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Supplementary Information for

Large-effect flowering time mutations reveal conditionally adaptive paths through fitness landscapes in *Arabidopsis thaliana*

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Supplemental Results

Here we discuss genotype-specific results for the mutants for flowering time as well as their variation in relation to fitness. A great deal is known about the repressive and inductive genetic pathways that control flowering in *A. thaliana* (1-6). Specifically, the photoperiod pathway senses long days to accelerate flowering and interacts with the ambient temperature pathway since both contain overlapping thermosensors (7-10). Flowering is also accelerated by exposure to long-term cold, transduced by the vernalization pathway (11-13). Finally, the autonomous and hormone pathways promote flowering but are less sensitive to specific environmental stimuli. In most natural environments, these pathways induce a winter annual life history in which seeds germinate in the fall, overwinter as vegetative rosettes, and flower in the spring. However, other populations cycle more rapidly as spring and summer annuals in which all three life stages occur within a single season (14-17). These alternative phenologies result from both genetic variation and from variation in environmental signaling (16, 18).

Phenology delay

The late-bolting cluster consisted mostly of lines with presumed high *FLC* expression (i.e. Col *FRI*), impaired *FLC* downregulation (i.e. *FRI:vin3, FRI*), or positive photoperiod integrators (i.e. *gi*). Functional *FRI* lines were generated by introgressing a strong functional *FRI* allele from the Sf-2 ecotype into *fri*-non-functional backgrounds. This introgression is known to result in high *FLC* expression, thus conferring a vernalization requirement. Lines with presumed high *FLC* activity delayed bolting in most environments, but especially so in the fall when the *FRI:vin3* mutant was extremely late-bolting. *VIN3* functions to register vernalizing cold and maintain the silencing of *FLC*, so without it even brief periods of warmth can erase repressive epigenetic *FLC* marks (11, 19, 20). In *FRI:vin3*, a strong *FRI* expressing a potent *FLC*-mediated floral repression was coupled with an impaired *vin3* leading to its inability to register vernalizing cold.

The autonomous pathway was also an important component of the delayed cluster because *ld* and *fve* could not downregulate *FLC,* even in the present of other inductive signals like vernalizing cold in the fall and longdays in the summer. Downstream (but not upstream) photoperiod mutants delayed bolting, especially *gi.* Finally, impairment of the ultimate integrator of all these pathways, the florigen *ft*, delayed flowering across most plantings but not as severely as the autonomous or vernalization mutants, indicating that the loss of function of *FT* may be partially compensated by other integrators such as *TSF*.

Phenology acceleration

The early-bolting cluster showed a mix of pathways with many upstream photoperiod mutants, and the most consistently early-bolting mutants were deficient in *PHYB*. In fact, *phyb+a/d/e* mutants form a subcluster that is constitutively fast-bolting across all plantings. *PHYD/E* obligately heterodimerize with *PHYB* but *PHYB* does not depend upon *PHYD/E* (21, 22), so that it might be expected that a *phyb* mutant would be more extreme than *phye* or *phyd*. Indeed, the data supported this expectation since single phytochrome mutants (*phyd* and *phye*) accelerated less than *phyb* or mixed double mutants (*phybe* or *phybd*). Furthermore, these obligately heterodimerizing mutants accelerated more than double mutants in genes that do not interact (such as *phyad*). *PHYB* also functions to integrate night-time temperature information (23) and is especially important during seasons with large differences between day and night-time temperatures, which may explain why *phyb* mutants are more likely to show sign plasticity across plantings.

The vernalization mutants present in the accelerated cluster were characterized by deficiencies in *FLC* either due to loss-of-function in its obligate enhancer *FRI* (in the *hua:fri* double mutant) or in *FLC* itself (in the *FRI:flc* mutant). Furthermore, mutations generated in the Col FRI background accelerated bolting relative to Col FRI, representing a two-step mutational path from Col to Col *FRI* to Col *FRI*+mutation (i.e. *FRI:frl*).

Phenology-fitness variation

These mutants were chosen to expand phenological variation, but we also observed that environments compressed and expanded the amount of variation that mutants expressed. For example, in Norwich fall bolting time varied between 7 and 18 thousands of accumulated photothermal units (kBPTU) while in Norwich summer it varied between 5 and 10 kBPTU. This is likely driven by the autumnal window of sensitivity in late fall that forces plants to balance the benefit of rapidly flowering before winter or waiting until spring, which is governed by the vernalization requirement in *FRI-FLC* functional genotypes (15). However, variation in phenology did not correlate to variation in fitness. This is seen in the opposite phenology and fitness variation trends between Halle fall (with greater fitness variation and lesser phenological variation) and Norwich fall (with lesser fitness variation and greater phenological variation). This points to the possibility of a trade-off between the sizes of phenological space and fitness space available to mutant plants in different environments. As new mutants explore fitness landscapes, marginal differences in phenotypes may be dampened relative to marginal differences in fitness. For example, in both Valencia fall and Halle fall, *co* decreased fitness relative to its ecotype background Col. However, in Halle fall it caused an approximate 5k seed proxy unit fitness decrease concomitant with 2 kPTU acceleration in bolting time, while in Valencia it caused a 7k seed proxy unit fitness decrease but a 1 kBPTU acceleration. This jaggedness in the relationship between mutant and ecotype background indicates that genotype-by-environment interaction is playing an outsize role determining how traits will be selected upon and which mutations will prove sufficiently adaptive to escape loss by drift.

Supplemental Methods

After field transplantation in order to ensure establishment and ameliorate transplant shock, plants were watered for one week. Growth plots were protected from herbivory by fences and molluscicide, and those plants that suffered herbivore wounding were excluded from our analyses. See Wilczek *et al.,* 2009 for further details (24).

Temperatures in the greenhouses were measured every 15 minutes by HOBO probes (HOBO H8 Pro Series, Onset Computer Corporation, Bourne, MA) interspersed randomly among growth benches. For field sites, temperature at rosette height (~1.5 cm above soil surface) was measured every 6 minutes by 5 thermistor temperature probes (model 107-I, Campbell Scientific Inc, Logan, UT) covered to prevent insolation. To calculate hourly temperatures used for photothermal time calculations, the ten measurements for each hour was averaged. Temperature data were curated and corrected as in Wilczek *et al.,* 2009.

Days to flowering was the number of days from field transplant until the petals of a plant's first flower were fully extended from its sepals. Initial leaf number was the number of fully unfurled, non-cotyledenous leaves in the rosette at the time of field transplant. Leaf length at bolting was the length of the longest leaf from the center of the rosette to that leaf's apex on the day of bolting. Main branch number indicated whether there was a single or multiple primary inflorescence shoots emerging from the rosette canopy. Cauline branch number was the number of branches originating from the axils of cauline leaves. The number of basal branches were the number of shoots that originated from the same rosette level as the primary inflorescence shoot. The number of higher order branches were the number that branched from cauline branches and were longer than 1cm.

To scale phenological measurements to photothermal time, we used the following equations:

$$photothermal\ unit\ PTU(t) = \begin{cases} [T(t) - T_b] \times P & , T(t) > T_b \\ 0 & , otherwise \end{cases}$$

$$P = \begin{cases} 1\ , Sunrise < t < Sunset \\ 0\ , otherwise \end{cases}$$

$$accumulated\ photothermal\ units\ (PTUs) = \sum_{t=1}^{t=trait\ end} PTU(t)$$

where *t* is hour, *T(t)* is the temperature at hour *t*, T_b is the base temperature which was held constant at 3°C as in Chew *et al.*, 2012 (23); *P* was photoperiod filter with a non-zero value only in daylight; *t=1* is the 12th hour of the day of germination; and *t=trait end* is the 12th hour of the day when a plant either bolted or flowered. The purpose of this scaling was not to model genotype-specific photothermal phenology, but rather to provide a uniform scaling to compare across genotypes while simultaneously reflecting the dominant effect of daytime temperature on setting overall phenology. Our photothermal scaling accomplishes this without attempting to parameterize the complex, environment-specific transformations that genotype-specific photothermal time models entail. Finally, the qualitative pattern of bolting (Fig. S3) and selection (Table S1) is the same when evaluating phenology in real time (Julian days) or in our estimate of photothermal time, so increasing complexity of the photothermal time model is unlikely to yield little useful results to answer the questions of selection on phenology among our mutant populations.

