MISSISSIPPI STATE UNIVERSITY™

SEED TECH

2018

Seed Treatments & Enhancements

July 31 & August 1, 2018

Proceedings of the MSU Seed Technology Short Course

Volume IV

Seed Tech 2018: Seed Treatments and Enhancements

Mississippi State University

Division of Agriculture, Forestry, and Veterinary Medicine

MSU Extension Service

Mississippi Agricultural and Forestry Experiment Station

Mississippi Crop Improvement Association

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Reuben Moore, DAFVM/MAFES	Dennis Reginelli, MSU Extension
Greg Flint, MCIA	Wes Lowe, MAFES
Randy Vaughan, MAFES	Steve Martin, MSU Extension

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Mike Philips, Department Head, Plant and Soil Sciences

Jonathan Pote, Department Head, Agricultural and Biological Engineering

Seed Tech 2018: Seed Treatments and Enhancements

Tuesday, July 31, 2018

8:45 Registration

9:15 Welcome and Introduction – *Comments by Dr. Gregg Bohach, VP DAFVM*

9:30 Plant Breeding Innovation and Public Perceptions – *Pat Miller, American Seed Trade Association*

10:00 Basic Considerations for Seed Applied Technologies – *Chip Graham, Bayer U.S. LLC*

10:30 Seed Treatment Considerations for Corn and Cereal Grains – *Jeff Daniels, DuPont Pioneer*

11:00 Seed Treatment Considerations for Legumes – *Dair McDuffee, Valent*

11:30 Lunch – by Cicero's Restaurant, *Sponsored by Pennington Seed Inc., Syngenta, & DeltAg. Comments by Dr. Gary Jackson, Director MSU ES*

12:30 Group Picture

12:45 Seedcare Formulation Technology: A Look Behind the Scene – *Dr. Lorelin Day, Syngenta*

1:15 Seed Treatment Processes and Equipment – *Quentin Edelman, KSi Inc. & Mark Domann, FarmChem*

2:00 Product Labels, Uniformity, and Calibration Considerations – *John Belding, Local Seed Co.*

2:30 Seed Coatings, Pelleting, and Encrusting – *Gerrard Denny, Incotec Inc.*

3:00 Comments from Sponsors

3:15 Break – Snacks & Refreshments, *Sponsored by KSi, FarmChem, Southern Ag., Bayer, LMC, & Pioneer*

3:30 On-site Equipment Demonstration: Treatment Processes, Quality Factors, Rates, Calibration, etc. – *Quentin Edelman, KSi Inc. & Mark Domann, FarmChem*

6:00 Social/Dinner – by Cicero's Restaurant *Sponsored by Pennington Seed Inc., Syngenta, & DeltAg*

Wednesday, August 1, 2018

7:30 Doors Open

8:00 Welcome and Introduction – *Comments by Dr. Jeff Johnson, Director of DREC*

8:15 Seed Treatment Considerations for Cotton – *Jeremiah Mullock, Bayer U.S. LLC*

8:45 Treatments and Enhancements for Grass Seed Applications – *Bill Talley, Summit Seed Coatings*

9:15 Biological and Microbial Technologies & Opportunities – *Tom Johnson, Former CEO, TJ Technologies, Inc., Current CEO, Changing Times LLC.*

10:00 Break – Snacks & Refreshments, *Sponsored by KSi, FarmChem, Southern Ag., Bayer, LMC, & Pioneer*

10:15 Safe Use/Handling and Environmental Stewardship of Treated Seed – *Gene Merkl, MSU Extension*

11:00 Seed Quality Evaluation and Testing – *Brent Turnipseed, South Dakota State University*

11:45 Lunch – by Cicero's Restaurant, *Sponsored by Pennington Seed Inc., Syngenta, & DeltAg.*

1:00 Labeling of Treated Seed: State Laws –
James Smith, Mississippi State Seed Testing Lab

1:45 Labeling of Treated Seed: Federal Laws –
Steve Malone, Seed Regulatory and Testing Division, USDA-AMS

2:30 Panel Discussion: Seed Treatments – Emerging Issues & Future Considerations

Dr. Jeffrey Gore – MSU ES/MAFES *Sam Cloete – Kannar Earth Science*
Dr. Don Cook – MAFES *Dr. Rocky Lemus – MSU ES*

3:00 Summary, Evaluation, Closing


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EXTENSION
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2018 Seed Technology
Short Course
July 31 - August 1, 2018

PLANT BREEDING INNOVATION & PUBLIC PERCEPTIONS

Pat Miller
Director, State Affairs

asta | american seed trade association

Plant Breeding Innovation Video

available at: seedinginnovation.org/video-library/

MILESTONES IN PLANT BREEDING

CROP DOMESTICATION

Farmers select the best wild species to create crops

10,000 BC

Domestication of wheat

HYBRID BREEDING

Crossing two genetically different individuals to develop better performing hybrid

More vigorous hybrid corn

1926

PLANT BREEDING BASED ON CROSS BREEDING

Development of improved varieties by combining good characteristics from two parents

1940

MUTAGENESIS

Developing new genetic diversity by exposing crop plants to chemical agents or radiation

Blast-resistant rice

GMO

Introducing foreign genes into the DNA of a plant

Insect-resistant cotton

1994

MARKER-ASSISTED SELECTION

Locating desirable traits in a plant for efficient selection and breeding

Barley resistant to yellow dwarf virus

2000

TARGETED BREEDING

Using modern tools such as genome editing for more targeted breeding

Waxy corn

now

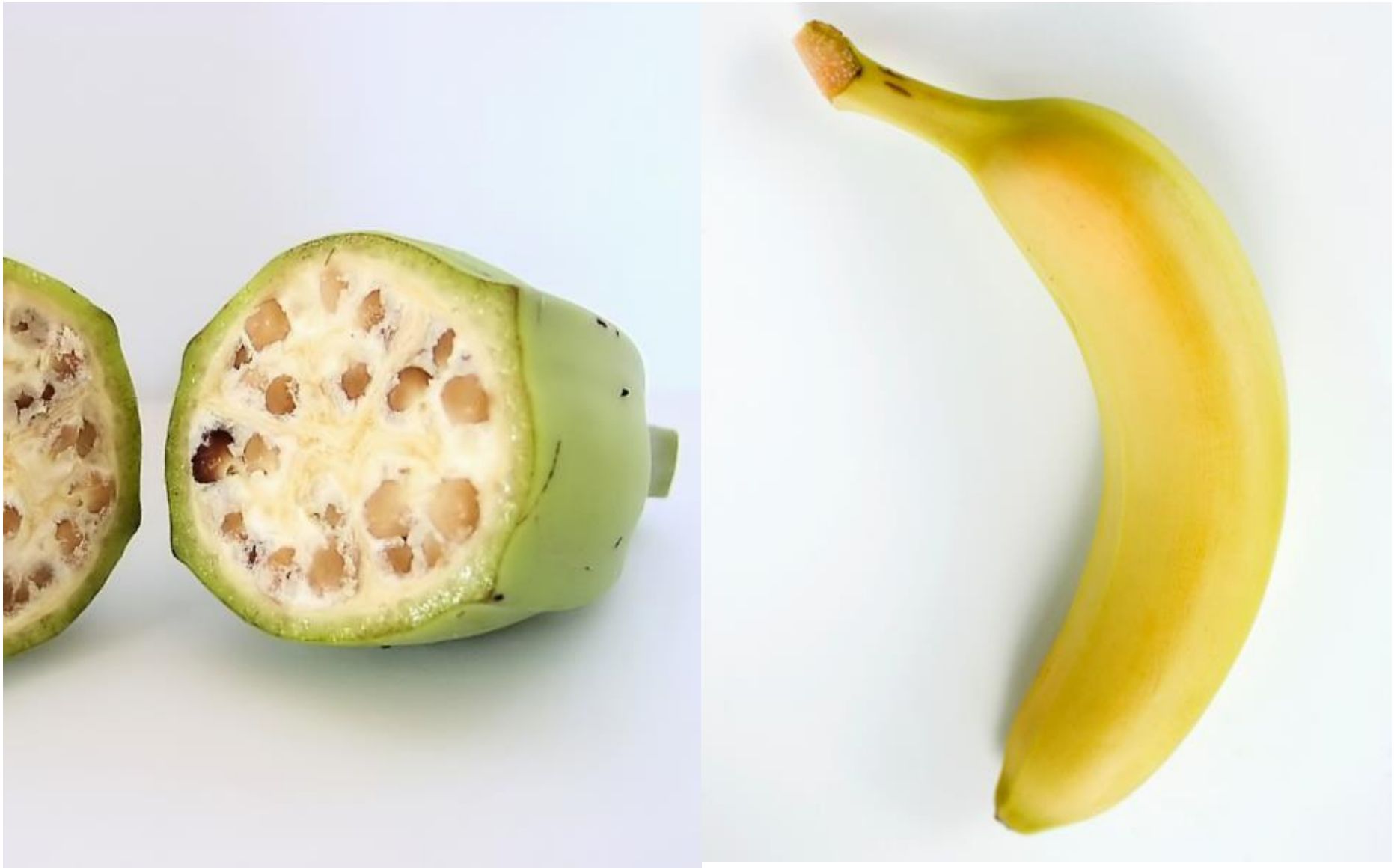
future

PLANT BREEDING BASED ON GENETIC INFORMATION

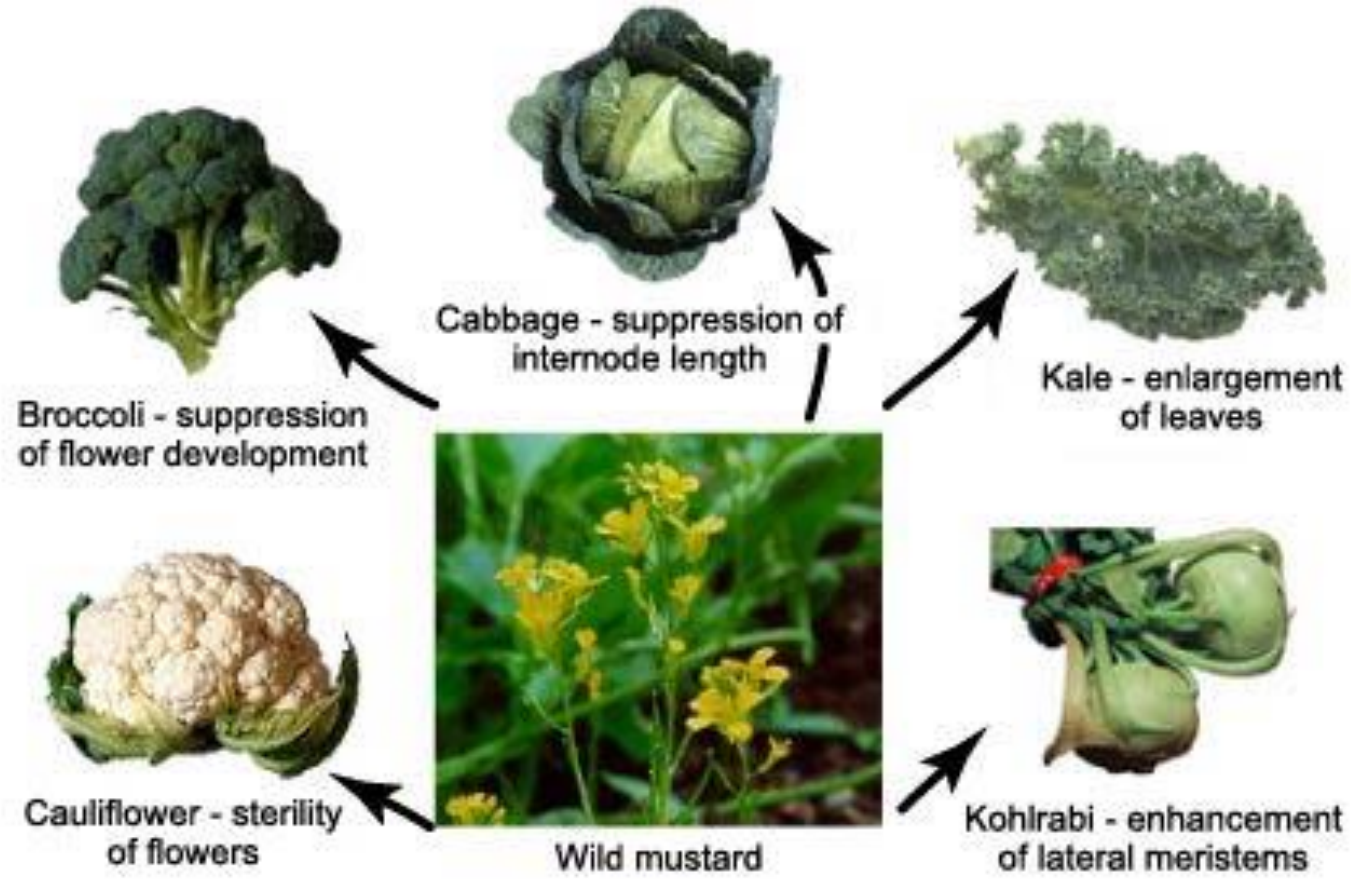
Development of improved varieties by working directly with the DNA

ISF International Seed Federation
Seed is Life

Plant breeders improved the modern banana into the beautiful, healthy and tasty fruit consumers have come to know and love



Traditional Breeding from Wild Mustard



evolution.berkeley.edu

Gene Editing: Three Ways

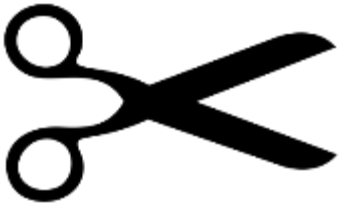
#1 Activate

e.g. drought tolerance

#2 Deactivate

e.g. disease sensitivity

#3 Make Small Changes



e.g. mimic characteristic found in wild relatives

Gene Editing *(think word processing)*

DELETE	**The plant DOES NOT have desired output.** **The plant DOES have desired output.**
EDIT	**The plant has TOLERANCE to drought.** **The plant has HIGH TOLERANCE to drought.**
SEARCH/REPLACE	**The plant is SUSCEPTIBLE to disease.** **The plant is RESISTANT to disease.**

Scope: Like Adding a Period in Book

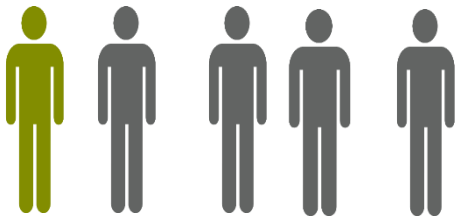
Farmer Acceptance: In order to grow more, using less, farmers need a variety of seed choices to:

- Use water and nutrients more efficiently
- Manage changing weather
- Fight plant disease and pests
- Use fewer inputs

Consumer Perceptions

Focus Groups:

- Consumer Influencers
- Looking at:
  - Plant breeding
  - Gene editing



<u>Key Findings:</u>

- **The jury is still out**
  - ✓ About 1 in 5 people haven't made up their minds yet
    - 28% have positive views
    - 17% negative
- **What do they want to know?**
  - That seeds are safe for them and safe for the environment.

Key Takeaways from Focus Groups

- Farmers and scientists (plant breeders) are good messengers
- Context: new methods are part of the STORY of plant breeding – history and evolution
- "Feeding the world" **doesn't** resonate
- Safety and environmental benefits **do** resonate
- Tie it to real-life (local) benefits: for consumers, farmers and the environment

Consumer Perspectives – Bottom Line

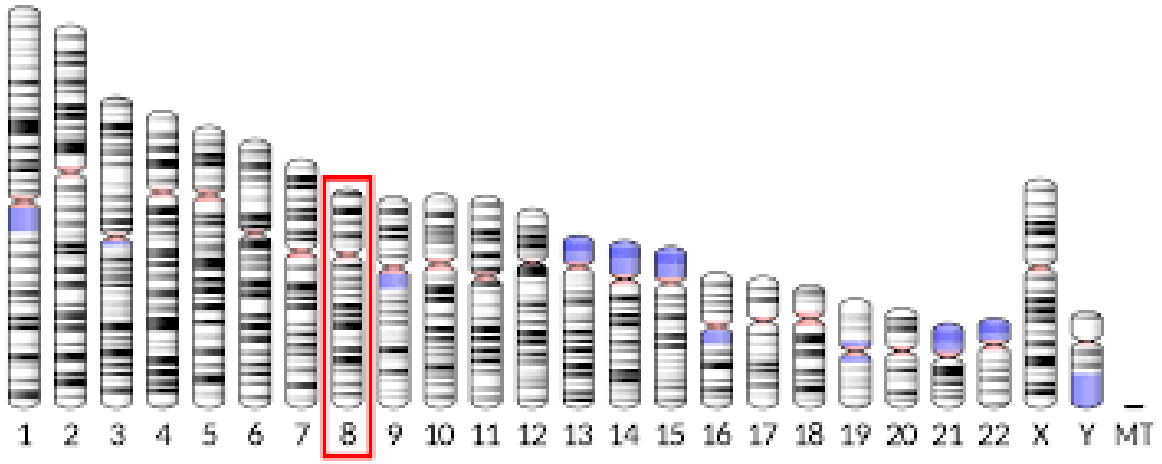
When it comes to food production, consumers want farmers to produce a variety of food choices, while conserving natural wisely, and reducing crop inputs.

Key Point to Communicate

Plant Breeding Innovation offers exciting possibilities for farmers, consumers and the environment

Evolution of Gene Editing

- In 2007, it cost $1m to map the human genome, today it could be done for less than $4,000
  - Thus, the technology has become more available to a broader group of breeders



Key Point to Communicate

The technology can be accessible to all breeders – all crops, all sizes, all sectors (public and private)

Breeders = Solutions

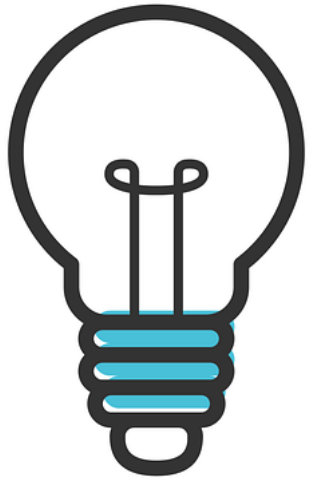
Breeders help farmers find new and innovative solutions to meet their local needs and address challenges like --

- Managing the impact of changing weather patterns
- Fighting plant disease and pests
- Use less crop inputs and conserve manage natural resources

Breeders = Solutions

While most of the general public doesn't know a whole lot about breeding, recent consumer focus groups have shown that when making purchase decisions at the grocery store, people want food that is:

- Healthy and safe for the their families
- Safe for the environment
- And they want a variety of options



Industry Commitment to Quality, Safety

Breeders have a long-standing track-record of safety.

- Test trials range from as few as 10 to 20 site-years for some plants, to 75 to 100 site-years for others (some 5 to 10 years).
- Regardless of the techniques used, new varieties are tested on multiple sites over many years before introduction into agricultural practice.

Key Point to Communicate

Ensure a federal policy process that focuses on the end product, not the process. These policies are best managed at the federal level - states don't have the proper resources

Current Regulatory Framework for Plants

Are foods and plants regulated?

- Yes! ALL foods derived from plants are regulated by the FDA under the Food Drug and Cosmetic Act.
- And USDA's Animal and Plant Health Inspection Service has authority under the Plant Protection Act to protect U.S. agriculture from the risks posed by plant pests and noxious weeds.

The question is not whether there is adequate regulation, but rather whether a specific pre-market review and clearance process is justified.

Desired Regulatory Framework for Plants

- Policy should be based on the end-product; not the method used to get there.

- If newer breeding methods result in plant varieties that are the same or indistinguishable from varieties developed through more traditional methods, they should not be treated differently from a regulatory perspective.

2018 USDA Statement on Plant Breeding

"Under its biotechnology regulations, USDA does not regulate or have any plans to regulate plants that could otherwise have been developed through traditional breeding techniques as long as they are not plant pests or developed using plant pests. This includes a set of new techniques that are increasingly being used by plant breeders to produce new plant varieties that are indistinguishable from those developed through traditional breeding methods. The newest of these methods, such as genome editing, expand traditional plant breeding tools because they can introduce new plant traits more quickly and precisely, potentially saving years or even decades in bringing needed new varieties to farmers."

It's important to note that the USDA statement reaffirms and clarifies existing policy, which sends a clear message to other governments that its regulatory policy on gene edited plants has not changed.

Federal Government Update

USDA

Proposed Rule to Revise Part 340 Biotech Regulations submitted by the previous administration (withdrawn)

FDA

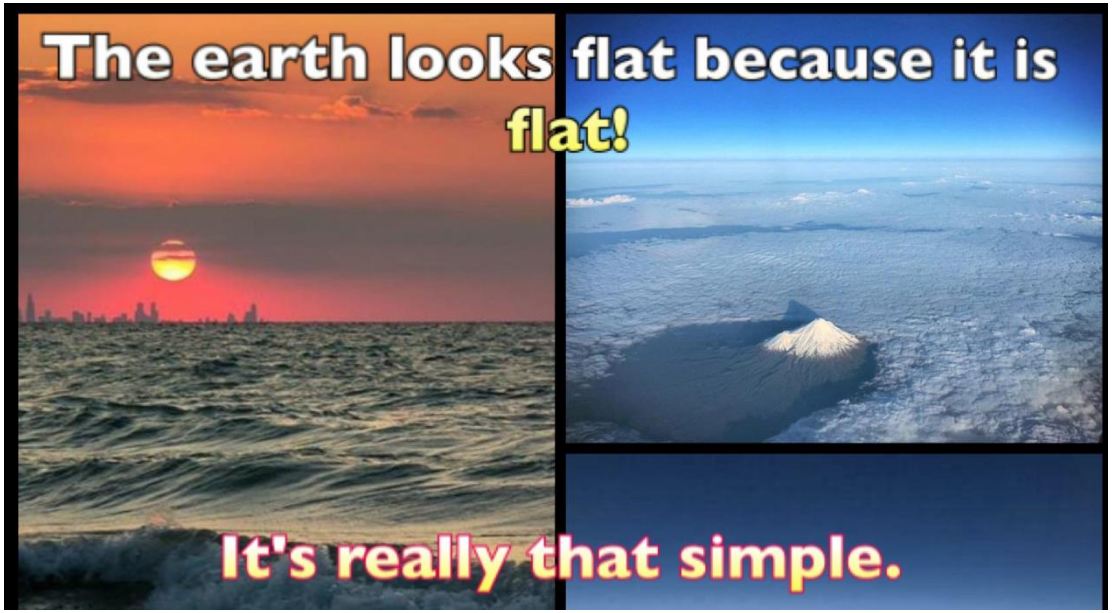
Request for Information on Gene Editing in Plants - Guidance For Industry #187 *Regulation of Intentionally Altered Genomic DNA in Animals*

Key Point for Consideration

International implications are significant – ASTA is fully engaged with our international partners

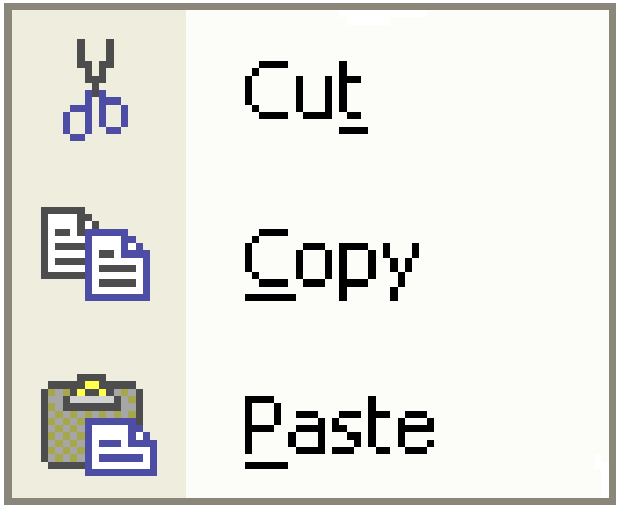
Messaging Hurdles

- Anti-science evangelists
  - Lack of expertise and general science literacy
  - Unfortunately, public believes them first



Messaging Hurdles

Public acceptance is critical, although they don't necessarily want to understand the technical aspects



Messaging Hurdles

- Must convince public that policies exist to protect them
  - Yet, states don't have the resources for implementation, thus must accept federal role

Messaging Hurdles

- Opposition groups/Activists
  - Those seeking market advantage
  - Big vs. small ag: industrial farming????
- No crisis – plenty of quality food exists now
- 1 in 3 Americans believe the U.S. shouldn't export food

Messaging Hurdles

- Growing trend in education to oppose (lost science emphasis in schools)
  - STEM should become STEAM (A=agriculture)
- Societal expectations are often unreal

Messages to Use

- Efficient use of resources, sustainable impact and environmental benefits
- Enhance quality of life
- Farming management solutions
- Evolving weather challenges
- Enhance natural plant characteristics
- Nutrition enhancements
- Safety

Plant Breeding Innovation & Apple Pie

- Cinnamon
  - Increase the Antioxidants
- Apples
  - Design specially for baking texture and flavor
- Crust
  - Gluten-free

Messages to Lose

- Feed 9 billion people / feed families across the globe
- Longer shelf-life
- Faster breeding process or speeding up the breeding process

Key Points to Communicate

- Gene editing offers exciting possibilities for farmers, consumers and the environment
- Ensure a federal policy process that focuses on the end product, not the process. These policies are best managed at the federal level - states don't have the proper resources
- International implications are significant – ASTA is fully engaged with our international partners
- The technology can be accessible to all breeders – all sizes, all sectors (public and private)
- Breeders have a long-standing track-record of safety

www.SeedingInnovation.org

- FAQs
- Breeder profiles
- Blog
- Videos
- One-pagers
- News articles
- Infographics

Join the Conversation!

Proactive state-based outreach through collaboration with:

- Value Chain
- State departments of agriculture
- Legislators
- Extension / University / Land Grant

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QUESTIONS & ANSWERS

Science For A Better Life

Seed Treatment: Innovation Driven, Environmentally Friendly, Committed to Plant Health

Chip Graham Bayer CropScience

What is a "Seed Applied Product"?

Seed application, as defined, relates to the placement on the seed of those products (i.e.., fungicides, insecticides, nematicides, minor elements, herbicide safeners, dyes, plant growth regulators, etc...) which are considered beneficial or necessary in maintaining or enhancing genetic yield potential of a crop. Those products being applied are termed *seed applied products.*

The Pillars of Seed Technology

Leading in Seed Treatment Technology

Bayer CropScience

Leading in Seed Treatment Technology

Advantages of Seed Treatment

Seed treatment is one of the most focused chemical crop protection methods available to date: a relatively small amount of the active substance is needed to provide the seed & seedling with a high level of protection against a wide variety of fungal diseases and insect pests.

Specialized equipment is used to deliver very small quantities of active ingredients to the surface of a seed, which in some instances is no larger than the point of a ball point pen. Advances in application technology have resulted in very little exposure to workers in seed conditioning plants

Seed treatments can be applied at rates of active ingredients per seed,

Crop Protection – different application systems

Spray treatment of the whole area

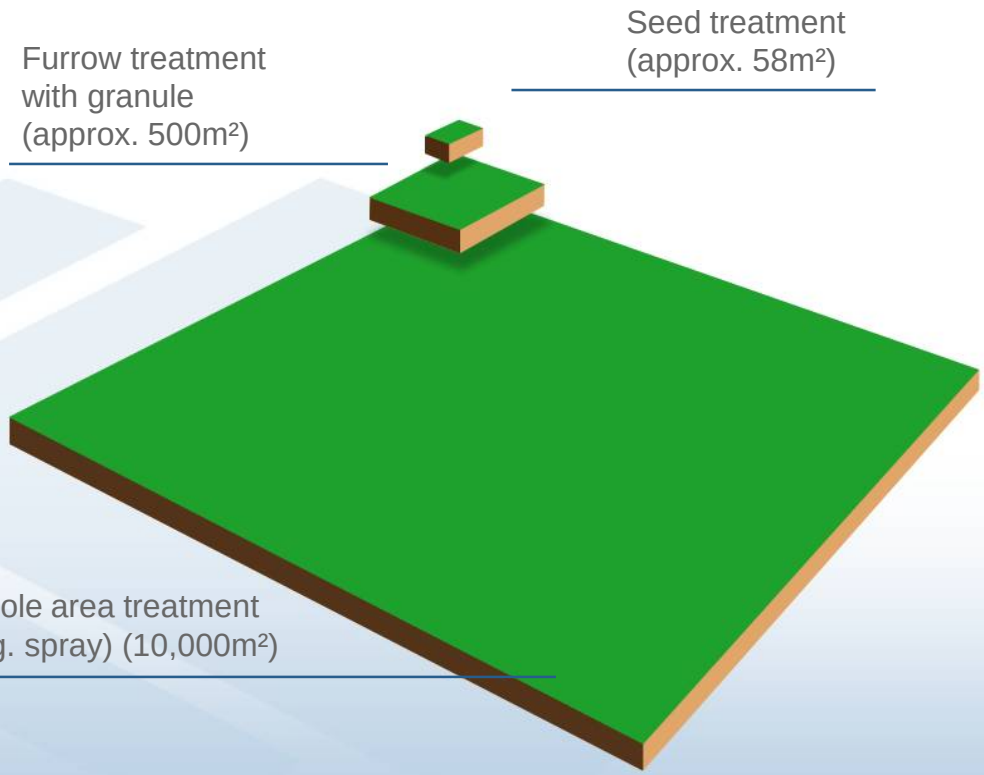
Granule treatment in furrow

Seed treatment

Advantages of Seed Treatment

Seed treatment is also interesting from an environmental point of view: compared with spraying, it effectively reduces the treated area.

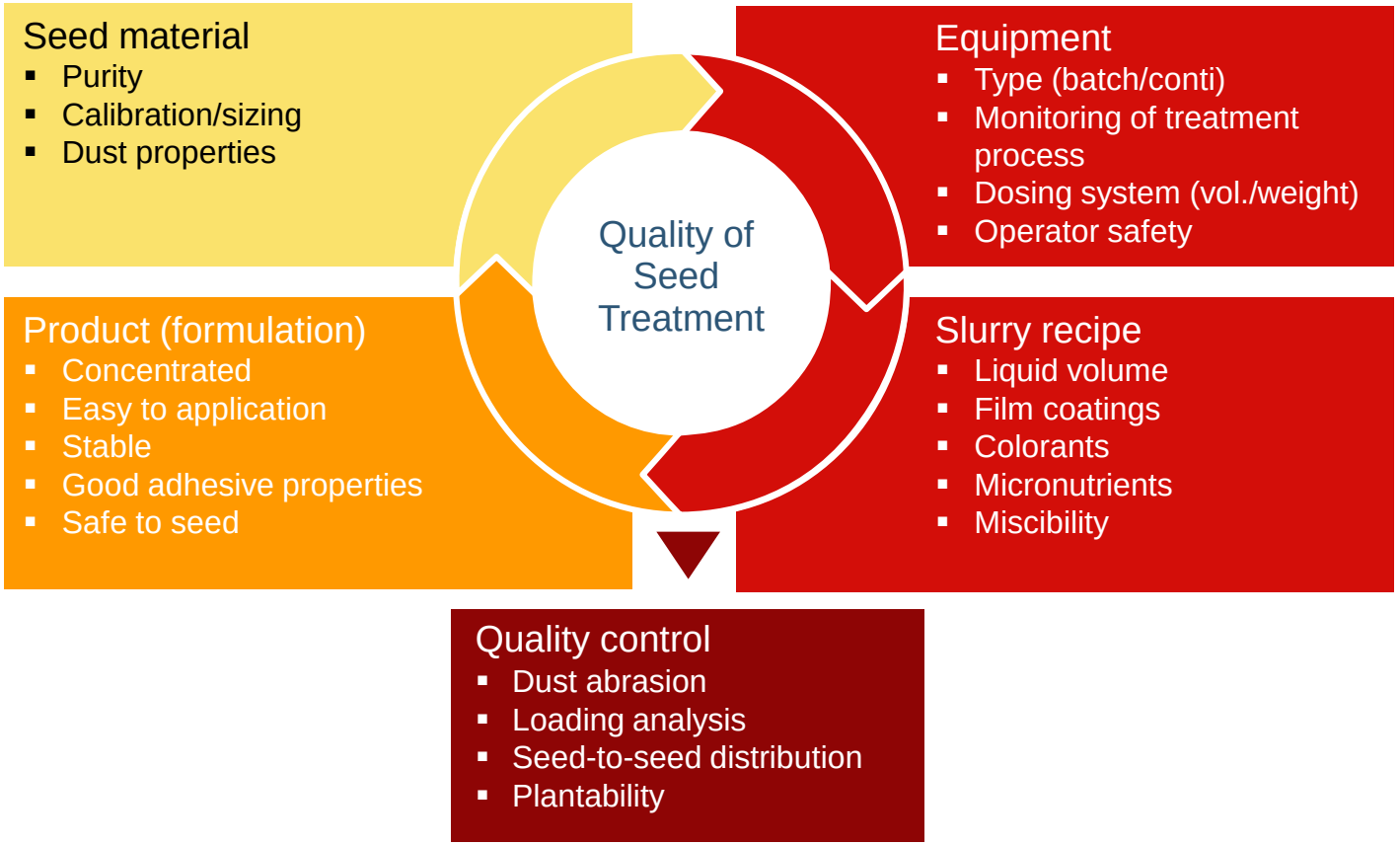
- While spraying 1 acre of land puts 4049 sq.m of soil in contact with the active ingredient, this shrinks to a mere 24 sq.m (less than 1 percent), when using seed treatment
- Moreover, seed treatment has less impact on non-target organisms
- Seed treatment is compatible with Integrated Pest Management (IPM)



Stewardship in Seed Treatment
Setting the Standard

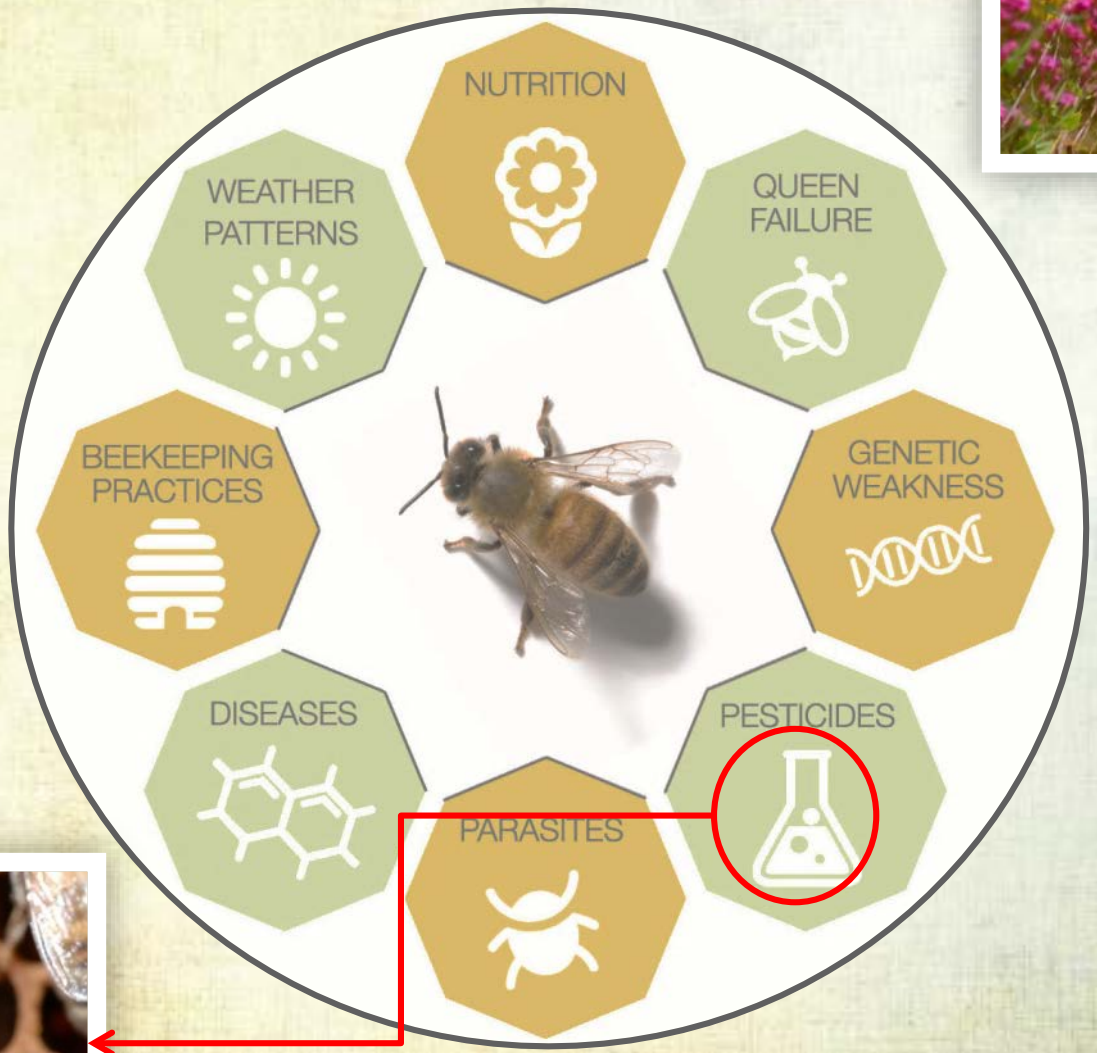
Leading in Seed Treatment Technology

Factors influencing seed treatment stewardship



Bayer CropScience

Multiple Stressors



Industry Relations

Engage, Promote & Support Stakeholders

FARMERS ADVOCATING RESOURCE MANAGEMENT
DELTA F.A.R.M.

Farmers & Beekeepers

Researchers

North American Pollinator Protection Campaign
NAPPC

HONEY BEE HEALTH COALITION

Conservation Groups

Commodity & Trade Associations

Conservation Technology Information Center

Seed Treatment Quality Standards Initiatives

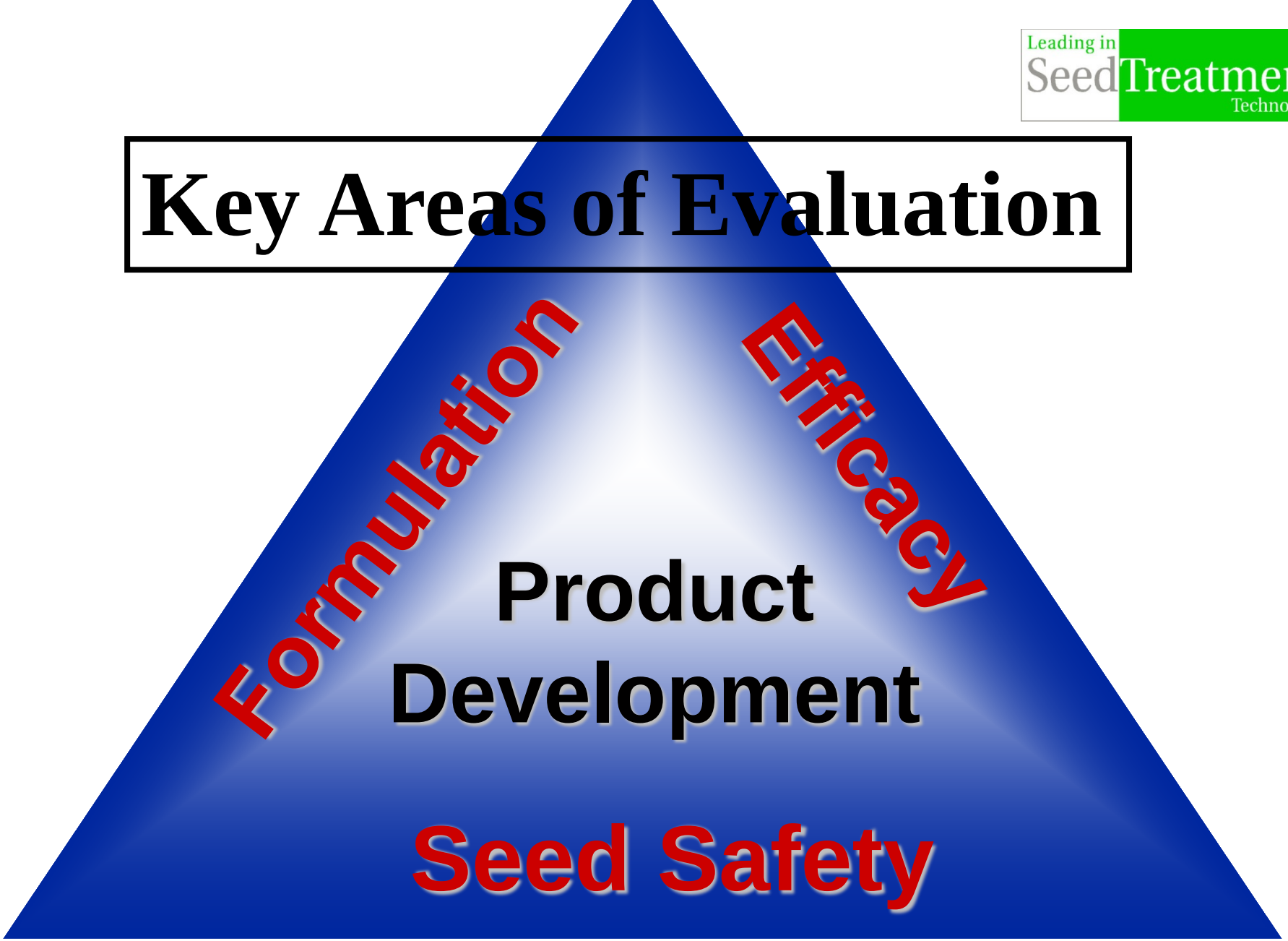
Industry commitment on quality assurance scheme

Key elements

- Application by trained professionals
- Effective use of film coatings
- Compliance with established quality standards
- Quality monitoring of commercially treated seed
- Guidelines for handling and planting of treated seed
- Promotion of a safe handling and use of treated seed

Leading in Seed Treatment Technology

Key Areas of Evaluation



Bayer CropScience

The uniqueness of seed treatment formulations

Seed is the target; seed are living organisms so there is no tolerance for a delivery system that negatively affects the health and/or contributes to an untimely death of seeds and/or seedlings.

Seed is the carrier of the pesticide(s).

Treated seeds must be robust enough to withstand **handling multiple times** after application. From the time the application is made, to packaging in bags and/or bins and finally in transport to the final destination...**the grower!**

Since seeds are a **3-dimensional**, they must be treated uniformly so that the active ingredients are evenly distributed to provide optimum protection in the growing environment.

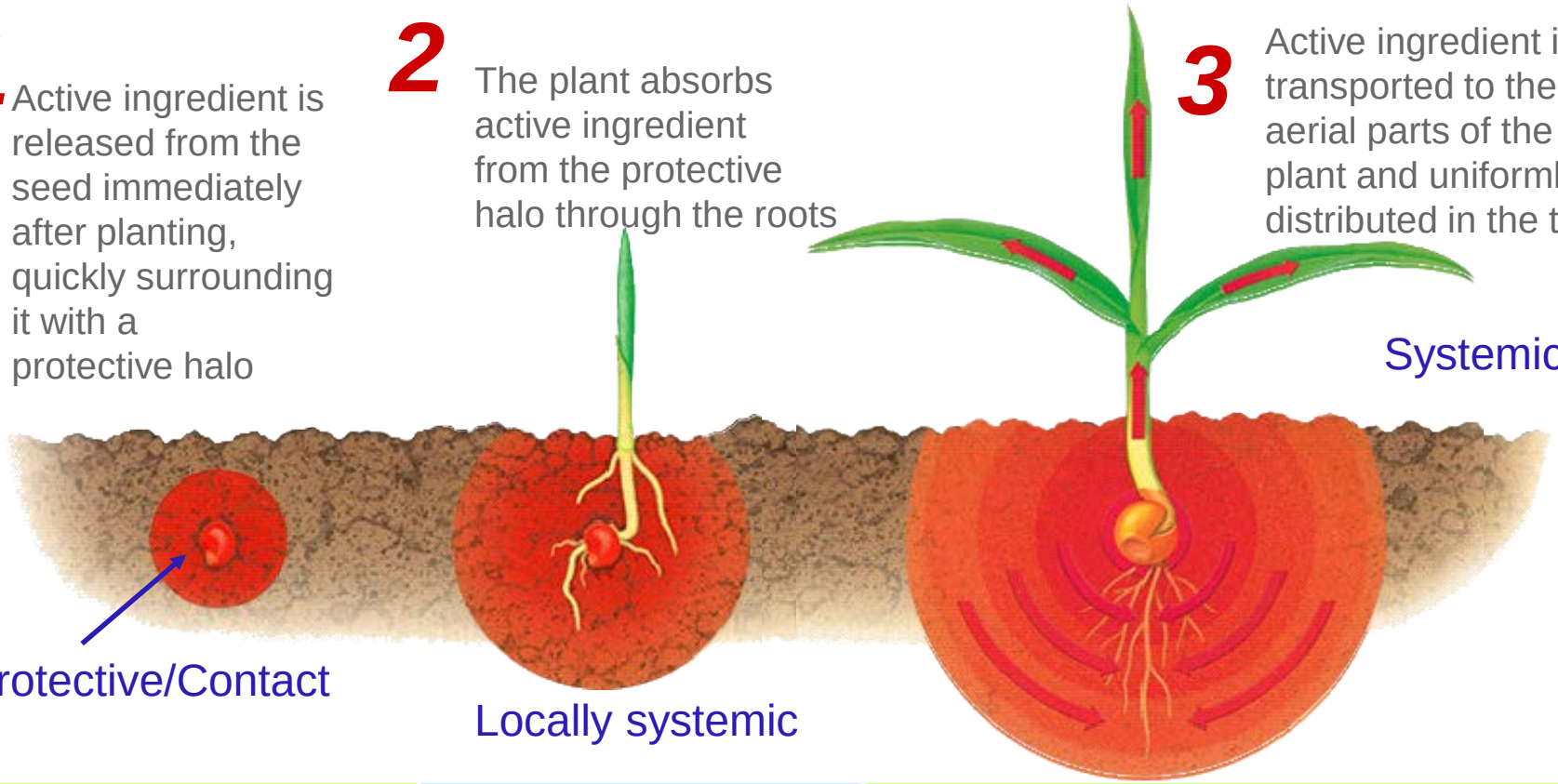
Seed treatment products can be quite sophisticated in that they may be formulated with one or more fungicides in combination with one or more insecticides, i.e., they can be **multi-functional products** delivered in a single container.

