

Engineering synthetic communication between plants and bacteria

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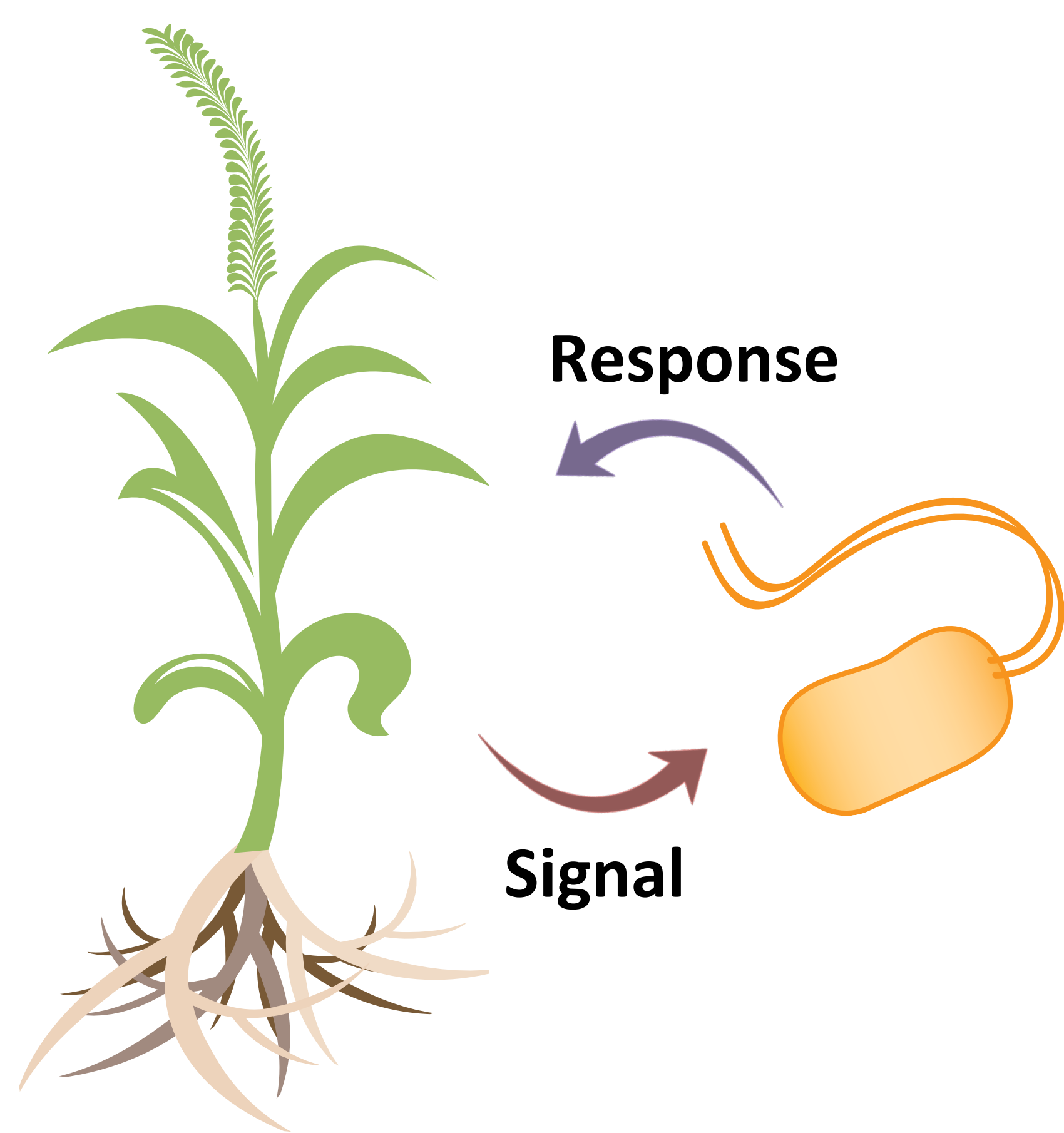
