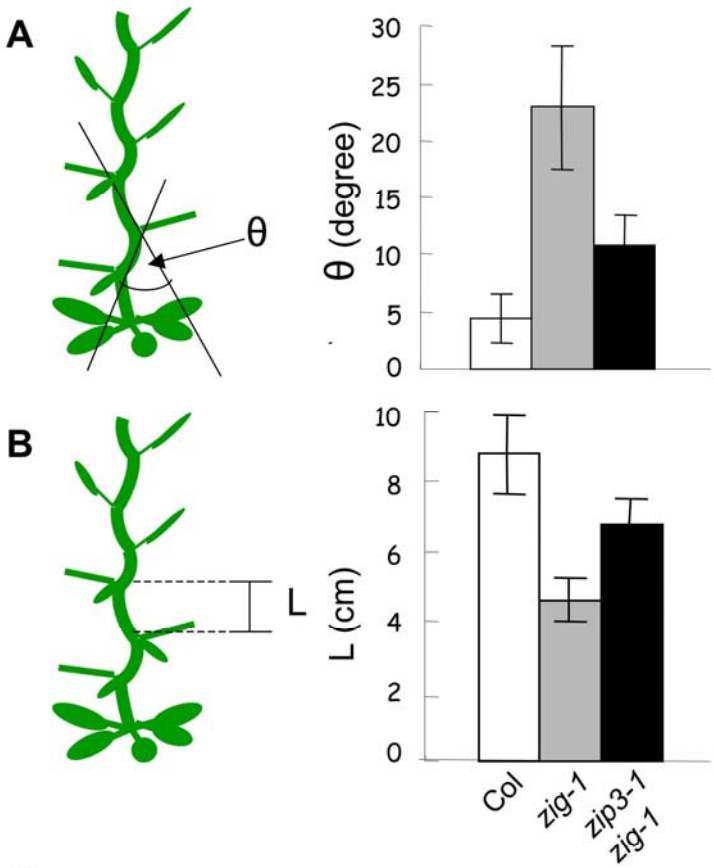
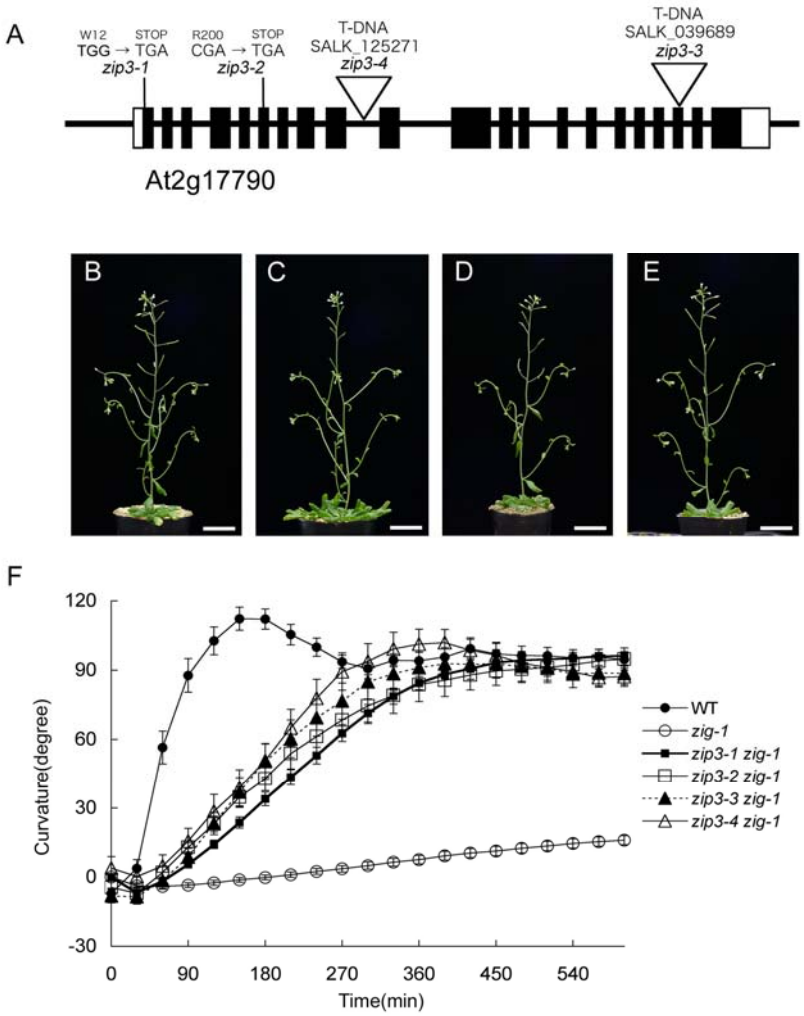