Seed Treatment - The Principle

1 Active ingredient is released from the seed immediately after planting, quickly surrounding it with a protective halo

2 The plant absorbs active ingredient from the protective halo through the roots

3 Active ingredient is transported to the aerial parts of the plant and uniformly distributed in the tissue



“Contact effect” against soil pests & diseases	Control of soil pests & diseases	Control of foliar pests & diseases

Evolution of Seed Treatment

Seed borne	Soil borne	Foliar	Nematode Protection	Application Technology	
Prior to 1980s	1980s	1990 - 2005	2000 - Current	2000- Current	
Primarily seed disinfection	**Seedling protection**	**Plant protection**	**Improved root health**	**In-Plant Handling, Dust Abrasion, Plantability**	**Delivery systems**
Prior to 1980: Dependence on contact fungicides such as captan and thiram and mercury based products. Use of systemics fungicides such as carboxin and chloroneb in the late 1970s.	**1980s** Introduction of low rate highly effective systemic fungicides, e.g., (triadimenol, metalaxyl . First seed treatment herbicide safener developed.	**Early 1990s**: systemic insecticides (**Gaucho®** - imidaclopriid). **2005:** new generations systemic insecticicide (**Poncho** – clothianidin) **Significant Yield Increases**	**2000 – Current** Introduction of first seed treatments that provide protection against nematodes Abamectin from Syngenta **VOTiVO** (biological) from Bayer CropScience	**Application technology becomes more important** •More seed treatment usage on high value transgenic seed •More product being applied. •Product retention •Handling •Plantability	Adoption of new seed treatment technology has lead to the development of innovative new seed treatment application equipment and coating technology. **New round of Seed Treatment innovation**

Innovation

Evolution of Seed Treatment

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Innovation


Untreated


BASE Fungicide

Peanut Fungicide Trial
Tim Brenneman Tifton, GA

Leading in Seed Treatment Technology

Standard Seed Treatment **Untreated**

Bayer CropScience

Evolution of Seed Treatment

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Innovation


Untreated


AERIS

2002 Wireworm Injury
Elizabeth City, NC

Leading in Seed Treatment Technology

Untreated Control

Poncho 250

Bayer CropScience

Healthier Leaves with ILeVO®

Sudden Death Syndrone

Evolution of Seed Treatment

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Innovation

Leading in Seed Treatment Technology

Seed Applied Nematicides

AERIS - Thiodicarb

Avicta – Abamectin

AVEO – Bacillus amyloliquefaciens

BIO ST – heat killed Burkholderia spp

COPeO Prime- fluopyram

Nemastrike - tioxazafen

VOTiVO – Bacillus firmus


Bob Kemerait Tifton, GA
Root Knot Nematode Field
Untreated
Insecticide Control
ST Nematicide

Charles Overstreet LSU

Charles Overstreet LSU

Charles Overstreet LSU

Leading in Seed Treatment Technology

Evolution of Seed Treatment

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Prior to 1980s	1980s	1990 - 2005	2000 - Current	2000- Current	
Primarily seed disinfection	**Seedling protection**	**Plant protection**	**Improved root health**	**In-Plant Handling, Dust Abrasion, Plantability**	**Delivery systems**
Prior to 1980: Dependence on contact fungicides such as captan and thiram and mercury based products. Use of systemics fungicides such as carboxin and chloroneb in the late 1970s.	**1980s** Introduction of low rate highly effective systemic fungicides, e.g., (triadimenol, metalaxyl . First seed treatment herbicide safener developed.	**Early 1990s**: systemic insecticides (**Gaucho®** - imidaclopriid). **2005:** new generations systemic insecticicide (**Poncho** – clothianidin) **Significant Yield Increases**	**2000 – Current** Introduction of first seed treatments that provide protection against nematodes Abamectin from Syngenta Fluopyram from Bayer CropScience	**Application technology becomes more important** • More seed treatment usage on high value transgenic seed • More product being applied. • Product retention • Handling • Plantability	Adoption of new seed treatment technology has lead to the development of innovative new seed treatment application equipment and coating technology. **New round of Seed Treatment innovation**

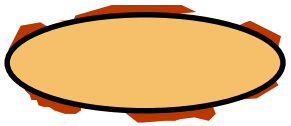
Innovation

Bayer CropScience

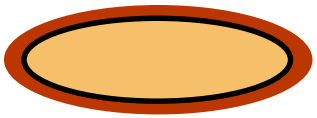
Seed Application Technologies & Definitions

Leading in Seed Treatment Technology

Seed + Active + Application Technology

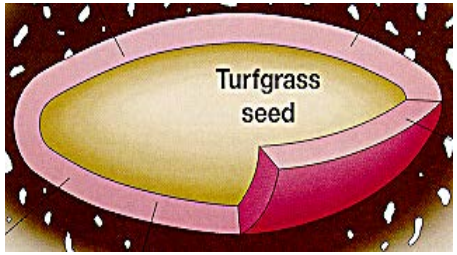


SEED DRESSING
TST

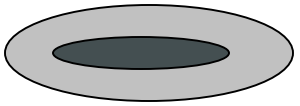


FILM COATING

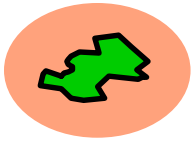
BioCoating



Nutrient Coating

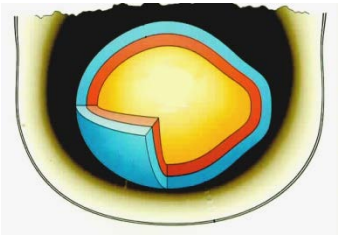


Encrusting/Sizing



PELLETING

PELLETING + COATING



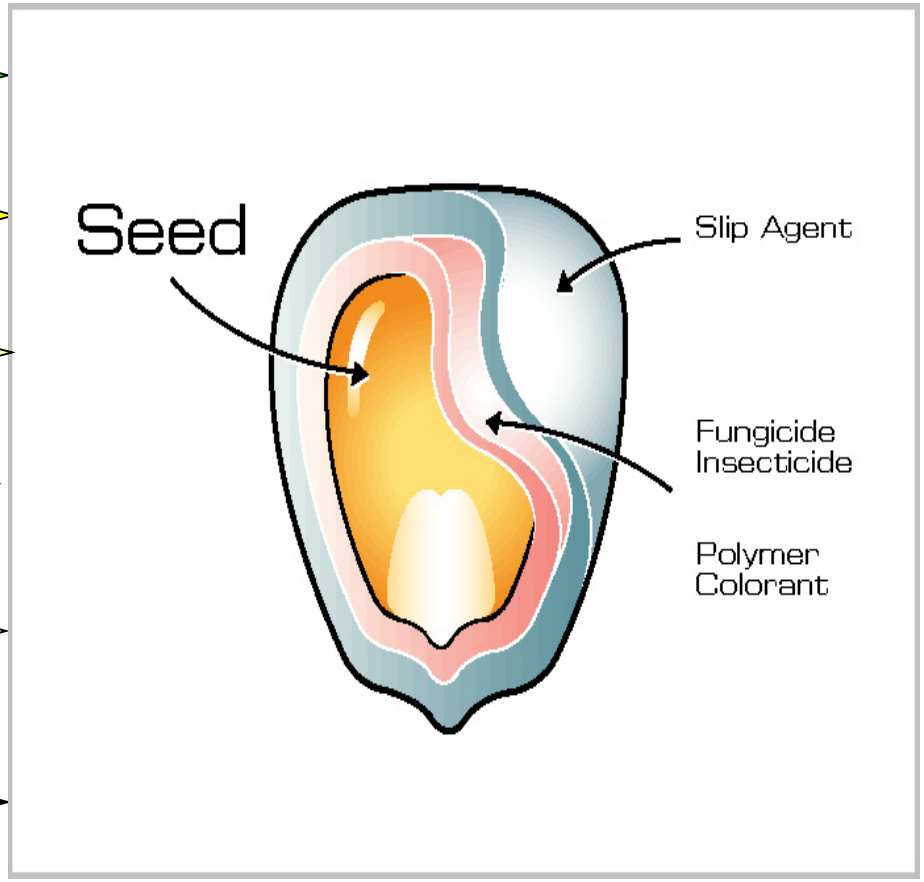
MULTILAYER COATING

Bayer CropScience

What's On The Seed

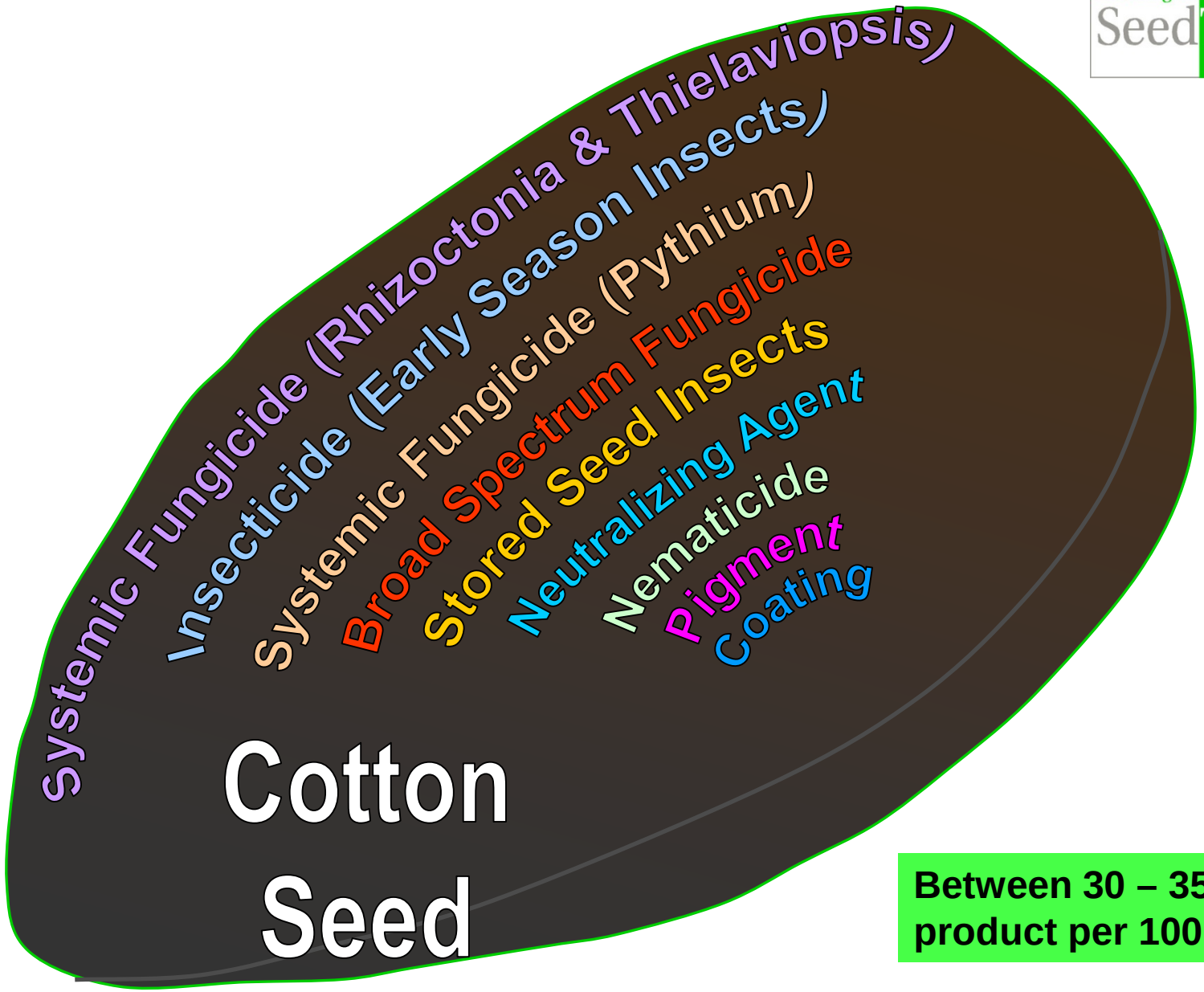
Leading in Seed Treatment Technology

- 70+ Seed Treatment Brands
- 30+ Different AI'S
- 20+ Fungicides
- 10+ Insecticides
- 6+ Nematicides
- 2 Herbicide Safeners



Bayer CropScience

Leading in Seed Treatment Technology



Between 30 – 35 oz of product per 100 lbs of seed

Bayer CropScience

Application Advancements

High Volume Batch Treater

Seed Pelleting

High precision Downstream Technology

- Newer technology targets +/- 2% accuracy to high volume facilities
- Seed testing for treatment quality characteristics.
- Improvement of quality is a combination of equipment, process controls and materials applied to the seed.
- Seedsmen are upgrading equipment training and stewardship initiatives.
- Seed coatings are becoming a standard with heavier loadings
- Seedsmen are more frequently engaging seed coating and applications experts to improve their product quality

Seed Treatment
Seed Quality – Seed Cleaning

Only well-cleaned seed should be used for treatment as:

- Contaminants such as dust and plant debris can result in excess particulates and inaccurate seed load.

The Pillars of Seed Technology

Leading in Seed Treatment Technology

Bayer CropScience

Leading in Seed Treatment Technology

Seed Applied Products

- Products that enhance Cool test results
- Products that induce ISR – Induced Systemic resistance in plants
- Products that promote early season vigor
- New Herbicide Safener products
- New drought tolerant products

Thank You!

CORTEVA™ agriscience

Agriculture Division of DowDuPont

Seed Treatment Considerations for Corn and Cereal Grains

Jeff Daniels
Global Seed Applied Technologies
Technical Services Leader

July 31, 2018

Seed Treatments Effective in Early-Season Pest Control

February 23, 2015 | Posted in Seeding & Planting, Crop Protection

Source: *Mississippi State University Extension Service*

Don Cook, an entomologist with the Mississippi Agricultural and Forestry Experiment Station and the Mississippi State University Extension Service, says corn and soybean insecticidal seed treatments have been used routinely for the last decade.

"At-planting treatments in general have value to our growers," says Cook, who is based at the MSU Delta Research and Extension Center in Stoneville. "They have a positive effect on early-season insect management in corn, especially seedling pests that attack above and below ground."

Reasons for Seed Treatments

Integrated Pest Management

- “Rescue” treatments are not an option for some pests

Promote seedling/stand establishment and vigor

Healthy start and grower confidence

Prevent disease transmission from seed-borne diseases

Prevent predation/feeding on seed and seedling

Prevent infection through vector control or suppression

- Virus transmission, SDS, etc.

Yield benefits

Bean leaf beetle

Source: A. Goggi, Iowa State University. 2011. Evolution, purpose and advantages of seed treatments. Seed Congress of Americas

The Corn Customer Experience

SEED TREATMENTS

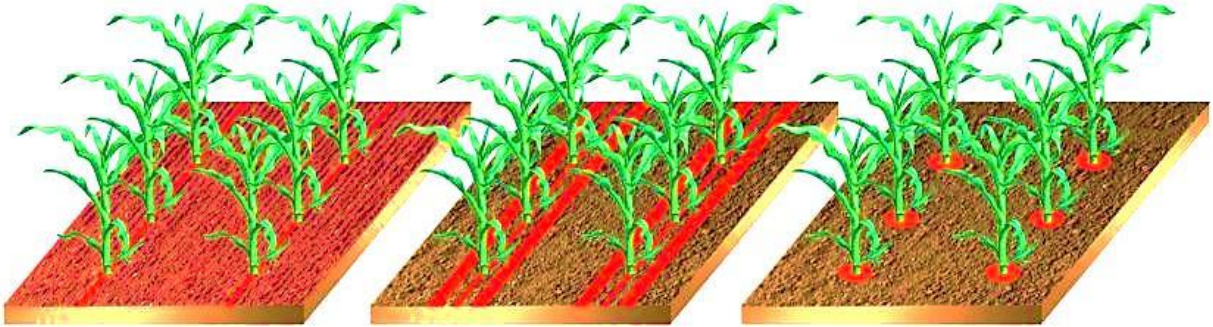
BIOTECHNOLOGY

BASE GENETICS

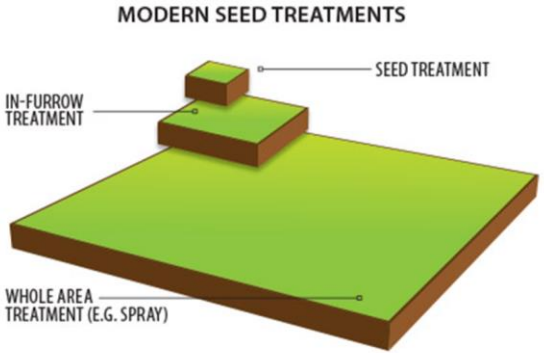
Treatment of whole area (spray)

In-furrow treatment with granules

Seed treatment (“do more with less”)



- 1% of a field is treated compared to broadcast spray



Brief History of Seed Treatments

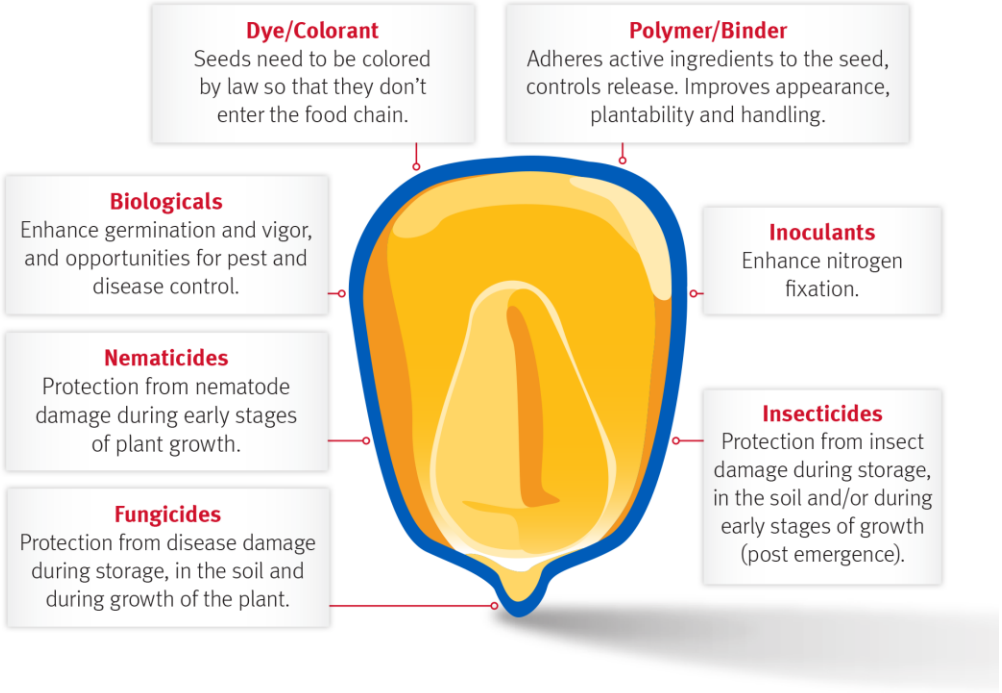
- Seed soaking
  - Recorded as early as 2000 BC—cypress sap or onion
  - Various salts (including copper and arsenic) through 1700s
  - 1740-1808 – Arsenic
  - 1915 – Mercury-containing compounds
- Modern insecticides (post WWII)
  - 1960s—first systemic fungicide (providing protection for more than the seed)
  - 1970s—first systemic fungicide active on airborne pathogens
  - 1982—ban of organomercurics
  - 1997—First seed treatment insecticide launched globally
  - 2003—First FST/IST combination for corn in the US
  - 2004—First FST/IST combo for soybeans in the US
  - 2005—First nematicide seed treatment (on cotton)
  - 2013-present – new IST and FST options

Source: International Seed Federation

Seed Treating has Come a Long Way

- Stewardship
- Education
- Training
- Safety
- Equipment
- Ingredients
- Efficiency
- Effectiveness

Treatment recipe is complex



Application in mg's of active ingredient per seed

Seed Applied Fungicides for Corn

- **20 years ago**
  - Captan or thiram
  - Broad spectrum “contact” fungicide
  - Zone of protection on and around the seed
  - Needed activity short in duration

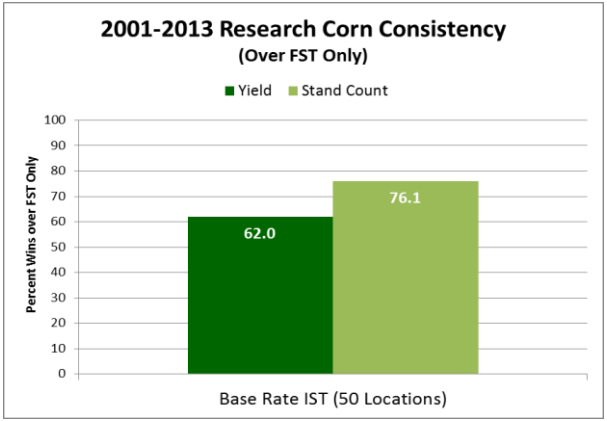
- **Today**
  - Low use-rate, disease specific “combinations”
  - May work by both “contact” and “systemic” activity
  - Protects both seed and seedling early in season
  - May protect for several weeks

Seed Applied Insecticides for Corn

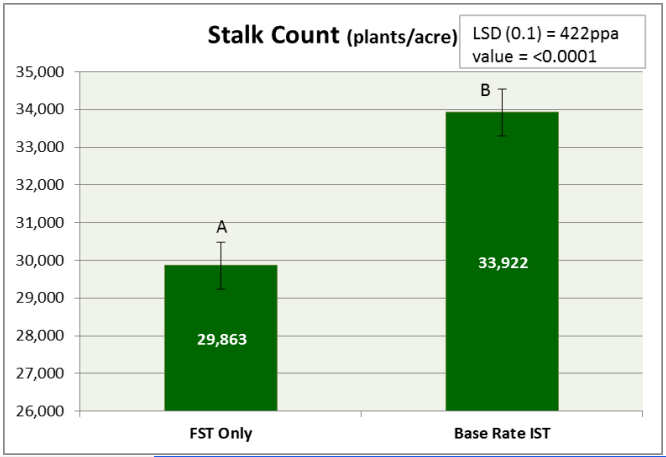
- **20 years ago**
  - Likely a “hopperbox” product
  - Initial screening to better understand value for new products
  - Minimal commercial use

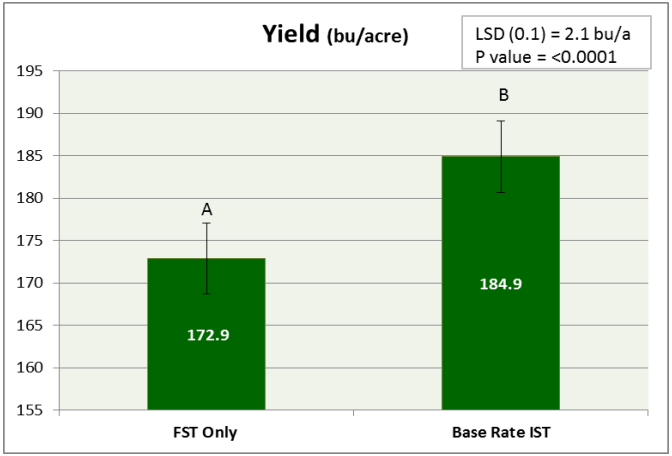
- **Today**
  - Delivering significant grower value
  - Mostly commercially applied
  - Different use-rates depending on “need”
  - Neonic and diamide classes of insecticides

EXAMPLE – Post-commercialization product performance data



- Research studies from 2001 to 2013
- 50 locations and >10 years
- Average insect pressure including: Wireworm, White Grub, Seedcorn Maggot, Corn Rootworm
- Base rate IST is the recommended for early season pests





Seed Applied Nematicides for Corn

- **20 years ago**
  - Likely delivered via granular insecticide/nematicide
  - No real seed treatment use

- **Today**
  - Significantly increased in acceptance
  - Greater grower awareness
  - Both chemical and biological

Seed Applied Biologicals for Corn

- **20 years ago**
  - Unknown

- **Today**
  - Significantly increased in adoption
  - Claims for both biostimulant and pesticidal
  - Many providers entering the market

Seed Applied Polymers and Colors for Corn

- **20 years ago**
  - Color only by “necessity” – low input
  - Polymer an unknown

- **Today**
  - Color plays a much more significant role
  - Polymer use is widespread – grower expectations have increased
  - Many providers entering the market

Pre-commercial evaluation

P Plantability: Does it plant as well as our current product(s)?

A Application: Does it adhere to the seed?

S Stewardship: Is it a sustainable solution for our customers?

S Seed Safety: Does it affect germination?

E Efficacy: Does it perform?

R Regulatory: Is it in compliance?

Plantability and Seed Flow

Clean seed = Less dust

Clean seed is better for consumers, farmers, our employees, and the environment

Deploy state-of-the-art seed conditioning and seed treatment systems

Quality Management: Clean Seed

Monitoring

Representative treated seed samples are submitted for dust-off testing in collaboration with product registrants

2011-16 dust-off results show significantly below most widely used industry standards

1gram

Less than a quarter of the weight of a paper clip in each ~50 lb bag of corn.

~50lbs

Guide to Seed Treatment Stewardship

- Covers Best Management Practices for applicators and users of treated seed
- Input from farmer groups, stewardship experts, and experts in seed treatment application
- Topics covered include: Safe Use and Handling, Selection of Treatment Product, Locating Hives and Communication with Beekeepers, Planting of Treated Seed, Application, Storage and Disposal

AgriLIFE EXTENSION
Texas A&M System

Seed Treatment Decisions for Use on Winter Wheat

Ronald French, Greta Schuster, Brent Bean and Carl Patrick[1]

The decision to treat wheat seed should be based on several factors that will vary between farms and individuals. There are many variables involved when making this decision. These include seed cost, cost associate with treating, crop value, field/crop history, seed quality, soil condition, tillage practices, planting date, anticipated disease and insect pressure, and an individual's tolerance to risk. Most of us look at seed treatments as "insurance". Seed treatments can be a means of preventing or reducing the risks from a number of soilborne and seedborne pathogens or insects. Seedling diseases tend to be

Seed treatments can be a means of preventing or reducing the risks from a number of soilborne and seedborne pathogens or insects.

Considerations with Seed Treatment for Cereals

- **Not all wheat is created equal**

- High yield or low input (grazing)
- Insect pressure – fall only or spring too?
- Concern about virus - ie Barley Yellow Dwarf
- Seed borne disease – saved seed?

Pests Controlled by Seed Treatment for Cereals

Crop	Protection Against the Following Diseases
Winter Wheat and Triticale	General Seed Rots[2] Seedling Blight, Root Rot, and Damping-Off caused by seed- and soil-borne *Fusarium* or *Rhizoctonia* Seedling Blight, Root Rot, and Damping-Off caused by soil-borne *Pythium* Seed-borne *Septoria* *Septoria* Leaf Blotch[5] Common Bunt[4] Flag Smut *Fusarium* Seed Scab Dwarf Bunt[4] Karnal Bunt Loose Smut *Pythium* Damping Off

Crop	Protection Against the following Insects
Winter Wheat	Aphids[1] European Chafer Wireworms[1]

Questions?

VALENT®

Products That Work, From People Who Care®

Seed Treatment Considerations for Legumes

Dair McDuffee
Seed Treatment Specialist

July 31, 2018

SUMITOMO CHEMICAL

VALENT BioSciences

Pace International

Mycorrhizal Applications

Outline

Considerations for Legumes

- Introduction
  - Sumitomo Chemical / Valent USA
  - Me
- Targets
- AI Case Study
  - Tolclofos-methyl
  - Ethaboxam

SUMITOMO CHEMICAL Co., Ltd.

- 1913
- 37,000+ employees
- Pharmaceutical, IT-related, Petrochemical, Health/Crop Science, Functional Materials

VALENT®

VALENT®

SEED PROTECTION

- 1988
- 350 employees
- Seed Protection established in 2006
- Net sales from 250 to 500 MM in less than a decade

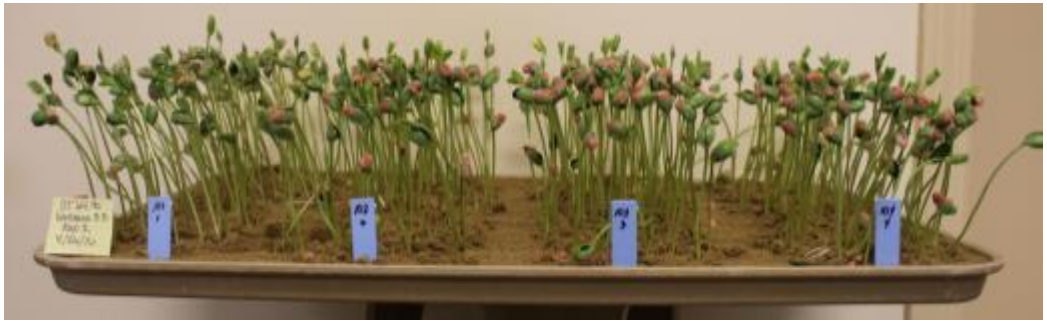
- Graduated from Purdue University with an M.S. in Plant Pathology
- Started June 1, 2008 as the first regional scientist in Seed Protection Group
- Worked from Canada to right outside in 16 different crops
- Stewarded multiple actives from Stage 1 to registration

Targets for Soybeans

- Safe
  - To the seed
- Efficacious
  - Compared to current/near-future market conditions
  - Bringing new technology to the market
- Easy to Use
  - Formulation
  - All-in-one

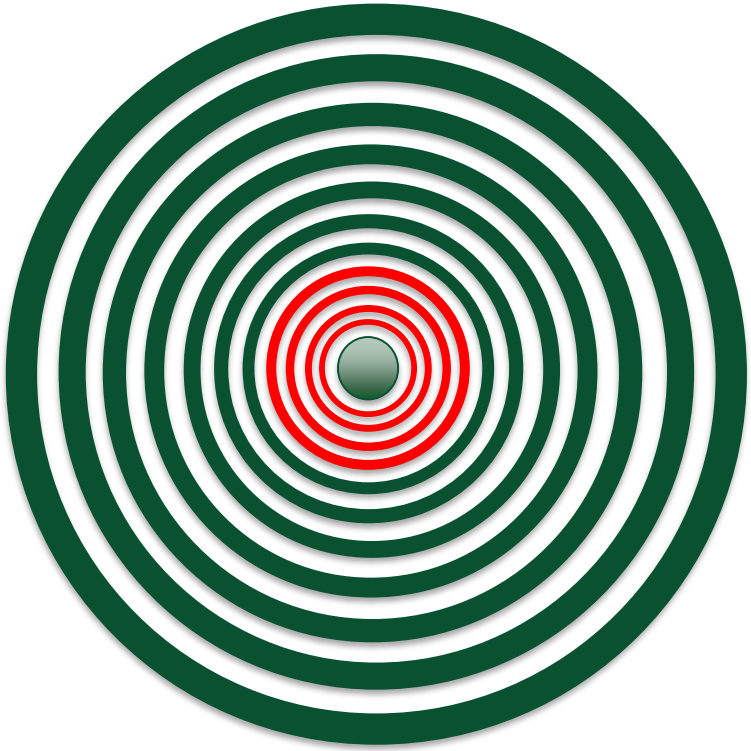
Safe

- Seed Safety
  - Germination and Cold Test
  - Components
    - Known formulation
  - Combinations
    - Known components
- 2x rates
  - Over-application, distribution curve



Efficacious

- Active Ingredients



Fungicide
Fungicide
Insecticide
Colorant

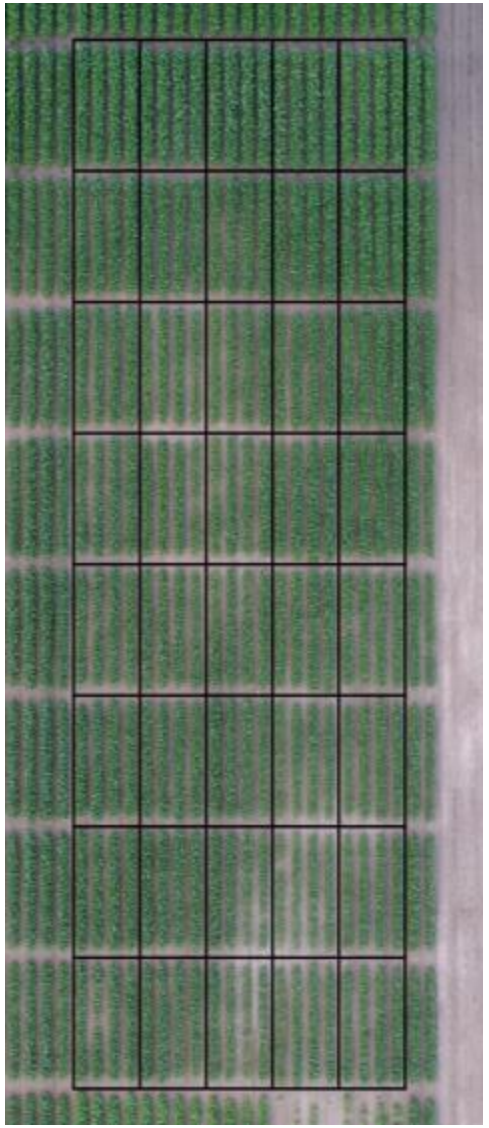
Fungicide
Fungicide
Nematicide
Inoculants
Polymer
Micronutrients
Mycorrhizal Fungi

Efficacious

- General Pest Concerns
  - *Pythium* sp.
  - *Rhizoctonia solani*
  - *Fusarium* sp. (non-SDS)
  - Insects – BLB, SA, WG, SCM

Efficacious

- Crop-specific Pest Concerns
  - Diseases
    - Phytophthora sojae
    - Sudden Death Syndrome
    - Charcoal Rot
  - Nematodes
    - Soybean Cyst Nematode
    - Root-knot Nematode
- Pairing Active Ingredients
  - Different FRAC group
  - Different physical characteristics



Easy to use

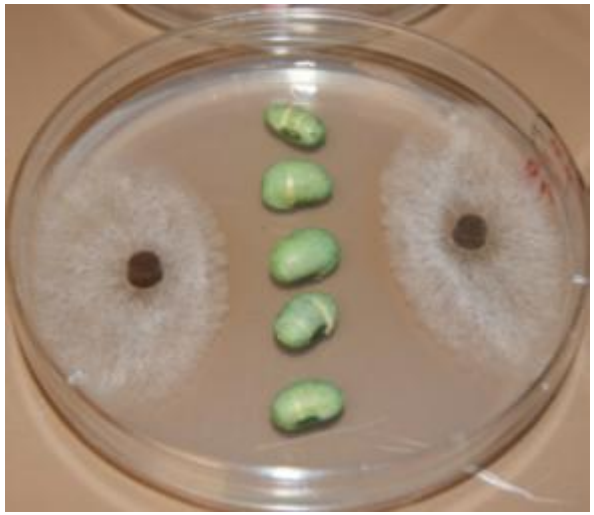
- Formulations
  - Compatibility
    - Amendments
    - Biologicals
  - Treating
    - Small scale
    - Large scale
  - Planting
    - Big John Seed Meter
    - Huebach Dust Meter

Case Study: Tolclofos-methyl

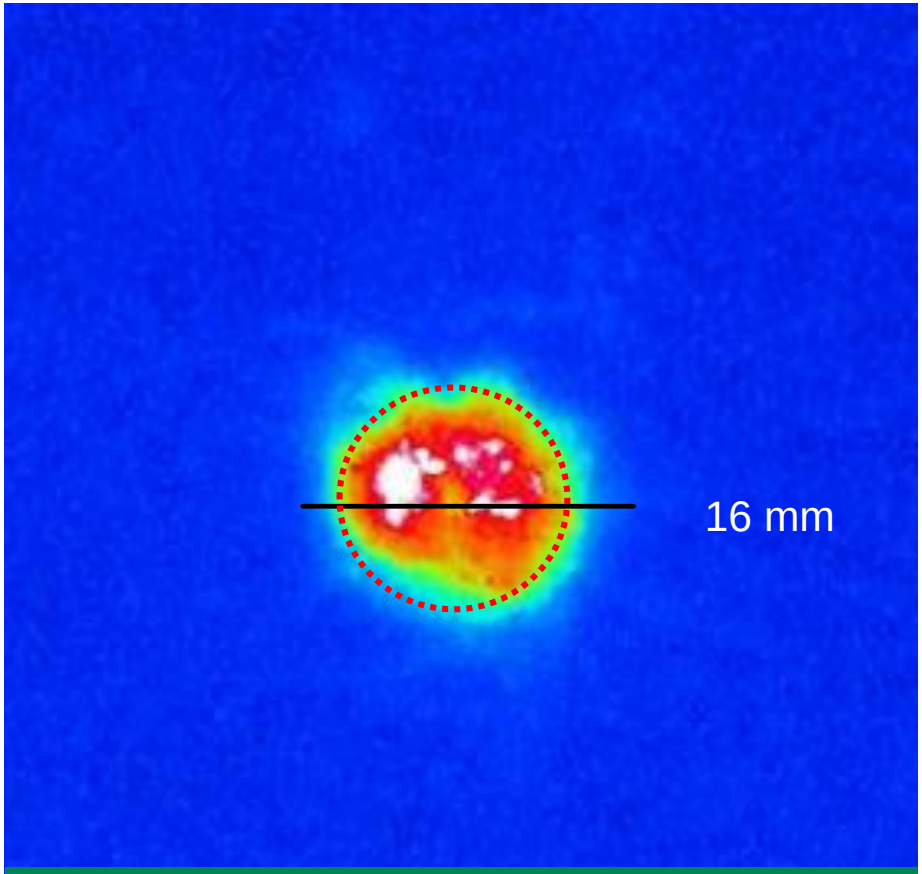
- Labeled as Rizolex Flowable Fungicide in 2013
- Broad spectrum contact fungicide
- We didn’t know SDHI’s incoming
- Can it be the foundation fungicide of a package?

Rhizoctonia Plate Assay

Tolclofos-methyl



Physical characteristics



Rizolex Corn Seed Radiograph
(7 days after seeding)

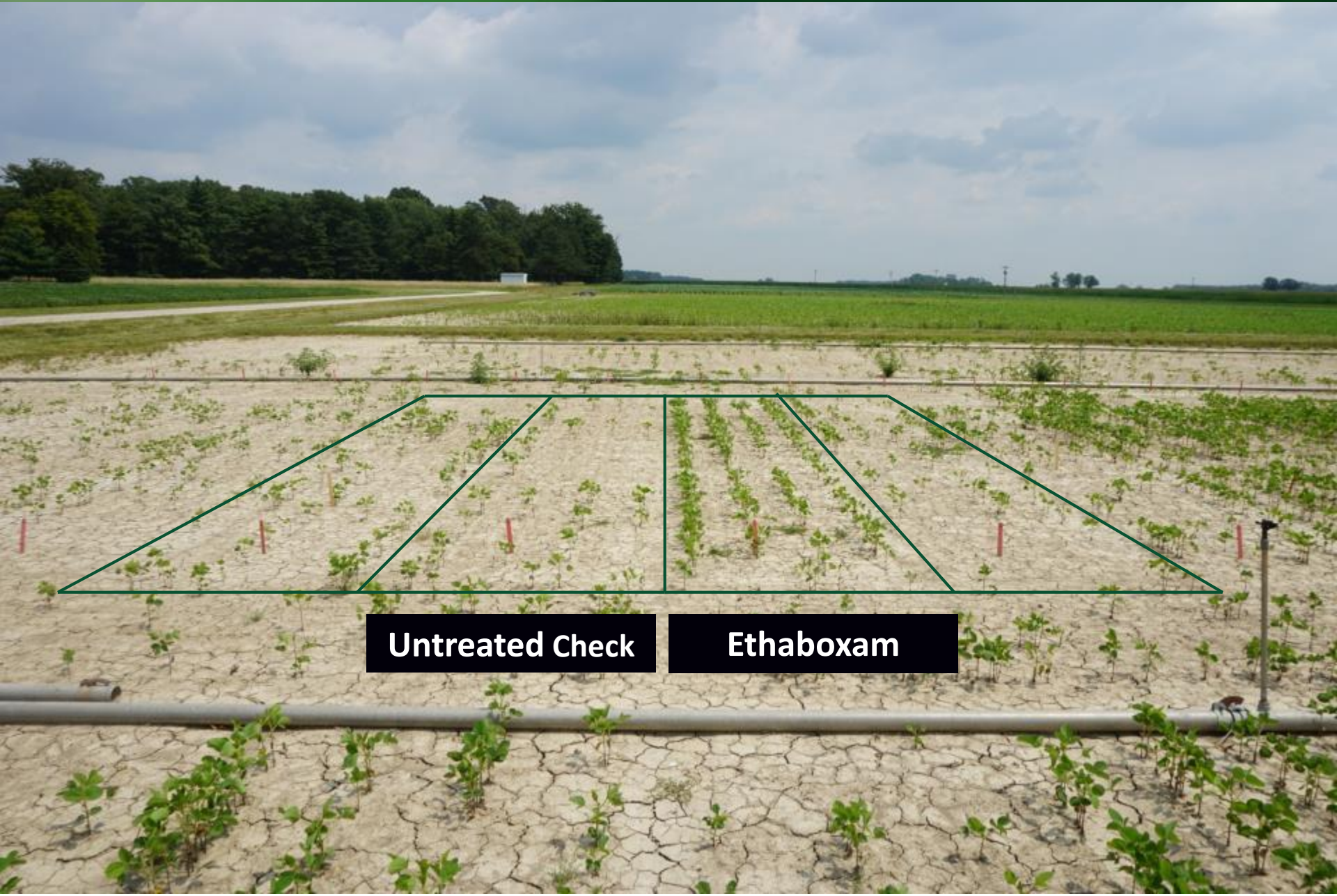
Targets

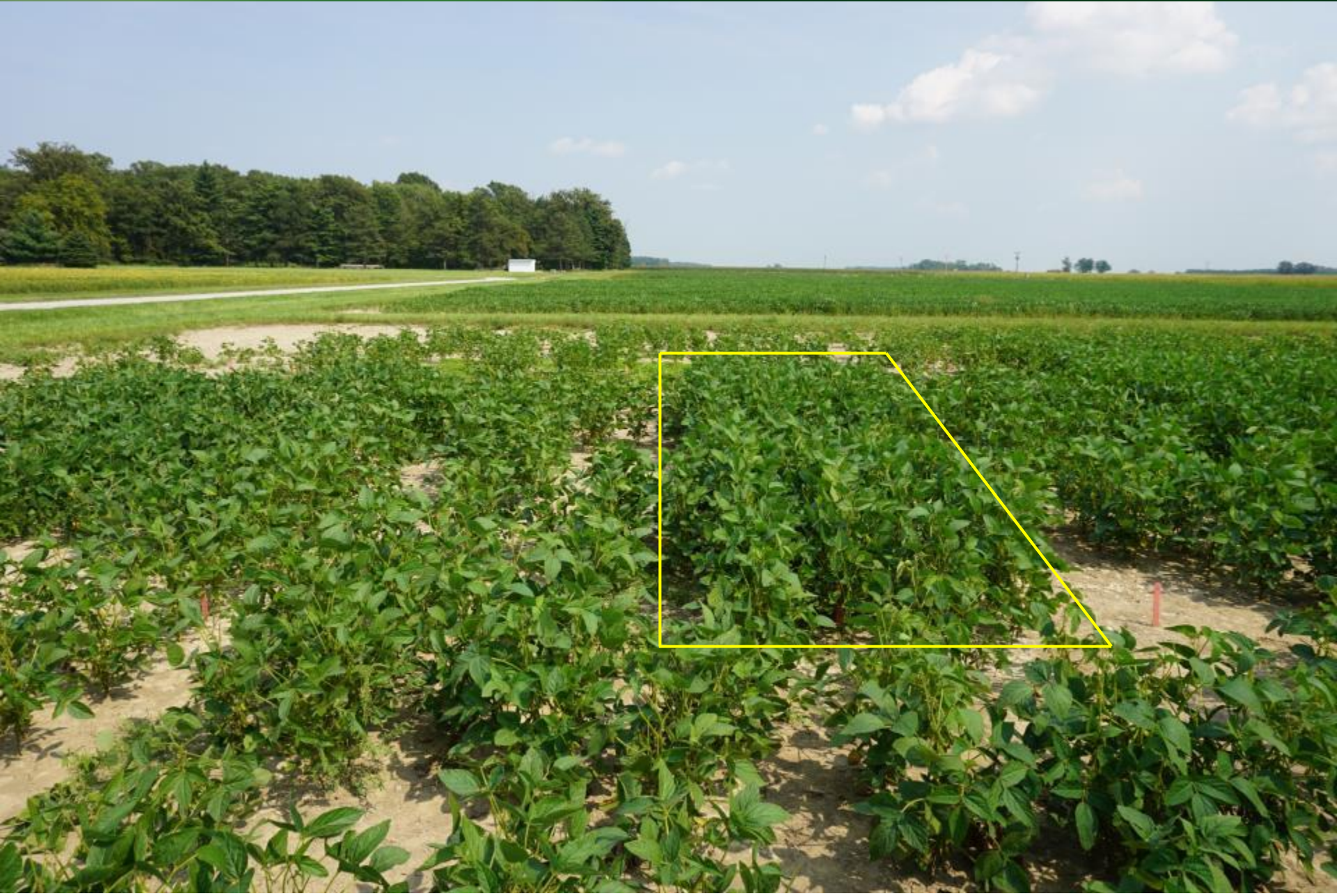
- Safe
  - Safe to seed

- Efficacious
  - Equal to other contact fungicides, but the market changed prior to registration
  - Broad spectrum, interesting physical characteristics
- Easy to Use
  - All-in-one less stable than current product
  - Product had a smell

Case Study: Ethaboxam

- Component of Intego Suite Soybeans
- Oomycete-specific systemic fungicide
- Is this a replacement for metalaxyl?


Untreated Check
Ethaboxam



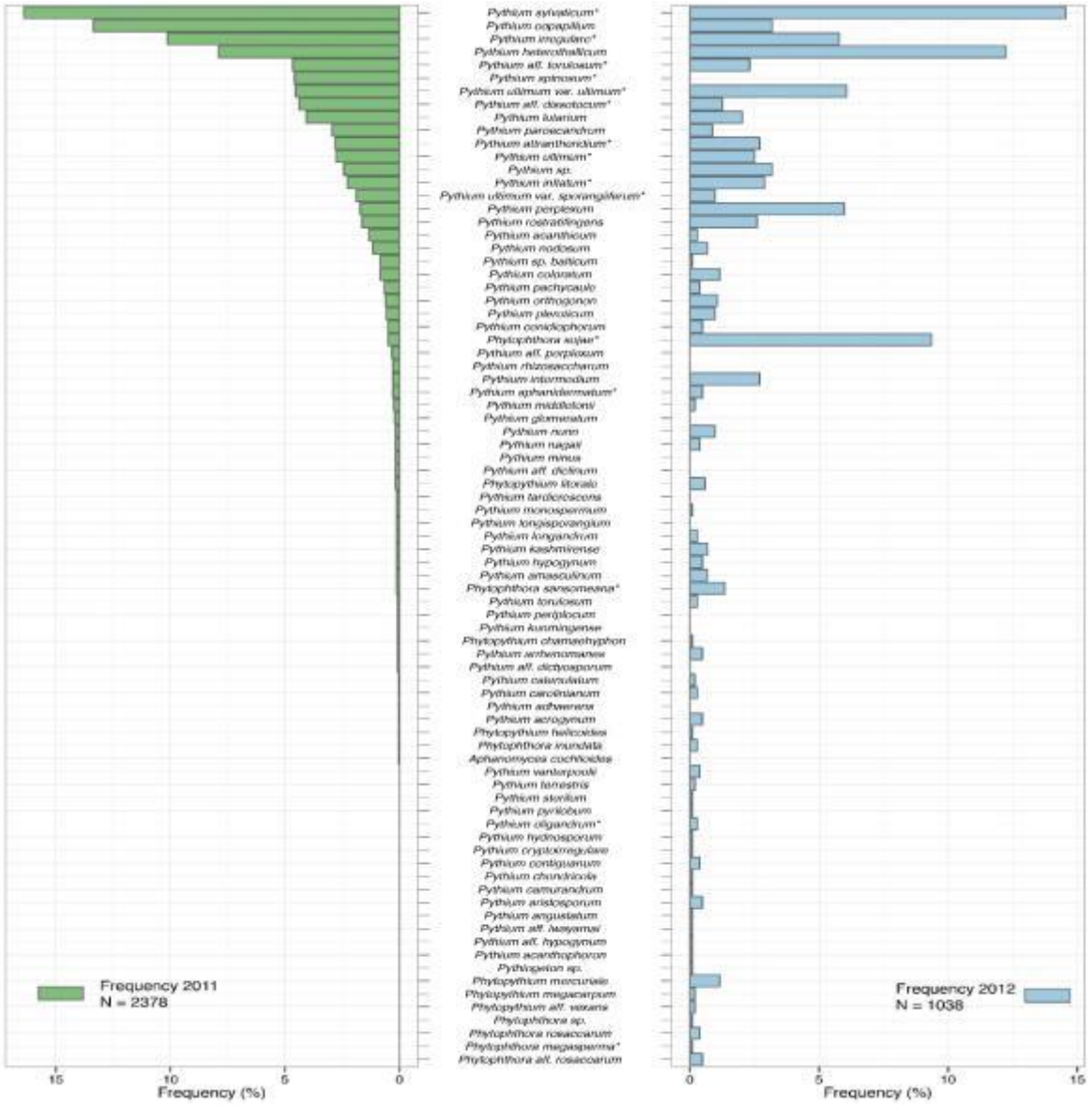
2010 – Pythium Species Screen

- Dr. Anne Dorrance and OSU staff
- Greenhouse (in-vivo) evaluations
- Laboratory (in-vitro) *Phytophthora sojae*, *Pythium* spp.(8)

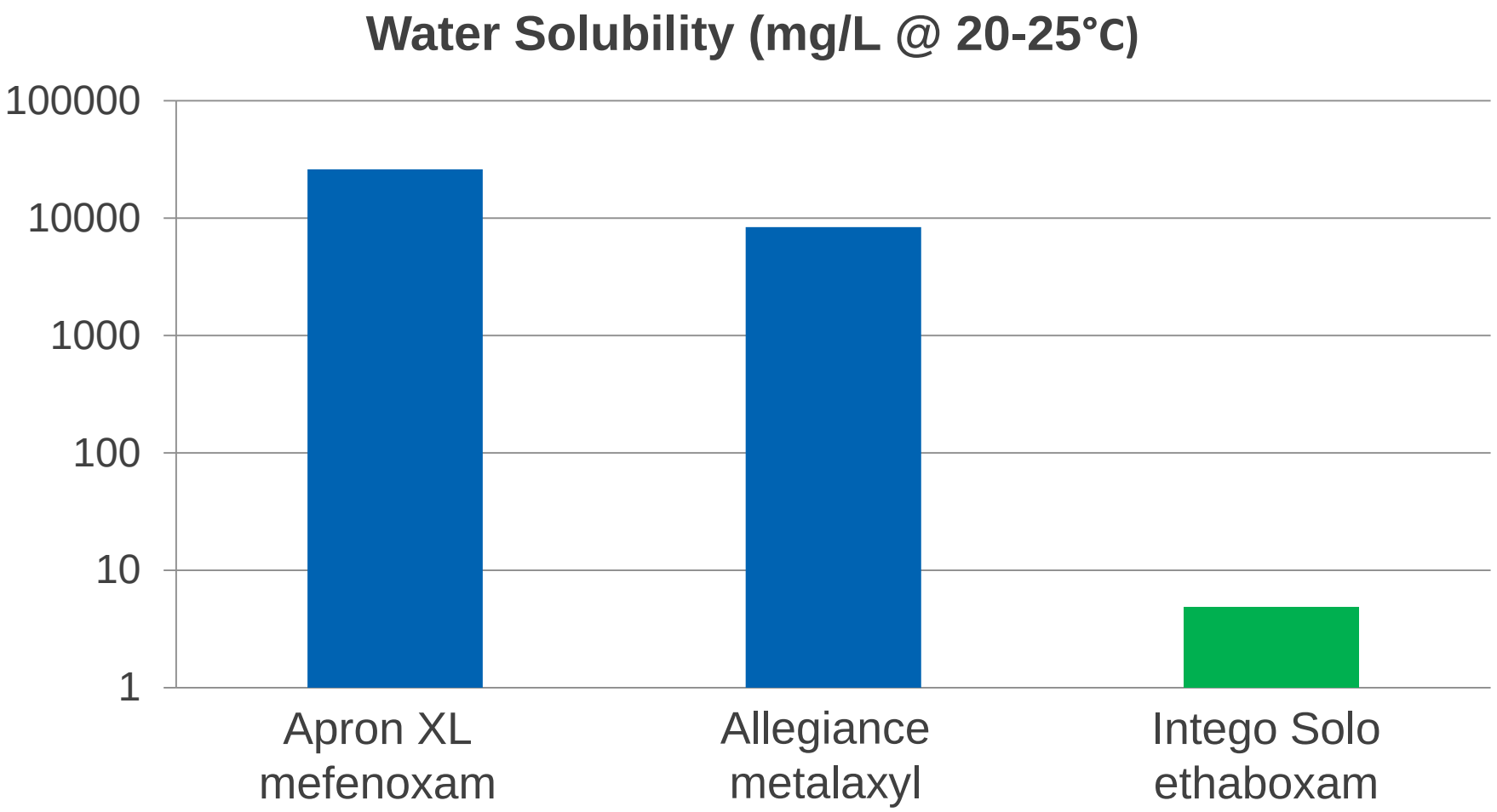
Ethaboxam > Metalaxyl	Ethaboxam ≤ Metalaxyl	Ethaboxam < Metalaxyl
Phytophthora sojae	*Pythium ultimum var. sporangiiferum*	*Pythium G7 Isolate*
Pythium dissoticum	*Pythium ultimum var. ultimum*	*Pythium aphanidermatum*
Pythium irregulare		*Pythium torulosum*
Pythium sylvaticum		*Phytophthora sansomeana*

2011-2012 USDA Oomycete Survey

- USDA funded study
- 82 Species Identified
  - 55 Pythium sp.
- Principals
  - Dr. Chilvers, MSU
  - Dr. Robertson, ISU

