
SD3	GDD-1.4	90.91-102.59	47.64-49.04	1	PvPHYA3-BMc324	16.54 (12.72)	11.47	46.55	***
	GDD-9.4	57.57-57.57	30.99-31.06	9	Pv09G204500-Pv09G204700	14.90 (12.74)	12.38	26.41	***
	GDD-7.1	45.52-52.59	28.75-31.12	7	P-BMc294	16.68 (12 .74)	2.38	-8.26	***
SD4	GDD-4.1	24.02-25.09	4.11-5.86	4	BMc155-Pv04G048200	12.42 (11.79)	6.67	7.81	***
	GDD-5.2	47.13-49.57	33.90	5	E32M60-263-PvCh05-33.9	13.60 (11.79)	4.59	5.82	***
	GDD-9.4	57.57-57.57	30.99-31.06	9	Pv09G204500-Pv09G204700	11.88 (11.79)	32.23	19.26	***
	GDD-8.1	23.75-28.09	7.06-7.85	8	BMc121-BM165	13.28 (11.79)	5.05	6.79	***
	GDD-10.1	0.00-12.24		10	E31M31-173-E31M50-168	22.96 (8.79)	5.25	4.08	*
SD5	GDD-4.6	41.01-41.65	10.00-26.75	4	Pv04G94900-Chr04.10.01	15.57 (11.70)	7.27	-3.94	***
SD6	GDD-9.1	10.15-13.24	1.86-3.56	9	BM154-PvFDc	32.87 (12.88)	17.53	7.81	***
LD1	GDD-4.1	24.02-25.09	4.11-5.86	4	BMc155-Pv04G048200	25.81 (10.84)	20.36	205.9	***
LD2	GDD-4.1	24.02-25.09	4.11-5.86	4	BMc155-Pv04G048200	33.38 (10.35)	18.4	90.12	***
LD3	GDD-4.1	24.02-25.09	4.11-5.86	4	BMc155-Pv04G048200	13.39 (12.98)	30.75	209.5	***
LD4	GDD-4.1	24.02-25.09	4.11-5.86	4	BMc155-Pv04G048200	123.73 (11.83)	53.87	467.87	***
LD5	GDD-4.1	24.02-25.09	4.11-5.86	4	BMc155-Pv04G048200	78.35 (12.72)	64.03	675.33	***
	GDD-9.4	57.57-57.57	30.99-31.06	9	Pv09G204500-Pv09G204700	27.18 (12.72)	1.81	92.82	***
LD6	GDD-1.4	90.91-102.59	47.64-49.04	1	PvPHYA3-BMc324	23.40 (13.24)	5.72	133.28	***
	GDD-4.1	24.02-25.09	4.11-5.86	4	BMc155-Pv04G048200	25.99 (13.24)	28.83	103.71	***

Table S5. Continued.

Env.	QTL	Position in cM[a]	Position in Mb[a]	Chromosome	Marker interval	F (F threshold)	R^{2c}	A[d]	
Photoperiod Response Index (PRI)									
2009	PRI-4.1	24.02-25.09	4.11-5.86	4	BMc155-Pv04G048200	13.47 (12.15)	19.83	26.12	***
2010	PRI-1.1	14.34-30.73	18.60	1	E32M60-147-PvFTa1	14.50 (11.16)	8.41	6.89	***
	PRI-4.1	24.02-25.09	4.11-5.86	4	BMc155-Pv04G048200	22.88 (11.16)	51.31	54.35	***
2011	PRI-4.1	24.02-25.09	4.11-5.86	4	BMc155-Pv04G048200	27.64 (9.69)	16.10	10.13	***
2013	PRI-4.1	24.02-25.09	4.11-5.86	4	BMc155-Pv04G048200	14.04 (11.23)	20.09	10.70	***
2015	PRI-4.1	24.02-25.09	4.11-5.86	4	BMc155-Pv04G048200	283.65 (11.76)	61.98	78.10	***
	PRI-9.5	62.16-63.66	30.86-30.84	9	PvFUL1-Pv09G203300	12.91 (11.76)	1.87	7.36	**
2016	PRI-4.1	24.02-25.09	4.11-5.65	4	BMc155-Pv04G048200	66.42 812.98)	39.5	13.59	***
	PRI-5.1	41.86-43.50	30.40-11.24	5	PvCh05-30.4-BMc321	13.63 (12.98)	4.03	12.65	***
Percentage of photoperiod sensitivity (PS)									
2009	Non significant	Non significant	Non significant						
2010	PS-4.1	24.02-25.09	4.11-5.86	4	BMc155-Pv04G048200	97.63 (13.55)	47.93	28.23	***
	PS-9.2	25.05-29.34	13.96-15.10	9	PvCOL3-PvCh09-15.1	14.87 (13.55)	9.32	-5.94	***
2011	Non significant	Non significant	Non significant						
2013	PS-4.1	62.16-63.66	4.11-5.86	4	BMc155-Pv04G048200	43.50 (10.97)	20.97	3.9	***
	PS-9.5	24.02-25.09	30.86-30.84	9	PvFUL1-Pv09G203300	16.59 (10.97)	4.92	1.77	***
2015	PS-4.1	62.16-63.66	4.11-5.86	4	BMc155-Pv04G048200	84.92 (12.12)	63.07	39.67	***
	PS-9.4	57.57-57.57	30.99-31.06	9	Pv09G204500-Pv09G204700	28.71 (12.12)	4.87	3.85	***
	PS-9.5	62.16-63.66	30.86-30.84	9	PvFUL1-Pv09G203300	31.97 (12.12)	2.17	8.44	***
2016	PS-4.1	24.02-25.09	4.11-5.86	4	BMc155-Pv04G048200	63.18 (12.50)	39.24	14.79	***
	PS-5.1	41.86-43.50	30.40-11.24	5	PvCh05-30.4-BMc321	14.06 (12.50)	4.14	4.74	***
Relative Response to Photoperiod (RRP)									
2009	Non significant	Non significant	Non significant						
2010	RRP-4.1	24.02-25.09	4.11-5.86	4	BMc155-Pv04G048200	21.36 (11.50)	46.96	0.25	***
2011	RRP-4.1	24.02-25.09	4.11-5.86	4	BMc155-Pv04G048200	42.13 (12.07)	22.81	0.10	***
2013	RRP-4.1	24.02-25.09	4.11-5.86	4	BMc155-Pv04G048200	46.16 (11.18)	21.97	0.06	***
	RRP-9.5	62.16-63.66	30.86-30.84	9	PvFUL1-Pv09G203300	17.26 (11.18)	4.95	0.03	***
2015	RRP-4.1	24.02-25.09	4.11-5.86	4	BMc155-Pv04G048200	79.15 (12.06)	61.44	0.49	***
	RRP-9.5	62.16-63.66	30.86-30.84	9	PvFUL1-Pv09G203300	35.04 (12.06)	3.27	0.01	***
2016	RRP-4.1	24.02-25.09	4.11-5.86	4	BMc155-Pv04G048200	64.36 (12.38)	38.66	0.23	***
	RRP-5.1	41.86-43.50	30.40-11.24	5	PvCh05-30.4-BMc321	12.49 (12.28)	3.71	0.09	***
Photoperiod response on a scale of 1-8 (CLASS)									
2009	Non significant	Non significant	Non significant						
2010	CLASS-4.1	24.02-25.09	4.11-5.86	4	BMc155-Pv04G048200	87.37 (11.81)	45.19	2.82	***
2013	CLASS-4.4	34.37-34.58	18.37-18.68	4	Pv04G091700-Pv04G92400	18.88 (10.48)	17.38	-0.63	***
2013	CLASS-4.5	35.76-36.04	14.42-16.56	4	Chr04.14.42-Chr04.16.56	18.14 (10.48)	13.34	0.14	***
	CLASS-7.2	83.24-95.79	50.69	7	E31M61-110-BMc216	10.79 (10.48)	6.55	-0.14	***
2015	CLASS-4.1	24.02-25.09	4.11-5.86	4	BMc155-Pv04G048200	81.30 (12.45)	62.16	3.94	***
	CLASS-9.5	62.16-63.66	30.86-30.84	9	PvFUL1-Pv09G203300	37.52 (12.45)	2.90	1.09	***
2016	CLASS-4.1	24.02-25.09	4.11-5.86	4	BMc155-Pv04G048200	60.34 (12.57)	38.20	1.51	***
	CLASS-5.1	41.86-43.50	30.40-11.24	5	PvCh05-30.4-BMc321	16.55 (12.57)	4.90	0.56	***