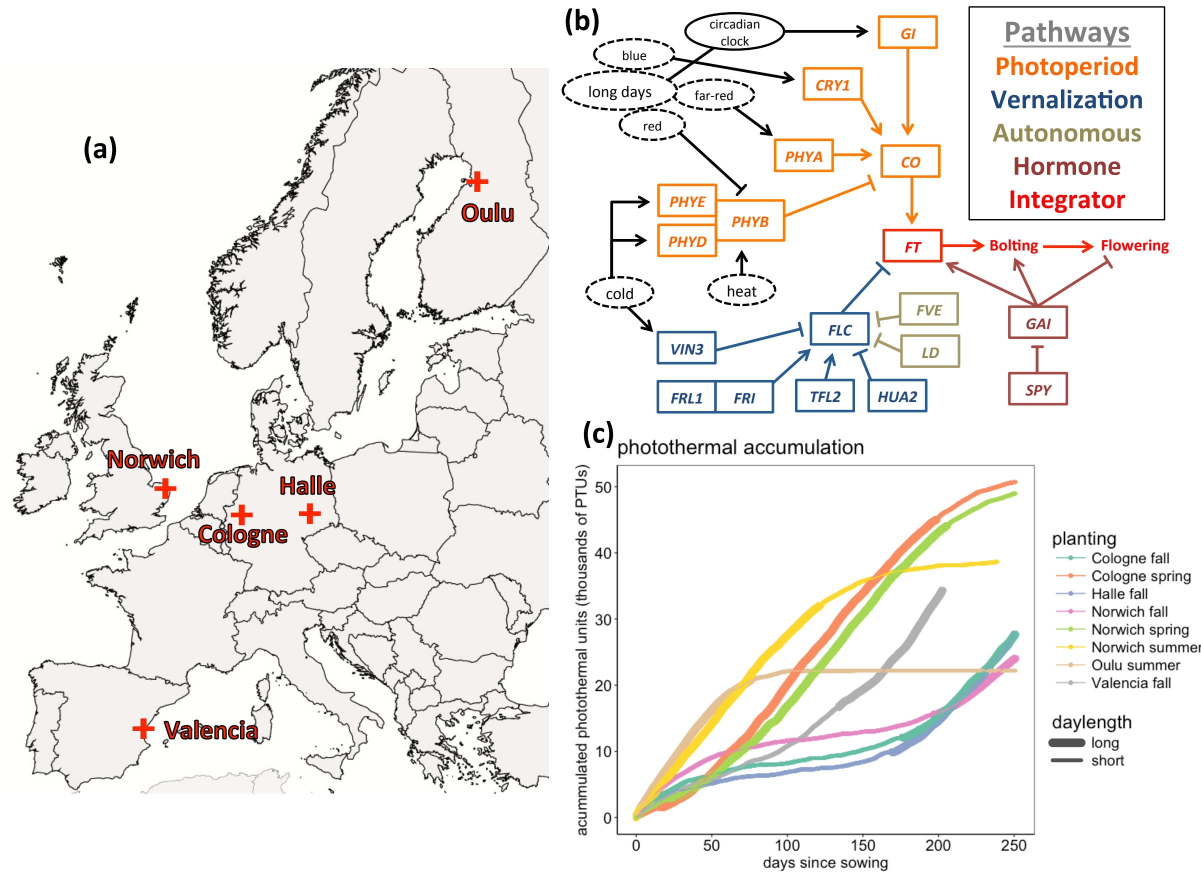

Fig. S1. (a) Locations of field sites in this experiment. **(b)** Primary network interactions of flowering time genes manipulated in this experiment. Genes are shown in solid rectangles, and environmental signals in dashed ovals. For genes, arrows mean that a functional allele has a positive effect on its downstream partner; blunt ends, a negative effect. For an environmental variable, arrows mean that it upregulates a gene; blunt ends, downregulates. **(c)** Accumulation of photothermal units from the date of sowing for each planting, which scales developmental progress by times when photosynthetically active radiation and temperature promote the transition from vegetative growth to reproduction.

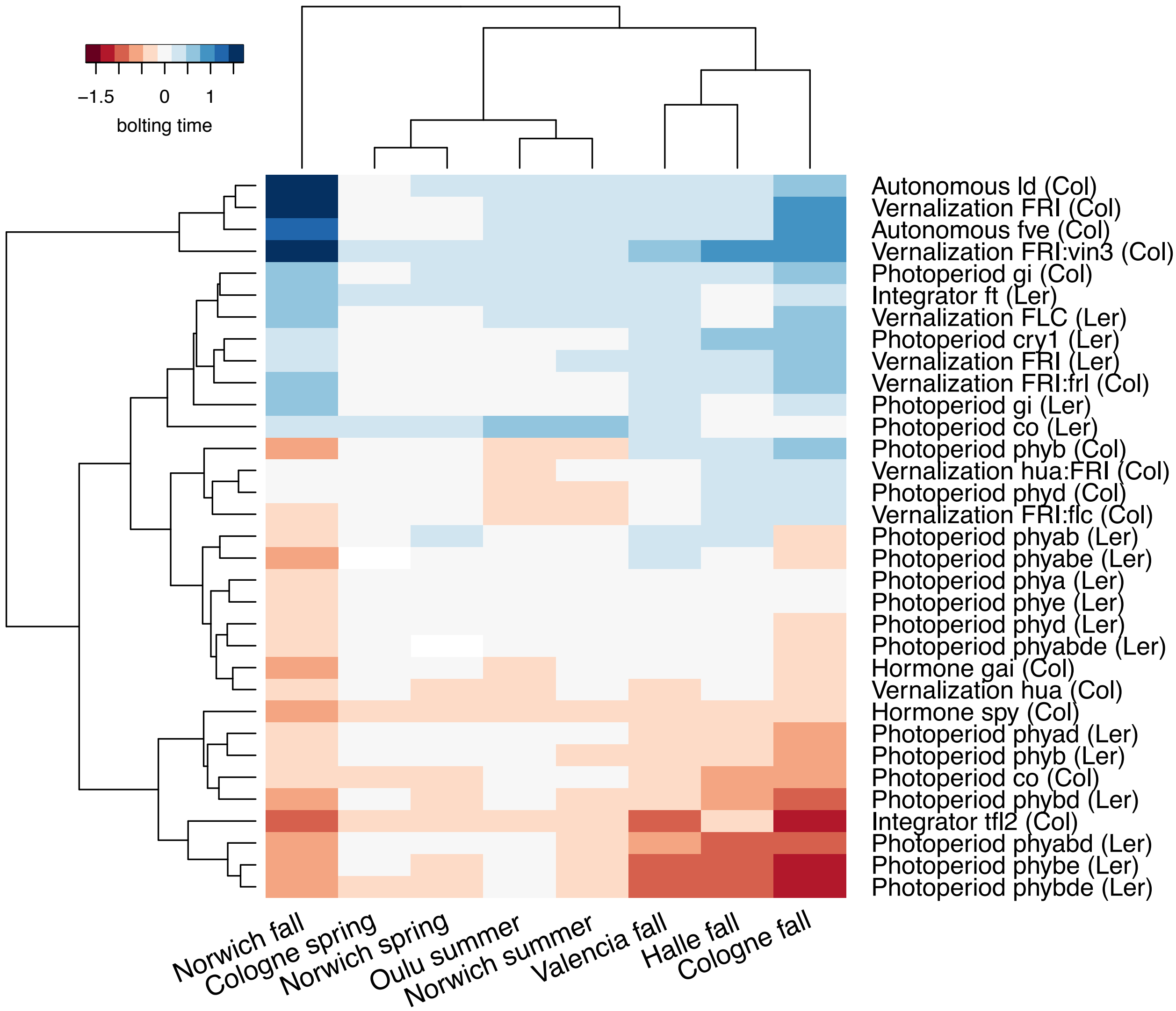

Fig. S2. Heatmap of days to bolting in calendar time in *Arabidopsis thaliana* using Euclidian, average-based clustering for both genotype (rows) and planting (columns) relative to ecotype background after log_2 transformation. The first word of the row identifiers show how lines are classified according to their traditional pathway designation. Subsequent lowercase gene names indicate loss-of-function alleles; uppercase, gain-of-function. Colons between pathways or genes indicate multiple gene mutations within a line, not gene fusions. Col and Ler in parentheses indicate each line's ecotype background (Col-0 and Ler-1, respectively).

