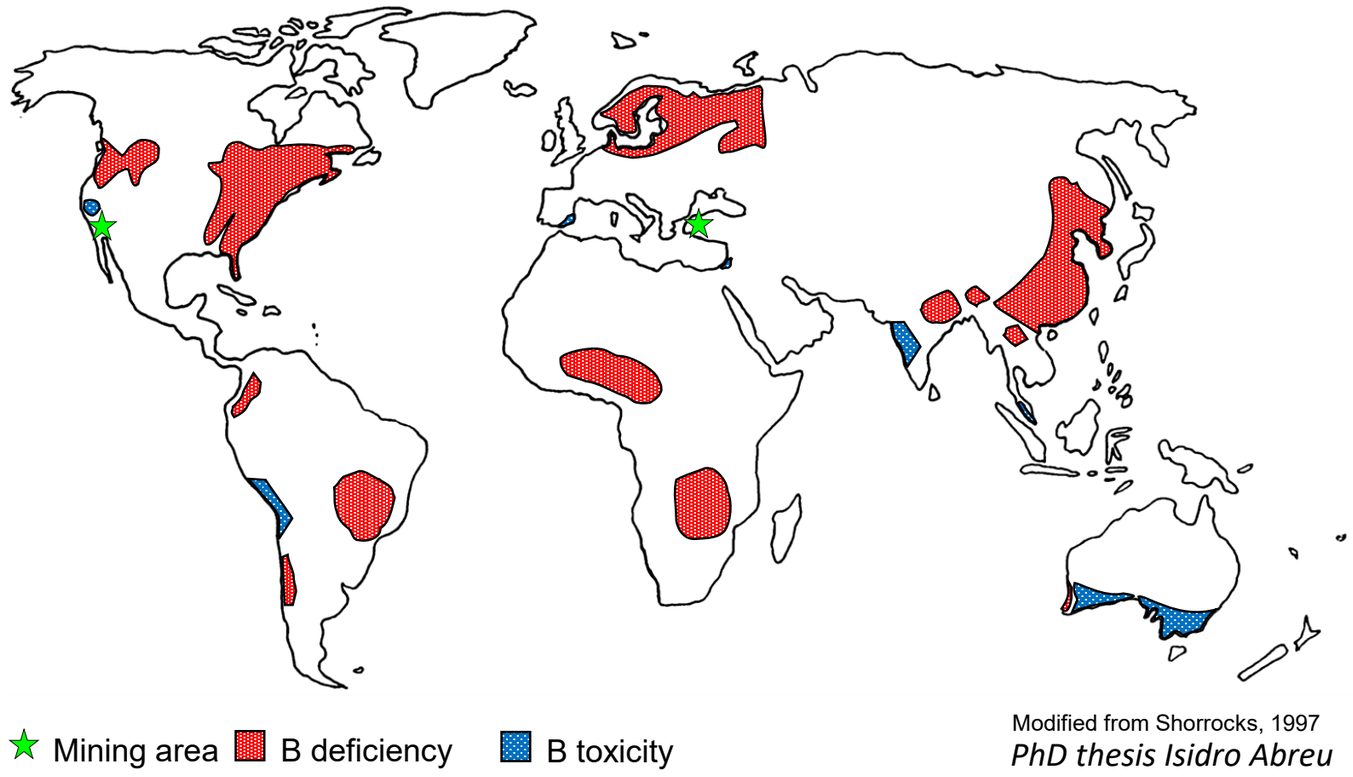
MtNIP5;1, A Novel *Medicago truncatula* Boron Diffusion Facilitator Induced Under Deficiency

Maria Reguera

1st International Electronic Conference on Plant Science

Some quick facts about B stress in plants

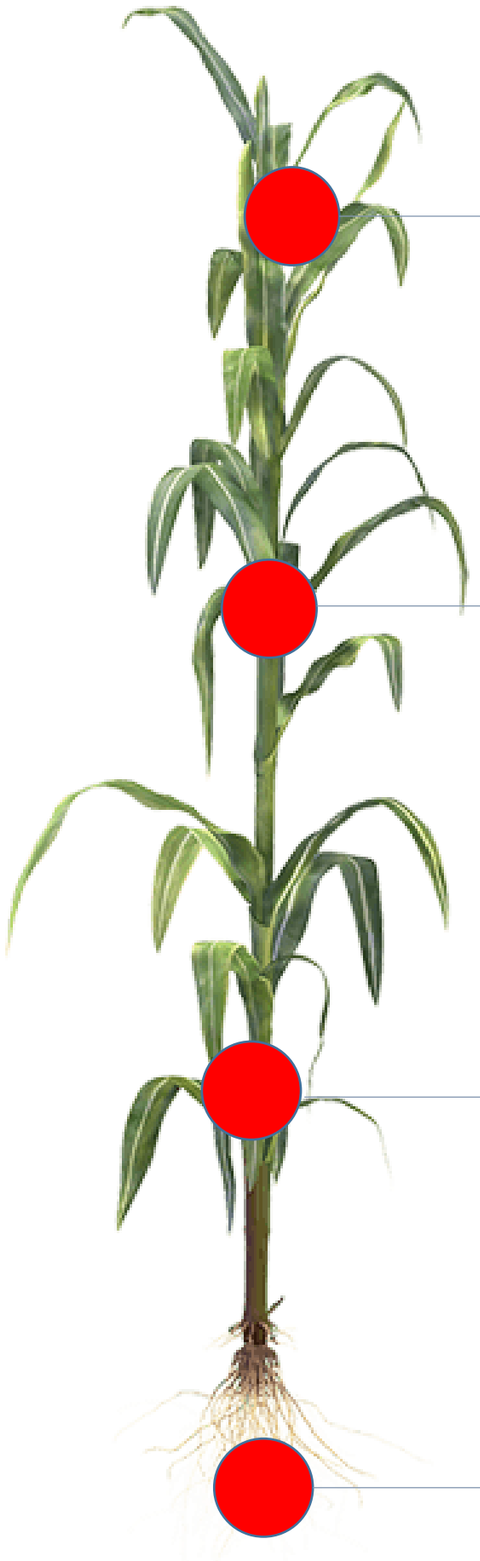
Occurrence of boron (B) deficiency and toxicity around the world

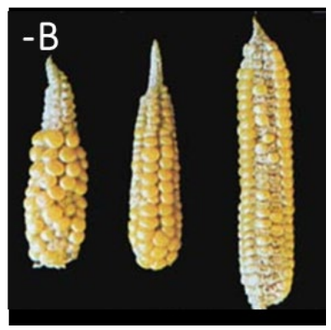


Modified from Shorrocks, 1997
PhD thesis Isidro Abreu

- ✓ Boron (B) is an **essential micronutrient** for vascular plants limiting crop productivity worldwide
- ✓ B is essential for plants but toxic in excess. B is the **most widespread micronutrient deficiency after zinc** and should be maintained within a narrow range of concentrations for optimal growth.
- ✓ The **tolerance** of plants to B stress **varies** significantly depending on the **plant species, genotype, and growing conditions.**

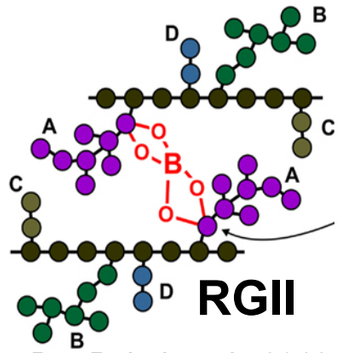
Some quick facts about B stress in plants





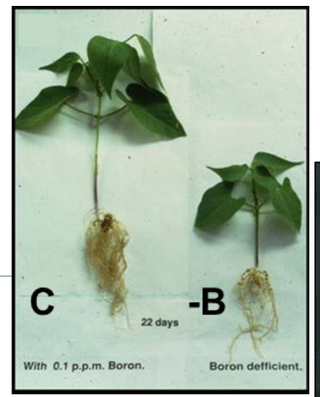
Owen Plank, University of Georgia

B affects **fertility** and **seed /fruit** setting and quality



Bar-Peled et al., 2012.
Front. Plant Sci.

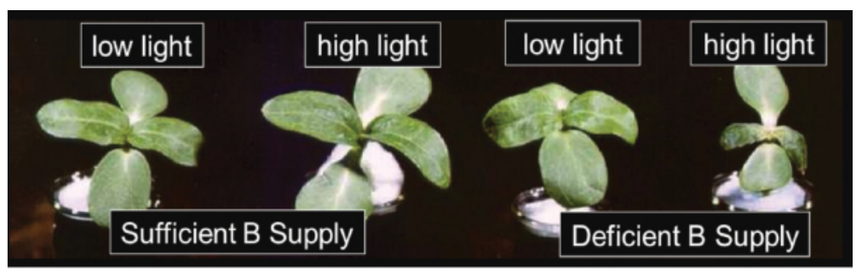
The effects of B stress rely on the capacity of B to form ester bonds with ***cis-diol*** **groups**.

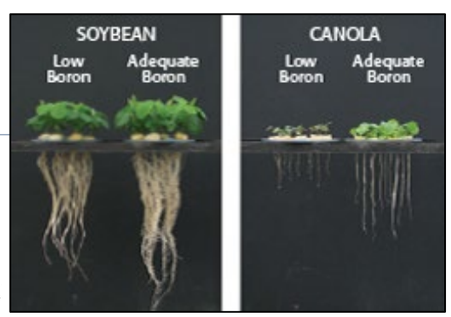


Bonilla et al., 2009.
Plant Physiology and Development

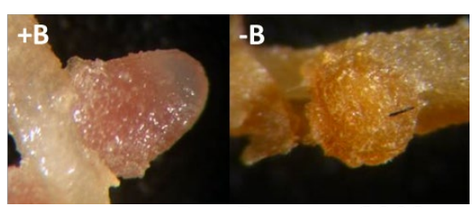
Plant **growth is inhibited** under B stress.

+B





Yazici and Cakmak



Reguera, 2009..

