Phosphate solubilizing microbes *Pantoea eucalypti* and *Pseudomonas poae* demonstrate dual potential as bio-fertilizers and bio-fungicides

Ryan Joyce[1,2,3], A. Hawkins[3,4], H. Hornick-Martyk[3,5], Y. Kroner[3], S. Saldias[3], S. Kandasamy[3]

1. Department of Microbiology and Immunology, Western University, London, ON; 2. Department of Pathology and Laboratory Medicine, Western University, London, ON; 3. A&L Biologicals, Agroecological Research Services Centre, London, ON; 4. Department of Basic Medical Sciences, Western University, London, ON; 5. Department of Earth Sciences, Western University, London, ON.

Introduction

- Phosphorus is an indispensable nutrient for plant growth, and its availability in soil plays a pivotal role in agricultural productivity
- However, phosphorus often remains predominantly insoluble in soil, and to be effectively absorbed, it must be transformed to its soluble form[1]
- *Pantoea eucalypti* (I77) and *Pseudomonas poa*e (I186) are phosphate solubilizers that provide crucial mechanisms to accelerate this process[2]
- Furthermore, these specific bacterial isolates demonstrate strong inhibitive effects on plant pathogens
- I186 is also known to use a novel mechanism of inhibition by releasing lipopeptides to control pathogens[3]

Objective

- In the study conducted, we sought to investigate the effects of isolated phosphate solubilizing bacterial strains, I77, I186, and a formulation of both, on plant growth promotion and disease management

Origin

- I77 and I186 were isolated from a highly productive portion of field which underwent corn-soybean rotation for several years (Figure 1)
- After functional trait screening, these isolate were chosen as highly productive phospate solubilizers for further research and analysis

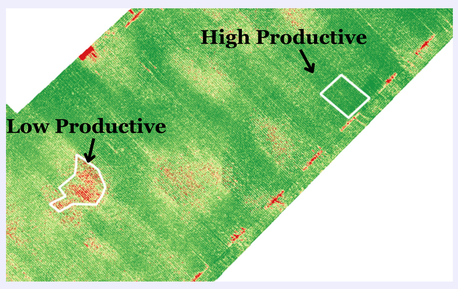

Figure 1: Yield mapping of corn-soybean field

Methods

To determine the effect of I77 and I186 on growth promotion and disease management, three trials were performed:

- Initial growth room trials using wheat, soybeans and corn, to provide evidence of isolate effectiveness
- Large scale field trials using corn, soybeans, red kidney beans and cranberry beans, to confirm market potential and validity of initial trial results
- Inhibition assays using isolates I77 and I186 were plated against a variety of common fungal pathogens, such as *Fusarium, Pythium, Sclerotinia, Colletotrichum* and *Microcodium* species

Results

Growth Room Trials

- To quantify growth, trials were subject to metrics of recorded lengths and biomasses of shoots and roots (Figure 2)
- Growth room trials of all tested crops demonstrated notable increases in growth of I77 and I186 shoots and roots (Figure 3)
- Results indicated value in further investigation

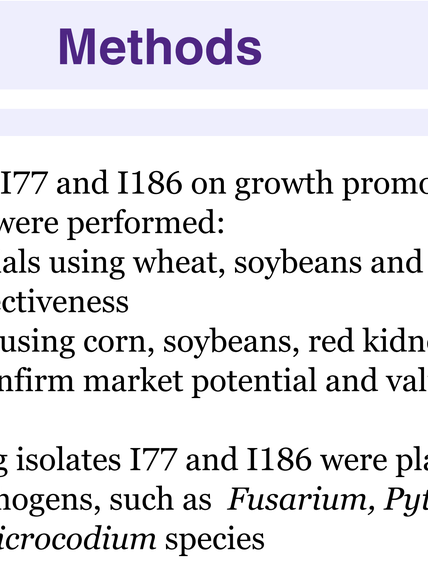

Figure 2: Wheat, Soybean and Corn growth trials

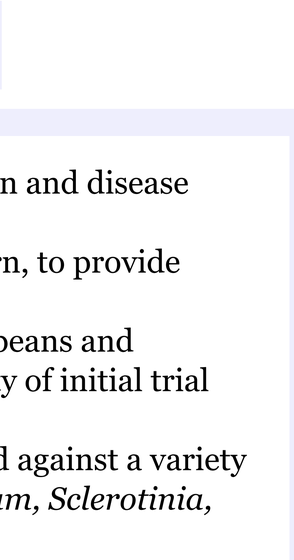

Figure 3: Wheat growth pouch harvest

Field Trials

- Field trials were conducted with soybeans, corn and coloured beans between 2020 and 2022 (Figure 4)
- Crops demonstrated consistent yield increase when treated with the formulations of I77 + I186 a
- A 5 - 17% average yield increase was demonstrated depending on crop type when compared to control
- Response was also shown to be much higher in fields used after corn rotation