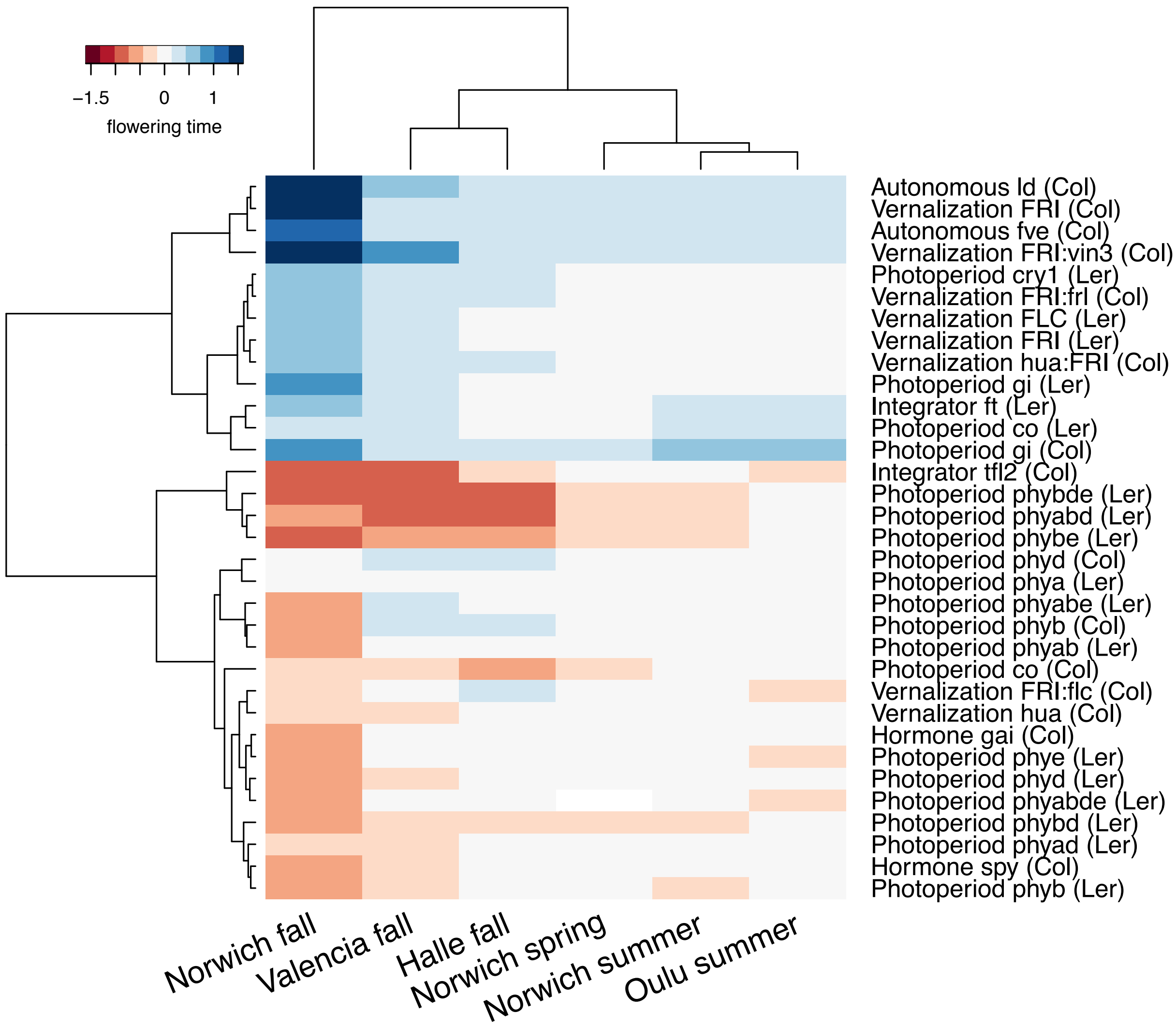

Fig. S3. Heatmap of days to flowering in calendar time in *Arabidopsis thaliana* using Euclidian, average-based clustering for both genotype (rows) and planting (columns) relative to ecotype background after log_2 transformation. Fewer plantings are available for flowering time than bolting time because flowering was measured in fewer sites. The first word of the row identifiers show how lines are classified according to their traditional pathway designation. Subsequent lowercase gene names indicate loss-of-function alleles; uppercase, gain-of-function. Colons between pathways or genes indicate multiple gene mutations within a line, not gene fusions. Col and Ler in parentheses indicate each line's ecotype background (Col-0 and Ler-1, respectively).

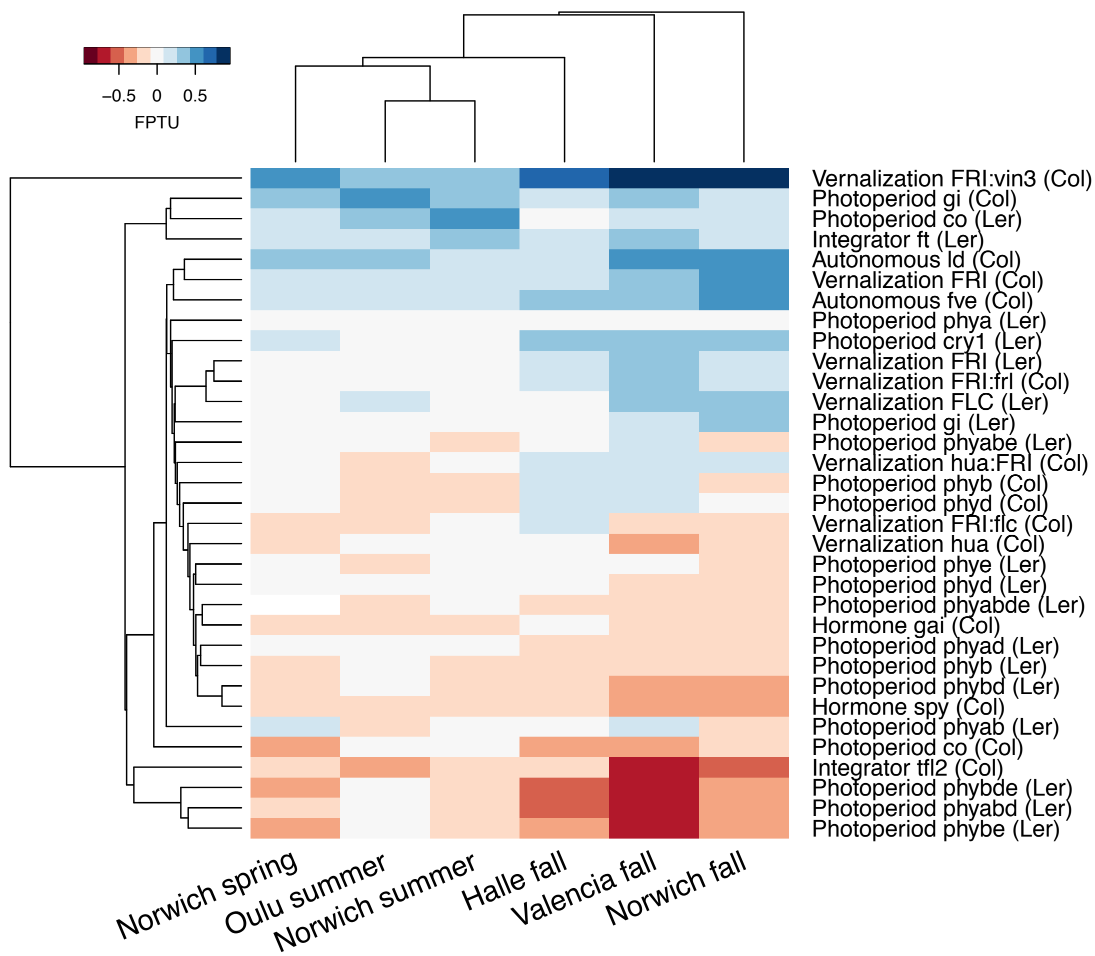

Fig. S4. Heatmap of accumulated photothermal units to flowering (FPTU) in *Arabidopsis thaliana* using Euclidian, average-based clustering for both genotype (rows) and planting (columns) relative to ecotype background after $\log_2$ transformation. Fewer plantings are available for flowering time than bolting time because flowering was measured in fewer sites. The first word of the row identifiers show how lines are classified according to their traditional pathway designation. Subsequent lowercase gene names indicate loss-of-function alleles; uppercase, gain-of-function. Colons between pathways or genes indicate multiple gene mutations within a line, not gene fusions. Col and Ler in parentheses indicate each line's ecotype background (Col-0 and Ler-1, respectively).

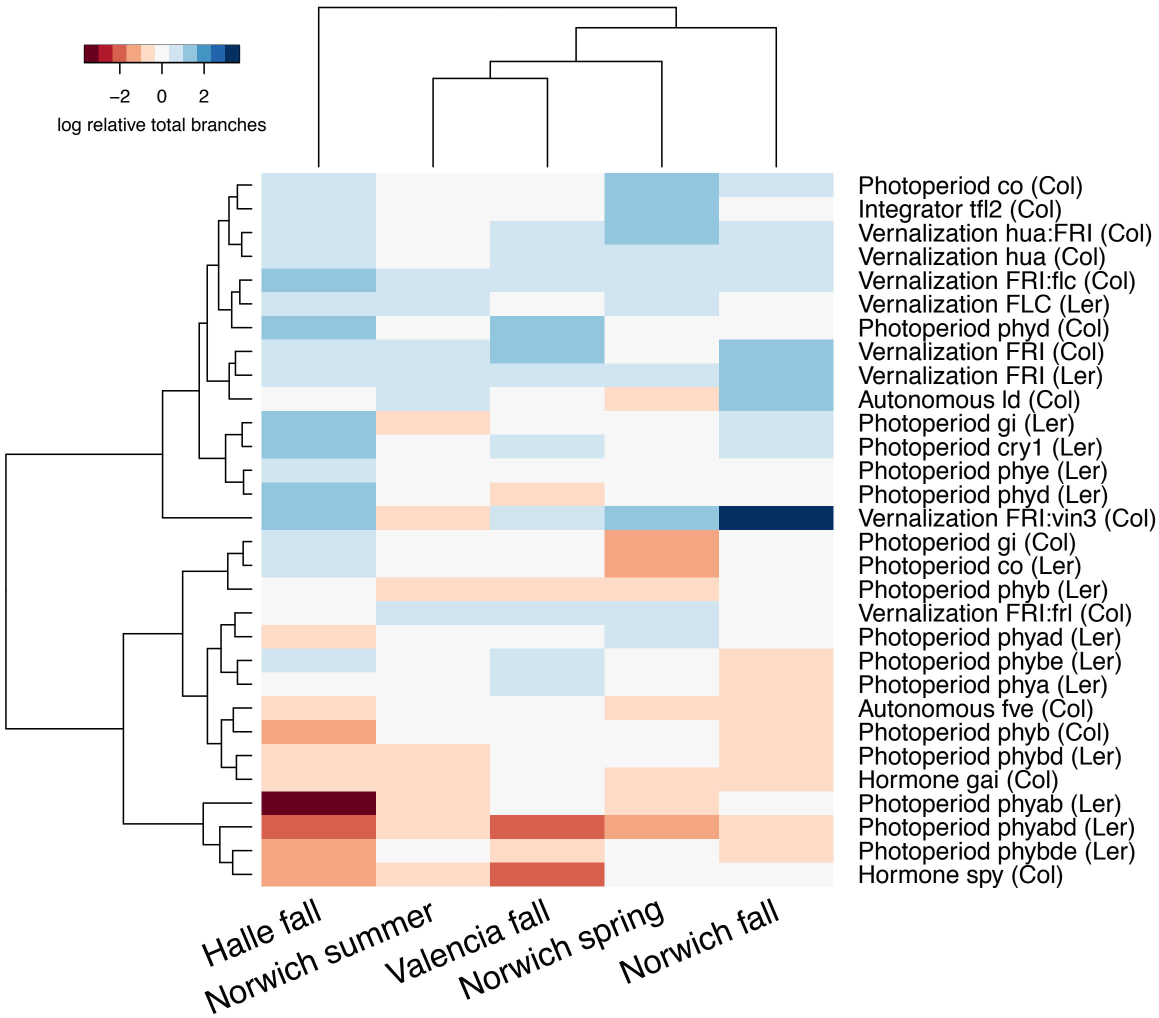

Fig. S5. Heatmap of least-square means of branching (total branch number) in mutants relative to ecotype background on a $\log_2$ scale, centered within plantings, visualizing two-step hierarchical cluster by a Euclidian distance, average-based algorithm for both genotype (rows) and planting (columns). All mutant pathways are represented though not all genotypes since some were not planted in all eight sites and seasons. The first word of the row identifiers show which pathway was manipulated in a mutant, as defined by FLOR-ID (51). Lowercase gene names indicate diminished function alleles, and uppercase, functional. Colons between pathways or genes indicate multiple genetic manipulations within a line, not gene fusions. (Col) and (Ler) in parentheses indicate each line's ecotype background, Col-0 and Ler-1, respectively. Genotypes with an induced mutation combined with a functional FRIGIDA (denoted by "FRI") were relativized against FRI (Col) instead of Col-0.

