Seed Science and Technology

Advances in Seed Technology –

Seed Treatment and Coating

VegR&D Forum

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Cornell University
College of Agriculture and Life Sciences

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

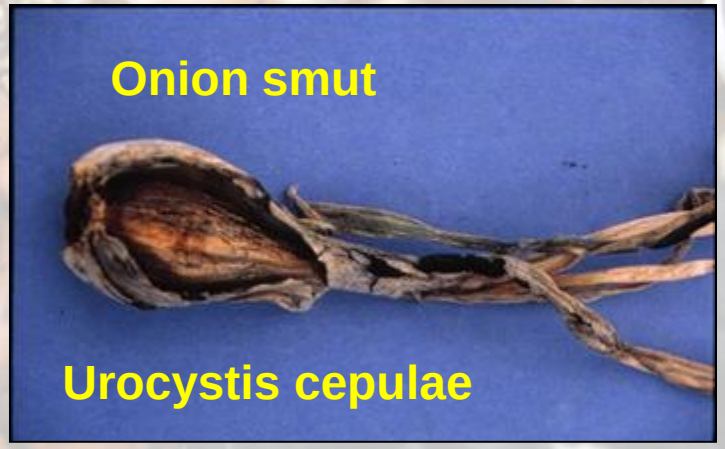
- Estimated value: $3.5 Billion in 2012
- Growth: >10% per year projected to 2015
- Projected value in 2015: $5.4 Billion

- 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

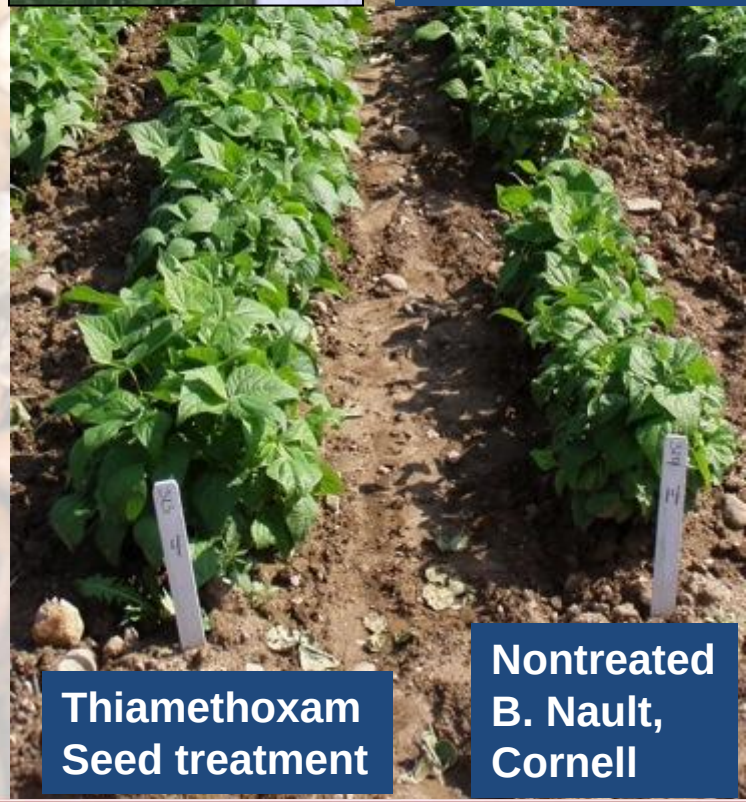
1. Largest value and growth rate of total seed treatment market, followed by seed trt. fungicides

2. Neonicotinoid seed treatments
   - 75% of global market
   - systemic – control below and above ground pests

   - imidacloprid (Gaucho – BCS)
   - thiamethoxam (Crusier – SYN)
   - clothianidin (Poncho – BCS)