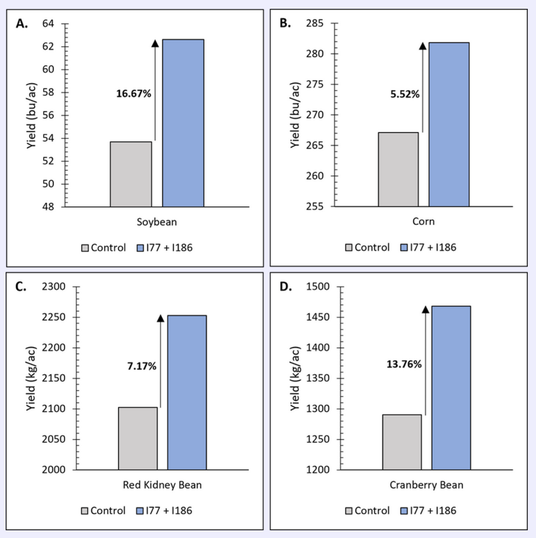

Figure 4: Field trial yield comparison between control and I77+I186 Formulation

Disease Management

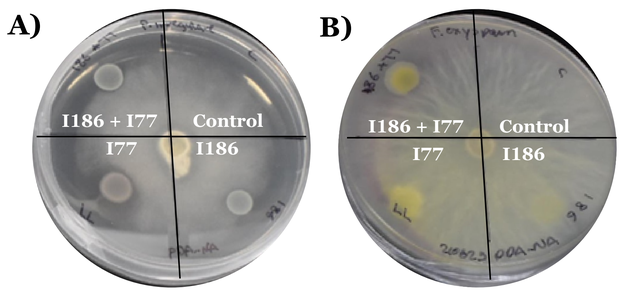

Figure 5: Inhibition assay model using I77, I186, and a formulation of both plated against A) *Pythium irregulare* and B) *Fusarium oxysporum*

- Inhibition assays were measured by qualitative fungal inhibition scoring (Table 1)
- I77 and I186 were plated individually and in formulation (Figure 5)
- When used in formulation together I77 and I186 showed even greater and more consistent inhibitive results

Fungal Pathogen	*I77*	*I186*
Fusarium	++	+++
Pythium	++	+++
Sclerotinia	++	++
Colletotrichum	+++	++
Microdochium	+++	++

Table 1: Fungal pathogens demonstrating inhibition by I77 and I186. Inhibition scoring scale: (-) = negative, (+) = weak positive, (++) = positive, (+++) = strong positive

Conclusions

- These findings demonstrate that the phosphate solubilizers, *Pantoea eucalypti* (I77) and *Pseudomonas poae* (I186) have considerable potential as biofertilizers and biocontrol agents
- They stimulate plant growth, act to control pathogenic burden and potentially limit soil pollution by reducing the demand of synthetic phosphorus fertilizers and fungicide applications on agricultural land

Future Directions

- Conduct more biocontrol trials to provide evidence of disease management outside of the laboratory setting and in more variable ecological conditions.
- Clarify crop responses to microbial treatment, as well as differential soil nutrient levels and nutrient use efficiency
- Begin product development for potential commercial use

References

1. Rodríguez H, Fraga R. Phosphate solubilizing bacteria and their role in plant growth promotion. Biotechnol Adv. 1998Oct;17(4-5):319-39. doi: 10.1016/s0734-9750(99)00014-2. PMID: 14538133.
2. Sharma SB, Sayyed RZ, Trivedi MH, Gobi TA. Phosphate solubilizing microbes: sustainable approach for managing phosphorus deficiency in agricultural soils. Springerplus. 2013 Oct 31;2:587. doi: 10.1186/2193-1801-2-587. PMID: 25674415; PMCID: PMC4320215.
3. Zachow C, Jahanshah G, de Bruijn I, Song C, Ianni F, Pataj Z, Gerhardt H, Pianet I, Lämmerhofer M, Berg G, Gross H, Raaijmakers JM. The Novel Lipopeptide Poaeamide of the Endophyte Pseudomonas poae RE*1-1-14 Is Involved in Pathogen Suppression and Root Colonization. Mol Plant Microbe Interact. 2015 Jul;28(7):800-10. doi: 10.1094/MPMI-12-14-0406-R. Epub 2015 Jul 9. PMID: 25761208.