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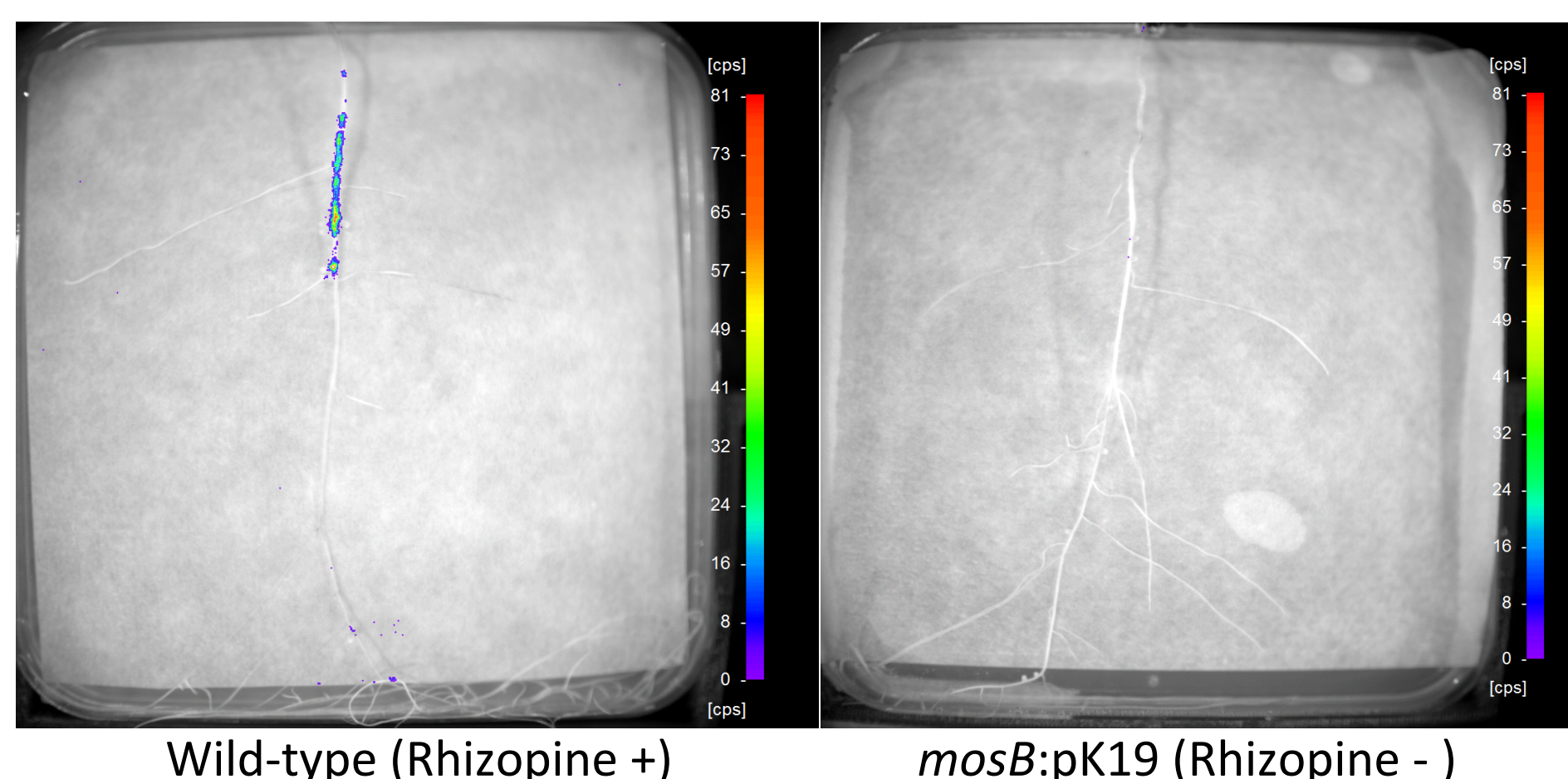
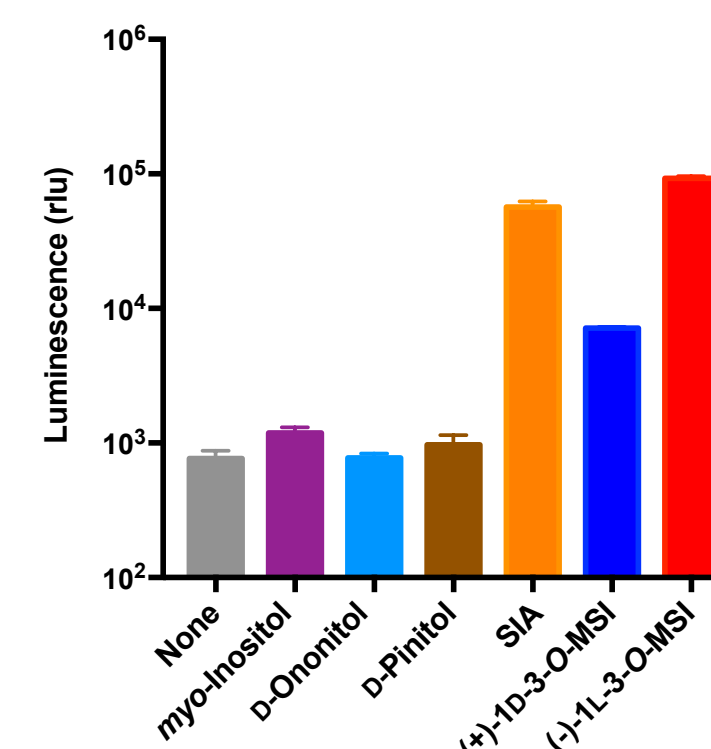
1. Signalling to the plant microbiota