Potato Leafhopper

Empoasca fabae



Thiamethoxam Seed treatment

Nontreated B. Nault, Cornell

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)**

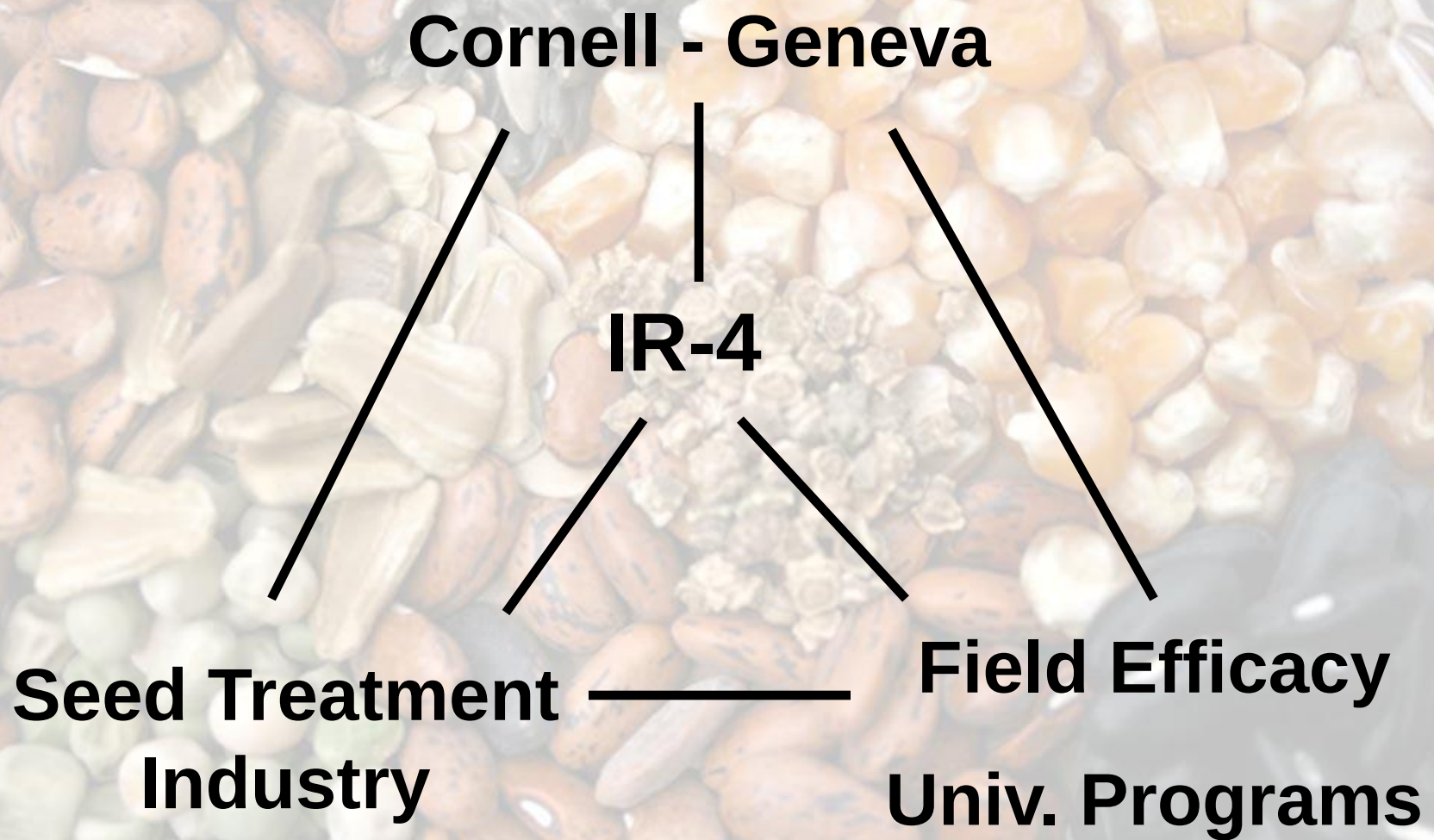
Induced Systemic Resistance

- **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



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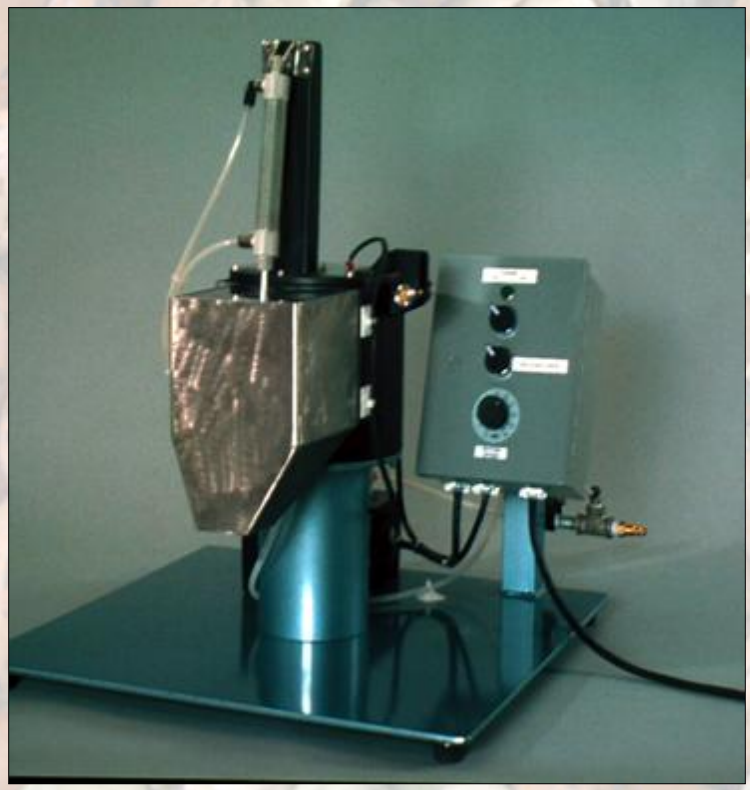
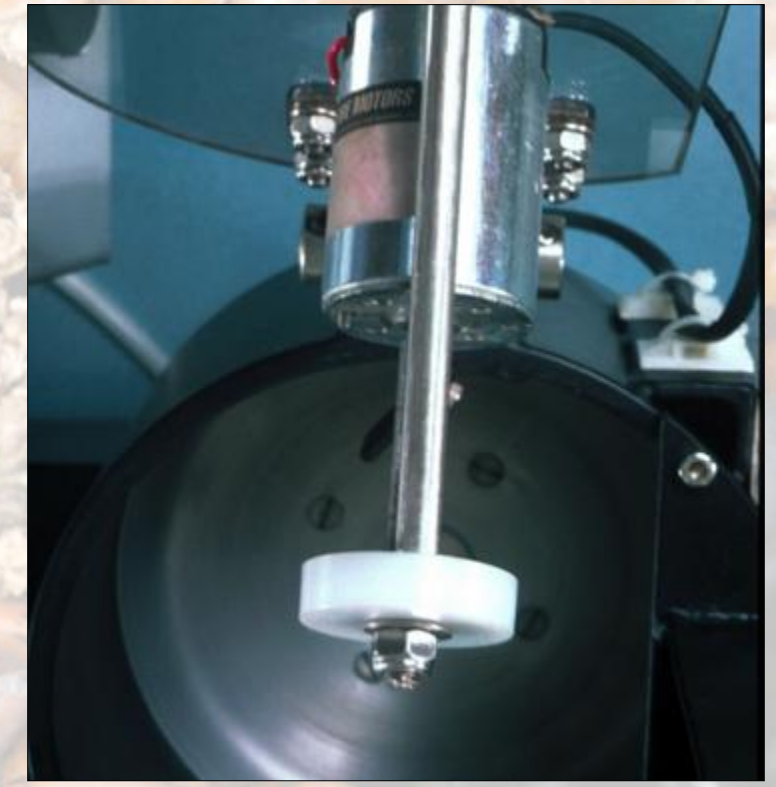
Seed Treating and Coating Technology

Rotary Pan Technology



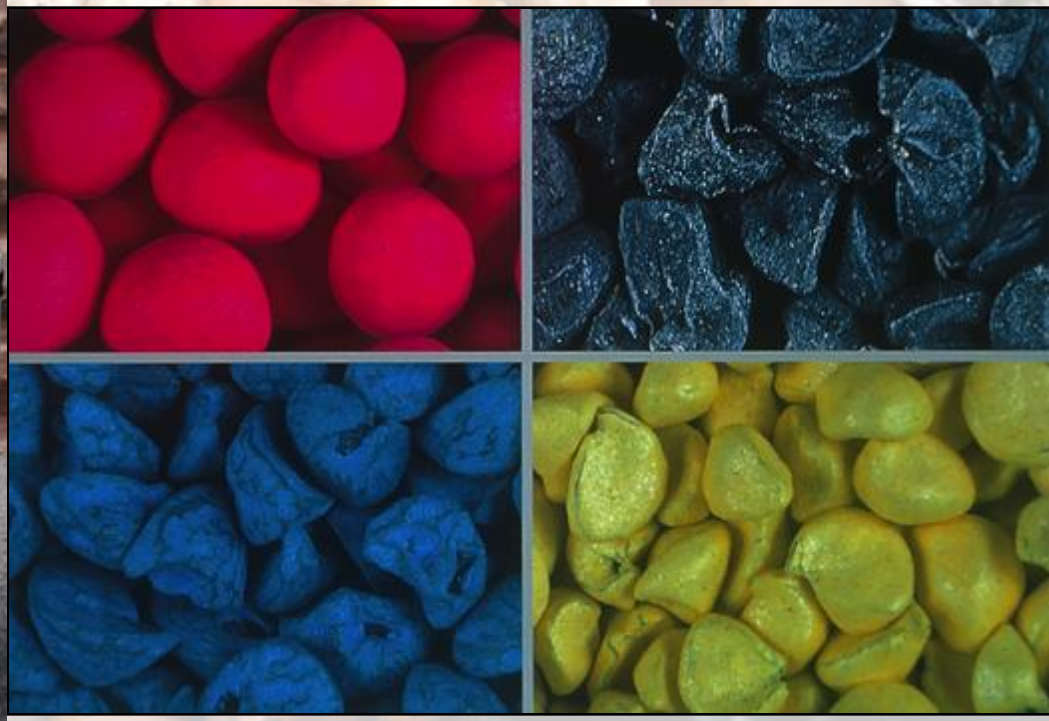


http://www.youtube.com/watch?v=XIgnpLEJ8MU

Onion Seed Coatings

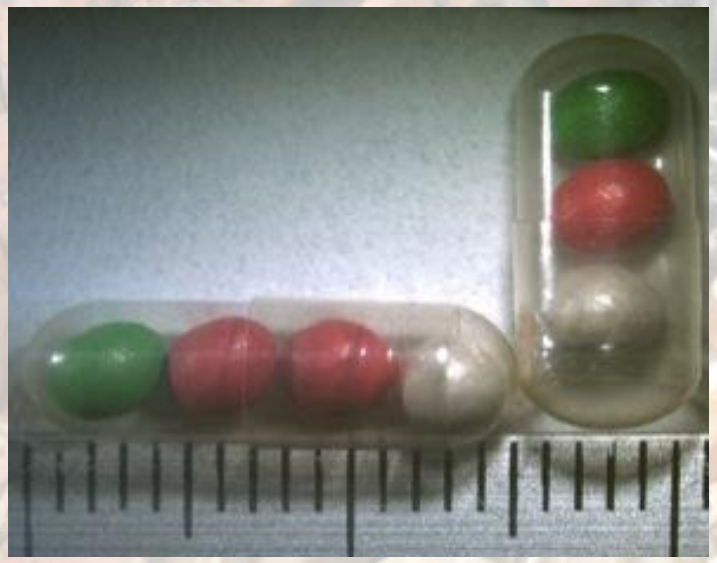
Pelleted Seed

Noncoated



Film coated

Encrusted



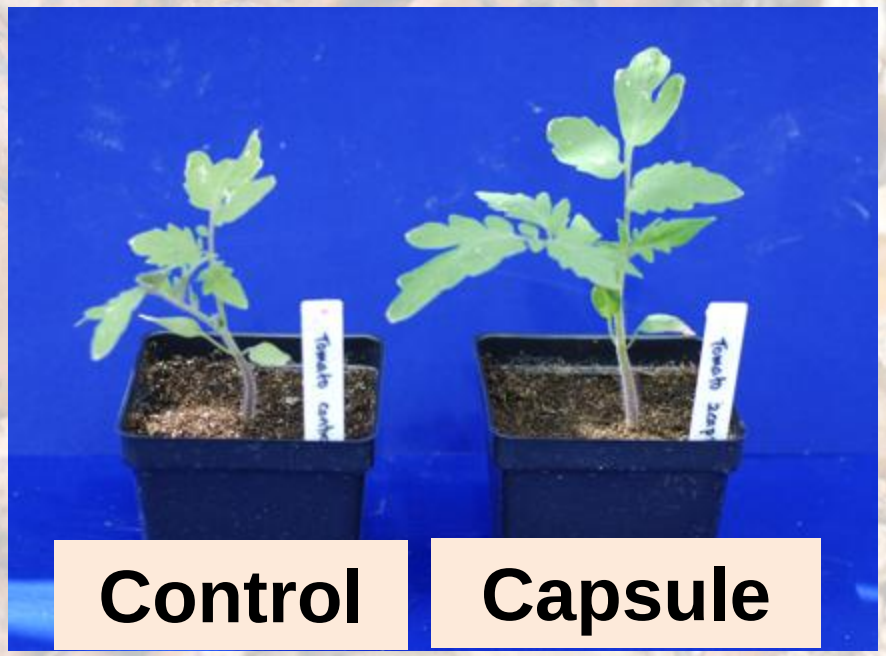
Lettuce pellet mix

Capsule placed adjacent to the seed in the pot (in the picture: two-capsule treatment = four ½ capsules)

Alliance SEED CAPSULES

COATING SUPPLY INC.

