Interdomain competition: Arabidopsis thaliana versus Soil Bacteria
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Abstract
Plants in their natural habitats are constantly competing with other organisms. Arabidopsis thaliana is a model plant that must germinate and grow in the presence of common soil bacteria such as Pseudomonas aeruginosa and Bacillus subtilis. A. thaliana may compete with soil bacteria such as for water, micronutrients, and the carbohydrate produced by photosynthesis. If there is competition between plants and soil bacteria, conditions that favor the growth of microorganisms will negatively impact plant development.

Arabidopsis thaliana was grown in petri dishes inoculated with Pseudomonas aeruginosa and Bacillus subtilis. Murashige and Skoog agar, a plant growth media, was used initially to favor plant growth. The experiment was done in both warm conditions, that favor bacteria, and cool conditions, that discourage bacterial growth, and at high and low concentrations of bacteria. Later in the experiment, the growth of P. aeruginosa and B. subtilis was enhanced by adding nutrient broth to the petri dishes.

We found that, under these conditions, the plants are only vulnerable to bacterial competition at the earliest stages, and only with low concentration of B. subtilis under warm conditions. Bacterial growth later in plant development actually seems to promote plant growth.

Hypothesis
Arabidopsis thaliana competes with soil bacteria such as Pseudomonas aeruginosa and Bacillus subtilis for water, micronutrients, and carbohydrate.

Conditions that favor the growth of microorganisms will negatively impact plant development.

“What counts is not necessarily the size of the dog in the fight; it’s the size of the fight in the dog”

Dwight D. Eisenhower (1890-1969) Thirty-Fourth President of the USA

Conclusions
• Bacillus subtilis seems to compete with Arabidopsis thaliana seedlings under limited conditions, such as when seedlings are very young.
• Age of the B. subtilis culture may be important in determining whether the bacterial cells will compete with the seedlings.
• A. thaliana had a higher germination rate in the presence of Pseudomonas aeruginosa under low concentration levels.

Growth Conditions

- 16 hours of light
- Ambient temperature
  - Cool 18-20°C
  - Warm 24-26°C
- 3 Replicates (10 seeds/plate) per treatment (10 treatments)

Experimental Design
Pseudomonas aeruginosa  Bacillus subtilis

- Set up competitive conditions
- Determine concentrations of bacterial cultures using optical density.
- Inoculate plates with bacterial cultures, incubate 24 hours.
- Inoculate plates with seeds of Arabidopsis thaliana and incubate 10 days.
- Monitor plant growth
- Plates were checked daily for 10 days to evaluate germination and growth of A. thaliana.
- Verify survival of bacteria
- After 7 days, swabs of the dishes were incubated in nutrient broth and checked for bacterial growth.
- Change conditions to enhance bacterial growth
- A layer of nutrient broth was added to aid in bacterial growth. Plant growth was again monitored.

Only Arabidopsis thaliana  Pseudomonas aeruginosa  Bacillus subtilis

<table>
<thead>
<tr>
<th>Temperature</th>
<th>A. thaliana</th>
<th>P. aeruginosa</th>
<th>B. subtilis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control 19°C</td>
<td>19°C 4.25 x 10⁶ cells</td>
<td>19°C 1.35 x 10⁷ cells</td>
<td>19°C 5.49 x 10⁶ cells</td>
</tr>
<tr>
<td>19°C 4.25 x 10⁶ cells</td>
<td>19°C 1.35 x 10⁷ cells</td>
<td>19°C 5.49 x 10⁶ cells</td>
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<tr>
<td>25°C 4.25 x 10⁶ cells</td>
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<td>25°C 5.49 x 10⁶ cells</td>
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<tr>
<td>25°C 4.4 x 10⁶ cells</td>
<td>25°C 1.35 x 10⁷ cells</td>
<td>25°C 5.49 x 10⁶ cells</td>
<td></td>
</tr>
</tbody>
</table>

Cold Chamber

- Low concentrations of P. aeruginosa showed the fastest growth.
- Lack of growth in Low B. subtilis
- Low concentration of P. aeruginosa

Results

Hot Chamber

- Low concentrations of B. subtilis showed the slowest growth.
- Warm 24-26°C
- Only B. subtilis
- High B. subtilis
- Low concentration B. subtilis

Future Research

- Labeling and tracking the growth of individual seeds as they developed.
- Increasing competition at an early stage by adding nutrients broth earlier in the experiment to enhance the growth of the bacteria.
- Testing to determine if cells life stage affects their ability to compete
- Enhancing aseptic techniques such as, paraffilming each Petri dish to avoid contamination.

Contamination due to Mold

Competition between plant, bacteria, and algae

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