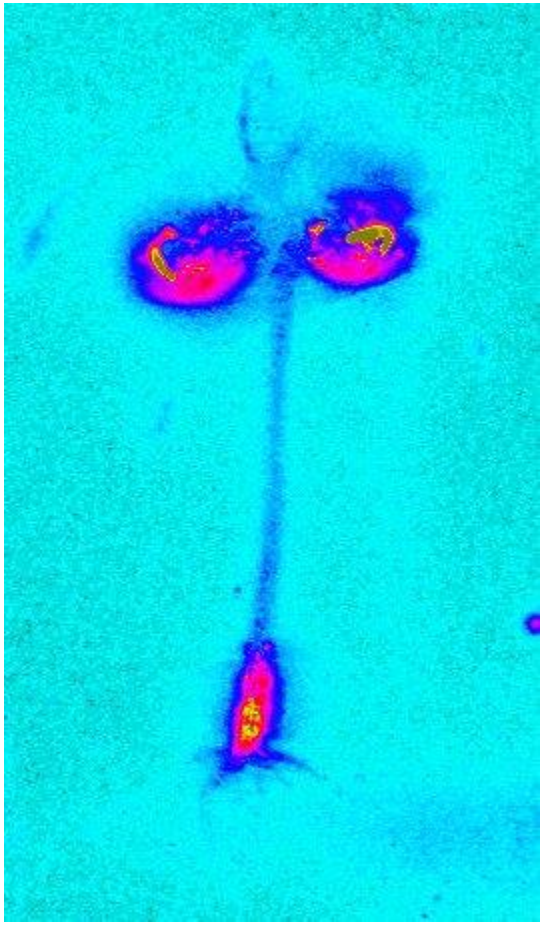


Physical Characteristics

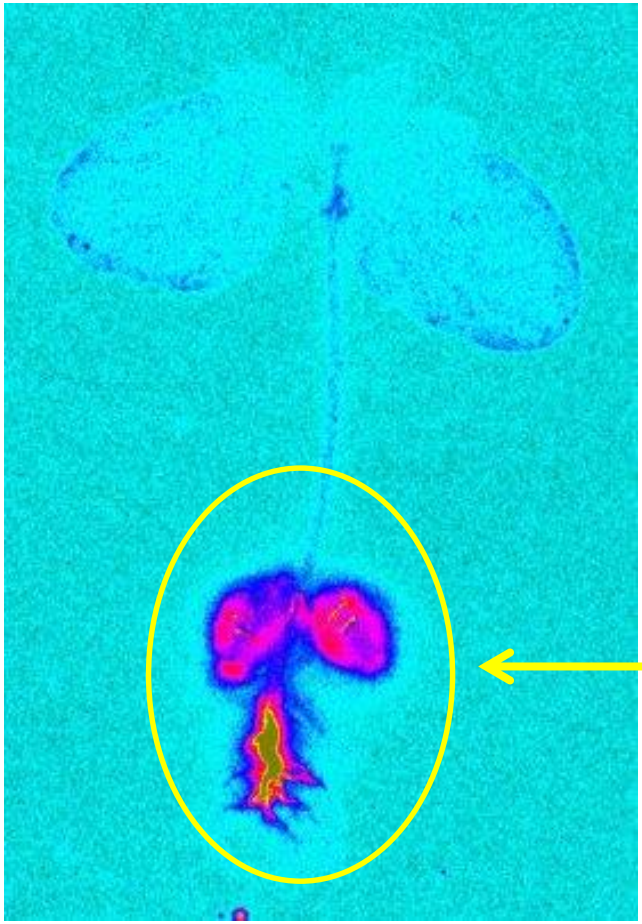


- Water solubility is a factor in determining how products move within the plant

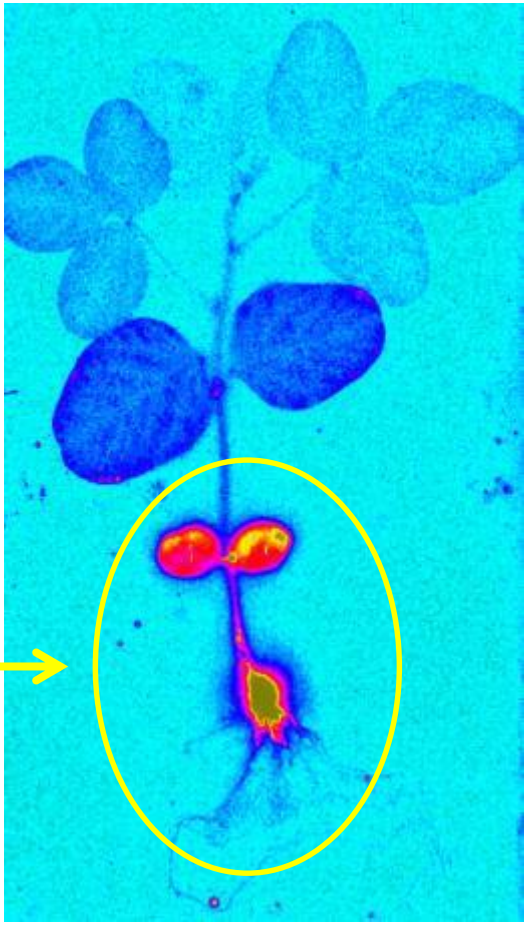
Radio-labeled Actives



7 days

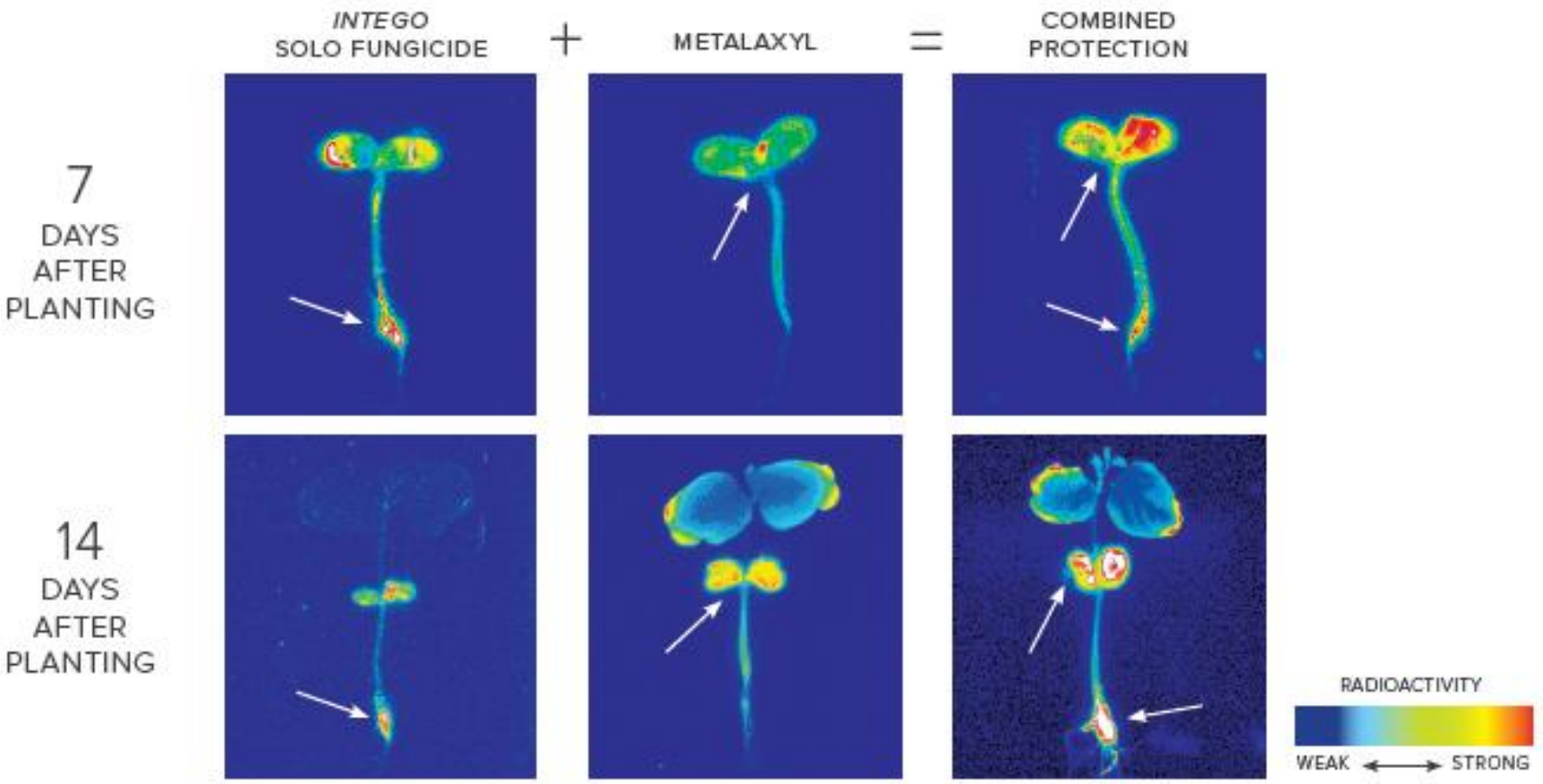


14 days



21 days

Radio-labeled Actives



Targets - Ethaboxam

- Safe
  - Safe to seed
- Efficacious
  - Offers broader spectrum, control of resistant isolates
  - Ethaboxam rate was too high alone
  - Ethaboxam and metalaxyl ended up being great partners
- Easy to Use
  - Less metalaxyl in formulation

Summary

- Soybeans offer some unique challenges
  - Downstream
  - Ready for amendments
- Crop-specific pest concerns are a key to success
- Pairing AI's is a key to success
- Formulation is a key to success

VALENT®

Products That Work, From People Who Care®

Thanks for your attention

THE SEEDCARE INSTITUTE ™

SEEDCARE FORMULATION TECHNOLOGY

A LOOK BEHIND THE SCENE

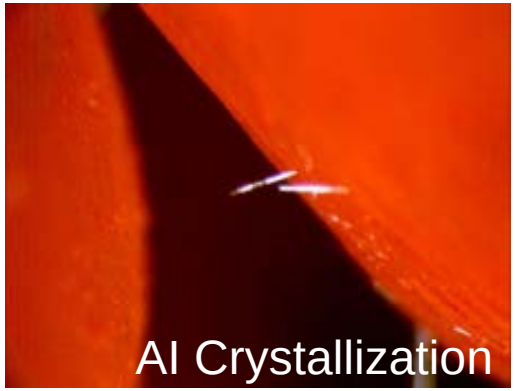
Lorelin Day
Seed Enhancement Regional Lead
Global SeedCare Institute Syngenta
July 31, 2018

Seedcare™

syngenta®

THE WAYS FORMULATIONS FAIL

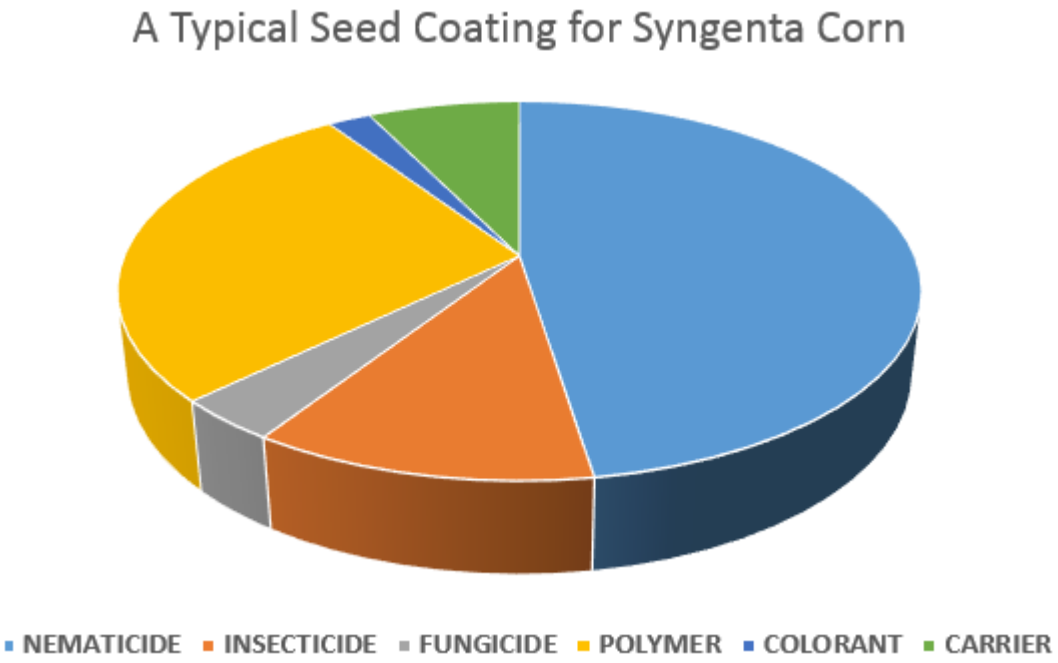
THE SEEDCARE INSTITUTE™



Seedcare™

syngenta®

DIRECT IMPACT ON SEED TREATMENT QUALITY

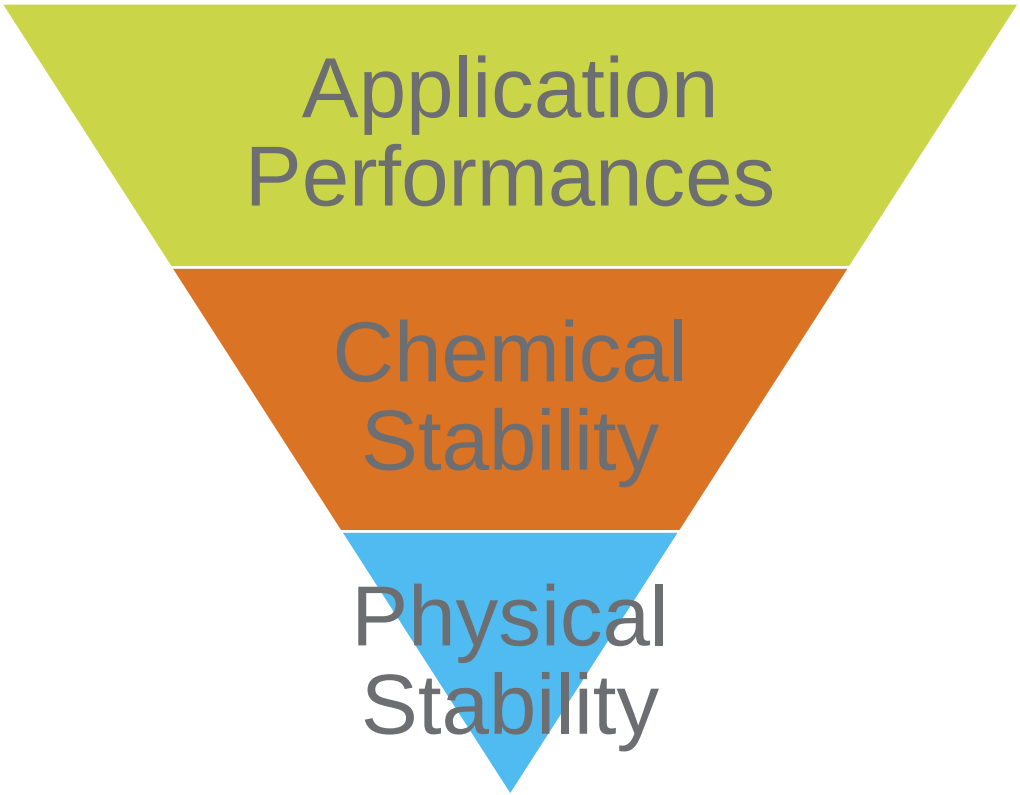


- Formulations, especially nematicides, insecticides or RTA formulations, play decisive role on how well seed coating performs
- Get it right the first time to avoid costly, ineffective remediation later in the product life cycle

A SHIFT IN FORMULATION STRATEGY

THE SEEDCARE INSTITUTE™

- **Application orientated design strategy**



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SEED TREATMENT PRODUCT DEVELOPMENT OVERVIEW

Active ingredient(s)

Formulation design

Physical, chemical testing

"in-can"

Application testing

"on-seed"

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Seed safety & biological testing

formulation re-design loop

Scale-up

Registration Process

Production

Finished Product

formulation refreshment

benchmarking

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COMPLEX COMPOSITION

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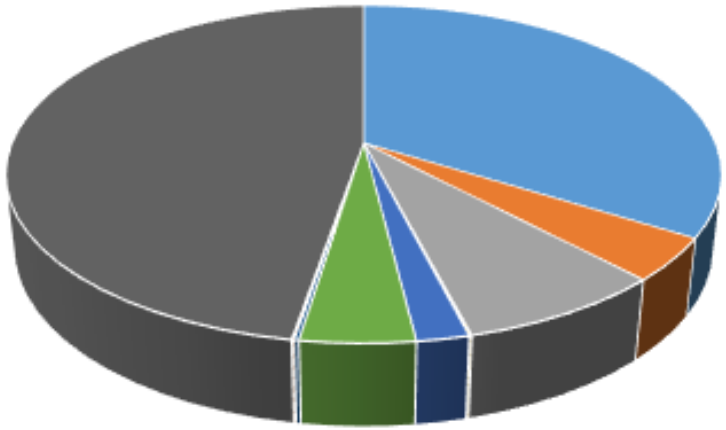
Maxim® Quattro



Formulation may also contain biologicals, built-in fluency aid, adjuvant, ….

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WHAT WE CONSIDER:

CRITICAL SUCCESS FACTORS

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- Multi-Active ingredients
- Liquids and solids
- Water based
- Shelf-life

Physical & Chemical Stability

- Multiple modes of action
- Synergist vs antagonism

Efficacy

- Appearance
- Seed flow
- Dust control
- Buildup
- Plantability

Application

- GMO
- Inerts
- Seed quality

Seed Safety

- Rhizobia
- Polymers
- Pigments
- Tank mix additives

Compatibility

- Production Siting
- Colored products
- Robust Processes

Ease of Manufacture

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A CASE STUDY

HOW WE APPROACH & DEVELOP SEEDCARE FORMULATIONS

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EVOLUTION OF CEREALS FORMULATIONS

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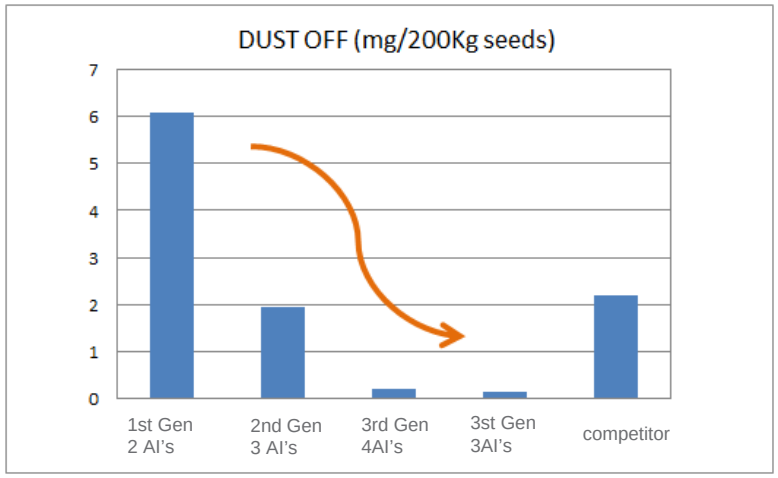
Drivers: cold handling, better coverage,& low dust



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UNINTENEDED CONSEQUENCES

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- Compatibility with air seeder planting equipment
  - Reduced seeding rate overtime due to buildup
- Chemical stability
  - Chemicals used to facilitate flow and improve coverage causing AI degradation
- Physical stability
  - Low viscosity RTA formulation leads to stratefication

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4th GEN CEREALS FORMULATION

Cruiser® Vibrance® Quattro

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- 5 AI's
  - Vibrance, Cruiser, Maxim, Apron, Dividend
- Ready to Use (RTA) formulation
  - Cold handling: freezing point ≤ -5°C
  - Bulk handling; suitable for bulk storage
- Fix all
  - Physical stability
  - Chemical stability
  - Plantability with air seeder

WHERE TO START

- ❑ Analyze root cause
- ❑ Design the right tools
- ❑ Test under the right conditions

Lab scale humidity test
1 Kg

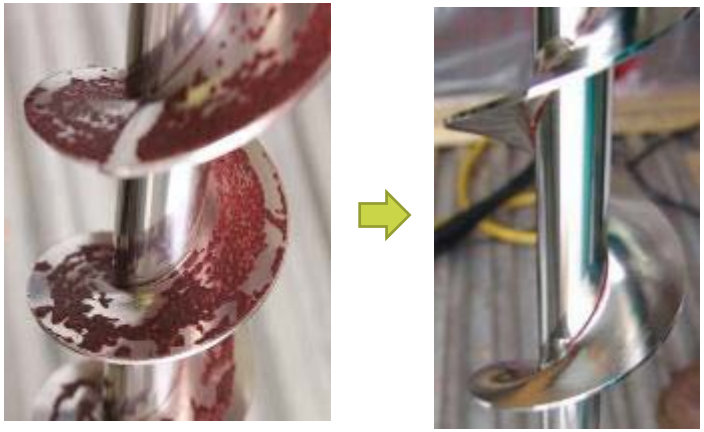
HRF Amazone test
4-5 Kg

Bourgault drill unit test
150 Kg

FRA planting trial
25,000 Kg

WHAT WE TESTED

- Accelerated Aging (physical stability)
- AI loading
- Seed Coverage
- Seed flowability with wet and dry seeds
- Dust off and Rub off
- Build up



Cruiser Vibrance Quattro after 8-hr drill test

Cruiser® Vibrance® Quattro

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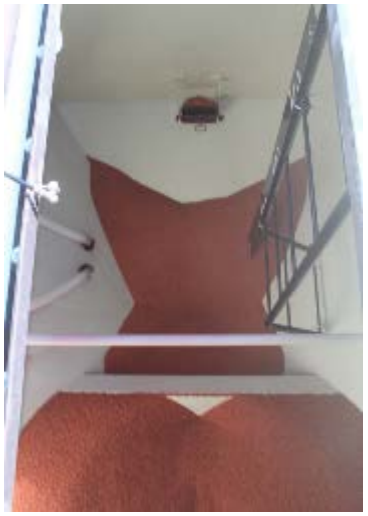
HOW WE DID – Application & Bourgault Planting

Excellent flowability. No bridging, sticky, or dusty seeds

No dust during trnafer



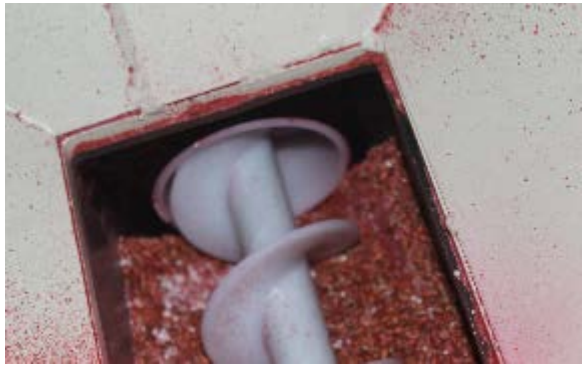
No build up or staining

Seeding went well

Untreated

Cruiser Vibrance Quattro

Excellent coverage



No impact on metering auger

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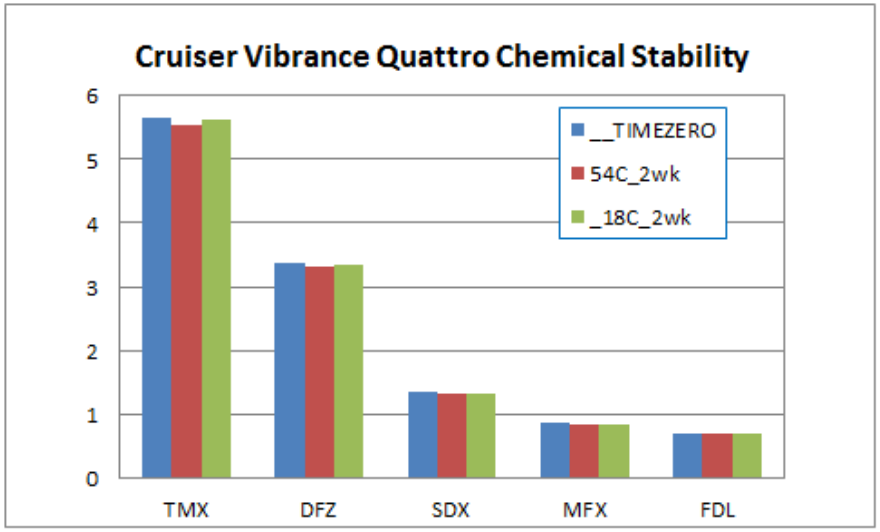
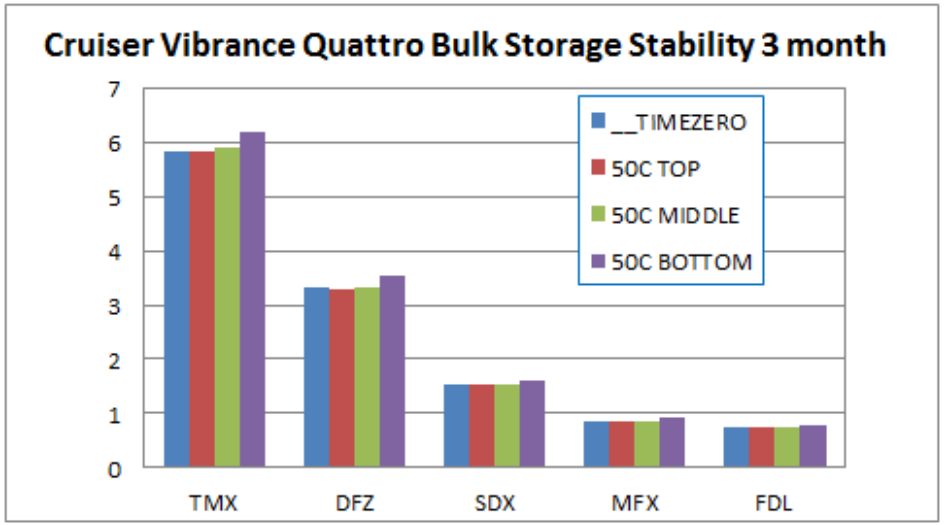
HOW WE DID – Chemical Stability & Bulk Storage



Chemically stable from -18°C to 54°C



No significant stratification under extreme bulk storage conditions

Cruiser® Vibrance® Quattro

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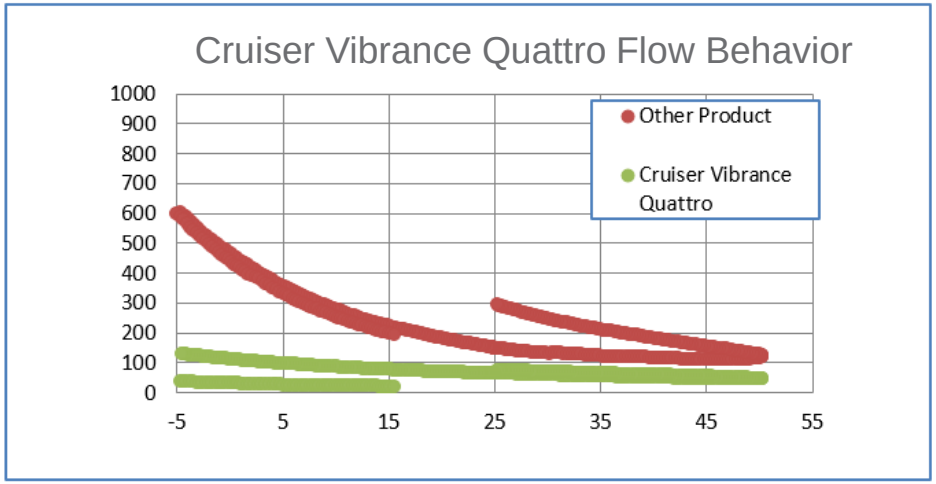
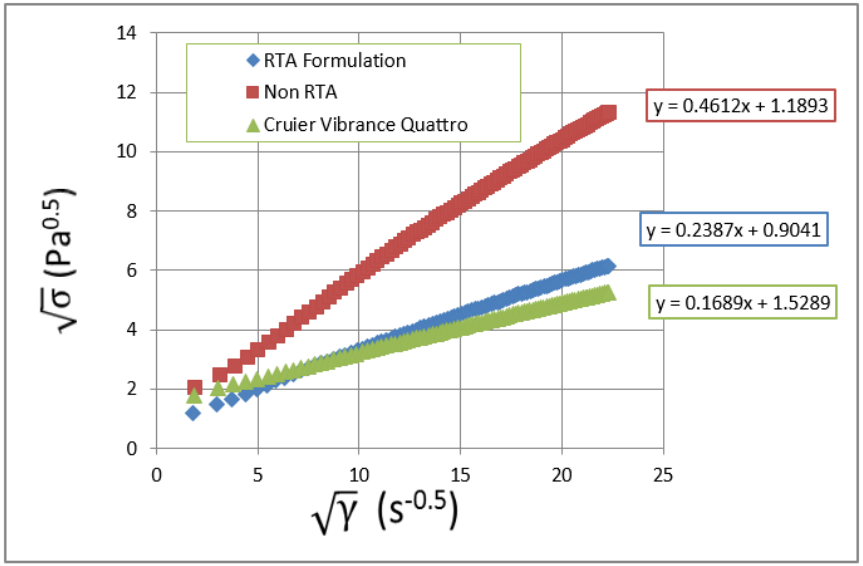
HOW WE DID – Physical Attributes under Extreme Conditions





- Flow characteristics and viscosity do not change over a wide temperature range
- No thickening or hystereis at elevated temperatures
- No significant viscosity change even when it approaches freezing point (-10°C)

Formulation	Yield Stress (Pa)	Casson Viscosity (mPa.S)
Non RTA Formulation	1.41	213
RTA Formulation	0.82	57
Cruiser Vibrance Quattro	2.34	28

- Why low viscosity≠ better cold handling
- Ideal formulation has high yield point and low plastic viscosity; Yield stress is the shear stress exerted to initiate flow; Casson Plastic Viscosity if the stress needed to maintain a constant flow. The higher the PV, the more difficult it is to pump.

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Summary

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- A successful formulation design starts with the application orientated design strategy
- A successful formulation development relies on the right and enabling tools to predict bulk, real world behavior at lab setting
- A successful formulation is a balance act: need oversight on all components, their individual purposes and the interactions between them

Seed Treatment Processes and Equipment

Seed Technology Short Course – July 31, 2018

Who is FarmChem?

- Who is FarmChem?
  - Founded in 1974
  - Seed, Chemical, and Energy equipment distributor based out of Floyd, IA. Manufacturing and distribution plant in Memphis, TN.
  - 2017-9500 ship to locations in all 50 States, 8 Provinces in Canada, and 6 foreign countries.
  - Knowledge and history of working with chemical, seed handling and treatment application equipment
  - Dedicated sales consultation-10 Outside sales reps to cover all U.S. regions, 3 Canadian reps, 12 inside sales and support staff.
    - On-Site Consultation-Site visits made for equipment recommendations and placement.
    - Equipment and Operation Experts
    - Extension of the KSi Sales Team
  - Backed by KSi sales and service support

Mark Domann

National Accounts Manager

FarmChem

Who is KSi?

- Leader in design and manufacturing of belt conveyors and related seed handling equipment
  - Patented Cleated Belt Design
- Offer a single-source solution for bulk and treating equipment
  - Conveyors, Hoppers, Seed Treaters/Applicators, and Software Controls
- Industry reputation for innovation and leading-edge products

Sabetha, KS

Cissna Park, IL

Quentin Edelman

National Accounts Manager

Seed Treatment Process Overview

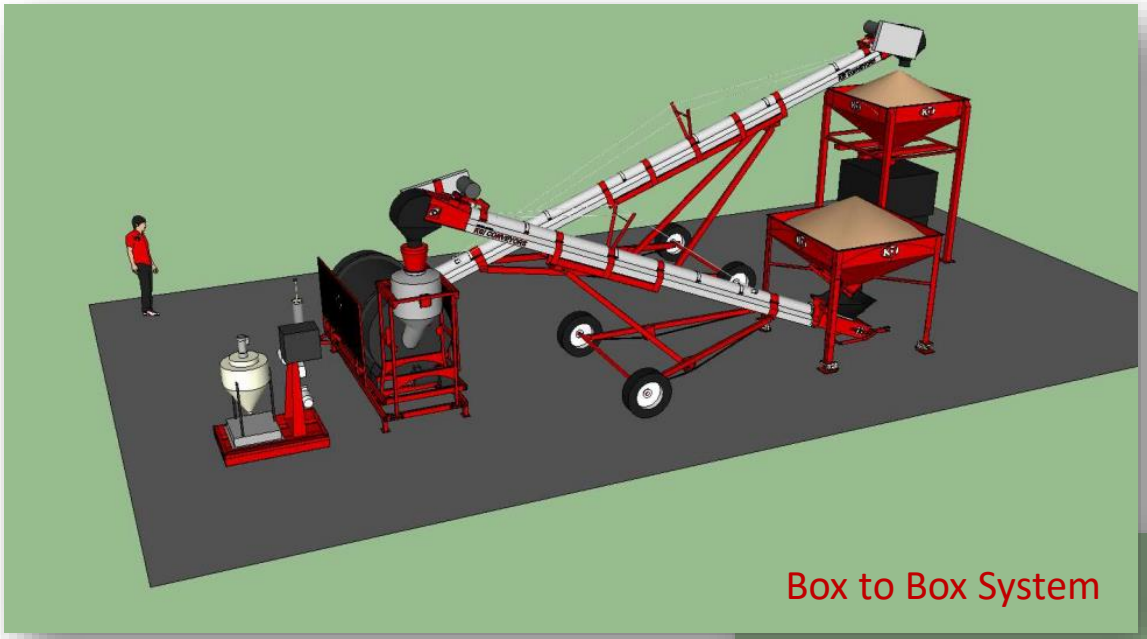
- Downstream Seed Treating
- Elements to the Seed Treating Process
- KSi Seed Treating Equipment
- Automation Software
- Data Management
- Accessory Equipment

Downstream Seed Treating

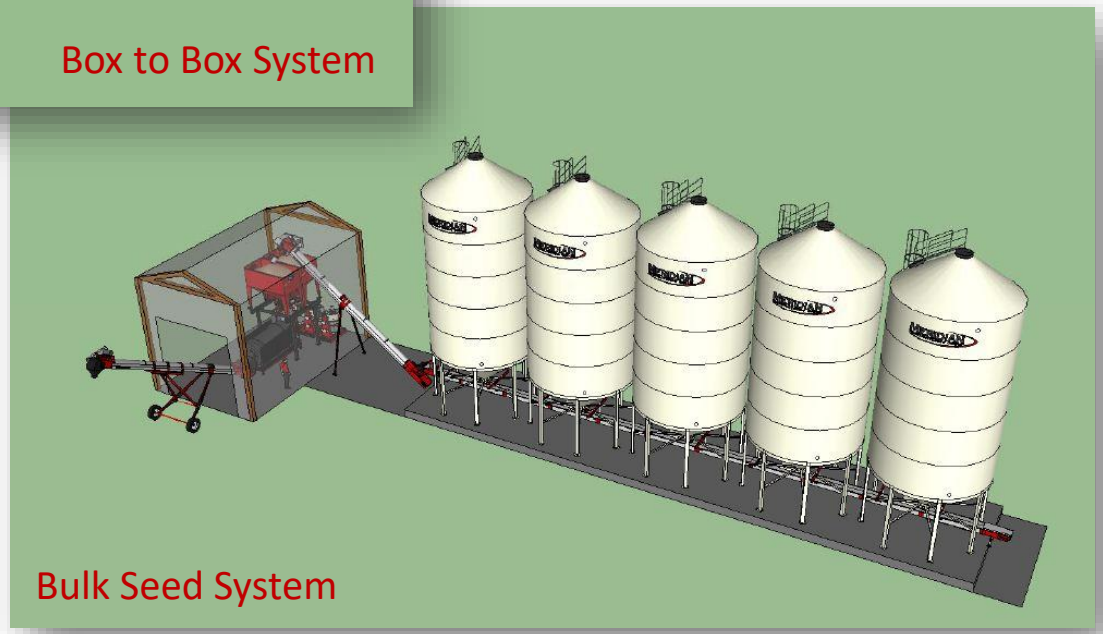
KSi Philosophy

- Capacity
  - System Design & Throughput
  - Bulk System – Box to Box
    - Continuous Flow
- Accuracy
  - Initial Application Efficiency
  - Software
  - Data Transparency
- Efficiency
  - Single Point of Control
  - Operational Capabilities
  - Serviceability

Downstream Seed Treating

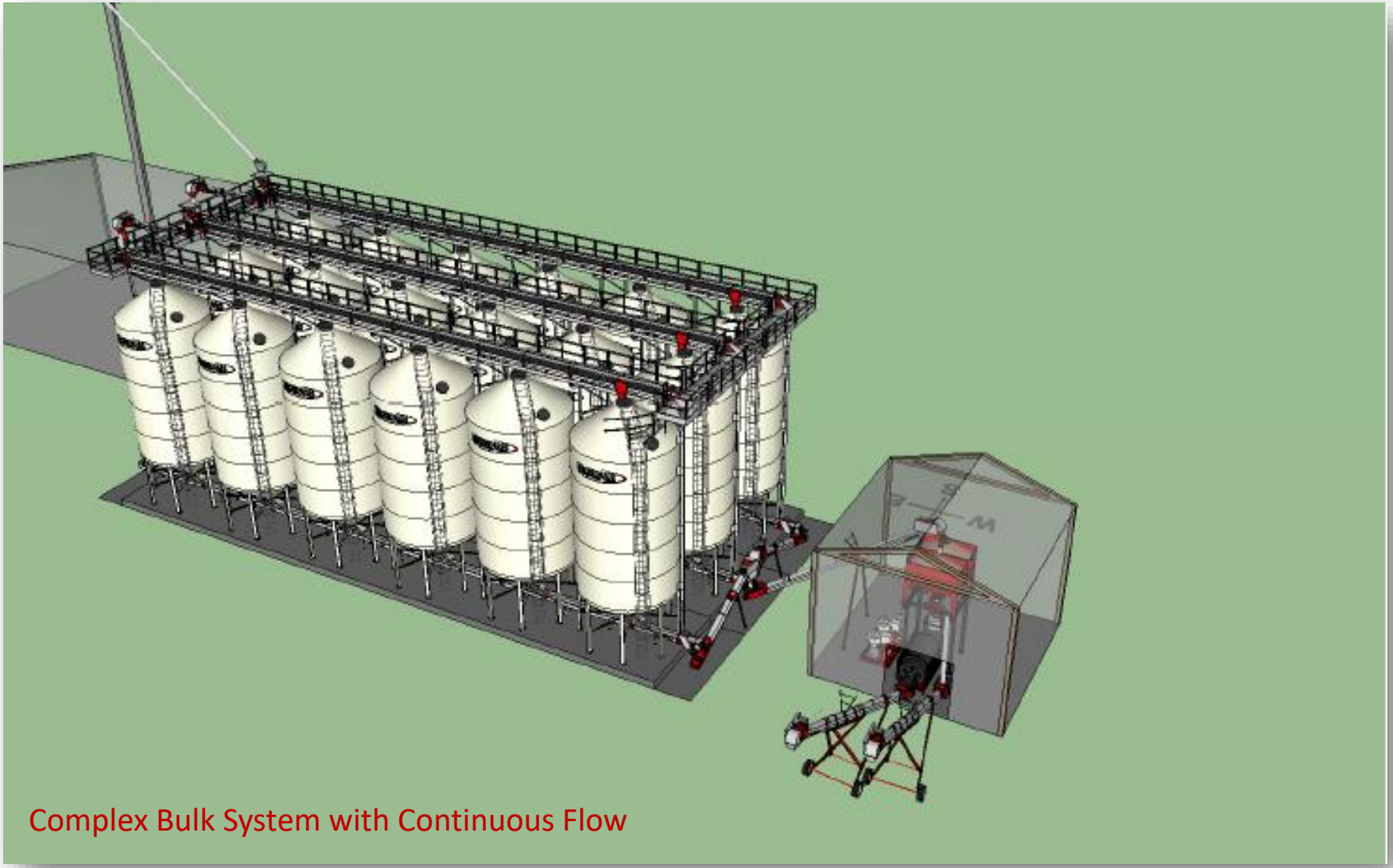


Box to Box System



Bulk Seed System

Downstream Seed Treating



Complex Bulk System with Continuous Flow

Elements of Accuracy in the Seed Treating Process

Elements to the Seed Treating Process

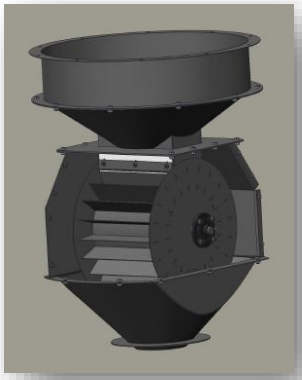
Objective:
Apply the right amount of treatment on the right amount of seed

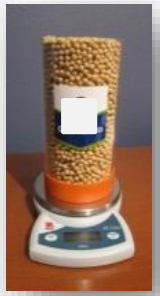
- Seed flow control
  - Seed wheel (volumetric)
  - KSi VariRate (gravimetric)
- Liquid flow control
  - Flow meter (volumetric)
  - Loss-in-weight (gravimetric)
- Basic control / Software Control
  - Application Rate (oz/100, oz/unit, mg AI/Seed)

Seed Metering / Control – Volumetric

- Seed Wheel
  - Traditional method of seed flow control

- Speed setting determined by:
  - Weight of seed in calibration container
    - Each seed size has unique calibration weight that needs to be known by the system
  - Calculation is either manual or automatic depending on system integration
  - Integrated systems including a scale can do automatic corrections

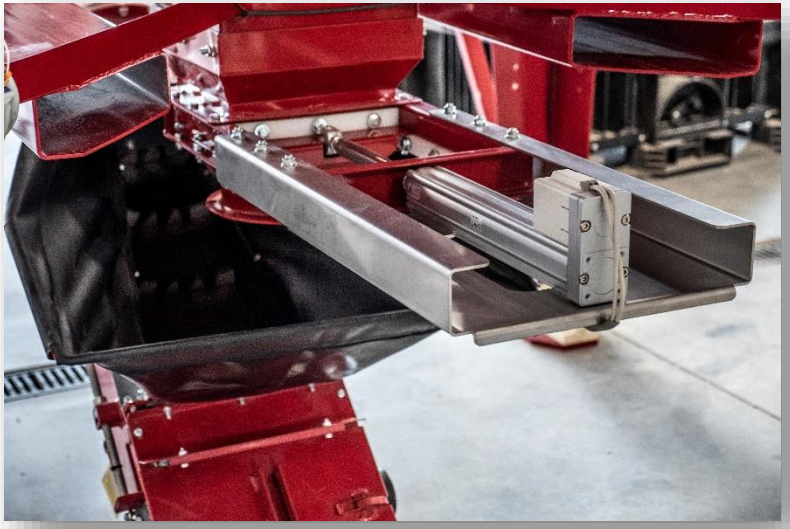




Seed Metering / Control – Gravimetric

- KSi VariRate (Loss-in-Weight)

- Directly measures and controls seed flow using loss-in-weight from scale
- Independent of seed size and seed flow-ability
- No calibration for different seeds
  - Eliminates the human error factor



Liquid Metering / Control

- Flow Meter (volumetric)
  - Based off of product viscosity
    - Daily Calibration (1-2 / day)

- Loss-in-Weight (gravimetric)
  - Based off of product density
    - Density will remain consistent within products
    - Less calibration will increase consistent accuracy

KSi Seed Treatment Equipment

KSi 4808NGA Seed Applicator

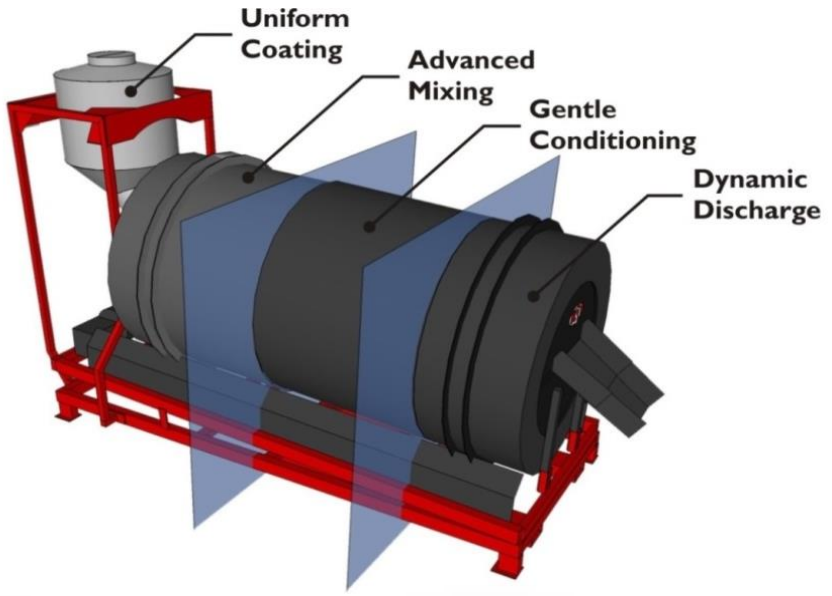
Uniform, Consistent Seed Flow

\+ Uniform, Consistent Chemical Flow

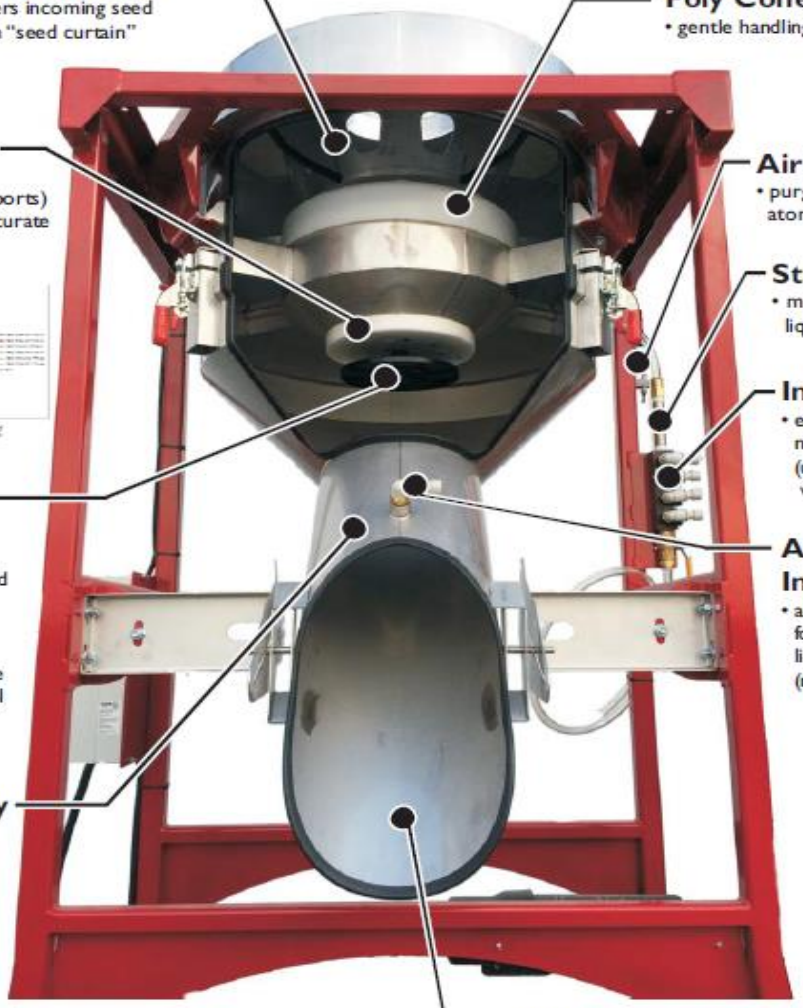
Accurate Seed Treatment System

KSi 4808NGA Drum Design

- Drum: 48” Dia. X 8’ Length
- 3-Stage Mixing/Conditioning Drum
- Dry and Marketable Seed
- Rate: 600 – 2,500 lb/min
- 30 – 45 sec. Cleanout
- Non-Reversing / Non-Tilting
- Ease of Access



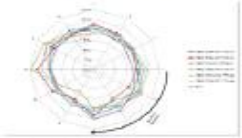
Initial Application Efficiency



Seed Distribution Ring
- gathers and centers incoming seed into thin, uniform "seed curtain"

Poly Cone
- gentle handling of incoming seed

Poly Plates
- routes liquid to atomizer disc (4 ports) for consistent, accurate liquid dispersion onto the seed



liquid distribution testing

Air Purge
- purges remaining liquid near atomizer after each run

Static Mixer
- mechanical helix mixes liquids upon entry

Input Ports
- expandable to meet number of liquid sources (up to 15 sources w/ KSi Automation)

Atomizer Disc
- open disc design w/ simple serrated edge for liquid atomization
- AC motor drive allows for variable speed and control system feedback

Auxillary Input Port
- additional input port for introduction of liquid additives (nutrients, inoculants, ...)