[a] Estimated confidence interval of QTL position in cM (Kosambi, 1943) and Mb (Phytozome web).
[b] Chr = chromosome.
[c] F values of significance of each QTL. The critical F-value was determined by a permutation test of 1000 repetitions at the confidence level of 95% (Churchill and Doerge, 1994).
[d] Percentage of the phenotypic variation explained by additive effects.
[e] Estimated additive effect. Positive values indicate that alleles from PHA1037 increase the trait value, and negative values indicate that positive effect is due to the presence of the alleles from Bolita. Experiment-wide P value. *P≤0.05, **P≤0.01, ***P≤0.001.
Trial years for photoperiod response traits: 2009 (LD1 *vs.* SD2), 2010 (LD4 *vs.* SD6), 2011 (LD2 *vs.* SD3), 2013 (LD6 *vs.* SD1), 2015 (LD5 *vs.* SD4), and 2016 (LD3 *vs.* SD5).

Table S6. Epistatic QTL detected for flowering time (DTF and GDD) and photoperiod (PRI, RRP, PS and CLASS) traits using multiple-QTL model mapping for individual environment and year analysis.

Env.	QTL (position)[a]	Chr[b]	Marker interval	QTL (position)[a]	Chr[b]	Marker interval	F (F threshold)[c]	R^{2d}	Aa[e]
Days to flowering (DTF)									
SD1	DTF-5.1 (41.86-43.50) (30.40-11.24)	5	PvCh05-30.4-BMc321	DTF-8.1 (23.75-28.09) (41.52-41.52)	8	BMc121-BM165	11.77 (8.91)	9.68	4.28 ***
SD5	DTF-7.2 (83.24-95.79) (50.69)	7	E31M61-110-BMc216	DTF-2.3 (65.21-65.77) (41.52-41.52)	2	PvAG2b-PvAG2a	18.11 (7.27)	9.61	-3.26 ***
LD3	DTF-4.1 (24.02-25.09) (4.11-5.86)	4	BMc155-Pv04G048200	DTF-1.4 (90.91-102.59) (47.64-49.04)	1	PvPHYA3-BMc324	24.12 (10.19)	9.34	26.54 ***
	DTF-4.1 (24.02-25.09) (4.11-5.86)	4	BMc155-Pv04G048200	DTF-3.2 (89.47-95.46) (47.39)	3	E45M50-389-BM189	36.83 (10.19)	14.51	44.29 ***
	DTF-4.1 (24.02-25.09) (4.11-5.86)	4	BMc155-Pv04G048200	DTF-5.1 (41.86-43.50) (30.40-11.24)	5	PvCh05-30.4-BMc321	23.14 (10.19)	6.68	5.59 ***
LD4	DTF-4.3 (32.65-33.02) (33.50-41.88)	4	BM140-Pv04G103000	DTF-9.3 (29.33-33.71) (15.10-16.74)	9	PvCh09-15.1-PV-at007	38.2 (11.59)	9.9	-37.88 ***
Growing degree days (GDD)									
LD3	GDD-4.2 (31.61-32.23) (12.73-11.16)	4	BM171-IAC91	GDD-5.1 (41.86-43.50) (41.86-43.50)	5	PvCh05-30.4-BMc321	25.15 (10.85)	7.53	233.12 ***
LD4	GDD-4.3 (32.64-33.02) (33.50-41.88)	4	BM140-Pv04G103000	GDD-9.3 (29.33-33.71) (15.10-16.74)	9	PvCh09-15.1-PV-at007	35.97 (11.87)	10.80	-320.85 ***
LD5	GDD-4.1 (24.02-25.09) (4.11-5.86)	4	BMc155-Pv04G048200	GDD-9.4 (57.57-57.57)(30.99-31.04)	9	Pv09G204500-Pv09G204	8.96 (8.00)	1.21	101.32 ***
	GDD-9.4 (57.57-57.57) (30.99-31.06)	9	Pv09G204500-Pv09G204	GDD-10.2 (44.73-45.85) (3.50-6.93)	10	IAC061-BMc234	8.14 (8.00)	1.47	-56.14 ***
Photoperiod Response Index (PRI)									
2010	PRI-4.1 (24.02-25.09) (4.11-5.86)	4	BMc155-Pv04G048200	PRI-1.1(14.34-30.73)(18.60)	1	E32M60-147-PvFTa1	13.67 (12.41)	5.62	19.54 ***
	PRI-4.2 (31.61-32.23) (12.73-11.16)	4	BM171-IAC91	PRI-8.1 (23.75-28.09) (7.06-7.85)	8	BMc121-BM165	20.25 (12.41)	12.07	48.28 ***
2013	PRI-4.3 (32.64-33.02) (33.50-41.88)	4	BM140-Pv04G103000	PRI-5.1 (41.86-43.50) (30.40-11.24)	5	PvCh05-30.4-BMc321	18.43 (11.56)	1.51	0.47 **
2015	PRI-4.1 (24.02-25.09) (4.11-5.86)	4	BMc155-Pv04G048200	PRI-9.5 (62.16-63.66) (30.86-30.84)	9	PvFUL1-Pv09G203300	12.36 (11.98)	1.50	12.45 ***
2016	PRI-8.3 (45.36-45.58) (48.34)	8	BMc316-E45M50-69	PRI-6.2 (12.72-13.47)	6	E45M50-167-E40M60-91	18.50 (11.79)	9.29	14.88 ***
Percentage of photoperiod sensitivity (PS)									
2010	PS-2.2 (15.58-16.80) (26.8-27.03)	2	Chr02.26.8-PvM115	PS-4.3 (32.64-33.02) (33.50-41.88)	4	BM140-Pv04G103000	13.25 (10.83)	6.95	-10.85 ***
	PS-4.1 (24.02-25.09) (4.11-5.86)	4	BMc155-Pv04G048200	PS-9.2 (25.05-29.34)(13.96-15.10)	9	PvCOL3-PvCh09-15.1	12.98 (10.83)	5.55	-8.77 ***
2011	PS-2.1 (14.23-14.44) (48.51)	2	E31M50-104-Chr02.48.5	PS-4.2 (31.61-32.23) (12.73-11.16)	4	BM171-IAC91	22.60 (8.30)	12.00	8.49 ***
	PS-2.2 (15.58-16.80) (26.8-27.03)	2	Chr02.26.8-PvM115	PS-4.2 (31.61-32.23) (12.73-11.16)	4	BM171-IAC91	12.63 (8.30)	7.03	-4.52 ***
2015	PS-9.4 (57.57-57.57) (30.99-31.06)	9	Pv09G204500-Pv09G204	PS-10.1 (0.00-12.24)	10	E31M31-173-E31M50-168	13.75 (10.0)	1.80	-3.01 ***
2016	PS-8.3 (45.36-45.58) (48.34)	8	BMc316-E45M50-69	PS-6.1 (7.26-7.497)	6	E45M38-113-E45M38-117	22.89 (11.27)	6.89	6.50 ***
	PS-9.2 (25.05-29.34)(13.96-15.10)	9	PvCOL3-PvCh09-15.1	PS-2.4 (65.67-67.12) (41.52-42.12)	2	PvAG2a-Chr02.42.12	17.31 (11.27)	5.41	3.35 ***