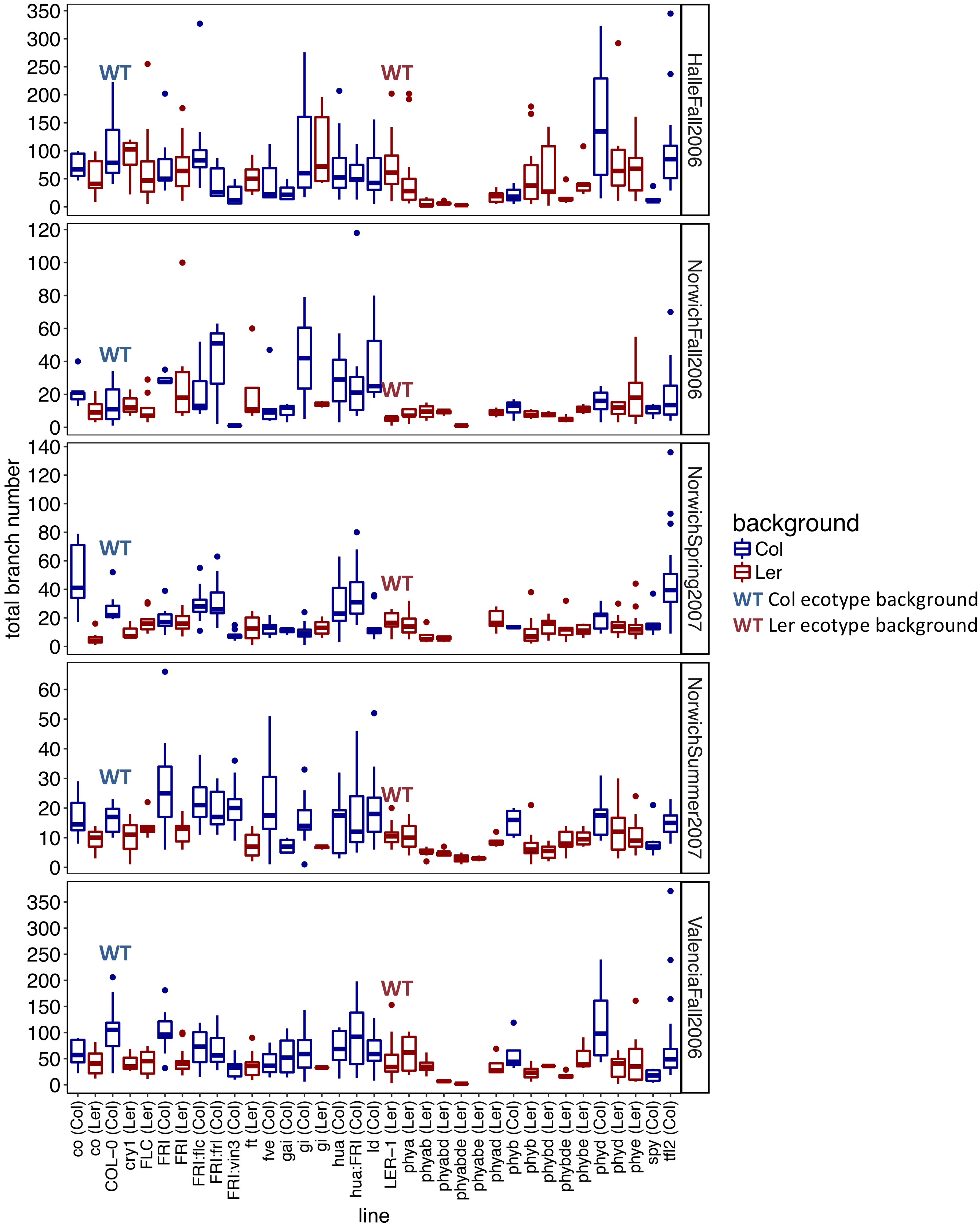
HalleFall2006
NorwichFall2006
NorwichSpring2007
NorwichSummer2007
ValenciaFall2006
WT
total branch number
line
co (Col)
co (Ler)
COL−0 (Col)
cry1 (Ler)
FLC (Ler)
FRI (Col)
FRI (Ler)
FRI:flc (Col)
FRI:frl (Col)
FRI:vin3 (Col)
ft (Ler)
fve (Col)
gai (Col)
gi (Col)
gi (Ler)
hua (Col)
hua:FRI (Col)
ld (Col)
LER−1 (Ler)
phya (Ler)
phyab (Ler)
phyabd (Ler)
phyabde (Ler)
phyabe (Ler)
phyad (Ler)
phyb (Col)
phyb (Ler)
phybd (Ler)
phybde (Ler)
phybe (Ler)
phyd (Col)
phyd (Ler)
phye (Ler)
spy (Col)
tfl2 (Col)
background
Col
Ler
WT Col ecotype background
WT Ler ecotype background

Fig. S6. Total branch number for all lines in this experiment. Lowercase gene names indicate loss-of-function alleles; uppercase, gain-of-function. Colons between the genes indicate multiple gene mutations within a line, not gene fusions. Col and Ler in parentheses indicate each line's ecotype background (Col-0 and Ler-1, respectively), as well as the boxplot color. "WT" does not represent data but is a label for the Col-0 ecotype background in blue and the Ler-1 ecotype background in red. Boxes represent the 25% and 75% quartiles, and the large dark line in the center of the box represents the median. Whiskers show the highest value within the boxplot range (1.5 × Interquartile Range). Points show values that exceed the boxplot range.