B stress influences the response to **other stresses** and *vice versa.*

B deficiency effects on rhizobia-legume symbiosis I: symptoms

Brenchley and Thornton, 1925.
Boron's essentiality

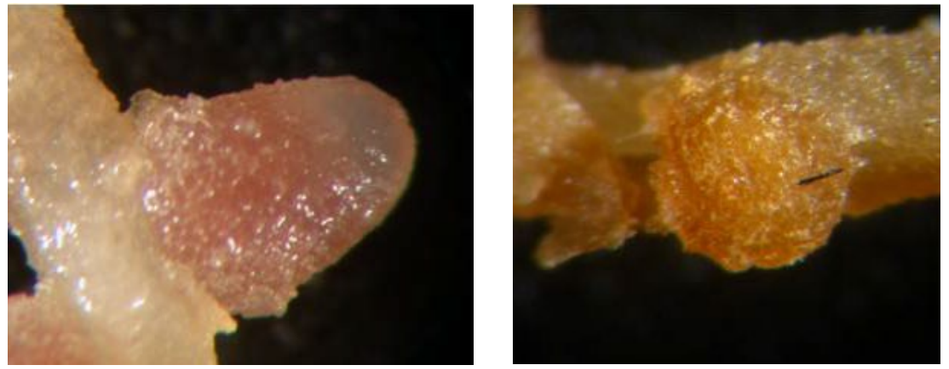
Rhizobia-legume symbiosis

Bolaños et al., 1994:
Pisum -Rhizobium

present

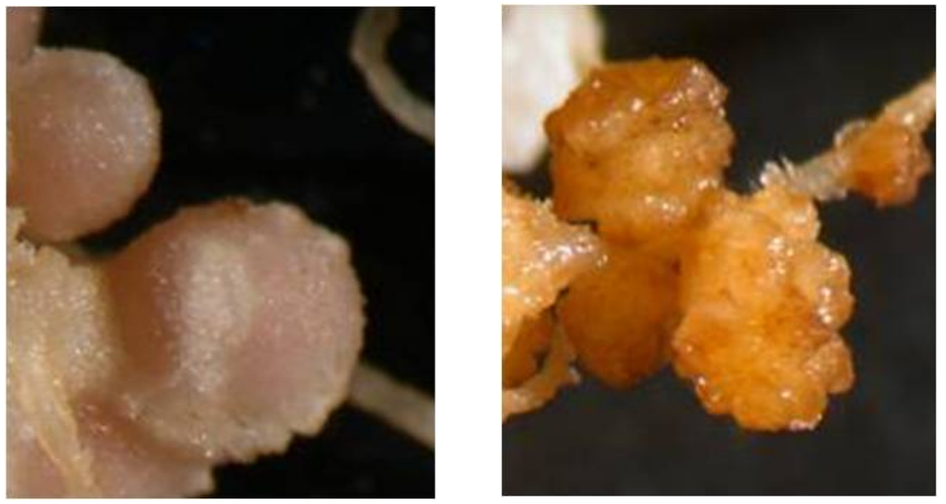
+B **-B**

Pisum sativum



+B **-B**

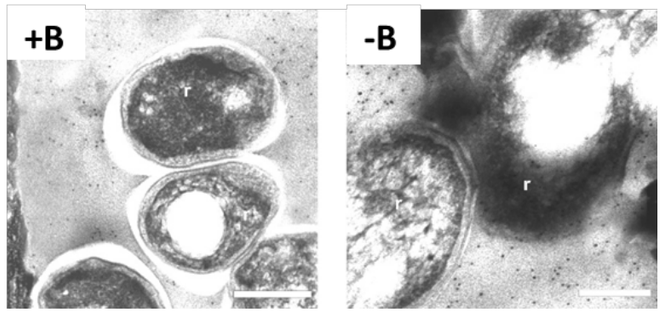
Phaseolus vulgaris



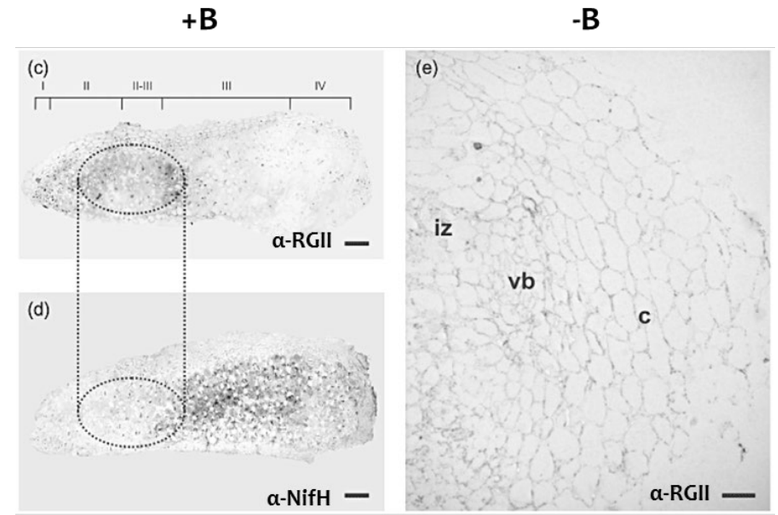
+B **-B**

Reguera, 2009. PhD thesis

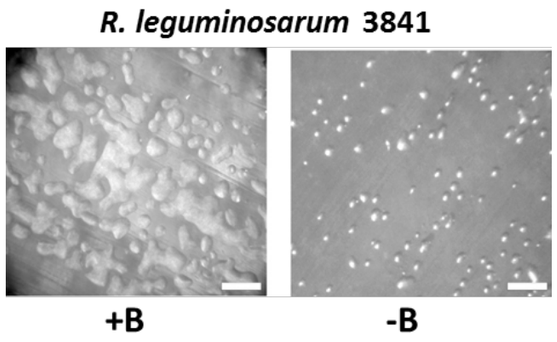
B deficiency effects on rhizobia-legume symbiosis



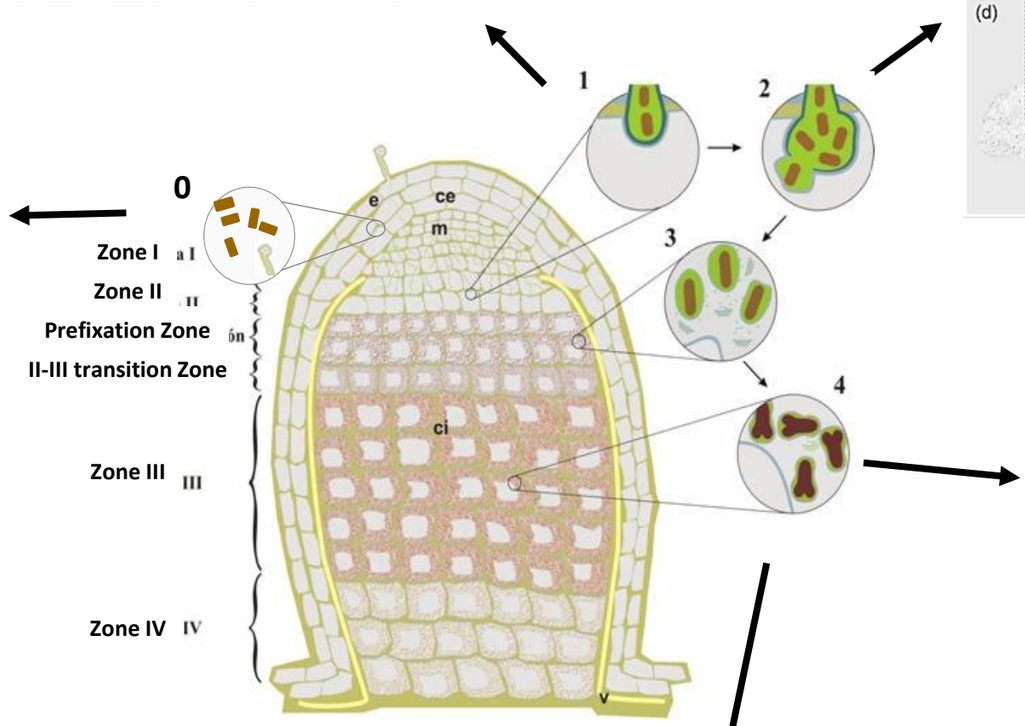
Reguera *et al*, 2010.
Plant Cell Environ.



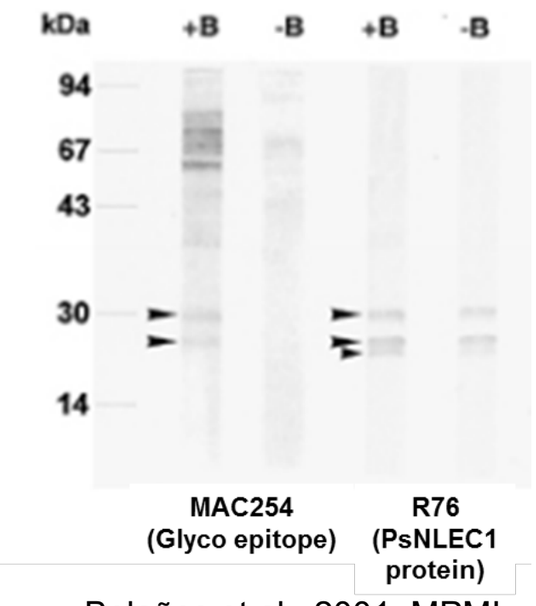
Redondo-Nieto et al., 2007.
Plant Cell Environ.



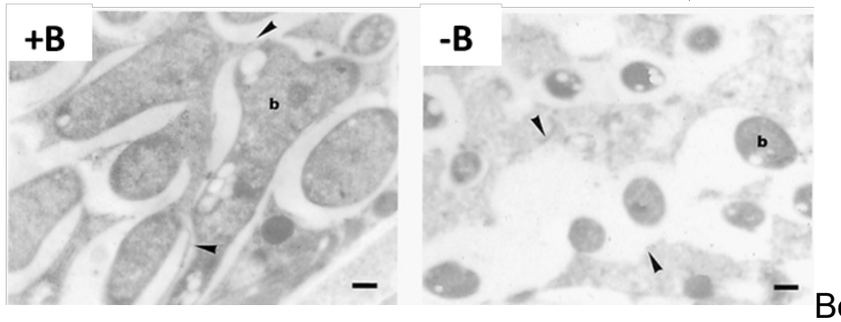
Reguera *et al*, 2010.
Plant Cell Environ.



Redondo-Nieto et al, 2004.