Table S6. Continued.

Env.	QTL (position)[a]	Chr[b]	Marker interval	QTL (position)[a]	Chr[b]	Marker interval	F (F threshold)[c]	R^{2d}	Aa[e]
Relative Response to Photoperiod (RRP)									
2010	RRP-2.1 (14.23-14.44) (48.51)	2	E31M50-104-Chr02.48.5	RRP-4.2 (31.61-32.23) (12.73-11.16)	4	BM171-IAC91	14.29 (10.12)	3.02	0.02 *
	RRP-2.2 (15.58-16.80) (26.8-27.03)	2	Chr02.26.8-PvM115	RRP-4.2 (31.61-32.23) (12.73-11.16)	4	BM171-IAC91	10.54 (10.12)	6.81	-0.18 ***
	RRP-4.2 (31.61-32.23) (12.73-11.16)	4	BM171-IAC91	RRP-8.1 (23.75-28.09) (7.06-7.85)	8	BMc121-BM165	51.94 (10.12)	3.58	0.19 ***
2011	RRP-2.1 (14.23-14.44) (48.51)	2	E31M50-104-Chr02.48.5	RRP-4.2 (31.61-32.23) (12.73-11.16)	4	BM171-IAC91	17.54 (9.80)	6.58	0.06 ***
	RRP-2.2 (15.58-16.80) (26.8-27.03)	2	Chr02.26.8-PvM115	RRP-4.2 (31.61-32.23) (12.73-11.16)	4	BM171-IAC91	19.35 (9.80)	8.02	-0.07 ***
2013	RRP-4.1 (24.02-25.09) (4.11-5.86)	4	BMc155-Pv04G048200	RRP-9.5 (62.16-63.66) (30.86-30.84)	9	PvFUL1-Pv09G203300	23.04 (13.45)	21.74	0.09 ***
2015	RRP-9.4 (57.57-57.57) (30.99-31.06)	9	Pv09G204500-Pv09G204	RRP-8.2 (37.81-39.54) (14.67-19.06)	8	PVEST194-IAC027	10.98 (9.06)	2.01	-0.08 ***
Photoperiod response on a scale of 1-8 (CLASS)									
2010	CLASS-2.2 (15.58-16.80) (26.8-27.03)	2	Chr02.26.8-PvM115	CLASS-4.3 (32.64-33.02) (33.50-41.88)	4	BM140-Pv04G103000	31.21 (12.08)	9.60	-1.30 ***
2011	CLASS-2.1 (14.23-14.44) (48.51)	2	E31M50-104-Chr02.48.5	CLASS-4.2 (31.61-32.23) (12.73-11.16)	4	BM171-IAC91	23.80 (7.97)	12.53	0.80 ***
	CLASS-2.2 (15.58-16.80) (26.8-27.03)	2	Chr02.26.8-PvM115	CLASS-4.2 (31.61-32.23) (12.73-11.16)	4	BM171-IAC91	11.38 (7.97)	6.38	-0.37 ***
2013	CLASS-4.1 (24.02-25.09) (4.11-5.86)	4	BMc155-Pv04G048200	CLASS-9.5 (62.16-63.66) (30.86-30.84)	9	PvFUL1-Pv09G203300	39.80 (8.47)	13.24	0.28 ***
2015	CLASS-9.4 (57.57-57.57) (30.99-31.04)	9	Pv09G204500-Pv09G204	CLASS-8.2 (37.81-39.54) (14.67-19.06)	8	PVEST194-IAC027	12.47 (9.76)	1.91	-0.57 ***
2016	CLASS-3.1 (41.40-44.79) (28.219-32.13)	3	BMd1-PVEST042	CLASS-9.6 (67.57-68.57)	9	E40M50-47-E40M50-51	31.21 (12.08)	9.60	-1.30 ***
	CLASS-5.1 (41.86-43.50) (30.40-11.24)	5	PvCh05-30.4-BMc321	CLASS-1.2 (32.54-35.08) (18.59-30.54)	1	PvFTc-BM200	12.61 (12.08)	2.85	-0.26 ***

[a] Estimated confidence interval of QTL position in brackets (in cM, Kosambi, 1943; and Mb, Phytozome web).
[b] Chr. = chromosome.
[c] F values of significance of each QTL. The critical F-value was determined by a permutation test of 1000 repetitions at the confidence level of 95% (Churchill and Doerge, 1994).
[d] Percentage of the phenotypic variation explained by additive by additive epistatic effects.
[e] Estimated additive by additive epistatic effect. Positive values indicate that alleles from PHA1037 increase the trait value, and negative values indicate that positive effect is due to the presence of the alleles from Bolita. Experiment-wide P value. *P≤0.05, **P≤0.01, ***P≤0.001.
Trial years for photoperiod response traits: 2009 (LD1 *vs.* SD2), 2010 (LD4 *vs* SD6), 2011 (LD2 *vs.* SD3), 2013 (LD6 *vs.* SD1), 2015 (LD5 *vs.* SD4), and 2016 (LD3 *vs.* SD5).

Table S7. The main QTL and QTL x Environment (QE) effects detected for flowering time (DTF and GDD) and photoperiod response (PRI, RRP, PS and CLASS) traits using a multi-environment analysis.