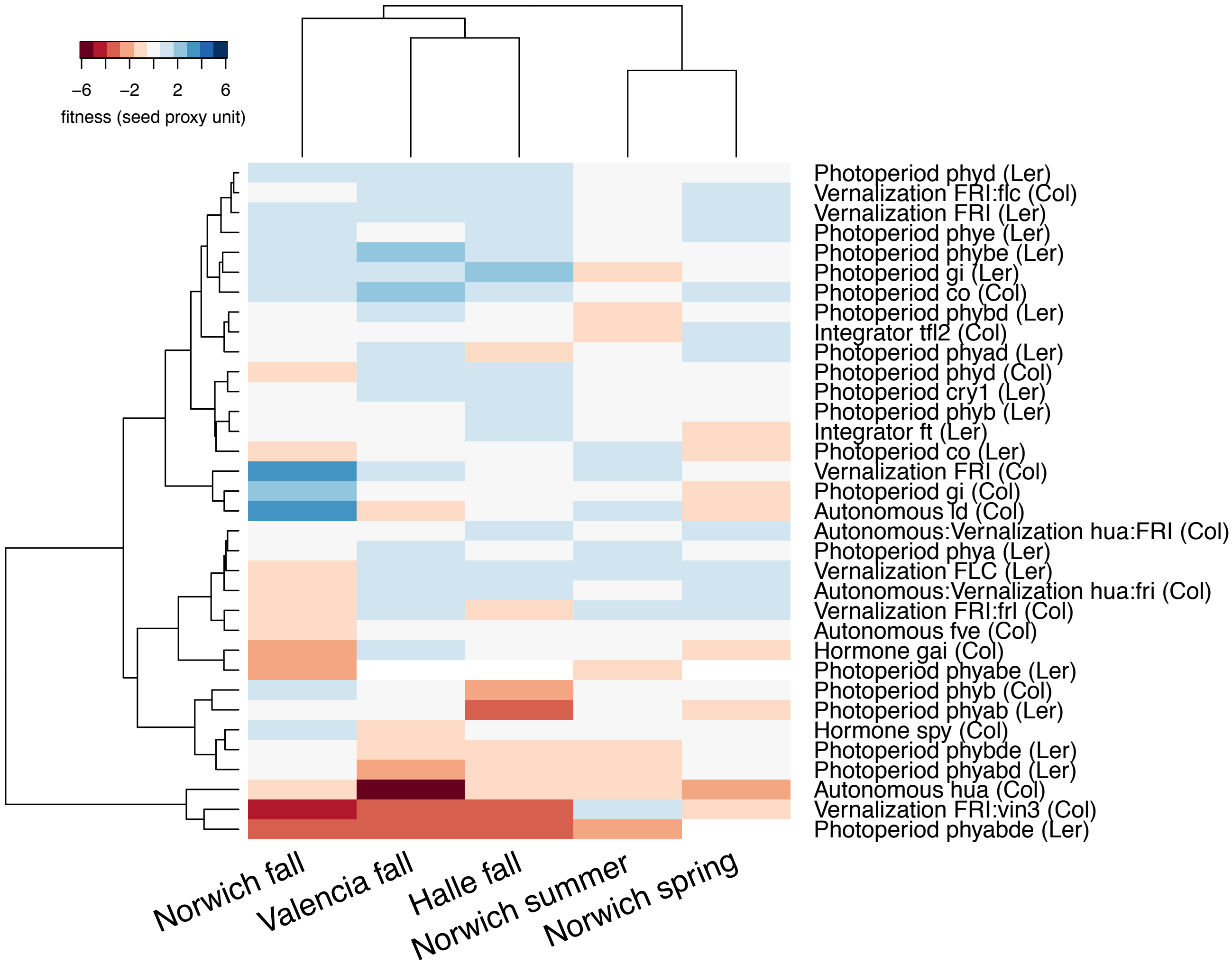

Fig. S7. Heatmap of least-square means of accumulated fitness (seed proxy units) in mutants relative to ecotype background on a $\log_2$ scale, centered within plantings, visualizing two-step hierarchical cluster by a Euclidian distance, average-based algorithm for both genotype (rows) and planting (columns). All mutant pathways are represented though not all genotypes since some were not planted in all eight sites and seasons. The first word of the row identifiers show which pathway was manipulated in a mutant, as defined by FLOR-ID (51). Lowercase gene names indicate diminished function alleles, and uppercase, functional. Colons between pathways or genes indicate multiple genetic manipulations within a line, not gene fusions. (Col) and (Ler) in parentheses indicate each line's ecotype background, Col-0 and Ler-1, respectively. Genotypes with an induced mutation combined with a functional FRIGIDA (denoted by "FRI") were relativized against FRI (Col) instead of Col-0.

Genotype	LoF Mutant No. (reference)	DTB	DTF	BPTU	FPTU	Initial Leaf No.	Leaf Length at Bolting
COL-0	ecotype	58.01	64.99	7362.99	8910.71	2.76	26.31
LER-1	ecotype	49.55	66.76	6931.42	8511.92	2.54	21.67
FRI (Col)	*FRI* NIL (25)	81.05	78.00	9609.40	11204.48	2.47	28.15
FRI:flc (Col)	*flc-3 (25, 26)*	57.65	65.42	7231.59	8815.84	2.41	24.10
FRI:frl (Col)	*frl1-1 (25, 27)*	70.44	70.34	8417.04	9856.68	2.49	26.11
FRI:vin3 (Col)	*FRI:vin3-1 (11, 25)*	86.05	76.83	11925.05	13274.95	2.13	27.40
FRI:hua2(Col)	*hua2-3 (25, 28)*	61.63	72.45	7832.02	9542.94	2.43	24.99
FRI (Ler)	*FRI* NIL (25)	67.60	82.28	8205.42	9798.51	2.31	27.18
ft (Ler)	*ft-2 (29)*	69.28	84.94	8954.64	10856.00	1.84	25.53
fve (Col)	*fve-4 (30)*	85.07	86.18	9648.44	11262.33	1.90	27.70
gai (Col)	*gai-d1 (31)*	51.81	64.97	7326.88	8768.60	1.64	19.99
gi (Col)	*gi-2 (32)*	77.45	84.51	9693.02	11909.13	2.28	28.38
gi (Ler)	*gi-6 (29)*	60.94	81.27	7749.28	9529.00	2.37	21.44
hua2 (Col)	*hua2-3 (28)*	51.93	66.76	7196.03	8850.69	2.15	20.66
ld (Col)	*ld-1 (33)*	87.44	92.57	10044.66	11751.54	2.10	24.29
spy (Col)	*spy-3 (34)*	48.61	62.20	6721.40	8295.28	2.41	19.47
tfl2 (Col)	*tfl2-1 (35)*	38.21	53.68	6031.25	7545.29	3.24	12.34
cry1 (Ler)	*hy4-1 (36)*	66.90	83.54	8239.75	10426.44	2.16	23.46
co (Col)	*co-1 (37)*	44.63	55.40	6915.81	8352.76	2.63	21.06
co (Ler)	*co-2 (38)*	63.25	84.25	8954.63	10871.75	2.05	23.54
phya (Ler)	*phya-2 (39)*	52.82	69.40	7187.43	8889.28	2.51	22.87
phyb (Ler)	*phyb-1 (40)*	41.87	55.86	6510.04	8282.50	2.13	18.32
phyb (Col)	*phyb-9 (41)*	66.94	71.80	7771.03	9204.25	2.10	20.01
phyd (Ler)	*phyd-1 (42)*	50.11	65.46	7029.72	8671.19	2.40	21.06
phyd (Col)	*phyd-2 (42)*	64.65	70.41	7682.14	9237.55	2.30	26.09
phye (Ler)	*phye-1 (43)*	53.77	65.77	7226.73	8697.22	2.36	21.85
phyab (Ler)	*phyb-1**	50.55	65.29	7185.64	9025.33	1.76	17.14
phyabd (Ler)	*b-1/d-1**	35.12	48.34	6064.32	7666.51	2.47	15.95
phyabde(Ler)	*b-1/d-1**	36.38	43.89	6915.64	8582.84	1.06	14.47
phyabe (Ler)	*phyb-1**	41.04	48.63	7258.51	8942.14	1.00	14.11
phyad (Ler)	*phyd-1**	45.40	60.40	6840.53	8472.59	2.59	20.72
phybd (Ler)	*b-1/d-1**	38.59	54.83	6294.95	8090.42	2.11	16.28
phybde (Ler)	*b-1/d-1**	32.80	42.39	5803.20	7317.59	2.03	12.79
phybe (Ler)	*phyb-1**	33.81	48.17	5868.16	7528.94	2.04	13.97

Table S1 continued next page :

genotype	Main Branch No.	Cauline Branch No.	Basal Branch No.	High Order Branch No.	Total Branch No.	Seed Proxy Units
COL-0	0.88	3.91	7.45	45.08	53.38	8265
cry1 (Ler)	1.00	6.47	2.63	28.53	32.16	2214
FRI (Ler)	0.95	5.76	5.87	32.40	39.23	6048
FRI (Col)	0.92	5.67	6.69	41.80	49.41	5327
FRI:flc (Col)	0.84	3.97	8.19	41.81	50.81	7224
FRI:frl (Col)	0.89	5.11	5.19	32.59	38.67	4455
FRI:vin3 (Col)	0.89	3.89	3.89	14.63	19.42	1137
ft (Ler)	0.91	6.00	3.72	21.65	26.28	2318
fve (Col)	0.93	5.33	4.29	23.13	28.35	2765
gai (Col)	0.83	2.38	3.33	15.83	20.00	1935
gi (Col)	0.85	4.40	6.08	36.94	43.17	3613
gi (Ler)	0.89	4.50	4.78	32.67	38.33	3983
hua2 (Col)	0.77	3.37	4.83	38.18	43.71	5966
hua2:FRI (Col)	0.87	4.49	5.28	43.59	49.74	7193
ld (Col)	0.77	4.48	7.44	32.00	40.21	3286
LER-1	0.89	4.68	5.32	30.78	37.00	7028
co (Col)	0.86	3.26	6.63	33.51	41.00	6264
co (Ler)	0.87	4.29	4.21	22.02	27.10	3073
phya (Ler)	0.85	3.70	4.06	18.87	23.78	3465
phyab (Ler)	0.84	2.69	1.91	8.53	11.28	603
phyabd (Ler)	0.96	2.54	0.92	4.21	6.08	781
phyabde (Ler)	1.00	1.00	0.17	1.33	2.50	111
phyabe (Ler)	1.00	2.00	0.00	2.00	2.40	106
phyad (Ler)	0.80	4.04	3.36	14.36	18.52	2900
phyb (Ler)	0.83	2.40	2.97	13.25	17.04	2650
phyb (Col)	0.91	2.91	3.30	18.00	22.22	2061
phybd (Ler)	0.89	2.54	2.07	15.75	18.71	3349
phybde (Ler)	0.68	1.03	2.87	8.58	12.13	1145
phybe (Ler)	0.79	2.25	4.25	17.96	23.00	3096
phyd (Ler)	0.86	3.87	3.71	23.77	28.34	4095
phyd (Col)	0.84	3.45	6.65	40.16	47.65	6662
phye (Ler)	0.88	3.49	4.61	21.09	26.58	4813
spy (Col)	0.89	2.85	2.50	11.08	14.07	2422
tfl2 (Col)	0.68	2.57	8.91	39.52	49.11	3878

Table S1 Across-site means for 11 non-fitness traits and 1 fitness trait (seed proxy units) analyzed in this study. (Col) refers to a Columbia-0 background, and (Ler) refers to a Landerburg *ERECTA-1* background. NIL stands for near-isogenic line. Capital letters in genotype names represent functional alleles introgressed from the ecotype Sf-2. *These mutant numbers are shown only for genes requiring disambiguation because more than one mutation used in this experiment. DTB stands for days to bolting; DTF stands for days to flowering; BPTU represents accumulated photothermal time to bolting; and FPTU represents accumulated photothermal time to flowering.

	df	SS	MS	F	p
planting	7	80.69	11.53	372.12	<0.0001
genotype	34	210.17	6.18	199.54	<0.0001
planting × genotype	236	60.46	0.26	8.27	<0.0001
Residual	4625	143.28	0.03		

