Overview of Vegetable Seed Technology

Seed Production and Harvesting

Seed Conditioning – traditional and new methods

Storage

Seed Enhancements

• seed treatment and coating technologies
• priming

Seed Testing – physiological and pathological

Seed Quality Assurance – labeling and authentication
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Seed Treatment and Coating Technologies Presentation Overview

- Seed Treatment Industry – New chemistry actives
- Seed Coating Technologies
- Seed Treatment and Coating Enhancements
- Controlled Release Seed Treatment Technologies
- Understanding Systemic Seed Treatment Uptake
Global Chemical Seed Treatment Industry

• Estimated value: $3.5 Billion in 2012
• Growth: >10% per year projected to 2015
• Projected value in 2015: $5.4 Billion

• Bayer CropSciences (BCS) and Syngenta (SYN)
  BCS + SYN have 75% of seed trt. market share
• BASF
• Chemtura AgroSolutions
• Others
Seed Treatment Fungicides

• Captan and Thiram – old chemistry

• Metalaxyl and Mefenoxam (Allegiance – BCS and Apron XL – SYN) – first generation new chemistry

• Many new chemistry materials – specific target pathogens

M. R. McDonald, U. Guelph
Seed Treatment Insecticides

1. Largest value and growth rate of total seed treatment market, followed by seed trt. fungicides

2. Neonicotinoid seed treatments
   • 75% of global market
   • systemic – control below and above ground pests
     • imidaclorpid (Gaucho – BCS)
     • thiamethoxam (Crusier – SYN)
     • clothianidin (Poncho – BCS)
Neonicotinoid Seed Treatments

Concerns in the environment and for pest management

1. Bee issues
   • implicated in colony collapse disorder
   • dust off from coated seeds from talc and graphite

2. Resistance management
   • thiamethoxam is converted to clothianidin in plants

3. Need alternate chemistries for efficient early season insect management
Other Insecticide Seed Treatments

Research at Cornell, IR-4 and other partners – examined spinosad as an insecticide seed treatment

- Spinosad (Dow AgroSciences– OMRI approved formulation, Entrust)

- Labeled product is Regard (SYN) on onions for maggot control. Compound is not systemic.

Onion maggot, Delia antiqua
B. Naut, Cornell
Bactericide Seed Treatments

Chemical Treatments

- lack of labeled bactericides for control of seed-borne bacteria that may be external or internal (deep seated)

Induced Systemic Resistance

- Acibenzolar-s-methyl (Actigard/Bion – SYN)
- Greenhouse tomato and pepper reduce infections

Physical treatments

- hot water treatments – example on Brassica for *Xanthomonas campestris pv campestris*
Seed Treatment Application

Cornell - Geneva

IR-4

Seed Treatment Industry

Field Efficacy

Univ. Programs
Seed Treating and Coating Technology

Rotary Pan Technology

http://www.youtube.com/watch?v=XIgnpLEJ8MU
Lettuce pellet mix

Capsule placed adjacent to the seed in the pot (in the picture: two-capule treatment = four ½ capsules)
Fresh Weight: Percent Increase Comparison by Crop

Hiromi Tasaki, Cornell PhD student in Dr. Taylor’s Lab

- Half capsule (0.5)
- One capsule (1.0)
- Two capsules (2.0)
- Three capsules (3.0)
Poster - Seed Coating Technologies Employing a Plant-based Green Binder

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2. University of California, Plant Science Department, Davis, California
Nanobiotechnology Seed Enhancements: Multi-Wall Carbon Nanotubes (MWCNT’s)
Nanobiotechnology Seed Enhancements by Increased Seed Coat Permeability

American Seed Research Foundation (ASRF)

• increased imbibition rates
• Increased seedling shoot and root length
Controlled Release of Seed Treatments

Concepts:

• Seed is widely used as a carrier to deliver agrochemicals where needed

• Controlled release provides the delivery of agrochemicals when needed

• Controlled release of agrochemicals is independent of seed germination
Controlled Release of Seed Treatments

Applications:

• Delayed delivery of agrochemicals for protection of transplanted crops

• Extended delivery of agrochemicals for direct seeded crops

• Extended protection time to match the needs of the growing plant

• Reduce phytotoxicity of seed treatments on germination
Release Patterns

1. Conventional Release
2. Sustained Release
3. Sustained Release with Burst
Electrospinning Set-up

Margaret Frey’s Lab, Cornell University
Materials

PLA – polylactic acid
  • Biodegradable, Renewable
  • Hydrophobic

Cellulose nanocrystals
  • Biodegradable, Renewable
  • Hydrophilic
Development of Controlled Release Beads

- Limitations with fibers applied as seed treatments
- Need free flowing formulation that can be applied with conventional seed treatment technology

PLA Beads

2.5 ± 0.7 µm
Development of Triggered Release Seed Treatments in Taylor’s Lab

Al Release Patterns

1. Conventional Release
2. Triggered Release

Graph showing Al Release over time with two distinct patterns.
Conceptual Basis of Microcapsule and Triggered Release

Core containing active

Release of active

Shell
Fluidized Bed and Microencapsulation

Mini Glatt

Micro-particles
Microparticles containing Rhodamine B as active and coated with Eudragit FS 30 D then exposed to phosphate buffer solutions at pH 6.5 or 7.5

1 h exposure

2 h exposure
The Rhodamine B release from Micro-Particles in a peat-lite greenhouse medium.
Triggered Release of Atrazine on Tomato

Applied pH Trigger 10 days after pH Trigger

21 Days after Sowing 31 Days after Sowing
Systemic Movement in Plants

Distribution of radioactivity in cucumber
28 days after sowing
application on soil
normal soil condition

Labeled thiamethoxam uptake in cucumber leaves

Leaf Petiole
Relative Systemic Uptake of Compounds

- Clothianidin
- Imidacloprid
- Rhodamine B
- Coumarin 151
- Thiamethoxam
- Fipronil & Spinosad
- Abamectin

Log $K_{ow}$
Scientific question – How are systemic seed treatment actives taken up by vegetable crops?

Pathway from seed treatment to embryo

1. Systemic seed treatments diffuse through the seed coat and are then taken up by plants
2. Systemic seed treatments are blocked by the seed coat, therefore taken up by the roots

Seed Coat Permeability and Uptake of Applied Systemic Compounds

American Seed Research Foundation Grant
Onion

Coumarin

--------- Rhodamine -----------
# Seed Coat Permeability Characteristics of Vegetable Crops

<table>
<thead>
<tr>
<th>Vegetable Crop Seed</th>
<th>Seed Coat Permeability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Snap bean</td>
<td>Permeable</td>
</tr>
<tr>
<td>Onion</td>
<td>Selective permeability</td>
</tr>
<tr>
<td>Tomato</td>
<td>Selective permeability</td>
</tr>
<tr>
<td>Pepper</td>
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</tr>
<tr>
<td>Sweet corn</td>
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</tr>
<tr>
<td>Lettuce</td>
<td>Non-permeable</td>
</tr>
<tr>
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New Chemistries
Controlled Release
Environment & Sustainability
Systemic Seed Treatment Uptake
Seed Coating Technologies
Growth Enhancement
Controlled Release