C

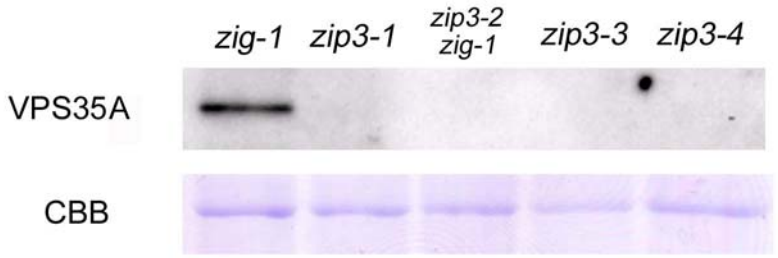
	WT	*zig-1*	*zip3-1 zig-1*
Length of petioles (mm)	9.80±2.13	5.71±0.73	7.37±0.77
Length of leaf blade (L; mm)	15.07±2.38	10.44±1.04	12.93±0.80
Width of leaf blade (W; mm)	10.45±1.60	9.51±0.80	10.00±0.71
Leaf index (L/W)	1.47±0.08	1.10±0.05	1.30±0.06

(n=16)

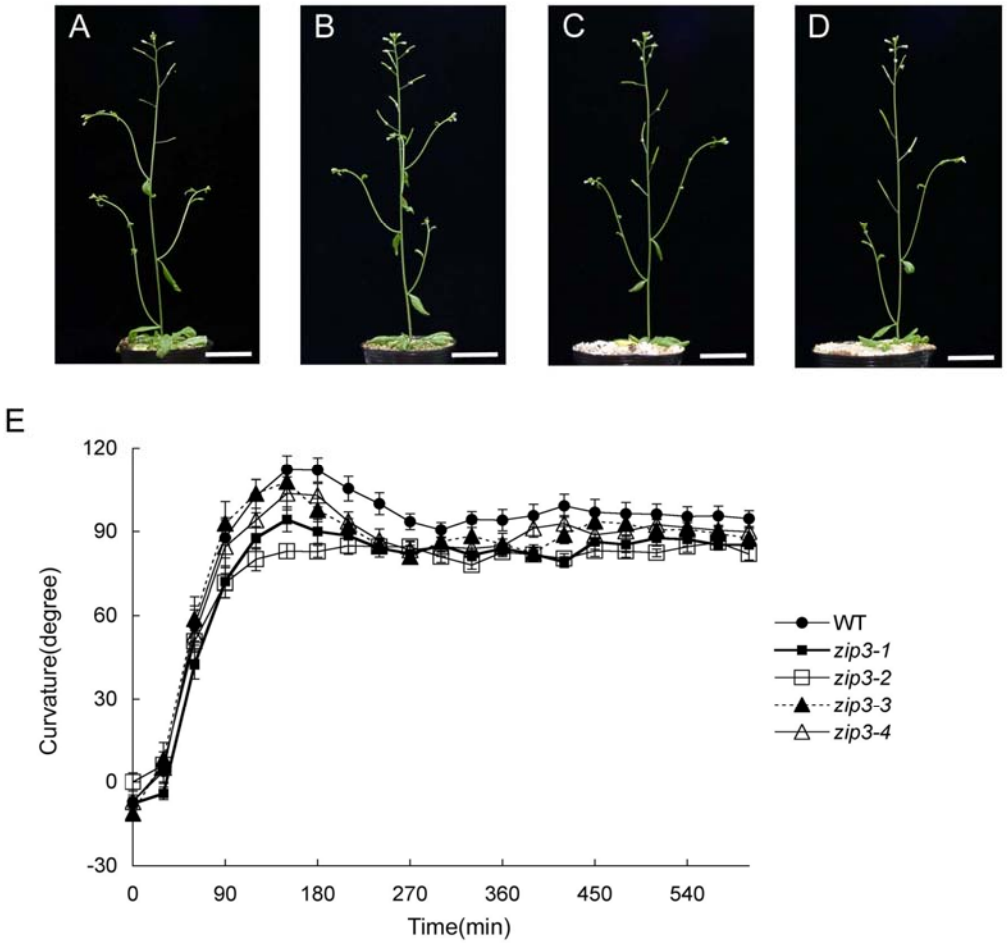
Supplemental Figure 1. Morphological phenotype of *zip3-1 zig-1*.
We determined three morphological features to evaluate the suppression effect of *zip3-1* on the *zig-1* phenotype. **(A)** The angles between two adjacent internodes of the primary shoot in the second metamer. N=12. **(B)** The internodal length in the second metamer. 7-8 week-old plants were used for measurement. N=12. **(C)** Leaf morphology. The fifth and sixth leaves from 4-week-old plants were used for the measurement. N=16. For all three features, the *zip3-1 zig-1* double mutant exhibited an intermediate phenotype between wild type and *zig-1*.



