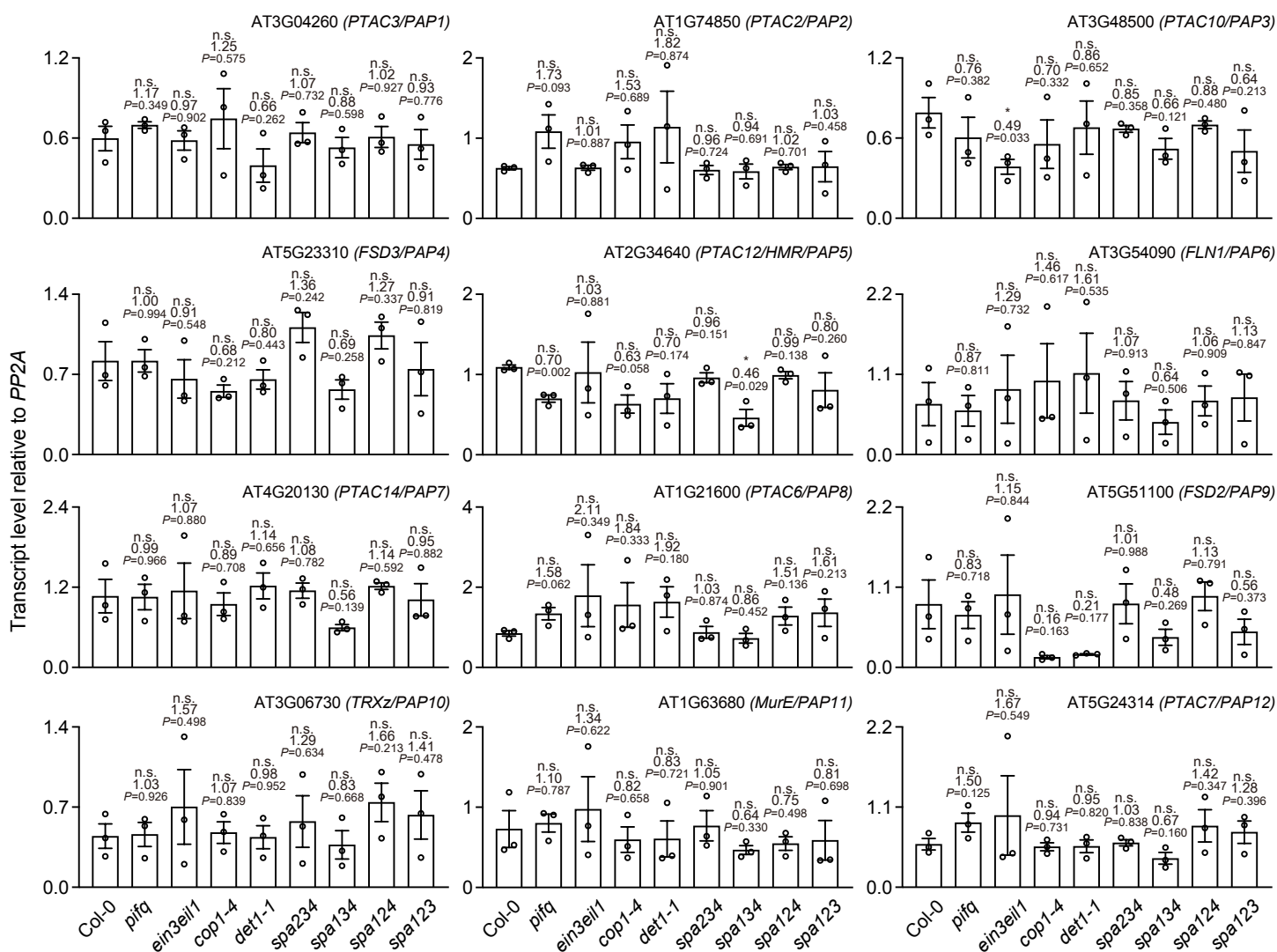
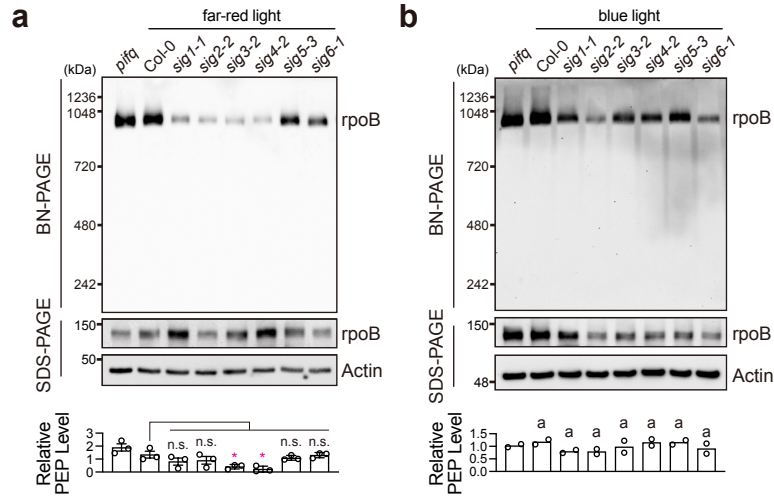




