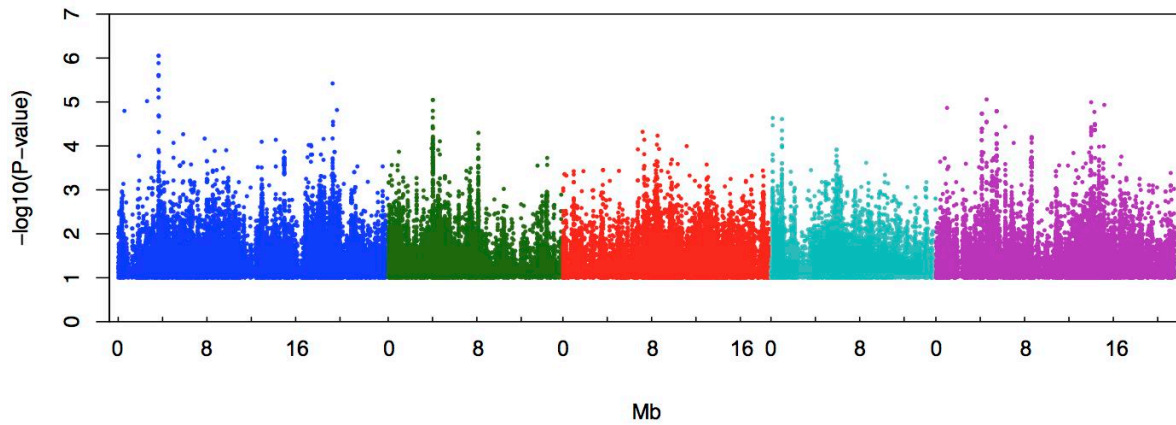


1 **Supplementary Note**

3 Correlations of pollen number with 107 published datasets, climatic variables, and *S*-haplogroups

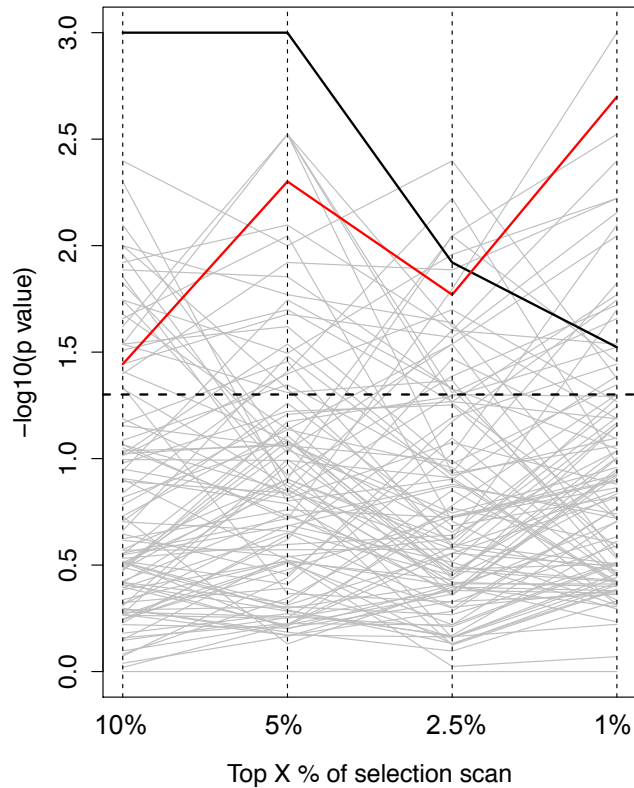
4 We analyzed the correlation of our data for pollen number per flower with the dataset of
5 107 published phenotypes, which includes diverse phenotypes of flowering and defense-related
6 ionomics and developmental phenotypes, but not the numbers of ovules, flowers, or seeds. We
7 found no significant correlations after performing Bonferroni correction for multiple testing (see
8 main text). When multiple testing was not considered, seven traits showed a correlation ($P <$
9 0.05). Among these, “fresh weight of plants” and “dry weight of plants” (“75_FW” and
10 “76_DW”, respectively, in Extended Data Table 4) were positively correlated with pollen
11 number per flower. This suggests that larger plants produce more pollen per flower, which is
12 consistent with empirical observations. Because plant size was measured mostly before
13 flowering and the generation of pollen grains, these data do not suggest that larger plant size is a
14 consequence of a larger number of pollen grains.

15 We also examined whether pollen number was associated with *S*-haplotypes (haplogroups
16 A, B, or C) (19). Because self-compatibility has been shown to have evolved independently in
17 each haplogroup, it may be possible that different alleles are responsible for reduced pollen
18 numbers. However, no significant correlation was found ($P = 0.682$; ANOVA; Table S8).



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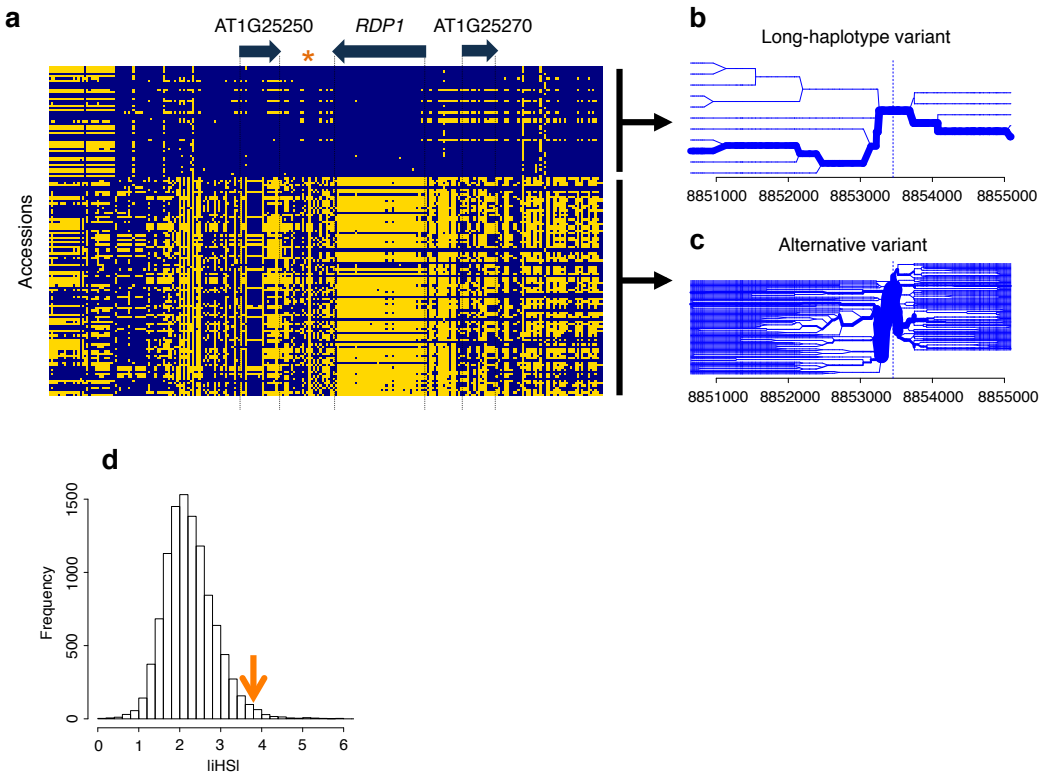
Extended Data Figure 1. Genome-wide association study of ovule number using 151 worldwide accessions (Extended Data Table 3). The five chromosomes are depicted in different colors. SNPs with a minor allele frequency > 0.15 are shown.



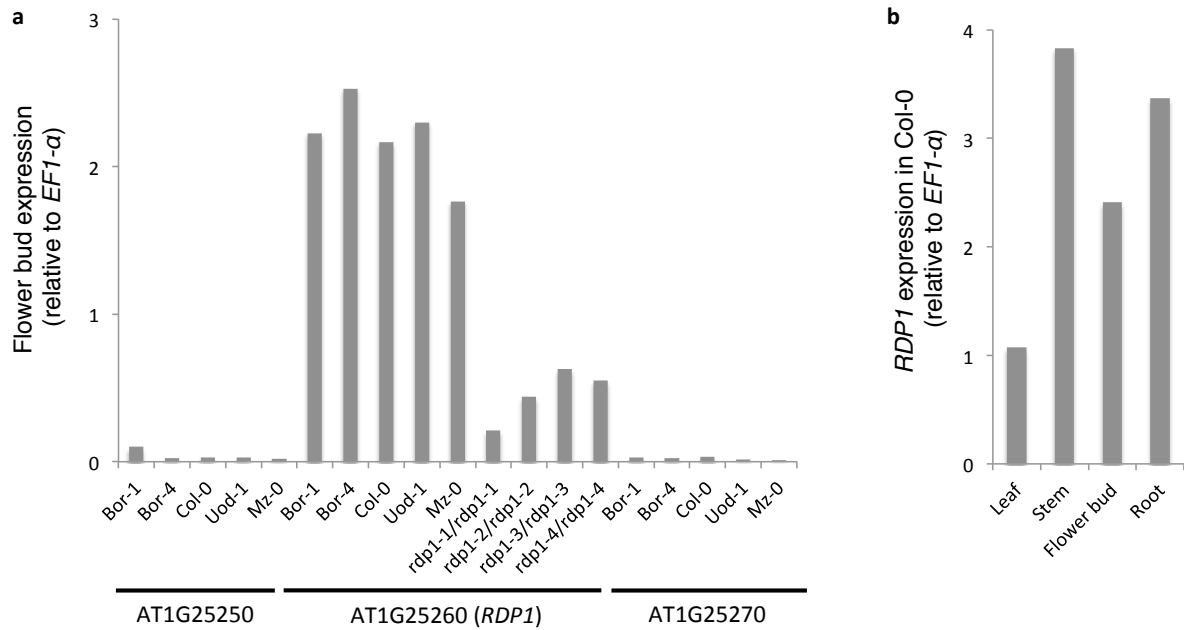
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27 **Extended Data Figure 2. P-values of the iHS enrichment analysis based on permutation**
 28 **tests (Fig. 1j).** Each line indicates a phenotype (red: pollen number, black: ovule number, gray:
 29 107 phenotypes reported in (18). The X-axis quantifies the extreme tails of the iHS statistic. A
 30 horizontal dashed line indicates the threshold of $P = 0.05$. Note that the minimum P -value is
 31 0.001 because permutation was performed 1,000 times (see method).

