The Effect of *Pseudomonas, Piriformispora indica* and *Laccaria bicolor* on the Growth of *Gossypium hirsutum*

Eric Armstrong, Oak Ridge High School

Sharon Thomas, AP Research Oak Ridge High School & Dan McDonald Phenotype Screening Corp.

Introduction and Objective

- The U.S. accounts for 17% of the global supply of cotton behind China & India
- The only proven way to improve plant yields are to control the amount water, nutrients, and herbicides used during the growing season
- Most studies evaluating biofertilizers, bacteria and fungi have focused on food crops
- Cotton studies have evaluated improving plant resistance to disease or salinity
- No studies with cotton have sought to improve yield or growth and none have evaluated combinations of bacterial and fungi

The purpose of this study is to evaluate a novel mixture of *Pseudomonas, Piriformispora indica* and *Laccaria bicolor* on the yield and growth of *Gossypium hirsutum*.

Experimental Methods

- Growing chamber construction
- 60 seeds sterilized & germinate
- Vigor analysis to determine seedlings to plant
- Place plant in growing chamber
- Inoculated plants have 3 alginate microbe sources placed at 250mm
- 10 hrs. exposure each day to halogen grow lights, the remainder of the time the plants were exposed to fluorescent light
- Temperature during light exposure was 84F, the remainder of the day the temperature was 74F
- Plants were watered with nutrient rich solution for 1 minute every 5 minutes
- Measurements were taken for the following height, fruiting branches & buds, flowers & bolls daily
- Weekly measurements were taken on root architecture
  - 16 images per plant were collected, digitized and assembled into complete 2d or stereo images.

Construction

Germination

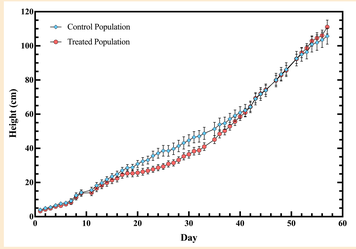
Planting

Abstract

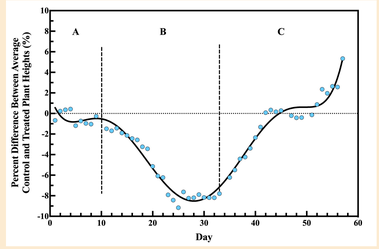
It has been shown in the literature that certain species of mycorrhizal fungi and bacteria can stimulate hormone production in food-bearing crops resulting in enhanced growth and yields. This study used a blend of bacteria and fungi developed by the Oak Ridge National Laboratory with cotton plants. The results indicated that inoculated plants went through 3 stages of growth; however, at the end of the study, the two populations were approximately the same height. The inoculated plants had 9 to 12 times more lateral roots per plants than the control plants, which is an indication of high levels of auxin in the plants, which can only come from the *Pseudomonas* and *L. bicolor*. At the end of the study, the yield was 14% higher in the inoculated samples. The increased flowering is an indication of both auxin and gibberellin in the plants. Hormones produced by the microbes altered plant development and require further study with cotton plants.

Results

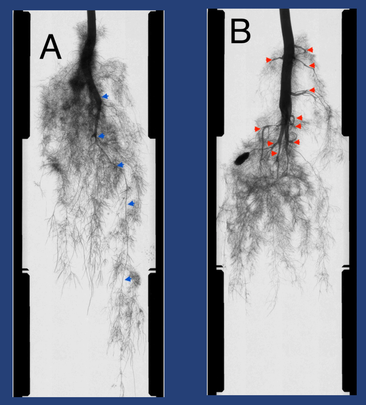
Plant Height as a Function of Time



% Difference in Average Plant Height

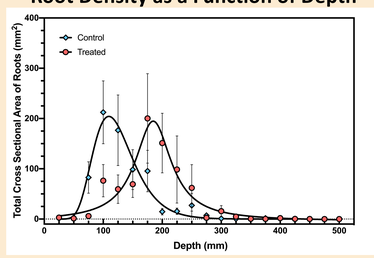


- Section A: no difference in growth rates; microbes are dormant for 10-14 days
- Section B: microbes are multiplying and occupying roots, competition for nutrients slows growth of inoculated plants
- Section C: microbes produce hormones that accelerate growth in inoculated plants



- Image A: typical control architecture, no lateral roots, true taproot (blue arrows)
- Image B: typical inoculated architecture, 9-12x more lateral roots (red arrows), no taproot

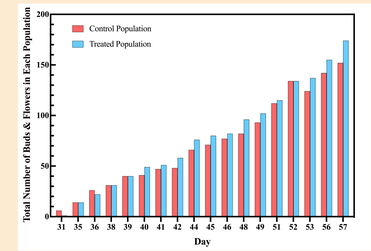
Root Density as a Function of Depth



- Control plants have shallower root structure
- Inoculated plants show positive gravitropism, higher density of roots deeper in growing media

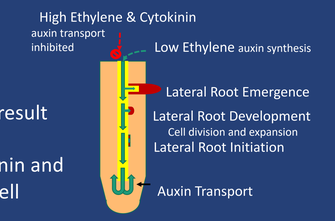
Results

Yield as a Function of Time



- Buds, flowers, bolls used as proxy for yield
- Inoculated plants produce 6.5 buds/day
- Control plants produce 5.5 buds/day
- At end of study inoculated plants had 14% higher yield than control plants

Discussion



- Lateral root formation and gravitropism both result from the hormone auxin
- High auxin gradients in the roots & low cytokinin and ethylene hormone levels initiate lateral root cell division and development
- Both pseudomonas and L. bicolor are know to stimulate auxin production in plants
- *P. indica* is known to signal the synthesis of gibberellin
- Gibberellin and auxin have been observed to increase flower formation in other species and believed to be responsible for the increased flowering and yield observed in this study

Conclusions

- Inoculating cotton with *pseudomonas, L. bicolor, and P. indica* resulted in:
  - *L. bicolor and pseudomonas* triggering high auxin levels and low cytokinin and ethylene levels in the roots resulting in a lateral root formation
  - *P. indi*ca potentially signaling gibberellin production combined with auxin leading to increased buds, flowers and bolls
  - A potentially significant increase in cotton yield
  - The mixture of *Pseudomanas, L. bicolor, and P. indica* have a positive impact on cotton development
- The potential increase in yield would be a significant step forward if real and follow on studies are warranted to verify the results of this study

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