SAKATA SEED SUDAMERICA LTDA



Control

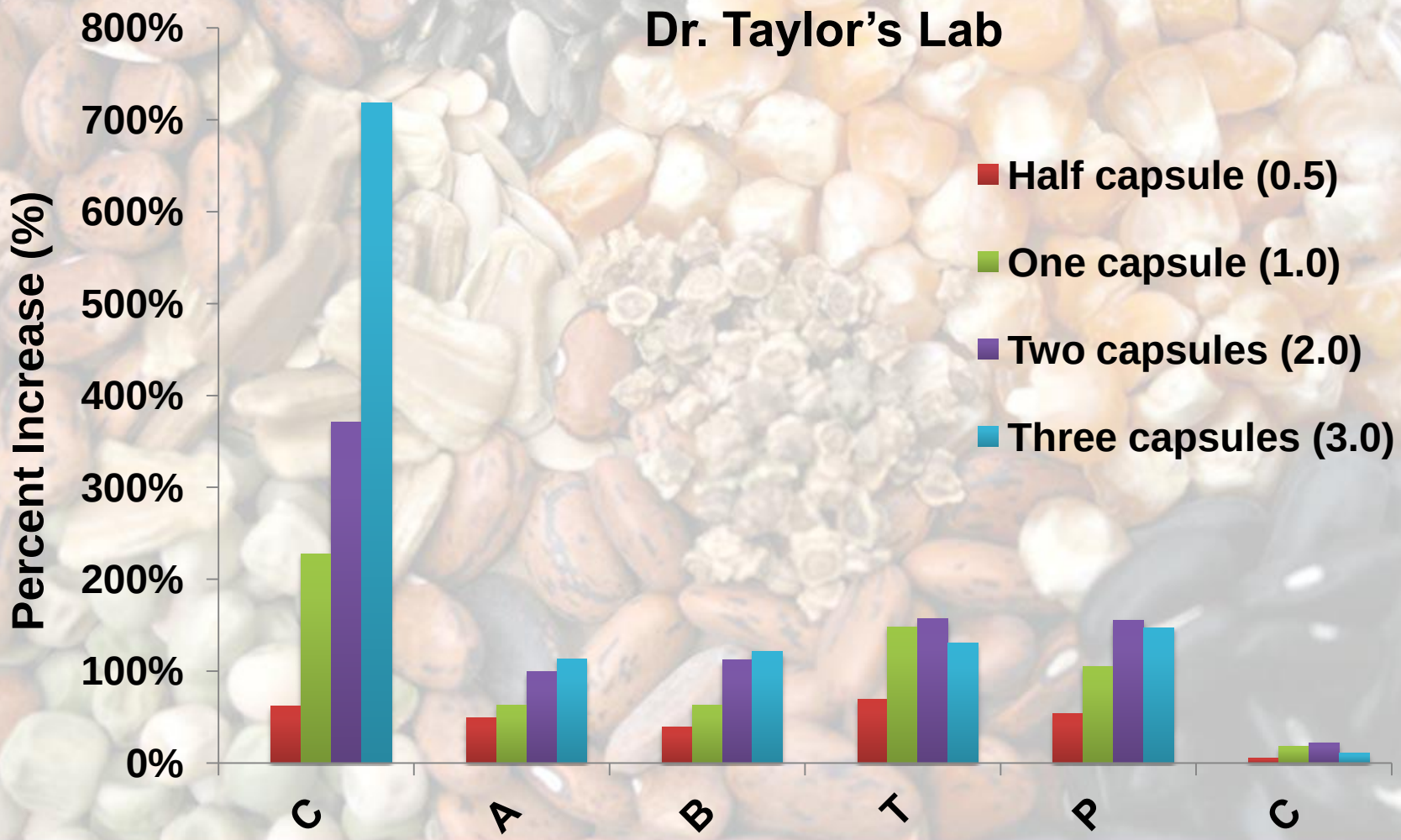
Capsule

Control

Capsule

Fresh Weight: Percent Increase Comparison by Crop

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



Poster - Seed Coating Technologies Employing a Plant-based Green Binder

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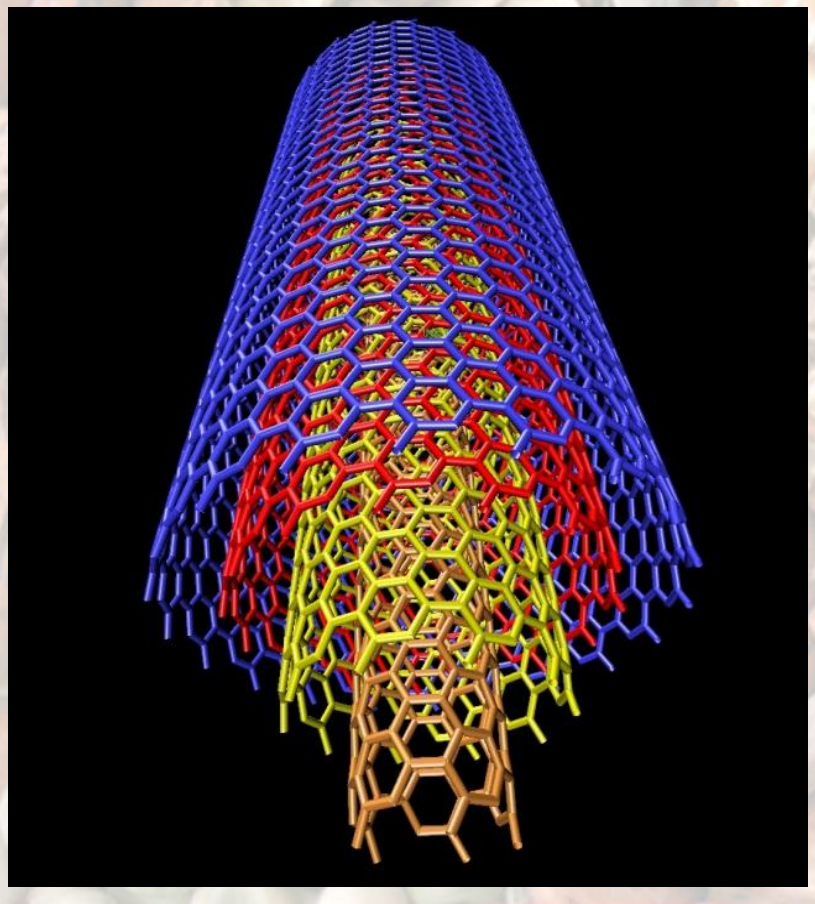
Nanobiotechnology Seed Enhancements: Multi-Wall Carbon Nanotubes (MWCNT's)



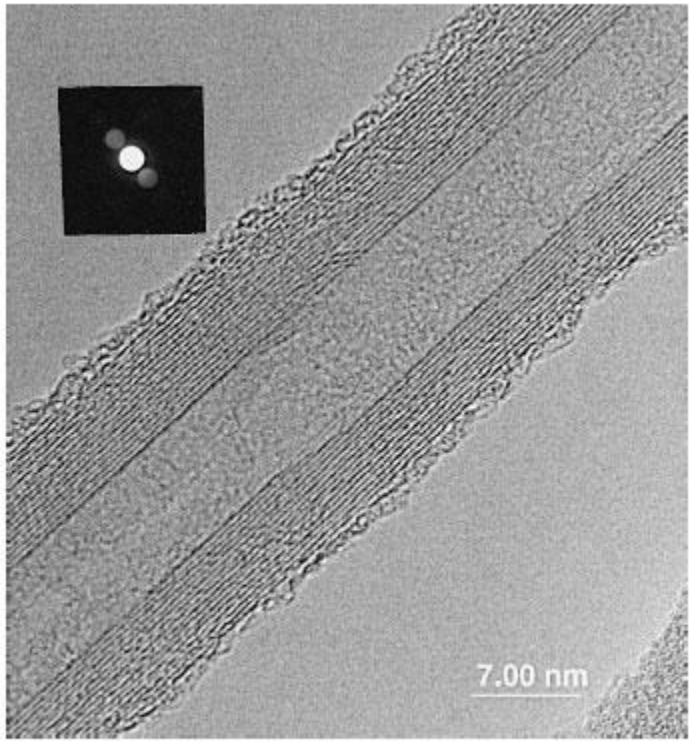
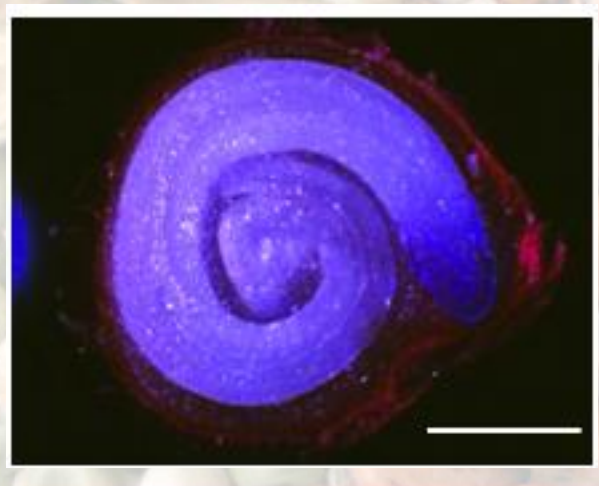


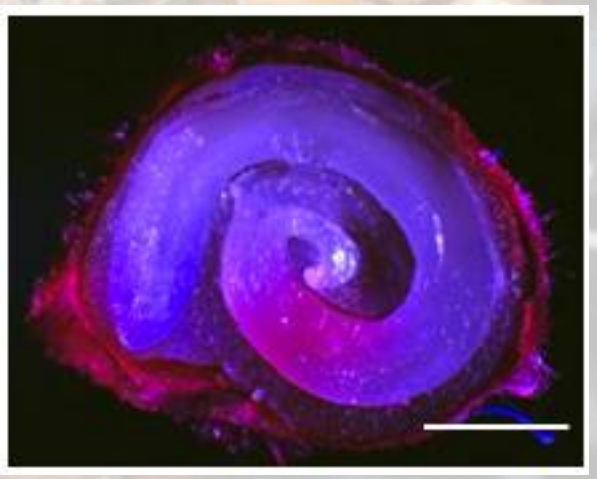
Fig. 3. HRTEM image (Phillips CM 200, 200 kV) showing the multilayered structure of a single MWNT. Inset: Typical (002) electron diffraction spots observed in a microdiffraction pattern.