We set out to establish synthetic communication between plants and bacteria that could be utilized to coordinate the activation of productive traits such as N₂-fixation in bacteria. This will help alleviate growth effects from constitutive expression of productive traits in microbes, and confine growth promotion effects to the target plant.



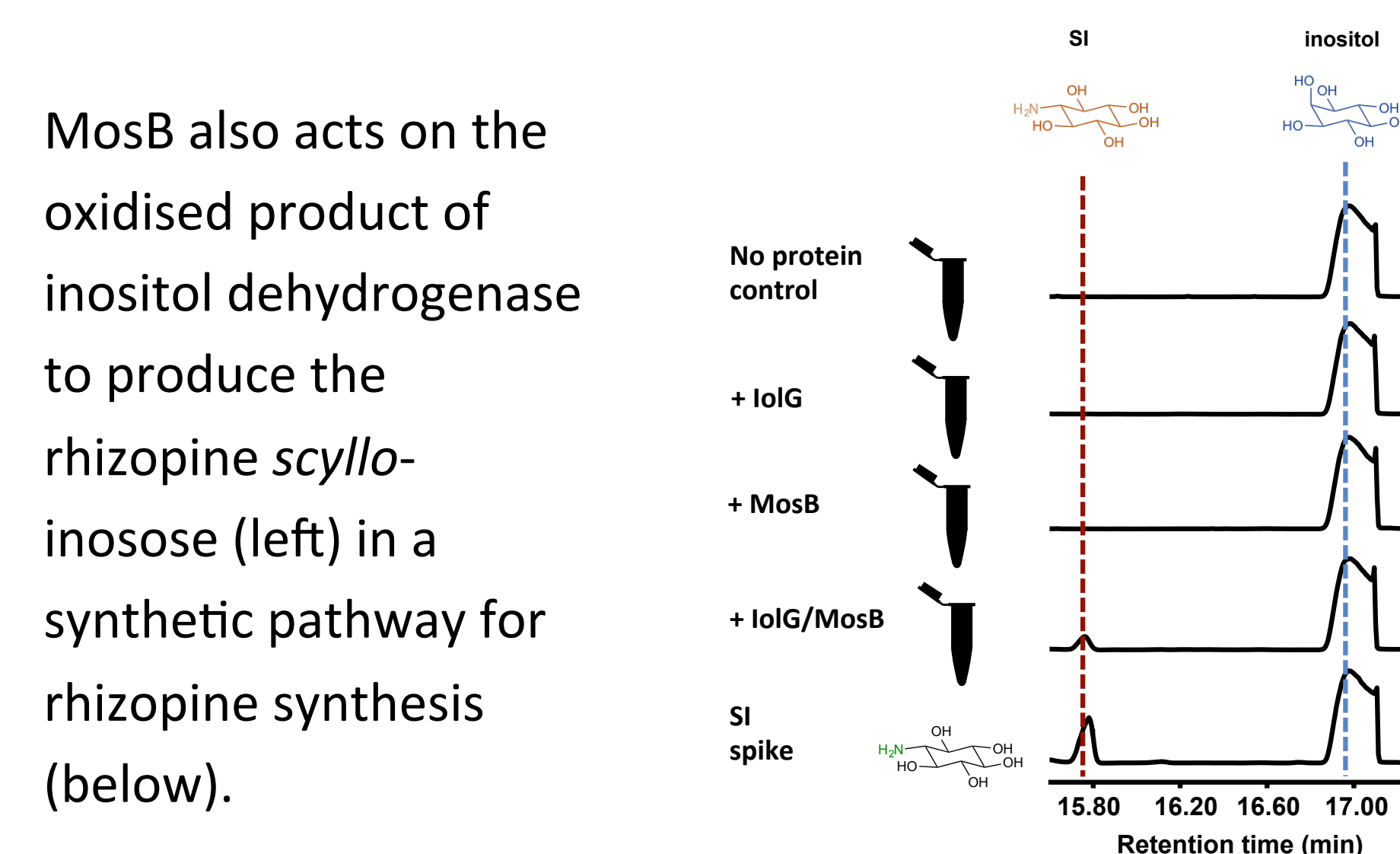
3. Rhizopines are exuded into the rhizosphere and bacteria can respond