Accessibility
- easily remove chute assembly for inspection and/or cleaning

Initial Application Efficiency
- The combination of a thin, uniform seed curtain w/ a consistent, even liquid distribution results in accurate, efficient seed treatment application (80% seed coverage in the atomizer chamber alone)

Liquid Pump Stands

- Customized Configurations
  - Number of Products
  - Product Packaging
  - Product Compatibilities
  - Application Rates
  - Water / Inoculant / Color

- Design Options
  - Poly or Stainless Steel Slurry Tank
  - Direct Draw
  - Multi-Head Application Pump
  - Drip Containment
  - Calibration Tube
  - Recirculation / Transfer Pump

Levels of Control

Levels of Control

	Control Level	Liquid / Seed Flow Control	Summary / Notes
Level 1	No Control	None	• No Control / Not Accurate • Calibration container and stopwatch used to determine flow rate • Ideal: measured and corrected often / Reality: “set and forget”
Level 2	Basic Control	FlowMeter SeedWheel KSi BasicTreat	• Common entry-level control • Basic liquid monitoring system - w/ flow meter and allows oz./min set point • Pump turns on/off from seed flow control system
Level 3	Semi-Automated	KSi VariRate KSi AutoLiquid Loss-in-Weight	• Popular upgrade for existing system (accuracy w/out cost of new treater) • Individual automated points of control
Level 4	Full Automation Integration	KSi AutoTreat Platform (Bulk Site or Stand Alone)	• Complete, integrated control system – ties seed delivery and seed treatment control into one interface • KSi AutoTreat – recipe based control platform that integrates and controls both seed flow and liquid flow. • Available for bulk site (integrates seed delivery) or treating only setups

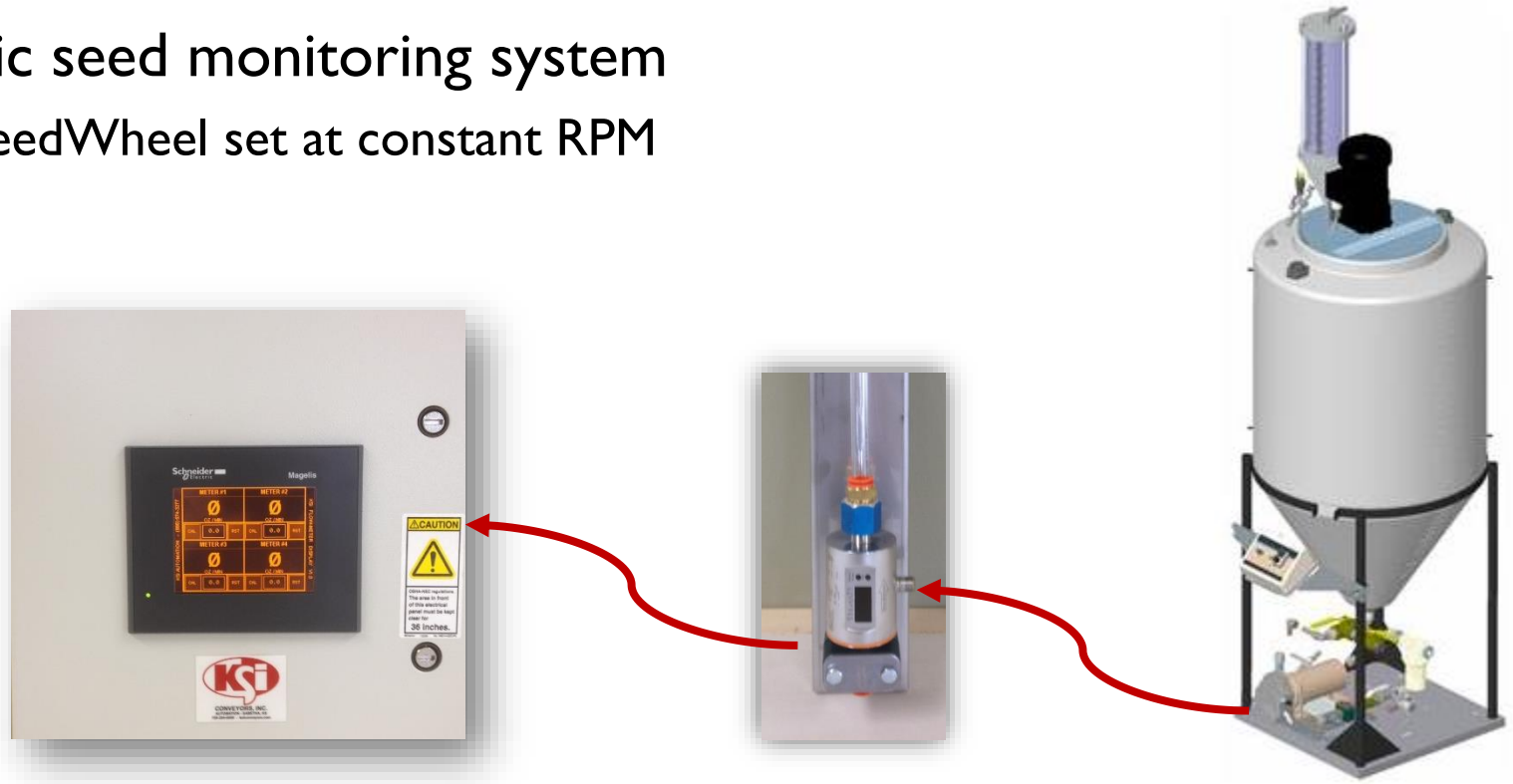
Level 1 – No Control

- No Control / Not Accurate
- Calibration with stopwatch to determine liquid and seed flow rates

- Ideal: measured and corrected often
- Reality: "set and forget"

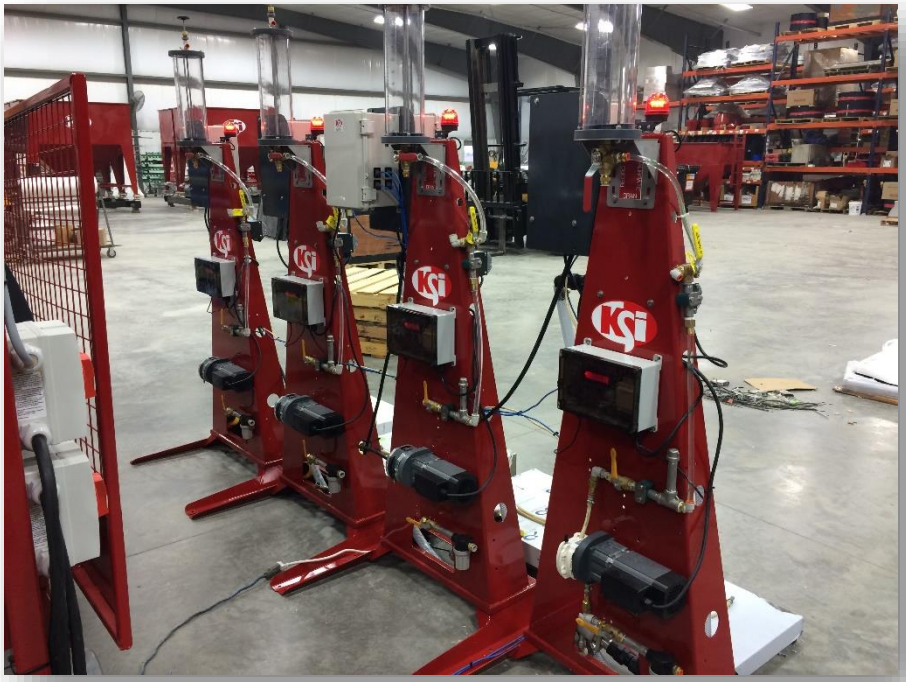
Level 2 – Basic Control

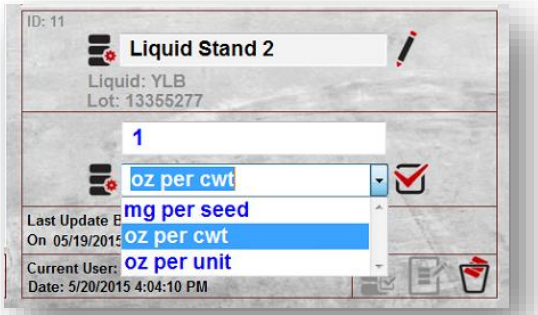
- Common entry-level control
- Basic liquid monitoring system
  - FlowMeter allows for oz./min set point
- Basic seed monitoring system
  - SeedWheel set at constant RPM

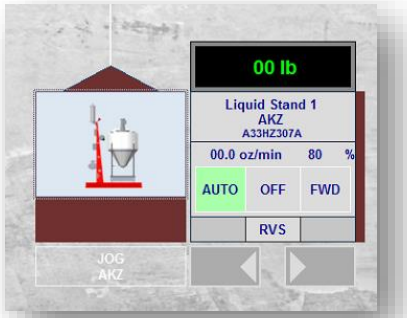


Level 3 - Semi-Automated Control

- Popular upgrade without the purchase of a new treater
- Individual automated points of control
  - Conveyor / Seed Batching
    - KSi AutoBatch
  - Seed flow control
    - KSi VariRate Controller
  - Liquid flow control
    - KSi AutoLiquid





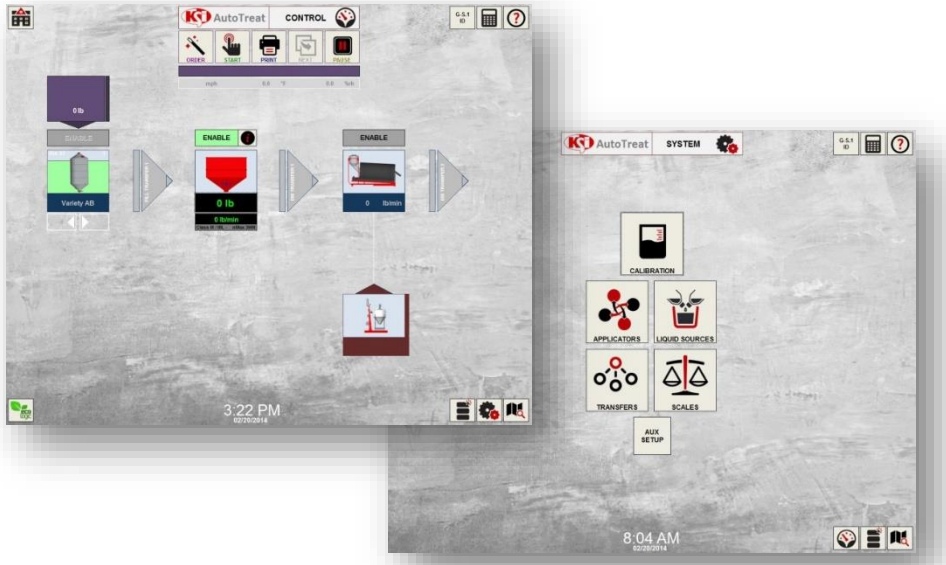


Level 4 - Full-Automated Control

- Single Point of Control
  - Conveyor Seed / Batching
  - Seed flow control
  - Liquid flow control
- Increased Efficiency
  - Less wasted time
- Increased Accuracy
  - System uses actual seed delivery amount (scale)
  - Makes Treating mg AI/seed possible
- Increased Throughput
- More Visible Data

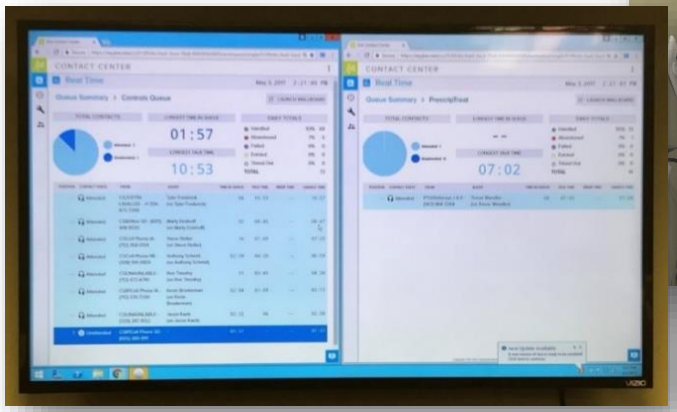
KSi AutoTreat v4 Platform

- Fully Integrated Treating System
  - Single Point of Control
  - 19” Windows Interface
  - Bulk and Box-to-Box Options
- Recipe-based Liquid Control
  - Eliminate manual calculations
  - Treat by oz/unit, AI/seed
- Data Collection
  - Onboard SQL Database
  - KSi SeedConnex
    - Web-Based Data Management
  - Recipes, Seed & Treatment Data, Historical Accuracy
- Serviceability
  - Screen Sharing Capabilities



KSi Call Support

- Support calls received between 3/1 – 5/31 – **8233**
  - Average Speed of Answer – **00:01:16**
  - Average Talk Time – **00:11:44**
  - Dispatched Services Required – **2%**
- Largest week (5/8 – 5/12) – **1277**
- Total Weekend Calls – **730**



Data Management

KSi SeedConnex

- Web-based Application – Available from any web browser
- Live connection between KSi AutoTreat & AutoBatch
- Ability to view / edit customers, seeds, recipes, etc.
- Access to reports / transaction receipts
- Multiple machine integration
- User Access / Restrictions
- Auto Updates
  - Bug fixes
  - Programing modifications
- API – 3rd party integration

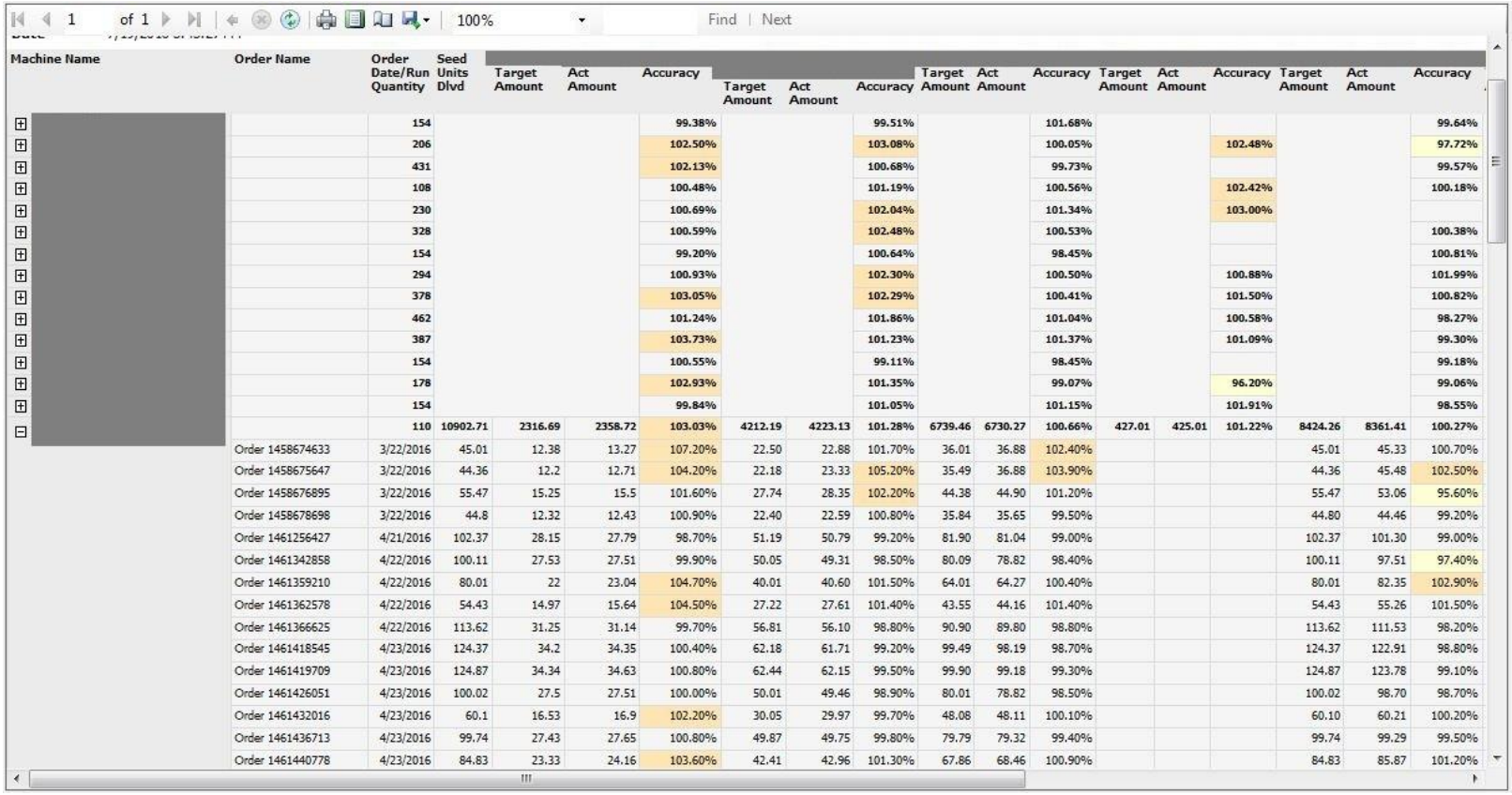
http://seedconnex.com

KSi SeedConnex

- API – 3rd Party Integration
  - Direct access to existing customer lists, seed inventory and treatment data
  - Ability to push and pull data transactions
  - Eliminates dual data entry
  - Multiple location tracking
    - Tiers of password protected access

KSi SeedConnex

- Accountability & Transparency



1 of 1 | 100% | Find | Next

Machine Name	Order Name	Order Date/Run Quantity	Seed Units Dlvd	Target Amount	Act Amount	Accuracy	Target Amount	Act Amount	Accuracy	Target Amount	Act Amount	Accuracy	Target Amount	Act Amount	Accuracy	Target Amount	Act Amount	Accuracy
[redacted]		154				99.38%			99.51%			101.68%						99.64%
		206				102.50%			103.08%			100.05%			102.48%			97.72%
		431				102.13%			100.68%			99.73%						99.57%
		108				100.48%			101.19%			100.56%			102.42%			100.18%
		230				100.69%			102.04%			101.34%			103.00%			
		328				100.59%			102.48%			100.53%						100.38%
		154				99.20%			100.64%			98.45%						100.81%
		294				100.93%			102.30%			100.50%			100.88%			101.99%
		378				103.05%			102.29%			100.41%			101.50%			100.82%
		462				101.24%			101.86%			101.04%			100.58%			98.27%
		387				103.73%			101.23%			101.37%			101.09%			99.30%
		154				100.55%			99.11%			98.45%						99.18%
		178				102.93%			101.35%			99.07%			96.20%			99.06%
		154				99.84%			101.05%			101.15%			101.91%			98.55%
		110	10902.71	2316.69	2358.72	103.03%	4212.19	4223.13	101.28%	6739.46	6730.27	100.66%	427.01	425.01	101.22%	8424.26	8361.41	100.27%
	Order 1458674633	3/22/2016	45.01	12.38	13.27	107.20%	22.50	22.88	101.70%	36.01	36.88	102.40%				45.01	45.33	100.70%
	Order 1458675647	3/22/2016	44.36	12.2	12.71	104.20%	22.18	23.33	105.20%	35.49	36.88	103.90%				44.36	45.48	102.50%
	Order 1458676895	3/22/2016	55.47	15.25	15.5	101.60%	27.74	28.35	102.20%	44.38	44.90	101.20%				55.47	53.06	95.60%
	Order 1458678698	3/22/2016	44.8	12.32	12.43	100.90%	22.40	22.59	100.80%	35.84	35.65	99.50%				44.80	44.46	99.20%
	Order 1461256427	4/21/2016	102.37	28.15	27.79	98.70%	51.19	50.79	99.20%	81.90	81.04	99.00%				102.37	101.30	99.00%
	Order 1461342858	4/22/2016	100.11	27.53	27.51	99.90%	50.05	49.31	98.50%	80.09	78.82	98.40%				100.11	97.51	97.40%
	Order 1461359210	4/22/2016	80.01	22	23.04	104.70%	40.01	40.60	101.50%	64.01	64.27	100.40%				80.01	82.35	102.90%
	Order 1461362578	4/22/2016	54.43	14.97	15.64	104.50%	27.22	27.61	101.40%	43.55	44.16	101.40%				54.43	55.26	101.50%
	Order 1461366625	4/22/2016	113.62	31.25	31.14	99.70%	56.81	56.10	98.80%	90.90	89.80	98.80%				113.62	111.53	98.20%
	Order 1461418545	4/23/2016	124.37	34.2	34.35	100.40%	62.18	61.71	99.20%	99.49	98.19	98.70%				124.37	122.91	98.80%
	Order 1461419709	4/23/2016	124.87	34.34	34.63	100.80%	62.44	62.15	99.50%	99.90	99.18	99.30%				124.87	123.78	99.10%
	Order 1461426051	4/23/2016	100.02	27.5	27.51	100.00%	50.01	49.46	98.90%	80.01	78.82	98.50%				100.02	98.70	98.70%
	Order 1461432016	4/23/2016	60.1	16.53	16.9	102.20%	30.05	29.97	99.70%	48.08	48.11	100.10%				60.10	60.21	100.20%
	Order 1461436713	4/23/2016	99.74	27.43	27.65	100.80%	49.87	49.75	99.80%	79.79	79.32	99.40%				99.74	99.29	99.50%
	Order 1461440778	4/23/2016	84.83	23.33	24.16	103.60%	42.41	42.96	101.30%	67.86	68.46	100.90%				84.83	85.87	101.20%

Accessory Equipment

KSi Dry Additive Feeder

- Dry powder application
  - Flow-ability agents
  - Shiny additives
  - Supplemental micronutrients
- Internal drum distribution applied to wet/tacky seed
- Auger Metering: "Stinger"
- Variable speed application

KSi Seed Filtration System

- Patent-Pending Design
  - Undergoing advanced testing and lab analysis
  - Not designed to improve atmospheric conditions
- In-line Filtration System
  - Dust / Debris Extraction and Collection
  - Dual Air Filters
  - Collection Bin
- Variable Air Flow
  - Damper
  - Relief Valve
- Filter “Blast” Clean-Out

Thank You

Seed Equipment Demo:
3:30

Mark Domann
National Accounts Manager
FarmChem

Quentin Edelman
National Accounts Manager
KSi

Cotton Seed Treatment Considerations

Jeremiah Mullock

Agenda

- Seedling Disease Complex
- Early Season Insects
- Nematode Protection
- Coating, Colorants, Neutralizer

Importance of Seed Treatments in Cotton

- Protect against pests for often there are not curative means
- Early season establishment and vigor essential to achieve optimum yields
- Grower convenience for protection of early season pests
- Protection from moment seed is planted though germination and stand establishment

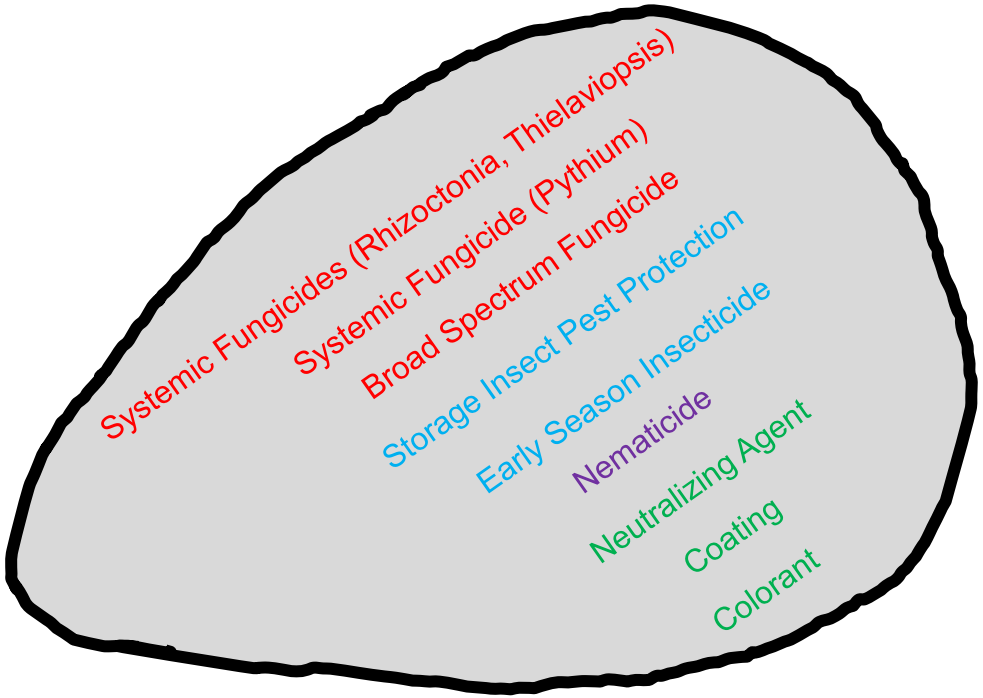
Why we use seed treatments in cotton?

Black Seed

Premium Seed Treatment


810 # Lint/A
Black Seed
1081 # Lint/A
Premium Seed Treatment
774 # Lint/A
Black Seed

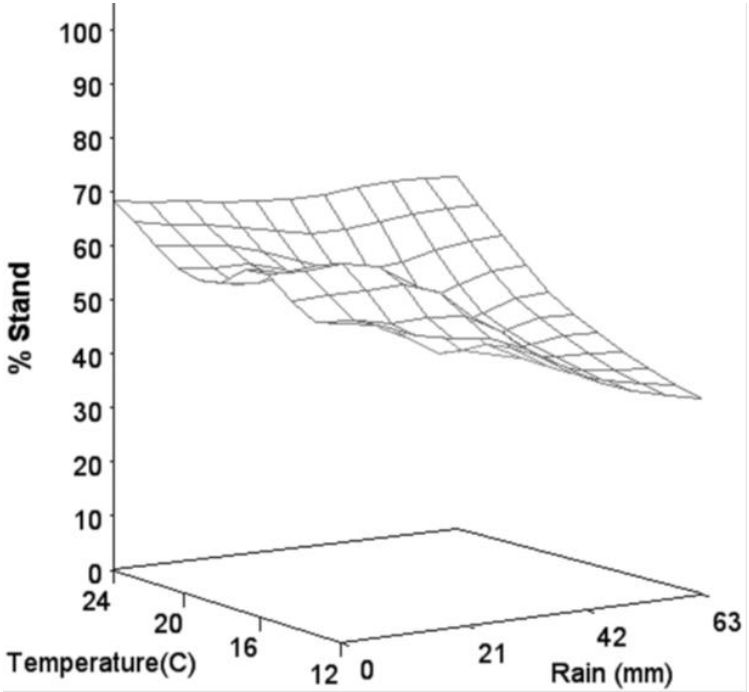
What Goes on a Cotton Seed?



Seedling Disease Complex

- Seedling disease complex consists of multiple genera of fungi and are ubiquitous in nearly all soils
  - *Pythium* spp.
  - *Rhizoctonia solani*
  - *Thielaviposis basicola*
  - *Fusarium* spp.
- Soil populations are not primary driver of seedling damage and severity
- Infection and damage dependent on conditions post planting
  - Damage favored in cool, wet
- Multiyear data support widespread use of seed treatment fungicides

Effect of plant stand on soil temperature and moisture for 3 days after planting



Rothrock et al., 2012

Pythium spp.

Multiple species of Pythium with a wide host range, generally favored under cool and wet conditions (soil temperatures <60 F)

- Seed rot, pre- and post- emergence damping causing stand loss and weak plants
- Symptoms: water-soaked tissue, sloughing of tissue around tap root
- Active ingredients: metalaxyl, mefenoxam, thiram

Rhizoctonia solani (Soreshin)

Infection can occur over range of soil moisture. Increased moisture does increase risk of infection due to slower cotton rate of growth

- Infect at soil level during emergence that can cause stunted plant and stand loss

Symptoms: sunken, red-brown lesions / girdles at soil line

Active ingredients:

- SDHI – penflufen, sedaxane, fluxapyroxad, carboxin
- DMI – ipconazole, prothioconazole, triadimenol, myclobutanil
- QoI – azoxystrobin, trifloxystrobin, pyraclostrobin
- fludioxonil

Thielaviopsis basicola (Black root rot)

Prevalent in regions in Texas, Mid-South and California in clay soils and more severe when soil temperatures range from 60-64 F.

- Black rotting of tap toot and lateral roots
- Symptoms: dry black discoloration, stunted plants, rarely causes stand loss
- Active ingredients: triadimenol, myclobutanil

Fusarium spp.

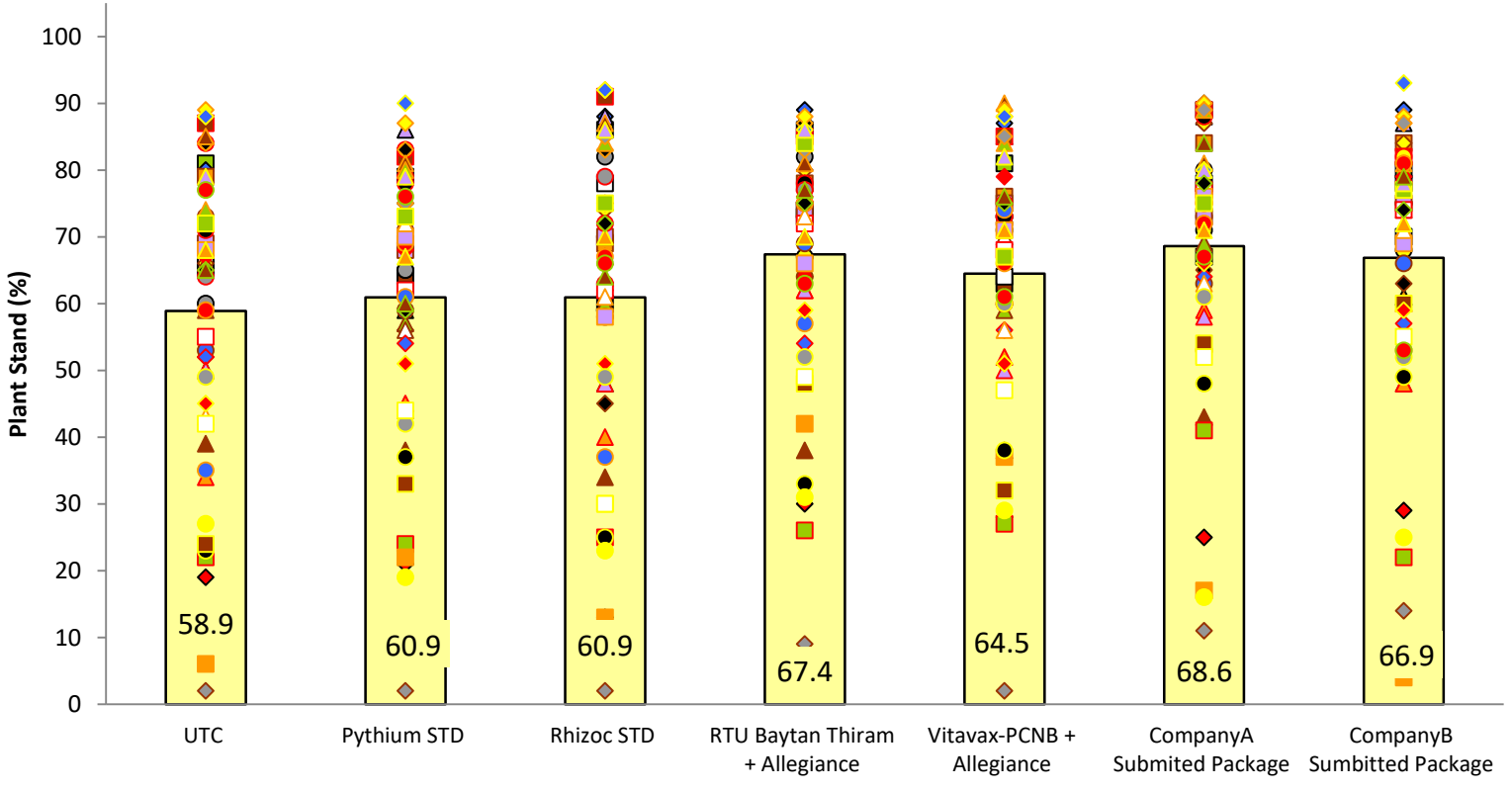
Several species of Fusarium can colonize and reproduce on cotton roots with some being pathogenic or non-pathogenic

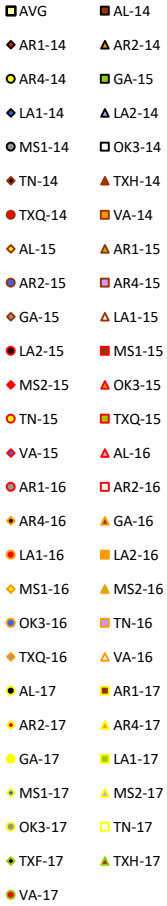
- Not aggressive stand-robber, but can cause less vigorous plants by causing root rot / necrosis
- Active ingredients:
  - DMI – ipconazole, prothioconazole
  - QoI – azoxystrobin, trifloxystrobin, pyraclostrobin
  - fludioxonil

Fusarium wilt - *Fusarium oxysporum* f.sp. *vasinfectum* (Fov) – relationship coupled with nematode feeding and damage

- Integrated with nematode management (variety tolerance, chemical control)

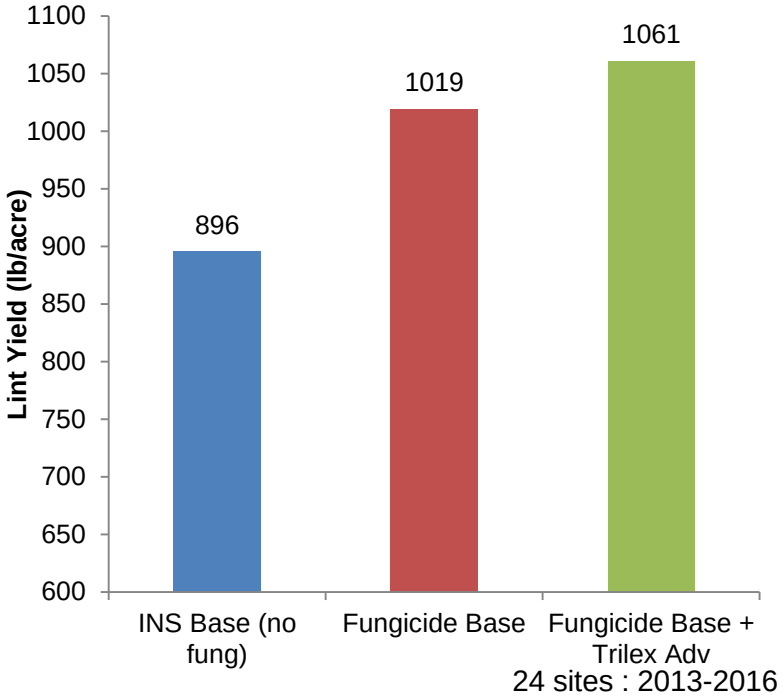
Summary of National Cotton Seed Treatment Test (2014-2017)





52 site-years

Using premium fungicide treatments provide increased vigor and yield potential



Insect Pests

- Seed Storage Protection
  - Low rate of insecticide applied to protect from Indian Meal Moth, Lesser Grain Borer in warehouse facilities
    - Fumigation recommended for stocks with existing insect populations
    - Rates do not offer protection on early-season insects
- Thrips
  - near ubiquitous early season insect in cotton

Thrips in Cotton

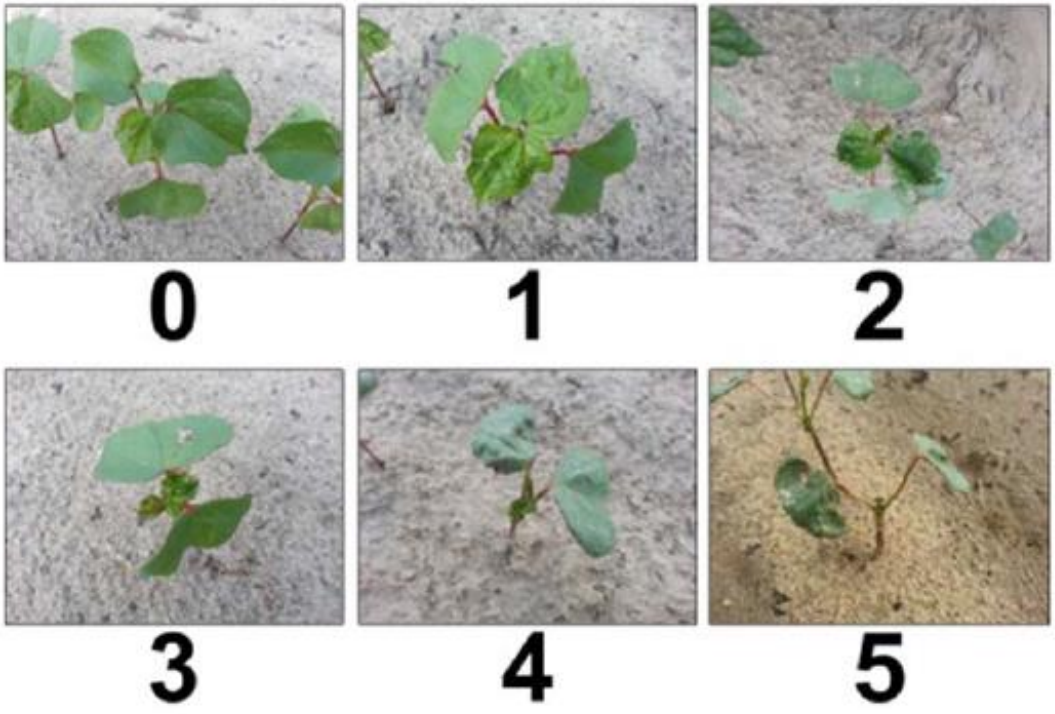
- Consistently among top 3 insect pest in annual yield loss estimates[1]
- Cotton susceptible from emergence to 5 weeks
- Severe injury can lead to loss of apical meristem, delays in maturity, and yield loss up to 50%[2]
- Mid-South Summary[3] showed an average increase of 102 lbs lint per acre using neonicotinoid seed treatments compared to fungicide base
- Usage of neonicotinoid seed treatments provide –
  - Immediate insecticide activity
  - Grower flexibility

[1] Williams, 2012, 2013,2014, 2015,2016
[2] Cook et al., 2011
[3] North et al., 2018

Thrips Damage Rating

use ½ increments

Seedling injury rating scale (J. Greene, Clemson)

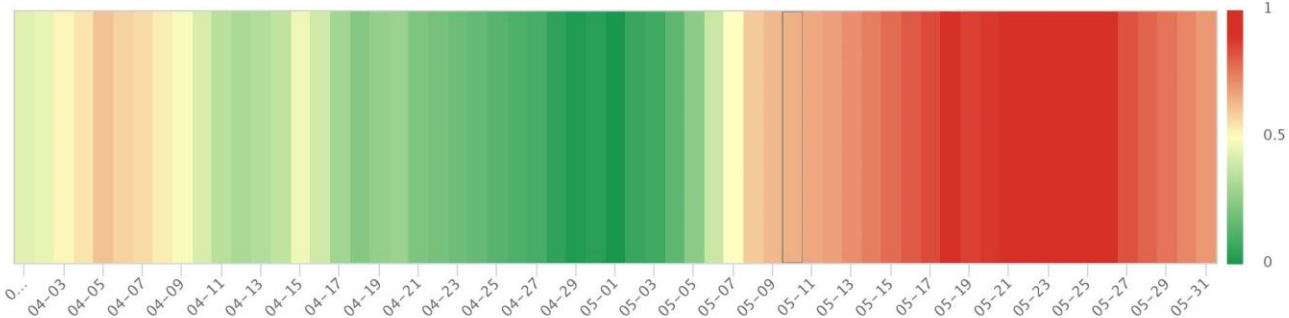


Thrips Injury Risk Predictor – Stoneville, MS (May 10, 2018)

https://climate.ncsu.edu/cottonTIP

Figure 1. Relative Thrips Injury Risk over the Current and Preceding 5 Years

Figure 2. Relative Thrips Injury Risk between April 1 and May 31, 2018



Impact of Seedling Vigor on Thrips Injury

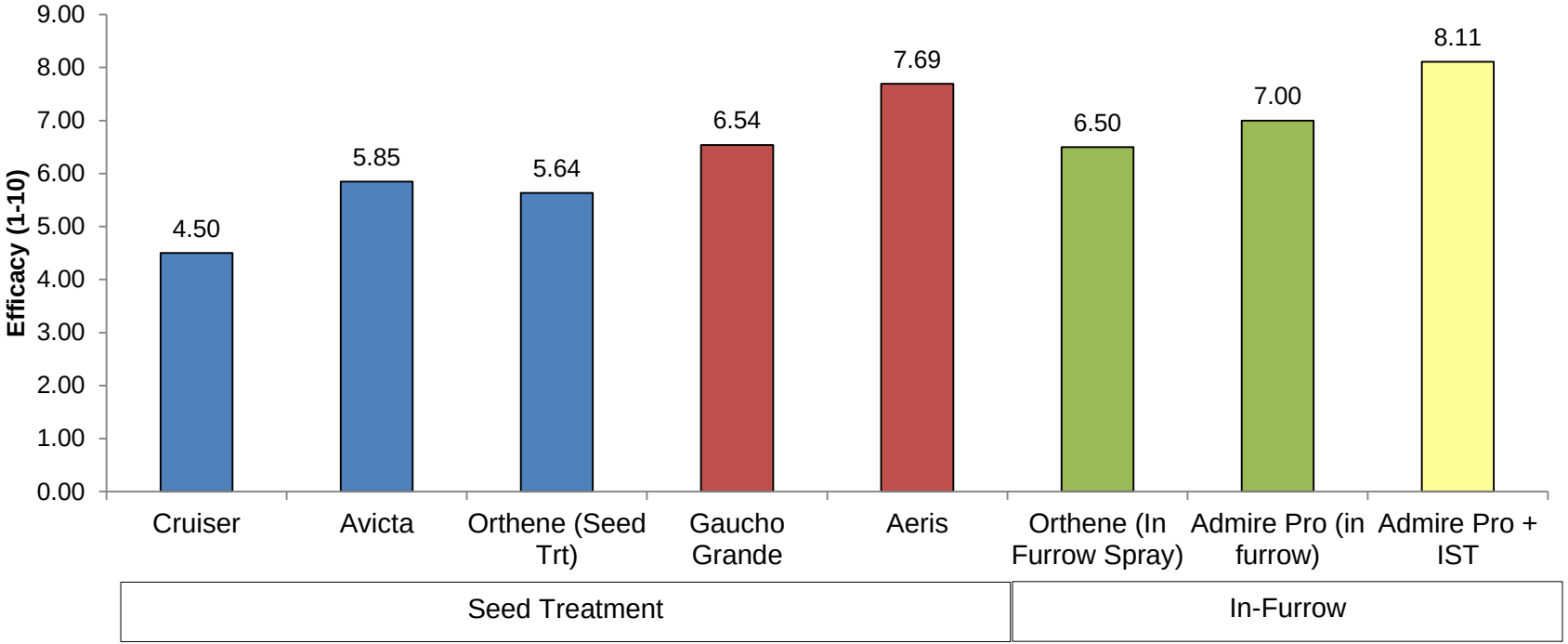
Variety 1 – Fungicide Base

Variety 2 – Fungicide Base

33 DAP

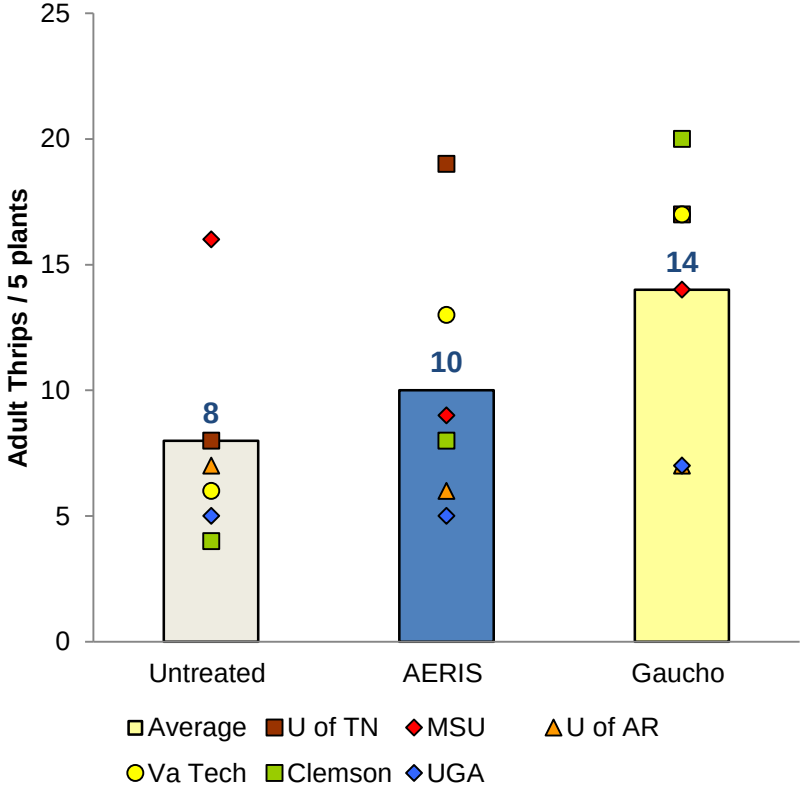
Same fungicide base, planted on the same day in same field

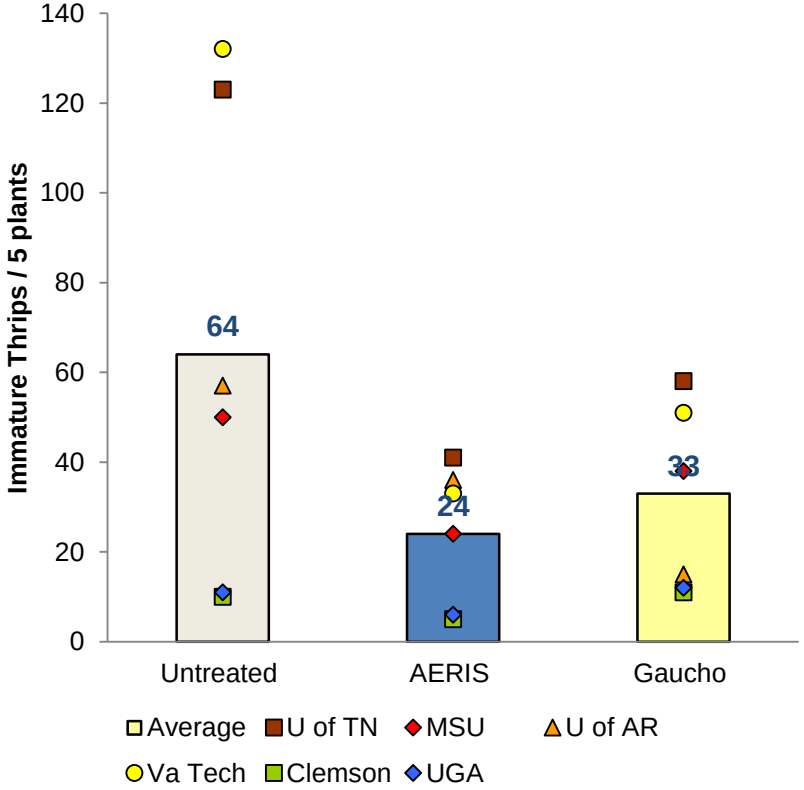
Survey of Insecticide Performance against Thrips



2017 University Entomologist Insecticide Survey
Ratings on 1-10 scale, where 1 = not effective and 10 = completely effective

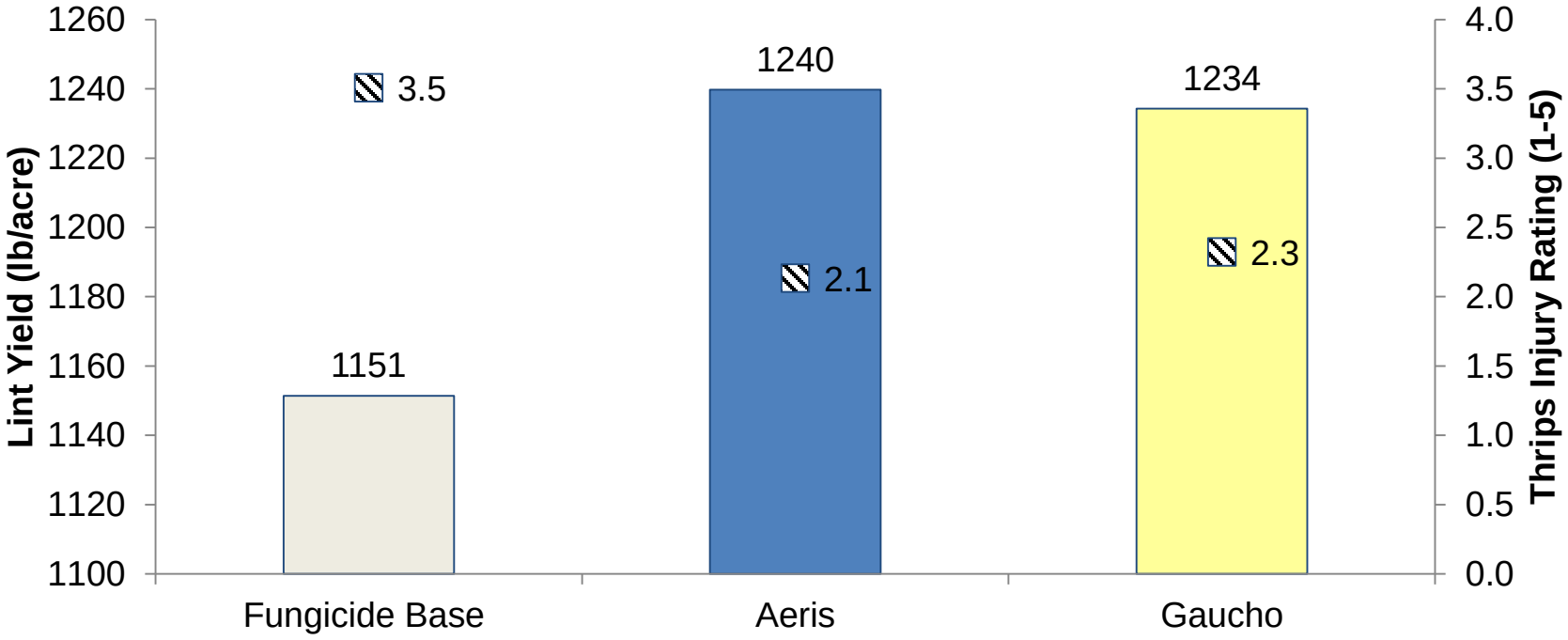
Imidacloprid Provides Larval Mortality and Reduced Oviposition Against Thrips





Suffolk VA
June 2016

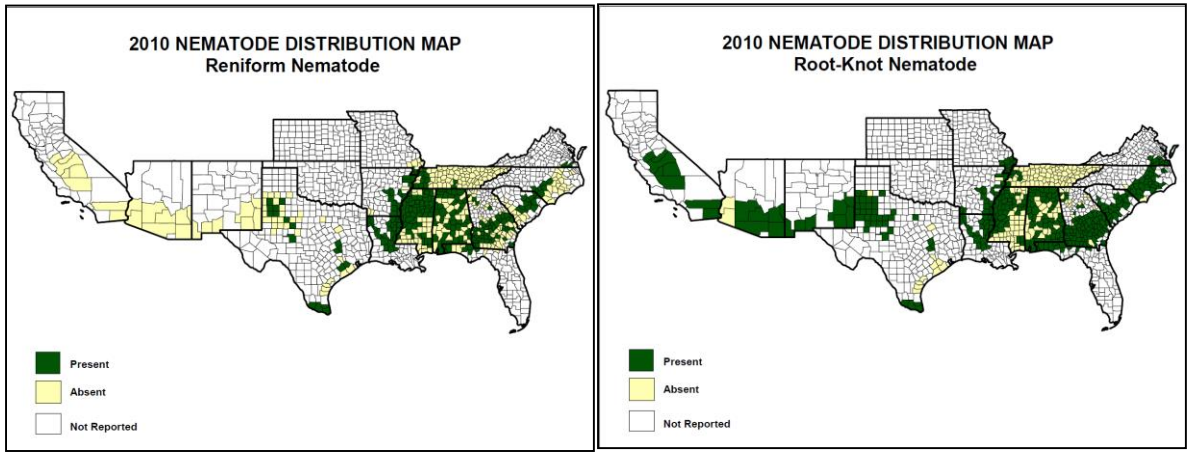
Imidacloprid based seed treatments provide consistent yield benefit by reducing immatures and damage