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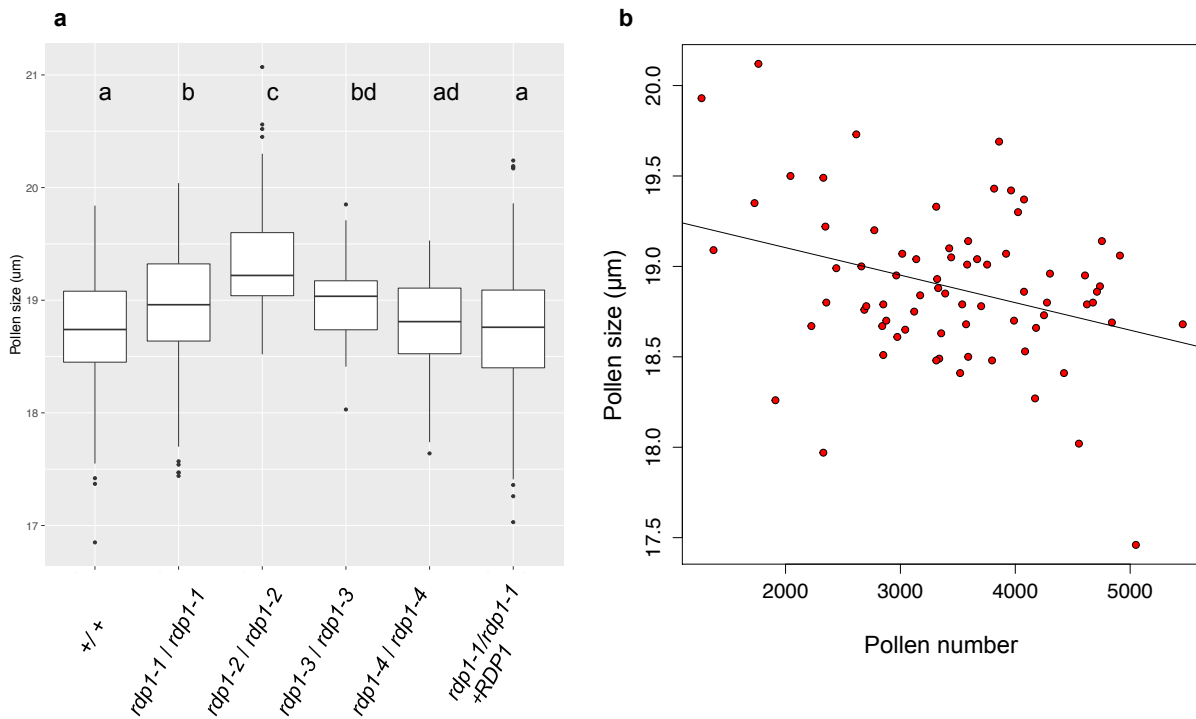


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 34 **Extended Data Figure 3. A signature of selection at the *RDP1* region.** (a) A haplotype map
 35 of 144 accessions at the *RDP1* region. Accessions were sorted by SNP “1-8853454” (asterisk)
 36 that showed the strongest iHS signal in the 10-kb window encompassing *RDP1*. Yellow and blue
 37 dots indicate polymorphisms. (b, c) Haplotype bifurcation diagrams for the long haplotype (b)
 38 and the alternative variants (c) in the *RDP1* region. Line width corresponds to the number of
 39 individuals with the indicated haplotype. (d) Genome-wide distribution of the absolute values of
 40 the iHS statistics. The *RDP1* region is in the upper tail of the distribution (arrow, empirical $P =$
 41 0.0149).
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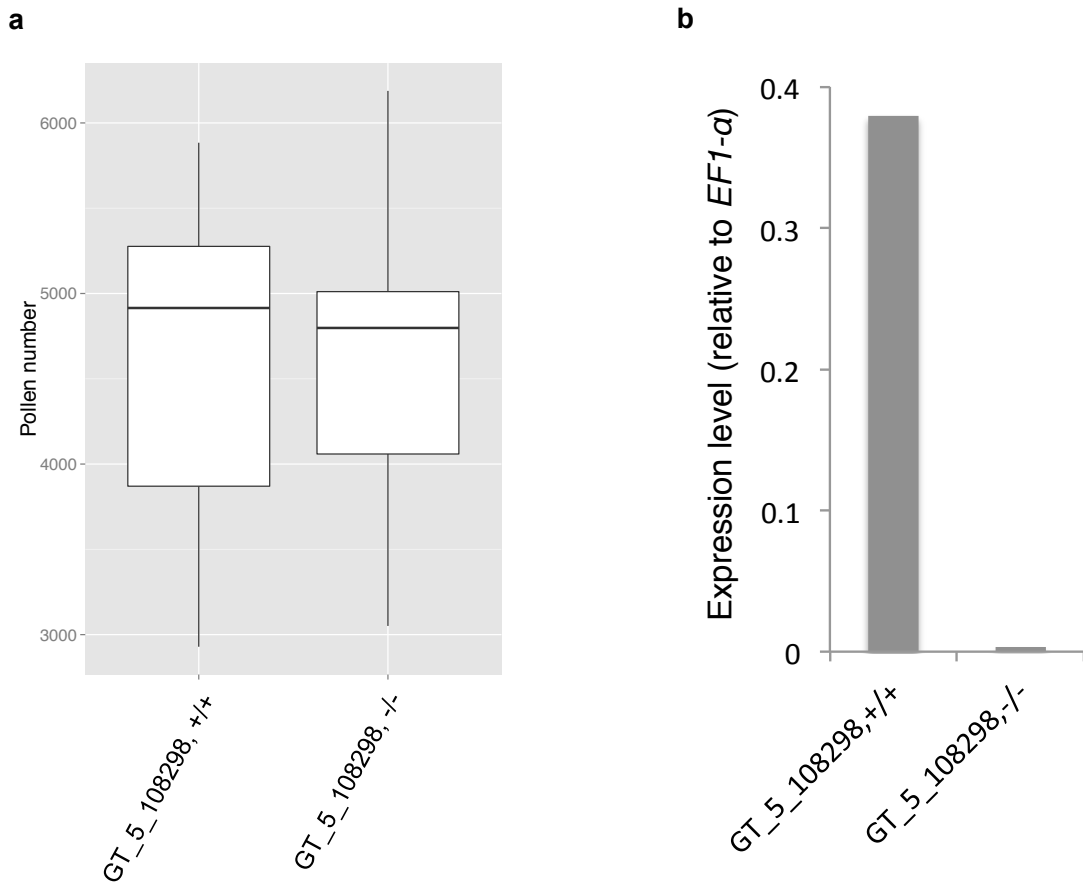


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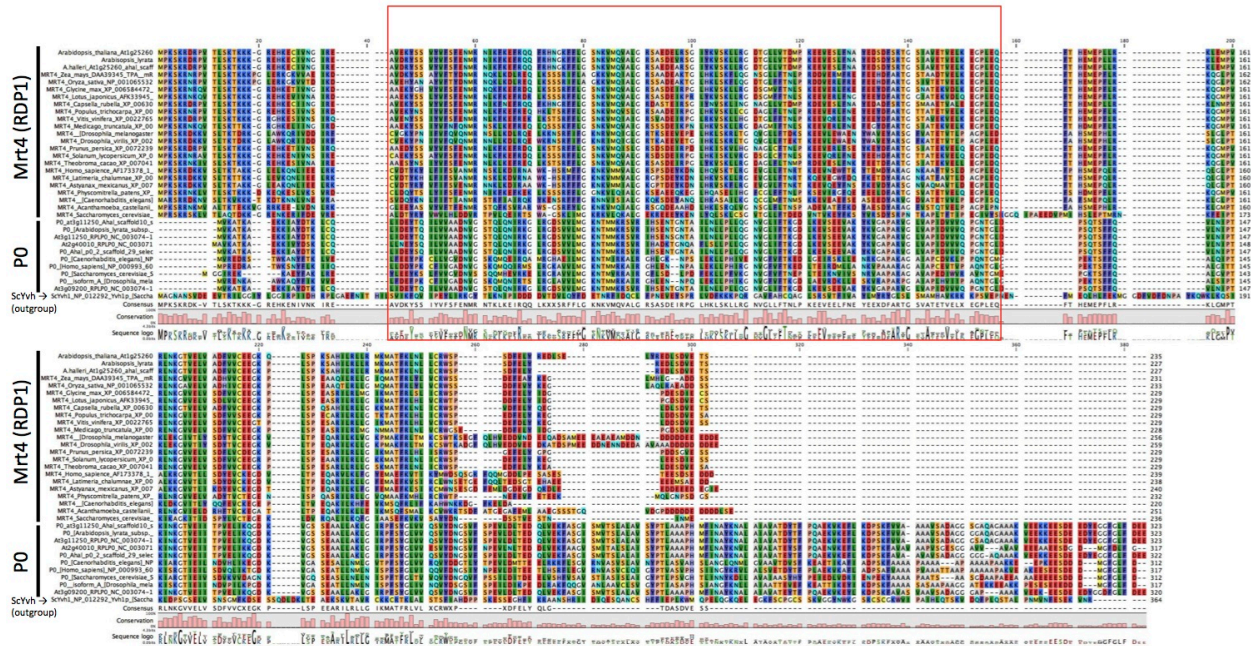
Extended Data Figure 4. Expression levels of *RDP1* and neighboring genes. (a) Flower bud expression of *RDP1* and neighboring genes (*AT1G25250* and *AT1G25270*) in natural accessions and mutants. (b) Expression levels of *RDP1* in leaf, stem, flower bud, and root of the Col-0 accession. Gene expression levels were normalized to *EF1-α* (*AT5G60390*).