Supplementa1 Figure 2. Phenotypes of alleles of *zip3 zig-1* double mutants.
(A) Schematic structure of the *ZIP3* (*At2g17790*) gene and the position of mutations and T-DNA insertions. Boxes indicate exons and white boxes represent untranslated regions. Morphological phenotypes of 5-week-old plants of *zip3-1 zig-1* **(B)**, *zip3-2 zig-1* **(C)**, *zip3-3 zig-1* **(D)**, and *zip3-4 zig-1* **(E)**. Scale bars; 3 cm. **(F)** Gravitropic phenotypes. The gravitropic response of inflorescence stems of 5-week-old plants was gravi-stimulated by being placed horizontally at 23° C under dim non-directional light. 15 individuals of each genotype were examined. Bars represent SE.

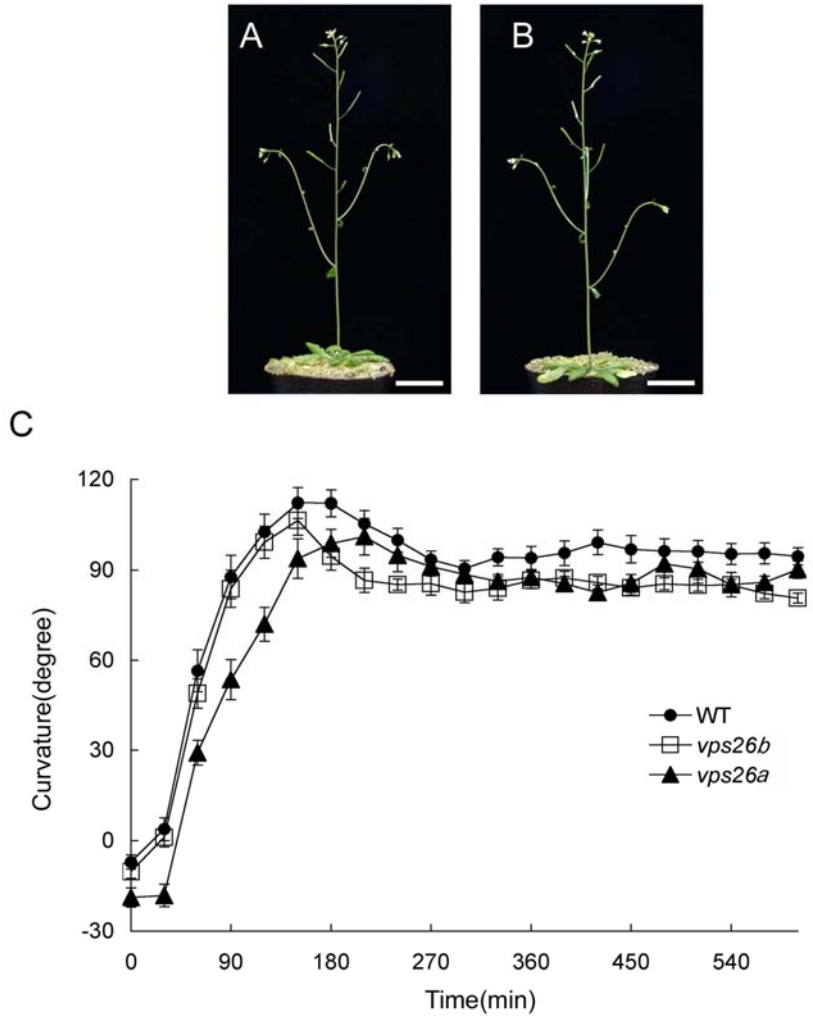


Supplemental Figure 3. Immunoblot analyziz of ZIP3/VPS35A protein