Bolaños et al., 2001. MPMI

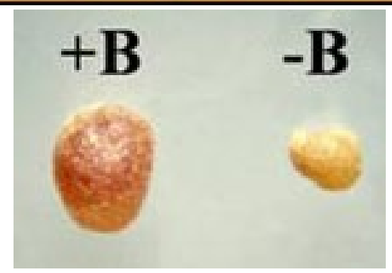


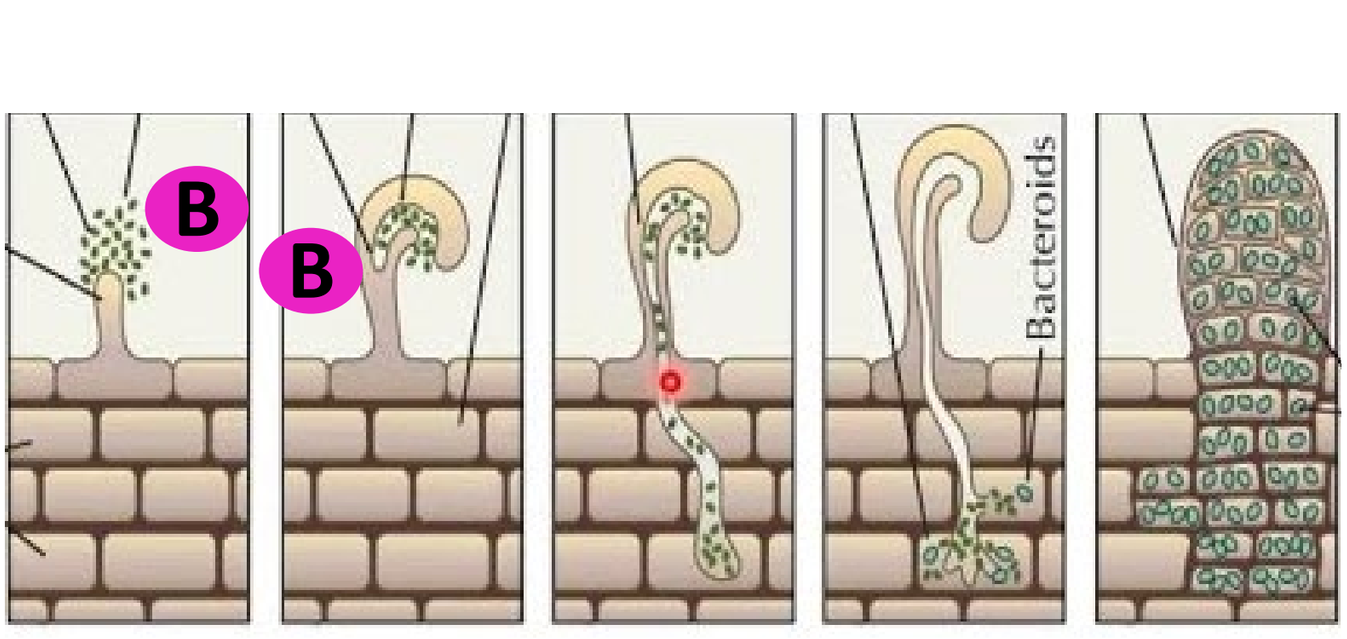
Bolaños *et al*, 2001. MPMI

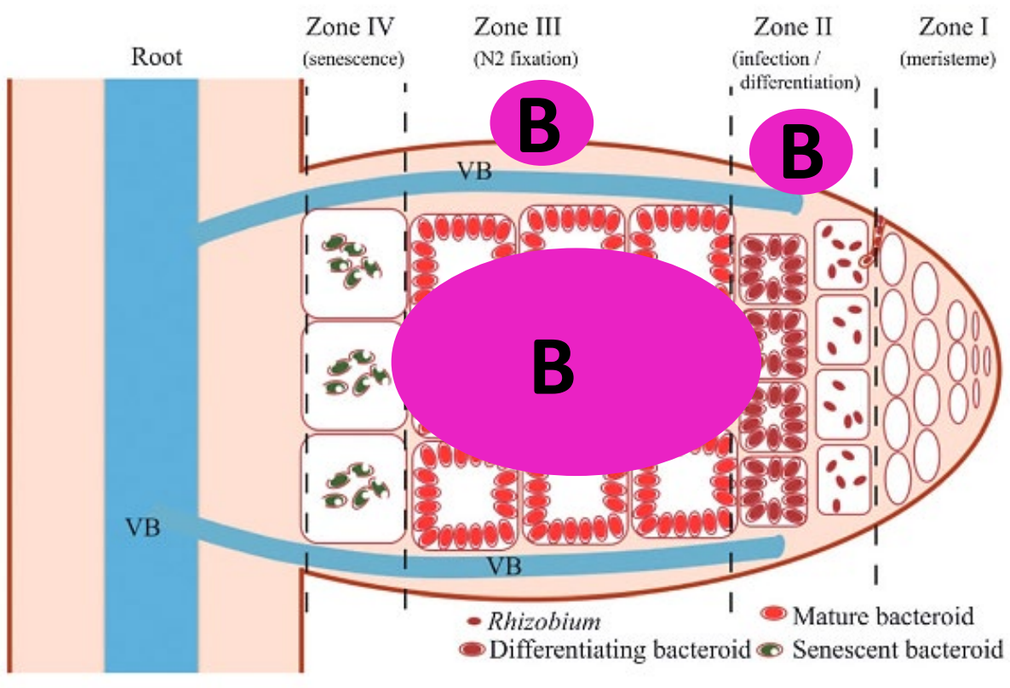
Legumes and B

Legumes are very sensitive to low B

B is necessary for the establishment of an effective symbiosis







What about B transport in legumes?

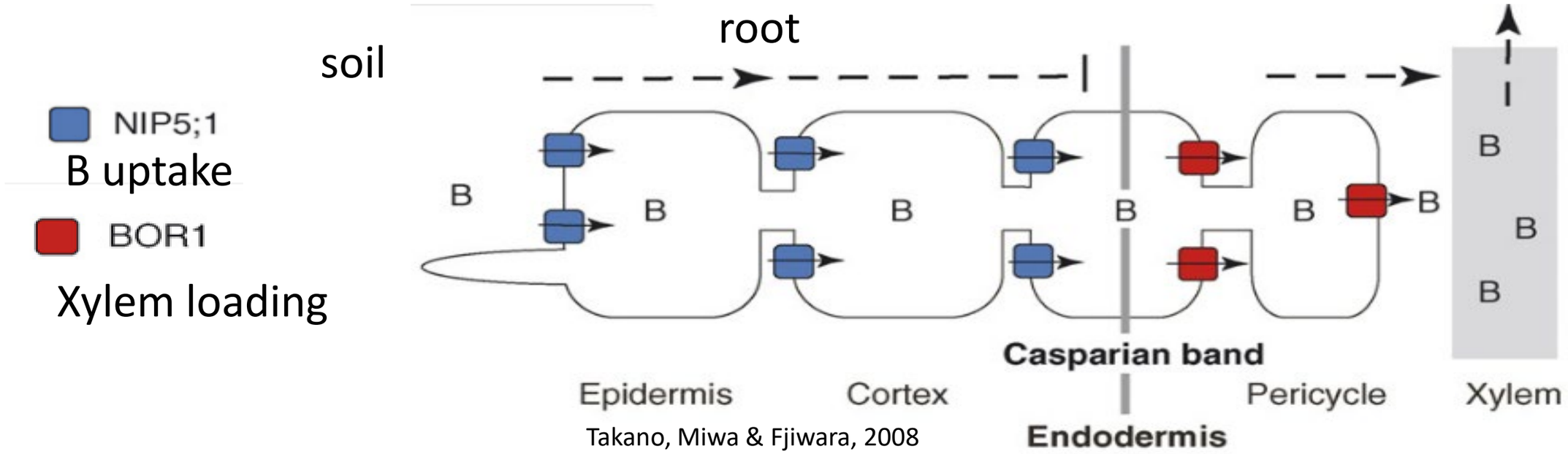
B transport in plants

- Passive diffusion under optimal conditions
- Mediated by transporters in suboptimal concentrations

  There are 2 types:

  ✓ **BOR** family. B Efflux transporters

  ✓ **MIP** family (including NIPs). Aquaporins



Takano, Miwa & Fjiwara, 2008

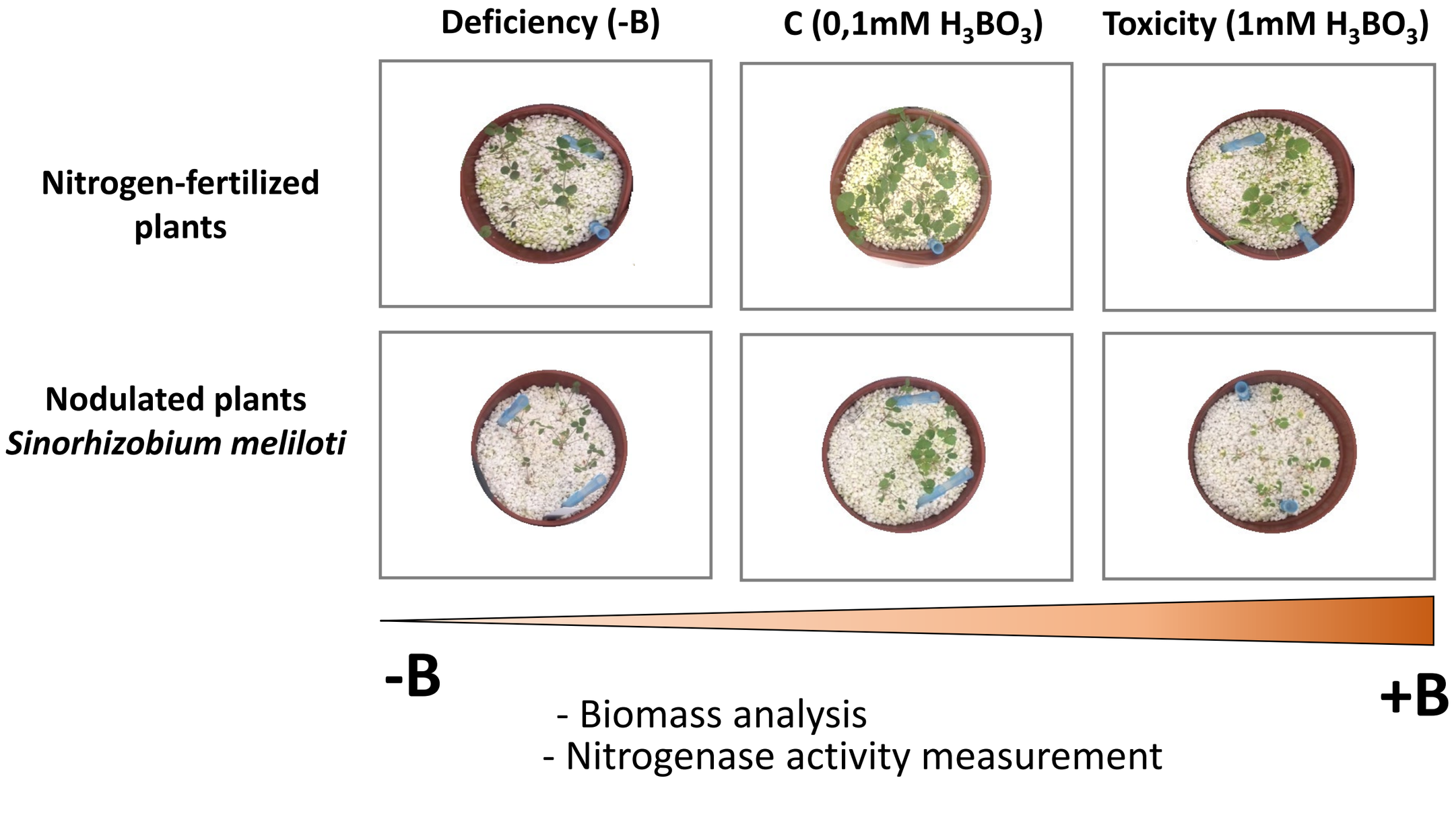
Medicago truncatula

Model organism for *Rhizobium-Legume* symbiosis studies

To identify and characterize genes that encode boron transporters

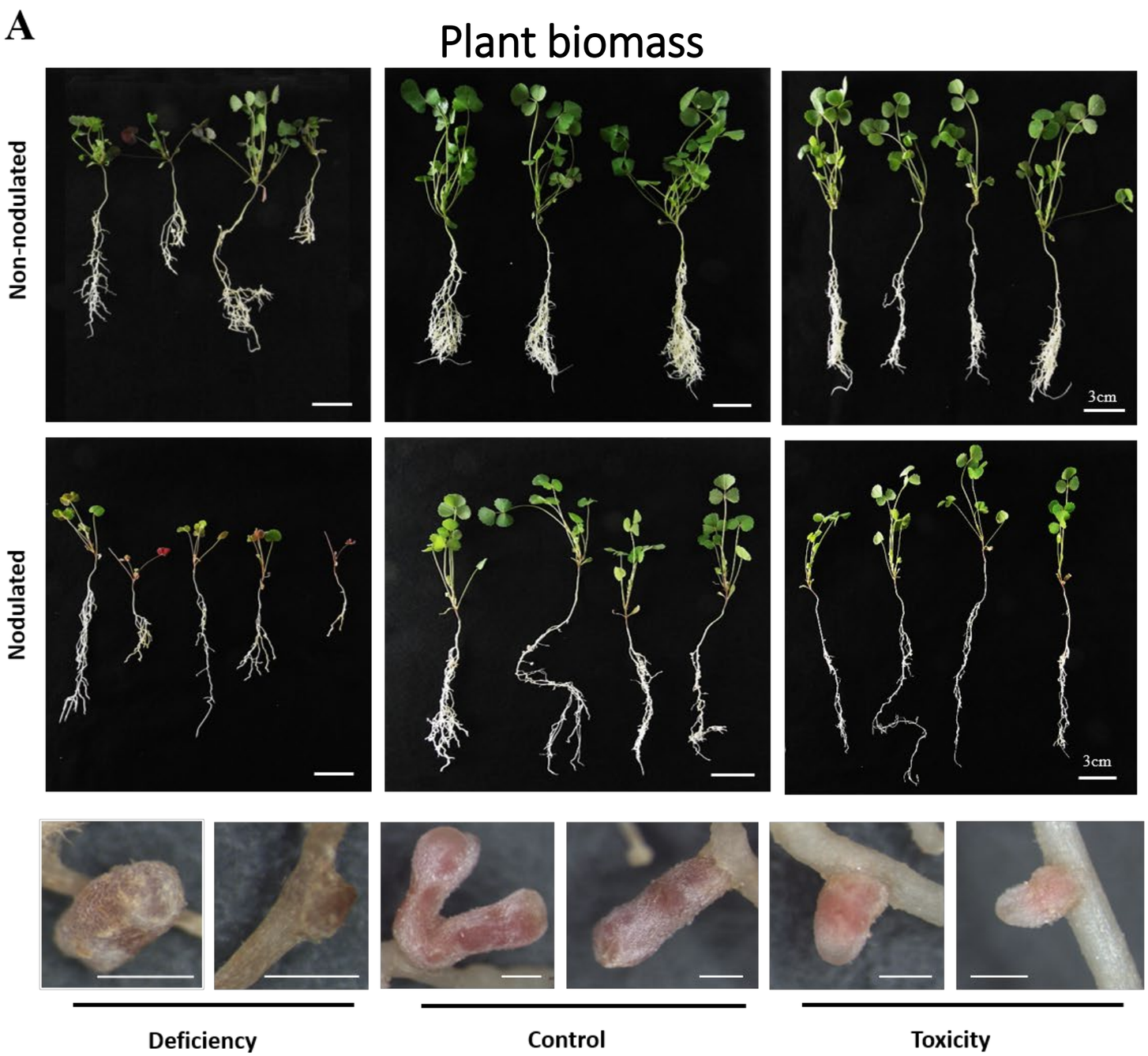
MtNIP candidates → *AtNIP5;1* homologs

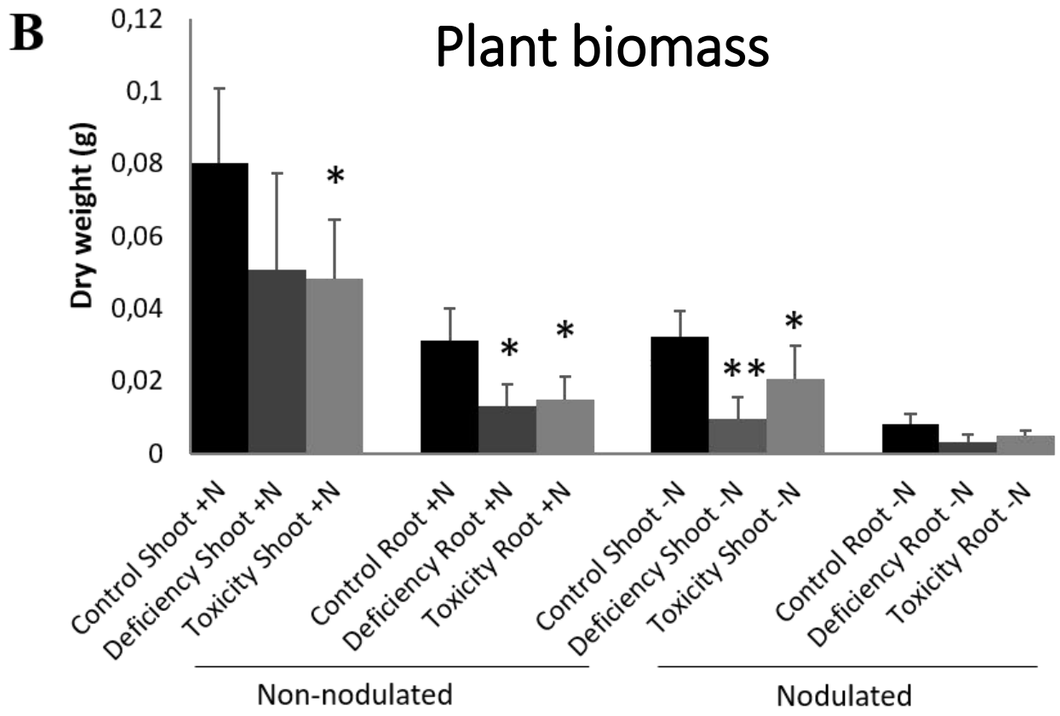
Phenotypic analysis of *Medicago truncatula* in a B gradient

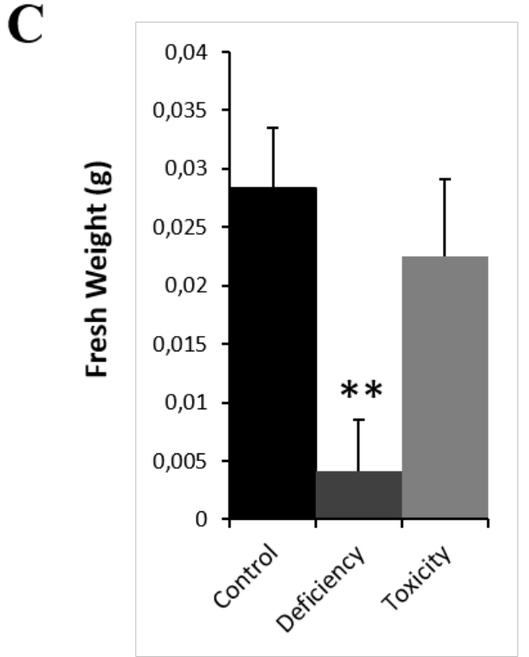


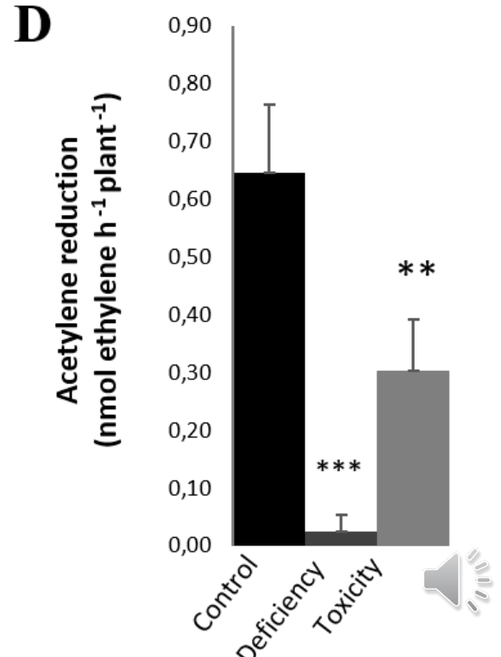
- Biomass analysis
- Nitrogenase activity measurement