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 52 **Extended Data Figure 5. Pollen size in *RDP1* mutants and its correlation with pollen**
 53 **number. (a)** Pollen size differences between four types of homozygous mutants (wild type (+/+),
 54 N = 135; *rdp1-1/rdp1-1*, N = 132; *rdp1-2/rdp1-2*, N = 45; *rdp1-3/rdp1-3*, N = 40; and *rdp1-*
 55 *4/rdp1-4*, N = 60), and the lines complemented with the Col-0 allele (*rdp1-1/rdp1-1+RDP1*, N =
 56 411). Letters (a–d) indicate significant differences in pollen number or size between lines,
 57 determined by a nested analysis of variance and *post hoc* Tukey test ($P < 0.05$). **(b)** Pollen size is
 58 negatively correlated with pollen number in the Col-0 accession (N = 73, $P = 0.00501$). This
 59 negative correlation may be attributed to developmental constraints (16).
 60



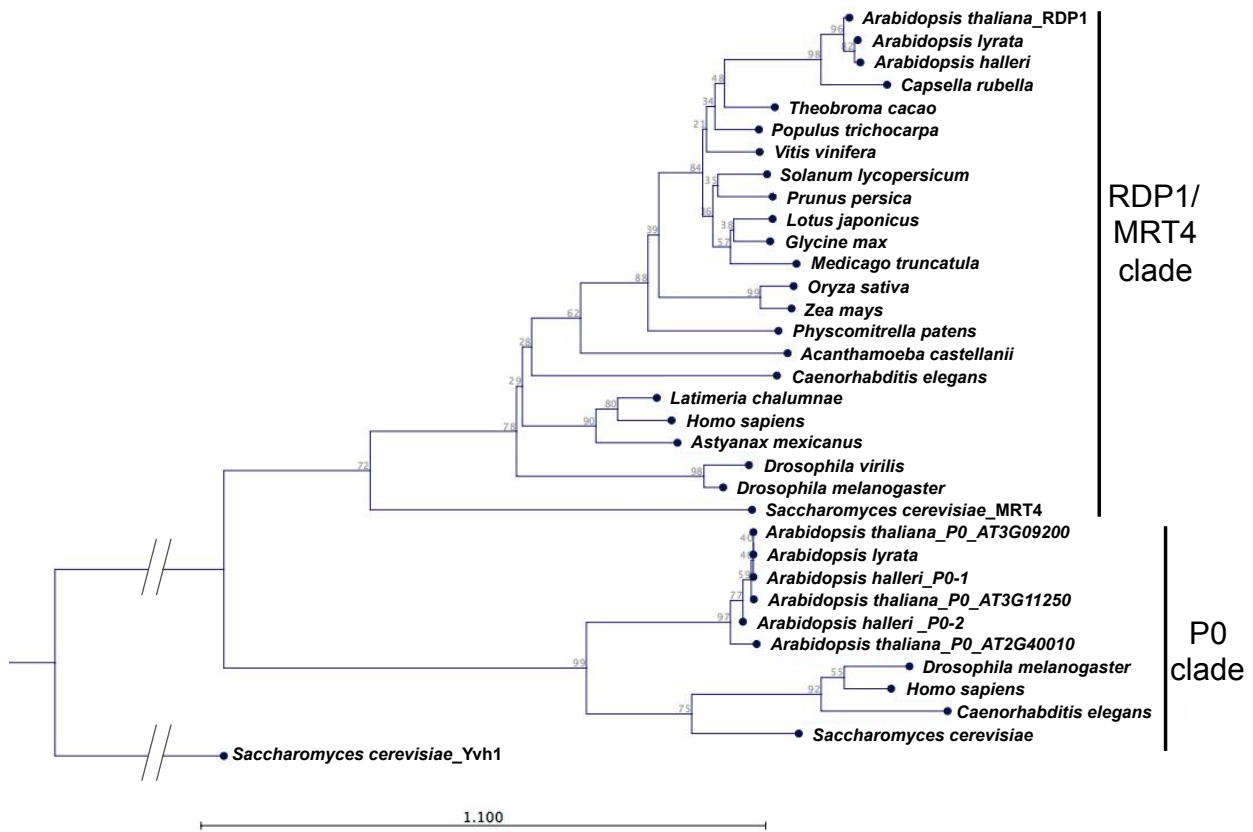
61
 62 **Extended Data Figure 6. Function and expression of *ATIG25250*, a neighboring gene of**
 63 ***RDPI*.** The GT_5_189298 T-DNA insertion line has a Ler-0 background, in which *ATIG25250*
 64 is relatively highly expressed compared with other natural accessions. **(a)** Pollen number did not
 65 differ significantly between the +/+ (“GT_5_108298, +/+”, N = 30) and the homozygous mutant
 66 (“GT_5_108298, -/-”, N = 19, $P = 0.880$, t test). **(b)** Reduced expression level in flower buds of
 67 the mutant (relative to *EF1-α*) compared with the wild type.
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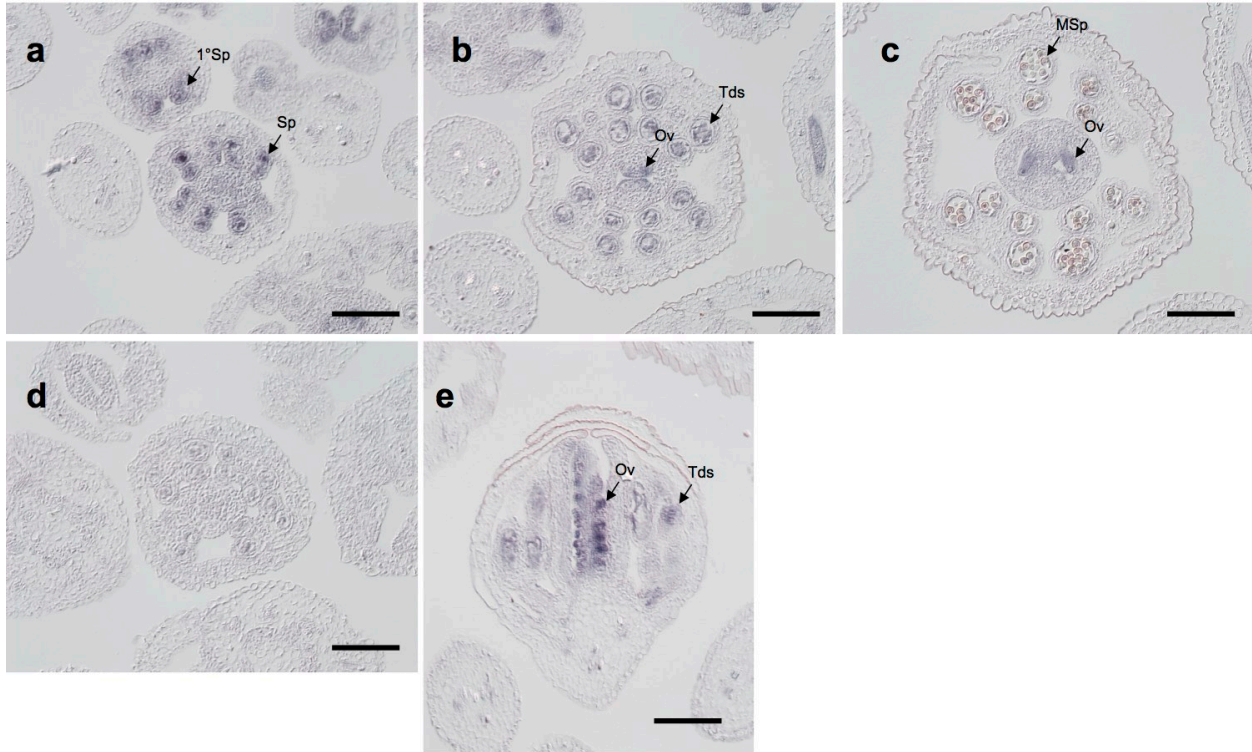
Extended Data Figure 7. Alignment of Mrt4 (RDP1) and P0 protein sequences generated by ClustalW. The phylogenetic tree (Extended Data Figure 8) was generated using the aligned region indicated by the red box (44–153 aa).