Proteins were extracted from 2-week-old seedlings from each genotype and subjected to SDS-PAGE, followed by immunoblot analysis using anti-VPS35A antibody. An approximately 90-kDa protein band was detected only in extracts prepared from the wild type plant. Lower panel shows CBB staining to indicate that a similar amount of protein was applied to each lane of the gel.

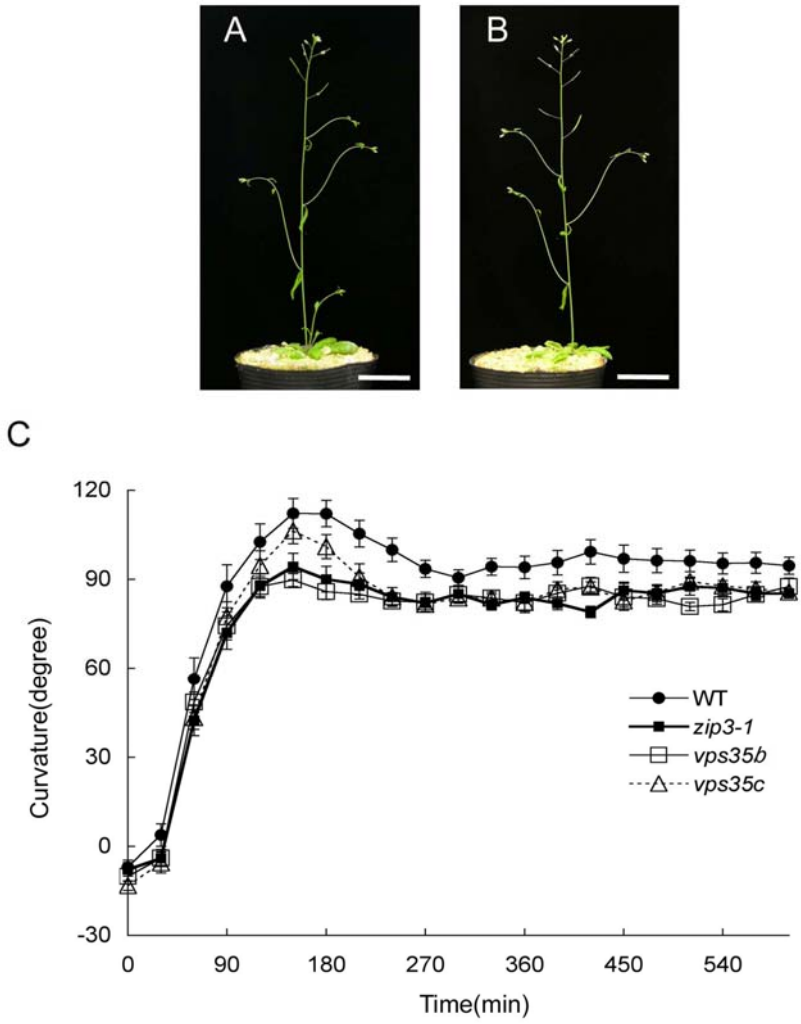


Supplemental Figure 4. Phenotypes of alleles of *zip3* single mutants.
5-week-old plants of *zip3-1* **(A)**, *zip3-2* **(B)**, *zip3-3* **(C)**, and *zip3-4* **(D)**. Scale bars; 3 cm.
(E) Gravitropic phenotypes. Gravitropic response of inflorescence stems of 5-week-old plants was gravi-stimulated by being placed horizontally at 23° C under dim non-directional light. 15 individuals of each genotype were examined. Bars represent SE.