Supplementary Fig. 1. The transcript levels of *PAPs* were not altered in dark-grown de-etiolated mutants. qRT-PCR results showing the steady-state transcript levels of the 12 *PAPs* in 4-d-old dark-grown seedlings of Col-0, *pifq*, *ein3eil1*, *cop1-4*, *det1-1*, *spa234*, *spa134*, *spa124*, and *spa123*. If the change between the mutant and Col-0 was less than twofold or not statistically significant based on two-tailed Student's t-test, it is labeled as n.s. (not significant). Error bars represent the s.e. of three biological replicates, and the centers of the error bars represent the mean values. The source data underlying the qRT-PCR analysis are provided in the Source Data file.



Supplementary Fig. 2. PEP assembly in *sig1-6* mutants in far-red and blue light. Immunoblots showing the levels of the PEP complex and the PEP component rpoB in 2-d-old Col-0 and *sig1-6* seedlings grown in $10 \mu\text{mol m}^{-2} \text{s}^{-1}$ monochromatic far-red (**a**) or blue (**b**) light. Total protein was isolated under either native or denaturing conditions and resolved via BN-PAGE or SDS-PAGE to assess the fraction of rpoB in the PEP complex or the amount of total rpoB by immunoblots, respectively. Dark-grown *pifq* seedlings were used as a control. Actin was used as a loading control. The graph below the immunoblots shows the relative PEP levels, which were estimated using the relative level of rpoB in the PEP complex (BN-PAGE) divided by the relative level of denatured rpoB (SDS-PAGE) in each sample. Asterisks in **a** indicate statistically significant differences compared with Col-0 based on two-tailed Student's t-test ($* P \leq 0.05$, $n = 3$ biological replicates). Different letters in **b** denote statistically significant differences in the relative PEP levels among the genotypes (ANOVA, Tukey's HSD, $P \leq 0.05$, $n=2$).

Supplementary Table 1. List of photosynthesis-associated nuclear genes (PhANGs) and plastid genes (PhAPGs) in *Arabidopsis*. LHCs, genes encoding light harvesting complex proteins; CHLs, genes encoding enzymes in chlorophyll biosynthesis; nPEACs, nuclear genes associated with photosystems, electron transport, ATP synthase, and the Calvin cycle.