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:

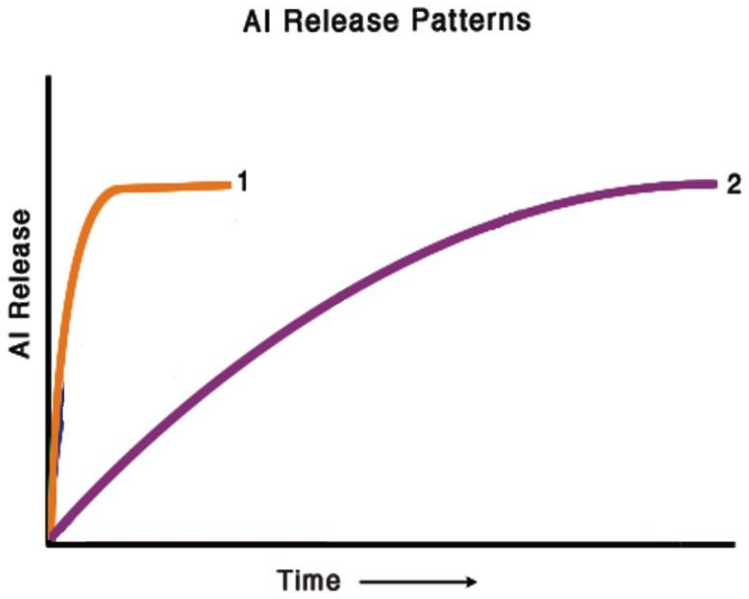
- Seed is widely used as a carrier to deliver agrochemicals where needed
- Controlled release provides the delivery of agrochemicals when needed
- Controlled release of agrochemicals is independent of seed germination

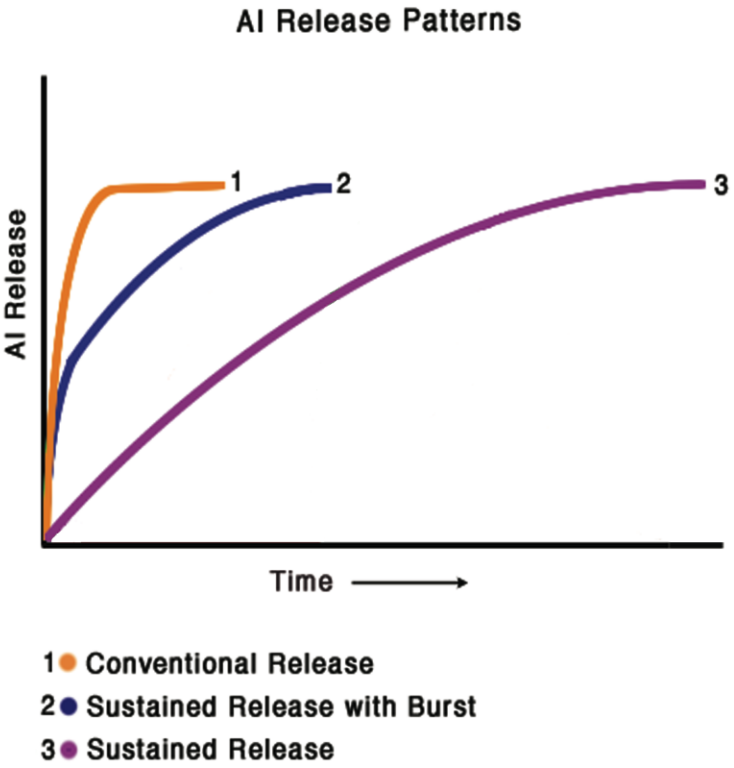
Controlled Release of Seed Treatments

Applications:

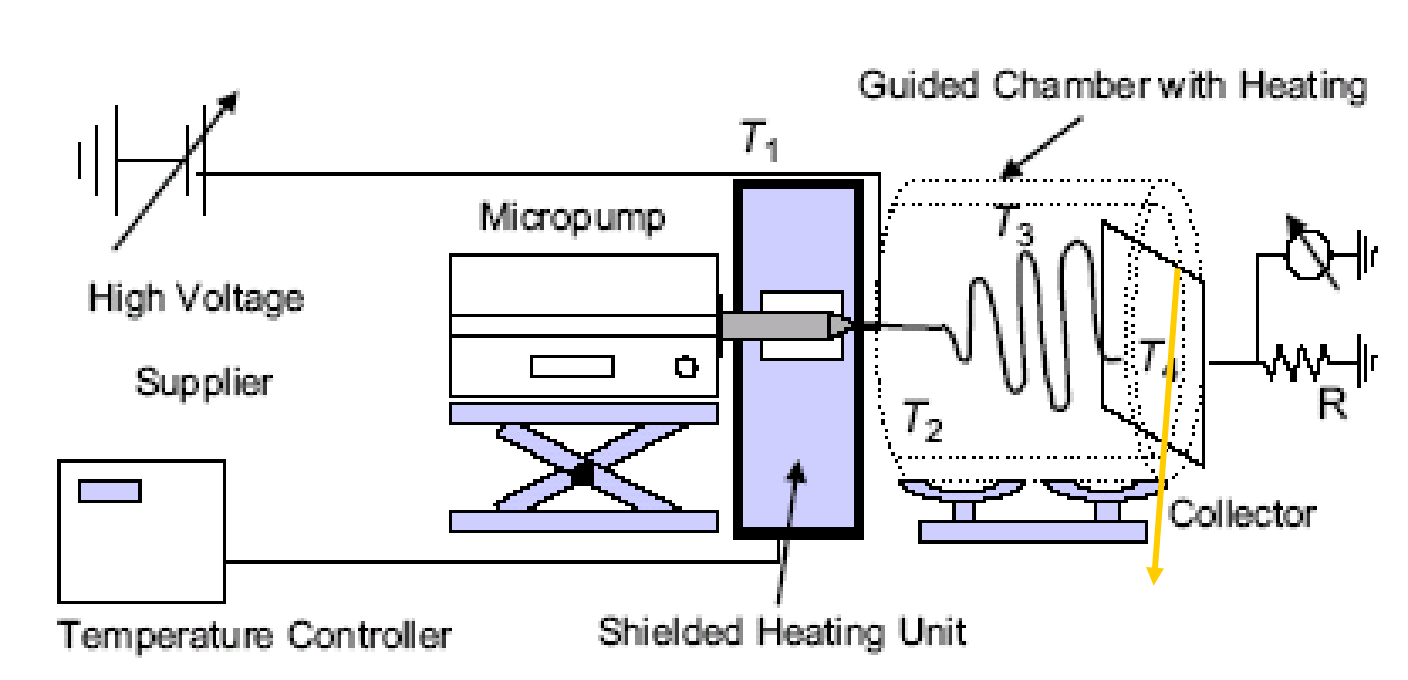
- Delayed delivery of agrochemicals for protection of transplanted crops
- Extended delivery of agrochemicals for direct seeded crops
- Extended protection time to match the needs of the growing plant
- Reduce phytotoxicity of seed treatments on germination