Phenotypic analysis of *Medicago truncatula* in a B gradient

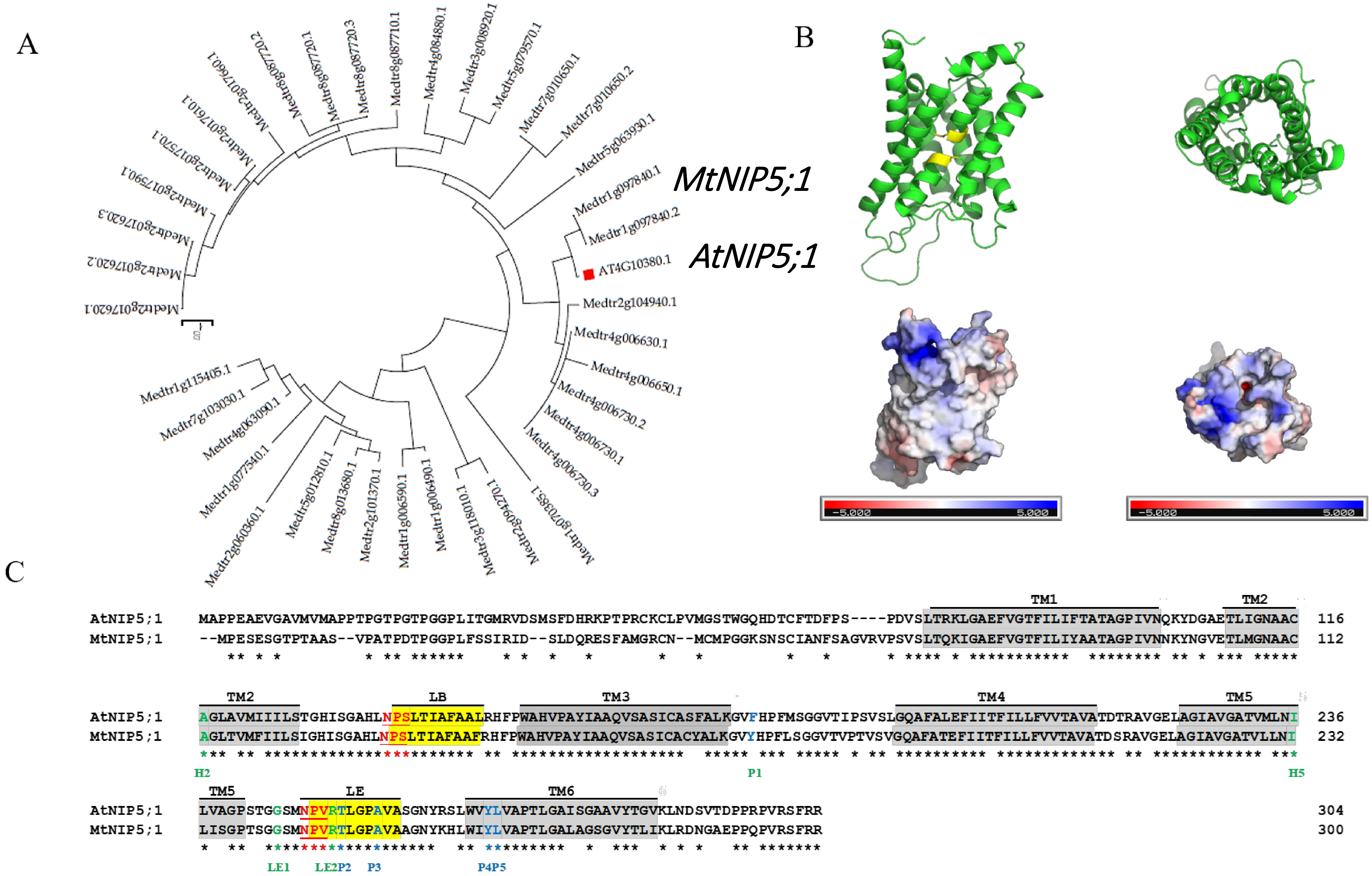




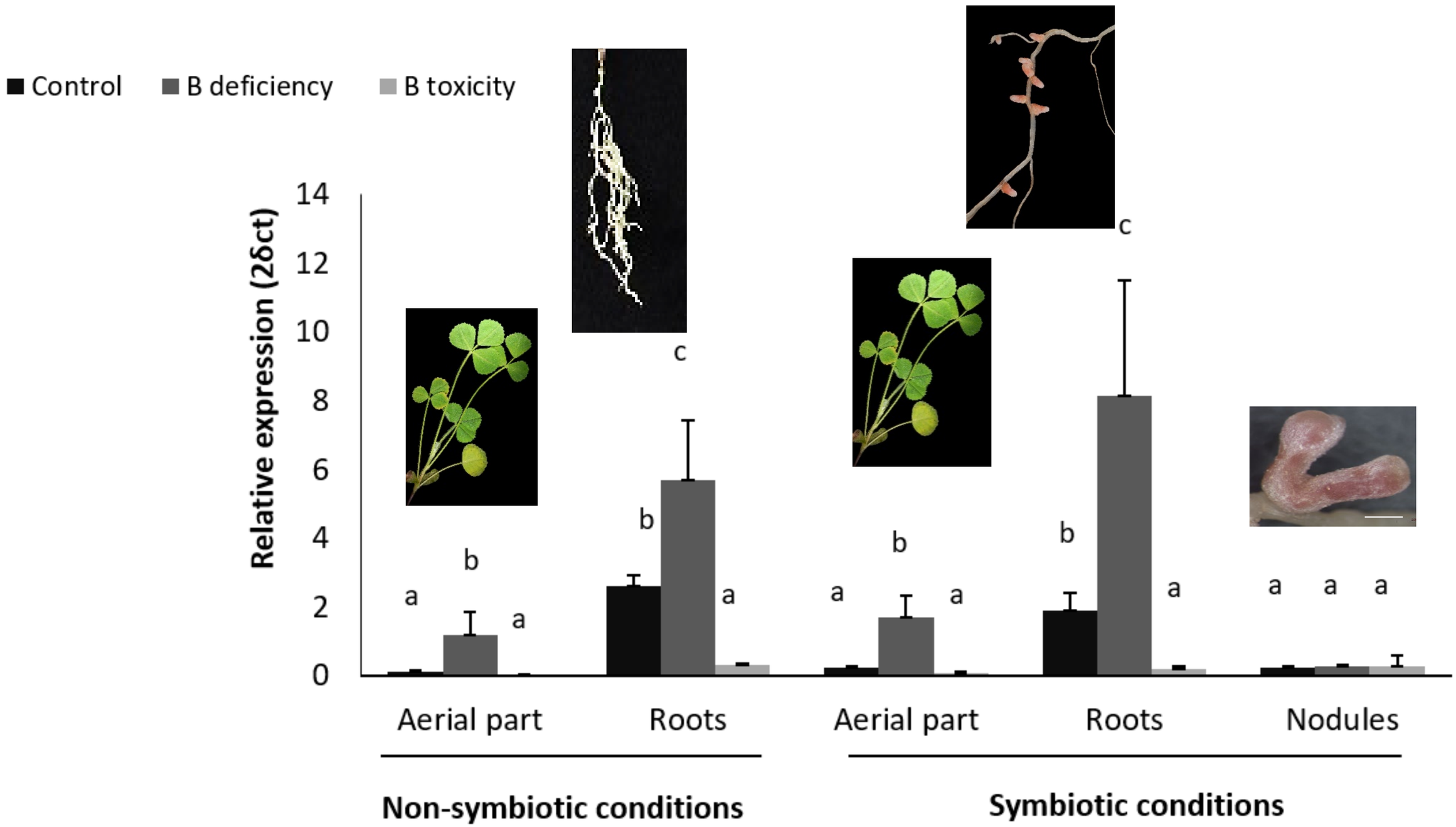




Candidate gene selection



Medtr1g097840 (*MtNIP5;1*) characterization



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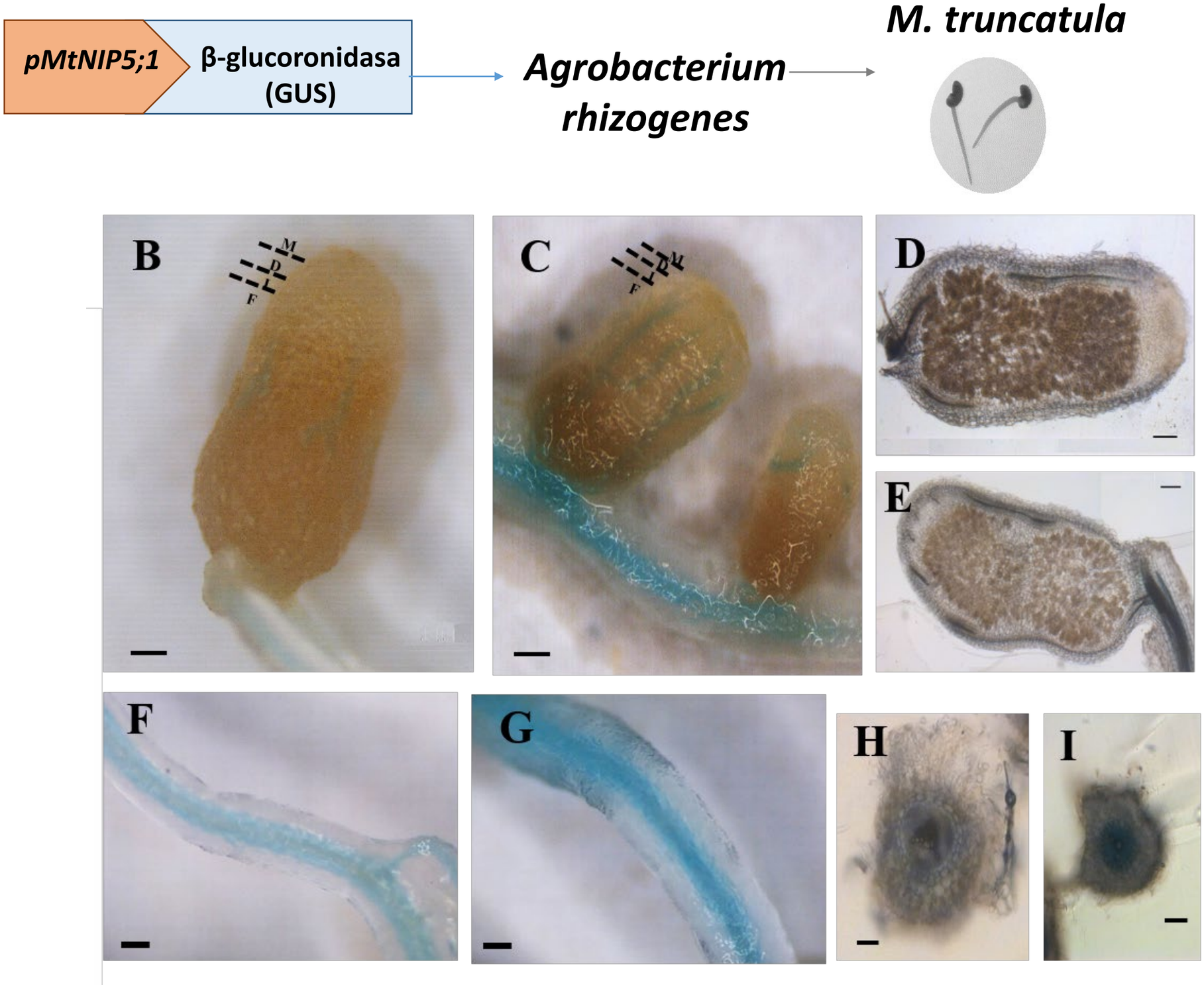
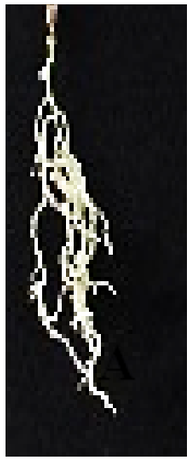