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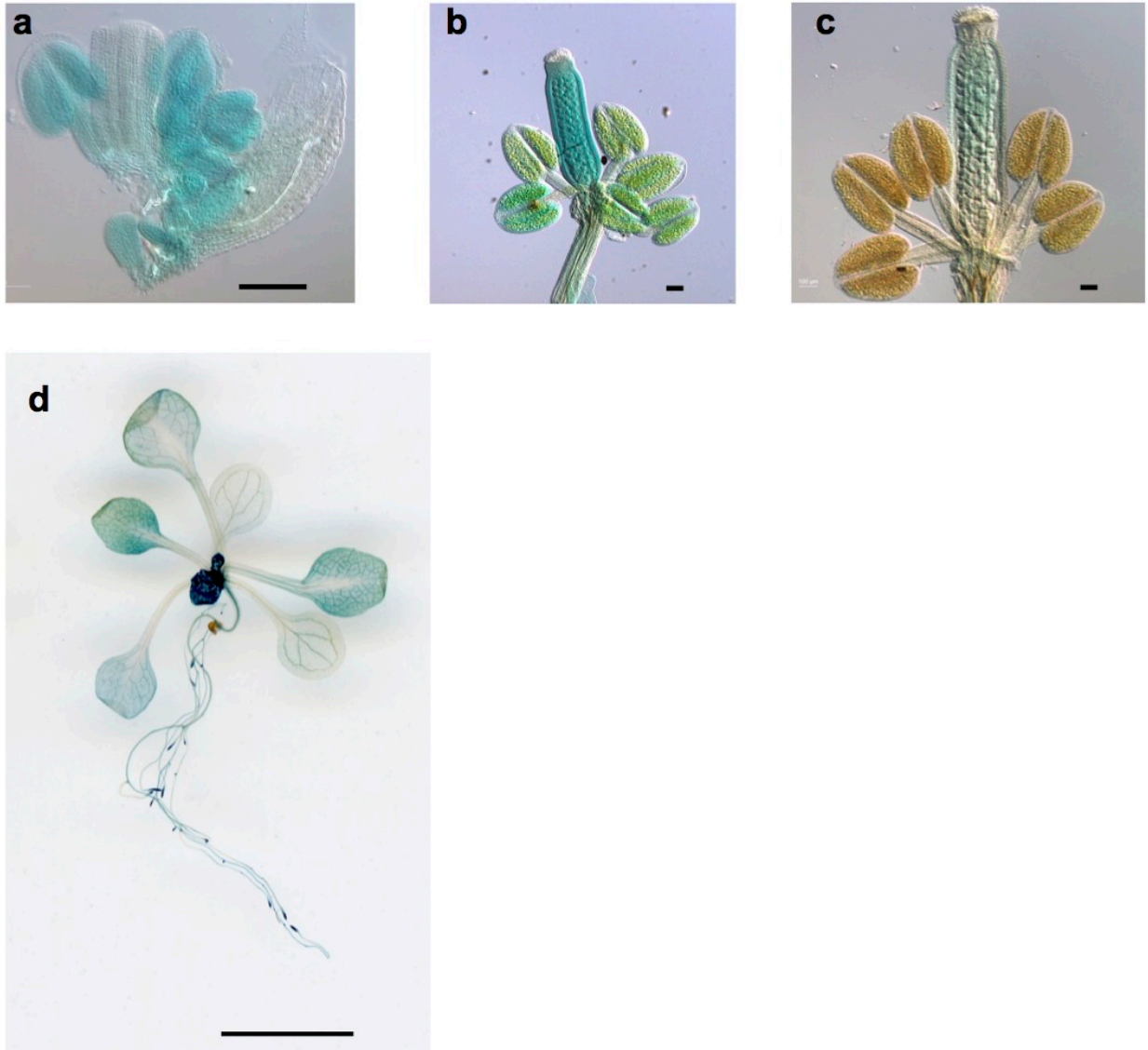
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Extended Data Figure 8. Phylogenetic tree of RDP1/Mrt4 and P0. Phylogenetic tree was constructed by using the neighbor-joining method with Kimura distance. Values on the branches indicate the percentage of 1,000 bootstrap replicates. See Extended Data Figure 7 for the alignment used for this tree. ScYvh1 was used as an outgroup.



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Extended Data Figure 9. *In situ* hybridization analysis of *RDPI* expression in *Col-0* with *RDPI* antisense (a, b, c, e) or sense (d) probes. Transverse (a–d) and longitudinal (e) cross sections of the flower buds. *RDPI* expression was detected at the early stages of pollen lineage (primary sporogenous layer (a; 1°Sp in stage 7 flowers), sporogenous cell (a; Sp in stage 8 flowers), and tetrad (b, e; Tds in stage 10 flowers), but not in the microspore (c; MSP in stage 11 flowers). *RDPI* expression was also detected in stage 10 and 11 ovules (b, c, e; Ov). Scale bars; 100 μ m.



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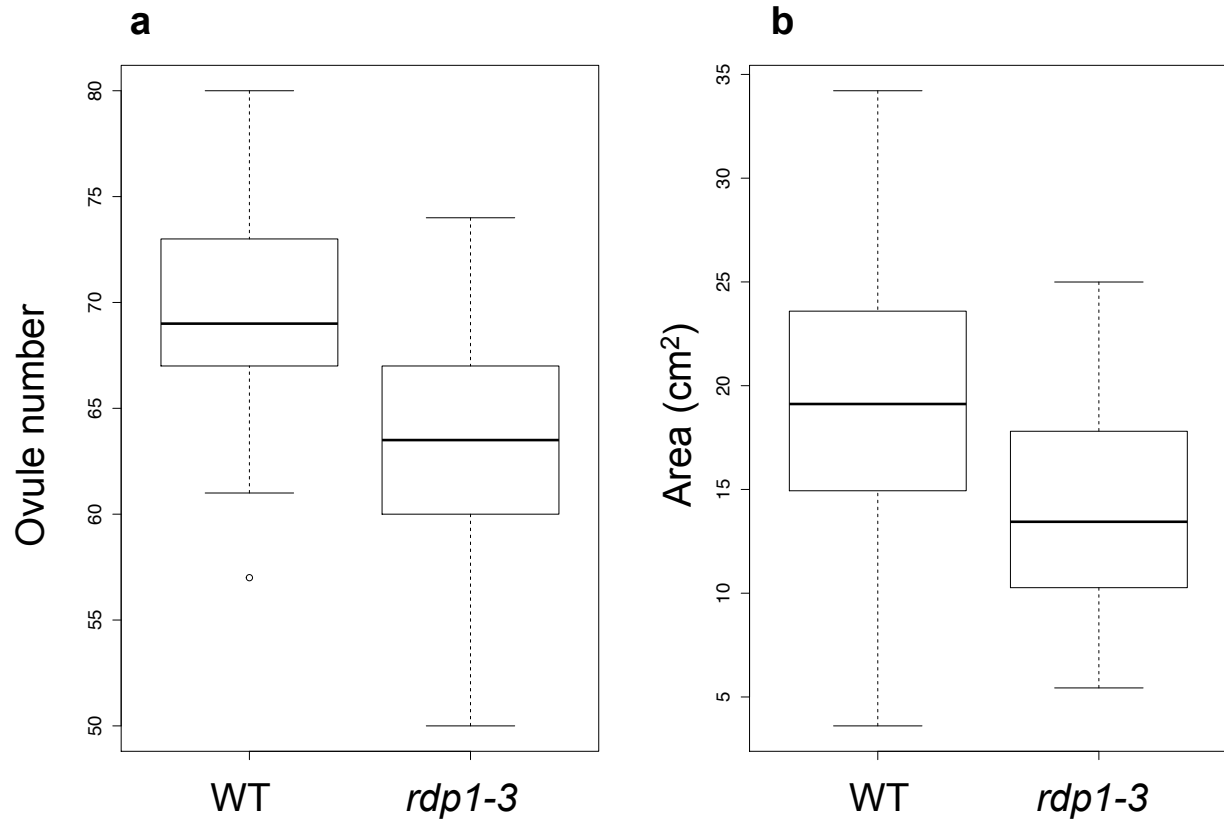
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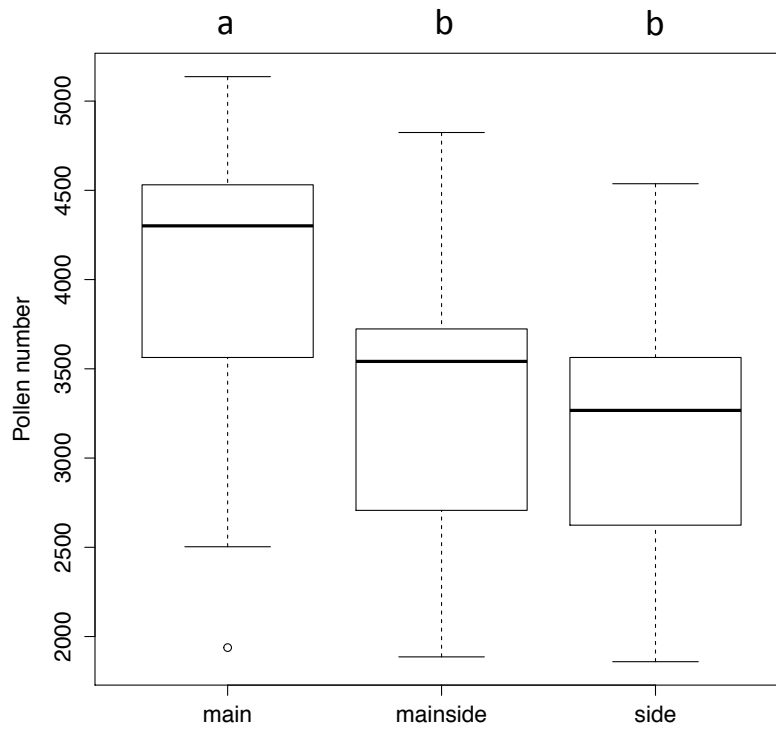
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Extended Data Figure 10. β -Glucuronidase (GUS) staining of pistil and stamens with *RDPI::GUS* at stage 9 (a), 11 (b), 13 (c), and seedling (d). Scale bars: 100 μ m for a–c, 5 mm for d. *RDPI* expression was preferentially detected in young stamens (a), in pistils (b), and in shoot and root apical meristems and young leaves (d).



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Extended Data Figure 11. Pleiotropy of *rdp1-3*. (a) Ovule number per flower was reduced in *rdp1-3* (N = 42, +/+; N = 53, *rdp1-3/rdp1-3*; *t* test, $P = 2.34 \times 10^{-8}$). (b) Rosette area was smaller in *rdp1-3* (N = 49, +/+; N = 27, *rdp1-3/rdp1-3*; *t* test, $P = 0.000986$).