QTL	Marker interval	Position[a]	Chr[b]	F (F threshold)[c]	A[d]	P	R^2(a)[e]	QE AE[f]						R^2 (ae)[g]	R^2(ae)[h]					
								LD1	LD2	LD3	LD4	LD5	LD6		LD1	LD2	LD3	LD4	LD5	LD6
Days to flowering (DTF)																				
DTF-4.1	BMc155-Pv04G048200	24.02-25.09	4	31.81 (4.31)	34.22 ***		31.94	-8.45 *	-20.18 ***		16.97 ***	37.94 ***	-24.99 ***	14.48	2.40	2.84		1.50	8.99	4.19
DTF-9.4	Pv09G204500-Pv09G204700	57.57-57.57	9	7.67 (4.31)	5.15 ***		0.88							0.17						
Growing degree days (GDD)																				
GDD-4.1	BMc155-Pv04G048200	24.02-25.09	4	32.26 (4.28)	275.59 ***		32.49	-104.39 ***	-169.34 ***		119.72 ***	331.83 ***	-187.18 ***	15.37	0.57	3.07		1.23	1.04	3.60
GDD-9.4	Pv09G204500-Pv09G204700	57.57-60.47	9	9.51 (4.28)	52.72 ***		0.57					29.45 *		0.29					0.06	0.07
QTL	**Marker interval**	**Position[a]**	**Chr[b]**	**F (F threshold)[c]**	**A[d]**	***P***	**R^2(a)[e]**	**QE AE[f]**						**R^2 (ae)[g]**	**R^2(ae)[h]**					
								SD1	**SD2**	**SD3**	**SD4**	**SD5**	**SD6**		**SD1**	**SD2**	**SD3**	**SD4**	**SD5**	**SD6**
Days to flowering (DTF)																				
DTF-9.1	BM154-PvFDc	10.15-13.24	9	12.69 (4.32)	1.22 ***		5.19					-0.71 *	2.18 ***	4.25					0.51	4.15
DTF-9.4	Pv09G204500-Pv09G204700	57.57-57.57	9	13.37 (4.32)	3.55 ***		9.80						-0.99 **	6.18						2.04
Growing degree days (GDD)																				
GDD-1.4	PvPHYA3-BMc324	90.91-102.59	1	9.34 (4.18)	34.29 ***		7.44			17.93 *		-16.35 *	-17.98 *	1.35			0.61		0.40	0.50
GDD-9.4	Pv09G204500-Pv09G204700	57.57-57.57	9	6.76 (4.18)	5.99 ***		3.14							0.47						
QTL	**Marker interval**	**Position[a]**	**Chr[b]**	**F (F threshold)[c]**	**A[d]**	***P***	**R^2(a)[e]**	**QE AE[f]**						**R^2 (ae)[g]**	**R^2(ae)[h]**					
								2009	**2010**	**2011**	**2013**	**2015**	**2016**		**2009**	**2010**	**2011**	**2013**	**2015**	**2016**
Photoperiod Response Index (PRI)																				
PRI-1.5	BMc324-E36M31-121	102.59-113.51	1	5.30 (4.27)	-2.50 ***		1.91		-3.82 *					2.06		0.76				
PRI-4.1	BMc155-Pv04G048200	24.02-25.09	4	30.87 (4.27)	33.77 ***		25.71	-25.68 ***	27.56 ***	-19.15 ***	-31.29 ***	45.79 ***		18.42	2.13	2.5	2.17	5.38	10.11	
PRI-9.2	PvCOL3-PvCh09-15.1	25.05-29.34	9	4.39 (4.27)	-0.41 ns		0.13	-7.68 ***				5.93 ***	5.04 ***	1.33	0.37			0.16	0-32	
PRI-9.4	Pv09G204500-Pv09G204700	57.57-57.57	9	4.79 (4.27)	2.99 ***		0.10					4.69 *		0.32				0.02		
Percentage of photoperiod sensitivity (PS)																				
PS-4.1	BMc155-Pv04G048200	24.02-25.09	4	26.66 (4.19)	17.39 ***		28.26	-15.77 ***	10.08 ***	-5.26 ***	-13.91 ***	23.92 ***		15.51	2.46	1.45	0.73	4.27	9.97	
PS-9.2	PvCOL3-PvCh09-15.1	25.05-29.34	9	6.01 (4.19)	-0.62 ns		0.16	-4.03 **	-4.89 ***	2.28 *		3.43 ***	1.99 *	2.01	0.38	1.24	0.03		0.28	0.33
PS-9.4	Pv09G204500-Pv09G204700	57.57-60.47	9	7.33 (4.19)	-2.31 ***		0.68			-2.53 *				1.60			0.07			
PS-9.5	PvFUL1-Pv09G203300	62.16-63.66	9	7.83 (4.19	2.41 ***		0.44					3.63 ***		1.07					0.71	
Relative Response to Photoperiod (RRP)																				
RRP-1.4	PvPHYA3-BMc324	90.91-102.59	1	4.88 (4.10)	-0.01 *		1.74		-0.02 *			0.02 *		1.65		0.80			0.09	
RRP-4.1	BMc155-Pv04G048200	24.02-25.09	4	25.96 (4.10)	0.19 ***		26.95	-0.22 ***	0.15 ***	-0.07 ***	-0.15 ***	0.26 ***		14.03	2.79	1.55	0.83	3.87	7.84	
RRP-9.2	PvCOL3-PvCh09-15.1	25.05-29.34	9	6.32 (4.10)	-0.02 ***		1.28	-0.08 ***	-0.04 **			0.05 ***	0.04 ***	1.49	0.37	0.84			0.15	
RRP-9.5	PvFUL1-Pv09G203300	62.16-63.66	9	7.80 (4.10)	0.01 *		1.66	-4.00 ***				0.05 ***		1.40	0.82				0.81	
Photoperiod response on a scale of 1-8 (CLASS)																				
CLASS-1.6	PVEST076-E32M51-329	114.10-115.60	1	5.23 (4.16)	-0.08 *		1.3		-0.19 *					1.35		0.79				
CLASS-4.1	BMc155-Pv04G048200	24.02-25.09	4	27.03 (4.16)	1.49 ***		27.55	-1.49 ***	01.09 ***	-0.49 ***	-1.23 ***	2.10 ***		15.14	2.1	1.68	0.76	4.37	9.53	
CLASS-9.2	PvCOL3-PvCh09-15.1	25.05-29.34	9	6.19 (4.16)	-9.00 *		0.16	-0.54 ***	-0.34 ***				0.30 **	1.83	0.72	0.72				
CLASS-9.5	PvFUL1-Pv09G203300	62.16-63.66	9	5.96 (4.16)	0.18 ***		0.3	-0.54 ***				0.71 ***		1.23	0.66				0.67	

Table S7. Continued.

[a] Estimated confidence interval of QTL position (in Kosambi cM).
[b] Chromosome (Chr).
[c] F values of significance of each QTL. The critical F-value was determined by a permutation test of 1000 repetitions at the confidence level of 95% (Churchill and Doerge, 1994).
[d] Predicted additive effect. Positive values indicate that alleles from PHA1037 increase the trait value, and negative values indicate that positive effect on the traits is due to the presence of the alleles from Bolita.
[e] Percentage of the phenotypic variation explained by additive effects.
[f] Predicted additive by environment interaction effect. The meaning of sign values is described in the footnote [d].
[g] Percentage of the phenotypic variation explained by additive x environment interaction effect.
[h] Percentage of the phenotypic variation explained by additive x environment interaction effect in each environment and year.
*P ≤ 0.05, **P ≤ 0.01, ***P ≤ 0.001. Only significant effects are listed.