Nematodes cause widespread damage across the Cotton Belt

- Yield loss estimates from nematode damage are more than double the estimated yield loss to seedling disease
- Across the Cotton Belt, estimated damage from nematodes total more that 672,000 bales, equaling over 5% yield loss
- The primary nematode species causing damage are Reniform and Root-Knot (RKN) nematodes

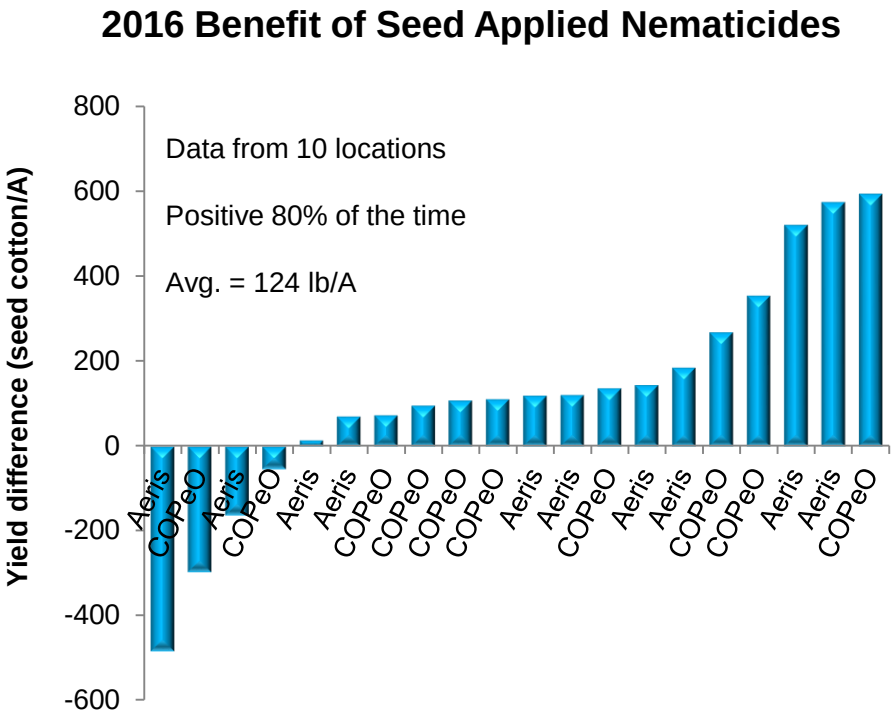
National Cotton Council

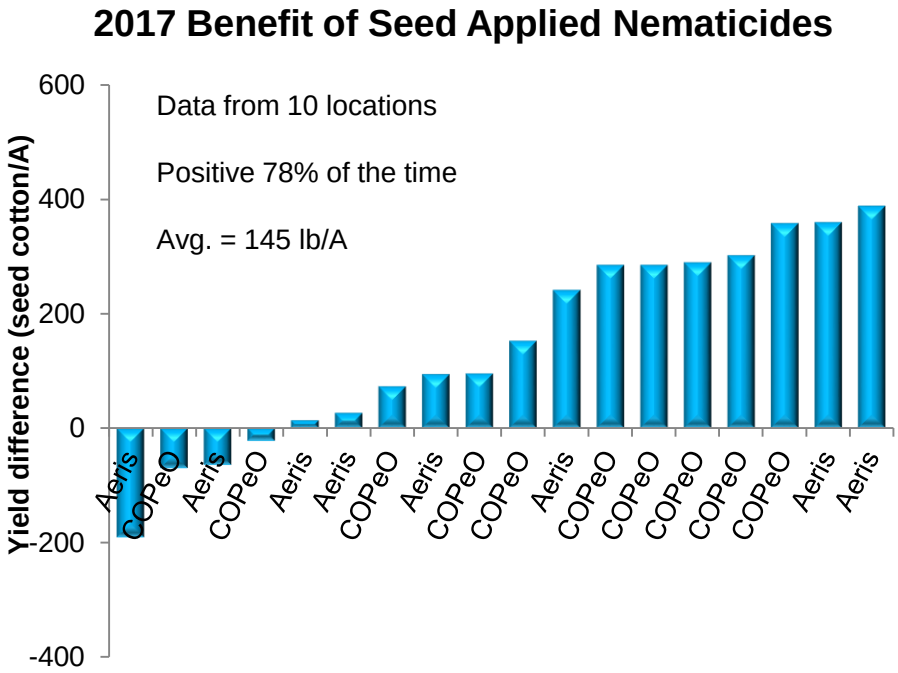


Nematode Management for Cotton

- Soil Sample (harvest, pre-planting)
- Variety Tolerance
- Crop Rotations
  - RKN reproduce on corn, soy, sorghum
  - Reniform reproduce on soy
- Chemical / Biologic Control
  - **seed treatments**, in-furrow, fumigants

Beltwide Nematode Research and Education Committee Report on Cotton Cultivars and Nematicide Responses in Nematode Soils, 2017



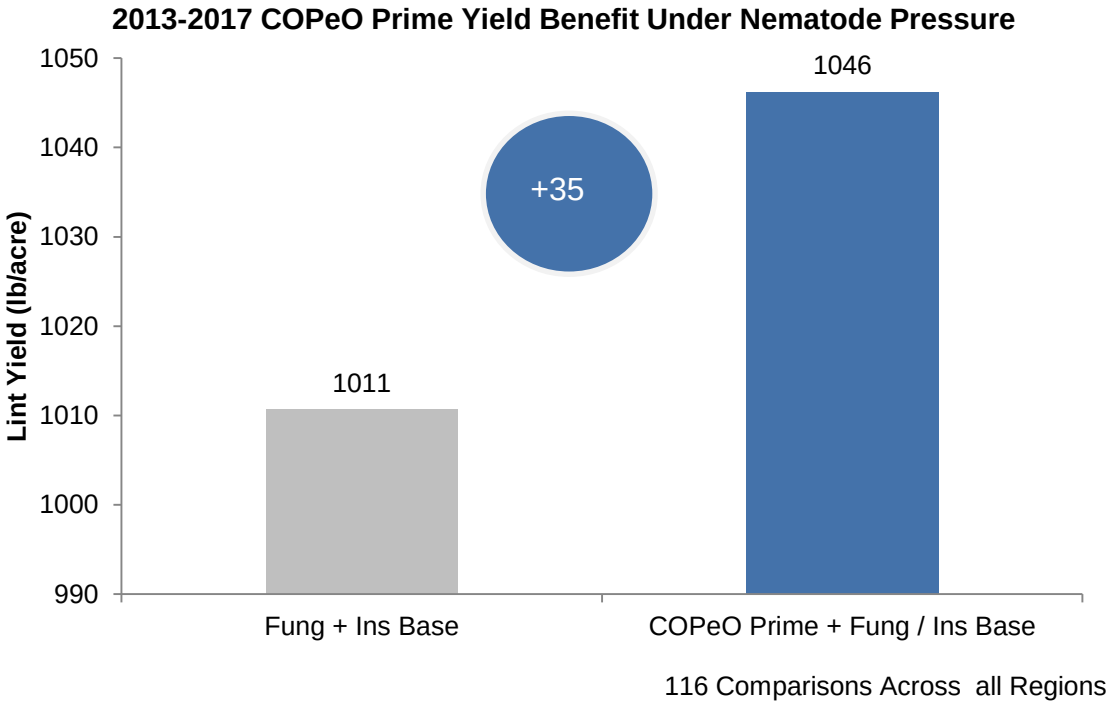


Faske et al, 2018, National Cotton Council Nematode Committee Report

Achieve higher yield with COPeO Prime by protecting against nematodes

COPeO® Prime contributes to higher yields under nematode pressure

- Protects cotton roots from economically significant reniform and root-knot nematodes
- Brings additional yield both with and without the use of nematode-tolerant varieties
- Multiple years of University and internal testing across the Cotton Belt has shown that COPeO Prime adds an average of 35 lb. lint/acre vs fungicide + insecticide base
- Available exclusively on BASF cotton seed brands
  - Stoneville – Base seed treatment
  - FiberMax – Premium commercial upstream treatment with Aeris & Trilex



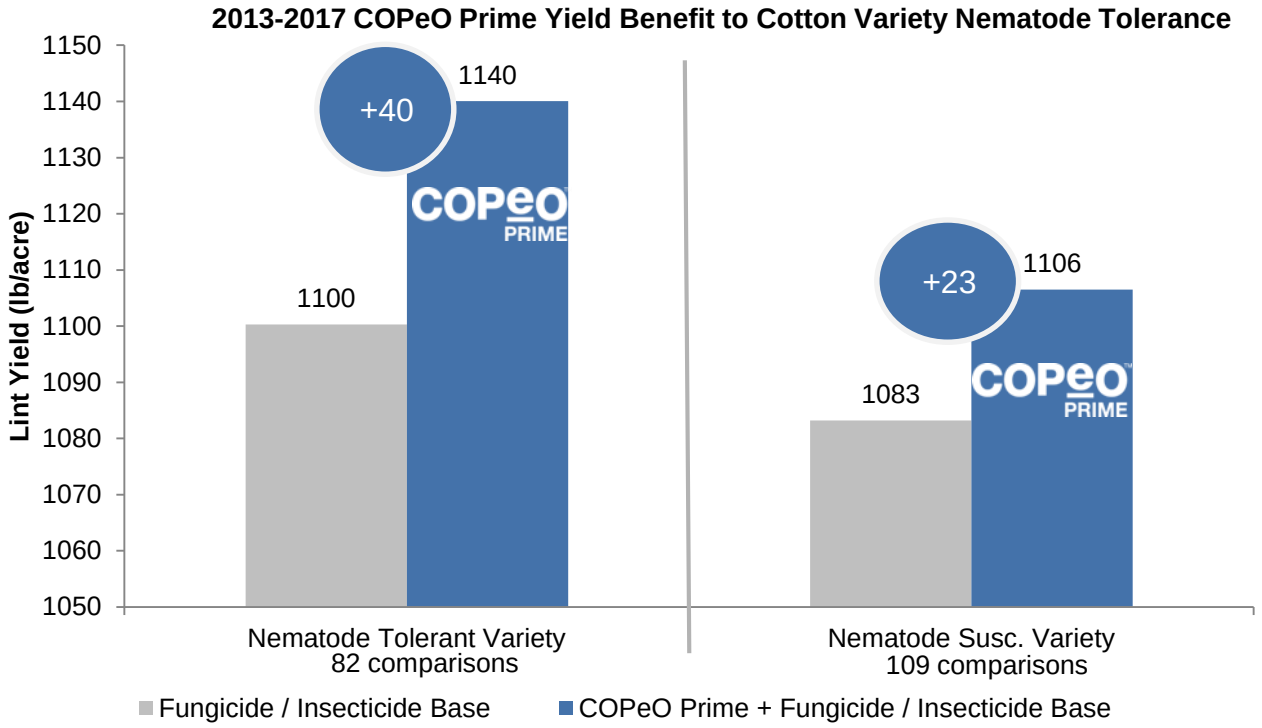
Increased growth and vigor with COPeO Prime under nematode pressure

Fungicide + Insecticide Base

COPeO Prime + Fungicide + Insecticide Base

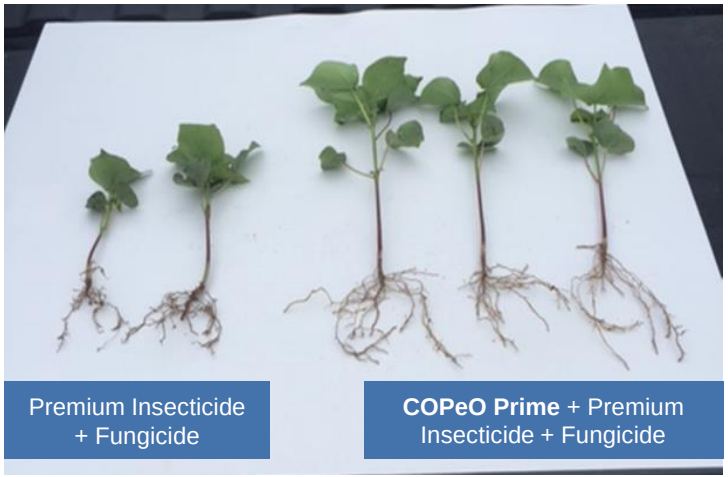
St. Joseph, LA

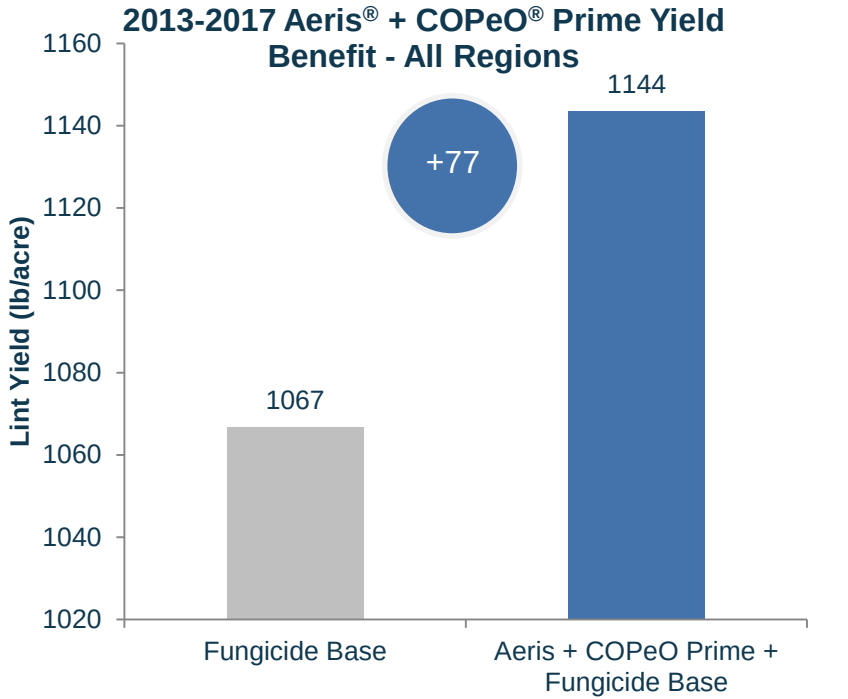
COPeO Prime provides added yield potential to partner with variety selection for nematode protection



Aeris® and COPeO® Prime provide : Added protection for increased yield – 2013-2017

- Improved nematode protection and even higher overall yields are achieved when pairing COPeO Prime with Aeris
- With Aeris and COPeO Prime together cotton growers can achieve higher yield potentials with 2 MOA against nematodes (thiodicarb & fluopyram) and 2 MOA against thrips (imidacloprid & thiodicarb)





55 comparisons across all Regions

COPeO Prime and premium (Aeris) insecticide deliver protection from key pests for increased yield potential

Base fungicide

COPeO Prime + base fungicide

COPeO Prime + premium insecticide + base fungicide

University of Arkansas, Travis Faske
Leachville, AR, June 29, 2017

Neutralizer, Coatings & Colorants

Neutralizing Agent necessary to raise pH after the acid delinting process

- low pH on seed coat can:
  - decrease germination
  - breakdown active ingredients

Coatings and Colorants are necessary for dust control and plant-ability

- High application volumes used in cotton can reduce flow ability
- Critical to ensure delivery of active ingredients on the planted acre and reduce abrasion
- Improved aesthetics and appearance

Thank you

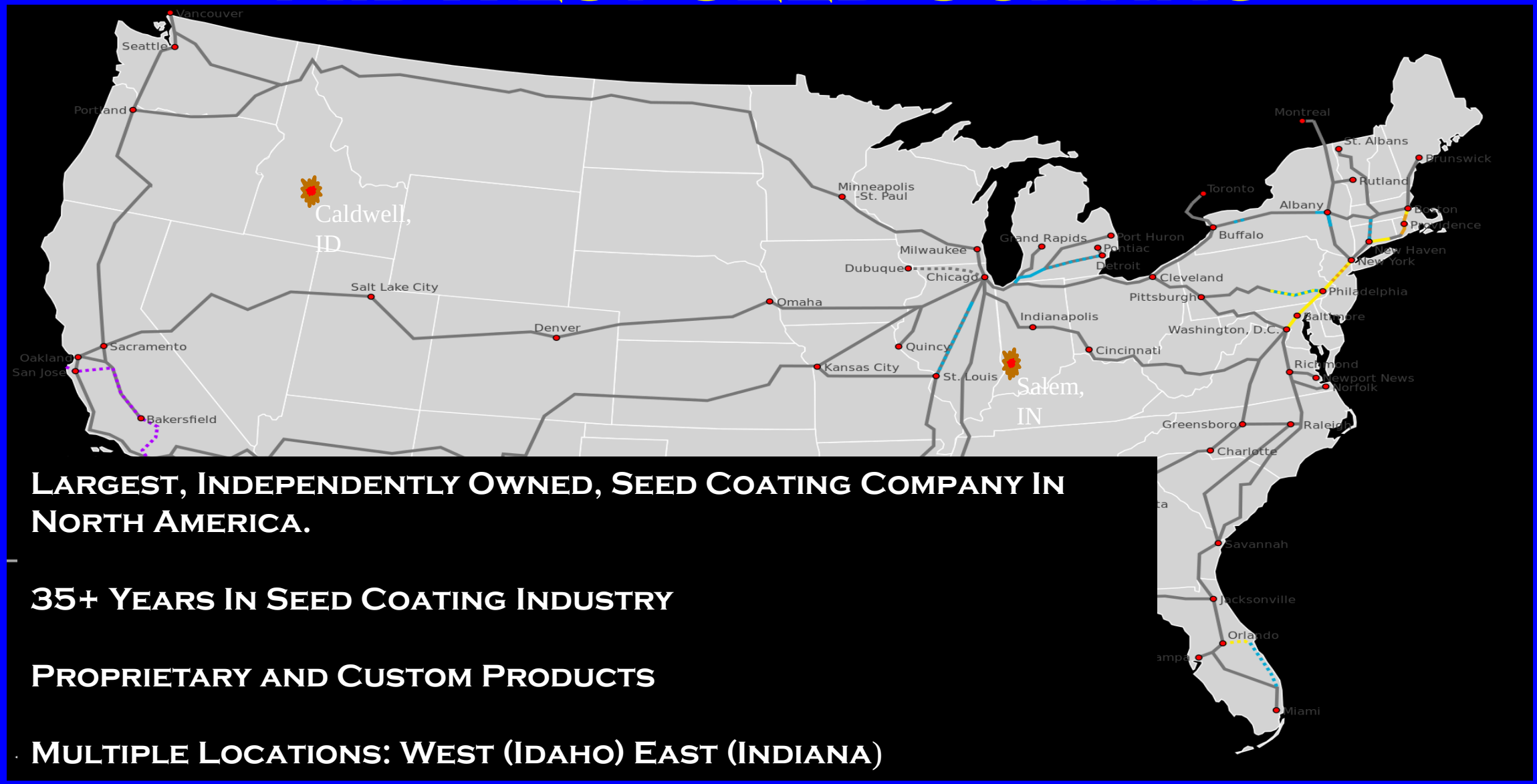

810 # Lint/A
Black Seed
1081 # Lint/A
Premium Seed Treatment
774 # Lint/A
Black Seed

Mississippi State Seed Tech Short Course

- Summit Seed Coatings
- Midwest Seed Coatings
- August 1, 2018
- Bill Talley

Summit Seed Coatings, "Who We Are"

MidWest Seed Coating



Largest, Independently Owned, Seed Coating Company In North America.

35+ Years In Seed Coating Industry

Proprietary and Custom Products

Multiple Locations: West (Idaho) East (Indiana)

May 19, 2017

Midwest Seed Coating

Step Sister to Summit Seed Coatings

Opened for Production July 1, 2018

Summit Seed Coatings Brands

- Apex
- Apex Plus
- Apex Hydroloc QS
- Apex Green – Organic OMRI
- Pinnacle
- Pinnacle Green
- Private Labels –Many

Forage Legumes

- Alfalfa
- Clovers
- Vetch
- Peas
- Trefoils

Cover Crops

- Being Coated or Potential
- Crimson Clover
- Radishes
- Annual Ryegrass
- Sun Hemp
- Peas
- Vetch

Warm Season Grasses

- Bermuda
- Centipede
- Carpetgrass
- Bahia

Cool Season Grass Seed

- Bent Grass
- Turf Fescue/ Fine , Creeper , Hard
- Perennial
- Orchard Grass
- Rye Grass
- Timothy
- Brome Grass

Organic Options

- Apex Green
- Surestand
- OMRI Listed for use
- Myco Seed Treatment
- Mycorhizze
- Micro-Nutrient
- Hydro Green Water Uptake Enhancer

Great Time to Be in Grass Coatings

- Low Inventories
- High Prices
- Consumer Demand
- New Technology and Enhancements
- Companies Committing Major Research Dollars

Oregon Grass production
Acres Declining

- Hazelnuts
- Blueberrys
- Grapes- Winery’s
- Blackberry’s
- Other crops
- Housing & Small Hobby Farms

Grass Seed Coatings
Growth & Expansion

- Steady growth last 15 years 3-5 %
- 2008 Scotts introduced in retail line
- Pennington , Barenburg & DLF Pick
- KY 31 Tractor Supply 2018
- More new seed treatments and enhancements last three years that last 30
- Large seed and Chemical companies bought in

Company Investments

- Big Chemical / Seed Companies
- Investment Over 3 Billion in Research and Aquireing
- Technology and Companies
- Expect a ROI\
- Do not want to be left Behind
- Yield and Plant Performance can be immediate
- Faster than Breeding process
- More Regulation??

New Technology

Equipment & Processes


CINTAS
First Aid Center

Rotary Blender

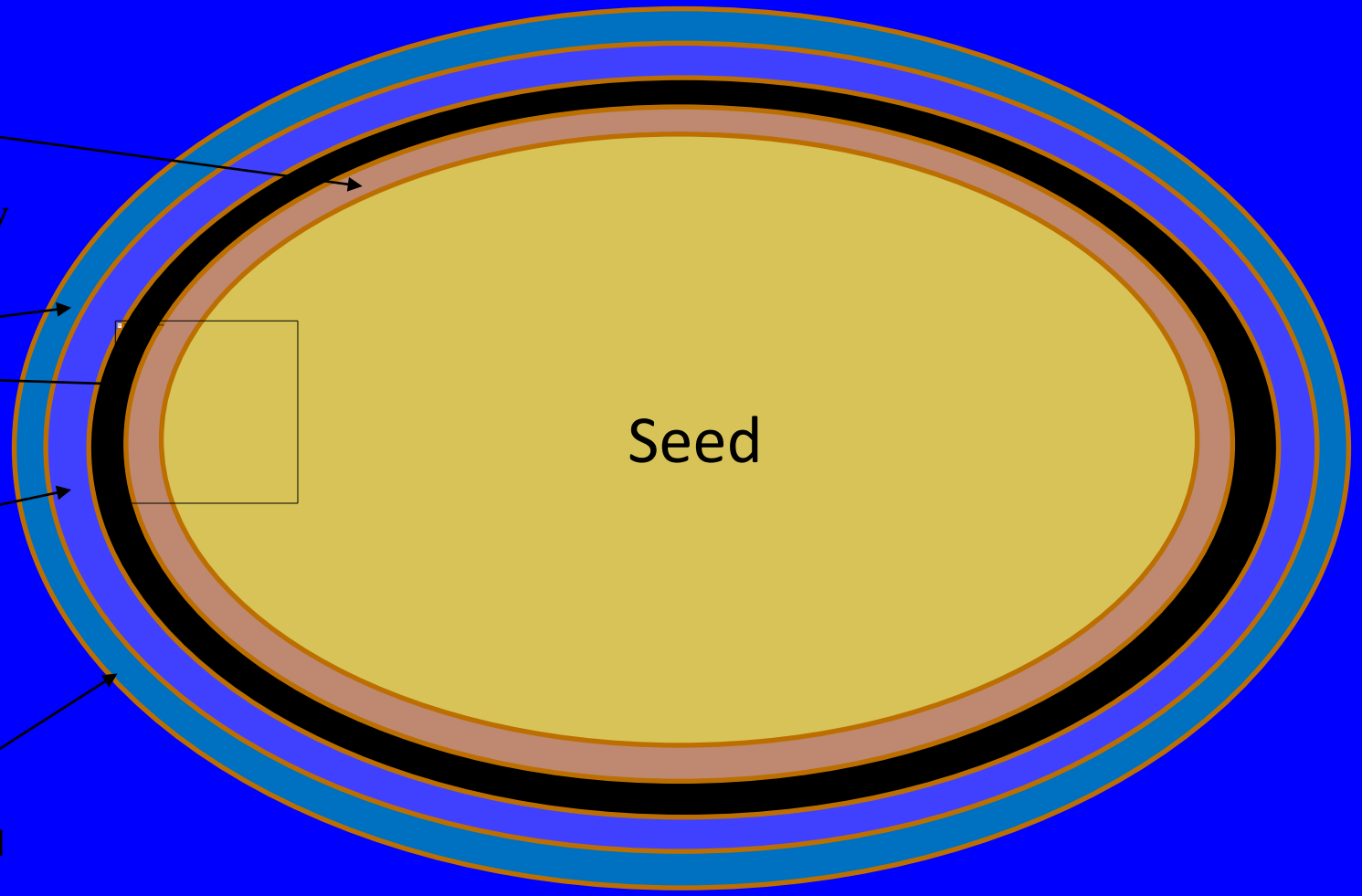

Oliver
Oliver
Oliver

Why Coat Seed Today?

- BECAUSE IT WORKS!!
  - Agronomically
  - Economically
- Technology Expansion
- Consumer Acceptance
- Limited Production Acres
- High Seed Cost

A Look Inside Coated Seed

- **Inoculant and Micronutrients**
  - Latest rhizobia strains available and Quick Start micro nutrients, close to the seed for easy absorption.
- **Hydration Component**
  - Hydroloc, 3X water holding capabilities that helps hold micros near the seed.
- **Fungicide/Insecticide**
  - Accurate placement away from seedling and rhizobium.
- **Coloring and low dust coated finish**
  - Apex or Pinnacle Coating, easy visualization and increased flowability through planting equipment.



DIFFERENT DENSITIES THROW DIFFERENT DISTANCES

Heavy Seed
Patent Pending

- Annual Rye Grass
- 4 to 1 Coating
- Spread 90 feet
- Standing Crops
- Seed gets to soil surface
- 8-10 pounds PLS
- Used Solo andwith Blends of Crimson and Radishes

New Technology Seed Coatings

Improved coatings

Value added Components

Many proprietary coatings

Screening Process for New Technology

- We do not try to invent sometimes we do
- Remarket a product under private label
- Corn Look at Grass first
- Soybean – Forage Legume
- Promising products are then cross checked
- In House Germinators Growth Chamber
- Contract Land Grant University Greenhouse and Field Trials

Fast Moving Technology

- AG is in Information Age Internet & Media
- Big investment from seed/chemical companies
- Technology is Changing much faster
- 1-3 years new products come online
- Less University testing
- Seed & Chemical companies doing their own testing
- Many products do not need EPA approval
- Companies want a unique product

Seed Enhancements/Seed Treatments

- Super Hydration Polymer/Components
- Micro Nutrients
- Mycorrhizae
- Fungicides
- Insecticides
- Biostimulants

BioStimulants & Biologicals

- Gillabrillic Acids
- Vitamin B-12
- Seaweed Extracts
- Plant Growth Hormones
- Plant Growth regulators

Quick Start (QS) Micro Nutrients

- Quick Start incorporates a unique micro-nutrient package to ensure the plants get off to a Quick Start. This package includes iron, zinc, and manganese that has proven to be beneficial to young seedlings such as grasses and legumes.

Biologicals

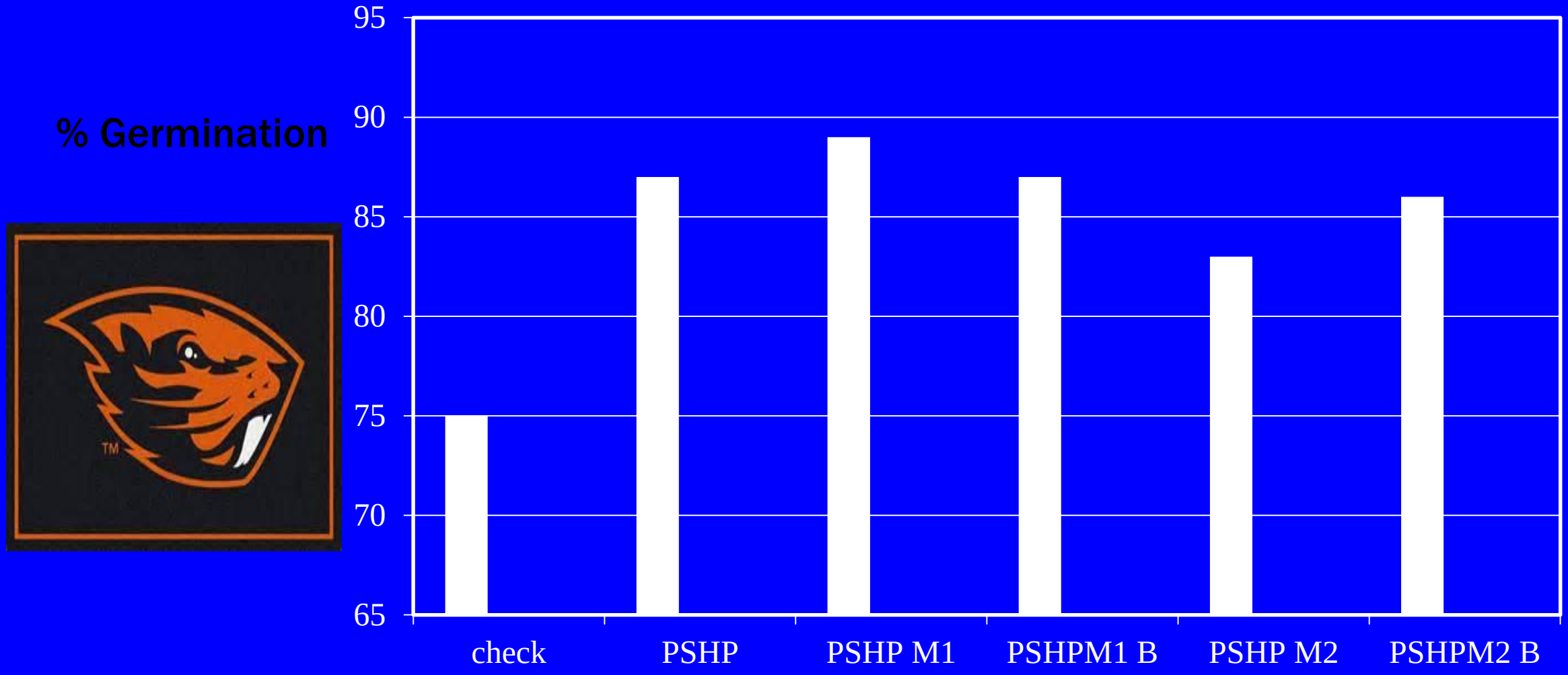
- BioPesticides – Regulated
- BioFertilizer - Regulated
- BioStimulants – Non regulated

Super Absorbent Polymers

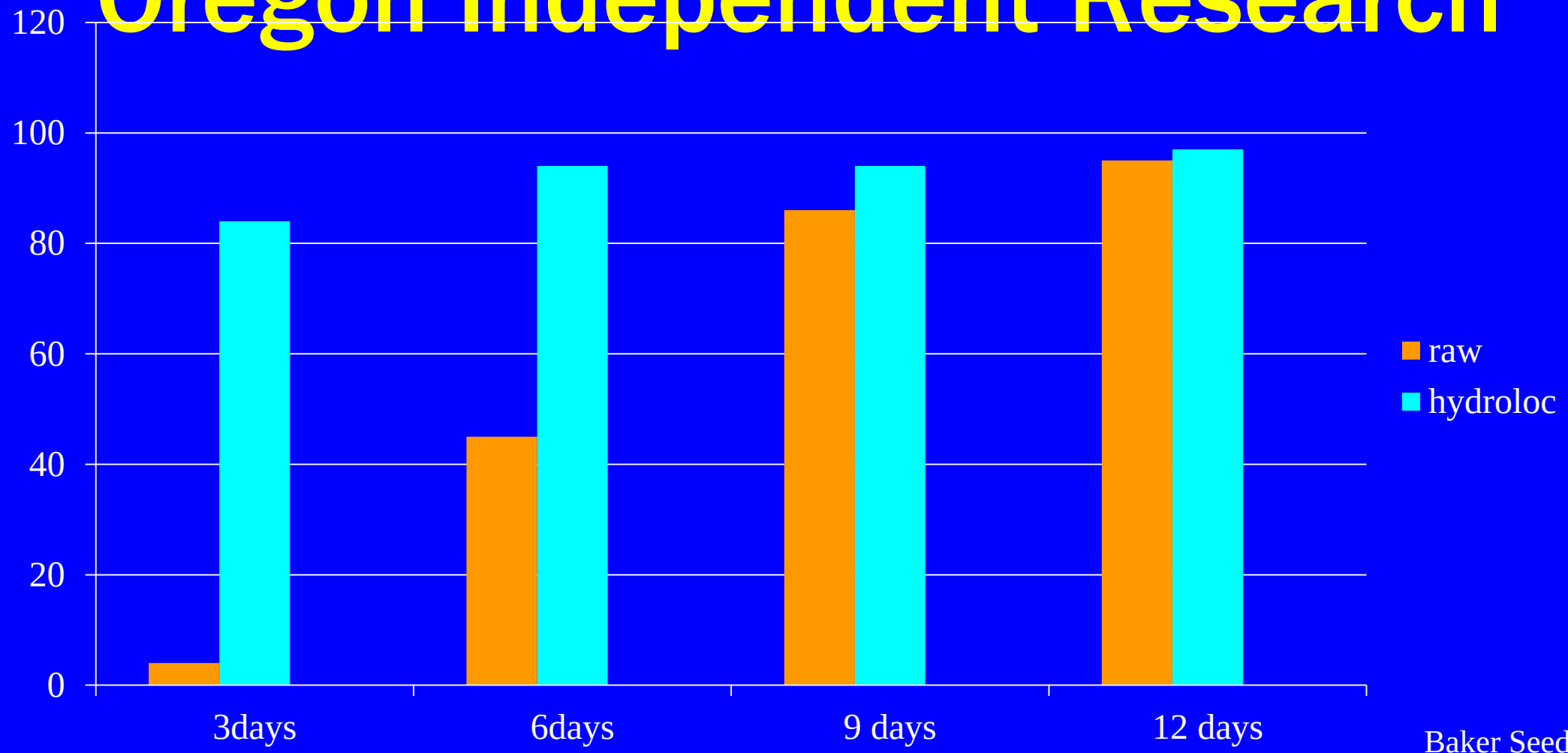
- Hydroloc Synthetic Polyacrylide
- Hydro Green Organic absorbent enhancer
- 2-3 X Moisture Absorption
- New Chemistry 10 X

Oregon State University

Germination Trial 2010



Tall Fescue Germination Rate
Oregon Independent Research

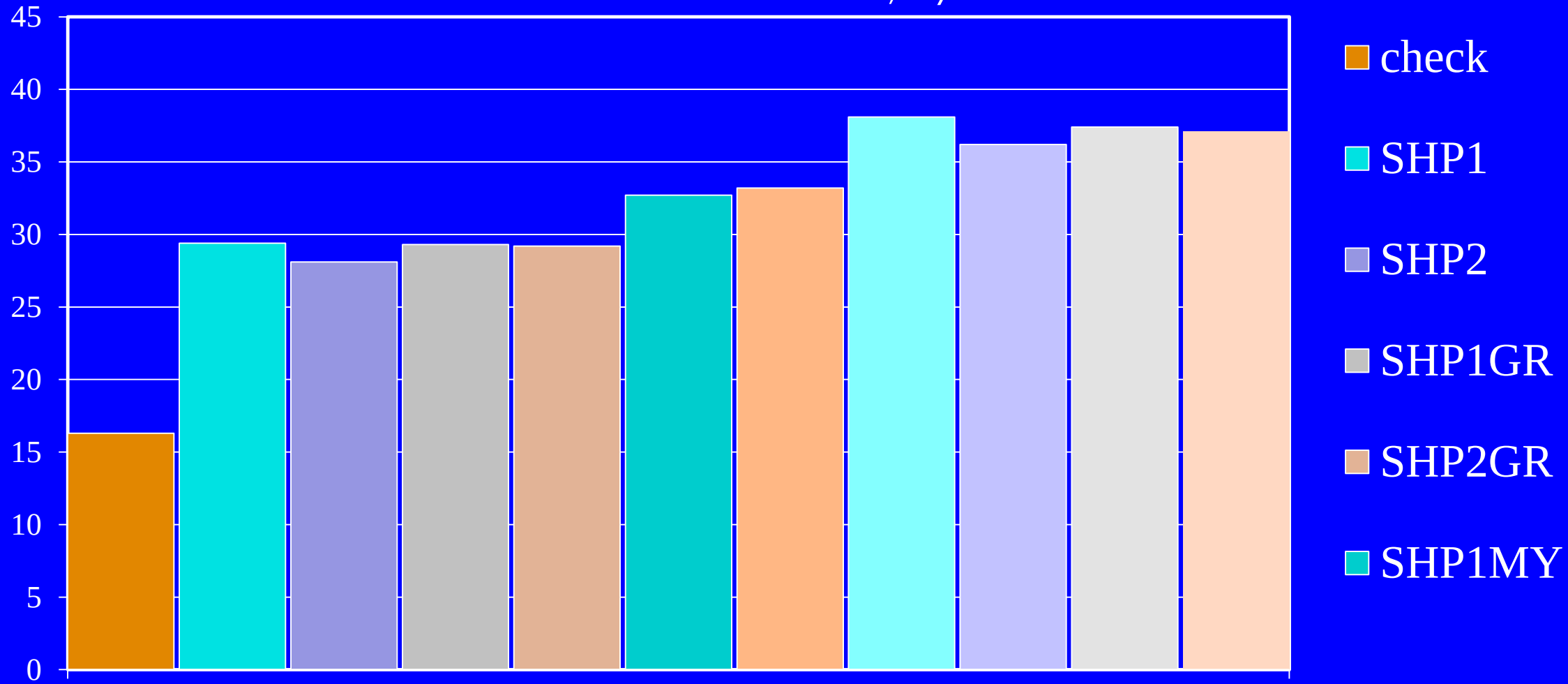


Baker Seed Technology
March 2016

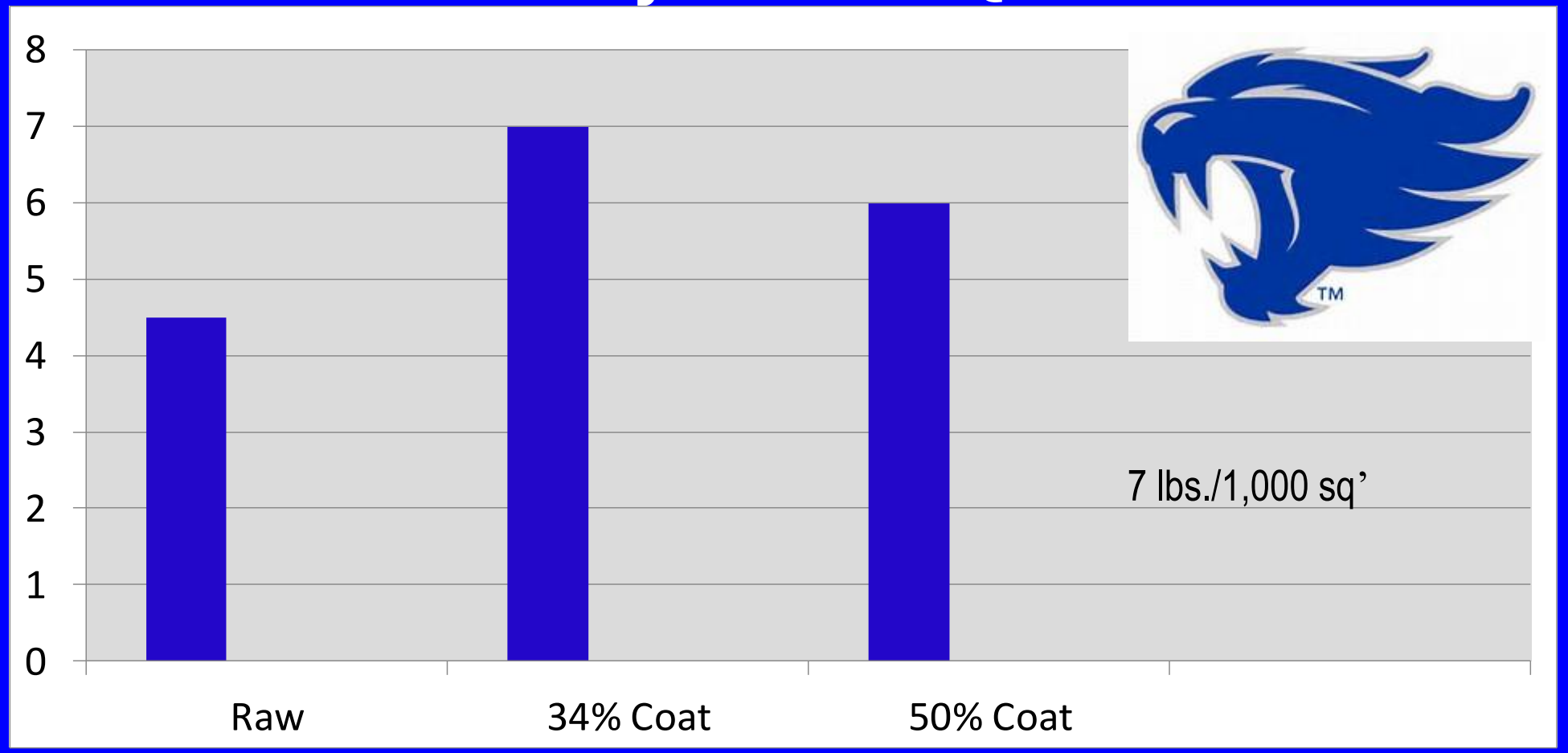
Oregon State University

Bluegrass Dry Matter Study

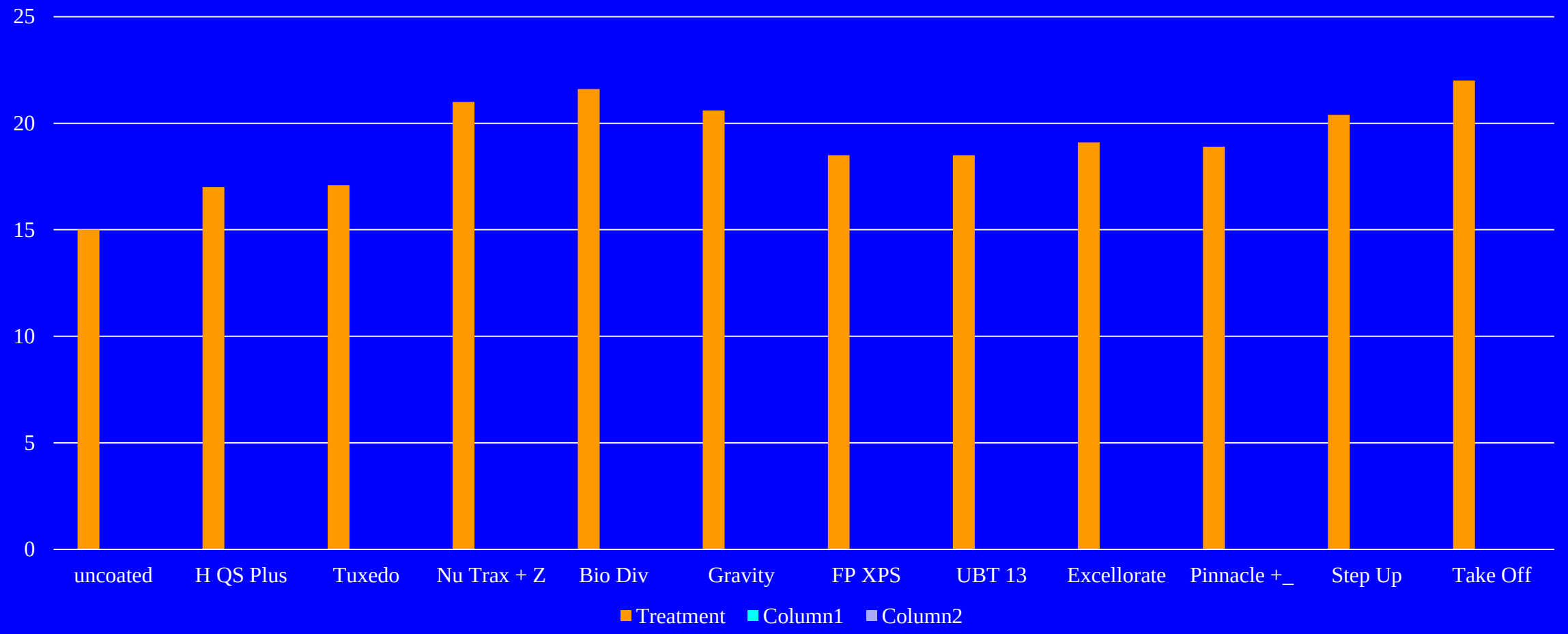
Raw vs. Coated, w/Seed Enhancements



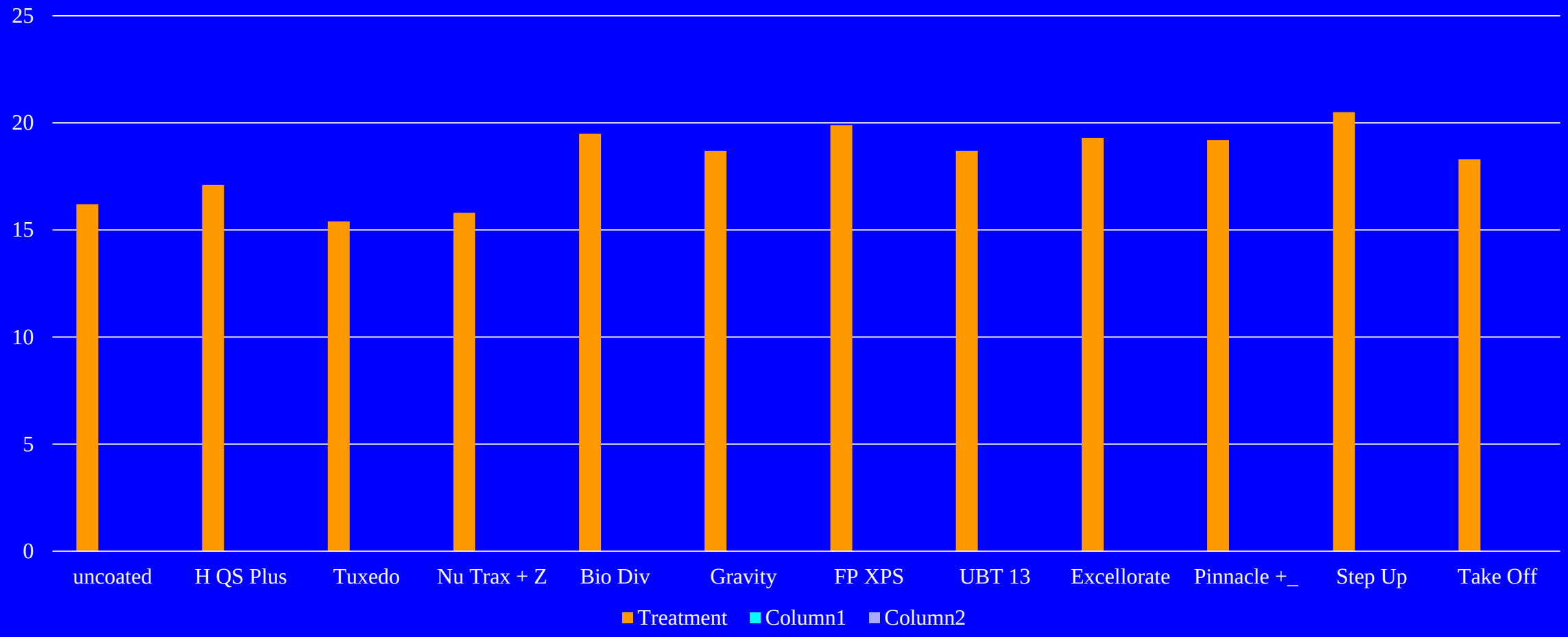
Turf Fescue University of KY Vigor & Cover: September Hydroloc QS