Rhizopine *lux* biosensor induction by rhizopines in free-living culture (left) and the rhizosphere (below).



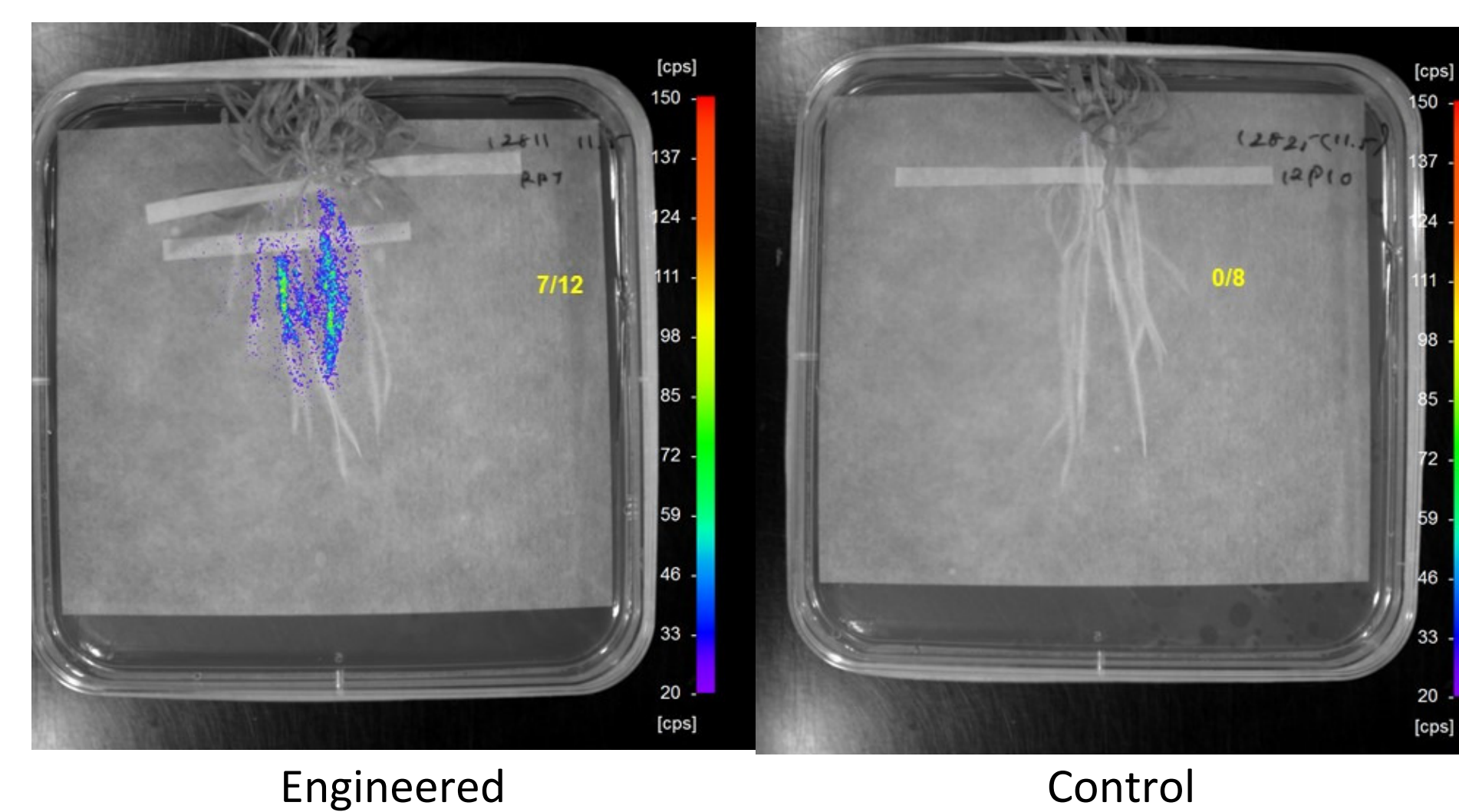
5. Engineering a synthetic pathway for rhizopine synthesis