Table S2. We implemented a linear model in the form:

$$relative\ BPTU_{ij} = \mu + planting_i + genotype_j + block_{i:k} + planting{\times}genotype_{ij} + \epsilon_{ij}$$

where BPTU refers to photothermal time to bolting; genotype represented mutants lines; *i* represents planting; *j* represents genotype; *k* represents block nested within planting *i*; df is degrees of freedom; SS is sum of squares; MS is mean squares; F is the F-statistic, and p is p-value. Block terms were nested within plantings. From this model, we detected that the relative bolting times of plantings, genotypes, and multifactorial combinations of planting and genotype factor levels differed. We used this model to perform subsequent specific contrasts within genotypes among plantings (Table S3).

genotype	planting	LS mean	SE	df	LCL	UCL	group
Photoperiod co Col	Norwich Spring	-0.226	0.026	328	-0.277	-0.174	a
	Koeln Spring	-0.211	0.033	328	-0.276	-0.147	ab
	Norwich Summer	-0.170	0.025	328	-0.220	-0.120	ab
	Halle Fall	-0.070	0.024	328	-0.117	-0.024	bc
	Oulu Summer	0.009	0.020	328	-0.030	0.048	cd
	Koeln Fall	0.043	0.027	328	-0.010	0.096	cd
	Valencia Fall	0.113	0.025	328	0.063	0.162	de
	Norwich Fall	0.230	0.028	328	0.176	0.284	e
Photoperiod co Ler	Norwich Spring	-0.021	0.025	301	-0.071	0.029	a
	Koeln Spring	0.002	0.038	301	-0.072	0.076	abc
	Halle Fall	0.020	0.022	301	-0.023	0.064	ab
	Norwich Summer	0.026	0.025	301	-0.024	0.076	ab
	Koeln Fall	0.133	0.026	301	0.082	0.185	bc
	Oulu Summer	0.161	0.019	301	0.125	0.198	c
	Valencia Fall	0.283	0.023	301	0.238	0.328	d
	Norwich Fall	0.329	0.025	301	0.280	0.378	d
Photoperiod cry1 Ler	Norwich Summer	-0.124	0.026	299	-0.176	-0.073	a
	Koeln Spring	-0.104	0.038	299	-0.180	-0.028	a
	Norwich Spring	-0.057	0.033	299	-0.123	0.008	ab
	Oulu Summer	0.000	0.020	299	-0.039	0.039	ab
	Halle Fall	0.102	0.025	299	0.054	0.150	bc
	Koeln Fall	0.182	0.031	299	0.121	0.243	cd
	Valencia Fall	0.296	0.025	299	0.247	0.346	d
	Norwich Fall	0.355	0.029	299	0.298	0.413	d
Vernalization FLC Ler	Norwich Summer	-0.107	0.026	316	-0.159	-0.055	a
	Koeln Spring	-0.092	0.033	316	-0.157	-0.028	ab
	Norwich Spring	-0.063	0.026	316	-0.115	-0.012	ab
	Halle Fall	0.035	0.023	316	-0.010	0.080	bc
	Oulu Summer	0.074	0.020	316	0.035	0.113	c
	Koeln Fall	0.178	0.028	316	0.123	0.234	c
	Valencia Fall	0.334	0.024	316	0.286	0.382	d
	Norwich Fall	0.389	0.027	316	0.336	0.441	d
Vernalization FRI Ler	Koeln Spring	-0.102	0.031	312	-0.163	-0.041	a
	Norwich Summer	-0.094	0.024	312	-0.141	-0.047	a
	Norwich Spring	-0.071	0.025	312	-0.121	-0.022	ab
	Oulu Summer	0.021	0.020	312	-0.018	0.060	ab
	Halle Fall	0.052	0.022	312	0.010	0.095	bc
	Koeln Fall	0.174	0.025	312	0.124	0.223	c
	Valencia Fall	0.331	0.023	312	0.285	0.376	d
	Norwich Fall	0.354	0.026	312	0.303	0.405	d
Vernalization FRI Col	Koeln Spring	-0.058	0.033	310	-0.123	0.007	a
	Norwich Summer	-0.048	0.024	310	-0.096	0.000	a
	Norwich Spring	-0.026	0.025	310	-0.075	0.023	a
	Halle Fall	0.068	0.023	310	0.023	0.112	ab
	Oulu Summer	0.119	0.019	310	0.081	0.157	bc
	Koeln Fall	0.235	0.027	310	0.181	0.289	cd
	Valencia Fall	0.326	0.024	310	0.279	0.374	de
	Norwich Fall	0.463	0.029	310	0.405	0.520	e
Vernalization FRI:frl Col	Norwich Summer	-0.175	0.025	323	-0.224	-0.127	a

	Koeln Spring	-0.115	0.032	323	-0.178	-0.053	ab
	Norwich Spring	-0.080	0.026	323	-0.130	-0.030	ab
	Oulu Summer	-0.003	0.019	323	-0.040	0.035	bc
	Halle Fall	0.065	0.024	323	0.019	0.111	c
	Koeln Fall	0.211	0.026	323	0.160	0.262	d
	Valencia Fall	0.309	0.024	323	0.261	0.357	d
	Norwich Fall	0.355	0.027	323	0.301	0.409	d
Vernalization FRI:vin3 Col	Norwich Summer	-0.023	0.026	295	-0.074	0.027	a
	Koeln Spring	0.043	0.031	295	-0.018	0.104	ab
	Norwich Spring	0.123	0.028	295	0.069	0.177	abc
	Oulu Summer	0.136	0.020	295	0.098	0.175	b
	Halle Fall	0.293	0.027	295	0.239	0.346	d
	Koeln Fall	0.295	0.033	295	0.230	0.360	cd
	Valencia Fall	0.533	0.024	295	0.486	0.581	e
	Norwich Fall	0.545	0.044	295	0.458	0.633	e
Integrator ft Ler	Norwich Summer	-0.016	0.026	308	-0.068	0.036	a
	Norwich Spring	-0.014	0.026	308	-0.066	0.038	a
	Koeln Spring	0.011	0.033	308	-0.053	0.075	ab
	Halle Fall	0.035	0.023	308	-0.010	0.079	ab
	Oulu Summer	0.109	0.019	308	0.072	0.146	ab
	Koeln Fall	0.165	0.026	308	0.114	0.215	b
	Valencia Fall	0.338	0.024	308	0.291	0.384	c
	Norwich Fall	0.365	0.027	308	0.312	0.418	c
Autonomous fve Col	Norwich Summer	-0.080	0.026	316	-0.131	-0.029	a
	Norwich Spring	-0.028	0.026	316	-0.078	0.023	ab
	Koeln Spring	-0.019	0.030	316	-0.078	0.040	abc
	Halle Fall	0.076	0.023	316	0.031	0.121	bc
	Oulu Summer	0.108	0.020	316	0.069	0.146	cd
	Koeln Fall	0.236	0.027	316	0.182	0.289	de
	Valencia Fall	0.350	0.024	316	0.304	0.397	ef
	Norwich Fall	0.423	0.028	316	0.368	0.478	f
Hormone gai Col	Norwich Summer	-0.168	0.027	292	-0.220	-0.116	a
	Koeln Spring	-0.163	0.060	292	-0.280	-0.045	abc
	Norwich Spring	-0.136	0.032	292	-0.199	-0.073	ab
	Oulu Summer	-0.065	0.019	292	-0.103	-0.027	ab
	Halle Fall	0.004	0.024	292	-0.043	0.051	bc
	Koeln Fall	0.088	0.029	292	0.030	0.145	cd
	Valencia Fall	0.186	0.027	292	0.132	0.240	d
	Norwich Fall	0.220	0.026	292	0.169	0.270	d
Photoperiod gi Ler	Norwich Summer	-0.170	0.026	313	-0.220	-0.120	a
	Koeln Spring	-0.140	0.031	313	-0.200	-0.080	a
	Norwich Spring	-0.072	0.025	313	-0.120	-0.023	ab
	Oulu Summer	0.010	0.019	313	-0.027	0.047	bc
	Halle Fall	0.019	0.022	313	-0.024	0.062	bc
	Koeln Fall	0.140	0.026	313	0.089	0.191	cd
	Valencia Fall	0.283	0.024	313	0.235	0.330	de
	Norwich Fall	0.387	0.027	313	0.334	0.440	e
Photoperiod gi Col	Koeln Spring	-0.011	0.029	320	-0.069	0.046	a
	Norwich Summer	0.003	0.024	320	-0.045	0.051	a
	Norwich Spring	0.015	0.024	320	-0.033	0.062	a