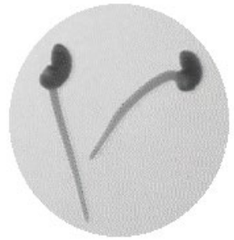
Medtr1g097840 (*MtNIP5;1*) characterization

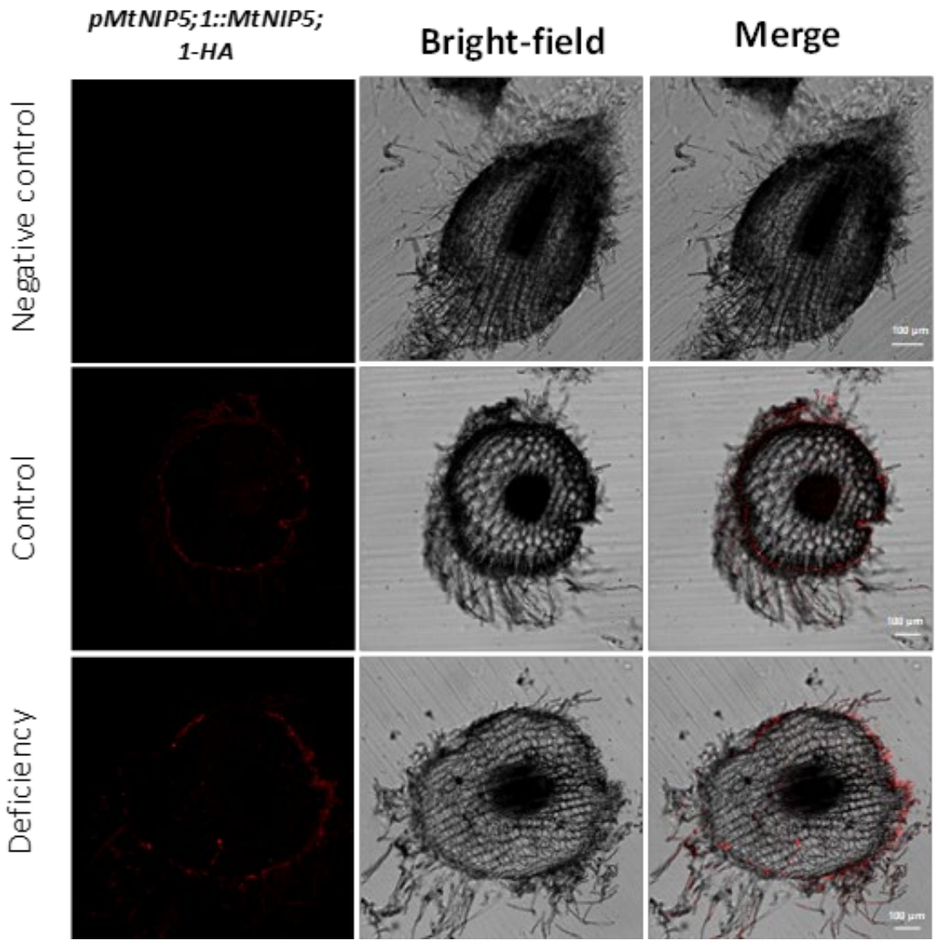
Location analysis

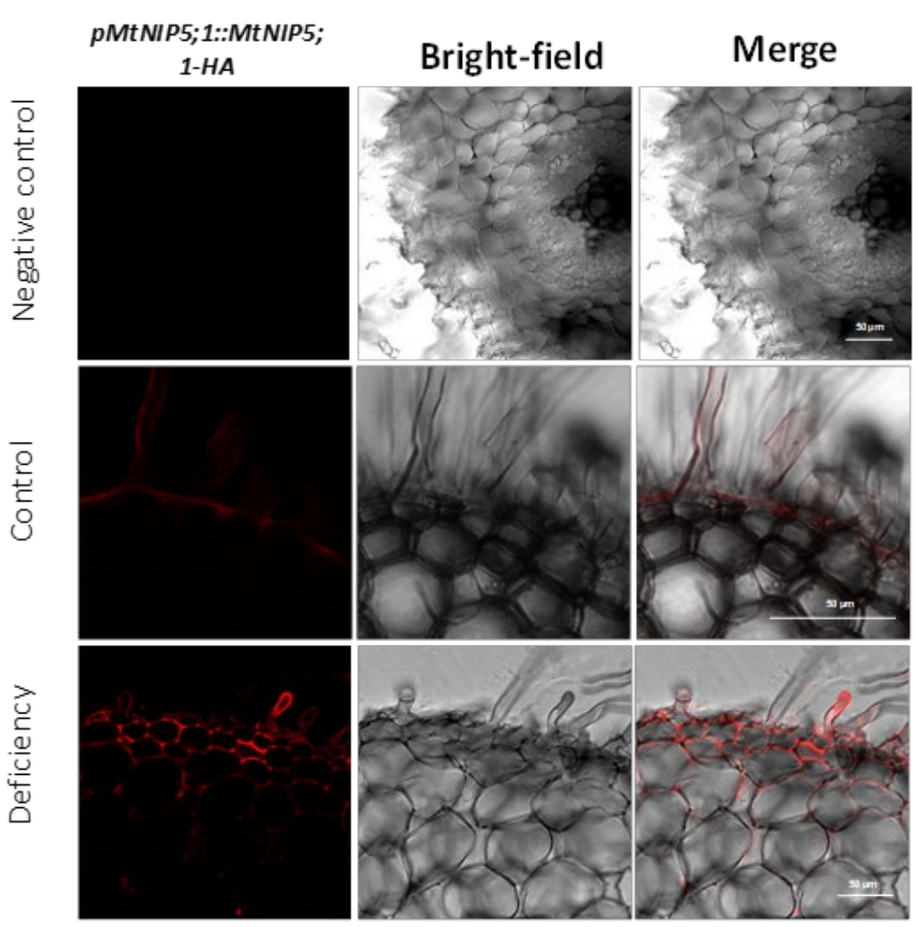


Agrobacterium rhizogenes

M. truncatula

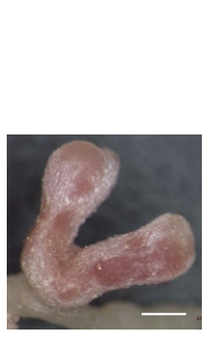






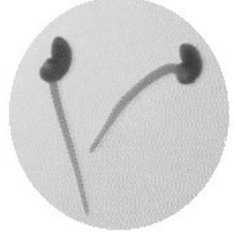
Medtr1g097840 (*MtNIP5;1*) characterization

