

Maximizing a plant's growth potential in the midst of adversity

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Plant Growth-Promoting Bacteria

Soil bacteria that facilitate plant growth; often found in association with plant roots, and sometimes on leaves or flowers, or within plant tissues



What do PGPB do for plants?

1. Resource Acquisition

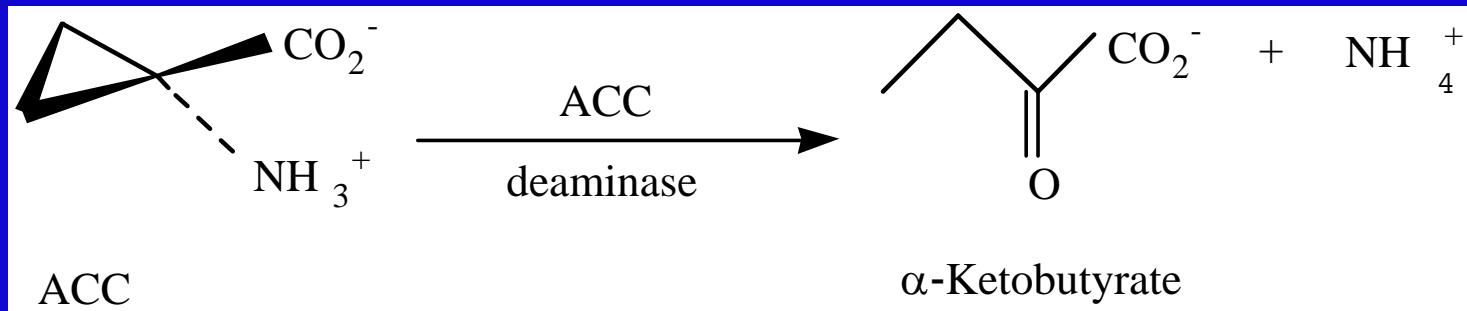
- a) Nitrogen
- b) Phosphorus
- c) Iron

2. Growth and Environmental Response

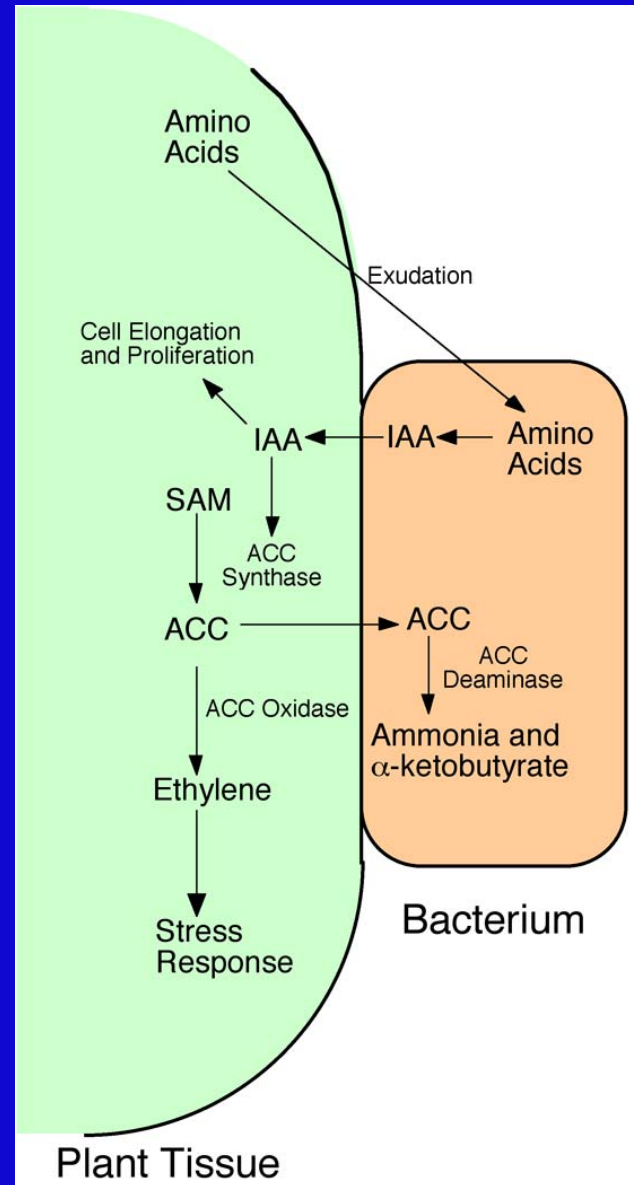
- a) Auxin
- b) Ethylene
- c) Cytokinin

3. Biocontrol

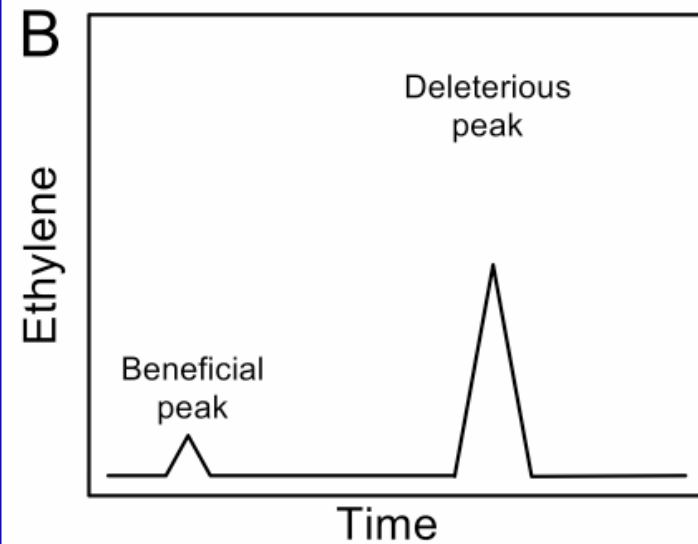