	Halle Fall	0.049	0.021	320	0.006	0.091	ab
	Oulu Summer	0.154	0.018	320	0.118	0.189	b
	Koeln Fall	0.178	0.025	320	0.129	0.227	b
	Valencia Fall	0.315	0.023	320	0.270	0.359	c
	Norwich Fall	0.381	0.026	320	0.331	0.432	c
Vernalization hua Col	Norwich Summer	-0.191	0.026	413	-0.242	-0.139	a
	Norwich Spring	-0.155	0.027	413	-0.208	-0.101	ab
	Koeln Spring	-0.149	0.037	413	-0.222	-0.077	abc
	Oulu Summer	-0.043	0.020	413	-0.082	-0.004	bcd
	Halle Fall	0.008	0.024	413	-0.039	0.055	cde
	Koeln Fall	0.094	0.028	413	0.039	0.149	def
	Valencia Fall	0.127	0.026	413	0.076	0.178	ef
	Norwich Fall	0.221	0.027	413	0.167	0.275	f
Autonomous ld Col	Norwich Summer	-0.042	0.025	308	-0.092	0.007	a
	Koeln Spring	-0.025	0.031	308	-0.086	0.036	a
	Norwich Spring	0.017	0.027	308	-0.035	0.070	a
	Halle Fall	0.066	0.023	308	0.021	0.110	ab
	Oulu Summer	0.151	0.019	308	0.113	0.189	b
	Koeln Fall	0.205	0.026	308	0.154	0.257	b
	Valencia Fall	0.392	0.024	308	0.346	0.439	c
	Norwich Fall	0.460	0.030	308	0.400	0.519	c
Photoperiod phya Ler	Norwich Summer	-0.204	0.024	542	-0.251	-0.157	a
	Koeln Spring	-0.130	0.031	542	-0.191	-0.070	ab
	Norwich Spring	-0.091	0.025	542	-0.139	-0.042	ab
	Oulu Summer	-0.027	0.018	542	-0.063	0.009	b
	Halle Fall	0.021	0.022	542	-0.022	0.063	bc
	Koeln Fall	0.116	0.025	542	0.066	0.166	cd
	Valencia Fall	0.212	0.023	542	0.166	0.258	de
	Norwich Fall	0.268	0.025	542	0.218	0.318	e
Photoperiod phyabd Ler	Norwich Summer	-0.227	0.026	316	-0.278	-0.176	a
	Norwich Spring	-0.182	0.027	316	-0.236	-0.129	ab
	Koeln Spring	-0.160	0.034	316	-0.227	-0.093	abc
	Halle Fall	-0.106	0.024	316	-0.153	-0.060	abc
	Koeln Fall	-0.034	0.028	316	-0.088	0.021	bc
	Oulu Summer	-0.031	0.020	316	-0.071	0.009	c
	Valencia Fall	0.017	0.028	316	-0.037	0.072	c
	Norwich Fall	0.185	0.028	316	0.131	0.240	d
Photoperiod phyabde Ler	Norwich Summer	-0.177	0.028	249	-0.232	-0.122	a
	Koeln Spring	-0.153	0.064	249	-0.280	-0.027	ab
	Oulu Summer	-0.038	0.022	249	-0.082	0.006	ab
	Halle Fall	0.031	0.039	249	-0.046	0.108	bc
	Koeln Fall	0.065	0.041	249	-0.016	0.146	bc
	Valencia Fall	0.208	0.036	249	0.137	0.279	c
	Norwich Fall	0.256	0.063	249	0.133	0.379	c
	Norwich Spring	NA	NA	NA	NA	NA	
Photoperiod phyad Ler	Norwich Summer	-0.214	0.029	327	-0.270	-0.157	a
	Norwich Spring	-0.126	0.029	327	-0.183	-0.070	ab
	Koeln Spring	-0.124	0.036	327	-0.194	-0.054	abc
	Oulu Summer	-0.022	0.021	327	-0.064	0.020	bc
	Halle Fall	-0.017	0.026	327	-0.068	0.033	bc

	Koeln Fall	0.052	0.030	327	-0.007	0.110	cd
	Valencia Fall	0.136	0.026	327	0.084	0.189	de
	Norwich Fall	0.255	0.030	327	0.197	0.313	e
Photoperiod phyb Ler	Norwich Summer	-0.228	0.026	607	-0.278	-0.177	a
	Koeln Spring	-0.169	0.034	607	-0.235	-0.103	ab
	Norwich Spring	-0.162	0.027	607	-0.214	-0.110	ab
	Oulu Summer	-0.042	0.020	607	-0.081	-0.004	bc
	Halle Fall	-0.036	0.024	607	-0.083	0.010	bc
	Koeln Fall	0.030	0.028	607	-0.024	0.084	cd
	Valencia Fall	0.124	0.026	607	0.074	0.174	de
	Norwich Fall	0.221	0.027	607	0.167	0.274	e
	Norwich Summer	-0.270	0.024	312	-0.318	-0.222	a
Photoperiod phybd Ler	Koeln Spring	-0.228	0.041	309	-0.310	-0.147	ab
	Norwich Summer	-0.226	0.028	309	-0.281	-0.171	a
	Norwich Spring	-0.206	0.029	309	-0.263	-0.149	ab
	Halle Fall	-0.059	0.026	309	-0.111	-0.008	bc
	Oulu Summer	-0.026	0.022	309	-0.069	0.018	c
	Koeln Fall	0.008	0.030	309	-0.051	0.067	c
	Valencia Fall	0.092	0.030	309	0.034	0.151	cd
	Norwich Fall	0.188	0.029	309	0.130	0.245	d
Photoperiod phybde Ler	Koeln Spring	-0.258	0.037	310	-0.330	-0.185	ab
	Norwich Spring	-0.247	0.026	310	-0.298	-0.195	a
	Norwich Summer	-0.246	0.025	310	-0.294	-0.197	a
	Halle Fall	-0.102	0.023	310	-0.148	-0.057	bc
	Koeln Fall	-0.066	0.027	310	-0.118	-0.014	c
	Oulu Summer	-0.034	0.020	310	-0.072	0.005	c
	Valencia Fall	-0.017	0.027	310	-0.070	0.037	c
	Norwich Fall	0.159	0.026	310	0.108	0.211	d
Photoperiod phybe Ler	Koeln Spring	-0.233	0.034	311	-0.301	-0.166	a
	Norwich Summer	-0.226	0.025	311	-0.274	-0.177	a
	Norwich Spring	-0.216	0.026	311	-0.267	-0.164	a
	Halle Fall	-0.096	0.022	311	-0.140	-0.052	ab
	Oulu Summer	-0.046	0.019	311	-0.083	-0.008	b
	Koeln Fall	-0.041	0.026	311	-0.092	0.011	b
	Valencia Fall	-0.013	0.026	311	-0.064	0.037	b
	Norwich Fall	0.171	0.027	311	0.118	0.223	c
Photoperiod phyd Ler	Norwich Summer	-0.194	0.026	540	-0.245	-0.143	a
	Koeln Spring	-0.141	0.033	540	-0.205	-0.077	ab
	Norwich Spring	-0.108	0.027	540	-0.160	-0.055	ab
	Oulu Summer	-0.014	0.020	540	-0.053	0.025	bc
	Halle Fall	0.019	0.024	540	-0.027	0.066	bc
	Koeln Fall	0.088	0.028	540	0.033	0.142	cd
	Valencia Fall	0.176	0.025	540	0.127	0.226	d
	Norwich Fall	0.226	0.028	540	0.172	0.280	d
Photoperiod phye Ler	Norwich Summer	-0.194	0.026	553	-0.245	-0.143	a
	Koeln Spring	-0.130	0.033	553	-0.196	-0.065	ab
	Norwich Spring	-0.110	0.027	553	-0.163	-0.057	ab
	Oulu Summer	-0.028	0.020	553	-0.067	0.011	b
	Halle Fall	0.032	0.024	553	-0.015	0.078	bc
	Koeln Fall	0.126	0.028	553	0.071	0.180	cd

	Norwich Fall	0.227	0.028	553	0.172	0.281	d
	Valencia Fall	0.234	0.025	553	0.185	0.284	d
Hormone spy Col	Norwich Summer	-0.258	0.026	322	-0.310	-0.207	a
	Koeln Spring	-0.218	0.035	322	-0.286	-0.150	a
	Norwich Spring	-0.178	0.028	322	-0.232	-0.123	ab
	Oulu Summer	-0.044	0.021	322	-0.085	-0.003	bc
	Halle Fall	-0.032	0.024	322	-0.079	0.015	bc
	Koeln Fall	0.062	0.028	322	0.007	0.117	cd
	Valencia Fall	0.128	0.026	322	0.077	0.178	d
	Norwich Fall	0.175	0.029	322	0.119	0.232	d
Integrator tfl2 Col	Norwich Summer	-0.244	0.025	526	-0.294	-0.194	a
	Koeln Spring	-0.227	0.034	526	-0.293	-0.161	ab
	Norwich Spring	-0.194	0.026	526	-0.246	-0.142	ab
	Oulu Summer	-0.118	0.019	526	-0.156	-0.080	abc
	Koeln Fall	-0.070	0.027	526	-0.123	-0.017	bc
	Halle Fall	-0.039	0.023	526	-0.085	0.006	c
	Valencia Fall	-0.038	0.025	526	-0.086	0.011	c
	Norwich Fall	0.118	0.027	526	0.066	0.171	d
Photoperiod phyab (Ler)	Norwich Summer	-0.132	0.028	244	-0.187	-0.076	a
	Cologne Spring	-0.050	0.056	244	-0.160	0.059	ab
	Oulu Summer	-0.020	0.021	244	-0.061	0.022	ab
	Norwich Spring	0.019	0.034	244	-0.047	0.086	ab
	Cologne Fall	0.024	0.032	244	-0.040	0.087	b
	Halle Fall	0.045	0.026	244	-0.007	0.096	b
	Norwich Fall	0.230	0.035	244	0.161	0.298	c
	Valencia Fall	0.363	0.039	244	0.286	0.439	c
Photoperiod phyabe (Ler)	Norwich Summer	-0.177	0.035	146	-0.247	-0.107	a
	Norwich Spring	-0.021	0.091	146	-0.201	0.158	ab
	Halle Fall	-0.011	0.049	146	-0.108	0.085	ab
	Cologne Fall	0.045	0.043	146	-0.040	0.131	b
	Oulu Summer	0.047	0.027	146	-0.006	0.101	b
	Norwich Fall	0.176	0.068	146	0.042	0.309	bc
	Valencia Fall	0.363	0.050	146	0.264	0.461	c
Photoperiod phyb (Col)	Norwich Summer	-0.332	0.029	207	-0.390	-0.275	a
	Cologne Spring	-0.199	0.042	207	-0.282	-0.115	ab
	Norwich Spring	-0.108	0.032	207	-0.170	-0.046	b
	Oulu Summer	-0.060	0.023	207	-0.105	-0.015	b
	Halle Fall	0.099	0.028	207	0.045	0.154	c
	Norwich Fall	0.200	0.029	207	0.144	0.257	cd
	Cologne Fall	0.271	0.029	207	0.215	0.328	d
	Valencia Fall	0.329	0.028	207	0.273	0.384	d
Photoperiod phyd (Col)	Norwich Summer	-0.251	0.033	226	-0.316	-0.186	a
	Cologne Spring	-0.193	0.042	226	-0.276	-0.110	ab
	Norwich Spring	-0.118	0.034	226	-0.184	-0.052	ab
	Oulu Summer	-0.071	0.026	226	-0.121	-0.020	b
	Halle Fall	0.073	0.029	226	0.015	0.131	c
	Cologne Fall	0.218	0.032	226	0.155	0.280	cd
	Valencia Fall	0.275	0.031	226	0.214	0.335	d
	Norwich Fall	0.291	0.033	226	0.225	0.357	d
Vernalization FRI:flc (Col)	Norwich Summer	-0.284	0.035	217	-0.354	-0.215	a