Release Patterns



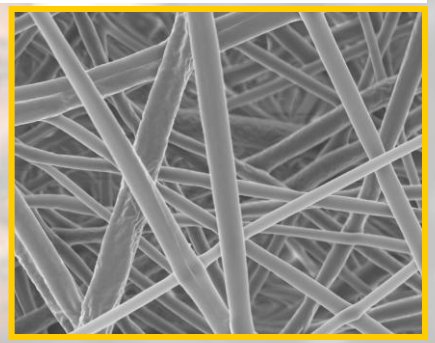


Electrospinning Set-up



Margaret Frey's Lab,

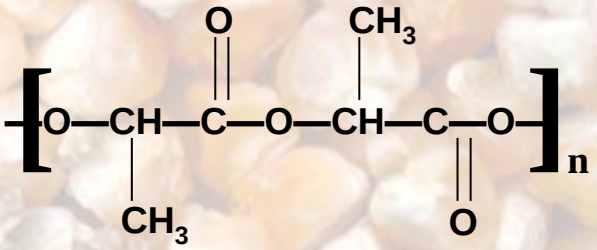
Cornell University



Materials

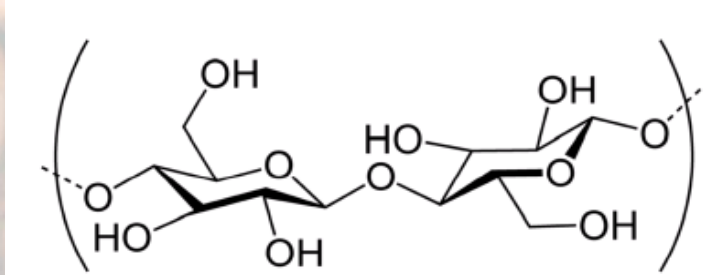
PLA – polylactic acid

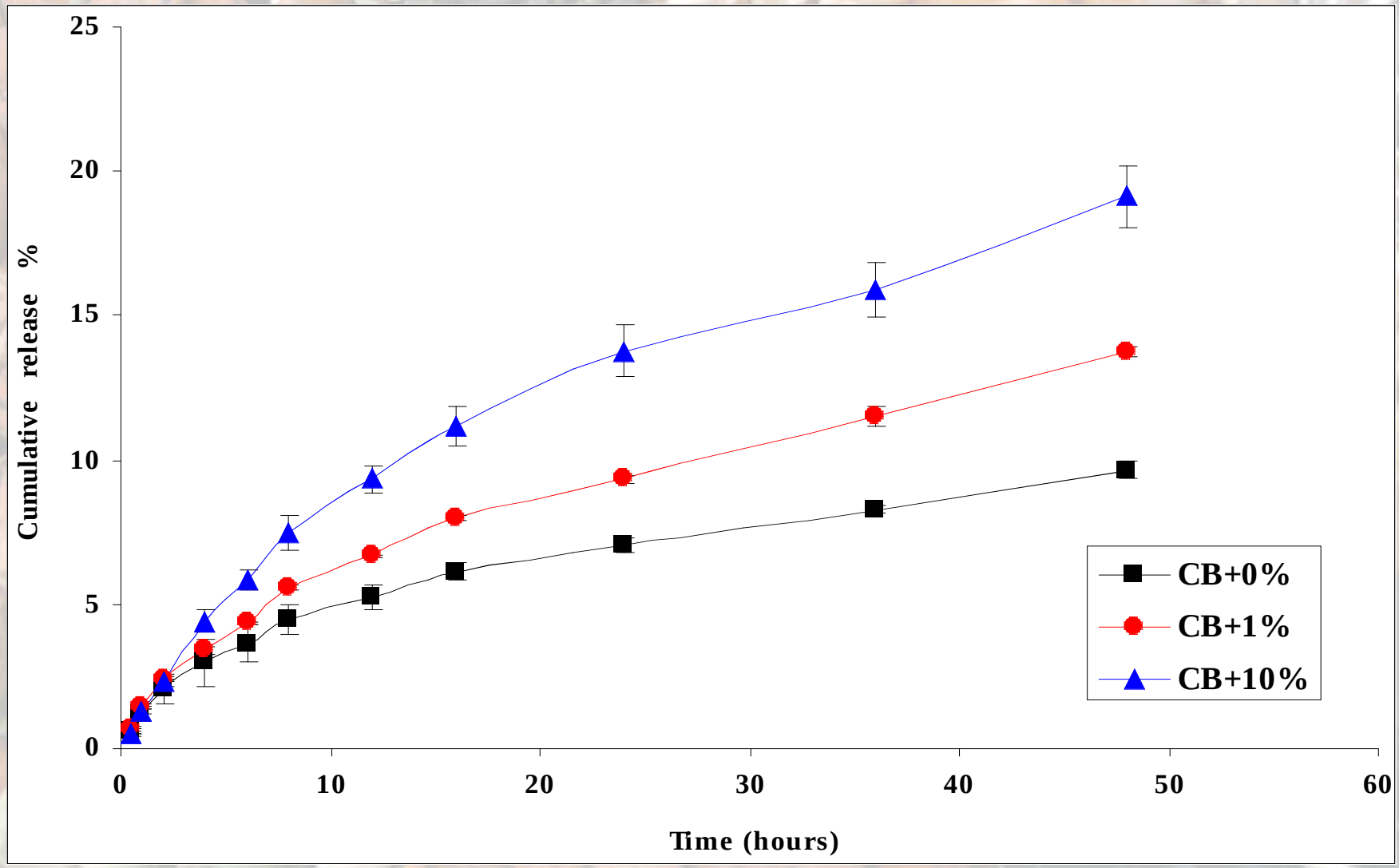
- ***Biodegradable, Renewable***
- ***Hydrophobic***



Cellulose nanocrystals

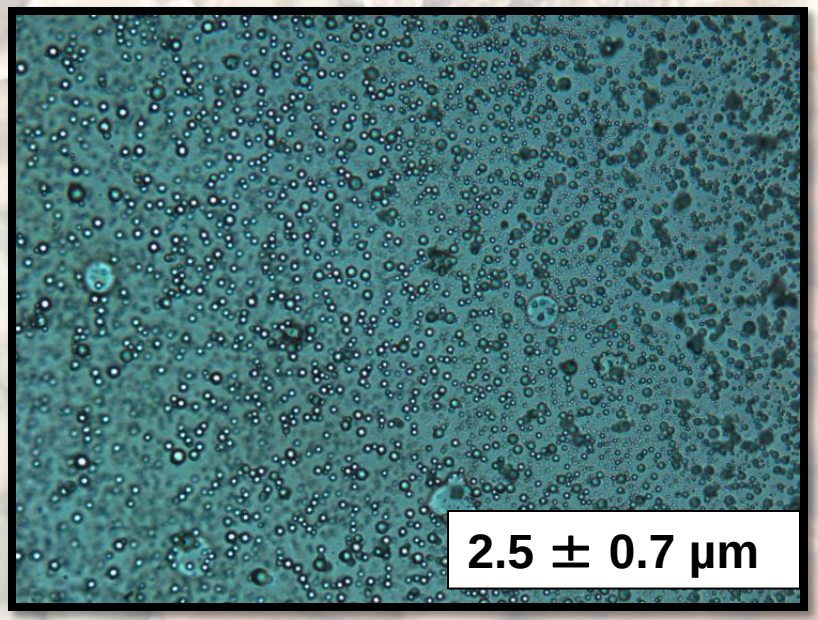
- ***Biodegradable, Renewable***
- ***Hydrophilic***




Cumulative release %
25
20
15
10
5
0
0
10
20
30
40
50
60
Time (hours)
CB+0%
CB+1%
CB+10%