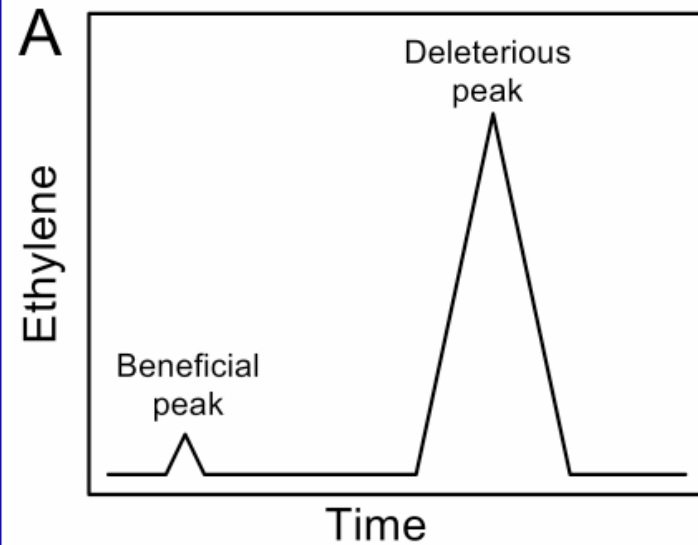
Cleavage of ACC to α -ketobutyrate and ammonia by ACC deaminase



Interaction of a bacterium containing ACC deaminase with a plant tissue, decreases both stress ethylene synthesis and the environmental damage to the plant



Stress ethylene
before and after
treatment with an
ACC deaminase-
containing
bacterium



Treating plants with ACC deaminase-containing bacteria protects plants from growth inhibitory ethylene produced as a response to stress from:

- Phytopathogens
- High salt
- Flooding
- Drought
- Heavy metals
- Temperature extremes
- Organic contaminants