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109 **Extended Data Figure 12. Pollen number in different floral stems.** Main stems (“main”, N =
 110 19), side stems branched from main stems (“mainside”, N = 20), and side stems (“side”, N = 19).
 111 Col-0 plants were used. Letters (a and b) indicate significant differences in pollen number
 112 between positions determined by analysis of variance and *post hoc* Tukey test ($P < 0.05$).
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Extended Data Table 1. *Arabidopsis thaliana* accessions used in this study.

ecotype_id#	Accession name	Pollen GWAS	Ovule GWAS	Atwell et al. (2010)	Selection scan
5837	Bor-1	y	y	y	y
6008	Duk	NA	NA	y	y
6009	Eden-1	NA	NA	y	y
6016	Eds-1	NA	NA	y	y
6040	Kni-1	NA	NA	y	y
6041	Lis-3	y	y	NA	y
6042	Lom1-1	NA	NA	y	y
6043	Löv-1	NA	NA	y	y
6046	Löv-5	NA	NA	y	y
6064	Nyl-2	NA	NA	y	y
6074	Ör-1	NA	NA	y	y
6108	T480	y	y	NA	y
6189	TDr-2	y	y	NA	y
6193	TDr-7	y	y	NA	y
6243	Tottarp-2	NA	NA	y	y
6709	Bg-2	NA	NA	y	y
6897	Ag-0	NA	NA	y	y
6898	An-1	NA	NA	y	y
6899	Bay-0	NA	NA	y	y
6900	Bil-5	NA	NA	y	y
6901	Bil-7	NA	NA	y	y
6903	Bor-4	y	y	y	y
6904	Br-0	NA	NA	y	y
6905	Bur-0	NA	NA	y	y
6906	C24	NA	NA	y	y
6907	CIBC-17	y	y	y	y
6908	CIBC-5	NA	y	y	y
6909	Col-0	y	y	y	y
6910	Ct-1	NA	NA	y	y
6911	Cvi-0	y	y	y	y
6913	Eden-2	NA	NA	y	y
6914	Edi-0	NA	NA	y	y
6915	Ei-2	y	y	y	y
6916	Est-1	NA	NA	y	y
6917	Fäb-2	NA	NA	y	y
6918	Fäb-4	NA	NA	y	y
6919	Ga-0	NA	NA	y	y
6920	Got-22	NA	NA	y	y
6921	Got-7	NA	NA	y	y
6922	Gu-0	NA	NA	y	y
6923	HR-10	NA	NA	y	y
6924	HR-5	NA	NA	y	y
6926	Kin-0	NA	NA	y	y
6927	Kno-10	NA	NA	y	y
6928	Kno-18	NA	y	y	y
6929	Kondara	y	y	y	y
6930	Kz-1	NA	NA	y	y
6931	Kz-9	y	y	y	y
6932	Ler-1	NA	NA	y	y
6933	LL-0	y	y	y	y
6936	Lz-0	y	y	y	y
6937	Mrk-0	y	y	y	y
6938	Ms-0	y	y	NA	y
6939	Mt-0	y	y	y	y

6940	Mz-0	y	y	y	y
6942	Nd-1	NA	NA	y	y
6943	NFA-10	y	y	y	y
6944	NFA-8	NA	y	y	y
6945	Nok-3	y	y	y	y
6946	Oy-0	NA	NA	y	y
6951	Pu2-23	y	y	y	y
6956	Pu2-7	y	y	y	y
6957	Pu2-8	y	y	y	y
6958	Ra-0	y	y	y	y
6959	Ren-1	y	y	y	y
6960	Ren-11	y	y	y	y
6961	Se-0	y	y	y	y
6962	Shahdara	NA	NA	y	y
6963	Sorbo	y	y	y	y
6964	Spr1-2	NA	NA	y	y
6965	Spr1-6	NA	NA	y	y
6966	Sq-1	y	y	y	y
6967	Sq-8	y	y	y	y
6968	Tamm-2	NA	NA	y	y
6969	Tamm-27	NA	NA	y	y
6970	Ts-1	y	y	y	y
6971	Ts-5	NA	NA	y	y
6972	Tsu-1	y	y	y	y
6973	UII2-3	NA	NA	y	y
6974	UII2-5	NA	NA	y	y
6975	Uod-1	y	y	y	y
6976	Uod-7	y	y	y	y
6977	Van-0	y	y	y	y
6978	Wa-1	NA	y	y	y
6979	Wei-0	y	y	y	y
6980	Ws-0	y	y	y	y
6981	Ws-2	NA	NA	y	y
6982	Wt-5	y	y	y	y
6983	Yo-0	NA	NA	y	y
6984	Zdr-1	y	y	y	y
6985	Zdr-6	y	y	y	y
6988	Alc-0	NA	NA	y	y
7000	Aa-0	NA	NA	y	y
7014	Ba-1	NA	NA	y	y
7033	Buckhorn Pass	NA	NA	y	y
7062	Ca-0	NA	NA	y	y
7064	Cnt-1	NA	NA	y	y
7081	Co	NA	NA	y	y
7094	Da-0	NA	NA	y	y
7123	Ep-0	NA	NA	y	y
7147	Gie-0	NA	NA	y	y
7163	Ha-0	NA	NA	y	y
7169	Hh-0	y	y	NA	y
7172	HI-3	y	y	NA	y
7176	Is-1	y	y	NA	y
7178	Jm-1	y	y	NA	y
7181	Je-0	NA	y	NA	y
7188	Kelsterbach-2	y	y	NA	y
7192	Kil-0	y	y	NA	y
7195	KI-1	y	y	NA	y

7199	Kl-5	y	y	NA	y
7201	Kr-0	y	y	NA	y
7205	Krot-2	y	y	NA	y
7210	La-1	y	y	NA	y
7223	Li-2:1	y	y	NA	y
7224	Li-3	y	y	NA	y
7227	Li-5:2	y	y	NA	y
7228	Li-5:3	y	y	NA	y
7229	Li-6	y	y	NA	y
7231	Li-7	y	y	y	y
7238	LI-1	y	y	NA	y
7239	LI-2	y	y	NA	y
7242	Lo-2	y	y	NA	y
7244	Mnz-0	y	y	NA	y
7246	Ma-2	y	y	NA	y
7252	Mc-0	y	y	NA	y
7255	Mh-0	y	y	y	y
7256	Mh-1	y	y	NA	y
7258	Nw-0	y	y	NA	y
7260	Nw-2	y	y	NA	y
7262	Nw-4	y	y	NA	y
7265	Nd-0	y	y	NA	y
7268	Np-0	y	y	NA	y
7275	No-0	y	y	y	y
7276	Ob-0	y	NA	NA	y
7277	Ob-1	y	y	NA	y
7280	Old-1	y	y	NA	y
7282	Or-0	y	y	y	y
7283	Ors-1	y	y	NA	y
7284	Ors-2	y	y	NA	y
7287	Ove-0	y	y	NA	y
7291	Pa-2	y	y	NA	y
7292	Pa-3	y	y	NA	y
7296	Petergof	NA	y	y	y
7297	Pf-0	y	y	NA	y
7299	Pi-2	y	y	NA	y
7300	Pla-0	y	y	NA	y
7301	Pla-1	y	y	NA	y
7303	Pla-3	y	y	NA	y
7305	Pt-0	y	y	NA	y
7306	Pog-0	NA	NA	y	y
7307	Pn-0	y	y	NA	y
7309	Po-1	y	y	NA	y
7310	Pr-0	y	y	NA	y
7316	Rhen-1	y	y	NA	y
7317	Ri-0	y	y	NA	y
7320	Rou-0	y	y	NA	y
7323	Rubezhnoe-1	NA	NA	y	y
7328	Sf-2	y	y	NA	y
7330	Sapporo-0	y	y	NA	y
7331	Sh-0	y	y	NA	y
7333	Sei-0	y	y	NA	y
7337	Si-0	y	y	NA	y
7340	Sav-0	y	y	NA	y
7343	Sp-0	y	y	NA	y
7344	Sg-1	y	y	NA	y

7346	Ste-0	NA	NA	y	y
7351	Ty-0	y	NA	NA	y
7352	Te-0	NA	y	NA	y
7353	Tha-1	y	y	NA	y
7354	Ting-1	y	y	NA	y
7355	Tiv-1	y	y	NA	y
7372	Tscha-1	y	y	NA	y
7373	Tsu-0	y	y	NA	y
7376	Tu-1	y	y	NA	y
7378	Uk-1	y	y	NA	y
7379	Uk-2	y	y	NA	y
7381	Uk-4	y	y	NA	y
7382	Utrecht	y	y	NA	y
7384	Ven-1	y	y	NA	y
7386	Vi-0	y	y	NA	y
7390	Wag-3	y	y	NA	y
7391	Wag-4	NA	y	NA	y
7392	Wag-5	y	y	NA	y
7394	Wa-1	y	y	NA	y
7403	Wei-1	y	y	NA	y
7404	Wc-1	y	y	NA	y
7405	Wc-2	y	y	NA	y
7406	Wt-1	y	y	NA	y
7408	Wt-3	y	y	NA	y
7411	WI-0	y	y	NA	y
7413	Wil-2	y	y	NA	y
7418	Zu-1	y	y	y	y
7423	Jl-2	y	y	NA	y
7424	Jl-3	y	y	y	y
7425	Jl-4	y	y	NA	y
7430	Nc-1	y	y	NA	y
7438	N13	y	y	y	y
7446	N4	y	y	NA	y
7449	N7	y	y	NA	y
7457	Rld-2	y	y	NA	y
7460	Da(1)-12	NA	NA	y	y
7461	H55	NA	NA	y	y
7477	WAR	NA	NA	y	y
7514	RRS-7	y	y	y	y
7515	RRS-10	y	y	y	y
7516	Vär2-1	NA	NA	y	y
7517	Vär2-6	NA	NA	y	y
7518	ÖMö2-1	NA	NA	y	y
7519	ÖMö2-3	NA	NA	y	y
7520	Lp2-2	y	y	y	y
7521	Lp2-6	y	y	y	y
7522	Mr-0	NA	NA	y	y
7523	Pna-17	y	y	y	y
7524	Rmx-A02	NA	NA	y	y
7525	Rmx-A180	y	y	y	y
7526	Pna-10	NA	NA	y	y
8213	Pro-0	NA	NA	y	y
8214	Gy-0	NA	NA	y	y
8215	Fei-0	NA	NA	y	y
8222	Lis-2	NA	NA	y	y
8230	Algutsrum	NA	NA	y	y