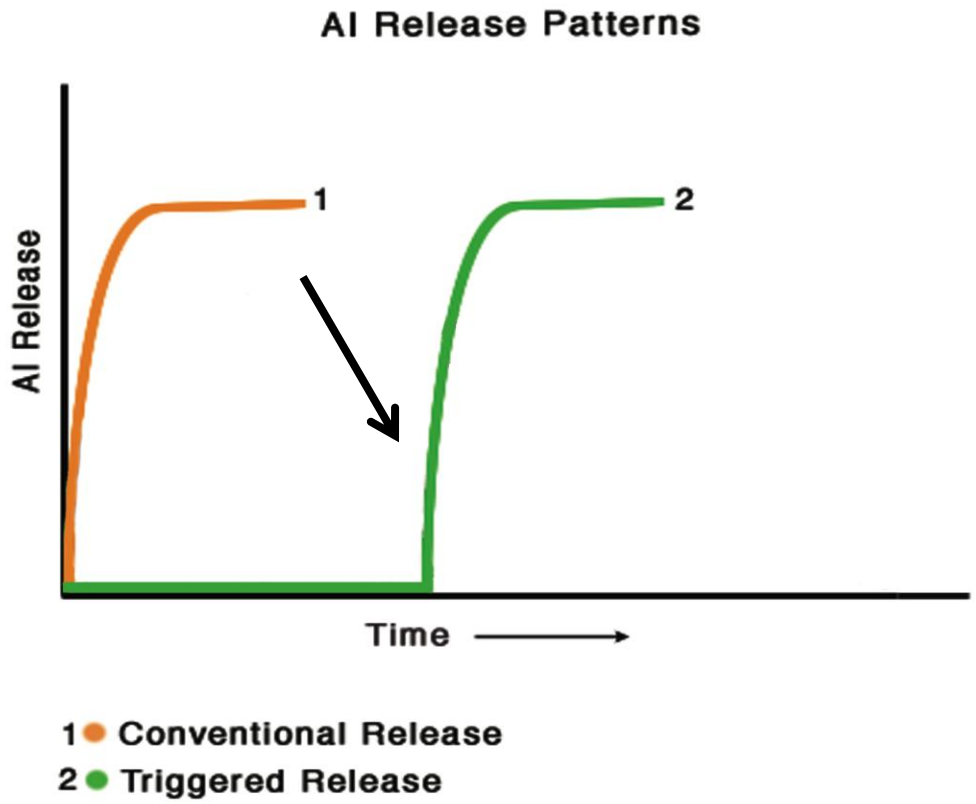
Development of Controlled Release Beads

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

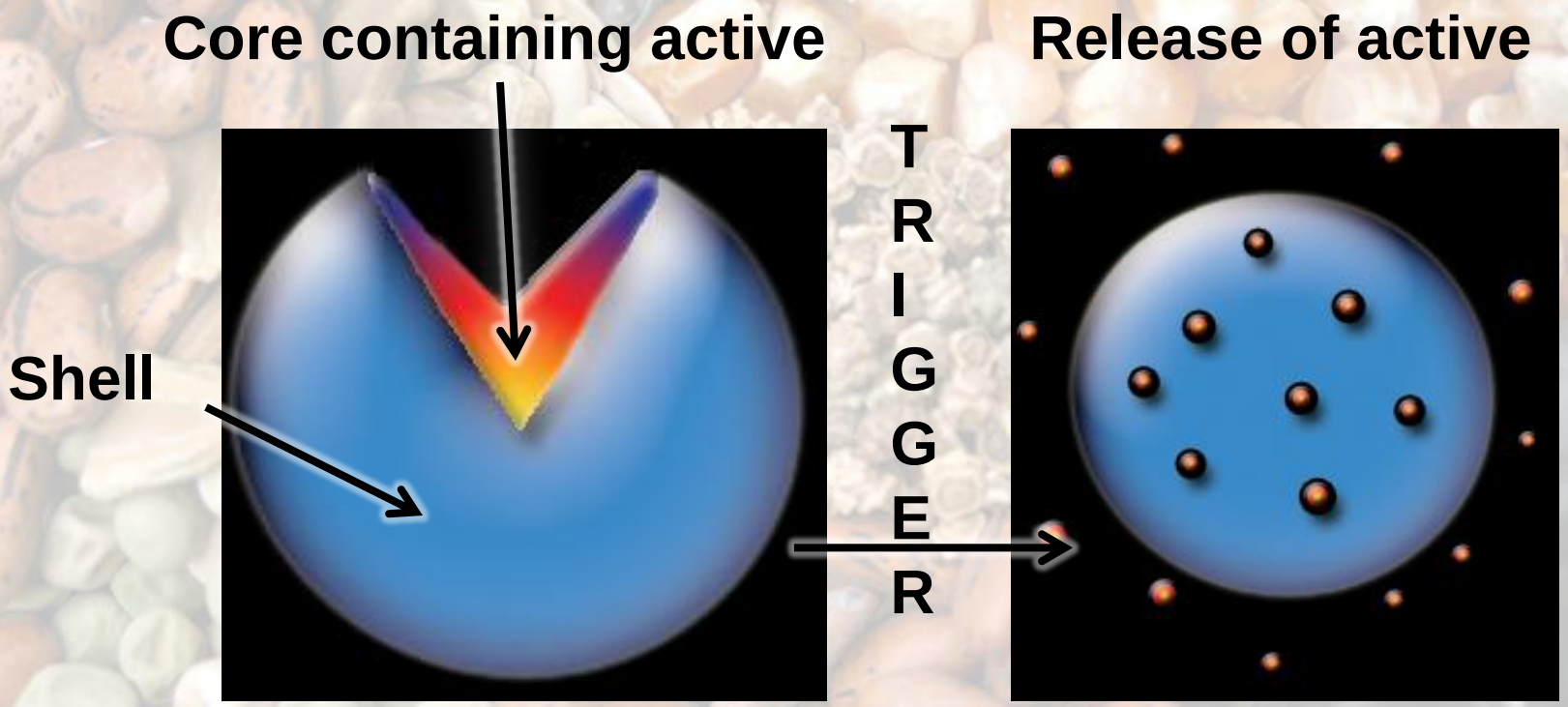


PLA Beads

Development of Triggered Release Seed Treatments in Taylor's Lab



Conceptual Basis of Microcapsule and Triggered Release

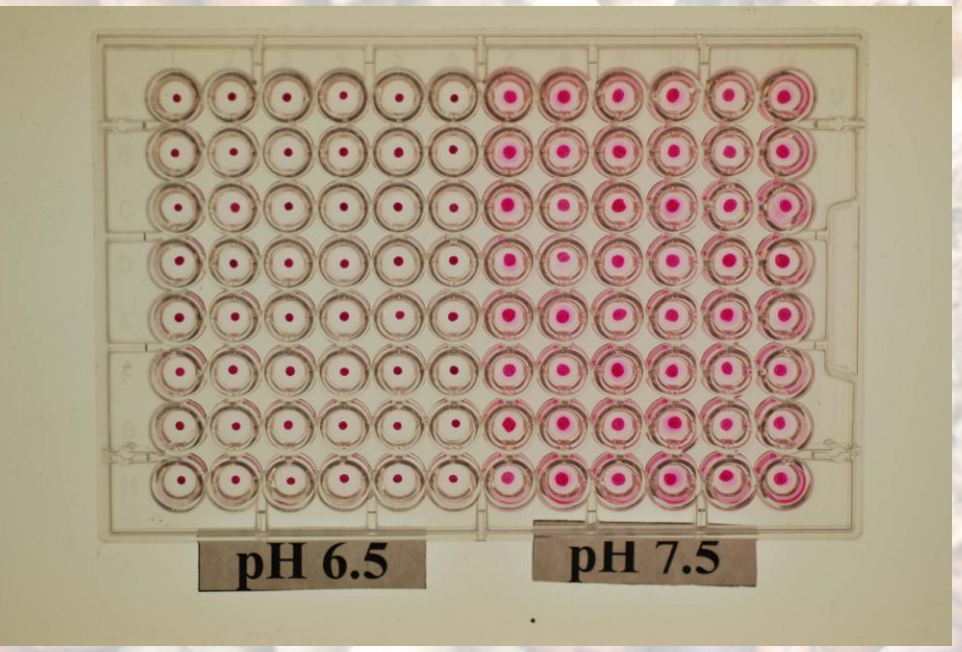


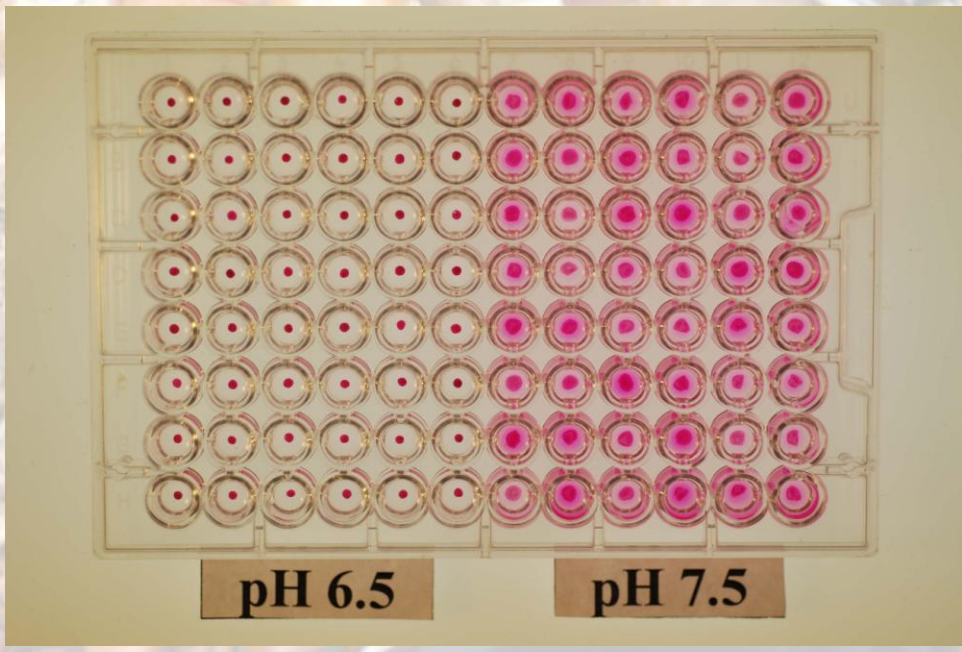
Fluidized Bed and Microencapsulation

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



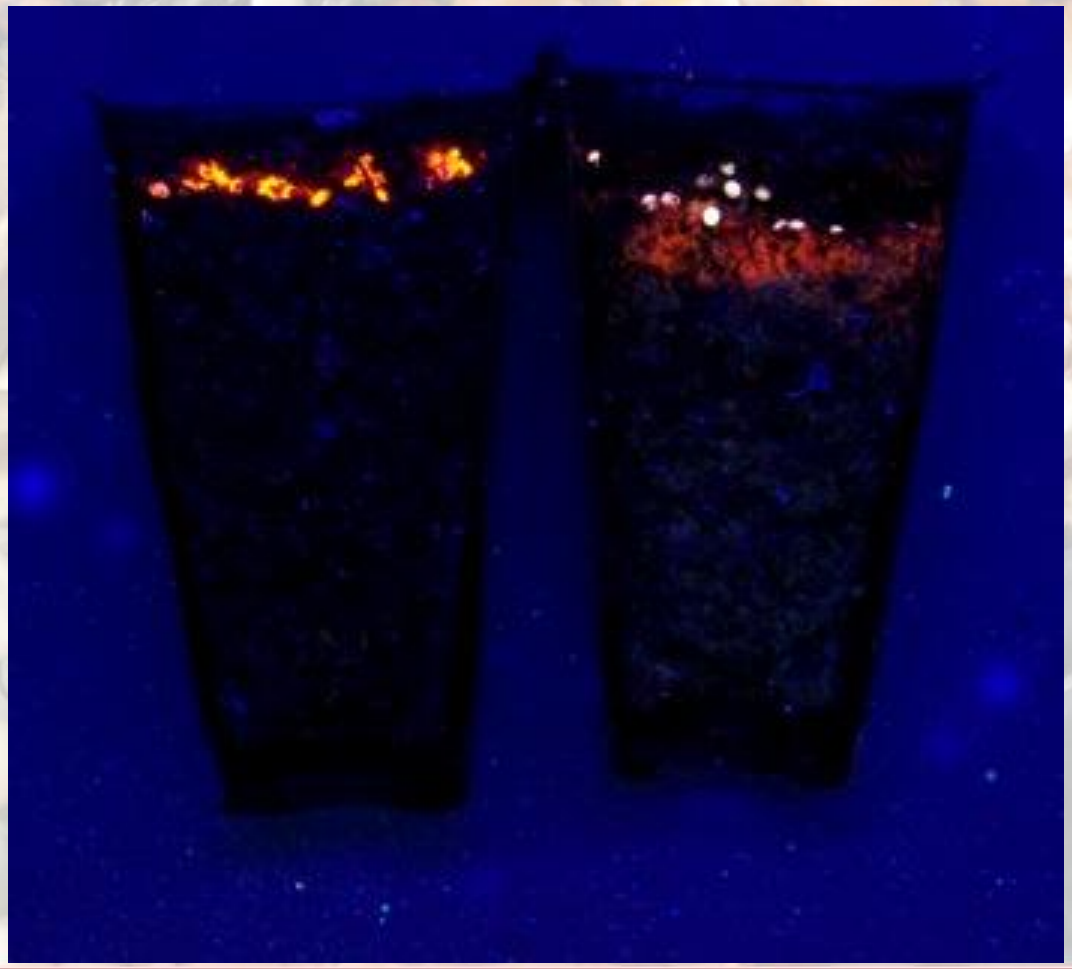


1 h exposure

2 h exposure

The Rhodamine B release from Micro-Particles in a peat-lite greenhouse medium.