MosB also acts on the oxidised product of inositol dehydrogenase to produce the rhizopine *scyllo*-inosose (left) in a synthetic pathway for rhizopine synthesis (below).



6. Synthetic transkingdom signalling between plants and microbes

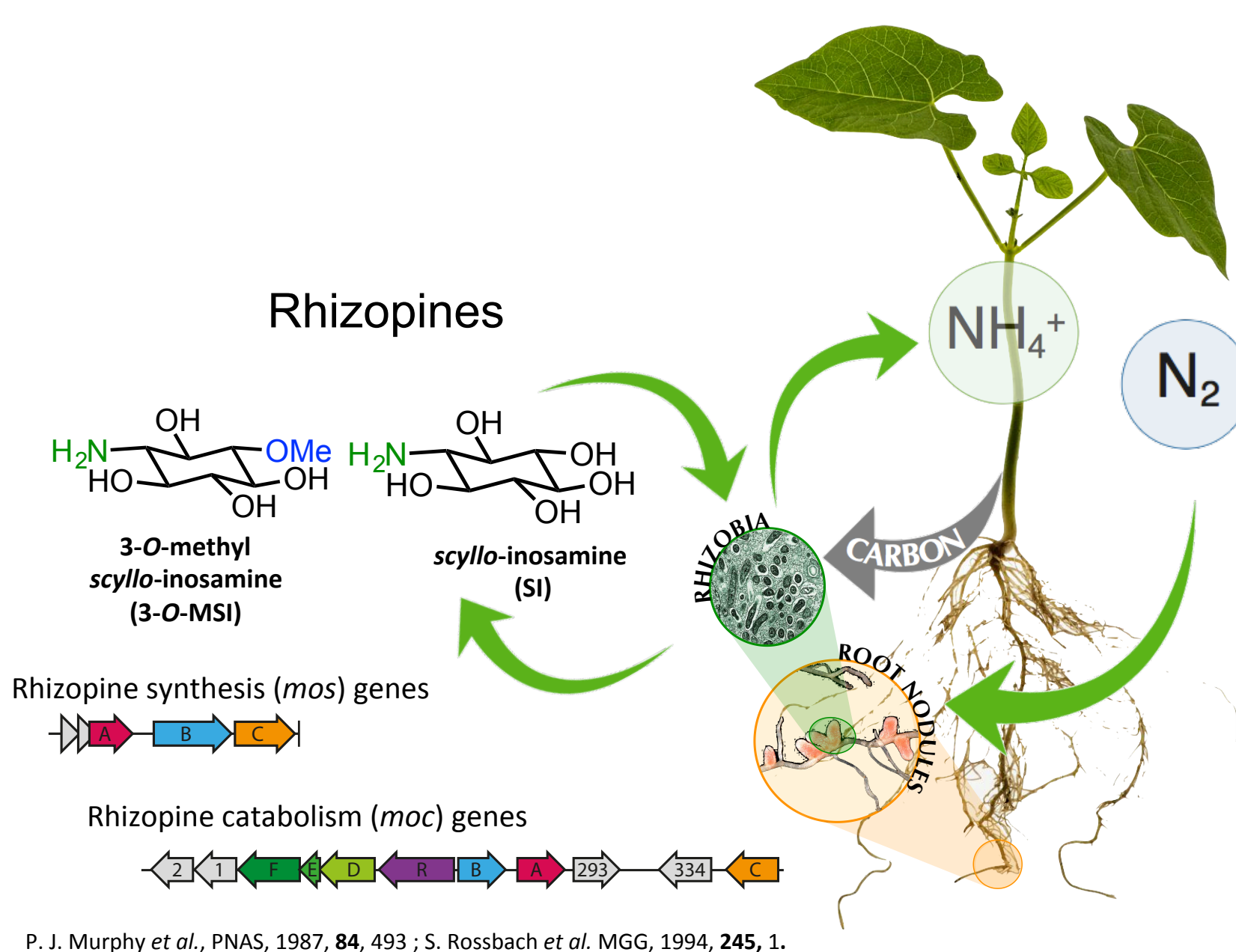
Barley plants engineered with synthetic rhizopine synthesis pathway elicit bioluminescent response from bacteria in the rhizosphere. For further information see talk by Ponraj Paramasivan in Parallel Session 10.