Subcategories	Functional groups	PhANGs		PhAPGs	
LHCs	Light harvesting antenna	<i>Lhca1</i> <i>Lhca2</i> <i>Lhca3</i> <i>Lhca4</i> <i>Lhca5</i> <i>Lhca6</i> <i>Lhcb1.1/CAB2</i> <i>Lhcb1.2/CAB3</i> <i>Lhcb1.3/CAB1</i> <i>Lhcb1.4</i> <i>Lhcb1.5</i> <i>Lhcb2.1</i> <i>Lhcb2.2</i> <i>Lhcb2.3</i> <i>Lhcb3</i> <i>Lhcb4.1</i> <i>Lhcb4.2</i> <i>Lhcb4.3</i> <i>Lhcb5</i> <i>Lhcb6</i>	At3g54890 At3g61470 At1g61520 At3g47470 At1g45474 At1g19150 At1g29920 At1g29910 At1g29930 At2g34430 At2g34420 At2g05100 At2g05070 At3g27690 At5g54270 At5g01530 At3g08940 At2g40100 At4g10340 At1g15820		
CHLs	Chlorophyll biosynthesis	<i>GTS</i> <i>HEMA1</i> <i>HEMA2</i> <i>HEMA3</i> <i>GSA1</i> <i>GSA2</i> <i>FLU</i> <i>ALAD1/HEMB1</i> <i>ALAD2/HEMB2</i> <i>PBGD</i> <i>UROS</i> <i>UROD1/HEME2</i> <i>UROD2/HEME1</i> <i>CPO1/HEMF1</i> <i>CPO3/HEMN1</i> <i>PPO1</i> <i>PPO2</i> <i>CHLI1</i> <i>CHLI2</i> <i>CHLD</i> <i>CHLH/GUN5</i> <i>CHLM</i> <i>CHL27/CRD1</i> <i>PORA</i> <i>PORB</i> <i>PORC</i> <i>DVR</i> <i>CHLG</i> <i>CHLP</i> <i>CAO</i> <i>FC1</i> <i>FC2</i> <i>HO1/GUN2</i> <i>HO2</i> <i>HO3</i> <i>HO4</i> <i>HY2</i> <i>UPM1</i> <i>SIRB</i> <i>ELIP1</i> <i>ELIP2</i>	At5g26710 At1g58290 At1g09940 At2g31250 At5g63570 At3g48730 At3g14110 At1g69740 At1g44318 At5g08280 At2g26540 At2g40490 At3g14930 At1g03475 At5g63290 At4g01690 At5g14220 At4g18480 At5g45930 At1g08520 At5g13630 At4g25080 At3g56940 At5g54190 At4g27440 At1g03630 At5g18660 At3g51820 At1g74470 At1g44446 At5g26030 At2g30390 At2g26670 At2g26550 At1g69720 At1g58300 At3g09150 At5g40850 At1g50170 At3g22840 At4g14690	<i>trnE</i>	AtCg00250
nPEACs	Photosystem II	<i>PsbO1</i> <i>PsbO2</i> <i>PsbP1</i> <i>PsbP2</i> <i>PsbQ1</i> <i>PsbQ2</i> <i>PsbR1</i> <i>PsbS</i> <i>PsbTn</i> <i>PsbW</i> <i>PsbX</i> <i>PsbY</i> <i>Psb27</i> <i>Psb28</i> <i>Psb29</i> <i>Psb32</i>	At5g66570 At3g50820 At1g06680 At2g30790 At4g21280 At4g05180 At1g79040 At1g44575 At3g21055 At2g30570 At2g06520 At1g67740 At1g03600 At4g28660 At2g20890 At1g54780	<i>psbA</i> <i>psbB</i> <i>psbC</i> <i>psbD</i> <i>psbE</i> <i>psbF</i> <i>psbH</i> <i>psbI</i> <i>psbJ</i> <i>psbK</i> <i>psbL</i> <i>psbM</i> <i>psbN</i> <i>psbTc</i> <i>psbZ</i>	AtCg00020 AtCg00680 AtCg00280 AtCg00270 AtCg00580 AtCg00570 AtCg00710 AtCg00080 AtCg00550 AtCg00070 AtCg00560 AtCg00220 AtCg00700 AtCg00690 AtCg00300