Mung bean \pm PGPB



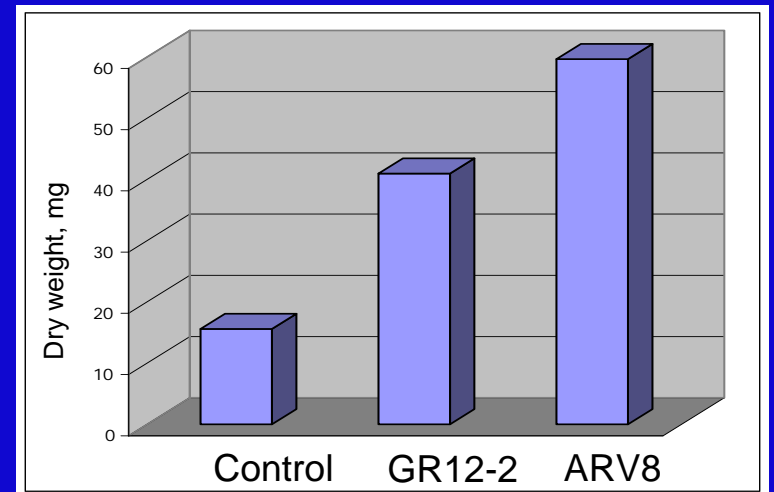
Castor bean +
Agro \pm PGPB



Canola + salt \pm PGPB



Tomato + flooding \pm PGPB



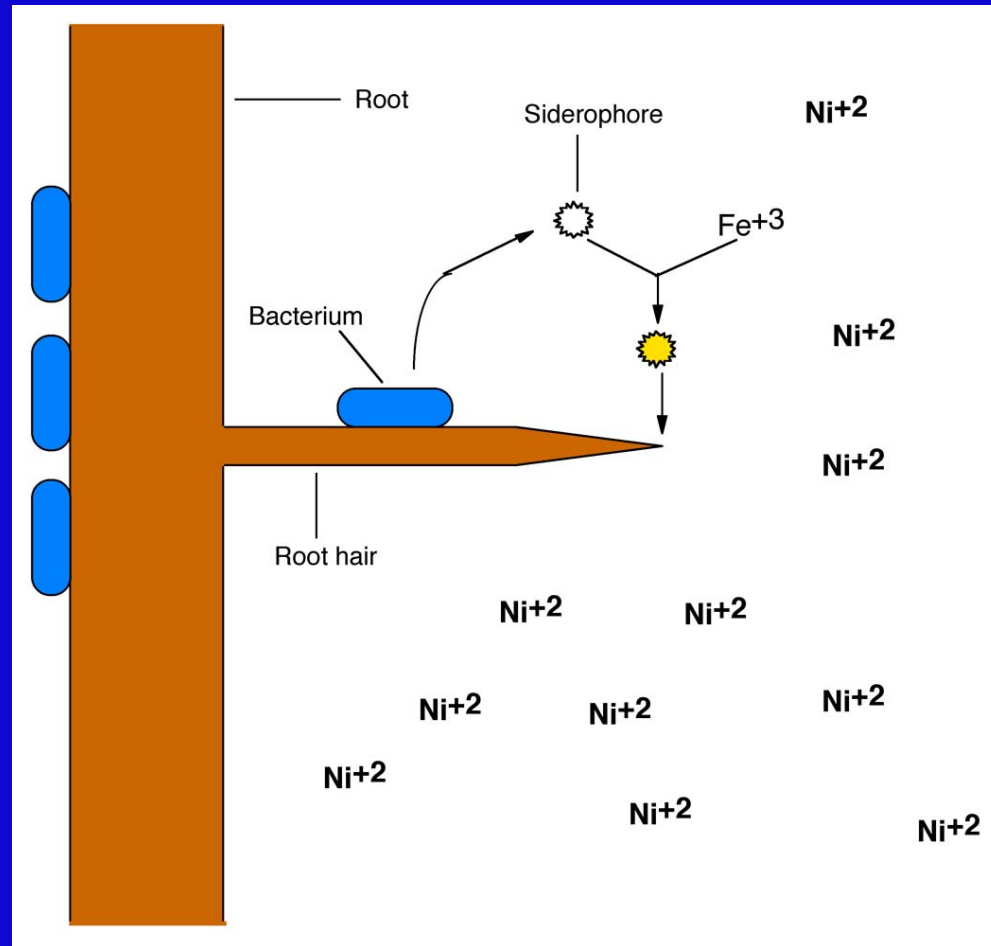
Tomato + drought \pm PGPB

Metal Contamination

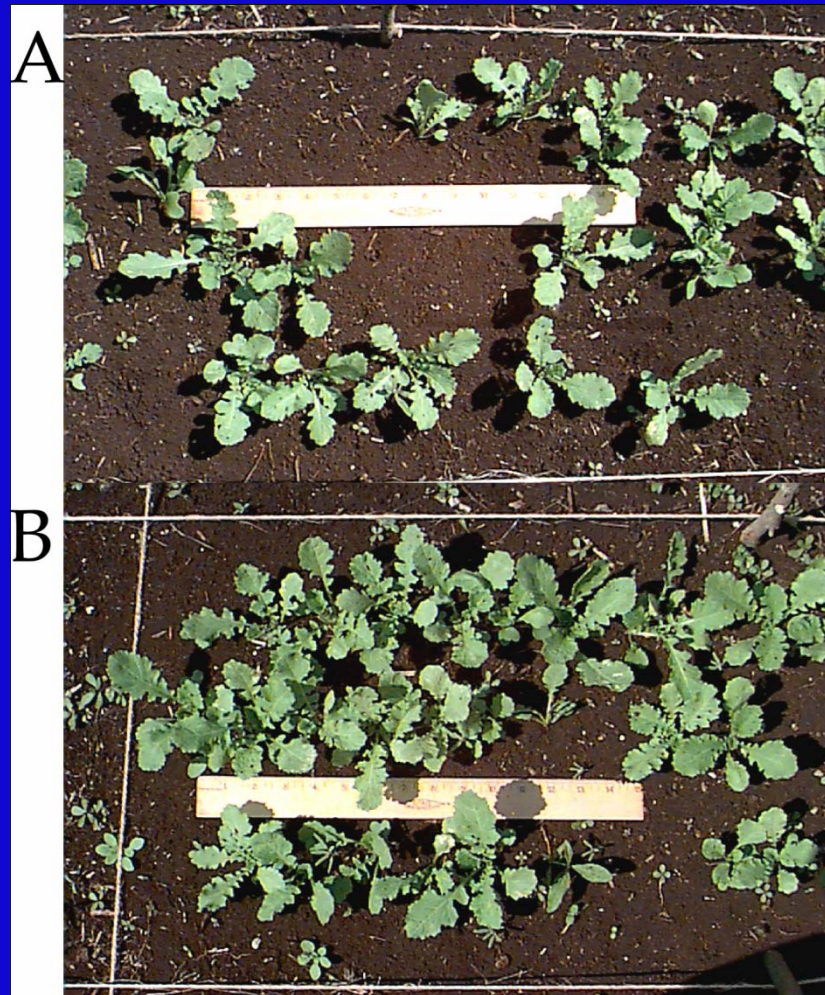
Plant exposure to metals

- Inhibited root and shoot development
- Iron deficiency
- Damage from active oxygen species
- Degradation of chlorophyll
- Expression of stress proteins
- Increased ethylene production

A bacterial siderophore overproducing mutant promotes plant growth more than the wild-type



ACC deaminase-containing PGPB promotes growth of *Brassica juncea* in nickel contaminated soil



ACC deaminase-containing PGPB promotes growth of tobacco in copper-contaminated soil



Unpublished data

Organic contaminants

PGPB relieve growth inhibition of rice (in China) by residual herbicides

+ PGPB



- PGPB



Unpublished data

ACC deaminase-containing PGPB promote growth of canola in PAH-contaminated soil



Control



Pseudomonas asplenii AC



Pseudomonas asplenii AC-1



Alginate encapsulated
Pseudomonas asplenii AC-1

ACC deaminase-containing PGPB are effective in the field as well as in the lab

Sarnia Land Farm – 2005



ACC deaminase-containing PGPB are effective at different sites with a range of contaminants

Triticale/Barley Mix
Year 1: Summer 2005, North East, AB
~ 1 % TPH on a 7 Hectare site