2. Rhizopines are candidate signals

Synthetic signal should be:

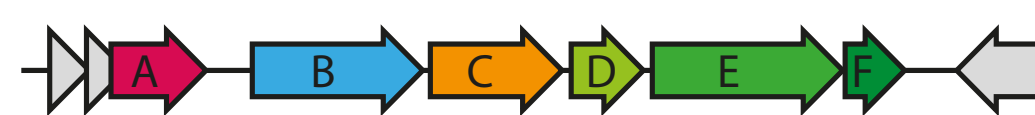
- 1) Amenable to engineering its synthesis in plants
- 2) Able to be perceived and responded to by bacteria
- 3) Secreted into the rhizosphere



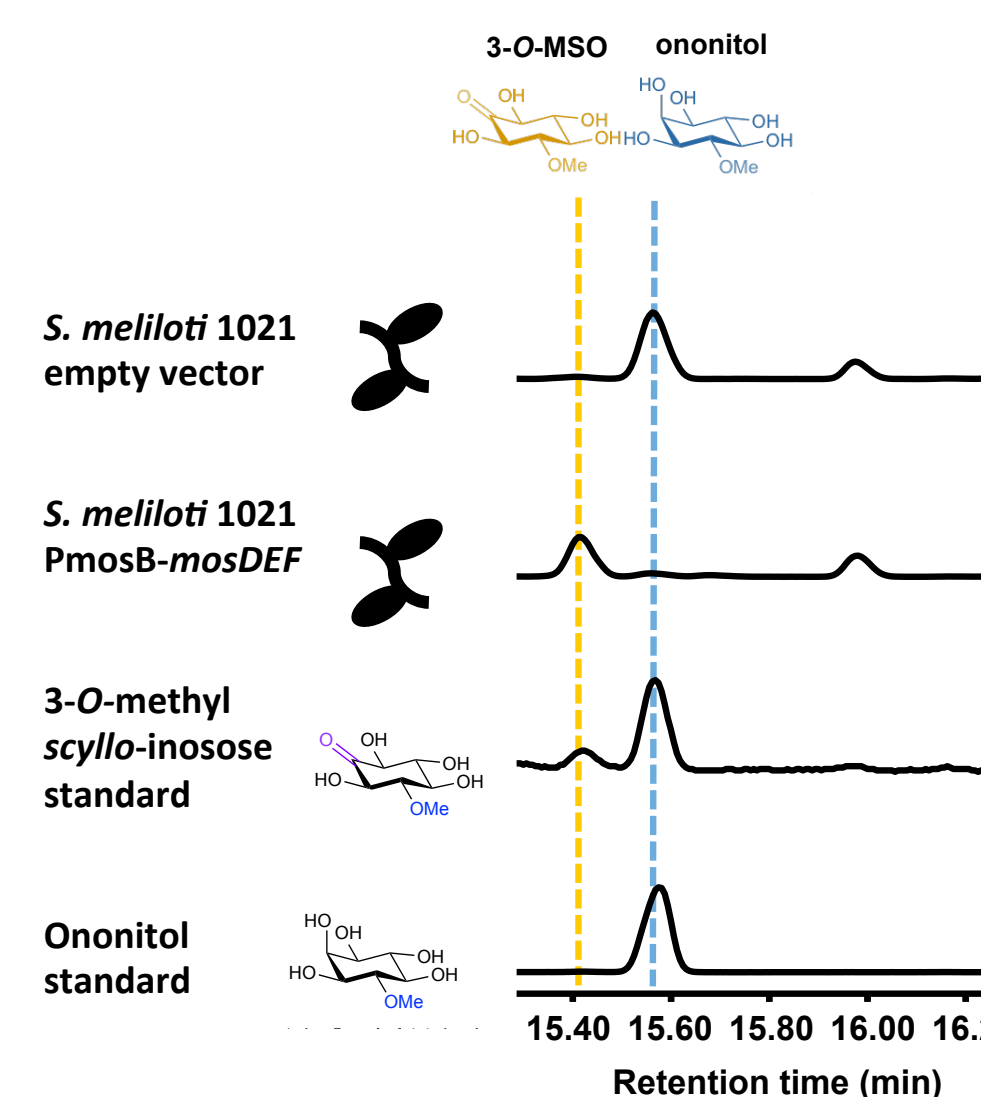
Rhizopines are produced by a small subset of N₂-fixing rhizobia in legume nodules that are also able to metabolize them as a sole carbon and nitrogen source. Genetic loci involved in their synthesis and catabolism have been identified, making them a good candidate for our synthetic signal assuming they are exuded into the rhizosphere.