8231	Brö1-6		NA	y	y
8233	Dem-4	NA	NA	y	y
8235	Hod	NA	NA	y	y
8236	HSm	NA	NA	y	y
8237	Kävlinge-1	NA	NA	y	y
8239	PHW-3	NA	NA	y	y
8240	Kulturen-1	NA	NA	y	y
8241	Liarum	NA	NA	y	y
8242	Lillö-1	NA	NA	y	y
8243	PHW-2	NA	NA	y	y
8245	Seattle-0	NA	NA	y	y
8247	San-2	NA	NA	y	y
8249	Vimmerby	NA	NA	y	y
8254	Ang-0	NA	NA	y	y
8256	Bå1-2	NA	NA	y	y
8258	Bå4-1	y	y	y	y
8259	Bå5-1	NA	NA	y	y
8264	Bla-1	NA	NA	y	y
8265	Blh-1	NA	NA	y	y
8266	Boo2-1	NA	NA	y	y
8270	Bs-1	NA	NA	y	y
8271	Bu-0	NA	NA	y	y
8274	Can-0	NA	NA	y	y
8275	Cen-0	NA	NA	y	y
8283	Dra3-1	NA	NA	y	y
8284	Drall-1	NA	NA	y	y
8285	Drall-1	NA	NA	y	y
8290	En-1	NA	NA	y	y
8296	Gd-1	NA	NA	y	y
8297	Ge-0	NA	NA	y	y
8300	Gr-1	NA	NA	y	y
8306	Hov4-1	NA	NA	y	y
8310	Hs-0	NA	NA	y	y
8311	In-0	NA	NA	y	y
8312	Is-0	NA	NA	y	y
8313	Jm-0	NA	NA	y	y
8314	Ka-0	NA	NA	y	y
8323	Lc-0	NA	NA	y	y
8325	Lip-0	NA	NA	y	y
8326	Lis-1	NA	NA	y	y
8329	Lm-2	NA	NA	y	y
8334	Lu-1	NA	NA	y	y
8335	Lund	NA	NA	y	y
8337	Mir-0	NA	NA	y	y
8343	Na-1	NA	NA	y	y
8351	Ost-0	NA	NA	y	y
8353	Pa-1	NA	NA	y	y
8354	Per-1	NA	NA	y	y
8357	Pla-0	NA	NA	y	y
8365	Rak-2	NA	NA	y	y
8366	Rd-0	NA	NA	y	y
8369	Rev-1	NA	NA	y	y
8374	Rsch-4	NA	NA	y	y
8376	Sanna-2	NA	NA	y	y
8378	Sap-0	NA	NA	y	y
8387	St-0	NA	NA	y	y

8388	Stw-0	NA	NA	y	y
8389	Ta-0	NA	NA	y	y
8395	Tu-0	NA	NA	y	y
8411	Rd-0	NA	NA	y	y
8412	Sav-0	NA	NA	y	y
8420	Kelsterbach-4	NA	NA	y	y
8422	Fjä1-1	NA	NA	y	y
8423	Hov2-1	NA	NA	y	y
8424	Kas-2	NA	NA	y	y
8426	UII1-1	NA	NA	y	y
8430	Lisse	NA	NA	y	y
8534	328ME007	NA	y	NA	y
8608	11ME1.23	y	y	NA	y
8730	11PNA1.9	y	y	NA	y
8770	11PNA3.65	y	y	NA	y
8787	11PNA3.86	y	y	NA	y
8791	11PNA3.90	y	y	NA	y
9057	Vinslöv	NA	NA	y	y
9058	Västervik	NA	NA	y	y
100000	Wil-1-Dean-Lab	NA	NA	y	y

* "y" indicates the accession was used for each analysis.

"ecotype_id" was according to Horton et al. (2012).

Extended Data Table 2. Pollen number phenotype of 144 accessions used for GWAS.

ecotype_id	Pollen number	ecotype_id	Pollen number	ecotype_id	Pollen number
5837	7355.416	7201	3420.000	7337	3276.000
6041	4459.114	7205	5904.000	7340	4068.000
6108	4219.922	7210	2808.000	7343	4032.000
6189	5265.087	7223	3168.000	7344	3384.000
6193	4626.375	7224	7632.000	7351	3888.000
6903	8549.642	7227	2952.000	7353	6696.000
6907	3871.534	7228	4608.000	7354	2880.000
6909	5508.000	7229	3924.000	7355	4680.000
6911	3024.000	7231	5544.000	7372	2844.000
6915	3904.466	7238	3708.000	7373	5256.000
6929	3280.487	7239	3816.000	7376	5760.000
6931	5265.087	7242	4536.000	7378	4104.000
6933	3488.480	7244	3600.000	7379	4464.000
6936	4043.128	7246	3528.000	7381	2592.000
6937	4336.052	7252	3564.000	7382	4788.000
6938	3784.004	7255	4104.000	7384	5472.000
6939	5090.893	7256	3132.000	7386	5616.000
6940	2710.240	7258	2952.000	7390	5976.000
6943	4336.052	7260	2088.000	7392	3996.000
6945	3771.871	7262	2808.000	7394	3672.000
6951	3465.081	7265	4608.000	7403	5004.000
6956	3627.142	7268	4536.000	7404	3024.000
6957	4112.459	7275	3060.000	7405	4212.000
6958	4103.793	7276	3780.000	7406	3384.000
6959	3003.163	7277	2880.000	7408	4500.000
6960	4568.310	7280	3528.000	7411	2880.000
6961	3349.818	7282	2880.000	7413	3132.000
6963	3284.820	7283	5652.000	7418	3240.000
6966	4219.922	7284	4176.000	7423	4032.000
6967	3929.599	7287	2772.000	7424	5472.000
6970	3384.484	7291	2304.000	7425	4356.000
6972	4667.107	7292	4176.000	7430	3456.000
6975	2594.110	7297	3816.000	7438	3067.294
6976	3523.146	7299	4644.000	7446	3600.000
6977	4452.181	7300	3240.000	7449	3888.000
6979	3407.016	7301	5040.000	7457	4392.000
6980	4452.181	7303	5112.000	7514	4944.431
6982	4112.459	7305	3996.000	7515	3000.563
6984	5126.425	7307	2880.000	7520	3465.081
6985	4452.181	7309	5544.000	7521	2942.499
7169	5256.000	7310	4356.000	7523	3290.887
7172	4068.000	7316	4644.000	7525	3037.829
7176	3636.000	7317	2844.000	8258	3290.887
7178	2808.000	7320	5832.000	8608	3581.210
7188	2124.000	7328	3096.000	8730	2926.033
7192	3744.000	7330	2304.000	8770	2587.177
7195	4140.000	7331	3888.000	8787	4045.728
7199	3204.000	7333	4104.000	8791	4219.922

Extended Data Table 3 Ovule number phenotype of 151 accessions used for GWAS

ecotype_id	Ovule number	ecotype_id	Ovule number	ecotype_id	Ovule number
5837	64.000	7192	78.667	7333	86.667
6041	87.556	7195	77.200	7337	79.600
6108	78.667	7199	66.250	7340	84.667
6189	74.000	7201	69.500	7343	71.500
6193	76.500	7205	66.000	7344	74.667
6903	85.333	7210	80.000	7352	50.000
6907	65.500	7223	74.000	7353	58.500
6908	64.800	7224	75.250	7354	56.500
6909	66.500	7227	60.750	7355	57.500
6911	71.000	7228	70.667	7372	69.500
6915	76.000	7229	61.000	7373	75.500
6928	54.000	7231	74.800	7376	60.000
6929	72.500	7238	56.500	7378	69.000
6931	79.000	7239	69.500	7379	63.500
6933	64.800	7242	62.000	7381	65.750
6936	81.067	7244	76.000	7382	70.750
6937	73.250	7246	66.000	7384	51.500
6938	65.000	7252	47.333	7386	65.800
6939	76.000	7255	73.750	7390	50.250
6940	59.429	7256	62.500	7391	47.000
6943	79.000	7258	66.000	7392	72.000
6944	84.000	7260	69.250	7394	70.000
6945	58.933	7262	72.000	7403	75.500
6951	68.286	7265	61.200	7404	64.000
6956	61.429	7268	78.667	7405	71.500
6957	64.000	7275	85.000	7406	68.000
6958	77.333	7277	55.500	7408	72.000
6959	73.750	7280	63.500	7411	65.500
6960	75.500	7282	71.000	7413	68.000
6961	70.286	7283	56.500	7418	61.600
6963	76.000	7284	55.000	7423	72.000
6966	81.538	7287	60.000	7424	66.500
6967	69.000	7291	52.500	7425	71.500
6970	65.500	7292	70.000	7430	76.750
6972	73.667	7296	74.000	7438	67.000
6975	71.000	7297	70.667	7446	50.000
6976	61.667	7299	75.000	7449	66.000
6977	68.667	7300	57.000	7457	71.333
6978	66.667	7301	41.000	7514	70.000
6979	73.500	7303	60.667	7515	47.000
6980	73.500	7305	84.000	7520	84.727
6982	64.000	7307	68.000	7521	71.429
6984	86.000	7309	55.500	7523	56.500
6985	65.000	7310	83.600	7525	67.200
7169	44.333	7316	58.667	8258	75.500
7172	77.000	7317	65.800	8534	59.333
7176	69.500	7320	60.000	8608	60.000
7178	75.500	7328	49.000	8730	62.667
7181	52.000	7330	66.000	8770	65.333
7188	65.500	7331	62.750	8787	71.500
				8791	68.000

Extended Data Table 4 Association between pollen and ovule numbers and the diverse set of 107 phenotypes