Water check



High pH buffer

Triggered Release of Atrazine on Tomato

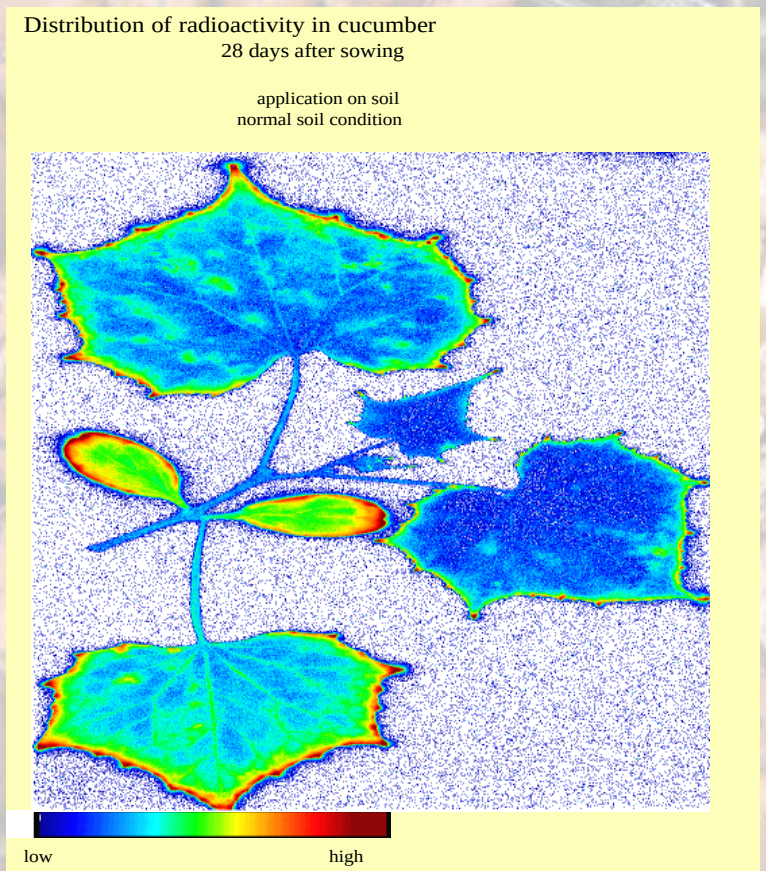
Applied pH Trigger

21 Days after Sowing

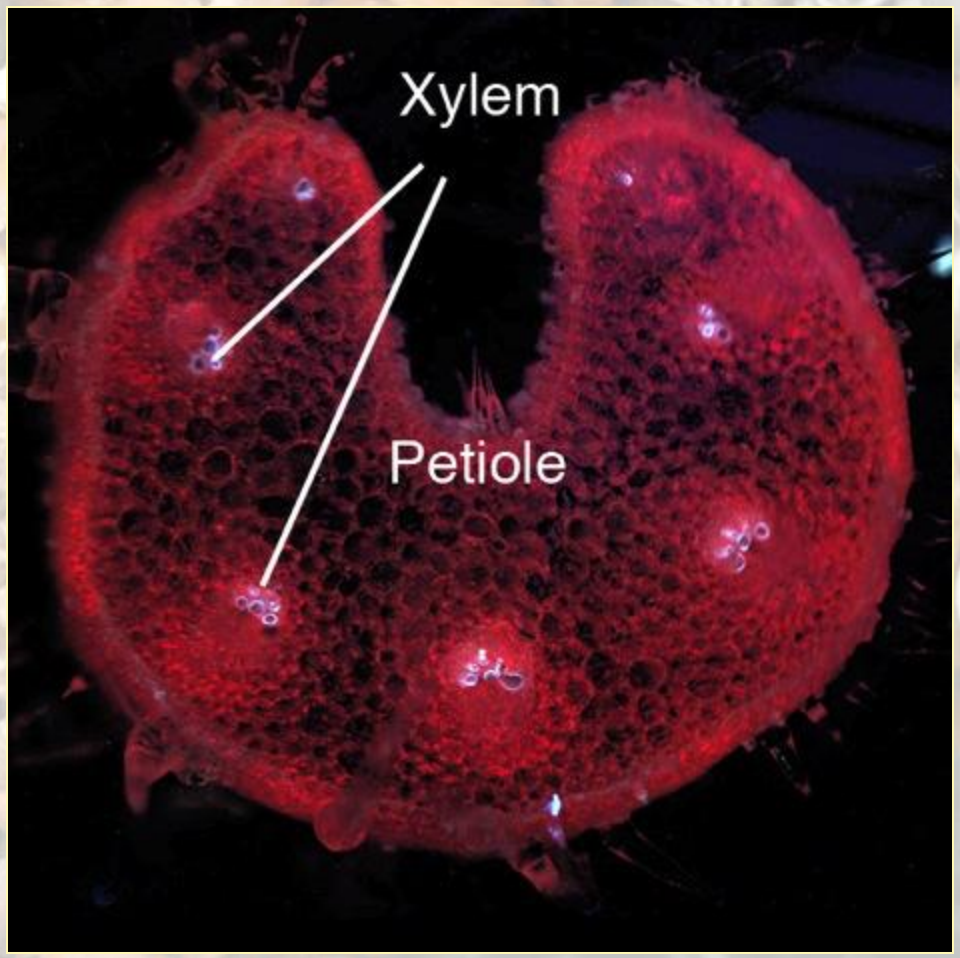
10 days after pH Trigger

31 Days after Sowing

Systemic Movement in Plants

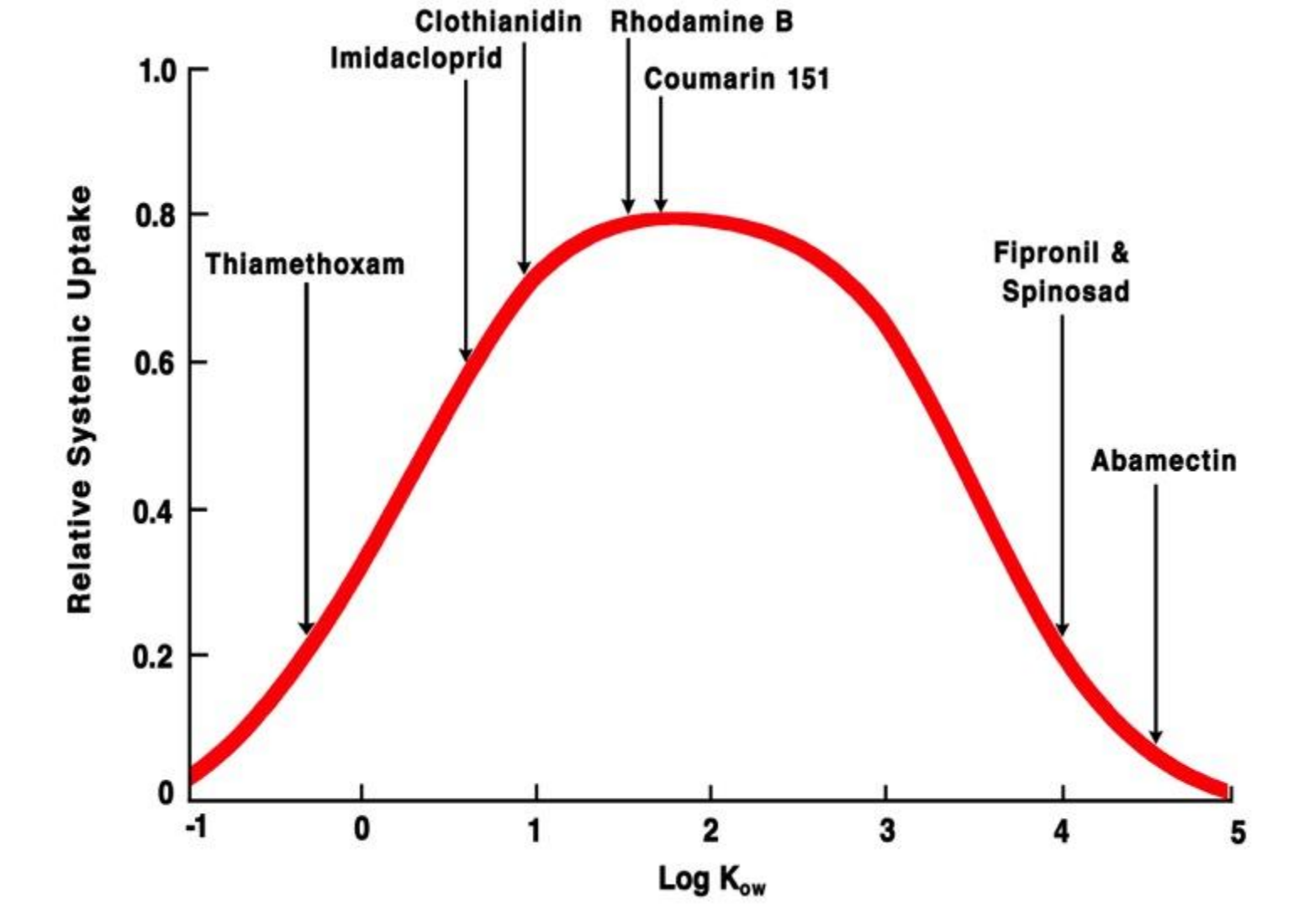


Labeled thiamethoxam uptake in cucumber leaves



Leaf Petiole

Relative Systemic Uptake of Compounds



Scientific question – How are systemic seed treatment actives taken up by vegetable crops?

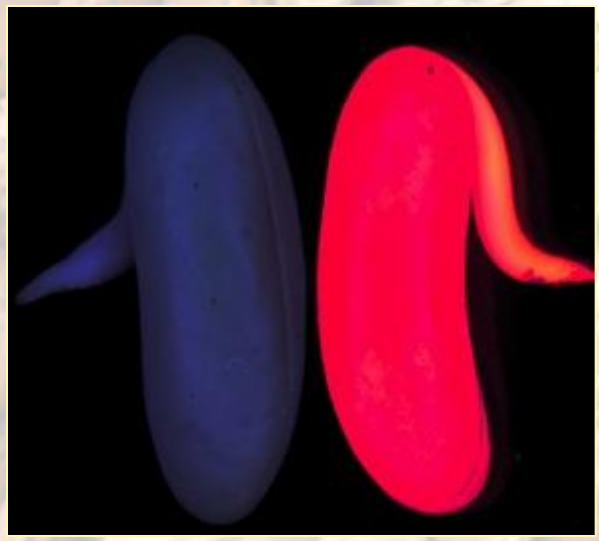
<u>Pathway from seed treatment to embryo</u>

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

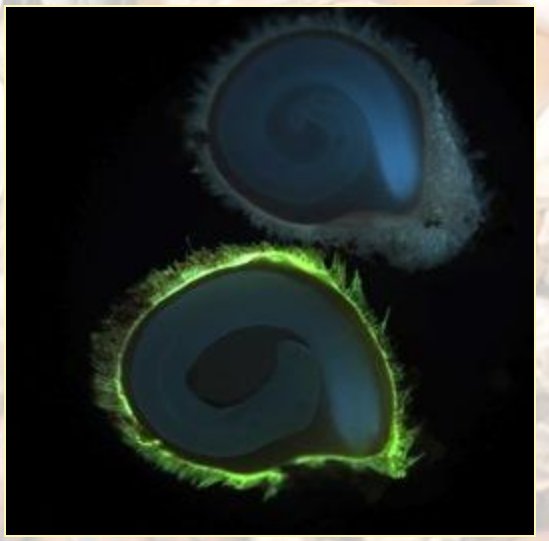