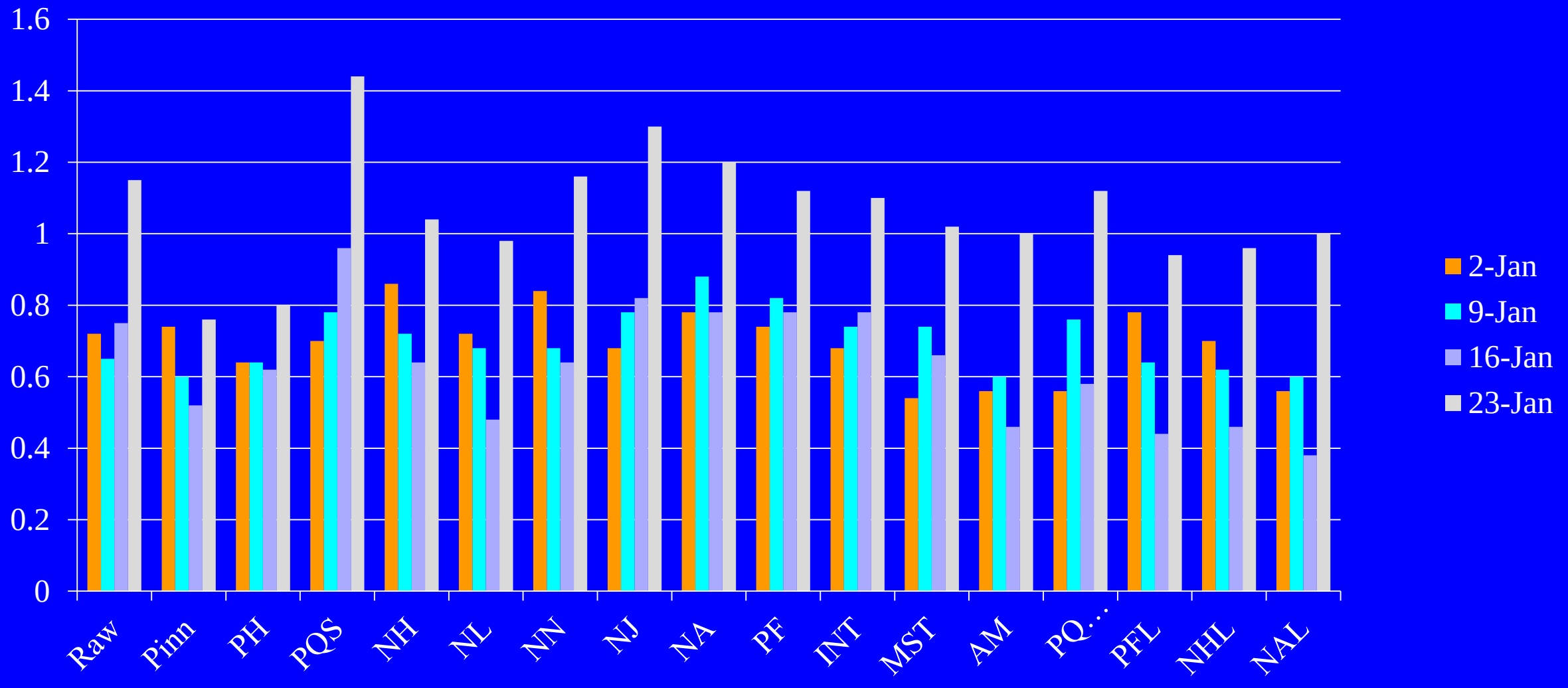
Oregon State University Turf Trial 2018
Optimal Water Dry Matter



Oregon State University Turf Trial 2018
Low Water Dry Matter



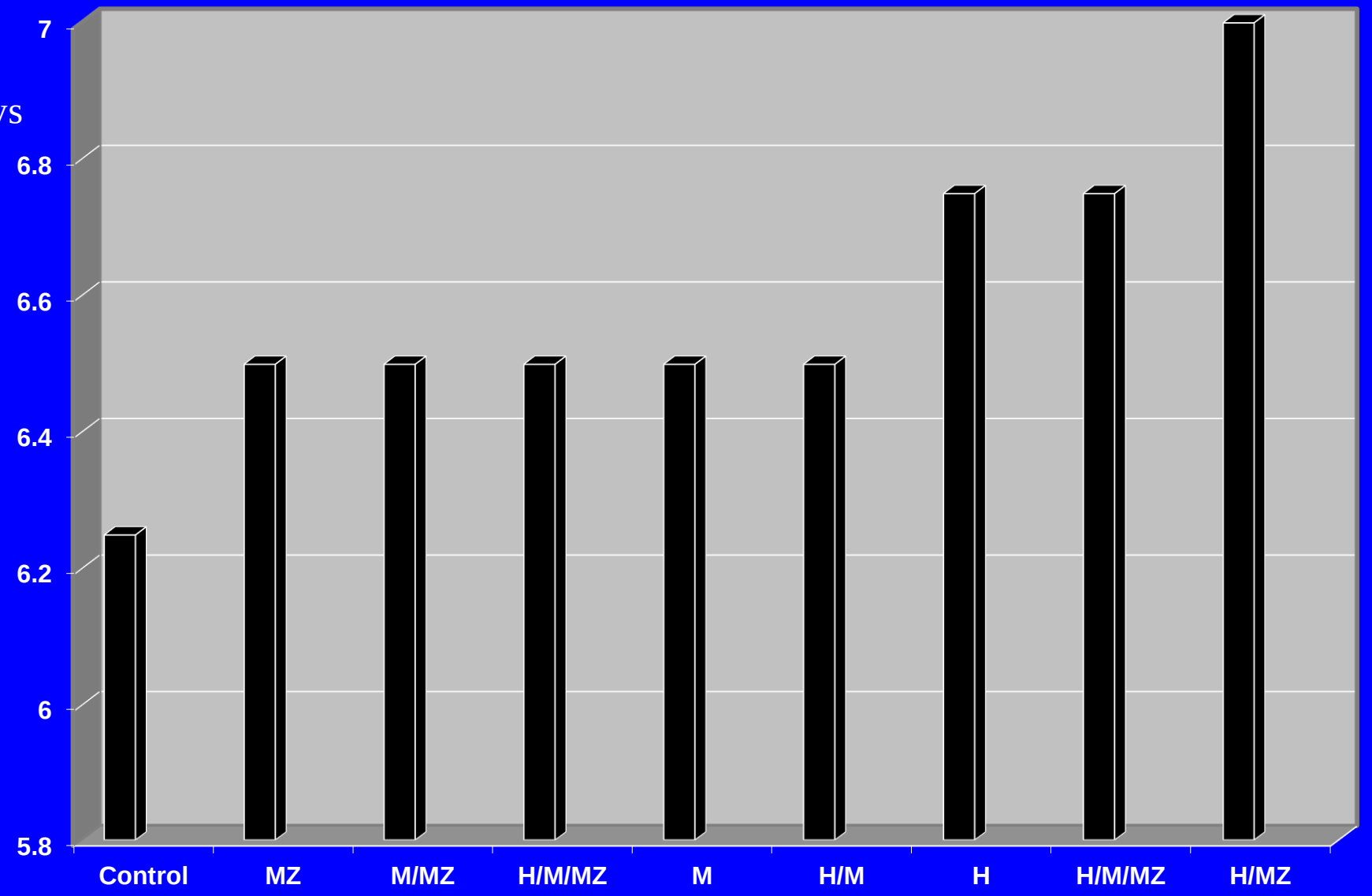
Turf Fescue Top Growth



University Of Wisconsin Coated Grass Seed Study

Quality Preliminary Results

LSD All-Pairwise Comparison 30 Days



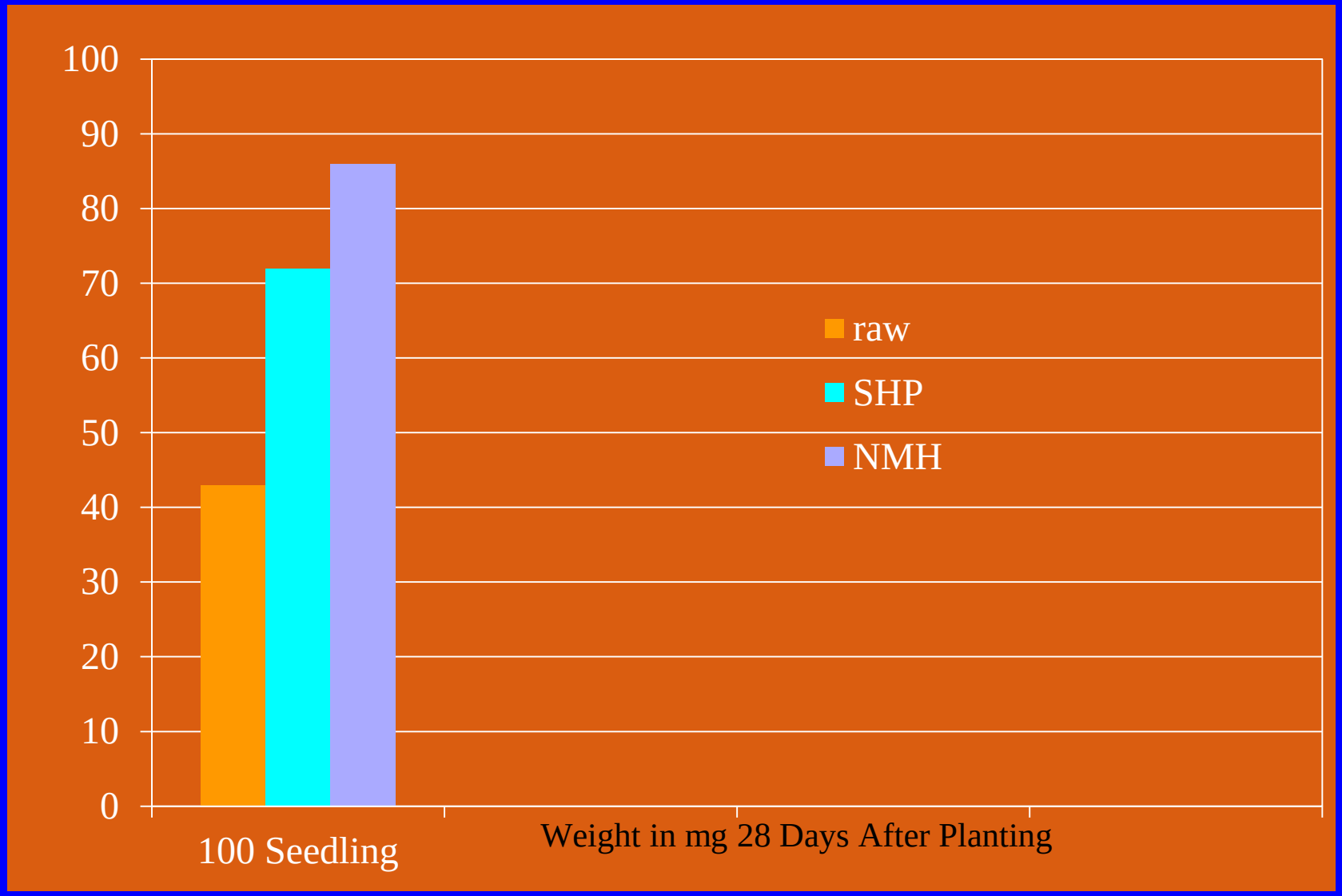
Super Absorbent Polymers

- Hydroloc Synthetic Polyacrylide and or Mineral Base
- Hydro Green Organic mineral only absorbent enhancer OMRI listed
- 2-3 X Moisture Absorption
- New Chemistry 10 X

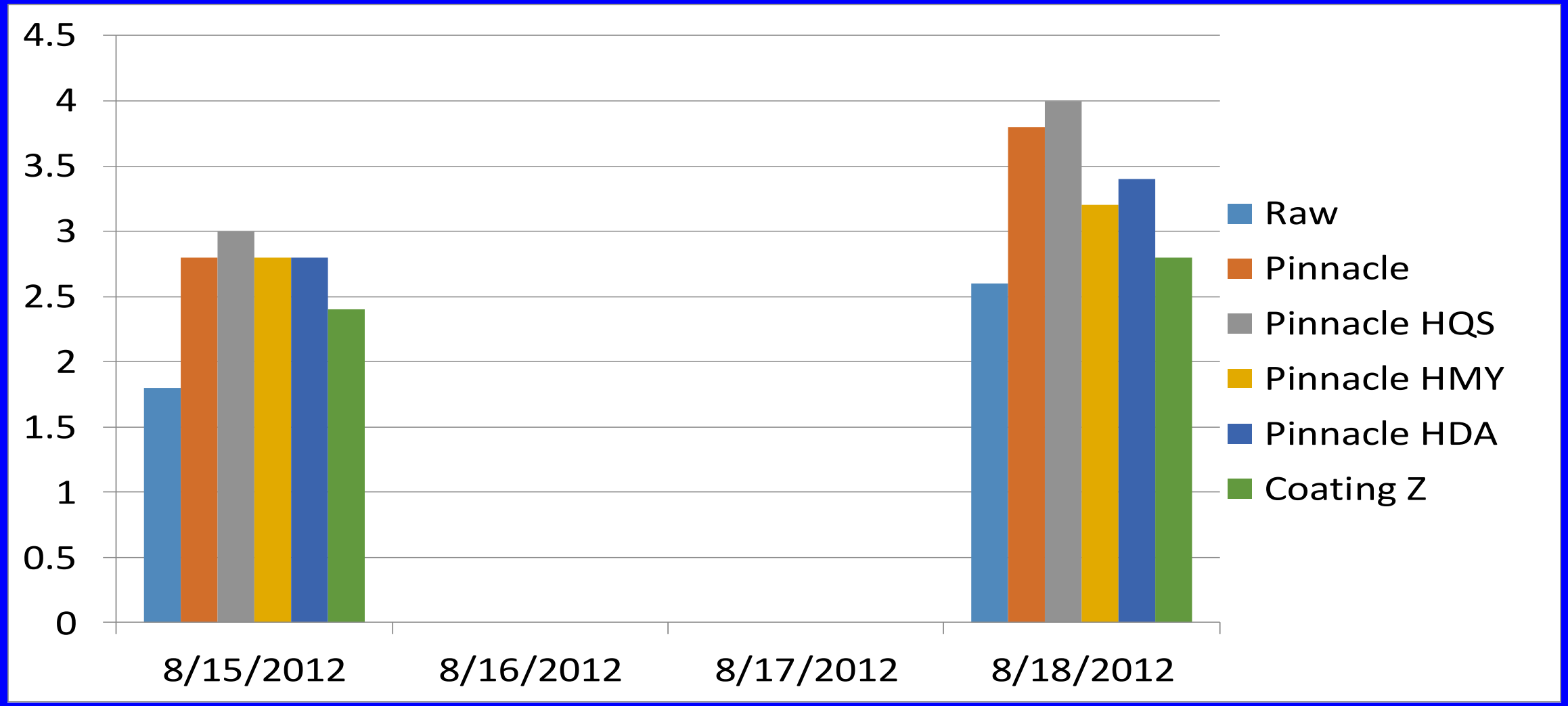
Oregon State University

SHP vs Natural Mineral Hydration (Hydroloc) 2014

Dry Matter Study



Seed Coating Study Turf Germination & Growth Oklahoma State University



Patent Applied New SHP

UP TO 20 X WATER HOLDING CAPACITY

WILL CYCLE BACK WET AND DRY

BIODEGRADABLE


20171122_145829
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Desktop
Links
9:09 AM
7/11/18

Benefits of Grass Seed Coating

- Achieves better seed to soil contact, less puddling
- Coating disguises seed from predation
- Colorant improves monitoring
- Seed larger and easier to handle
- Penetrates stubble and thatch (added weight)
- Better distribution when broadcast (60%)
- Encapsulates seed with formulated nutrients
- Additional micro's and seed enhancements
- Increases seedling survival (micro-environment)

Thanks for including us

Bill Talley
Ph 270-625-3345
billtalley@bellsouth.net

MSU 2018 SEED TECH

Future of Biological Stimulants and Microbials

Preentation By:
Tom Johnson
Changing Times, LLC

Some task are harder than you first thought!

Timeline

- My first Micronutrient trials - 1982
- My first Bio Stimulant trials – 1983
- My first Microbial trials – 1985
- First breakthrough Micronutrient product release – 1995 (TJ Micromix)
- Never did release a Bio Stimulant product
- First Breakthrough Microbial product release – 2004 (TJ QuickRoots)

Plant Hormones

- Plant Hormones products are real, but very difficult to manage
- Micronutrients are essential precursors for many Plant Hormones

Microbial Development Issues

- Microbe(s) must colonize on the surface of the seed, a hostile environment
- Environment must not change the growth patterns and metabolites of the organism
- Desirable to have the Radicle colonized first by the microbial seed treatment.
- Microbes must have a long survival time on seed to be commercially viable
- Microbe production must be predictable and stable.

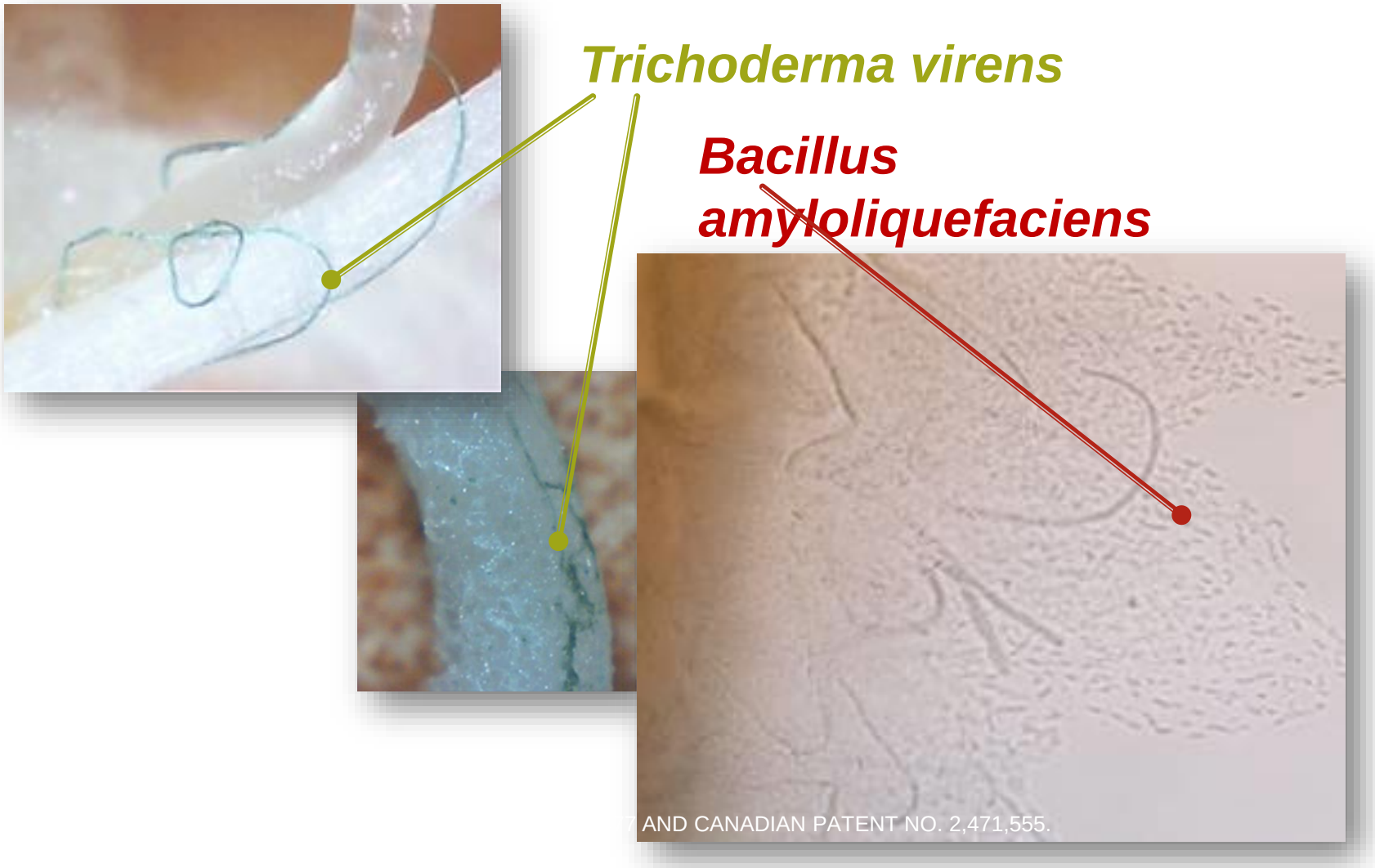
Quickly Colonizes

Microbes can be antagonistic to each other!

- The desire is to discover microbes that are synergistic.

Claim to Fame - QuickRoots!

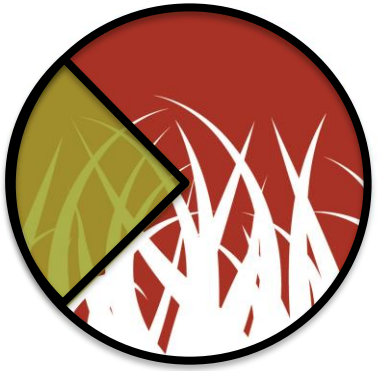
Two Live Microorganisms On the Root!



Fungi/Bacteria Ratios

TREES
Fungi dominant

GRAINS
Narrow ratio of bacteria to fungi



GRASSLANDS
Bacteria dominant

Microbes vs. Bio Stimulants

- Many different modes of action from Bio Stimulants
- May effect microbial growth, plant growth or both

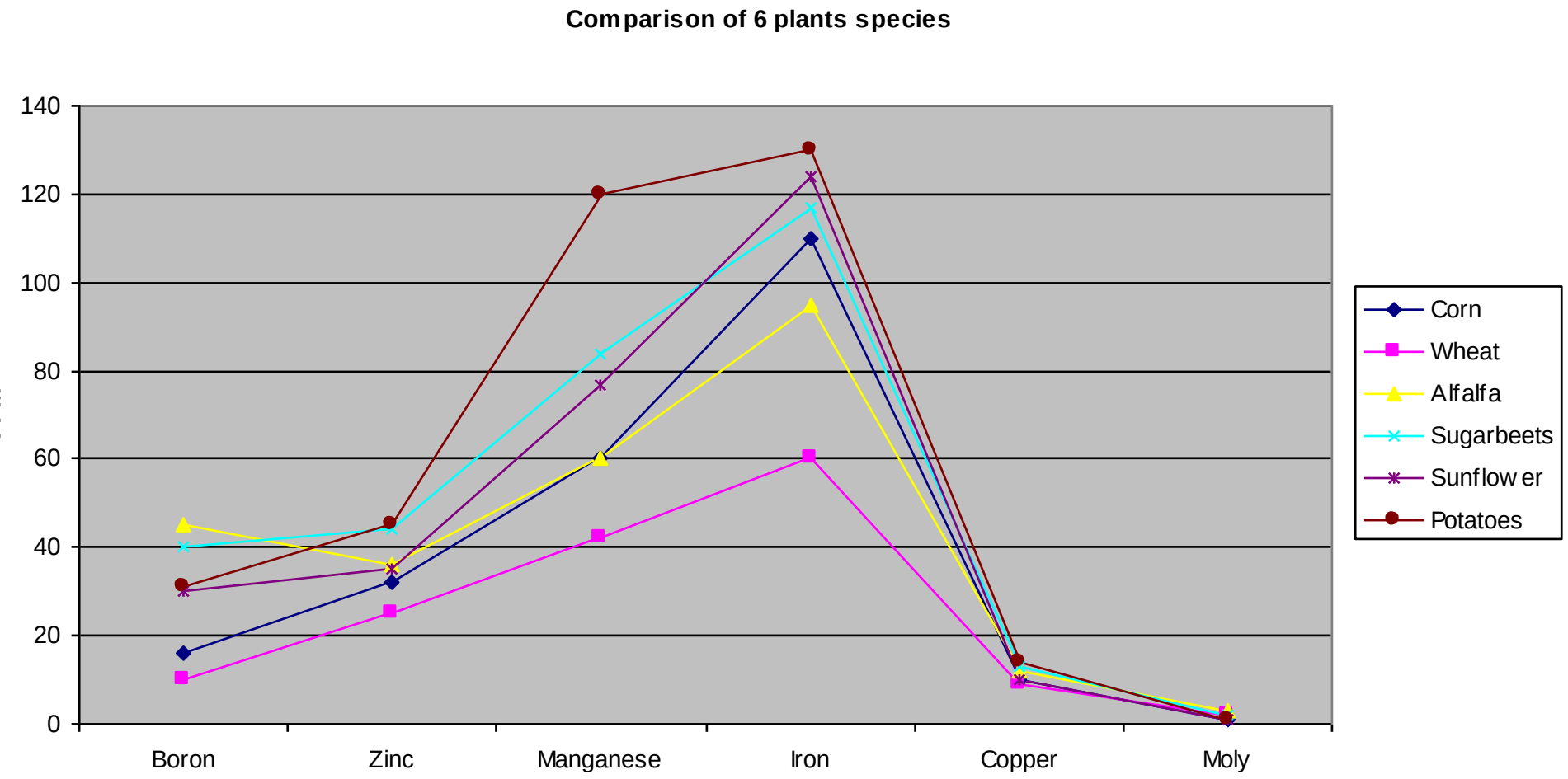
Microbes need Nitrogen and Carbon

- Microbes also need a balance of secondary nutrients and micronutrients
- The balance they need is very similar to what the plants need
- Microbes in the soil will always eat first – They can starve the plant to get what they need.
- Therefore, proper plant fertilization is essential to proper microbial function.

Plants Need Nitrogen and Carbon Also!

- But, Plants get there Carbon mostly from Carbon Dioxide – Above Ground
- Plants need Oxygen below below Ground
- Bio Stimulants can boost Photosynthesis, Stimulate Microbes, Create Synergies, and Enhance Nutrient Intake

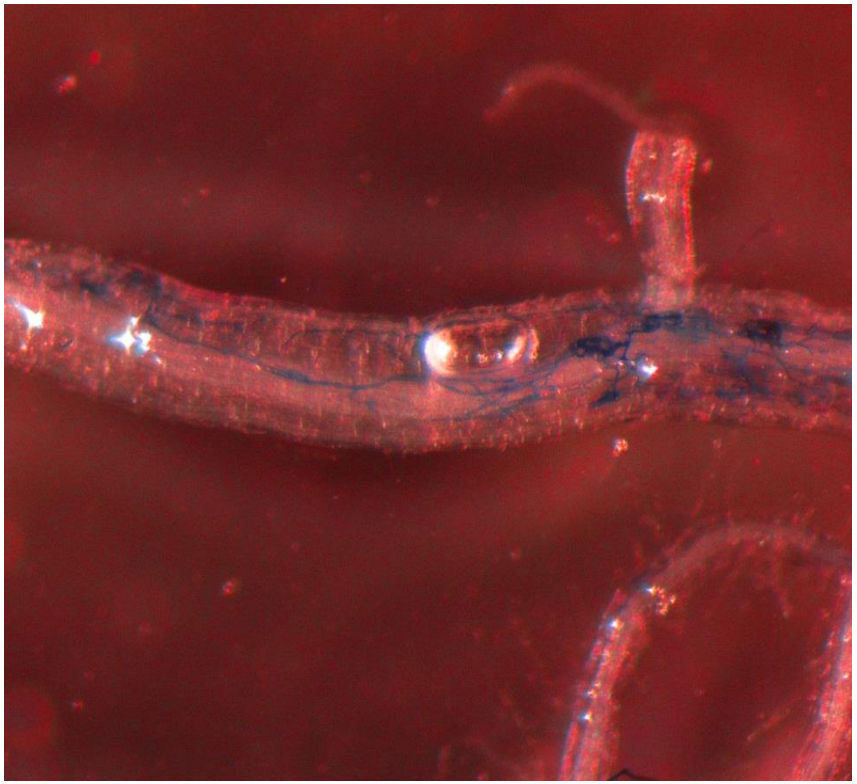
Micronutrients are Essential



Microbes and nutrients have two separate target functions

- Assist Plant Growth
- Facilitate Soil Health
- Each can do both, but the management of Soil Health is very different from Plant Growth!

Mycorrhizal Are Soil Builders and Nutrient Transport



- Form symbiosis with 80% of plant species which
  - Increases nutrient availability and uptake
  - Enhances water uptake
  - Long-term soil building

Microbial impact on Soil

Solving Carbon to Nitrogen Ratio Problems

- Corn Stover – apply 1 pound of N for every 100 pounds of dry matter added to the soil
- Wheat Straw – apply 1.5 pounds of N for ever 100 pounds of dry matter added to the soil
- The soil microbes will use the N and keep it from the plant – so you must pay attention to the C:N ratios

Don't let the situation confuse you...

The Future of Microbials and Bio Stimulants

- There will be a continued clear divide between Soil Health and Plant Growth Products.
- Plant Growth product will become more and more precision applied not less.
- Better, Faster and More Accurate plant analysis will develop to facilitate precision
- Soil Health Products will routinely become part of the soil fertility management.

Check

Total Jackpot Micromix

The goal is maximum health for plants

We Strive to keep ALL The Customers are Very Happy!

Seed Treatment Products

Safe Use, Handling, and Environmental Stewardship

Gene Merkl, Program Manager
Pesticide Safety Education Program (PSEP)
(662) 325-5829
gm53@msstate.edu

MISSISSIPPI STATE UNIVERSITY™
EXTENSION

Seed Treatment Products

Safe Use, Handling, and Environmental Stewardship

MSU Seed Technology Short Course

Recertification Credits

Category 10 – Demonstration and Research

Category 4 – Seed Treatment

MISSISSIPPI STATE UNIVERSITY™ EXTENSION

Seed Treatment Products

Safe Use, Handling, and Environmental Stewardship

MISSISSIPPI STATE UNIVERSITY™ EXTENSION

MISSISSIPPI PSEP PESTICIDE SAFETY EDUCATION PROGRAM

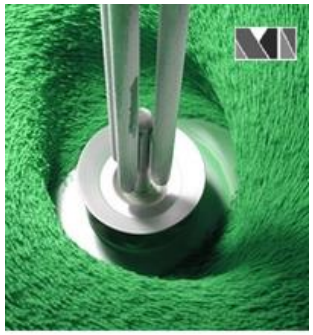
Now offering Online Recertification in limited categories

- **I (A) – Agricultural Pest Control (Plant)**
- **II – Forest Pest Control**
- **III – Ornamental & Turf Pest Control**
- **VI – Right-of-Way Pest Control**
- **VII (A) – Industrial, Institutional, Structural & Health-related Pest Control**
- **VII (3) – Industrial Weed Control**
- **X – Demonstration & Research Pest Control**

Seed Treatment Products

Global Market at a Glance

- 2017 global market $5.1 billion
- From 2008–2013, increased tonnage from 5,400 to 9,600
- Projected to be $11.31 billion by 2022
- North America dominates use (39.7%) in the world market
- U.S. market $2.02 billion in sales 2017; 76% of N. American market
- Projected cumulative annual growth rate (CAGR) 10%



https://www.mordorintelligence.com/industry-reports/seed-treatment-market

Seed Treatment Products

Trends in Use

- 2016 – insecticides 56%, fungicides 24%, nematicides 20% of market revenue
- Globally, 60% of seed treatment market is insecticides or combo of insecticides/fungicides
- Only 30% of acreage planted with treated seed
- Major market players
  - Adama Ag Solutions, Valent Biosciences
  - BASF, Bayer, Bioworks, and Syngenta

https://www.mordorintelligence.com/industry-reports/seed-treatment-market

Safety Perspective

Asking the Right Questions

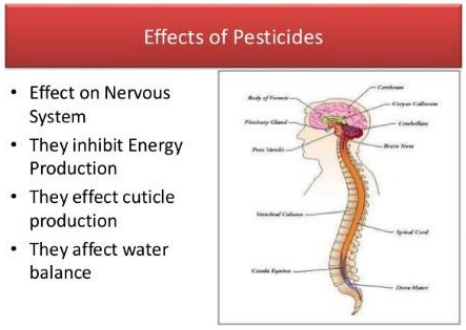
- Does increased product use = increased exposure?
- Does benefit outweigh risk of increased exposure for:
  - seed producers?
  - applicators?
  - the ag producer?
  - the environment?

Safety Perspective

Asking the Right Questions

What are the potential health risks?

- Skin and eye irritation
- Skin sensitization—allergic response to a substance after skin contact
- Toxic effects to nervous system/other organs and systems

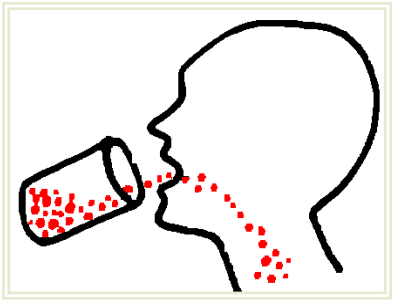


Safety Perspective

Asking the Right Questions

What are the chemical exposure pathways?

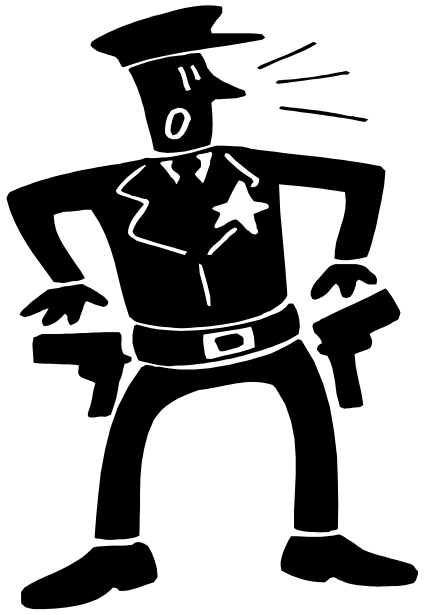
- Inhalation of dusts or mists
- Skin absorption
- Ingestion



Safety Perspective

Where to Find the Right Answers

- Product label
  - By the way, it's the law
- Safety data sheet (SDS)
  - Engineering controls
  - Occupational exposure levels (OELs)
  - Ventilation/monitoring requirements

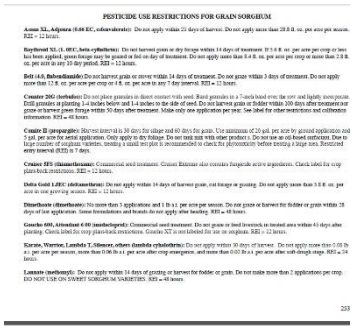


Safety Perspective

Where to Find the Right Answers

Product label

- Signal word and warning language
- Dictated by EPA risk assessment
- Simplified instructions, minimal detail
- Intended audience
  - Seed treaters **(Non-ag Use)**
  - Applicators (planters) of treated seed **(Ag Use)**



PESTICIDE USE RESTRICTIONS FOR GRAIN SORGHUM

Acuon XL, Adjuvo (0.66 EC, celaviaretic): Do not apply within 21 days of harvest. Do not apply more than 28.8 fl. oz. per acre per season. REI = 12 hours.

Baythroid XL (1. OEC, beta-cyfluthrin): Do not harvest grain or dry forage within 14 days of treatment. If 5.8 fl. oz. per acre per crop or less has been applied, green forage may be grazed or fed on day of treatment. Do not apply more than 8.4 fl. oz. per acre per crop or more than 2.8 fl. oz. per acre in any 14 day period. REI = 12 hours.

Belt (4.0, flubendiamide): Do not harvest grain or stover within 14 days of treatment. Do not graze within 3 days of treatment. Do not apply more than 12 fl. oz. per acre per crop or 4 fl. oz. per acre in any 7 day interval. REI = 12 hours.

Counter 20G (terbufos): Do not place granules in direct contact with seed. Band granules in a 7-inch band over the row and lightly incorporate. Drill granules at planting 1-4 inches below and 1-4 inches to the side of seed. Do not harvest grain or fodder within 100 days after treatment nor graze or harvest green forage within 50 days after treatment. Make only one application per year. See label for other restrictions and cultivation information. REI = 48 hours.

Counter II (propargite): Shortest interval is 30 days for silage and 60 days for grain. Use minimum of 20 gal. per acre by ground applications and 5 gal. per acre for aerial application. Only apply to dry foliage. Do not tank mix with other product s. Do not use as oil-based surfactant. Due to large number of sorghum varieties, treating a small test plot is recommended to check for phytotoxicity before treating a large area. Restricted entry interval (REI) is 7 days.

Cruiser 5FS (thiamethoxam): Commercial seed treatment. Cruiser Extreme also contains fungicide active ingredients. Check label for crop plant-back restrictions. REI = 12 hours.

Delta Gold 1.5EC (deltamethrin): Do not apply within 14 days of harvest grain, cut forage or grazing. Do not apply more than 3.8 fl. oz. per acre in one growing season. REI = 12 hours.

Diuethoate (dimethoate): No more than 3 applications and 1 lb a.i. per acre per season. Do not graze or harvest for fodder or grain within 28 days of last application. Some formulations and brands do not apply after heading. REI = 48 hours.

Gaucho 600, Attendant 4.00 (imidacloprid): Commercial seed treatment. Do not use grain or feed livestock in treated area within 45 days after planting. Check label for crop plant-back restrictions. Gaucho XT is not labeled for use on sorghum. REI = 12 hours.

Karate, Warrior, Lambda T, Silencer, others (lambda cyhalothrin): Do not apply within 30 days of harvest. Do not apply more than 0.16 lb a.i. per acre per season, more than 0.96 lb a.i. per acre after crop emergence, and more than 0.02 lb a.i. per acre after soft-dough stage. REI = 24 hours.

Lannate (methomyl): Do not apply within 14 days of grazing or harvest for fodder or grain. Do not make more than 2 applications per crop. DO NOT USE ON SWEET SORGHUM VARIETIES. REI = 48 hours.

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GRAIN SORGHUM INSECT CONTROL (continued)

PESTICIDE USE RESTRICTIONS FOR GRAIN SORGHUM cont.)

Lorsban, Chlorfos, Chlorpyrifos, others 4E (chlorpyrifos): Do not apply more than a total of 3 pt. per acre per crop. Do not graze treated crop or harvest for fodder within 30 days of last application of 1 pt. per acre, or 60 days of rates greater than 1 pt. per acre. Do not treat drought stressed sorghum within 21 hours of a rain. DO NOT USE ON SWEET SORGHUM VARIETIES. REI = 24 hours.

Mustang MAX, Respect (0.8E) (zeta-cypermethrin): Do not apply more than 21.5 fl. oz. per acre per season. Do not make applications less than 10 days apart. Do not apply within 14 days of harvest for grain and stover or within 45 days for forage. REI = 12 hours.

Declare, Proaxis (gamma cyhalothrin): Do not apply within 30 days of harvest. Do not apply more than 0.04 lb a.i. per acre per season, more than 0.03 lb a.i. per acre after crop emergence, and more than 0.03 lb a.i. per acre after soft-dough stage. REI = 24 hours.

Seven XLR Plus, 4F, Carbaryl ch (carbaryl): Do not apply within 21 days of harvest or within 14 days of grazing of harvest for forage or silage. Do not apply more than 6 qt per acre per year. REI = 12 hours.

Tracer 480 (spinosad): Do not apply within 7 days of grain or fodder harvest or within 14 days of grazing forage harvest. No grazing interval but do not allow cattle to graze treated area until spray has dried. REI = 4 hours.

Tombstone (2-6, cyhalothrin): Do not harvest grain within 14 days of treatment. Do not apply more than 0.4 fl. oz. per acre per crop or more than 2.8 fl. oz. per acre in any 30 day period. REI = 12 hours.

Safety Perspective

Agricultural Use Requirements - Gaucho 600

Note: 12-hour Restricted Entry Interval (REI)

PPE required for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil, or water, is: **coveralls, chemical resistant gloves, shoes plus socks, protective eyewear.**

Safety Perspective

Non-Agricultural Use Requirements - Gaucho 600

PERSONAL PROTECTIVE EQUIPMENT (PPE)

Some materials that are **chemical-resistant** to this product are listed below. If you want more options, follow the instructions **for category C** on an EPA chemical resistance category selection chart.

Applicators and other handlers must wear: Long-sleeved shirt and long pants, socks and shoes and chemical-resistant gloves (such as nitrile, butyl, neoprene, barrier laminate, polyvinyl chloride or Viton). Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

For use in commercial seed treaters only, with the exception of application to canola, cotton (de-linted seed), field corn, sorghum, millet, wheat and barley, which may be made either by commercial seed treatment or as an end-use seed treatment on agricultural establishments at, or immediately before, planting. This product is to be used in **liquid or slurry treaters**.

Safety Perspective

Non-Agricultural Use Label Requirements vs. Agricultural Use Label Requirements

- *Always make the distinction between Ag Use and Non-ag use*
- *PPE requirements are usually different/more stringent in Ag Use*
- *Seed treatment is considered to be application but is a Non-ag use because no crop is being produced.*

Safety Perspective

Where to Find the Right Answers

Safety Data Sheet

- Detailed hazard information
- Worker protection, emergency medical response, spill clean up, transportation, and disposal
- **SDS intended audience** = manufacturers, formulators, emergency responders, and HSE (health, safety and environmental) personnel

MATERIAL SAFETY DATA SHEET

Bayer CropScience

Date of Issue: 20 March 2008

1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER

Product name	**Gaucho® 600 Flowable Seed Dressing Insecticide**
Other names	None
Product code	4953311 (20 L), 4953303 (175 L), 6528805 (1000 L)
Chemical group	Chloronicotinyl
Recommended use	Agricultural insecticide used as a seed treatment
Formulation	Flowable concentrate for seed treatment (FS)
Supplier	Bayer CropScience Pty Ltd ABN 87 000 226 022
Address	391 - 393 Tooronga Road, East Hawthorn Victoria 3123, Australia
Telephone	(03) 9248 6888
Facsimile	(03) 9248 6800
Website	www.bayercropscience.com.au
Contact	Development Manager (03) 9248 6888
Emergency Telephone Number	1800 033 111 – Orica SH&E Shared Services

2. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW
HAZARDOUS SUBSTANCE (see Risk phrases below) – DANGEROUS GOOD

Hazard classification	Hazardous (National Occupational Health and Safety Commission - NOHSC)
Risk phrases	R22 – Harmful if swallowed. R43 – May cause sensitisation by skin contact.
Safety phrases	See Sections 4, 5, 6, 7, 8, 10, 12, 13
ADG classification	Classified as a "Dangerous good" for transport by road or rail according to the Australian Code for the Transport of Dangerous Goods by Road and Rail: PESTICIDE, LIQUID, TOXIC, N.O.S. (contains imidacloprid), Division 6.1, UN 2902, Packing Group III.
SUSDP classification	Schedule 6 (Standard for the Uniform Scheduling of Drugs and Poisons)

3. COMPOSITION / INFORMATION ON INGREDIENTS

Ingredients	CAS Number	Concentration (g/L)
Imidacloprid	[138261-41-3]	600
Glycerin	[56-81-5]	124
Propane-1,2-diol	[57-55-6]	7 to 17
Isothiazolone	[55965-84-9]	~ 0.02
Other ingredients, including emulsifiers, stabilisers and water	Non-hazardous	~ 499

Remember…..The Label is the Law

Safety Perspective

EPA Risk Assessment Concepts-Risk Aversion Protocols

- Label-required PPE based on signal word & chemical characteristics
- Concepts rely primarily on PPE—limited engineering controls
- Typically overprotective—PPE variably effective
- Rules apply to entire industry, regardless of specific exposure conditions
- Result in conservative control requirements
- Simple to follow, but inflexible—easier said than done

Safety Perspective

Following the Guidelines

From the risk assessment concepts come safety guidelines for:

- manufacture,
- handling and storage,
- transport,
- use, and
- disposal of treated seed products

Safety Perspective

Following the Guidelines

From the guidelines we determine the best management practices to:

- reduce exposure to personnel
- reduce agricultural chemicals in the environment
- reduce environmental impacts to pollinators and non-target organisms

Safety Guidelines – Manufacturing

Four Elements of Focus

1. Engineering controls
   - Prevent chemical release
   - Build protections into the process
2. Work practices
   - Minimize contamination in normal work tasks
3. Personal hygiene controls
   - Reduce accidental transfer to personnel, food, etc.
4. Personal protective equipment
   - Utilize as an additional protective measure

Safety Guidelines – Manufacturing

Engineering Controls

To reduce exposure in chemical mixing and treatment operations:

- maintain “closed” chemical transfer system
- keep treating equipment closed to prevent escape of mist or dust
- address leaks or spills immediately to minimize clean up and prevent prolonged exposure

Safety Guidelines – Manufacturing

Engineering Controls

Dust control – the monster in the room

- Effective dust control requires containment and local exhaust ventilation, filtration systems
- Dust reduction is the primary goal in managing seed treatment exposure

Safety Guidelines – Manufacturing

Engineering Controls

Implement dust reduction at:

- treating equipment
- conveyor transfer points, belts, screens
- bagging stations

and when:

- dumping back treated seed
- manually transferring treated seed

Safety Guidelines – Manufacturing

Work Practices

When operating treatment equipment

- Keep equipment closed when operating to prevent splashes
- Use care in opening mixing vats and observing operations
- Wear proper PPE to protect eyes and body
- Clean up spills promptly to minimize dust contamination
- Clean tools after use to prevent transfer of treatment residues to other equipment

Safety Guidelines – Manufacturing

Work Practices

When handling freshly treated seed remember:

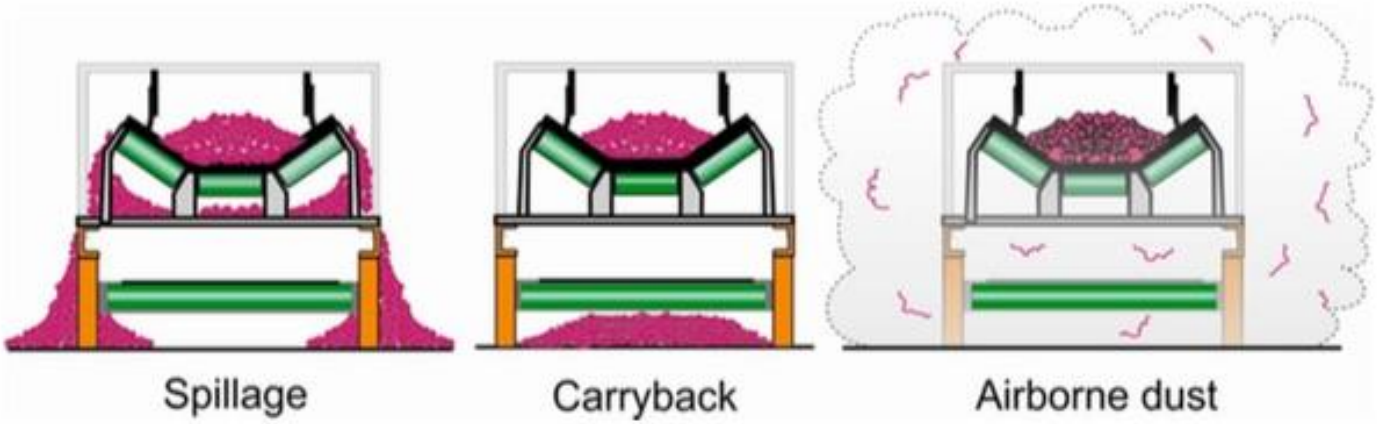
- Damp, **freshly treated seeds** present a **minimal exposure hazard**
- But always wear PPE according to the label

Safety Guidelines – Manufacturing

Work Practices

When handling freshly treated seed:

- Identify leaks in transfer equipment and repair them promptly
- Clean up spilled seed promptly to minimize slipping hazards and work area contamination



Safety Guidelines – Manufacturing

Work Practices

When bagging/dumping back treated seed remember:

- Dumping back dry treated seed requires careful work practices to control exposure
- Handle empty bags carefully and place them in disposal bags immediately after emptying
- Wear respirator and protective clothing as required by the label

Safety Guidelines – Manufacturing

Work Practices

When performing maintenance:

- Minimize use of compressed air to clean equipment and dislodge seed—compressed air spreads dust
- Minimize sweeping—it spreads dust, too
- Use HEPA filter vacuum cleaning equipment as much as possible
- Clean tools immediately after use to prevent contamination of other equipment and transfer to hands, etc.
- Wear appropriate PPE—follow the label

Safety Guidelines – Manufacturing

Personal Hygiene

- Restrict eating, drinking and smoking
- Provide suitable washing and clean-up facilities
- Require workers to clean up before leaving work
- Utilize specific work clothes or uniforms and dedicated work shoes
- Don't take chemicals home!

Safety Guidelines – Manufacturing

Personal Protective Equipment (PPE)

- Follow EPA label precautions at a minimum
- Label requirements can change—read frequently
- Conduct a risk assessment to determine additional PPE requirements
- Train workers how to use and maintain PPE
- Site respirator programs must meet OSHA standards (including: written program, medical certification, training, fit testing)
- Review program effectiveness—amend as needed

Safety Guidelines – Manufacturing

Summary

- **Good chemical management practices** are paramount for safe seed treatment processes
- **Investments in worker safety** will ensure protection and provide confidence for handling a wide range of products
- **Increased worker awareness** is the key to personal protection, and thus safety
- **Tighter workplace exposure controls** reduce the potential for contamination
- **Improved enforcement of PPE and personal hygiene rules** helps to ensure the safety of the workforce

Safety Guidelines – Handling

Three Elements of Focus

1. Conveyance and delivery – as dust free as possible
   - Ensure that belts, conveyors, bagging equipment, and palletizing systems are operating properly
   - Check for "leaks" and residue on equipment
   - Collect waste and store it for disposal
2. Personal protective equipment (PPE)
   - Wear in conveying operations and clean up
3. Spill prevention and clean up
   - HAVE A PLAN – failing to plan is planning to fail

Safety Guidelines – Storage

- Storage environment
  - What are label requirements for raw materials and finished products?
  - Are Temperature control and/or humidity critical?
- Security considerations
  - Controlled access – **Keep out bad actors!**
  - Emergency access plan – **Fire or storm event?**
  - Inventory maintenance – **Know what's on hand!**

Safety Guidelines – Storage

- Inventory and posting
  - Update stored inventory daily
  - Post on exterior of each storage area
- Spill preparedness
  - Spill kit in separate area from storage
  - Train employees in emergency spill procedures.

Safety Guidelines – Transport

Three areas of regulatory concern:

- Common carriers must follow USDOT requirements for hazardous material (based on hazard class)
- Transport from storage to field use—ag producers
- Transport from dealer to storage—ag producers

Safety Guidelines – Transport

Agricultural Producers

From storage to field use

- Certain exemptions granted
- Emergency response and hazmat training waived **(under 150 miles)**
- Exemptions **null if transporting for others** or for hire

Safety Guidelines – Transport

Agricultural Producers

From dealer to storage

- Outside 150-mile radius to or from farm, all regulatory requirements must be met **unless:**
  - **Carrying less than** 502 gal. or 5,070 lbs. of ag product

    AND
  - **ag producer is an intrastate motor carrier** (unless hauler for hire or for others)

Safety Guidelines – Use

Agricultural Producers

In Planting Operations:

- Plant at label rates
- Immediately clean up spillage at load sites
- If using open bin systems:
  - wear required PPE
  - avoid dust
- When possible, plant excess seed material
- Be cautious of dust drift from planting operations

Safety Guidelines – Disposal

Small Quantities of Seed

- Plant in non-crop areas at normal rates
  - If broadcast, incorporate to at least 1” depth
- Avoid:
  - “double sowing”
  - Leaving exposed seed
  - dust drift

Safety Guidelines – Disposal

Large Quantities of Seed

- Take to an approved municipal landfill
- Use as a fuel source
- Incinerate
- Ferment for non-consumption alcohol

Safety Guidelines – Disposal

What **Not** to Do

- Compost
- Spread/incorporate at higher-than-approved rates
- Apply resultant wastewater to land
- Use ethanol by-products in feed/agronomic practice
- Burn in stoves for heating/cooking in shop or home

Safety Guidelines – Disposal

Summary

The best way to deal with the disposal of treated seed is to **minimize the amount** that needs to be discarded.