Photosystem I	<i>PsaD1</i> <i>PsaD2</i> <i>PsaE1</i> <i>PsaE2</i> <i>PsaF</i> <i>PsaG</i> <i>PsaH1</i> <i>PsaH2</i> <i>PsaK</i> <i>PsaL</i> <i>PsaN</i> <i>PsaO</i> <i>PsaP</i>	At4g02770 At1g03130 At4g28750 At2g20260 At1g31330 At1g55670 At3g16140 At1g52230 At1g30380 At4g12800 At5g64040 At1g08380 At2g46820	<i>psaA</i> <i>psaB</i> <i>psaC</i> <i>psaI</i> <i>psaJ</i>	AtCg00350 AtCg00340 AtCg01060 AtCg00510 AtCg00630
Cytochrome b₆f	<i>PetC</i> <i>PetM</i>	At4g03280 At2g26500	<i>petA</i> <i>petB</i> <i>petD</i> <i>petG</i> <i>petL</i> <i>petN</i>	AtCg00540 AtCg00720 AtCg00730 AtCg00600 AtCg00590 AtCg00210
Other electron transfer components	<i>PC1/PetE1</i> <i>PC2/PetE2</i> <i>FD1/PetF2</i> <i>FD2/PetF1</i> <i>FNR1/PetH1</i> <i>FNR2/PetH2</i> <i>PetJ</i>	At1g76100 At1g20340 At1g10960 At1g60950 At5g66190 At1g20020 At5g45040		
ATP synthase	<i>AtpC1</i> <i>AtpC2</i> <i>AtpD</i> <i>AtpG</i>	At4g04640 At1g15700 At4g09650 At4g32260	<i>atpA</i> <i>atpB</i> <i>atpE</i> <i>atpF</i> <i>atpH</i> <i>atpI</i>	AtCg00120 AtCg00480 AtCg00470 AtCg00130 AtCg00140 AtCg00150
NADH dehydrogenase	<i>NdhL</i> <i>NdhM</i> <i>NdhN</i> <i>NdhO</i> <i>NdhS</i> <i>NdhT</i> <i>NdhU</i> <i>NdhV</i> <i>PnsB1</i> <i>PnsB2</i> <i>PnsB3</i> <i>PnsB4</i> <i>PnsB5</i> <i>PnsL1</i> <i>PnsL2</i> <i>PnsL3</i> <i>PnsL4</i> <i>PnsL5</i>	At1g70760 At4g37925 At5g58260 At1g74880 At4g23890 At4g09350 At5g21430 At2g04039 At1g15980 At1g64770 At3g16250 At1g18730 At5g43750 At2g39470 At1g14150 At3g01440 At4g39710 At5g13120	<i>ndhA</i> <i>ndhB.1</i> <i>ndhB.2</i> <i>ndhC</i> <i>ndhD</i> <i>ndhE</i> <i>ndhF</i> <i>ndhG</i> <i>ndhH</i> <i>ndhI</i> <i>ndhJ</i> <i>ndhK</i>	AtCg01100 AtCg00890 AtCg01250 AtCg00440 AtCg01050 AtCg01070 AtCg01010 AtCg01080 AtCg01110 AtCg01090 AtCg00420 AtCg00430
Calvin cycle	<i>RBCS1A</i> <i>RBCS1B</i> <i>RBCS2B</i> <i>RBCS3B</i> <i>PGK1</i> <i>PGK2</i> <i>CP12-1</i> <i>CP12-2</i> <i>CP12-3</i> <i>GAPCP1</i> <i>GAPCP2</i> <i>GAPA-1</i> <i>GAPA-2</i> <i>GAPB</i> <i>TIM</i> <i>FBA1</i> <i>FBA2</i> <i>FBA3</i> <i>FBP/HCEF1</i> <i>RPE</i> <i>SBPASE</i> <i>TKL1</i> <i>TKL2</i> <i>PRK</i> <i>RCA</i> <i>CA1</i> <i>CA2</i> <i>CA5</i>	At1g67090 At5g38430 At5g38420 At5g38410 At3g12780 At1g56190 At2g47400 At3g62410 At1g76560 At1g79530 At1g16300 At3g26650 At1g12900 At1g42970 At2g21170 At2g21330 At4g38970 At2g01140 At3g54050 At5g61410 At3g55800 At3g60750 At2g45290 At1g32060 At2g39730 At3g01500 At5g14740 At4g33580	<i>rbcl</i>	AtCg00490

Supplementary Table 2. List of RNA-seq datasets used in this study.

BioProject	Genotype	Growth condition	Reference
PRJNA259643	<i>pifq, det1-1</i>	4-d-old, dark grown, 1X MS, 1% sucrose	Dong, J. <i>et al.</i> Arabidopsis DE-ETIOLATED1 represses photomorphogenesis by positively regulating phytochrome-interacting factors in the dark. <i>Plant Cell</i> 26 , 3630–3645 (2014). ²⁹
PRJNA480268	<i>ein3/eil1</i>	2.5~3-d-old, dark grown, 1X MS, 1% sucrose	Huang, P. <i>et al.</i> Integrated Regulation of Apical Hook Development by Transcriptional Coupling of EIN3/EIL1 and PIFs in <i>Arabidopsis</i> . <i>Plant Cell</i> 30 , 1971-1988 (2018). ⁴⁸
PRJNA448672	<i>cop1-4, spaq</i>	3-d-old, dark grown, 1X MS,	Pham, V. N. <i>et al.</i> Molecular bases for the constitutive photomorphogenic phenotypes in <i>Arabidopsis</i> . <i>Development</i> 145 , (2018). ⁴⁹
PRJNA182723	<i>pifq</i>	2-d-old, dark grown	Pfeiffer, A. <i>et al.</i> Combinatorial complexity in a transcriptionally centered signaling hub in <i>Arabidopsis</i> . <i>Mol. Plant</i> 7 , 1598–1618 (2014). ⁵⁰
PRJNA610701	Col-0	3-d-old, dark-to-light transition	Kurihara, Y. <i>et al.</i> Time-course transcriptome study reveals mode of bZIP transcription factors on light exposure in <i>Arabidopsis</i> .", <i>Int J Mol Sci</i> 21 ,1993 (2020). ⁵⁸

Supplementary Table 3. qRT-PCR primers for the nuclear genes examined in this study.