Table S8. Epistatic QTL and epistatic QTL x Environment (QE) effects detected for flowering time (DTF, GDD) and photoperiod (PRI, RRP, PS and GDD) traits using multi-environment analysis.

QTLi[a]	Marker interval	Chr (position)[b]	QTLj[a]	Marker interval	Chr (position)[b]	F (F threslod)[c]	Aa[d]	$R^2(aa)$[e]	epistatic QE AAE[f]						$R^2(aae)$[g]	$R^2(aae)$[g]					
									LD1	LD2	LD3	LD4	LD5	LD6		LD1	LD2	LD3	LD4	LD5	LD6
DTF-4.1	BMc155-Pv04G048200	4 (24.02-25.09)	DTF-9.4	Pv09G204500-Pv09G204700	9 (57.57-57.57)	8.15 (4.26)	8.99 ***	2.20			9.55 ***			-5.88 *	0.96			0.60			0.33
DTF-1.6	E36M31-83-PVEST076	1 (113.62-114.10)	DTF-4.2	BM171-IAC91	4 (31.61-32.23)	7.35 (4.26)	10.09 ***	2.17			6.79 *				0.97			0.43			
DTF-4.3	BM140-Pv04G103000	4 (32.65-33.02)	DTF-9.7	BMc184-PvCOL3	9 (20.25-25.05)	5.30 (4.26)	-3.09 *	0.05	-11.47 *		13.46 ***	-20.21 ***	12.89 ***		2.74	0.56		0.58	1.50	0.51	
GDD-1.9	BM53-IAC93	1 (41.14-42.15)	GDD-4.1	BMc155-Pv04G048200	4 (24.02-25.09)	5.19 (4.29)	3.71 ns	0.00		-51.02 *					0.93		0.49				
GDD-1.6	E36M31-83-PVEST076	1 (113.62-114.10)	GDD-4.2	BM171-IAC91	4 (31.61-32.23)	10.53 (4.29)	81.77 ***	2.51			47.97 *			-42.76 *	0.98			0.38			0.29
GDD-4.3	BM140-Pv04G103000	4 (32.65-33.02)	GDD-9.7	BMc184-PvCOL3	9 (20.25-25.05)	6.18 (4.29)	-20.97 ns	0.00	-90.98 *		101.49 ***	-169.09 ***	111.35 ***		2.76	0.52		0.49	1.51	0.63	

QTLi[a]	Marker interval	Chr (position)[b]	QTLj[a]	Marker interval	Chr (position)[b]	F (F threslod)[c]	Aa[d]	$R^2(aa)$[e]	epistatic QE AAE[f]						$R^2(aae)$[g]	$R^2(aae)$[g]					
									SD1	SD2	SD3	SD4	SD5	SD6		SD1	SD2	SD3	SD4	SD5	SD6
DTF-1.7	BM200-E43M38-138	1 (35.08-37.36)	DTF-2.5	GATS91-BMc367	2 (0.0-8.139	4.50 (3.97)	-0.34 *	0.70						-1.73 ***	2.97						2.76
DTF-1.8	PvCh01-10.6-BM53	1 (40.27-41.14)	DTF-2.6	Chr02.42.26-Chr02.42.23	2 (62.98-63.26)	5.59 (3.97)	-0.88 ***	1.74							1.29						
GDD-2.6	Chr02.42.26-Chr02.42.2	2 (62.98-63.26)	GDD-7.2	E31M61-110-BMc216	7 (83.24-95.79)	4.66 (4.07)	-12.51 ***	3.47	-15.33 ***						1.14	0.91					
GDD-4.1	BMc155-Pv04G048200	4 (24.02-25.09)	GDD-7.1	P-BMc294	7 (45.52-52.59)	4.16 (4.07)	7.60 ***	0.46	10.43 ***				-8.48 *	-7.40 *	1.58	0.73				0.51	
GDD-5.3	IAC286-PvCh05-30.4	5 (35.93-41.86)	GDD-8.5	E31M50-580-BMc330	8 (41.36-42.09)	4.35 (4.07)	10.40 ***	1.76							1.10						

QTLi[a]	Marker interval	Chr (position)[b]	QTLj[a]	Marker interval	Chr (position)[b]	F (F threslod)[c]	Aa[d]	$R^2(aa)$[e]	epistatic QE AAE[f]						$R^2(aae)$[g]	$R^2(aae)$[g]					
									2009	2010	2011	2013	2015	2016		2009	2010	2011	2013	2015	2016
PRI-6.3	PvCh06-19.5-E45M50-50	6 (10.90-11.43)	PRI-8.4	BM211-PVEST194	8 (37.67.37.81)	6.21 (4.29)	6.54 ***	1.79	11.28 *				-14.22 ***	12.15 **	1.88	0.90				0.10	0.54
PRI-6.3	PvCh06-19.5-E45M50-50	6 (10.90-11.43)	PRI-8.2	PVEST194-IAC027	8 (37.81-39.54)	4.86 (4.29)	3.93 *	0.94	11.59 **						1.71	1.20					
PS-4.7	SNP-4564-BSNP-49	4 (0.0-10.40)	PS-9.2	PvCOL3-PvCh09-15.1	9 (25.05-29.34)	5.64 (4.06)	0.52 ns	0.90		-7.15 ***				5.14 ***	2.03						0.64
RRP-1.6	E36M31-83-PVEST076	1 (113.62-114.10)	RRP-4.2	BM171-IAC91	4 (31.61-32.23)	7.00 (4.32)	0.06 ***	1.84				-0.03 *			0.65				0.26		
RRP-9.2	PvCOL3-PvCh09-15.1	9 (25.05-29.34)	RRP-9.5	PvFUL1-Pv09G203300	9 (62.16-63.66)	4.44 (4.32)	-0.03 ***	1.57					-3.00 *		0.55					0.33	
CLASS-1.10	PVEST270-IAC21	1 (72.68-74.509	CLASS-9.8	E31M51-59-Pv09G227300	9 (70.27-73.68)	6.49 (4.34)	-0.28 ***	1.17				-0.33 ***			1.24				0.57		
CLASS-1.6	E36M31-83-PVEST076	1 (113.62-114.10)	CLASS-4.2	BM171-IAC91	4 (31.61-32.23)	9.29 (4.34)	0.48 ***	2.21							0.72						
CLASS-4.1	BMc155-Pv04G048200	4 (24.02-25.09)	CLASS-9.5	PvFUL1-Pv09G203300	9 (62.16-63.66)	5.10 (4.34)	0.34 *	0.68			0.79 ***				0.43			0.38			
CLASS-4.1	BMc155-Pv04G048200	4 (24.02-25.09)	CLASS-9.2	PvCOL3-PvCh09-15.1	9 (25.05-29.34)	4.33 (4.34)	0.21 *	0.35		-0.97 ***			0.41 *	0.38 *	1.63		1.22			0.32	0.28

[a] QTLi and QTLj are the pair of QTLs involved in epistatic interaction.