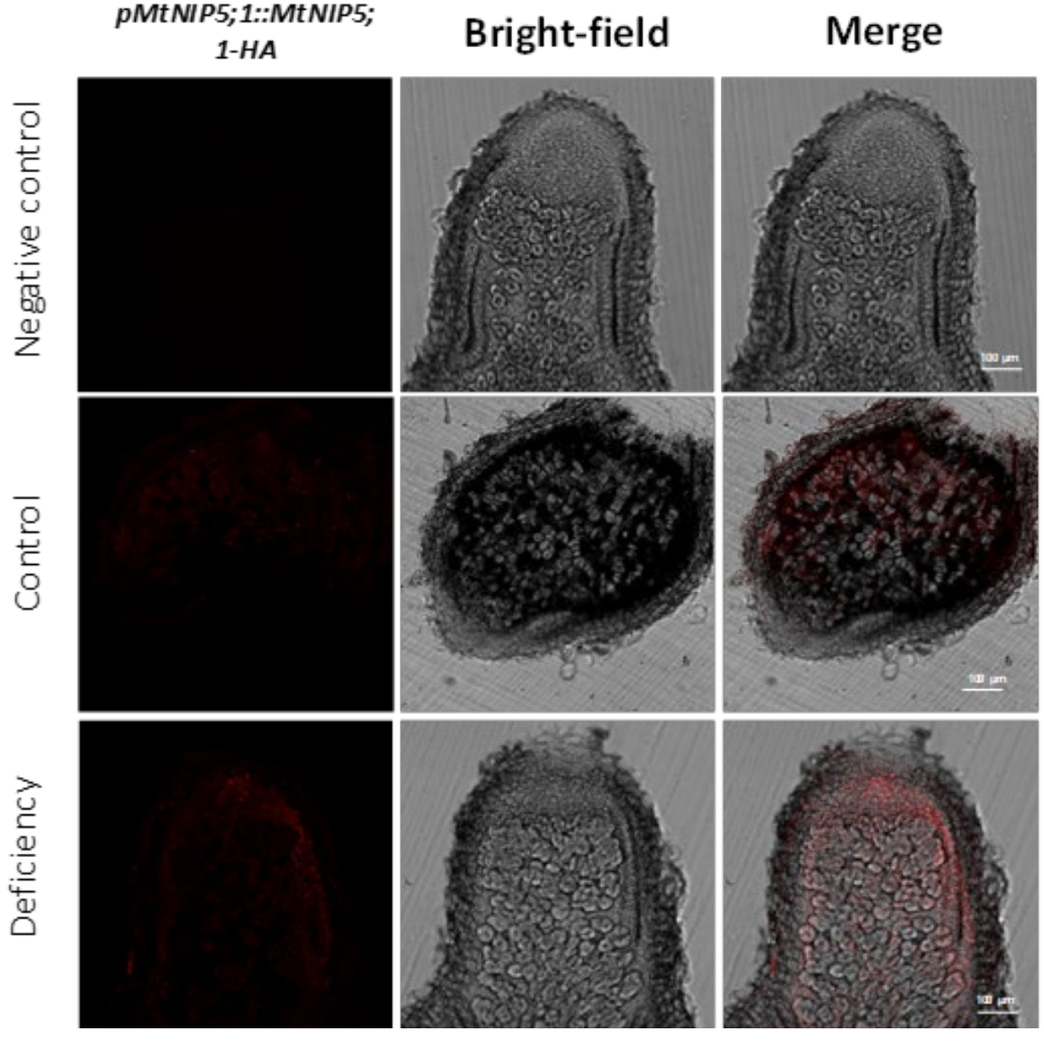
Location analysis

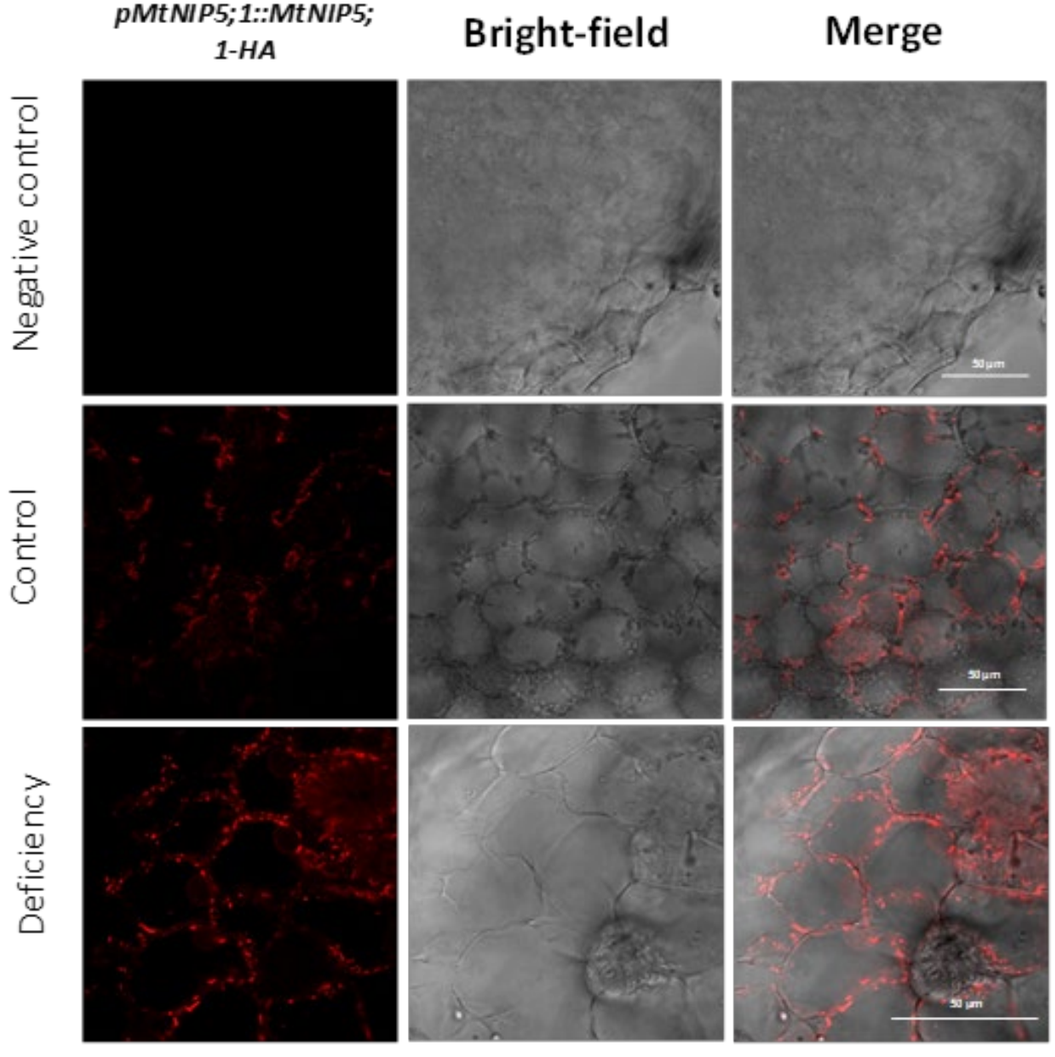


Agrobacterium rhizogenes

M. truncatula

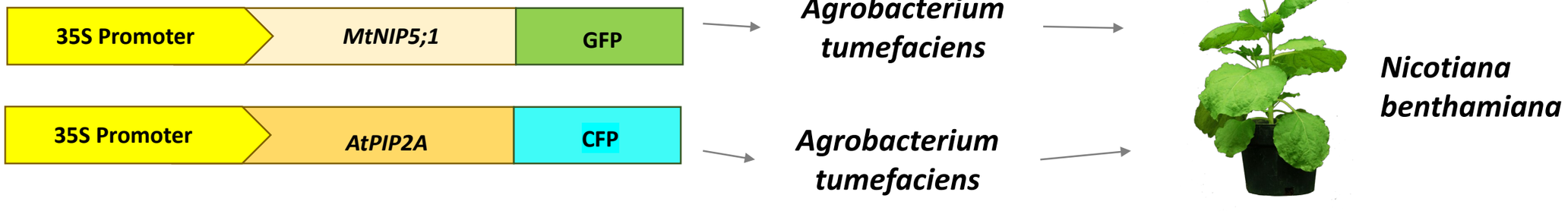


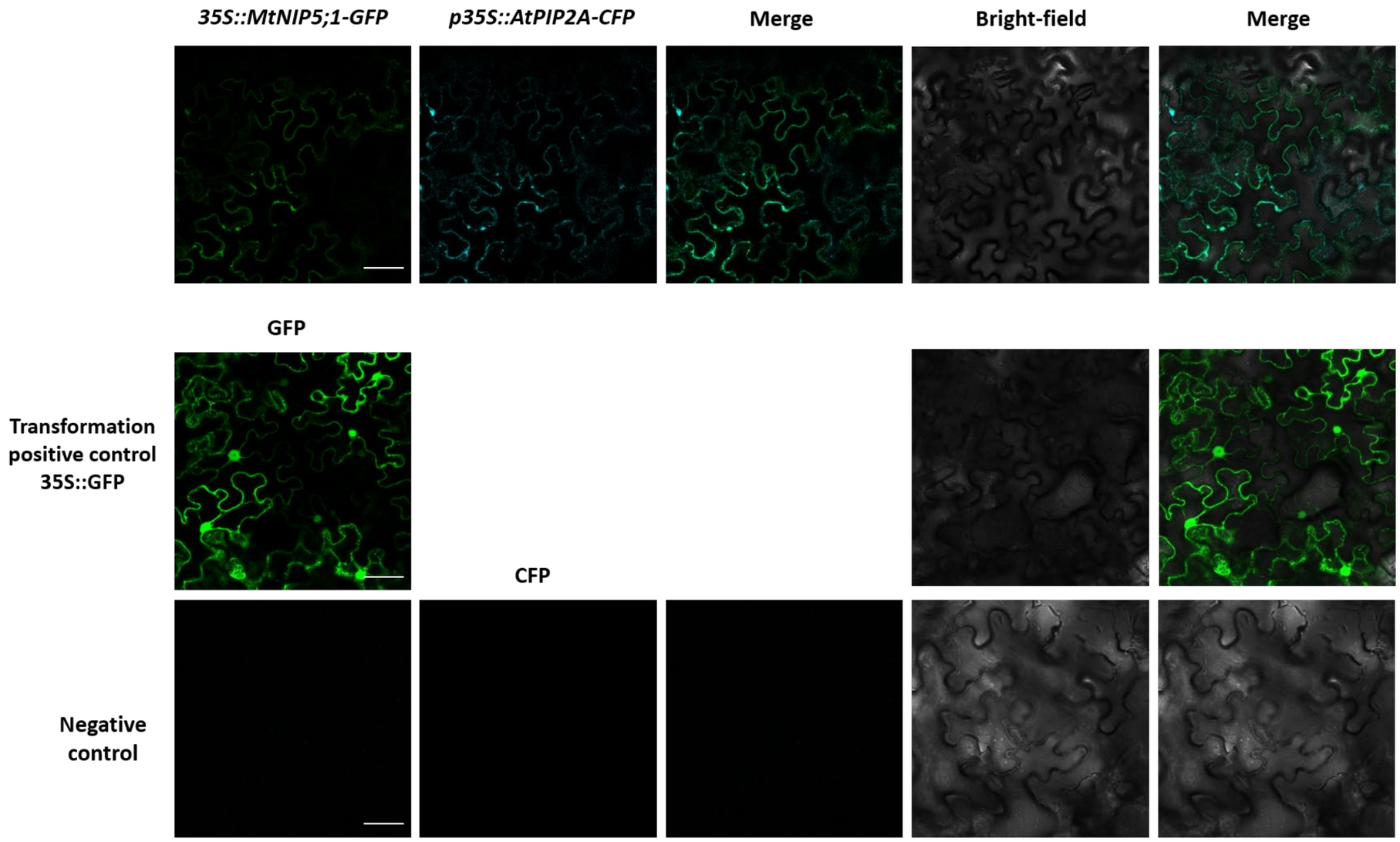




Medtr1g097840 (*MtNIP5;1*) characterization

Subcellular location analysis





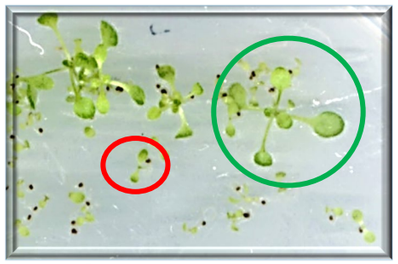
Medtr1g097840 (*MtNIP5;1*) characterization