Environmental Impacts & Stewardship

Pollinator Protection

The end of the world as we know it?

Environmental Impacts & Stewardship

Pollinator Myths – Busted

MYTH #1: Honey bees are becoming extinct.

- Number of colonies has increased globally from 65 million to 83 million in the last few decades
- Beekeeping as a profession is what is threatened by increased production costs related to parasitic mites, *Nosema*, new hive pests, nutrition issues, and pesticides as part of a mosaic

Dr. Jeff Harris: "Balancing Pest Management and Pollinator Health," PowerPoint, 4/20/18

Environmental Impacts & Stewardship

Pollinator Myths – Busted

MYTH #2: When honey bees go extinct, humans will die within days to weeks.

- Most of the top 10 crops that feed the world do not need a pollinator (e.g., wheat, corn, barley, rice, soybean, cassava, yams)
- Humans would not starve if honey bees were lost

Dr. Jeff Harris: “Balancing Pest Management and Pollinator Health,” PowerPoint, 4/20/18

Environmental Impacts & Stewardship

Pollinator Myths – Busted

MYTH #3: Colony losses are strongly correlated to the use of neonicotinoids.

- In the U.S. and Canada, there is no correlation between colony losses on an area-wide basis and the use of ANY insecticide, let alone neonicotinoids*
- Properly used neonicotinoid seed treatments have been shown to remarkably reduce yield losses in a number of agronomic crops, without increased ill effects to pollinators.

*Dr. Jeff Harris: "Balancing Pest Management and Pollinator Health," PowerPoint, 4/20/18

Environmental Impacts & Stewardship

Best Management Practices

Read and follow the label

- It's the law
- Label will indicate specific precautions as to pollinators and non-target organisms (NTOs)

Environmental Impacts & Stewardship

Best Management Practices

Practice IPM when deciding to use seed treatments

- Understand the pest
- Conduct appropriate scouting
- Utilize injury and action thresholds
- Use least disruptive control strategy
- Evaluate
- Record

Environmental Impacts & Stewardship

Best Management Practices

IPM challenges with seed treatments

- Treated seeds traditionally used as an “insurance” policy
- Appears to run contrary to IPM
- Widely utilized, especially with fungicides
- Is targeted “insurance” legitimate IPM?
  - Answer lies in reduced spray applications and yield losses

Environmental Impacts & Stewardship

Best Management Practices

Develop and share communication with beekeepers

- Get to know your proximate beekeepers
- Communicate your intentions as to applications
- Get beekeepers to communicate their plans to you
- Clear communication always minimizes the potential for disputes

Environmental Impacts & Stewardship

Best Management Practices

Recognize pollinator habitat and reduce dust exposure

- Be aware of pollinator forage and/or habitat at field margins, turnrows, and corners
- Avoid seed treatment applications that coincide with blooming of non-crop pollinator forage
- Take special note of hive locations in proximity

Environmental Impacts & Stewardship

Best Management Practices

Avoid generating dust when handling/loading

- Minimize use of seed lubricants when possible
- Use closed loading systems if practical

Environmental Impacts & Stewardship

Best Management Practices

Manage equipment to decrease dust drift

Environmental Impacts & Stewardship

Best Management Practices

Proper clean up and disposal

- Store empty seed containers/bags in closed containers—dispose of properly
- Wash residue from planting equipment
- Plant or dispose of excess seed according to label directions

Environmental Impacts & Stewardship

Best Management Practices

Report suspected pollinator pesticide poisonings *as required by the state in which you are operating.*

Environmental Impacts

Other Non-target Organisms – Read the Label

Environmental Hazards—Gaucho 600

- This pesticide is highly toxic to **bees, birds and aquatic invertebrates**. For terrestrial uses, do not apply directly to water, or to areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water when disposing of **equipment wash waters**. Cover or **incorporate spilled treated seeds**.
- Ensure that planting equipment is functioning properly in accordance with manufacturing specifications to minimize seed coat abrasion during planting to **reduce dust which can drift** to blooming crops or weeds.

Environmental Impacts

Advantages of Using Treated Seed

- Less active ingredient per acre compared to broadcast pesticide applications **(4 to 8 times less)**
- May actually **reduce the total number of broadcast** applications required
- **Reduces the need to handle** chemicals and dispose of containers
- **Less reliance on favorable weather conditions** than with foliar spray applications
- **May be less harmful to certain non-target organisms** (e.g., earthworms)
- May **minimize potential runoff** to waterways

Environmental Impacts

Disadvantages of Using Treated Seed

- May provide **increased exposure to workers** in manufacturing process
- Application **requires greater awareness of pollinator habitat and forage activity**
- Requires **diligence to ensure soil incorporation** to protect birds and mammals
- Requires **special consideration for disposal** of excess seed

Additional Resources

- International Seed Federation
  - Seed Treatment Operator Safety Guidelines
  - http://www.worldseed.org/wp-content/uploads/2015/10/ISF_Seed_Treatment_Operator_Safety_Guidelines.pdf
- Syngenta
  - Seed Treatment and Safety Regulations
  - Treated Seed Disposal
  - https://www.naehss.org/PastSchools/2009/SeedTreatmentSafety.pdf

Gene Merkl, Program Manager
Pesticide Safety Education Program (PSEP)
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Questions?

MISSISSIPPI STATE UNIVERSITY™
EXTENSION

Seed Treatment—Review Questions

Q1. The North American market represents nearly _____% of the world market in treated seed. a) 55, b) 40, c) 83, d) 36

Q2. Skin sensitization is: a) a response to injury, b) an allergic reaction, c) caused by dust alone, d) a one-time occurrence.

Q3. The primary occupational safety concern in all facets of seed treatment operations is: a) poor spill management, b) improper storage, c) exposure to contaminated dust, d) failure to clean equipment.

Seed Treatment—Review Questions

Q4. The two primary sources of information available to us as manufacturers and applicators are the _____. a) label and product notes, b) label and exposure data, c) label and safety data sheet, d) EPA label revisions and state law

Q5. Which section of the product label contains special language for PPE requirements of the Worker Protection Standard? a) Agricultural Use, b) Non-agricultural Use, c) Environmental Hazards, d) Precautionary Statements

Q6. The engineering controls and occupational exposure levels are typically found in the: a) ChemTrek Handbook, b) safety data sheet, c) supplemental literature, d) precautionary statements

Seed Treatment—Review Questions

Q7. Which of the groups below is the intended audience for the safety data sheet? a) farm workers, b) private applicators, c) pesticide mixers and loaders, d) first responders

Q8. EPA risk assessment concepts usually generate conservative control requirements that are: a) simple to follow, but generally inflexible, b) difficult to follow, but generally flexible, c) environmentally effective, d) enforced by the product label.

Q9. Of the four focuses of treated seed manufacturing, which of the following practices is common to all? a) engineering controls, b) keeping treatment equipment closed, c) spill monitoring and clean up, d) precautionary statements

Seed Treatment—Review Questions

Q10. Respirator requirements for workers in manufacturing facilities are different from agricultural use requirements in that they are regulated by the _____. a) Mine Safety and Health Administration (MSHA), b) Occupational Safety and Health Administration (OSHA), c) Worker Protection Standard (WPS), d) Environmental Protection Agency (EPA)

Q11. _____ should be kept in close proximity to treated seed storage facilities, but never in the same secure containment area. a) Inventory data, b) Spill kit and clean-up materials, c) Operations and maintenance manuals, d) Contaminated PPE

Q12. Agricultural workers involved in the planting of treated seeds are **primarily** subject to the _____ requirements found on the label. a) non-agricultural use, b) agricultural use, c) maximum rate, d) environmental hazard

Seed Treatment—Review Questions

Q13. Interstate transportation of treated seed as a hazardous material is regulated by _____. a) state department of transportation, b) U.S. Department of Transportation, c) International Seed Federation, d) both a and b

Q14. Which of the following is not an approved disposal method for large quantities of treated seed? a) approved landfill, b) fermentation, c) composting, d) incineration

Q15. Which of the following statements is true about the status of honey bees in the world today? a) Honey bees are becoming extinct. b) When honey bees go extinct, humans will die in days to weeks. c) Bee colony losses are correlated to the use of neonicotinoid pesticides. d) The beekeeping profession is being threatened by increased production costs related to parasites, disease, new hive pests, nutrition issues, and pesticides.

Seed Treatment—Review Questions

Q16. Which of the following is not a traditional component of integrated pest management (IPM)? a) understanding the pest, b) appropriate scouting, c) using seed treatment as an insurance policy, d) utilizing injury and action thresholds

Q17. Which of the following is not considered to be a best management practice for seed treatment stewardship? a) share communications with your beekeeper, b) recognize pollinator habitat and reduce dust exposures, c) clean up and dispose of seed properly, d) always use open loading systems

Q18. The requirements for reporting suspected bee kill incidents: a) are dependent upon pollinator protection plans, b) are enforced by the beekeeper, c) are enforced by the applicator's attorney, d) may vary widely from state to state.

Seed Treatment—Review Questions

Q19. _____ is an **advantage** of utilizing treated seed. a) Using less active ingredient per acre in comparison to broadcast pesticide applications, b) Increasing the total number of broadcast applications required, c) Dust contamination, d) Consideration for disposal of excess seed.

Q20. In which of the following processes is contaminated dust not likely to be a concern? a) manufacturing, b) planting, c) bulk transfer of treated seed, d) mid-season evaluation for effectiveness of seed treatment.

Seed Treatment—Review Questions

Q21. Which of the following statements is false? a) seed can be treated with a slurry or liquid formulation, b) seed dressings are only applied industrially, c) seed dressing is the most common method of seed treatment, d) seed can be dressed with a dry formulation

Q22. When treating seed indoors using open system, it is best to use the equipment in conjunction with a _____ capacity exhaust system. a) 100 CFM, b) 250 CFM, c) 500 CFM, d) 750 CFM

Seed Treatment—Review Questions

Q23. Which of the following statements is true? a) open system seed treatment is generally safer than closed system in the manufacturing process, b) closed system equipment can only treat small amounts of seed at a time, c) closed systems are more prone to leaks and spillage than open systems, d) both wet and dry treatments can be applied using closed systems

Q24. The seed treatment process of pelleting involves: a) adding bio-agents through osmosis, b) encapsulating the seed with treatment material, c) coating the seed with a liquid or dry material, d) inoculating the seed to promote plant health.

Seed Quality Evaluation and Testing

Brent Turnipseed

Professor/Manager, SDSU Seed Testing Lab

South Dakota State University

Why test seed?

- **Ultimately to determine their suitability for planting.**
- **Labeling purposes**
- **Quality control**
- **Meet standards (Certification, State, Federal)**
- ***Want rapid, uniform emergence! Repeat clients!***

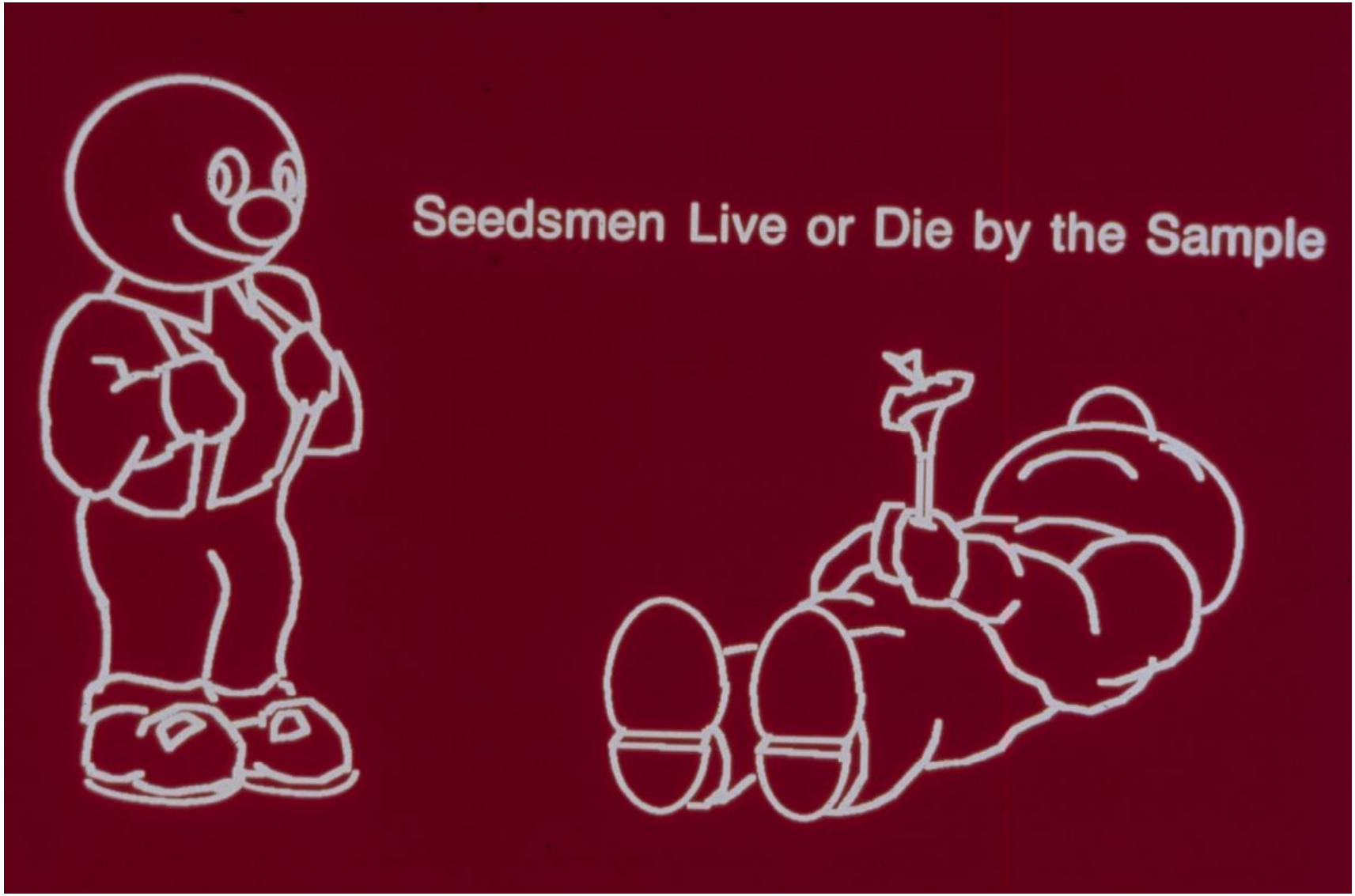

April 15, 2018

What is seed quality and how do we measure it?

- Traditional seed tests
- Vigor tests
- Disease testing
- Variety verification or Identification
- Varietal purity
  - Hybridity level
- GMO testing
- Storage environment
  - Moisture related, Temp., RH

The key to seed testing begins with the sample submitted.

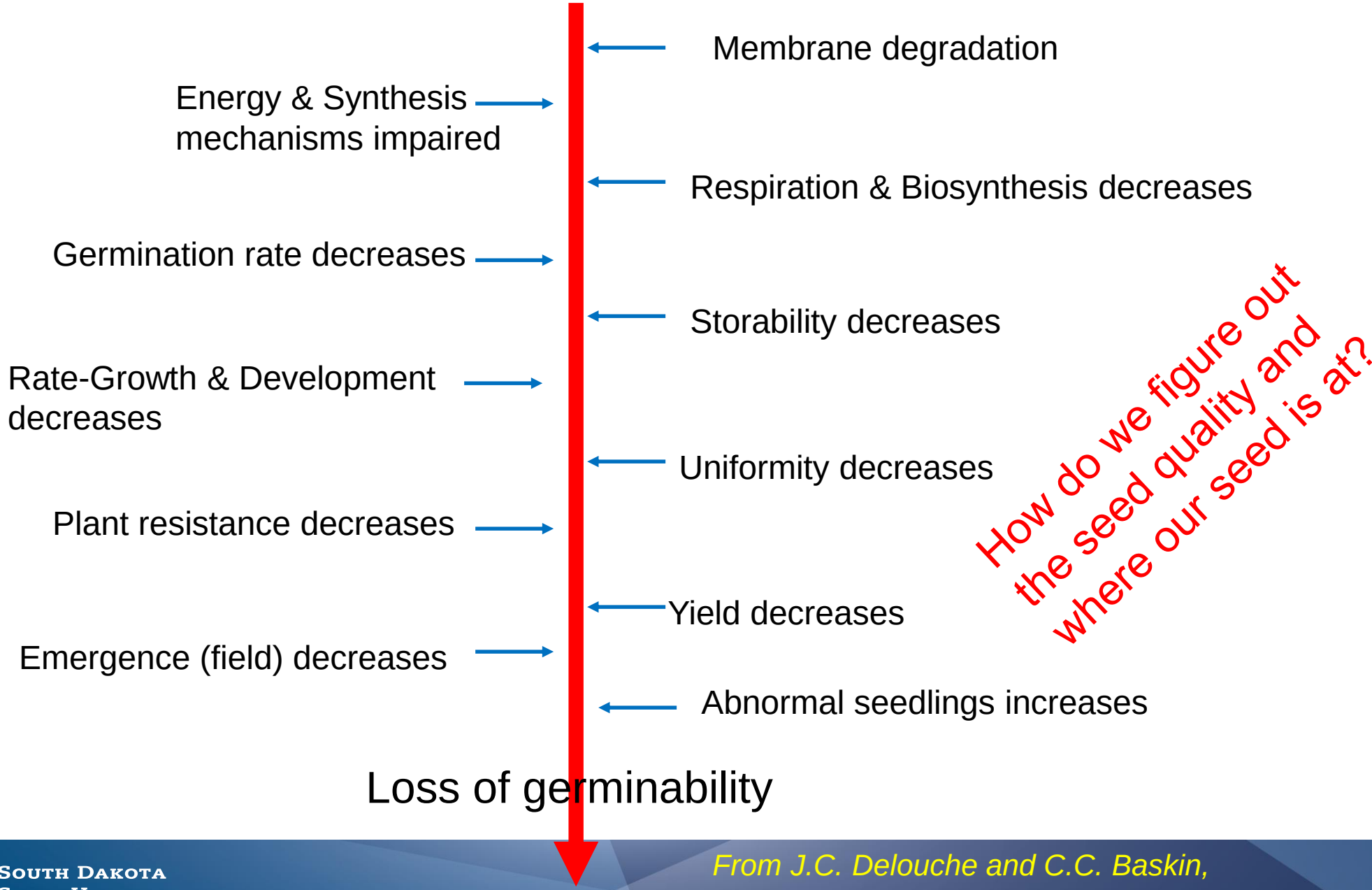
- Representative
- Accurately taken (use right kind of probe)
- Timely



from Charlie Baskin


TECUMSEH PRODUCTS COMPANY
SEED LABORATORY
SEED LABORATORY
HANSMEIER & SON, Inc.
HANSMEIER & SON, Inc.
SEED TESTING LABORATORY
SOUTH DAKOTA STATE UNIVERSITY
BROOKINGS, SOUTH DAKOTA
USA20c
3992

Probable sequence of changes in seed during deterioration



How do we figure out the seed quality and where our seed is at?

From J.C. Delouche and C.C. Baskin, 1973

Basic Quality Tests for labeling

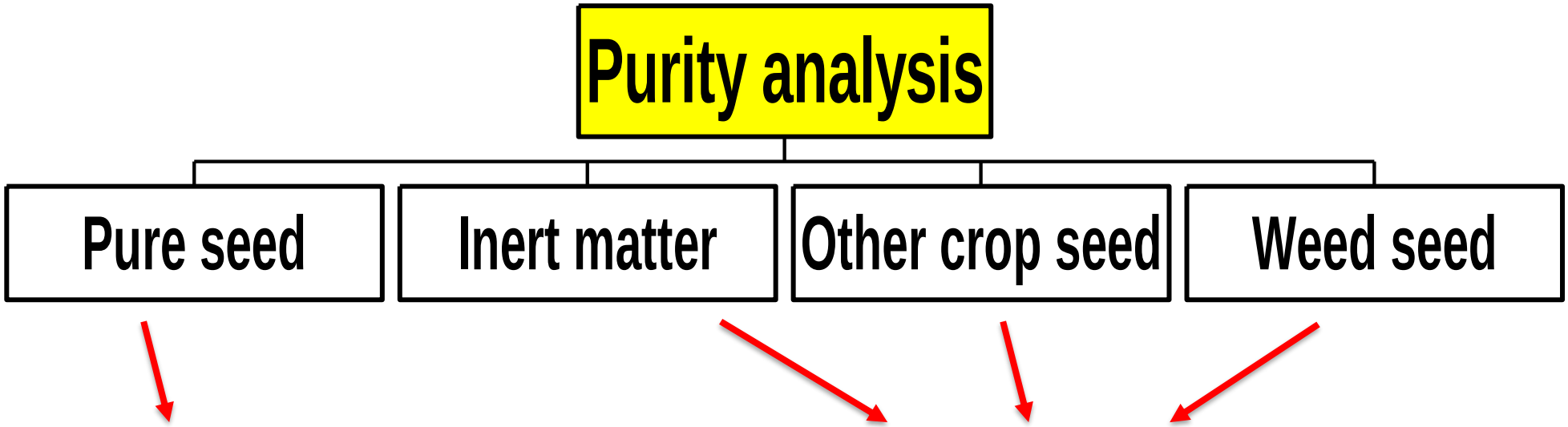
- **Purity Analysis**
- **Noxious Weed Seed Examination**
- **Germination Test**

AOSA Rules for Testing Seeds

- specifies minimum quantity of seed for each species that need to be analyzed in a purity analysis or noxious exam.
- specifies conditions and methods used in germination testing.
- definitions of pure seed, inert matter, etc.
- etc.


CEREALS
SORGHUMS

Purity Analysis - determines physical makeup of seedlot.



This is what we want it all to be in the bag.

We don't want inert, other crop and weeds (there's enough in the soil already)

Pure Seed

- kind and/or cultivar under consideration
- Immature, shriveled, diseased
- seed which are cracked or damaged
- broken seeds - >one-half original size
- seeds that have started to germinate
- intact fruits whether they contain a seed or not --> example) - sunflower, buckwheat
- grass units with some degree of endosperm development
- etc.

Inert Matter

- pieces of broken & damaged seed units - one-half the original size or less
- separated cotyledons of legumes
- legumes, crucifers, & conifers with entire seedcoat removed
- chalcid-damaged alfalfa, clovers, etc.
- ergot, nematode galls, smut, soil particles, stones, glass, chaff, stems, flowers, etc.
- empty grass seed (lack caryopsis)
- etc.

Other Crop Seed

- seeds of plants grown as crops (other than the kind in question).
- interpretations and definitions for pure seed shall apply in determining whether seeds are other crop or inert matter.
- identified by common and scientific names

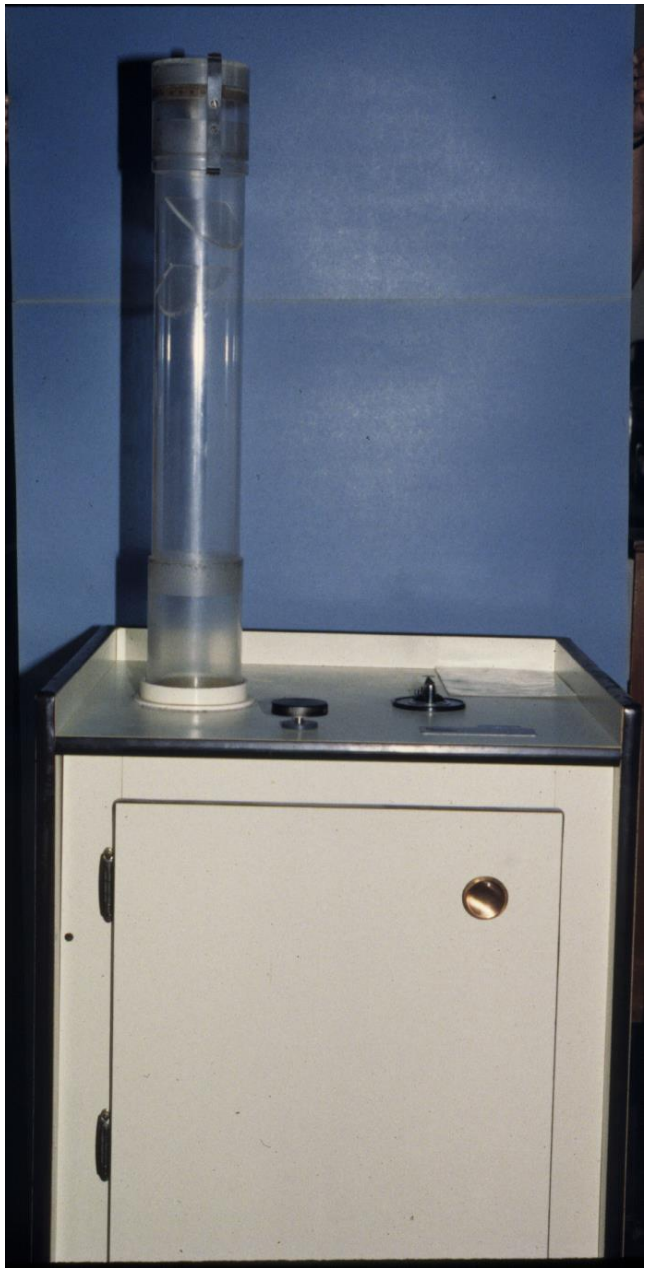
Weed Seed

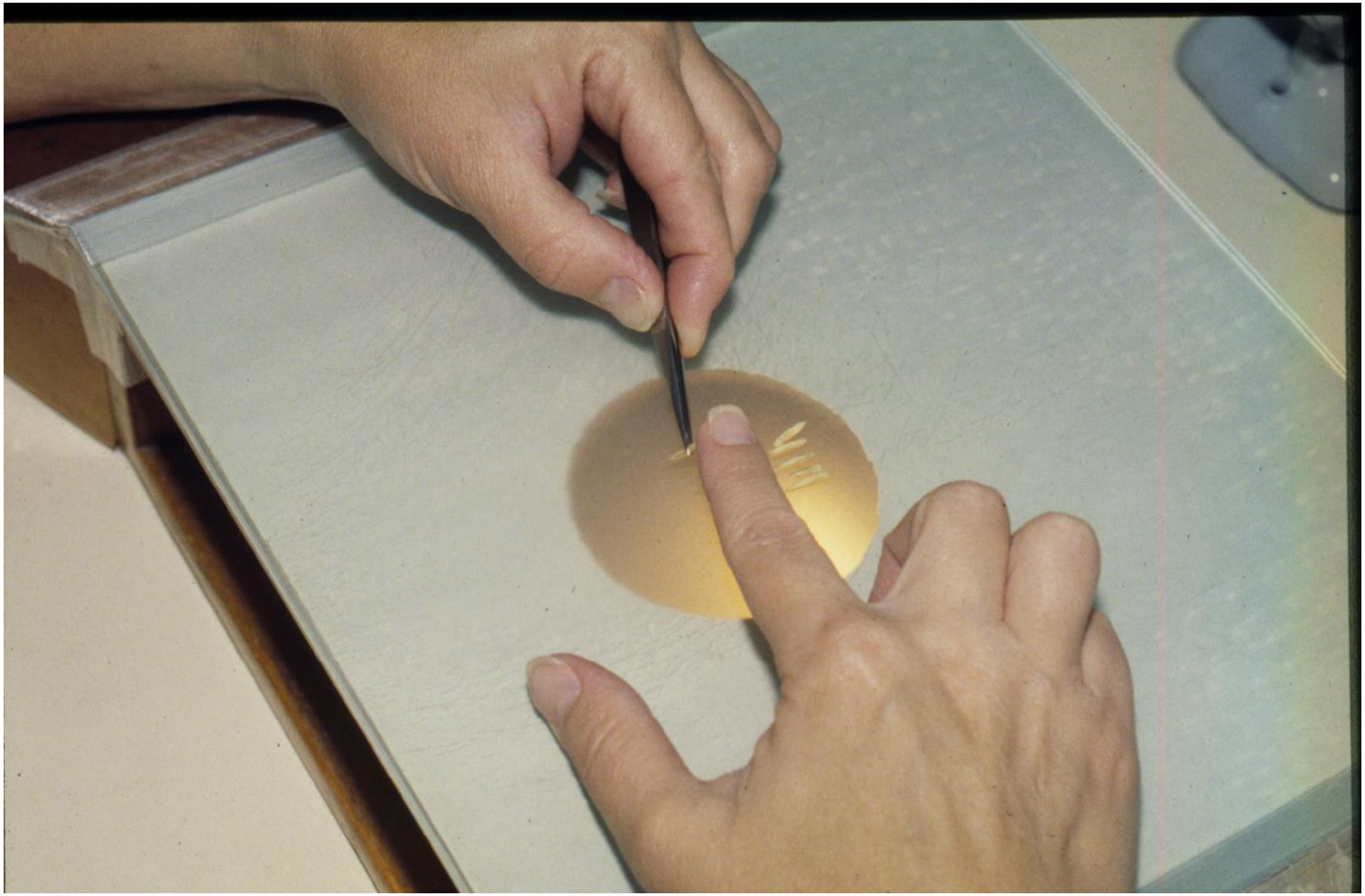
- **Seeds, florets, bulblets, tubers, recognized as weeds by laws, regulations, or general usage shall be considered as weed seeds.**
- **individual seeds and seedlike structures are to be removed from fruiting structures and counted and included with the weed seeds. Example) - nightshade berry must be opened and individual seeds counted.**
- **identified by common and scientific name**

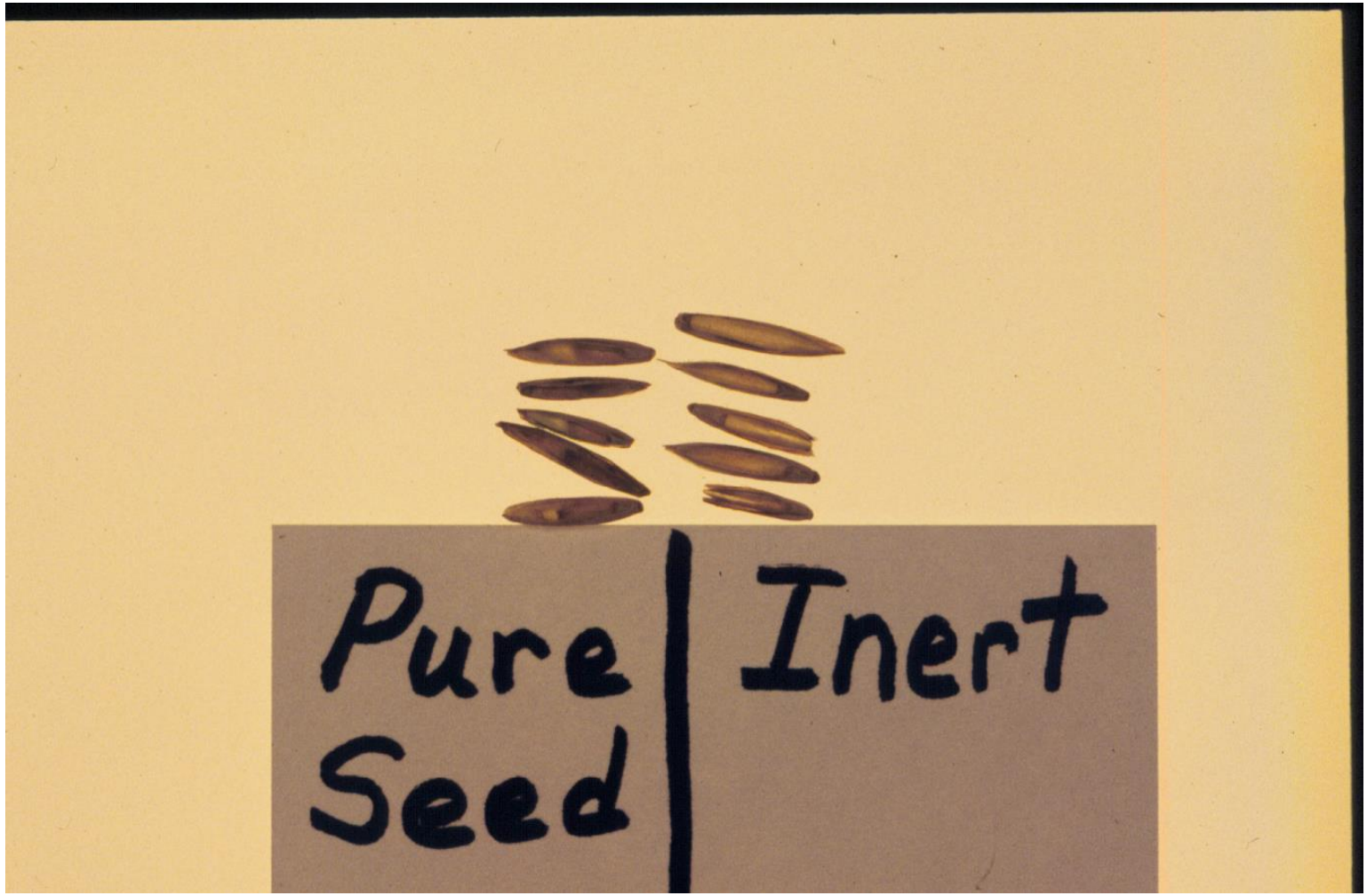

PURITY

Various aids used in Purity and Noxious exams

- South Dakota Seed Blower
- Hand Testing Screens/Sieves
- Purity Board Light (diaphonoscope)






Pure Seed
Inert

Seedcounts (seed per pound)

- **How are they used?**
  - **calculating plant populations**
  - **precision planting**
  - **basis of seed sale**

(need a purity analysis to use properly)

Noxious Weed Seed Examinations

Noxious Exams

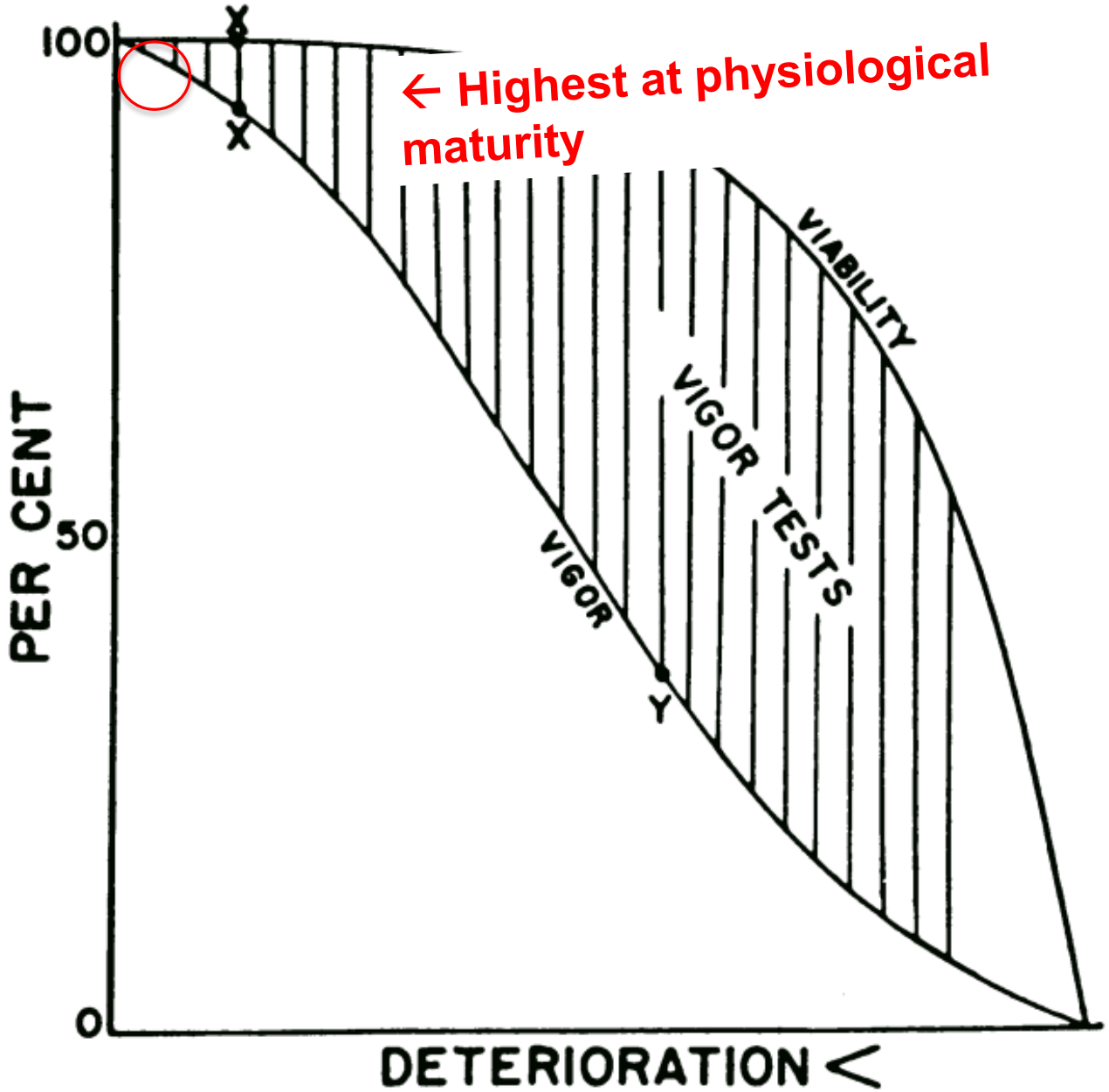
- SD/MN/ND Exams (State)
- USA Exam (crossing state lines)
- CIA Exams (custom)
  - also look for other crops
  - larger samples
  - varietal check
  - other problems


NOXIOUS
TESTING

Good establishment – influenced by 2 aspects of seed quality

- Germination

- Vigor



Relationships among seed vigor, viability (germinability) and deterioration, and the area for application of vigor tests. The *x* and *y* points on the viability and vigor curves illustrate the increasing "gap" between germinability and vigor with increasing deterioration. From Delouche and Caldwell (1960).

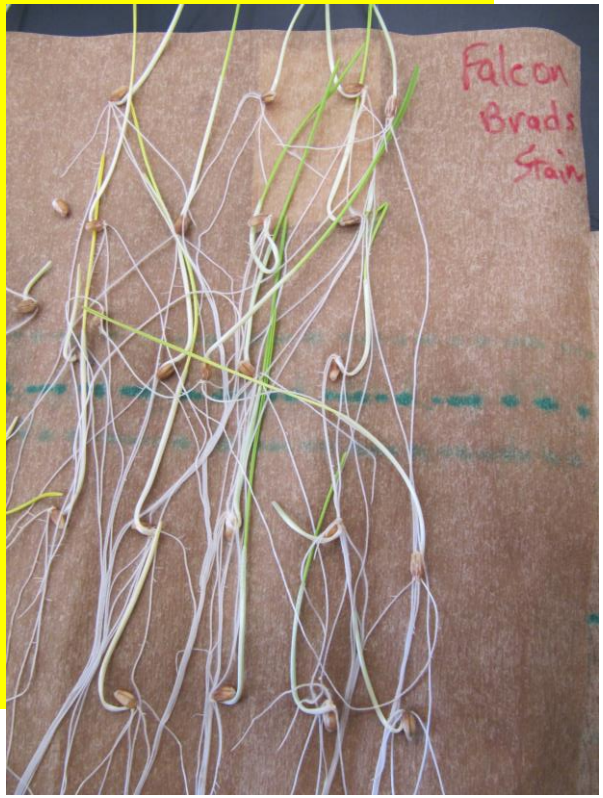
Germination Test

- follow "AOSA Rules for Testing Seeds"
- conducted under ideal conditions
  - proper medium
  - optimum temperature
  - proper moisture
- 400 seeds tested - usually planted in 4 replications of 100 seeds
- evaluation of seedlings at proper times

- *Can watch for disease, weak vs. strong seedlings, abnormals – do what the client/company wants.*

Germination Substrata (media)

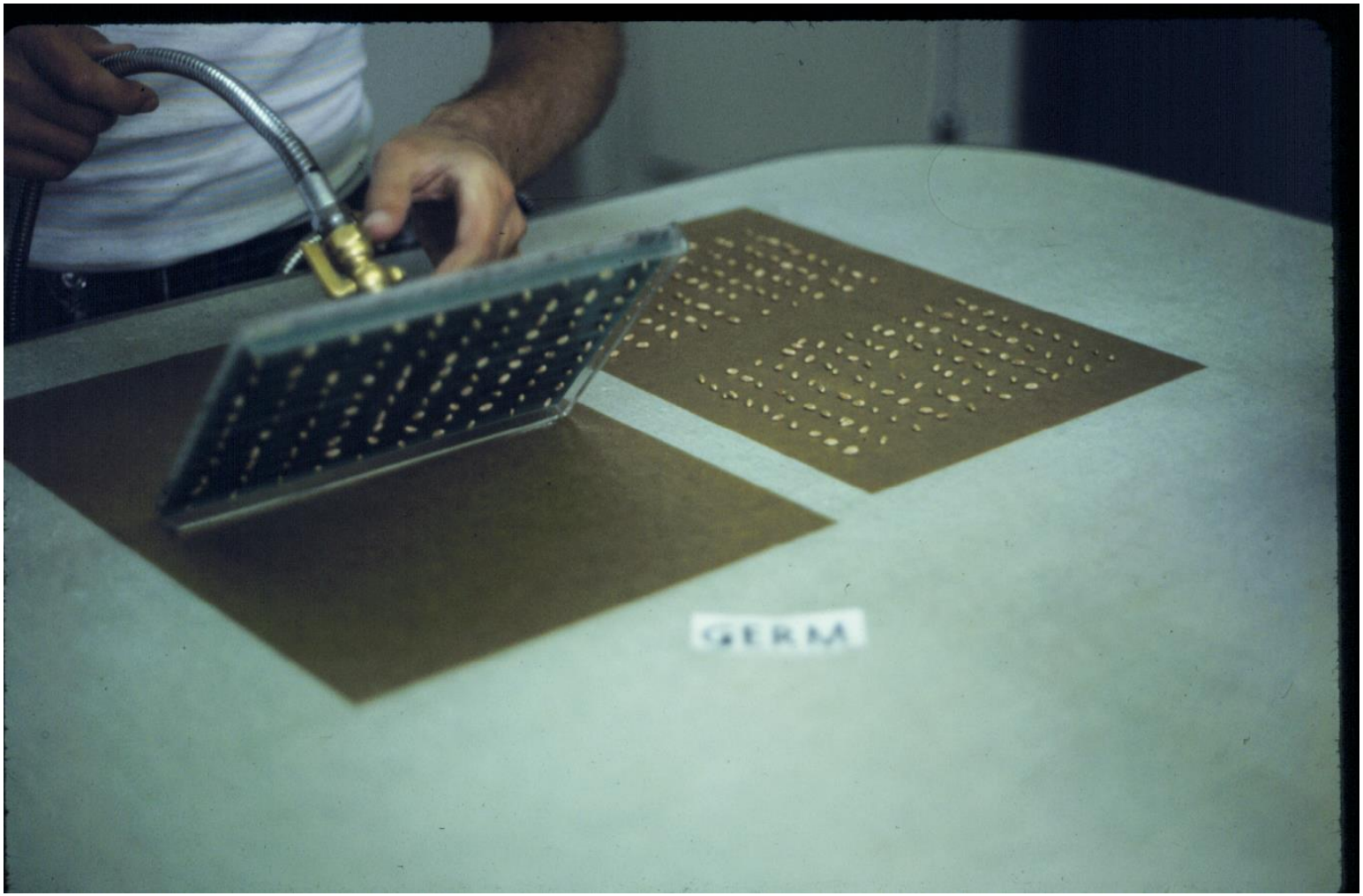
- **Germination towels** (paper towels)**
- **Blotter paper****
- **Kimpak****
- **Sand/soil**
- **Filter paper (Whatman's No. 2)****



- ** specially produced non-toxic medium

Wetting Agents - Germ. Test

- Water (tap vs. RO vs. distilled vs. deionized)
- KNO_3 (0.2% solution)
- Gibberellic acid (500 ppm solution)
- Ethephon (.0029% solution)


GERM

Definitions

- **Seed Germination - the emergence and development from the seed embryo of those essential structures which, for the kind in question, are indicative of the ability to produce a normal plant under favorable conditions.**
- **Normal seedlings - having no defects or only slight defects which will not impair the continued development of the seedling or plant when grown in soil under favorable conditions.**
- **Abnormal seedlings - having defects which prevent further growth or development into mature plants under favorable conditions in the soil.**

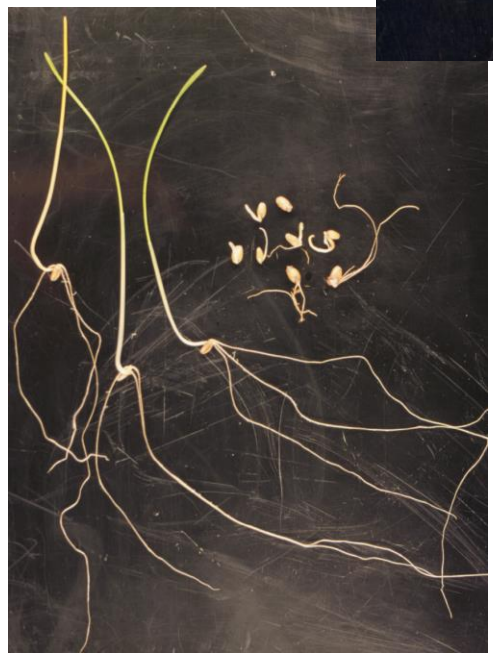
Definitions

- **Hard seeds - water impermeable seedcoat (dormant).**
- **Dormant seed - viable seeds, other than hard seeds, which fail to germinate under favorable conditions. Seeds remain firm at the end of the test period. Viability determined by other tests.**
- **Prechill - a cold, moist treatment applied to seeds to overcome dormancy prior to the germination test. The prechill method varies among species, but is usually performed by holding imbibed seeds at low temps. (5C or 10C) for specified periods.**

Evaluation of Cereal Germination

- **Normal Seedlings**
- at least one vigorous seminal root
- vigorous green leaf, not badly split, extending at least half-way up into the coleoptile

- **Abnormal Seedlings**
- none to spindly, weak roots
- no leaf, only coleoptile
- badly shredded leaf
- shoot thin, spindly, pale, or watery
- badly frost damaged
- deep open cracks in the mesocotyl