[b] Chromosome (Chr.) and the estimated confidence interval of QTL position in brackets (in Kosambi cM).

[c] F values of significance of each QTL. The critical F-value was determined by a permutation test of 1000 repetitions at the confidence level of 95% (Churchill and Doerge 1994).

[d] Estimated additive by additive epistatic effect. Positive values indicate that alleles from PHA1037 increase the trait value, and negative values indicate that positive effect on the traits is due to the presence of the alleles from Bolita.

[e] Percentage of the phenotypic variation explained by additive by additive epistatic effects.

[f] Predicted additive by additive epistatic effect by environment interaction effect. Epistasis associated with environments. The meaning of sign values is described in the footnote [d].

[g] Percentage of the phenotypic variation explained by additive by additive epistatic effect by environment interaction effect.

*P ≤ 0.05, **P ≤ 0.01, ***P ≤ 0.001. Only significant effects are listed. ns = No significant effects on the five environmental conditions evaluated.

Table S10. Polymorphisms in potential candidate genes underlying flowering time QTL.

QTL	Gene		Polymorphism genome location	SNP			InDel			Polymorphism gene position	Functional consequence
				Reference genome (*P. vulgaris* V2.1)	PHA1037	BOLITA	Reference	PHA1037	BOLITA		
DTF1..4	*PvPHYA3*	Phvul.001G221100	Chr01:47,647,439	G	G	A	-	-	-	CDS (5th exon)	Non-synonymous substitution (Gly-1066-Ser)
DTF1..4	*PvARP5*	Phvul.001G232900	Chr01:48,672,298	A	C	C	-	-	-	CDS (12th exon)	Non-synonymous substitution (Glu-631-Ala)
			Chr01:48,672,828	A	A	T	-	-	-	CDS (11th exon)	Non-synonymous substitution (Glu-494-Val)
DTF-4.1	*PvRPK2*	Phvul.004G037600	Chr04:4,360,349	A	G	G	-	-	-	2nd intron	-
			Chr04:4,361,034	A	G	G	-	-	-	2nd intron	-
			Chr04:4,362,329	C	T	T	-	-	-	2nd intron	-
			Chr04:4,367,511	C	G	G	-	-	-	2nd intron	-
DTF-4.1	*PvCOL2*	Phvul.004G046601	Chr04:5,650,186	A	T	A	-	-	-	5'UTR (1st exon)	-
DTF-9.1	*PvAP3*	Phvul.009G013900	-	-	-	-	-	-	-	-	-
DTF-9.1	*PvFDc*	Phvul.009G018700	Chr09:3,565,457	T	T	G	-	-	-	2nd intron	-
			Chr09:3,566,057	G	G	C	-	-	-	2nd intron	-
			Chr09:3,567,128	C	T	T	-	-	-	2nd intron	-
DTF-9.4	*PvE1*	Phvul.009G204600	Chr09:31,042,488	-	-	-	AATTAATC GTTGAGG GAATCACA AACATAAC CTCTATA	AATTAATC GTTGAGG GAATCACA AACATAAC CTCTATA	GTCT	3' region (at 29 bp downstream of the stop codon)	-
DTF-9.5	*PvFUL1*	Phvul.009G203400	Chr09:30,864,591	-	-	-	AA	AAA	AA	6th intron	-

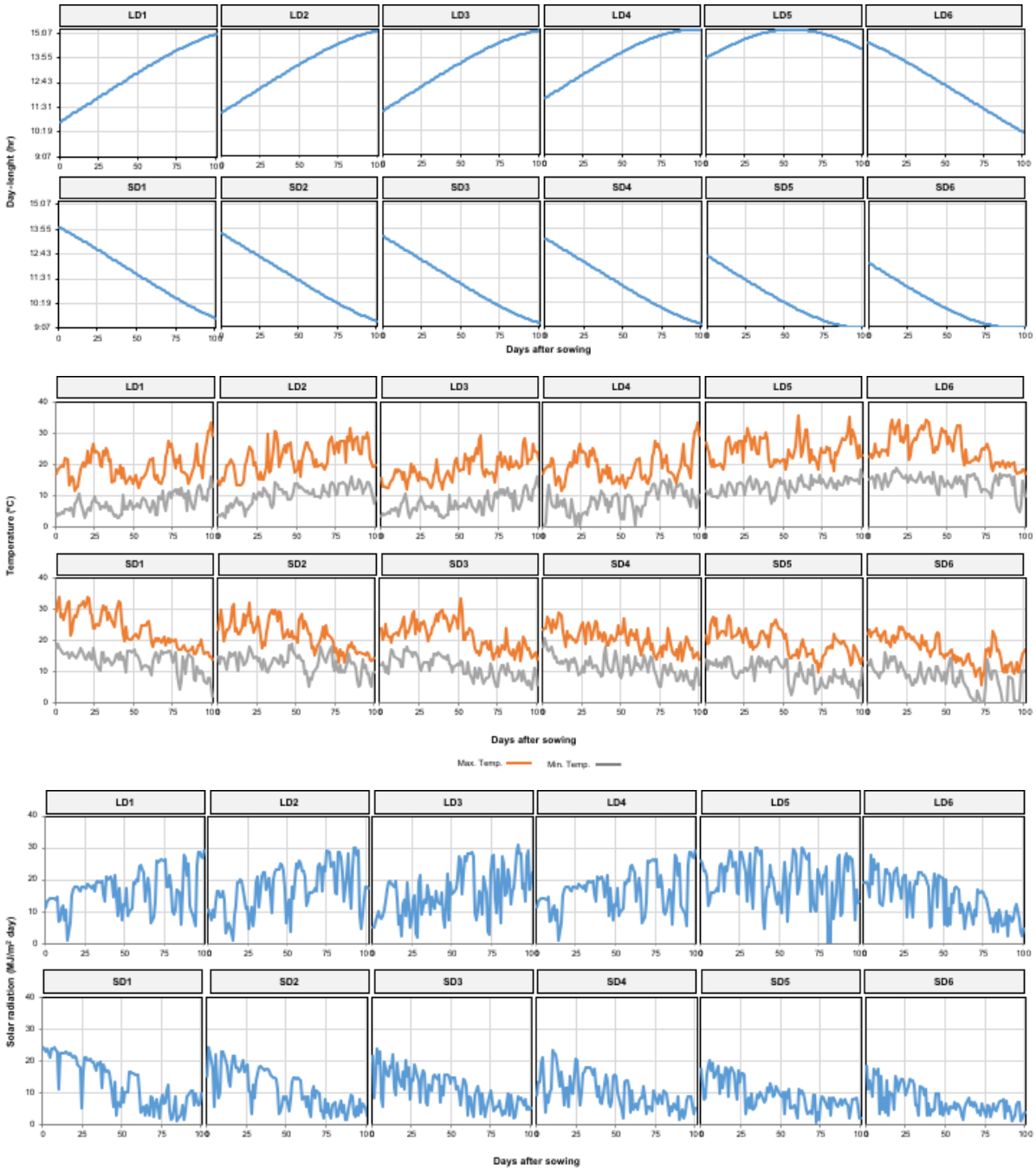

Fig. S1. Profiles of climatic variables (daylength, hr; maximum and minimum temperature, °C; and solar radiation, MJ / (m^2día)) observed during the first 100 days after sowing, at long-day (LD) and short-day (SD) environments in one location across six years.