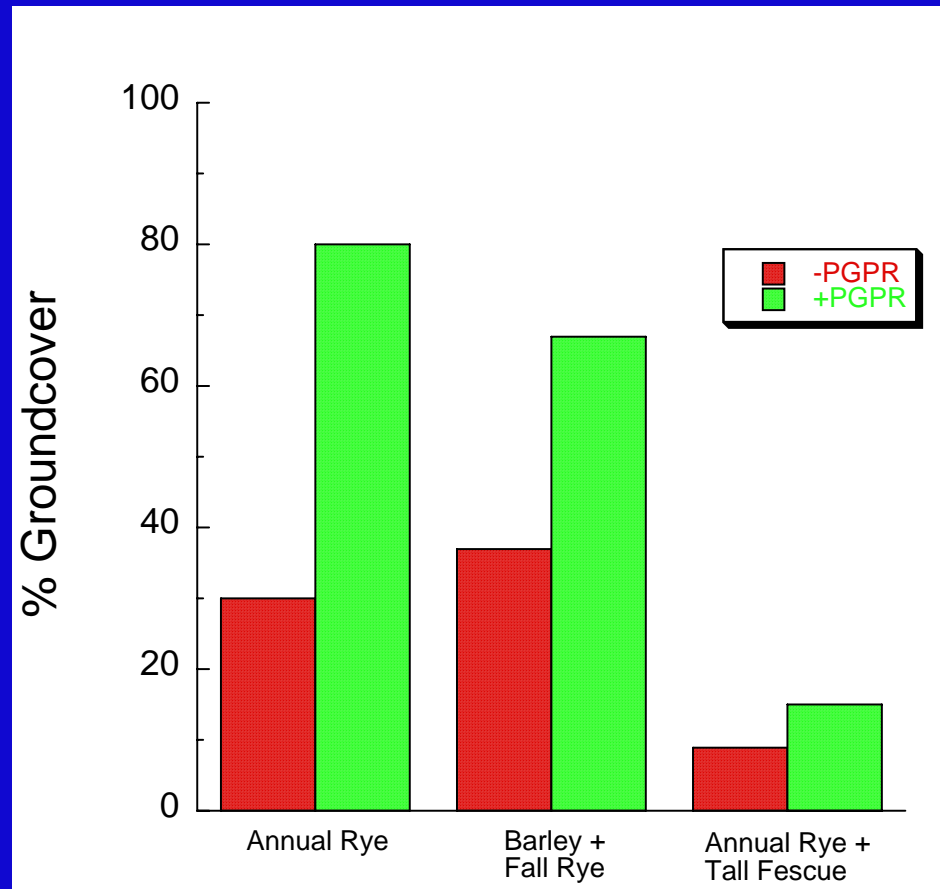


- PGPR

+PGPR

70 d growth on good soil

PGPB increase the extent of ground cover at two separate field sites

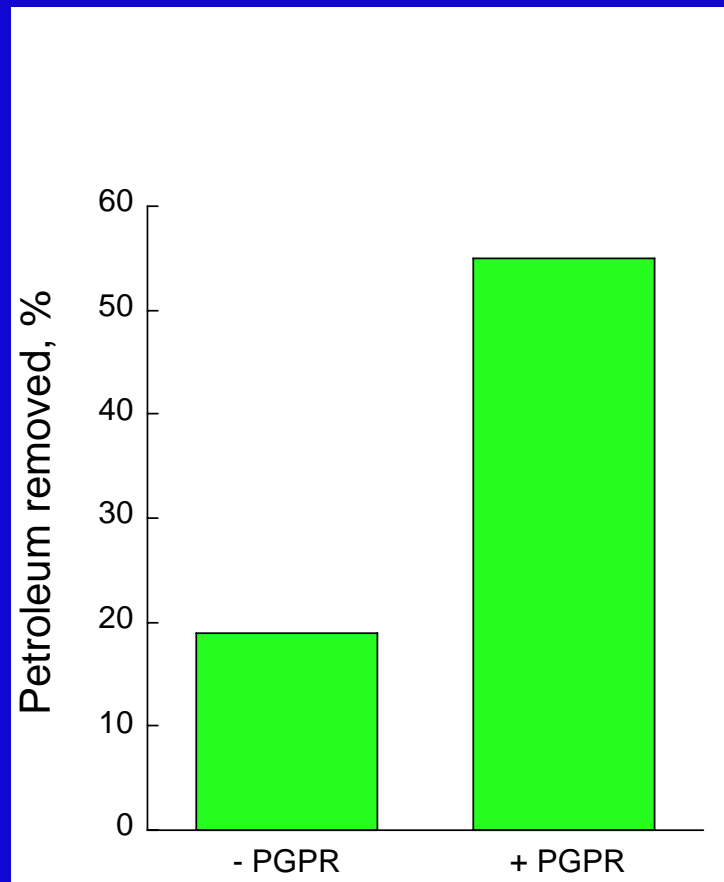


Unpublished data

Petroleum-contaminated soil ± ACC deaminase-containing PGPB



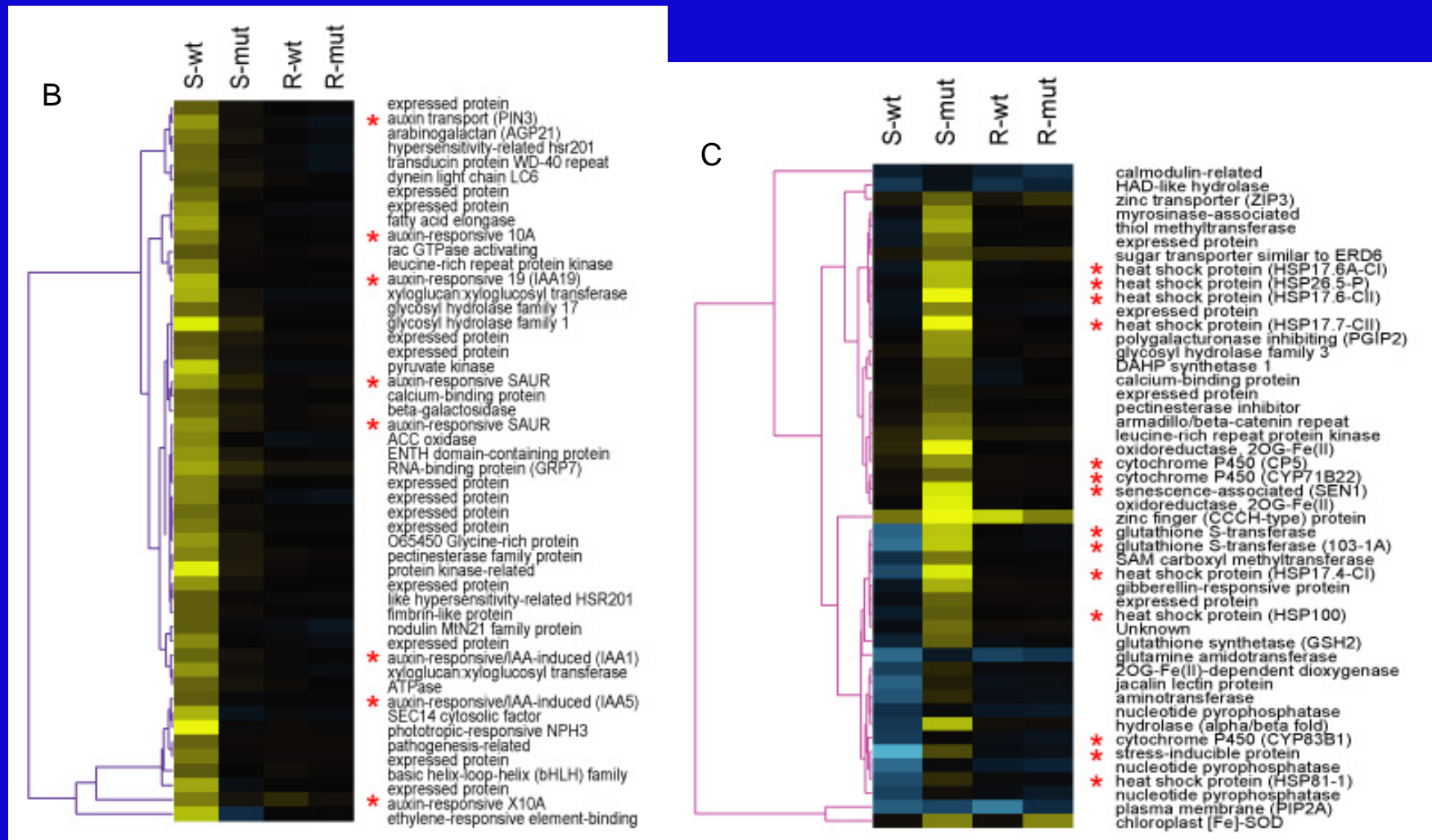
Removal of petroleum hydrocarbons from a field site following one year's phytoremediation



Transgenic plants with *ProID*-ACC deaminase
are similar to plants treated with PGPB + ACC
deaminase in response to nickel

What does treatment with
ACC deaminase-containing
PGPB do to plants?