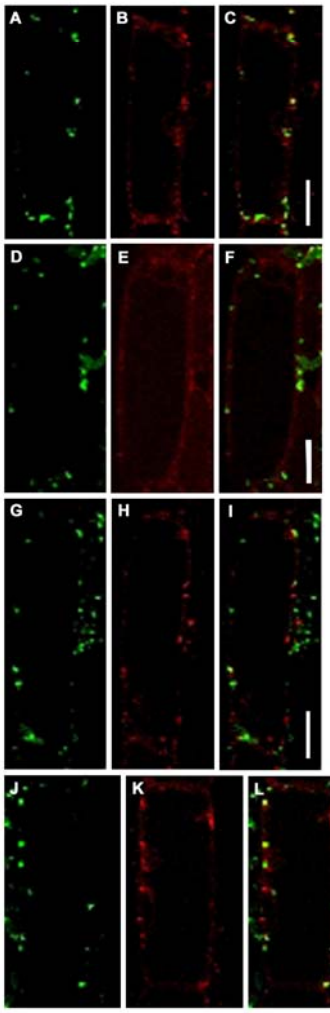
Supplemental Figure 5. Morphological phenotypes of *mag1-1* and *mag1-1 zig-1* mutants.
5-week-old plants of *mag1-1* **(A)**, *mag1-1 zig-1* **(B)**. Scale bars; 3 cm.



Supplemental Figure 6. Phenotypes of *vps26* single mutants.
The 5-week-old plants of *vps26a* **(A)** and *vps26b* **(B)**. Scale bars; 3 cm. **(C)** Gravitropic phenotypes. Gravitropic response of inflorescence stems of 5-week-old plants were gravi-stimulated by being placed horizontally at 23° C under dim non-directional light. 15 individuals of each genotype were examined. Bars represent SE.



Supplemental Figure 7. Phenotypes of *vps35b* and *vps35c* single mutants.
5-week-old plants of *vps35b* **(A)** and *vps35c* **(B)**. Scale bars; 3 cm. **(C)** Gravitropic phenotypes. Gravitropic response of inflorescence stems of 5-week-old plants was gravi-stimulated by being placed horizontally at 23° C under dim non-directional light. 15 individuals of each genotype were examined. Bars represent SE.



M

	WT	*zig-1*	*zip3-1 zig-1*	*zip3-1*
GFP (VTI12)	10.52±0.66	12.76±0.84	11.98±0.64	11.76±0.60
RFP (ARA6)	12.98±0.80	12.86±0.82	10.02±0.60	12.44±0.64
merge	3.64±0.34	2.72±0.29	2.28±0.21	2.42±0.23

(n = 50)

Supplemental Figure 8. Localization of GFP-VTI12 and ARA6-mRFP in endodermal cells

Confocal images of GFP-VTI12 and ARA6-mRFP in endodermal cells. **(A-C)** wild type, **(D-F)** *zig-1*, **(G-I)** *zip3-1 zig-1*, **(J-L)** *zip3-1*. VTI12 and Ara6 were observed with GFP **(A, D, G, H)** and RFP fluorescence **(B, E, H, K)**, respectively. *zip3-1 zig-1/ VTI12pro:GFP-VTI12* and *WT/SCRpro:ARA6-mRFP* lines were crossed, and four genotypes of wild type, *zig-1*, *zip3-1 zig-1* and *zip3-1* bearing both constructs homozygously were isolated. **(M)** Quantitative analysis of GFP-, RFP- and both signal- positive dots. The number of dots in images of endodermal cell as shown in A to L was counted. Values represent means ± SE. Fifty cells of each genotype were examined.

Supplemental Table 1. Localization of amyloplasts in the endodermal cell.

Position	WT	*zig-1*	*zip3-1 zig-1*	*zip3-1*
Top	**0.06±0.03**	**3.2±0.35**	**0.22±0.07**	**0.04±0.03**
Middle	**0.18±0.08**	**2.0±0.51**	**0.36±0.12**	**0.24±0.09**
Bottom	**5.16±0.24**	**2.94±0.28**	**3.78±0.29**	**4.8±0.33**

Localization of amyloplasts in the endodermal cell. An endodermal cell is divided into three areas (top, middle, bottom), and then the number of amyloplasts (mean Å} SD) located at each area was counted, based on the image of longitudinal sections shown in Figure 3 A -D. Fifty cells of each genotype were examined.