4. Discovery of the natural pathway of rhizopine synthesis

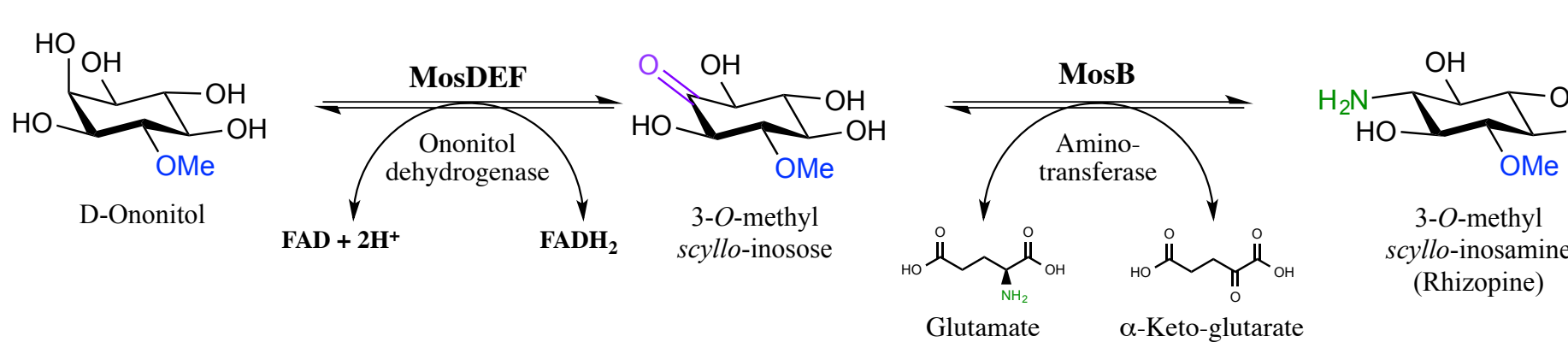
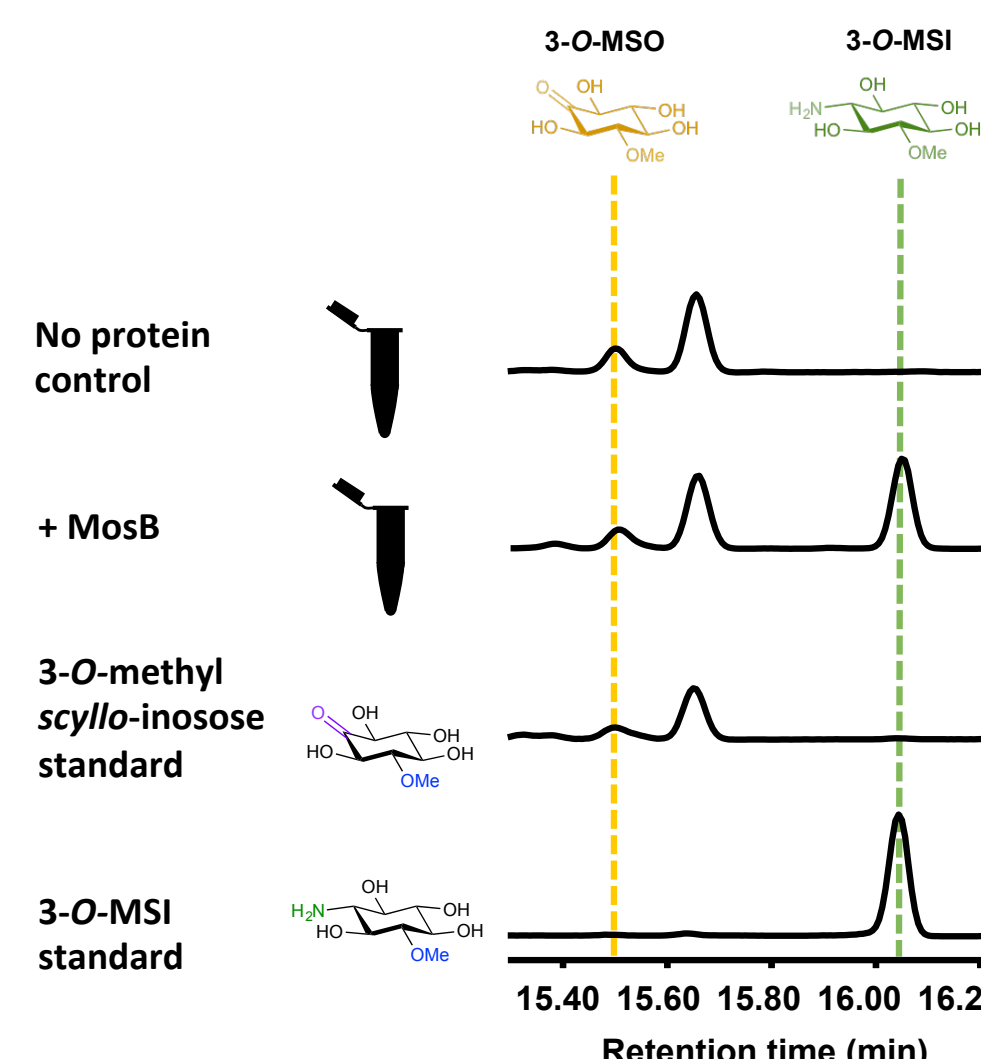
New *S. meliloti* L5-30 rhizopine locus



New rhizopine synthesis genes *mosDEF* (above) encode an ononitol dehydrogenase that produces 3-*O*-methyl-*scyllo*-inosose (right)



MosB is an aminotransferase that acts on the product of MosDEF to produce 3-*O*-MSI (right), thus we established a novel pathway of rhizopine synthesis (below).



7. Conclusions

- Transkingdom signalling could control plant growth promotion traits in engineered microbes
- We discovered two novel pathways of rhizopine synthesis
- Rhizopine synthesis was engineered in plants and we established transkingdom signalling to bacteria