Category	Phenotype name	r (pollen)	P (pollen)	r (ovule)	P (ovule)	Category	Phenotype name	r (pollen)	P (pollen)	r (ovule)	P (ovule)
FL	1_LD	-0.8552	0.3974	-1.5384	0.1308	FL	40_2W	-1.2746	0.2106	-5.3055	<0.0001
FL	2_LDv	-1.0132	0.3169	-1.8827	0.0661	FL	41_4W	-1.3665	0.1805	-5.2682	<0.0001
FL	3_SD	-0.8687	0.3903	-2.0476	0.0466	FL	42_8W	-1.5652	0.1260	-4.4811	0.0001
FL	4_SDV	-0.0641	0.9492	-1.5905	0.1189	FL	43_FLc	-1.3672	0.1790	-0.7493	0.4575
FL	5_FT10	-0.6123	0.5433	-0.4831	0.6310	FL	44_FRI	-0.5210	0.6052	-1.8254	0.0744
FL	6_FT16	-1.0725	0.2891	-1.7206	0.0914	FL	45_8W.GH.FT	-0.9187	0.3636	-4.7241	<0.0001
FL	7_FT22	-1.7315	0.0899	-3.3504	0.0015	FL	46_8W.GH.LN	-0.3272	0.8161	-0.0032	0.9999
DEV	8_Seed.Dormancy	-0.9639	0.3415	-0.2198	0.8271	FL	47_0W.GH.FT	-1.5063	0.1405	-3.8167	0.0004
DEF	9_Ernco5	-1.0075	0.3204	-1.2389	0.2226	FL	48_0W.GH.LN	-1.1528	0.2564	-3.4669	0.0012
DEF	10_Ernwa1	1.5968	0.1193	-0.0721	0.9429	FL	57_FT.Field	0.4327	0.6675	0.0373	0.9704
DEF	11_Ernw1	1.8927	0.0667	-0.0061	0.9951	FL	58_FT.Diameter.Field	-1.4339	0.1592	-0.4120	0.6823
DEF	12_Hiks1	1.3100	0.1995	-0.5055	0.6163	FL	59_FT.GH	-1.6428	0.1081	-3.1723	0.0027
DEF	13_Noco2	1.2426	0.2220	1.5227	0.1357	DEV	60_FT.Duration.GH	-1.5166	0.1370	-1.6283	0.1103
ION	14_L17	2.1396	0.0389	3.0258	0.0042	DEV	61_LC.Duration.GH	-1.9732	0.0552	-3.0069	0.0043
ION	15_B11	-1.0237	0.3125	0.0339	0.9731	DEV	62_LFS.GH	-1.8465	0.0720	-3.1233	0.0031
ION	16_Na23	0.3026	0.7638	-0.8206	0.4165	DEV	63_MT.GH	0.7352	0.4664	2.0756	0.0435
ION	17_Mg25	1.6761	0.1019	-0.3061	0.7610	DEV	64_RP.GH	-1.1985	0.2376	-0.3450	0.7317
ION	18_P31	-1.6564	0.1059	-0.1148	0.9091	DEF	65_A11	-0.2961	0.7667	-1.2011	0.2360
ION	19_S34	0.5911	0.5560	0.4184	0.6778	DEF	66_A11.CFU2	-0.4207	0.6762	0.9256	0.3996
ION	20_K39	0.0590	0.9532	-2.1852	0.0345	DEF	67_As	-2.9794	0.0049	-0.9480	0.3482
ION	21_Ca43	0.7194	0.4763	-0.6555	0.5157	DEF	68_As.CFU2	-0.1424	0.8875	-0.3565	0.7231
ION	22_Mn55	-0.8659	0.3920	1.1553	0.2545	DEF	69_Bs	1.5872	0.1203	-0.8652	0.3915
ION	23_Fe56	0.2868	0.7758	-1.8483	0.0716	DEF	70_Bs.CFU2	0.2052	0.8385	-0.0102	0.9919
ION	24_Co59	-0.7493	0.4583	-0.5890	0.5590	DEF	71_A12	-1.2512	0.2181	-1.6334	0.1094
ION	25_Ni60	0.4532	0.6530	-0.0888	0.9296	DEF	72_A12.CFU2	-0.6648	0.5100	-0.6018	0.5503
ION	26_Cu65	0.0718	0.9431	0.6302	0.5320	DEF	73_As2	-0.2429	0.8094	-0.7852	0.4365
ION	27_Zn66	0.6017	0.5009	-1.0796	0.2865	DEF	74_As2.CFU2	0.9693	0.3382	1.3879	0.1720
ION	28_As75	0.2697	0.7899	1.8220	0.0756	DEV	75_FW	2.6348	0.0120	0.8764	0.3857
ION	29_Se82	0.9042	0.3716	0.6291	0.5327	DEV	76_DW	2.1601	0.0370	1.0485	0.3003
ION	30_Mo88	-0.1156	0.9086	0.1483	0.8828	DEV	77_LES	-1.0778	0.2877	0.3975	0.6929
ION	31_Cd114	0.9132	0.3669	0.0092	0.9927	DEV	78_YEL	-0.2012	0.8416	0.3321	0.7414
DEF	32_i.avrPpB.i.	0.7417	0.4631	1.1303	0.2651	DEV	79_LY	-0.9568	0.3445	0.5497	0.5554
DEF	33_i.avrRpm1.i.	0.9748	0.3365	1.2484	0.2195	FL	80_LN10	-0.3843	0.7028	0.5851	0.5614
DEF	34_i.avrRpt2.i.	0.0851	0.9327	-0.4572	0.6500	FL	81_LN16	-1.2748	0.2097	-2.1525	0.0368
DEF	35_i.avrB.i.	1.0172	0.3157	1.3865	0.1731	FL	82_LN22	-1.7027	0.0962	-3.1208	0.0031
FL	39_OW	-1.7238	0.0936	-4.5784	<0.0001	DEV	158_Silique.16	-0.3224	0.7489	1.4653	0.1501

FL: flowering phenotypes. DEV: developmental phenotypes. DEF: defense-related phenotypes. ION: ionomics phenotypes. For the details of phenotypes, see Atwell et al. (2010).
r: Pearson's correlation coefficient. P: P-values. For pollen number, log-transformed phenotype values were used.

Category	Phenotype name	r (pollen)	P (pollen)	r (ovule)	P (ovule)
DEV	159_Silique.22	-1.8674	0.0694	-0.6675	0.5143
DEV	161_Germ.10	1.2372	0.2231	-1.2910	0.2032
DEV	162_Germ.16	1.3593	0.1817	-0.0174	0.9882
DEV	163_Germ.22	-1.0055	0.3205	-0.6597	0.5127
DEV	164_Width.10	-0.9511	0.3471	1.1540	0.2544
DEV	165_Width.16	0.5501	0.5853	1.8152	0.0762
DEV	166_Width.22	1.0230	0.3123	1.0241	0.3112
DEV	167_Chlorosis.10	-0.7454	0.4603	-1.0094	0.3181
DEV	168_Chlorosis.16	-0.6342	0.5296	-1.2568	0.2163
DEV	169_Chlorosis.22	1.5453	0.1300	1.8458	0.0714
DEV	170_Anihocyanin.10	-0.9742	0.3357	0.9999	0.3226
DEV	171_Anihocyanin.16	1.4269	0.1614	0.9579	0.3432
DEV	172_Anihocyanin.22	-0.9137	0.3662	1.7044	0.0951
DEV	173_Leaf.serr.10	0.4007	0.6908	1.1439	0.2589
DEV	174_Leaf.serr.16	1.2759	0.2093	0.6462	0.5214
DEV	175_Leaf.serr.22	-0.1472	0.8837	-0.6053	0.5480
DEV	176_Leaf.roll.10	0.1889	0.8511	0.0975	0.9228
DEV	177_Leaf.roll.16	0.5837	0.5627	-1.1581	0.2529
DEV	178_Leaf.roll.22	-0.1862	0.8532	0.8616	0.3934
DEV	179_Rosette.Erect.22	-0.2484	0.8051	-0.1686	0.8668
DEV	182_Hypocotyl.length	-0.7765	0.4424	-0.2015	0.8413
DEF	183_Trichome.avg.C	-2.1268	0.0398	-0.8471	0.4016
DEF	184_Trichome.avg.A	-1.5666	0.1253	-0.4948	0.6232
DEF	185_Aphid.number	-0.1845	0.8546	-0.5621	0.5770
DEF	186_Bacterial.titer	0.5172	0.6079	0.4432	0.6599
DEV	272_Seeding.Growth	0.1026	0.9188	0.8743	0.3867
DEV	273_Vern.Growth	-0.1666	0.8686	-0.0107	0.9915
DEV	274_Alter.Vern.Growth	0.6230	0.5368	0.8083	0.4232
DEV	277_Secondary.Dormancy	2.2562	0.0304	1.6605	0.1048
DEV	278_Germ.in.dark	-2.1808	0.0360	-2.2820	0.0280
DEV	279_DSD50	0.2367	0.8141	1.1101	0.2730
DEV	280_Seed.bank.133.91	0.1515	0.8904	0.8540	0.3978
DEV	281_Storage.7.days	-0.6102	0.5452	1.5378	0.1312
DEV	282_Storage.28.days	0.3415	0.7345	0.6413	0.5247
DEV	283_Storage.56.days	0.4940	0.6240	-0.8072	0.4239

Extended Data Table 5 Association between pollen and ovule numbers and climate variables

	<i>r</i> (pollen)	<i>P</i> value (pollen)	<i>r</i> (ovule)	<i>P</i> value (ovule)
LATITUDE	0.0252	0.9799	0.4996	0.6182
LONGITUDE	0.4021	0.6883	1.3283	0.1865
bio4.temperature.seasonality	-0.0660	0.9475	1.3853	0.1684
bio5.maximum.temperature.in.the.warmest.month	-0.2095	0.8344	-0.9161	0.3613
bio6.minimum.temperature.in.the.coldest.month	-0.0695	0.9447	-2.2712	0.0248
bio13.precipitation.in.the.wettest.month	-1.2478	0.2145	-1.0581	0.2920
bio14.precipitation.in.the.driest.month	-0.3502	0.7268	-0.5938	0.5537
bio15.precipitation.cv	0.0513	0.9592	1.0617	0.2904
PAR_SPRING	0.3633	0.7170	-1.5635	0.1204
length.of.the.growing.season	0.1641	0.8699	-1.2036	0.2310
number.of.consecutive.cold.days	-0.2329	0.8162	0.8765	0.3824
number.of.consecutive.frost.free.days	-0.0637	0.9493	-2.9642	0.0036
relative.humidity_spring	-0.5172	0.6060	0.3048	0.7610
daylength.spring	-0.2057	0.8374	-0.0372	0.9704
aridity.index	-0.5043	0.6150	-1.7755	0.0782

For the details of climate variables, see Hancock et al. (2011).

r: Pearson's correlation coefficient. For pollen number, log-transformed phenotype values were used.