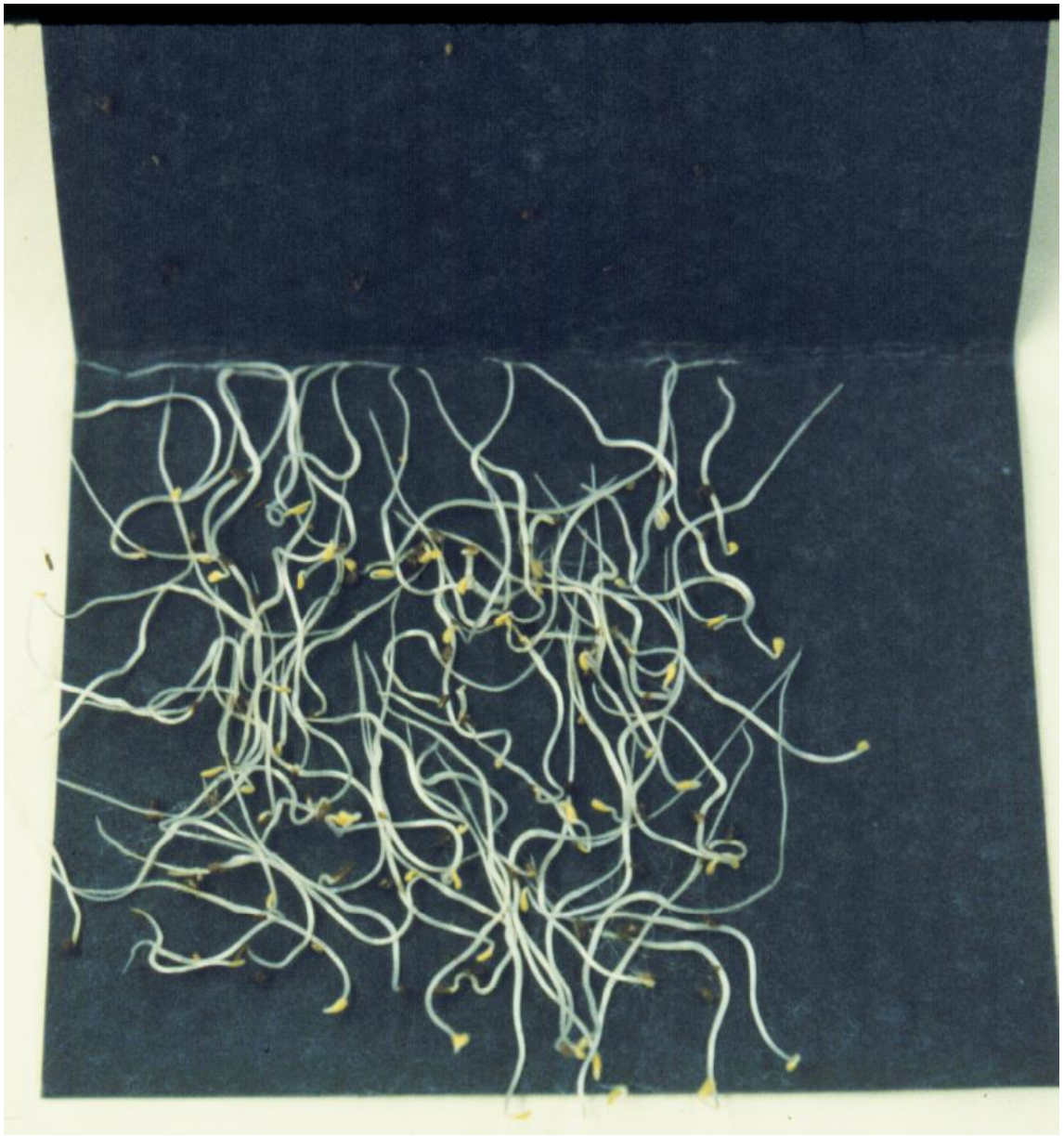



SDSU
Seed Testing
Laboratory
Scab
mycelium
(pinkish)
Other fungi
mycelium

Evaluation of Soybean Germination

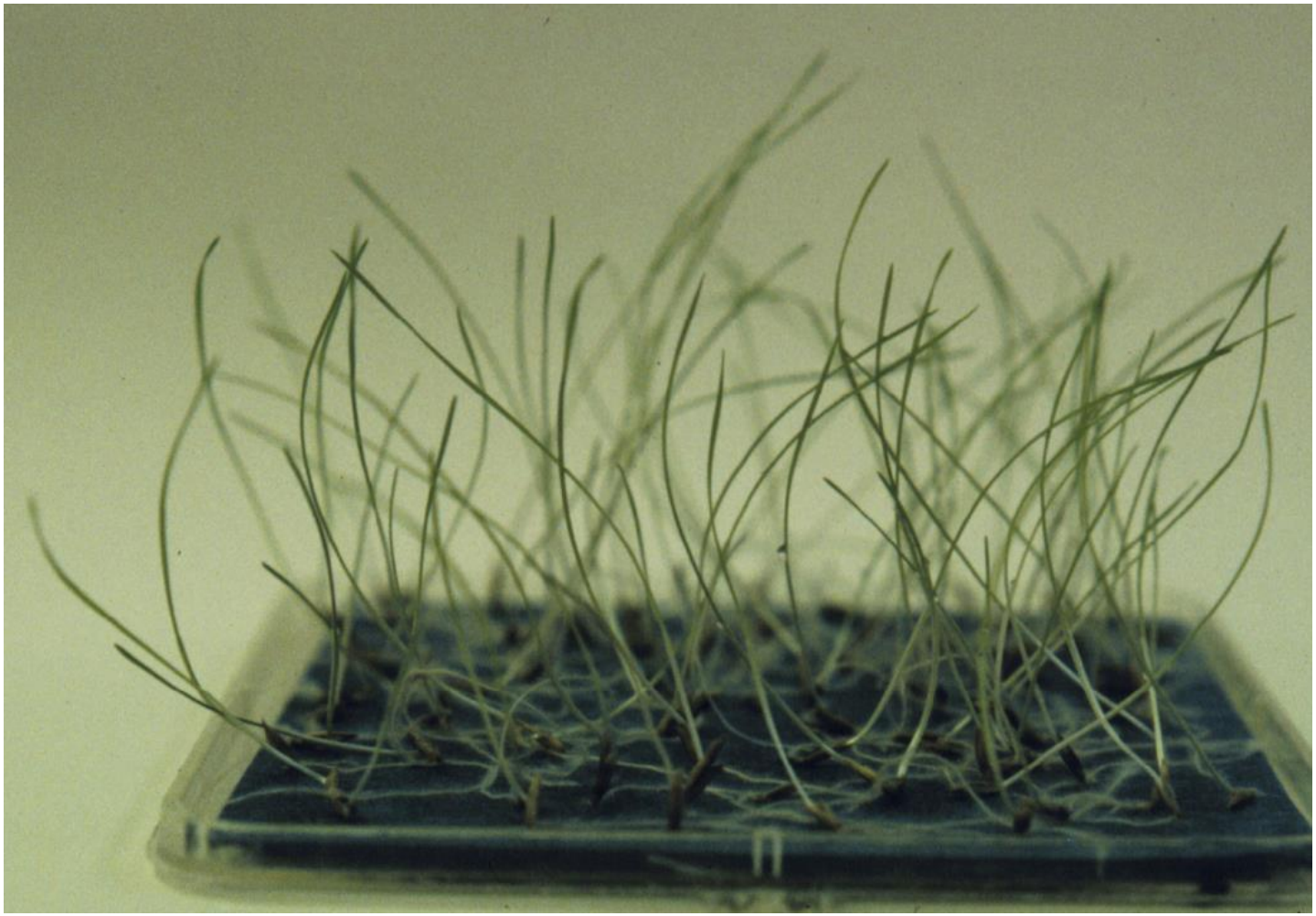
- **Normal Seedlings**
- vigorous primary root or set of secondary roots
- sturdy hypocotyl with no open breaks or lesions extending into the central conducting tissues
- at least one cotyledon
- at least one primary leaf and an intact terminal bud

- **Abnormal Seedlings**
- none to weak, stubby or missing primary root
- hypocotyl with deep open cracks extending into the conducting tissue, mal-formed, thickened, etc.
- less than half of original cotyledon or less than half free of necrosis or decay
- missing epicotyl, less than one leaf, etc.
- albino seedling




Normal Seedlings
Abnormal Seedlings


Hard Seed
Dead Seeds



Germination Reports

- **Percent Germination (normal seedlings)**
- **Percent Dormant seeds**
- **Percent Hard seeds**
- **Percent Total Viable**

  (normal seedlings + dormant + hard)

Other seed quality tests

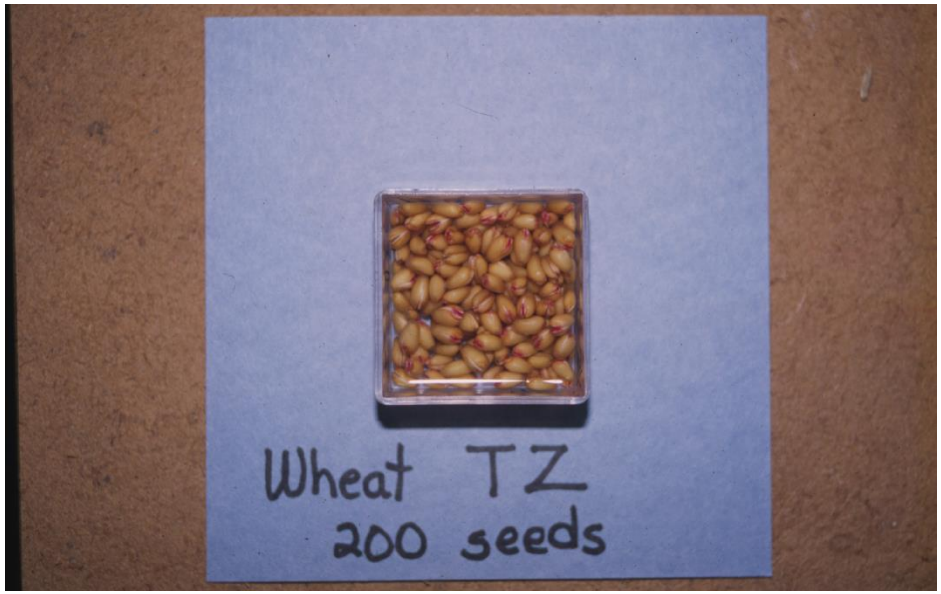
- Tetrazolium tests (TZ)
- Vigor tests (AA, Cold)
- Seedcounts (#/lb.) or thousand-kernel weight
- Moisture tests (wet weight basis)
- Test weights (lb./bushel)
- Protein content

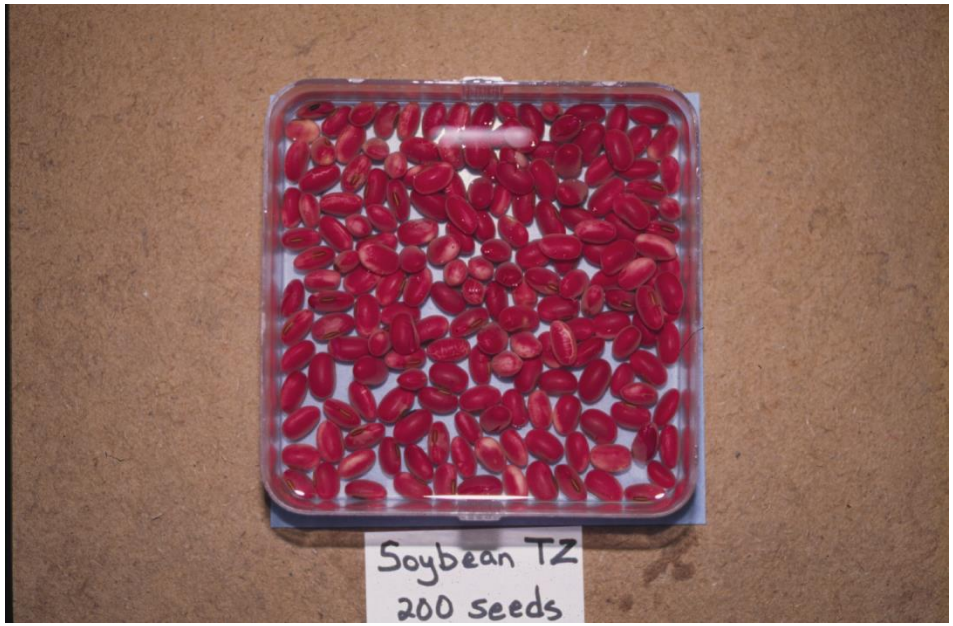
Tetrazolium Test (TZ)

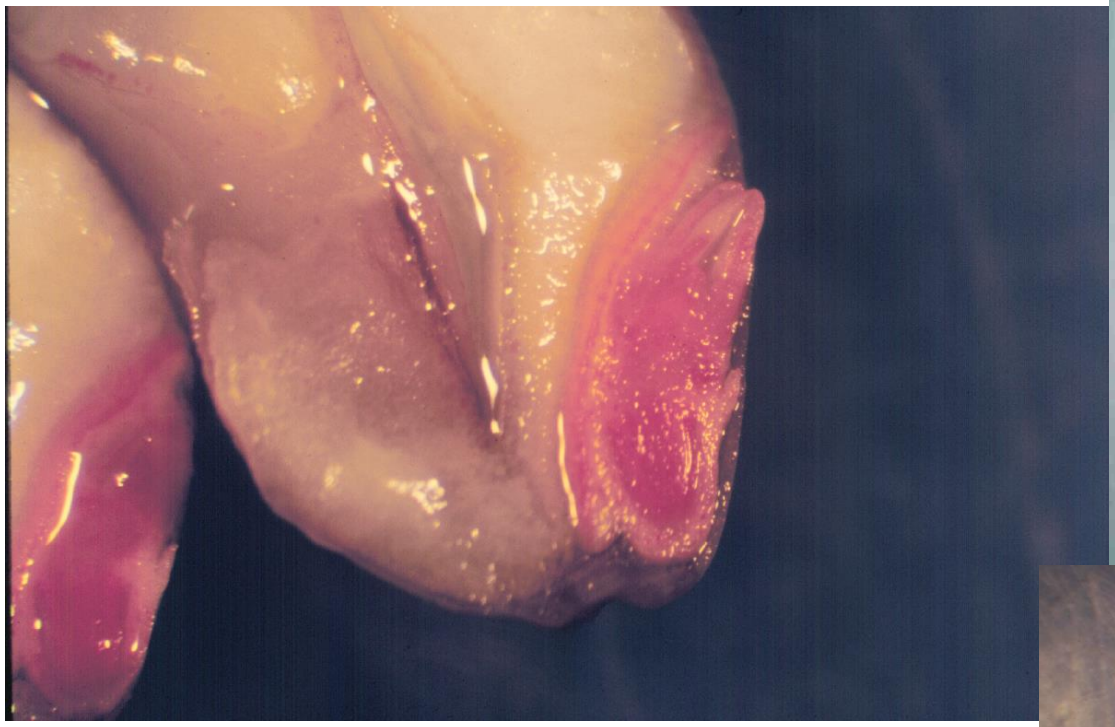
The TZ test is a rapid and accurate method that estimates germination potential within 24 hrs.

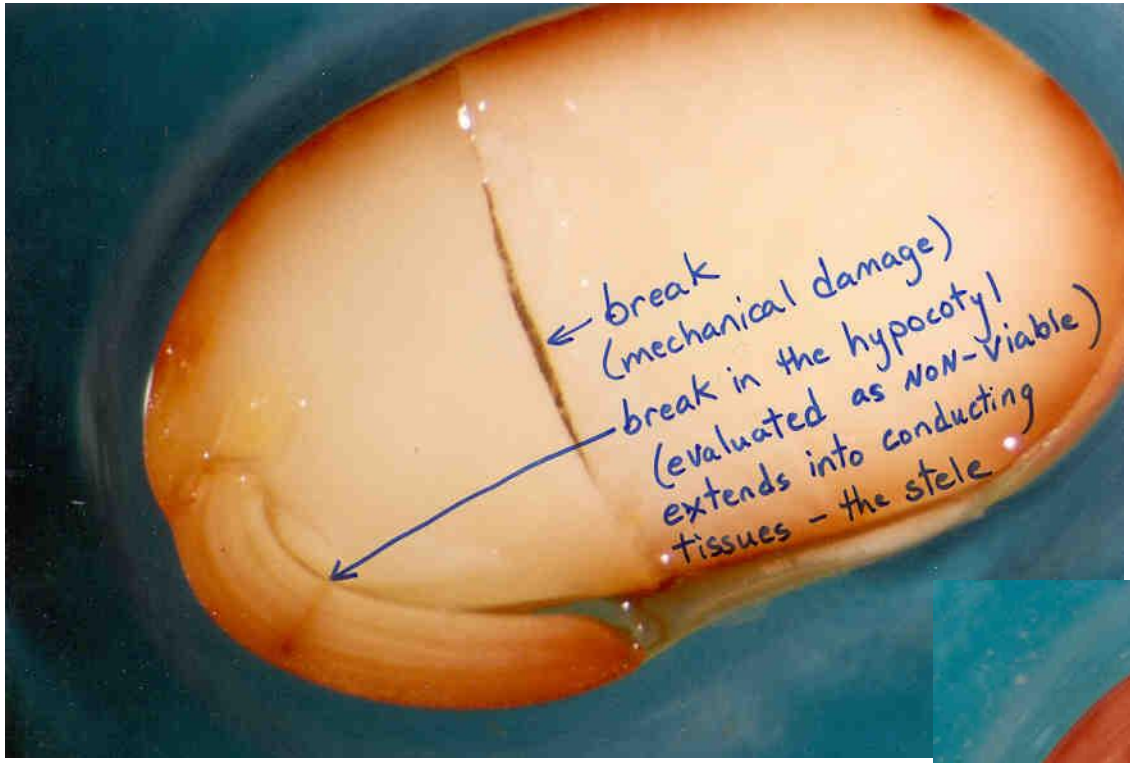
Principle:

The TZ test distinguishes between viable and dead tissues of the embryo on the basis of their relative respiration rate in the hydrated state. TZ solution is colorless and reacts with living tissues. Live tissues will stain a reddish color, while dead or non-living tissues will not stain. The analyst interprets the topographical staining pattern of the embryo and the intensity of the red coloration. Relating the stained areas (roots, shoot, cotyledons) to a seedling/plant the analyst evaluates the seed as alive or dead.

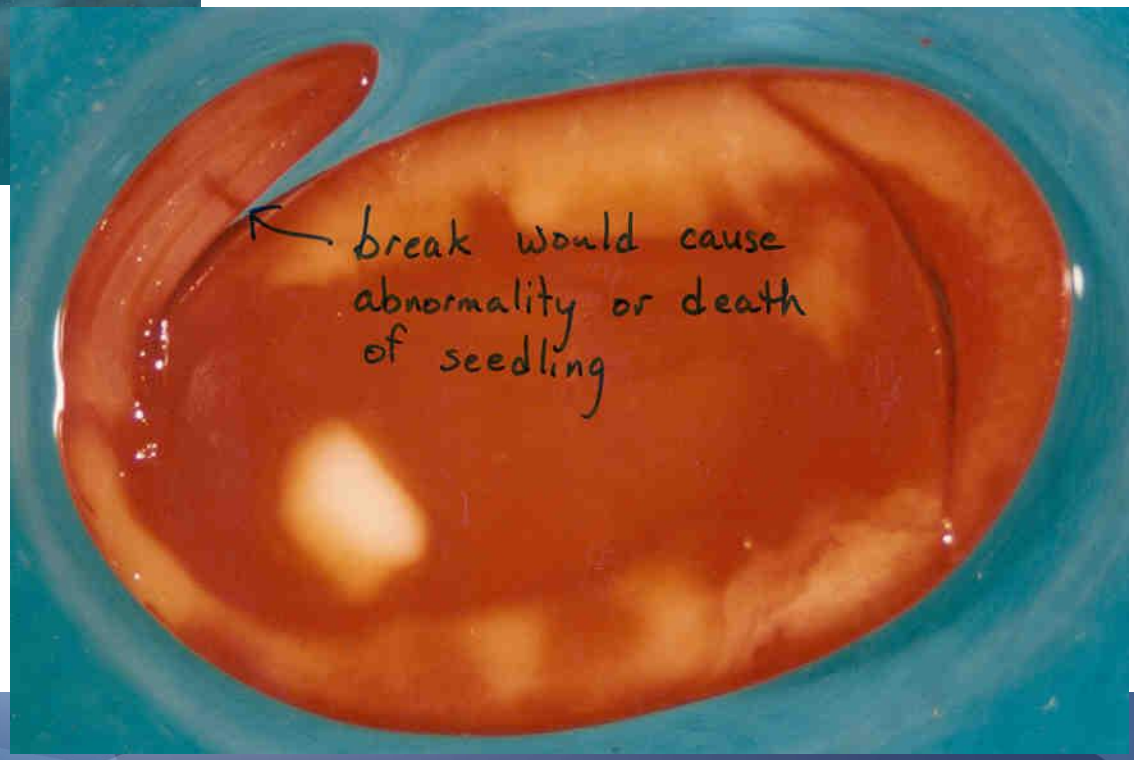

Wheat TZ
200 seeds


Soybean TZ
200 seeds





- Is a seed lot worth saving for conditioning?
- Quick check to verify germ of seed from a 3rd party
- Quick check before planting



The TZ test can be used as:

- a vigor test
- to identify mechanical damage (and where it occurs)
- to identify frost damage

Vigor Testing

- **Vigor - seed vigor comprises those seed properties which determine the potential for rapid, uniform emergence, and development of normal seedlings under a wide range of field conditions.**
- **Often see vigor problems in soybeans, cotton, and corn.**

Seed Vigor Tests

- Direct Tests - (Simulate unfavorable field conditions)
  - hard to duplicate from lab to lab (country to country)
- Indirect Tests- (Measure physiological attributes of seed)
  - more easily reproducible
  - still, see variation in interpretation, equipment, etc.
- Biochemical tests – i.e. – tetrazolium, etc.

Vigor Tests

- **Accelerated Aging Tests**
  - high temperature 40-45C
  - high RH (approx. 99% RH)
  - 48-96 hours depending on crop
- Soybeans - 41C, 72 hrs.

- **Other Vigor Tests include:**
- Cold Test (corn primarily)
- Cool Germination test
- TZ tests (interpretation more demanding)
- Conductivity (seed leachate)
- Seedling Growth Rate Test
- Speed of Germination Test

Seed Vigor Tests

- Accelerated Aging Test - (Soybeans 1º)
  - Stresses applied:
    - high temperature 40 - 45C
    - high RH (~ 100% RH)
    - 48 - 96 hours depending on crop

Seed Vigor Tests

Cold Test- (direct test for vigor!)

One of most widely used vigor test

Stresses applied:

- microorganisms from soil - Pythium (involved in complex of damping off)
- Restricted O_2 availability (70% saturation)
- Low temperature - 10C (~50F) for seven days, then 25C (~77F) for five days.

Rolled towel method - SDSU

Tray Method with Kimpak
http://seedlab.oregonstate.edu/importance-seed-vigor-testing

Seed Vigor Tests

- Cool Germination Test - (Cotton 1º)
  - Most widely used vigor test in cotton
  - germination at 18C (temperature crucial)
  - only make one count on the seventh day
  - normal seedlings 4 cm (1 ½ inches) are vigorous.
  - remaining seedlings not counted.

http://csd.net.au/media/20-seed-vigour-index-to-be-replaced

Seed Health Testing

- What is seed health
- Refers to presence or absence of disease causing organisms such as:
  - Fungi
  - Bacteria
  - Viruses
  - Insects
  - nematodes
  - and impure materials such as weed seeds, soil particles, etc.

Why seed health is important

- Affects seedling vigor
- Affects plants per unit area
- Source of inoculum – within the field but also long distance spread
- Food/feed quality – mycotoxins, moldy feed
- Germplasm conservation and exchange

Seed health testing – detection methods, storage fungi

- Agar testing (time consuming & expensive
- Blotter tests – simple and inexpensive
- Non-cultural tests – visual exam (ergot, smut balls, etc.)
- Seed wash tests
- ELISA tests
- PCR
- Lateral Flow Strips

- Storage fungi
  - 3 major types
    - Aspergillus (approx. 12 spp.)
    - Penicillium (approx. 5 spp.)
    - Sporonema (1 species)

Seed Health Testing

Field fungi - greater incidence in cereals and grasses. Invade seeds (kernels) before harvest, or after swathing, but prior to threshing. Varies with crop and region.

Four major types of field fungi:

1. Alternaria - common in grasses, cereals, peanuts
2. Helminthosporium - cereals, rice, causes discoloration of seed. Can cause death in young seedlings - roots rot.
3. Fusariums - cereals, wheat "scab" most prevalent problem in our northern great plains.
4. Cladosporium - discoloration of hulls, cereals

Field fungi will typically die out over time when seeds are in good storage conditions. No known effect on storage.

Selected seed health issues

- Nematodes
- Scab on cereals
- White mold (Sclerotinia) in soybeans
- Karnal bunt
- Ergot
- Purple stain of soybean
- Black tip on wheat
- Viruses (SMV/BPMV)


Pod and stem rot of soybean

Moisture – impacts viability, vigor and seed health, storability

- Moisture content of seeds expressed on a wet weight basis
- Seeds are hygroscopic.
- When sending in for moisture test - place seeds in a closed plastic bag.

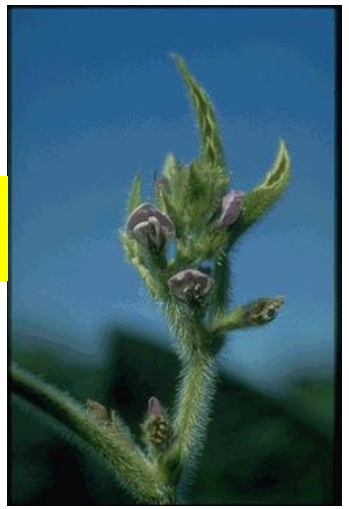
- Types of Meters
  - Resistance type
  - Dielectric type
- Motomco
- Burrows
- Seedburro
- Dole
- Star
- Steinlite
- Dickey-john
- Ohaus
- Delmhorst

Cultivar Purity Testing

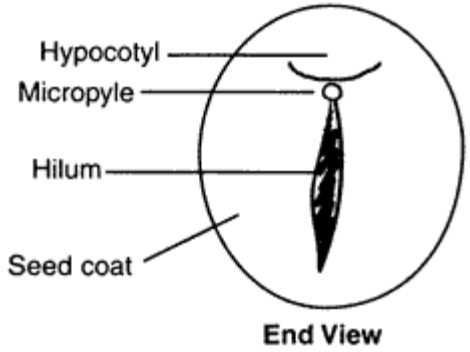
Types of Cultivar Identification Tests

- Morphological (seed, seedling & mature crop)
- Chemical (chemical assays & electrophoretic analysis of proteins, PCR)

Stem/Pod pubescence color



Morphological

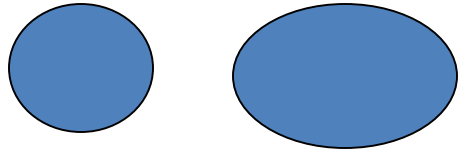


- Seed Morphology:
  - seed size (environmental influences)
    - 1600 to 10,000+ per pound
  - hilum color





  - seed shape



  - presence/absence of awns
  - Luster of seed coat

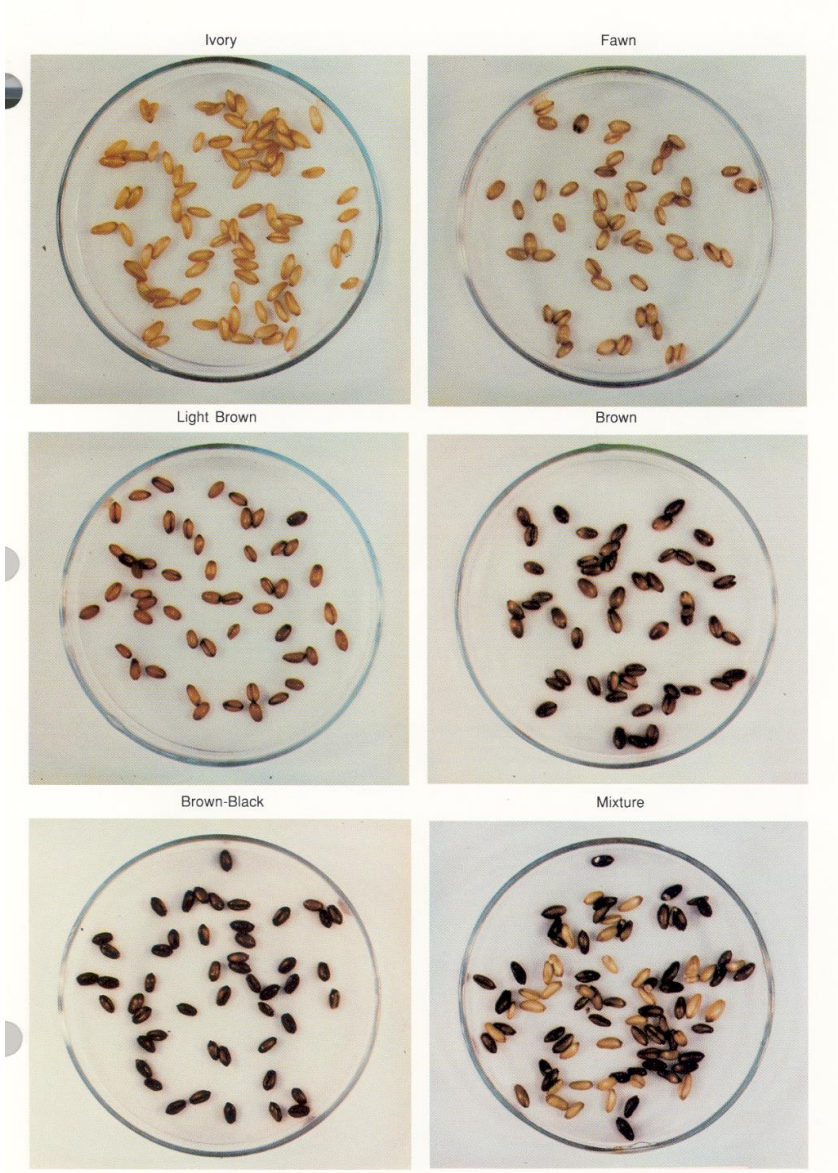


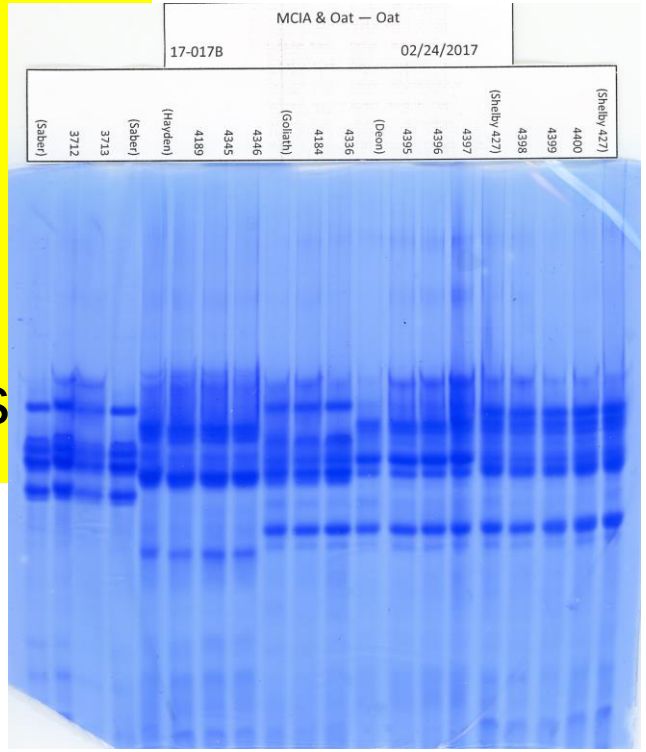
Figure 9. The phenol test for wheat: Examples of the five different color categories.

Phenol test for barley, bluegrass, Oats, Ryegrass, Wheat

AOSA Rules

Uses of Electrohoresis/HPLC

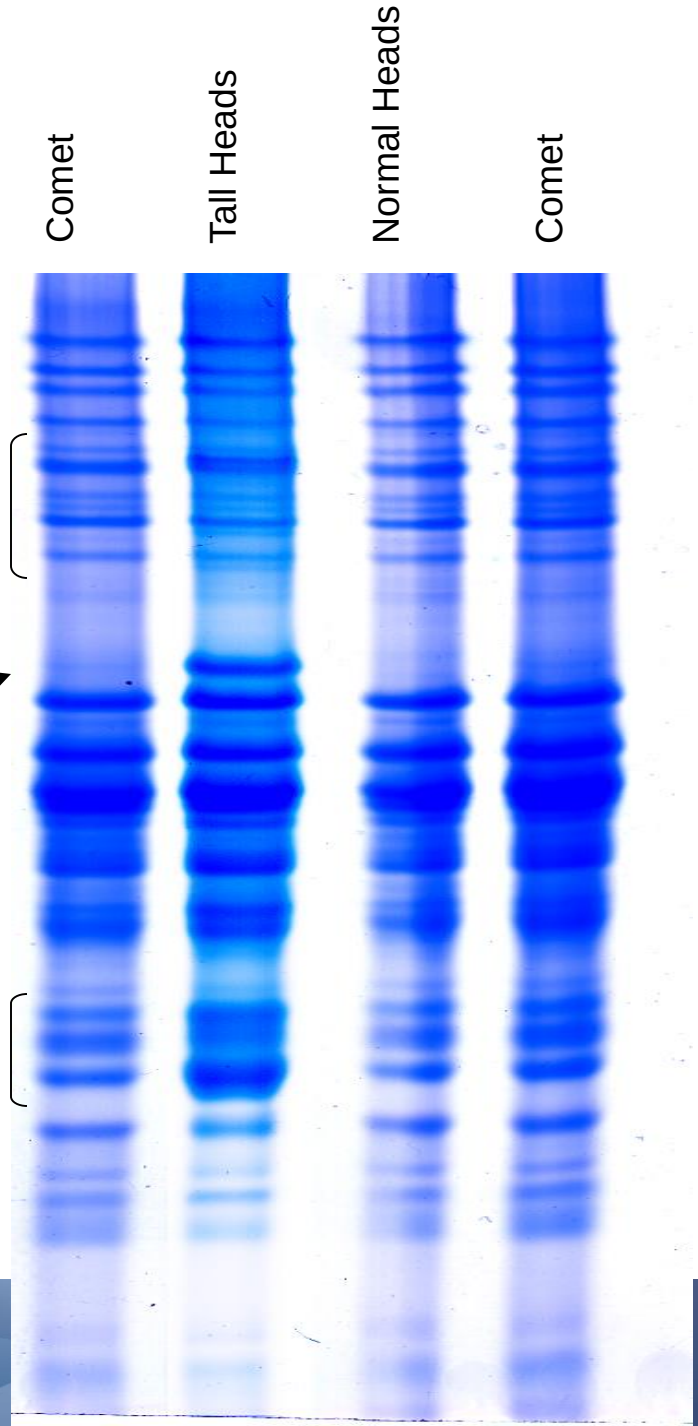
- Quality control in programs – verify variety
  - Identify varieties within mixtures
- Foundation/Breeder fields – determine if a "tall" offtype is actually different
- PVP applications
- PVP enforcement
- Criminal court cases
- Back-up to other varietal purity checks



Electrophoresis – using alcohol soluble proteins

Spelt

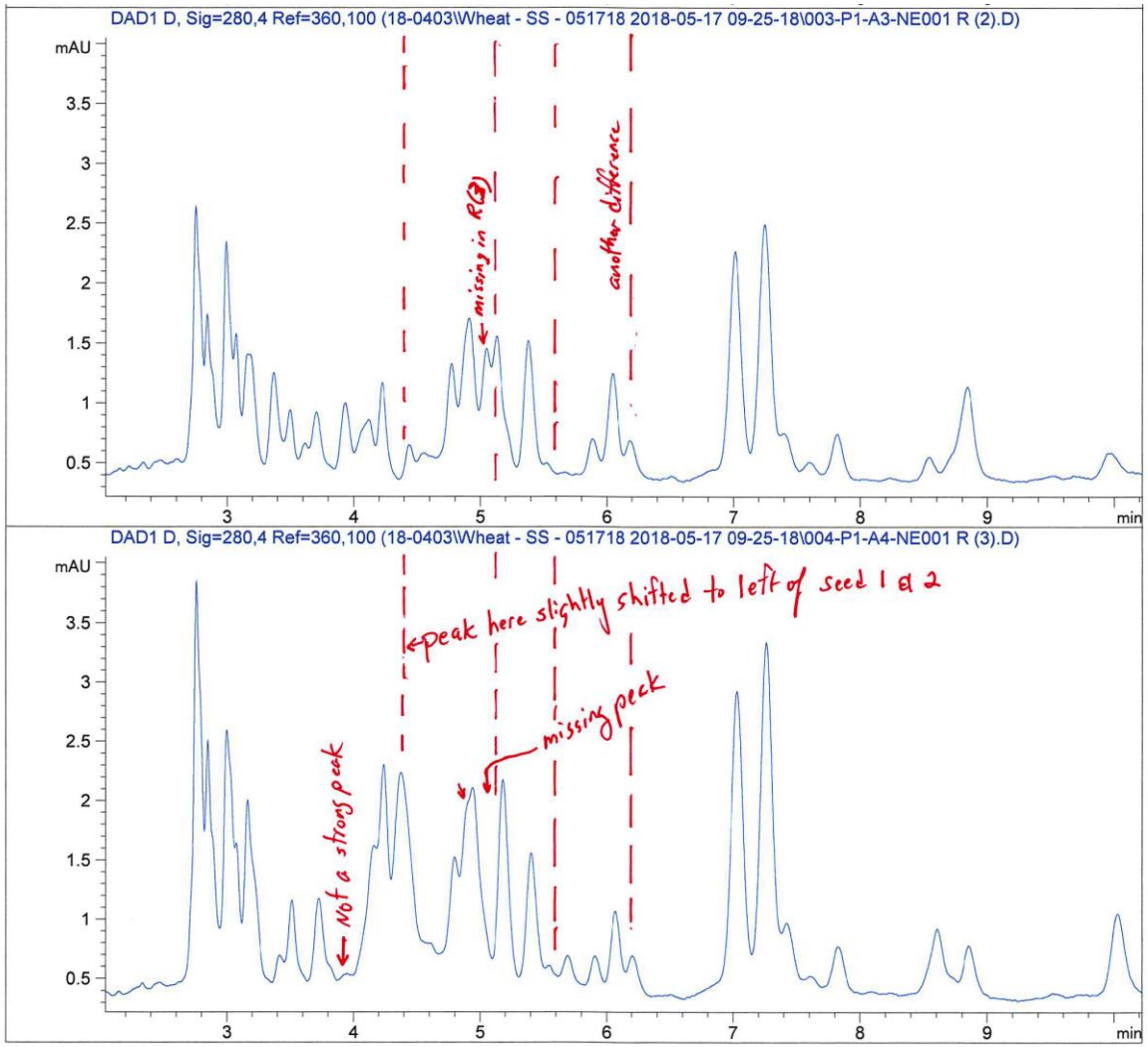
SDSU Seed Testing Lab
SDS Gel #01-071
07/19/01



Note:
"Normal Heads" match Comet, while "Tall Heads" does not. See bands and arrows for primary areas of differences.

HPLC

High Performance Liquid Chromatography



Genetic purity testing benefits for seed production and distribution

- Confirmation that seed meets genetic purity standards
- Identification of selfing and outcrossing in hybrid seed lots
- Determination of variants, segregation and seed mixes in hybrid or inbred seed production lots
- Variety verification, ensuring that producers and customers receive the variety they expect

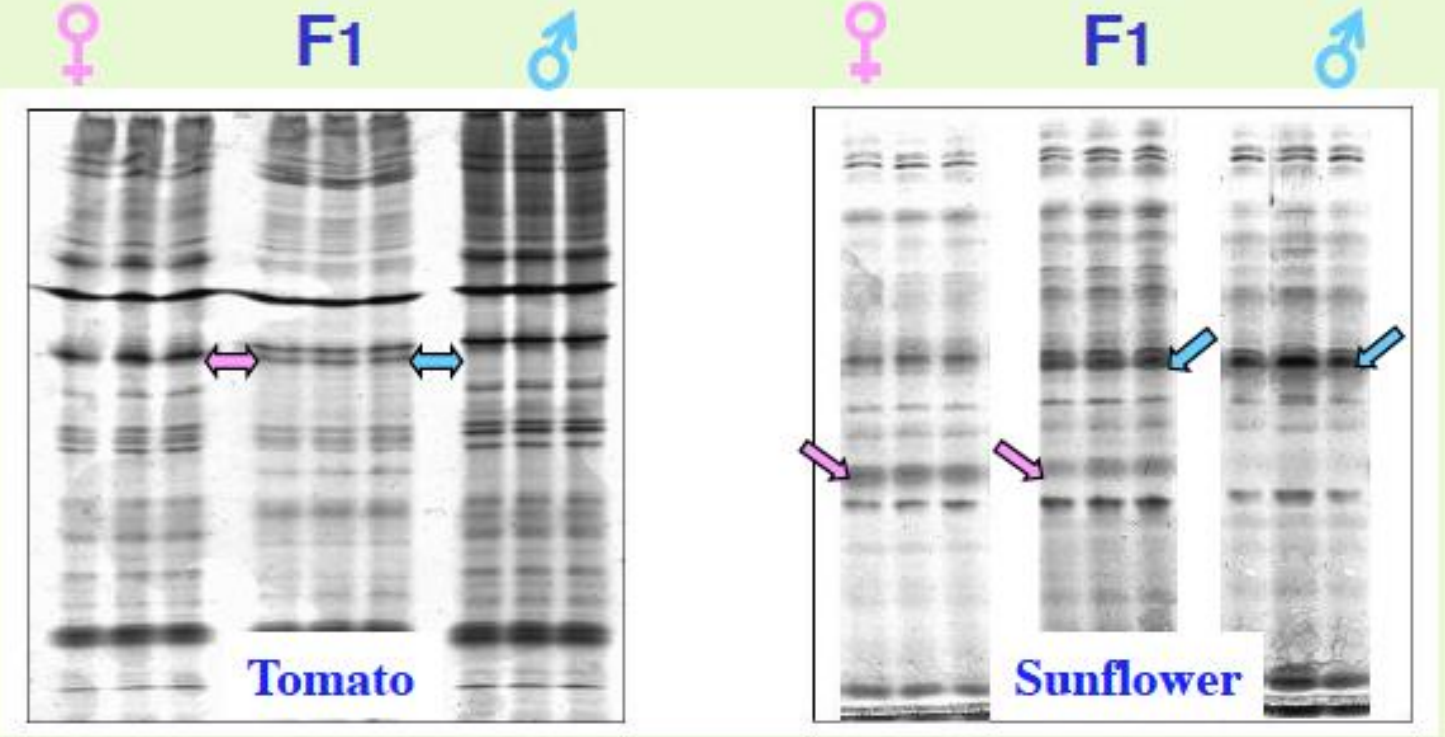
Genetic purity testing benefits for breeding programs

- Identification of any outcrossing present in breeder seed lots
- Assurance that high-value inbred selections are genetically pure and free of segregation
- Assurance of the purity of a line prior to the production of foundation seed
- Determination that the breeder seed selection is homozygous

CREDITS: EUROFINS BIODIAGNOSTICS

Modern methods

- **Protein reserves; electrophoresis**



- **Molecular markers: DNA extraction; PCR**
- **Microsatellites: Simple Sequence Repeats (SSR)**

Source: https://www.seedtest.org/upload/cms/user/S4.9.0900.Powell1.pdf

Biotechnology Trait/GMO Purity Testing

- Trait or lack of trait confirmation
  - Herbicide
  - Insecticide
  - Disease
  - Modified product (i.e. – Lysine, starch)
- Adventitious presence
- Low level presence

- Test methods
  - PCR
  - ELISA
  - Bioassys
  - Lateral flow strips

Example of an unreacted, negative (1-line) and positive (2-lines) test strip

Where to obtain seed quality tests?

- State (AOSA) and CIA labs
- Private labs (make sure they have RST on board and they are used to testing your crop).
- Self-test
- Seed testing is an extremely important step in farming or business, and it will be your cheapest input!

Remember, you wouldn't buy a car without a test drive - so don't sell seed without seed quality testing!

Labelling Treated And Coated Seed

General Information required on all labels

- Lot Number
- Kind and Variety
- Net Weight
- Origin
- Pure Seed
- Inert Matter
- Other Crop Seed
- Weed Seed (% by weight)

- Germination exclusive of hard or firm seed
- Percentage of hard seed
- Percentage of firm (dormant) seed.
- Total Germination plus hard seed
- Date of test
- Noxious weeds
- Name and Address of labeler

Treated Seed

- A statement in no less than eight point type indicating that the seed has been treated.
- Must include the commonly accepted coined, chemical, or abbreviated name used in such treatment in type no less than eight points.

- A caution statement if the substance used in such treatment in the amount remaining with the seed is harmful to humans or other vertebrate animals shall be labelled to show a statement such as “POISON”, “POISON TREATED”, or “TREATED WITH POISON”. The word “POISON” shall be in red letters on a distinctly contrasting background

- In addition, the label shall show a representation of a skull and crossbones at least the size of type used for the name of the substance and the statement indicating the seed has been treated.

- Seedtreated with other harmful substances(other than mercurials or similarly toxic substances), if the amount remaining with the seed is harmful to humans or other vertebrate animals, shall be labelled to show a caution statement, in type no smaller than eight points, such as : “DO NOT USE FOR FOOD, FEED, OR OIL.”

Coated (Encrusted) Seed

- When labelling coated(encrusted seed), the coating material must be accounted for on the label.
- There are two ways this can be done

1) Show the coating material as part of the inert matter

2) Show the coating material on a separate line

Kind and Variety	Pure Seed	Germination	Hard Seed	Total Germ and Hard Seed
Dixie Crimson Clover	48.05%	75%	5%	80%

Other Crop Seed: 0.16%
Inert Matter: 51.61%**
Weed Seed: 0.18%

Origin: OR
Net Weight: 50 LBS
Test Date: July 2018
Lot Number: L99-18-CC33333CTD

Noxious Weeds: (Name And Number Per Pound)

NONE FOUND

** Inert matter contains 50.00% coating material

ABC SEED CO.
111 Main Street
Anywhere, MS 39111

Kind and Variety	Pure Seed	Germination	Hard Seed	Total Germ and Hard Seed
Dixie Crimson Clover	48.05%	75%	5%	80%

Other Crop Seed: 0.16%
Inert Matter: 1.61%
Weed Seed: 0.18%
Coating Material: 50.00%

Origin: OR
Net Weight: 50 LBS
Test Date: July 2018
Lot Number: L99-18-CC33333CTD

Noxious Weeds: (Name And Number Per Pound)

NONE FOUND

ABC SEED CO.

111 Main Street

Anywhere, MS 39111

- The rules for treated seed also apply when treatments are included in the coating.

- Questions??

Treated Seed: Federal Seed Act Considerations

Steve Malone

U.S. OECD Seed Schemes Program Manager
USDA, AMS, LPS, Seed Regulatory and Testing Division

Gastonia, NC

Basic Labelling Requirements for Agricultural Seed

Sect. 201.8 – 201.24a – FSA Regulations

- Kind name
- Variety name or Variety Not Stated
- % Pure Seed
- % Other crop seed
- % Weed seed
- % Inert matter
- Noxious Weed Seeds - name and rate per/lb
- Origin (alfalfa, red clover, white clover, non-hybrid field corn)
- Percent Germination and Test Date
- Lot number
- Interstate shippers name and address or AMS #
- Inoculated seed- include expiration date
- Treatment (if treated)

§201.31a Labeling treated seed.

- (a) Contents of label. Any agricultural seed or any mixture thereof or any vegetable seed or any mixture thereof, for seeding purposes, that has been treated shall be labeled in type no smaller than 8 point to indicate that the seed has been treated and to show the name of any substance or a description of any process (other than application of a substance) used in such treatment, in accordance with this section; for example,
- Treated with _____ (name of substance or process) or _____ (name of substance or process) treated.
- If the substance used in such treatment in the amount remaining with the seed is harmful to humans or other vertebrate animals, the seed shall also bear a label containing additional statements as required by paragraphs (c) and (d) of this section. The label shall contain the required information in any form that is clearly legible and complies with the regulations in this part. The information may be on the tag bearing the analysis information or on a separate tag, or it may be printed in a conspicuous manner on a side or top of the container

- (b) *Name of substance*. The name of any substance as required by paragraph (a) of this section shall be the commonly accepted coined, chemical (generic), or abbreviated chemical name. Commonly accepted coined names are free for general use by the public, are not private trade-marks, and are commonly recognized as names of particular substances; such as thiram, captan, lindane, and dichlone. Examples of commonly accepted chemical (generic) names are: blue- stone, calcium carbonate, cuprous oxide, zinc hydroxide, hexachlorobenzene, and ethyl mercury acetate. The terms "mercury" or "mercurial" may be used in labeling all types of mercurials. Examples of commonly accepted abbreviated chemical names are: BHC (1, 2, 3, 4, 5, 6-Hexachlorocyclohexane) and DDT (dichloro diphenyl trichloroethane).

- (c) *Mercurials and similarly toxic substances.* (1) Seed treated with a mercurial or similarly toxic substance (Environmental Protection Agency Toxicity Category I), if any amount remains with the seed, shall be labeled to show a representation of a skull and crossbones at least twice the size of the type used for information required to be on the label under paragraph (a) and shall also include in red letters on a background of distinctly contrasting color a statement worded substantially as follows: "This seed has been treated with Poison," "Treated with Poison," "Poison treated," or "Poison". The word

  "Poison" shall appear in type no less than 8 point.

- (2) Mercurials and similarly toxic substances (Environmental Protection Agency Toxicity Category I) include the following:

  Aldrin, (technical), Demeton, Dieldrin, p-Dimethylaminobenzenediazo sodium sulfonate, Endrin, Ethion, Heptachlor, Mercurials (all types), Parathion, Phorate, Toxaphene, O - O - Diethyl-O-(isopropyl-4-methyl-6-py- rimidyl) thiophosphate, O, O-Diethyl-S-2-(ethylthio) ethyl phosphorodithioate

- Any amount of such substances remaining with the seed is considered harmful within the meaning of this section.

- (d) *Other harmful substances.* If a substance, other than one which would be classified as a mercurial or similarly toxic substance under paragraph (c) of this section, is used in the treatment of seed, and the amount remaining with the seed is harmful to humans or other vertebrate animals, the seed shall be labeled with an appropriate caution statement in type no smaller than 8 point worded substantially as follows: "Do not use for food," "Do not use for feed," "Do not use for oil purposes," or "Do not use for food, feed, or oil purposes." Any amount of any substance, not within paragraph (c) of this section, used in the treatment of the seed, which remains with the seed is considered harmful within the meaning of this section when the seed is in containers of more than 4 ounces, except that the following substances shall not be deemed harmful when present at a rate less than the number of parts per million indicated:
- Allethrin—2 p.p.m.
- Malathion—8 p.p.m.
- Methoxyclor—2 p.p.m.
- Piperonyl butoxide—8 p.p.m. on oat and sorghum and 20 p.p.m. on all other seeds.
- Pyrethrins—1 p.p.m. on oat and sorghum and 3 p.p.m. on all other seeds.

So what does 8 point mean?

- There is some variation in the exact size. Standards have changed through the years and proportionality based on the media.
- 8 point in different font styles.
- But generally 1 point of type seems to be about 1/72 of an inch or 0.35 mm.
- So, whatever 8/72nds works out to be
- However, the main point is that it is obvious, stands out from other printing on the label.

The rest of this slide is in 18 point, but this line is in 8 point

Where must treatment information be labelled?

- **§201.8 Contents of the label.**
- The label shall contain the required information in any form that is clearly legible and complies with the regulations in this part. The information may be on a tag attached securely to the container, or may be printed in a conspicuous manner on a side or the top of the container. The label may contain information in addition to that required by the act, provided such information is not misleading.
- Analysis label
- Certification label
- On the container
- On a separate tag provided by treatment manufacturer

Records
§201.2

- (l) Complete record. (1) The term "complete record" means information which relates to the origin, treatment, germination, and purity (including variety) of each lot of agricultural seed transported or delivered for transportation in interstate commerce, or which relates to the treatment, germination, and variety of each lot of vegetable seed transported or delivered for transportation in interstate commerce. Such information includes seed samples and records of declarations, labels, purchases, sales, cleaning, bulking, treatment, handling, storage, analyses, tests, and examinations.

Do I need a new lot number for treated seed?

- **YES**
- §201.2v) *Lot of seed.* The term "lot of seed" means a definite quantity of seed identified by a lot number, every portion or bag of which is uniform, within permitted tolerances, for the factors which appear in the labeling.
- When treated, the characteristics of the lot have been changed.
- Therefore, it should be assigned a new lot number
- Traceable to the original lot, absolutely, but it is a new lot.

Inoculated Seed

- **§201.24a Inoculated seed.**
- Seed claimed to be inoculated shall be labeled to show the month and year beyond which the inoculant on the seed is no longer claimed to be effective by a statement such as, “Inoculant not claimed to be effective after____(Month and year).”

Biologicals

- Not Currently addressed in the FSA regulations but an update is under consideration
- How to label and keep records of Biological seed treatment products?
- Coordination with regulations of other agencies such as EPA, FDA.
- Label & Recordkeeping responsibility of Seed Company vs. product manufacturer
  - Product claims
  - Effect on seed quality
  - Shelf-life of product (expiration date different from test date of the seed)
- Similar to current requirements for seed treatments?
  - Or more similar to those for inoculants?
- Opportunity to work closely with the seed industry to get this right!

Seed Regulatory & Testing Division
801 Summit Crossing Place, Suite C
Gastonia, NC 28054
704-810-8871

https://www.ams.usda.gov/rules-regulations/fsa