	Cologne Spring	-0.213	0.042	217	-0.296	-0.129	ab
	Norwich Spring	-0.158	0.036	217	-0.229	-0.087	ab
	Oulu Summer	-0.093	0.027	217	-0.147	-0.039	bc
	Halle Fall	0.060	0.032	217	-0.004	0.124	cd
	Valencia Fall	0.169	0.032	217	0.105	0.233	d
	Cologne Fall	0.202	0.036	217	0.132	0.272	d
	Norwich Fall	0.226	0.037	217	0.153	0.298	d
	Norwich Summer	-0.195	0.031	219	-0.256	-0.133	a
	Cologne Spring	-0.194	0.047	219	-0.285	-0.102	ab
	Norwich Spring	-0.126	0.033	219	-0.191	-0.062	ab
Vernalization hua:FRI (Col	Oulu Summer	-0.033	0.024	219	-0.080	0.015	bc
	Halle Fall	0.071	0.029	219	0.014	0.129	cd
	Cologne Fall	0.220	0.032	219	0.158	0.283	de
	Valencia Fall	0.258	0.030	219	0.199	0.316	e
	Norwich Fall	0.318	0.034	219	0.251	0.384	e

Table S3. Results of post-hoc tests from the linear model described in Table S2 among plantings using Tukey's honest significant differences at 95% confidence. LS means indicate least-squares means for photothermal time to bolting; SE is for standard error; df is for degrees of freedom; LCL is the lower confidence limit; UCL is the upper confidence limit; group represents significant difference within a genotype among plantings.

planting	coef	trait	est.	SE	p	trait	est.	SE	p
Halle fall	β	Days to flowering (DTF)	-0.233	0.061	0.2	Leaf length at bolting	0.383	0.077	0.0
Halle fall	γ		-0.172	0.030	0.0		0.157	0.084	1.0
Norwich fall	β		0.127	0.130	1.0		0.214	0.121	1.0
Norwich fall	γ		0.055	0.101	1.0		0.033	0.184	1.0
Norwich spring	β		-0.308	0.066	0.0		0.149	0.083	0.2
Norwich spring	γ		0.016	0.051	1.0		-0.042	0.087	1.0
Norwich summer	β		0.141	0.040	0.0		0.301	0.033	0.0
Norwich summer	γ		-0.090	0.032	0.0		0.052	0.047	1.0
Valencia fall	β		-0.221	0.058	0.0		NA	NA	NA
Valencia fall	γ		-0.273	0.076	0.0		NA	NA	NA
Halle fall	β	Flowering photothermal units (FPTU)	-0.052	0.040	1.0	Cauline branch number	0.201	0.047	0.0
Halle fall	γ		3.301	6.004	1.0		-0.028	0.062	1.0
Norwich fall	β		0.177	0.100	1.0		0.066	0.143	1.0
Norwich fall	γ		6.287	14.301	1.0		0.105	0.153	1.0
Norwich spring	β		-0.351	0.068	0.0		0.152	0.068	0.3
Norwich spring	γ		14.781	8.003	1.0		0.031	0.068	1.0
Norwich summer	β		0.141	0.033	0.0		0.243	0.056	0.0
Norwich summer	γ		0.001	6.898	1.0		-0.051	0.058	1.0
Valencia fall	β		-0.151	0.048	0.0		0.164	0.068	0.4
Valencia fall	γ		-8.001	27.041	1.0		0.032	0.107	1.0
Halle fall	β	Initial leaf number	0.049	0.039	1.0	Basal branch number	0.525	0.053	0.0
Halle fall	γ		-0.192	0.084	0.4		0.105	0.049	0.6
Norwich fall	β		0.018	0.097	1.0		0.637	0.073	0.0
Norwich fall	γ		-0.061	0.133	1.0		0.305	0.206	0.8
Norwich spring	β		NA	NA	NA		0.387	0.053	0.0
Norwich spring	γ		NA	NA	NA		0.059	0.027	1.0
Norwich summer	β		0.077	0.073	1.0		0.201	0.039	0.0
Norwich summer	γ		-0.018	0.077	1.0		0.019	0.020	1.0
Valencia fall	β		0.000	0.016	1.0		0.269	0.058	0.0
Valencia fall	γ		0.000	0.082	1.0		-0.072	0.046	1.0
Halle fall	β	High order branch number	0.872	0.058	0.0				
Halle fall	γ		0.301	0.173	1.0				
Norwich fall	β		1.200	0.173	0.0				
Norwich fall	γ		1.255	0.841	1.0				
Norwich spring	β		0.755	0.044	0.0				
Norwich spring	γ		-0.141	0.178	1.0				
Norwich summer	β		0.610	0.052	0.0				
Norwich summer	γ		0.067	0.154	1.0				
Valencia fall	β		0.873	0.072	0.0				
Valencia fall	γ		0.051	0.229	1.0				

Table S4. Selection coefficients for *Arabidopsis thaliana* traits in five field environments, analogous to partial derivatives of polynomial regression techniques. β is analogous to the directional selection coefficient and γ is analogous to the stabilizing or disruptive coefficient. Coef stands for coefficients; est. for the estimate of this coefficient; SE for numerically approximated standard error; and p for p-value. Shaded cells indicate significance greater than α=0.05.

planting	trait	N	μ	H^2	df	trait	N	μ	H^2	df
Halle fall	Basal branch number	332	9.4	0.56	45	Initial leaf number	277	2.0	0.49	45
Norwich fall		197	4.2	0.27	45		201	3.0	0.54	46
Norwich spring		367	2.6	0.27	44		369	1.4	0.24	44
Norwich summer		346	2.5	0.28	46		335	3.1	0.19	46
Valencia fall		315	7.5	0.28	45		317	2.4	0.33	45
Halle fall	Cauline branch number	331	5.5	0.52	45	days to flowering (DTF)	318	159.6	0.90	45
Norwich fall		196	2.2	0.29	45		191	81.7	0.74	46
Norwich spring		366	4.8	0.44	44		366	60.3	0.85	44
Norwich summer		345	2.3	0.26	46		342	31.5	0.64	46
Valencia fall		312	4.5	0.33	45		308	92.7	0.71	45
Halle fall	High order branch number	332	54.7	0.26	45	FPTU	318	9457.4	0.87	45
Norwich fall		197	12.0	0.33	45		191	10326.0	0.77	46
Norwich spring		367	15.9	0.56	44		366	8228.8	0.85	44
Norwich summer		346	10.5	0.40	46		342	9038.0	0.64	46
Valencia fall		315	50.5	0.30	45		308	10356.4	0.74	45
Halle fall	Main branch number	331	0.9	0.37	45	Leaf length at bolting	177	27.5	0.73	44
Norwich fall		196	0.7	0.20	45		198	25.2	0.34	46
Norwich spring		367	1.0	0.14	44		364	18.8	0.60	44
Norwich summer		346	0.9	0.20	46		341	15.6	0.66	46
Valencia fall		314	0.8	0.29	45		61	31.8	0.40	15
Halle fall	Days to bolting	320	108.1	0.84	45	Total branch number	332	64.9	0.30	45
Norwich fall		198	62.6	0.78	46		197	16.8	0.34	45
Norwich spring		367	53.7	0.86	44		367	19.5	0.54	44
Norwich summer		343	24.9	0.73	46		346	13.8	0.41	46
Valencia fall		303	83.3	0.73	45		317	58.4	0.30	45
Halle fall	BPTU	320	7082.7	0.87	45	fitness (seed proxy units)	333	12078.8	0.33	45
Norwich fall		198	9136.1	0.79	46		201	1896.2	0.31	46
Norwich spring		367	7004.8	0.86	44		369	4475.8	0.33	44
Norwich summer		343	7172.8	0.73	46		346	2297.8	0.43	46
Valencia fall		303	9169.9	0.74	45		317	7111.6	0.27	45

Table S5. Ratio of genetic variation to phenotypic variation estimates for *Arabidopsis thaliana* mutant and parental ecotypes. BPTU and FPTU are the number of accumulated photothermal units to bolting and flowering, respectively. N is the number of plants included in the analysis; μ is the trait mean; H^2 is the ratio of genetic to phenotypic variation as a proxy estimate for broad-sense heritability; and d.f. is the degrees of freedom.

Supplemental Information References

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