Supplemental Table 2. Quantitative analysis of the cytological phenotype of living endodermal cells based on the observation as shown in Figure 3 H-K.

	WT	*zig-1*	*zip3-1 zig-1*	*zip3-1*
Öü	**6.42±0.46**	**4.12±0.39**	**5.66±0.48**	**6.6±0.63**
Ö†	**3.04±0.34**	**0.16±0.07**	**1.78±0.23**	**4.44±0.49**
Ö°	**0.46±0.21**	**4.14±0.39**	**2.1±0.30**	**0.38±0.14**
Ö¢	**35**	**5**	**29**	**33**
Ö£	**0**	**13**	**6**	**0**

Quantitative analysis of the cytological phenotype of living endodermal cells based on the observation as shown in Figure 3 H-K. Time-lapse imaging for 5 min with 15 seconds-intervals were performed. Five characteristics of amyloplasts and vacuolar membrane were quantitatively observed in living endodermal cells (I to V). I; Average number of amyloplasts in an endodermal cell in a focal plane at a timepoint (time 0). II; Average number of amyloplasts that appeared to be enclosed by the vacuolar membrane within I. III; Average number of amyloplasts that hardly move during a 5 min-observation within I. IV; Number of cells in which transvacuolar strands arose during 5 min-observation, indicating vacuolar membrane dynamics. V; Number of cells in which abnormal clusters of vesicles were found during 5 min-observation. Fifty cells were observed for each genotype and then analyzed.

Supplemental Table 3.

Primer sets for cloning and RT-PCR

Primer name	Sequence
gZIP3-F	5ÕCCCGGGAAATGTTAGATGCTTC-3Õ
gZIP3-R	5ÕCCCGGGTTTACATTTCGAGCAGC-3Õ
cZIP3-F	5ÕGTTCCCGGGATGATCGCAGACGGATCAGA-3Õ
cZIP3-R	5ÕGTTCCCGGGTACTTTGATCGCCTGGTATC-3Õ
cVPS35B-F	5ÕCTTGGATCCATGAGAACGCTCGCCGGAGTAG-3Õ
cVPS35B-R	5ÕCTTGGATCCTCACAGCTTGATAGGGTCATA-3Õ
cVPS35C-F	5ÕCTTGGATCCATGATCGCCGACGACGATGAG-3Õ
cVPS35C-R	5ÕCTTGGATCCTCATTCAAACCATTCCATTTTG-3Õ
cVPS35B-F2	5ÕAAGAGTTCTTCTCTGTTTAAGACG-3Õ
cVPS35B-R2	5ÕTGTGTCTCGGATTTAAGTCACAGC-3Õ
cVPS35C-F2	5ÕATTCTGCAAGACTCCTAAGGAAGC-3Õ
cVPS35C-R2	5ÕTCTTCTTGCTGTCTCTGAAACTCG-3Õ
cVPS26A-F1	5ÕGTCTCTCTCCGATTGAAATAAACC-3Õ
cVPS26A-R2	5ÕTGCATACAGAAAGTCTTGAAAAGG-3Õ
cVPS26B-F1	5ÕATTACGCTCTTAACATCAGCTTGG-3Õ
cVPS26B-R2	5ÕATCTGAGTACACAAAGTCTAAAGC-3Õ
ACT8 Df	5ÕGAGAGATTCAGGTGCCCAG -3Õ
ACT8 Dr	5ÕAGAGCGAGAGCGGGTTTTCA -3Õ
pSCR(-30)D	5ÕTCTTACCTTATTTATAACCTAGGC-3Õ
cVPS35B-R1	5ÕGATACATTCTGGGCAATATGTTGC-3Õ
cZIP3-R2	5ÕATACAGTCTATTAGGTAATATTGG-3Õ
cVPS35C-R1	5ÕATTCATGTGTGCATCACCATCTCC-3Õ