Microarray data obtained after treating canola plants with wild-type and ACC deaminase mutant PGPB

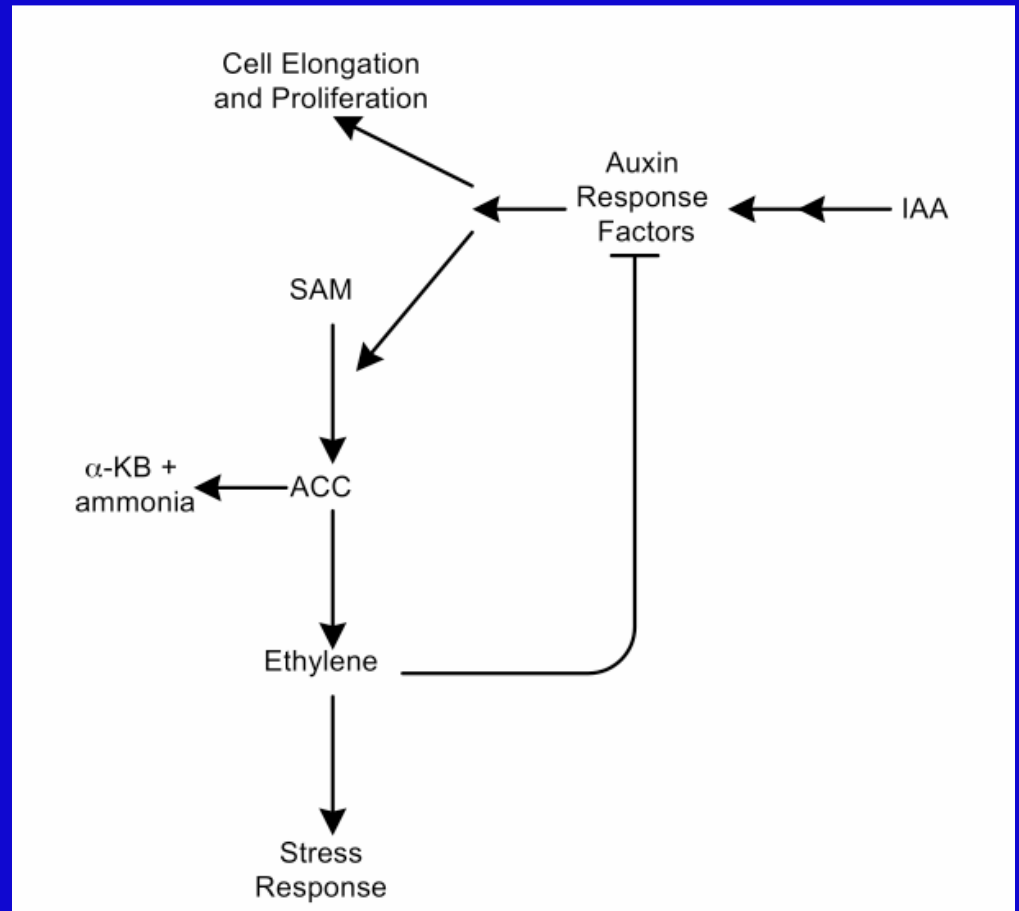


Some effects of bacterial ACC deaminase on canola gene expression

- De-repression of auxin response factor gene expression
- Mitigation of plant stress response due to bacterial inoculation
- Repression of jasmonic acid response gene expression (which may require increased ethylene)

Model for ACC deaminase and IAA promoting plant growth

- ACC deaminase leads to an increase in IAA-mediated gene expression
- This feedback loop normally prevents too much IAA (and ethylene) from being synthesized



Future prospects?

Instead of genetically engineering plants to resist environmental stresses, PGPB may be used to perform this function

PGPB are readily incorporated into a range of different phytoremediation protocols

The following people all contributed to the work discussed

Shimon Mayak

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