American Seed Research Foundation Grant

Snap Bean



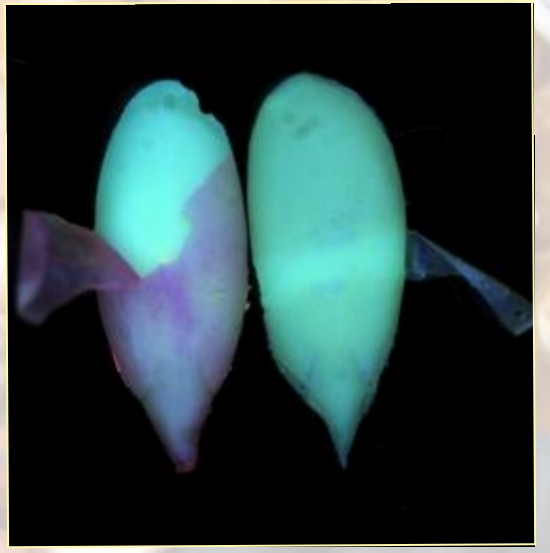
Rhodamine staining

Tomato



Fluorescein staining

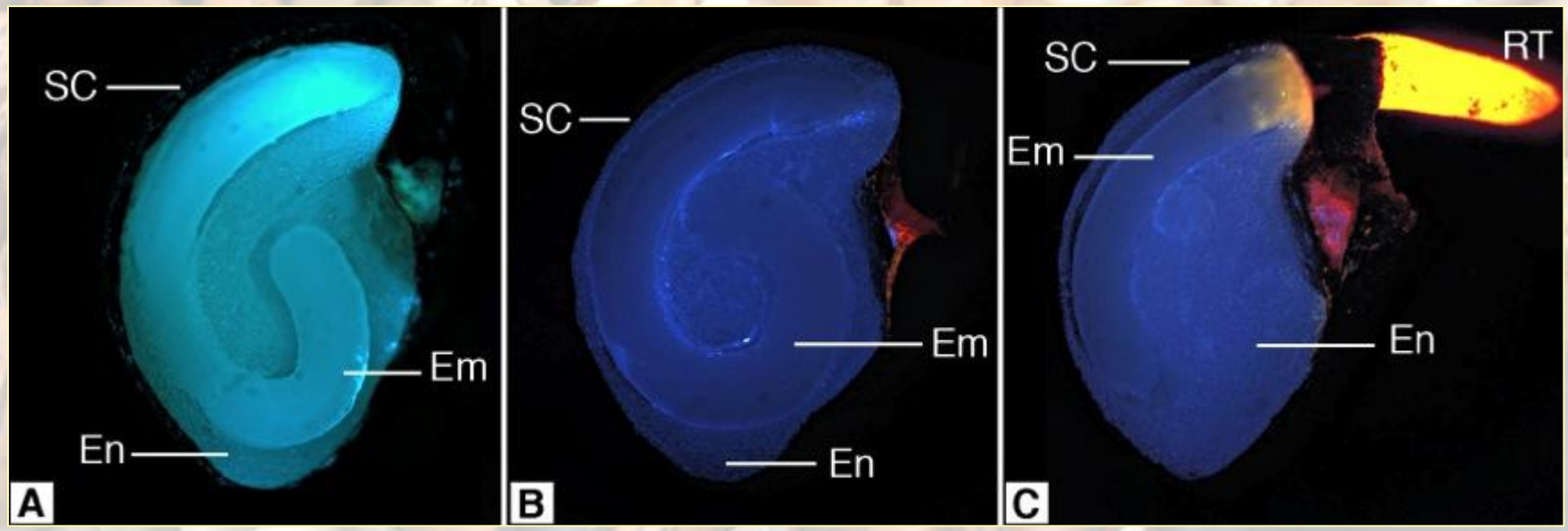
Cucumber



Rhodamine staining

Onion

Coumarin ---------- Rhodamine ----------



Seed Coat Permeability Characteristics of Vegetable Crops

Vegetable Crop Seed	Seed Coat Permeability
Snap bean	Permeable
Onion	Selective permeability
Tomato	Selective permeability
Pepper	Selective permeability
Sweet corn	Selective permeability
Lettuce	Non-permeable
Cucumber	Non-permeable

New Chemistries

Environment
& Sustainability

Seed Coating
Technologies

Systemic
Seed
Treatment
Uptake

Growth
Enhancement

Controlled
Release