Accession	Gene name	Forward primer	Reverse primer
AT1G13320	<i>PP2A</i>	TATCGGATGACGATTCTTCGTGCAG	GCTTGGTCGACTATCGAATGAGAG
AT1G29920	<i>LHCB1.1</i>	GAGCCAAGTTCTATCTGTTTG	TCTACCATCCACCACAAACAC
AT2G34430	<i>LHCB1.4</i>	TCCTGCTTTGACCGGAAAGG	GGCTTTGCGCATGGTGATTC
AT3G54890	<i>LHCA1</i>	TCTGCTCCTGGTGACTTTGG	CCAGGAACAGCGAGCATAG
AT5G64040	<i>PsaN</i>	GCGAGAGCATTCACTGTTCA	TTCGCATTCCAAAGCAATATC
AT4G09650	<i>AtpD</i>	GAGGTTAGGTCGGTGGTGAA	AACCGTCTTAACCCGAACATT
AT1G12900	<i>GAPA-2</i>	GCACCTGGAAAAGGTGACAT	ACGAATGGAGCGAGACAGTT
AT1G64860	<i>SIG1</i>	AACTAAAACACGCAGCGAGGA	TCTTAAGGATCATTGCCTCCATTT
AT1G08540	<i>SIG2</i>	AGTCCAGAATGATAAGATTGCC	CTCTTTCACCCTATATGTTGCT
AT3G53920	<i>SIG3</i>	GTCTTTGTACATCCTCATCCT	TCTGCTTTCCTCTTTGACTG
AT5G13730	<i>SIG4</i>	CCATCTCCTTCTTTATCATCCC	CTATCAACCACTCTATCCACTG
AT5G24120	<i>SIG5</i>	GTGGTGAGGAGAAGAAAGTG	GCAATCCGTTTATCAAGACTC
AT2G36990	<i>SIG6</i>	CGGGCATTGTACAGGCTTAAG	AGCATGAAGTCCATGGCTGTTT
AT3G04260	<i>PAP1/pTAC3</i>	TCGCTGAGAAAGGAGCTAGG	GCGAGGATTTCTAGGCCTCT
AT1G74850	<i>PAP2/pTAC2</i>	TTGAACCGGACATGGAGACA	GGTGTGAAAGCAACAAGCG
AT3G48500	<i>PAP3/pTAC10</i>	CATACCGGTTTCGGTTTCCC	CCTTCCTCCTCTGGCTTTGA
AT5G23310	<i>PAP4/FSD3</i>	CTGAACCACTTGGTGTCGTG	TTGGTTGGGACTTGGGACTT
AT2G34640	<i>PAP5/HMR</i>	CCAGTAATTGTATTGTGCAGAGAC	CACTTACATCACCATCTCCATC
AT3G54090	<i>PAP6/FLN1</i>	AGTCGCAAAGGGAGGAAGAA	TCGTCGTACGGAAACTCGAT
AT4G20130	<i>PAP7/pTAC14</i>	ATCGCTGCAGCAAGAACATT	TGCTCTGCTGTTGTGGGATA
AT1G21600	<i>PAP8/pTAC6</i>	AATGTCAAAGTCGCCGACAG	GTTCCGGTGGTCACAGAATGG
AT5G51100	<i>PAP9/FSD2</i>	AGCCGGGAAACCTTGATTGA	CTCCCAGAAGAACTCGTGGT
AT3G06730	<i>PAP10/TrxZ</i>	GGAAGGTGCCGTTGATTGTT	GCGTGCAAACCTCGTACTCAT
AT1G63680	<i>PAP11/MurE</i>	GCCGATGTTCAACCGTTAAA	AGAGGAGCTCCAACAGCAAT
AT5G24314	<i>PAP12/pTAC7</i>	AGCGTAGCAGCTGAAGCAAC	AAAGCCGAGATCGTTCACAC

Supplementary Table 4. Primers used for cDNA synthesis and qRT-PCR analysis of plastid genes.

Accession	Gene name	Primer for cDNA synthesis	Primer pair for qRT-PCR
ATCG00020	<i>psbA</i>	TAGATGGAGCCTCAACAGCAGCTA	ACATTTCTTCTTAGCGGCTT CGTCCTTGACTATCAACTACTGA
ATCG00680	<i>psbB</i>	CATCCAAATCTGGATCAATACCAG	GAATTAGATCGTGCGACTTTGA CTAGCACCATGCCAAATGTGTC
ATCG00490	<i>rbcL</i>	CTTCACAAGCAGCAGCTAGTTCAGG	GGAGATGATTCTGTACTACAAT GTCCCTCATTACGAGCTTGTAC