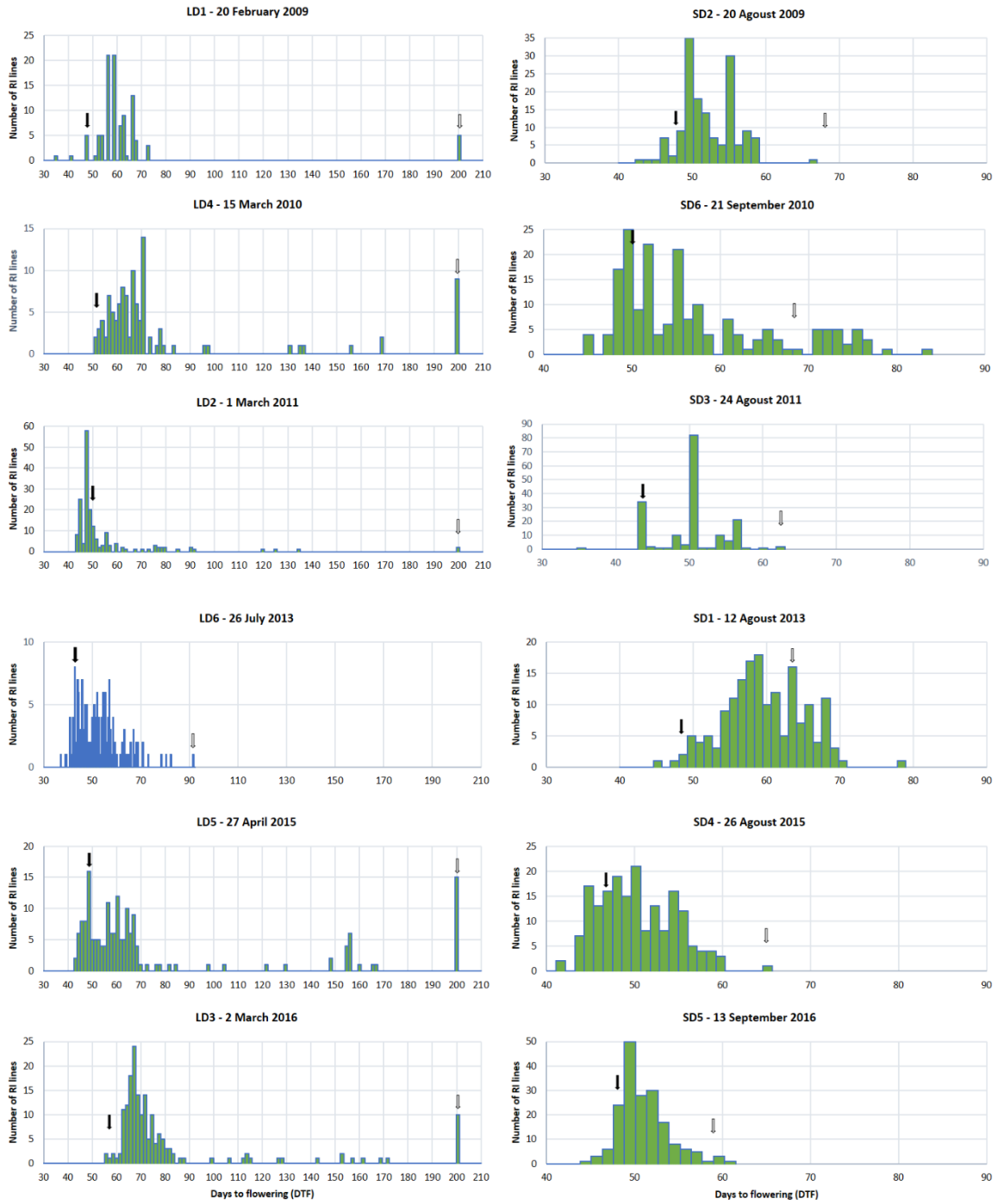

Fig. S2. Distribution of days to flowering (DTF) in the RI population of a biparental cross between the cultivar Bolita (indeterminate type II, photoperiod-insensitive) and the landrace PHA1037 (indeterminate type IV, photoperiod-sensitive) grown in twelve environments; where black and white arrows correspond to Bolita and PHA1037 parents, respectively. The environments are ranging according to sowing dates from late-February to late-July (LD1-6 environments) and from mid-August to late-September (SD1-6) in each trial year (2009-2016). DTF (X axis) and number of RI lines (Y axis). The landrace PHA1037 and a proportion of RIL individuals remained vegetative until termination of the LD experiments (NF: non-flowering; 200 days).