Extended Data Table 6 Top rank traits showing fold enrichments of more than 3 in the selection scan.

Phenotype name	Phenotype category	Short description	Fold enrichment	P-value
Pollen number	This study	Pollen number per flower	6.35	0.002
Manganese (Mn55)	Ionomics	<i>In planta</i> ion concentration of Manganese	5.88	0.006
Bs CFU2	Defense-related	<i>In planta</i> bacterial growth (number of CFU / leaf area) of the <i>Pseudomonas viridiflava</i> strain RMX3.1b	5.77	0.003
Leaf roll 22	Developmental	Presence or absence of rolled leaves at 8 weeks post germination for plants grown at 10° C	5.13	0.001
LN10	Flowering	Leaf number at flowering time, 10° C	4.71	0.004
LN16	Flowering	Leaf number at flowering time, 16° C	4.44	0.006
Aphid number	Defense-related	Aphid offspring	4.44	0.008
RP GH	Developmental	Number of days between the appearance of the first flower and the plant complete senescence	4.26	0.009
LN22	Flowering	Leaf number at flowering time, 22° C	4.17	0.007
Storage 28 days	Developmental	Primary dormancy	4.00	0.015
As	Defense-related	Disease presence or absence following inoculation with <i>Pseudomonas viridiflava</i> strain RMX23.1b	3.92	0.022
Nickel (Ni60)	Ionomics	<i>In planta</i> ion concentration of Nickel	3.85	0.019
Noco2	Defense-related	Disease presence or absence following inoculation with <i>Perenospora parasitica</i> isolate Noco2	3.77	0.017
Ovule number	This study	Ovule number per flower	3.64	0.03
Molybdenum (Mo98)	Ionomics	<i>In planta</i> ion concentration of Molybdenum	3.57	0.03
Germ 10	Developmental	Days from removal from stratification until emergence of first cotyledon at 10° C	3.27	0.018

Pollen and ovule numbers, and phenotypes of Atwell et al. (2010) are shown.

Phenotype categories are based on Atwell et al. (2010).

Extended Data Table 7. Primer list

Target	Purpose	Forward primer		Reverse primer	
		Primer name	sequence (5'-3')	Primer name	sequence (5'-3')
<i>AT1G25250</i>	qPCR	3931_At1g25250RTf1	ACACCAGCTAACAGATCCAGATG	3932_At1g25250RTr1	AGATCTCACACACACGTAACCGATCTG
<i>AT1G25260 (RDP1)</i>	qPCR	3933_At1g25260RTf1	AGCGAGATPAGACCAGTGACTTTGTC	3934_At1g25260RTr1	CAACAGCCTCCCTAATTCACATTCAC
<i>AT1G25270</i>	qPCR	4075_At1g25270RTf1	TTCCGATCATGACTGGGAGCAATG	4076_At1g25270RTr1	CGAAAACCACGATTCCCGAAATAAAGC
<i>AT5G60390 (EF1-α)</i>	qPCR	3529_AhEF1aF	TGAGCACGCTCTTCTTGCTTTCA	3530_AhEF1aR	GGTGGTGGCATCCCATCTTGTITACA
<i>AT1G25250</i>	genotyping for <i>GT_5_108298</i> (wild-type)	3100_GT_5_107916_LP	AGACATGTTGGCTCAGGACAC	3101_GT_5_107916_RP	ATGTAAAGGTGGGAGGTCAATG
	genotyping for <i>GT_5_108298</i> (mutant)	3100_GT_5_107916_LP	AGACATGTTGGCTCAGGACAC	3264_Ds3-1	ACCCGACCCGGATCGTATCCGGT
<i>AT1G25260 (RDP1)</i>	genotyping for <i>rdp1-1</i> (wild-type)	3619_At1g25260F04	TATGATACCCCAATTGAATG	3195_SA_064854_RP	TTTCCATTGTGGCCTAAACTGC
	genotyping for <i>rdp1-1</i> (mutant)	2939_SALK_T_DNA_LB	ATTTTGCCGATTTCCGGAAC	3195_SA_064854_RP	TTTCCATTGTGGCCTAAACTGC
	genotyping for <i>rdp1-2</i> (wild-type)	3622_At1g25260F07	TTGTAGTTTGTGAAGAAGG	3551_At1g25260R01	GTTTAAAATGAGAGAAACCCCG
	genotyping for <i>rdp1-2</i> (mutant)	3622_At1g25260F07	TTGTAGTTTGTGAAGAAGG	2946_GABI_T_DNA_LB	ATATTGACCATCATACTCATTTGC

Extended Data Table 8 S-haplogroups of the accessions used for pollen number GWAS.

ecotype_id	Accession name	S-haplogroup	ecotype_id	Accession name	S-haplogroup	ecotype_id	Accession name	S-haplogroup
5837	Bor-1	A	7201	Kr-0	C	7337	Si-0	A
6041	Lis-3	NA	7205	Krot-2	NA	7340	Sav-0	A
6108	T480	NA	7210	La-1	A	7343	Sp-0	A
6189	TDr-2	NA	7223	Li-2:1	A	7344	Sg-1	A
6193	TDr-7	NA	7224	Li-3	A	7351	Ty-0	NA
6903	Bor-4	A	7227	Li-5:2	NA	7353	Tha-1	NA
6907	CIBC-17	A	7228	Li-5:3	NA	7354	Ting-1	NA
6909	Col-0	A	7229	Li-6	A	7355	Tiv-1	NA
6911	Cvi-0	B	7231	Li-7	A	7372	Tscha-1	NA
6915	Ei-2	A	7238	LI-1	A	7373	Tsu-0	NA
6929	Kondara	A	7239	LI-2	C	7376	Tu-1	A
6931	Kz-9	A	7242	Lo-2	A	7378	Uk-1	A
6933	LL-0	A	7244	Mnz-0	NA	7379	Uk-2	A
6936	Lz-0	C	7246	Ma-2	A	7381	Uk-4	A
6937	Mrk-0	A	7252	Mc-0	NA	7382	Utrecht	NA
6938	Ms-0	A	7255	Mh-0	NA	7384	Ven-1	NA
6939	Mt-0	A	7256	Mh-1	A	7386	Vi-0	A
6940	Mz-0	A	7258	Nw-0	A	7390	Wag-3	NA
6943	NFA-10	A	7260	Nw-2	A	7392	Wag-5	NA
6945	Nok-3	A	7262	Nw-4	A	7394	Wa-1	A
6951	Pu2-23	A	7265	Nd-0	A	7403	Wei-1	A
6956	Pu2-7	A	7268	Np-0	NA	7404	Wc-1	A
6957	Pu2-8	NA	7275	No-0	A	7405	Wc-2	A
6958	Ra-0	C	7276	Ob-0	A	7406	Wt-1	A
6959	Ren-1	A	7277	Ob-1	NA	7408	Wt-3	NA
6960	Ren-11	A	7280	Old-1	A	7411	WI-0	NA
6961	Se-0	A	7282	Or-0	A	7413	Wil-2	A
6963	Sorbo	A	7283	Ors-1	NA	7418	Zu-1	A
6966	Sq-1	A	7284	Ors-2	NA	7423	Jl-2	A
6967	Sq-8	A	7287	Ove-0	A	7424	Jl-3	A
6970	Ts-1	A	7291	Pa-2	A	7425	Jl-4	NA
6972	Tsu-1	A	7292	Pa-3	A	7430	Nc-1	A
6975	Uod-1	A	7297	Pf-0	A	7438	N13	NA
6976	Uod-7	A	7299	Pi-2	A	7446	N4	NA
6977	Van-0	A	7300	Pla-0	A	7449	N7	NA
6979	Wei-0	A	7301	Pla-1	A	7457	Rld-2	A
6980	Ws-0	A	7303	Pla-3	A	7514	RRS-7	NA
6982	Wt-5	C	7305	Pt-0	A	7515	RRS-10	NA
6984	Zdr-1	A	7307	Pn-0	A	7520	Lp2-2	A
6985	Zdr-6	A	7309	Po-1	A	7521	Lp2-6	A
7169	Hh-0	NA	7310	Pr-0	A	7523	Pna-17	NA
7172	HI-3	A	7316	Rhen-1	NA	7525	Rmx-A180	NA
7176	Is-1	A	7317	Ri-0	NA	8258	Bâ4-1	NA
7178	Jm-1	A	7320	Rou-0	A	8608	11ME1.23	NA
7188	Kelsterbach-2	A	7328	Sf-2	A	8730	11PNA1.9	NA
7192	Kil-0	A	7330	Sapporo-0	NA	8770	11PNA3.65	NA
7195	KI-1	A	7331	Sh-0	A	8787	11PNA3.86	NA
7199	KI-5	A	7333	Sei-0	A	8791	11PNA3.90	NA

The S-haplogroup assignment was based on Shimizu et al. (2008).

NA: not known.