Mutant complementation

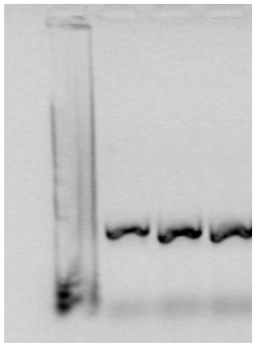
+ Kanamycin resistance gene

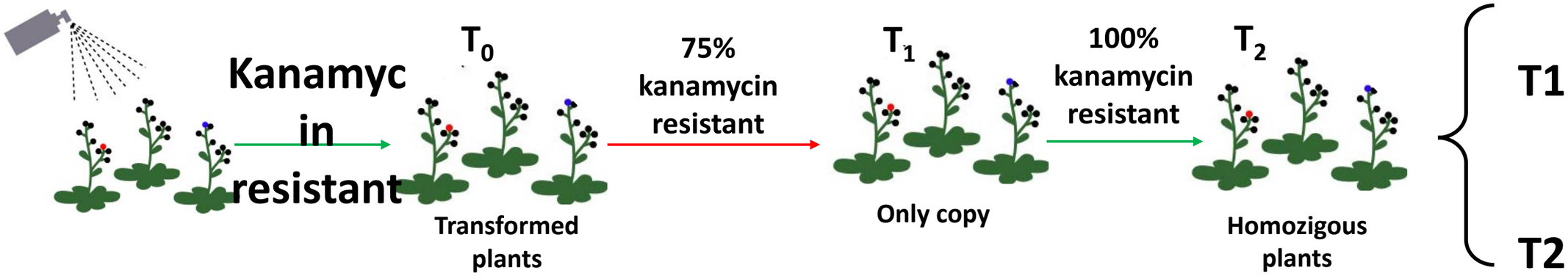
Agrobacterium tumefaciens

Arabidopsis thaliana nip5;1-1



Medium ½ MS + Km50





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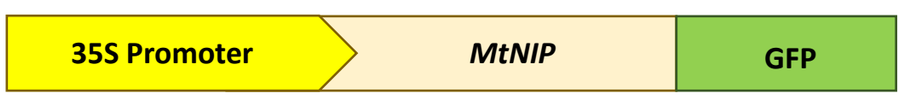

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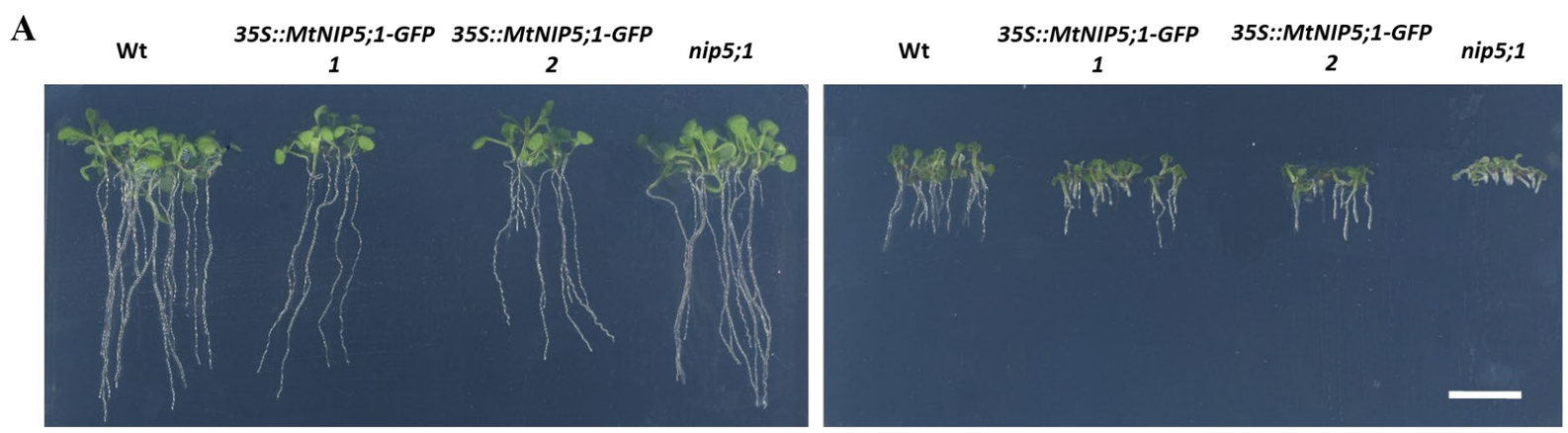
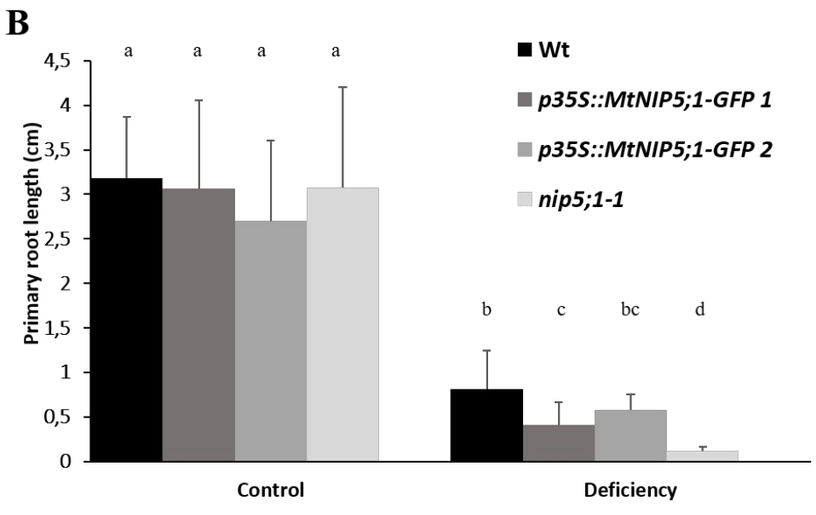
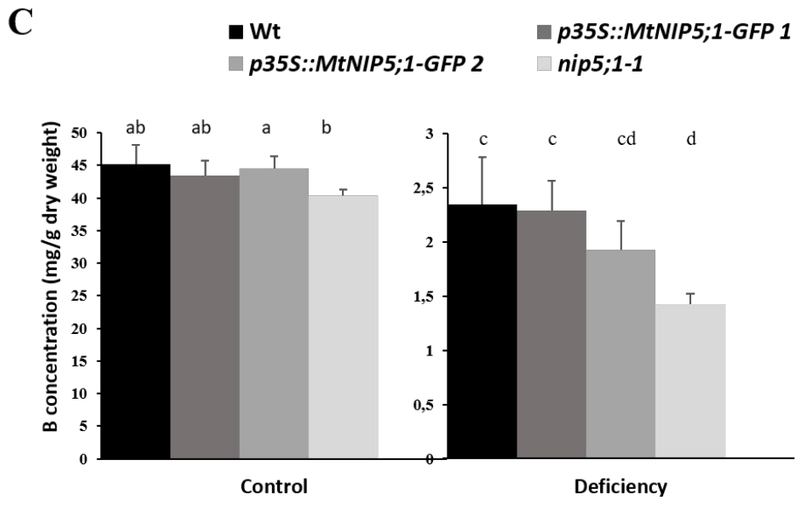
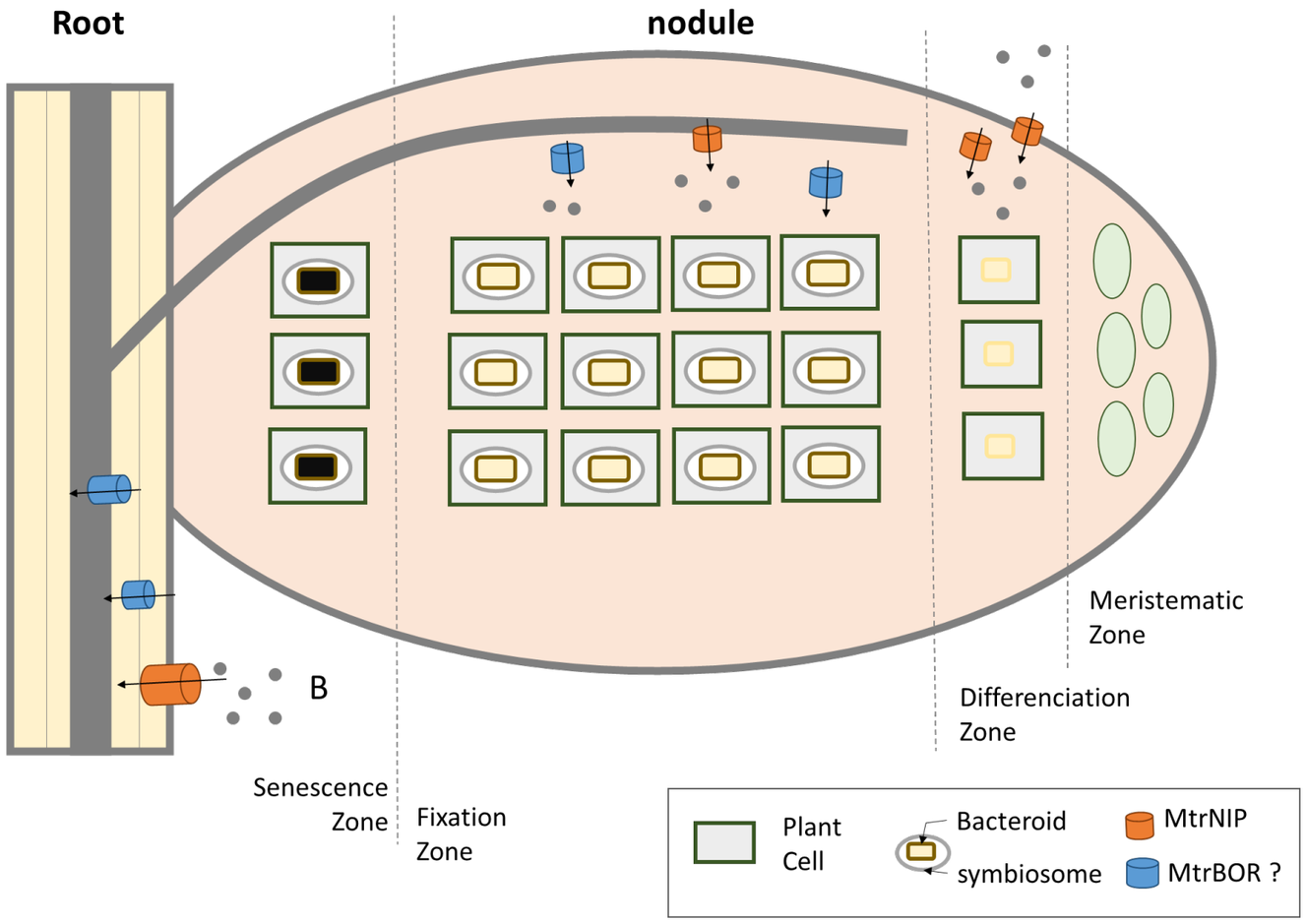






Summary

The induced expression under B deficiency and the repression under B toxic levels, together with this protein localization patters and the partial complementation of *nip5;1* mutant, support **a role of MtNIP5;1 functioning as a B transporter under B deficiency.**



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