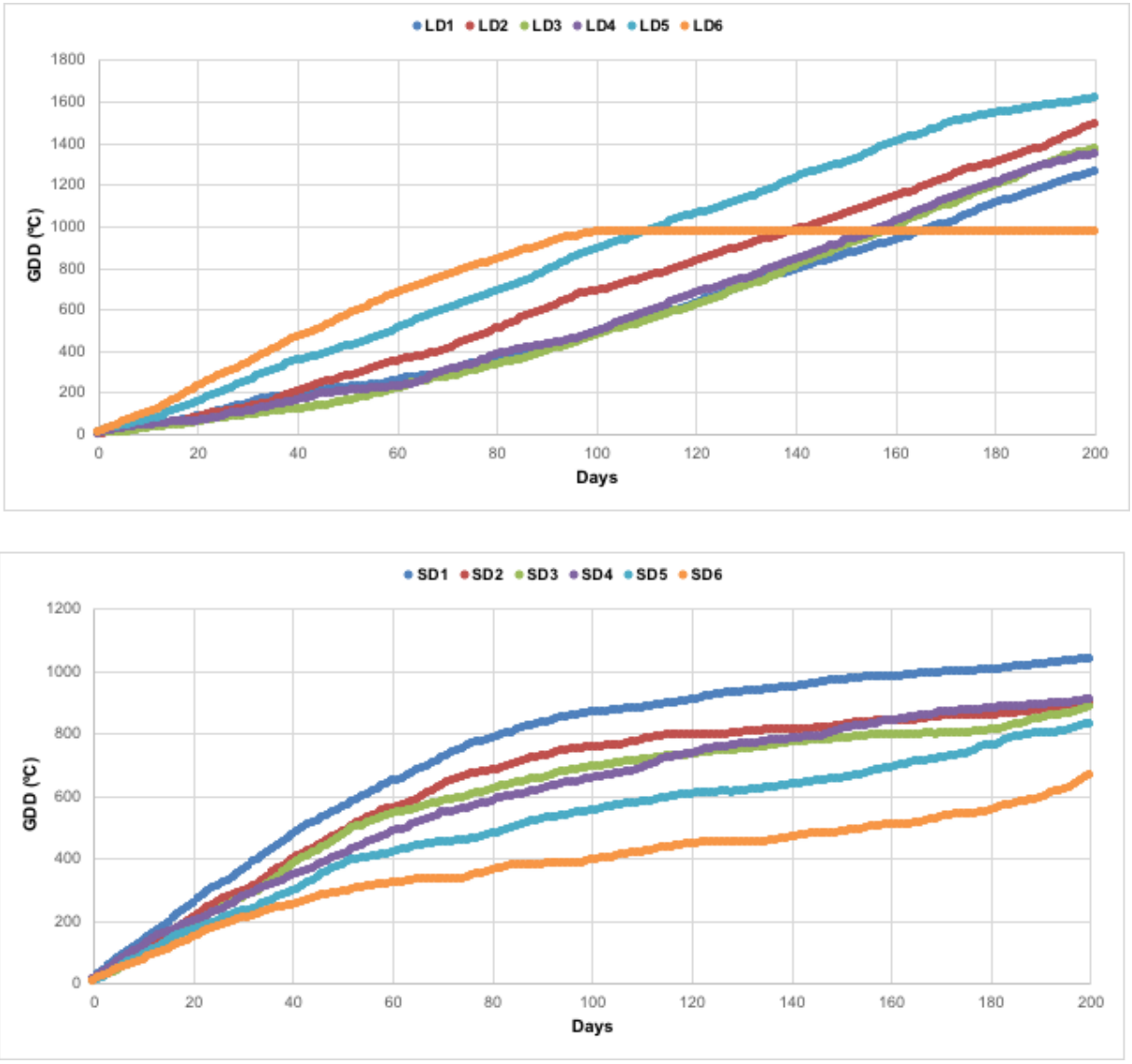

Fig. S3. Distribution of growing degree days (GDD, °C) during each of the LD and SD environments.

Fig. S4. Distribution of the Photoperiod Response Index (PRI), response photoperiod classes 1 to 8 (CLASS), and the photoperiod sensitivity (PS) in the RI population of a cross between the Andean cultivar Bolita (indeterminate type II, photoperiod-insensitive) and the Andean landrace PHA1037 (indeterminate type IV, photoperiod-sensitive); where black and white arrows correspond to Bolita and PHA1037 parents, respectively. Response to photoperiod was measured as a relative change in rate of flowering under long and short day-lengths in several years. PRI values close to zero indicate non-photoperiod-sensitive flowering (stable flowering period), while values close to 30 or even higher indicate high sensitivity to photoperiod (non-flowering). PS values close to or lower than 30% could be classified as photoperiod insensitive, while values over 50% indicate high sensitivity to

photoperiod. Grouping response classes 1 and 2 were classified as day-neutral, 3 and 4 as intermediate, and 5-8 as sensitive.

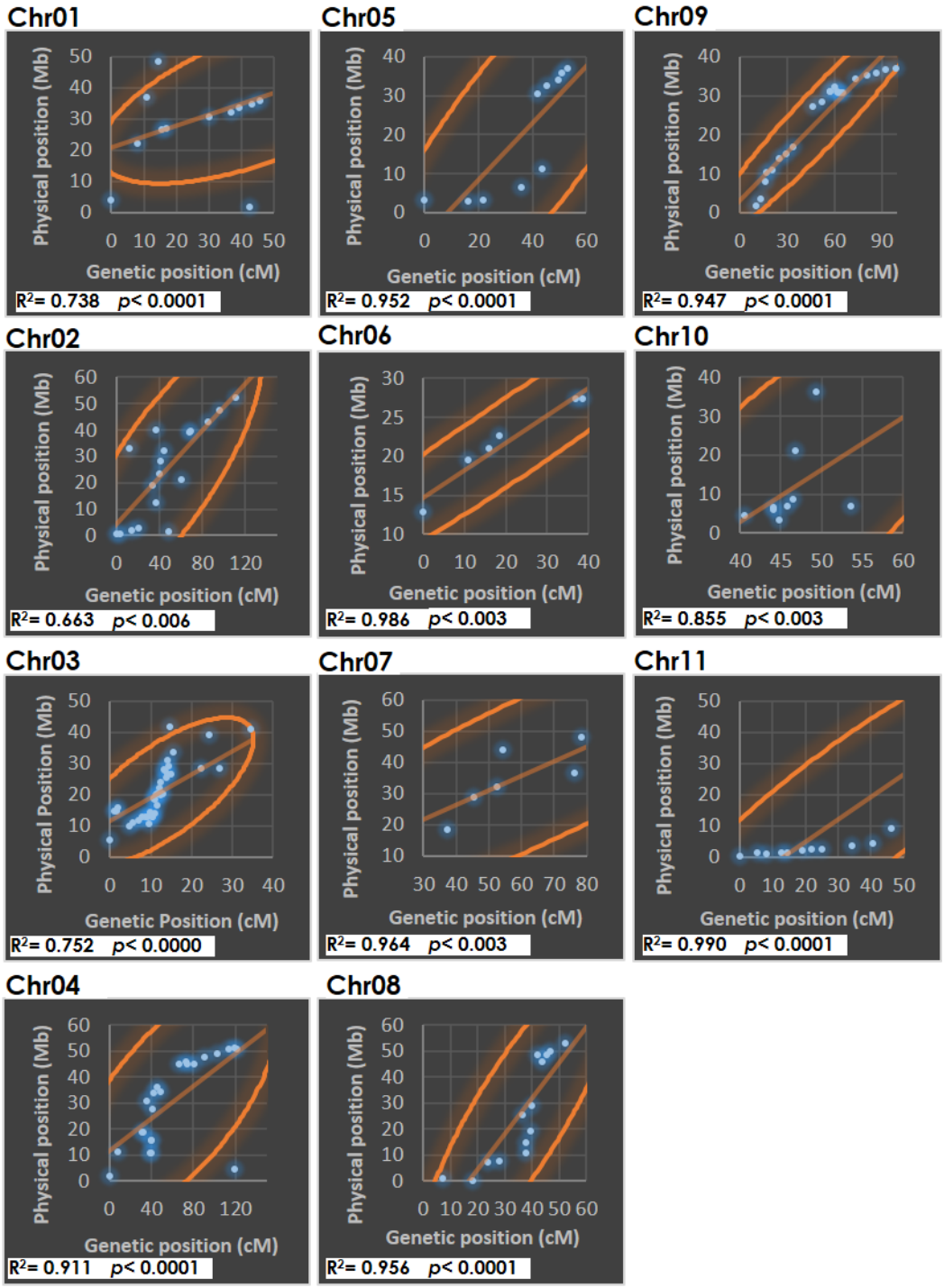

Fig. S5 Correlation of the genetic and physical positions and its distribution in chromosomal rearrangement regions. The blue dots represent the genetic and physical positions of markers. Total-sample data ellipses are shown as orange, solid curves. The horizontal axis represents the genetic position (cM) of the markers on the genetic linkage map. The vertical axis represents the physical position (Mb) according to the *Phaseolus vulgaris* reference genome (Phytozome). R^2 represents the Spearman correlation coefficients between the genetic and physical positions in each chromosome.