



# Fungicide Applications to Mitigate Soybean Stress



**Jason Carr**

5/27/2017







# Agenda

- // Fungicidal seed treatments
- // Foliar fungicide applications
- // Choosing the correct product and application method
- // Research results



# *Introduction to fungi and fungicides*

**Plant Pathology 101**



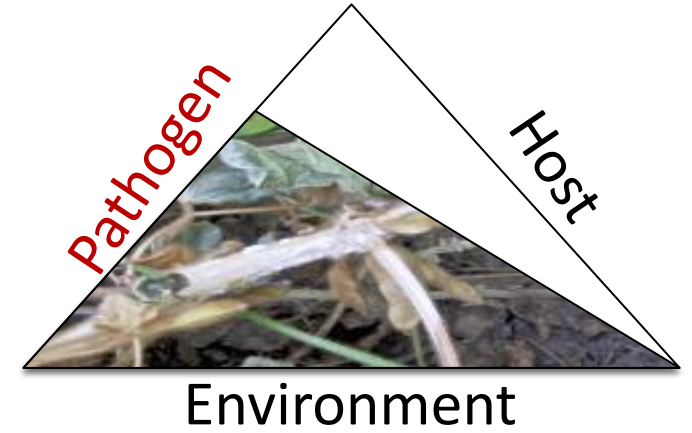
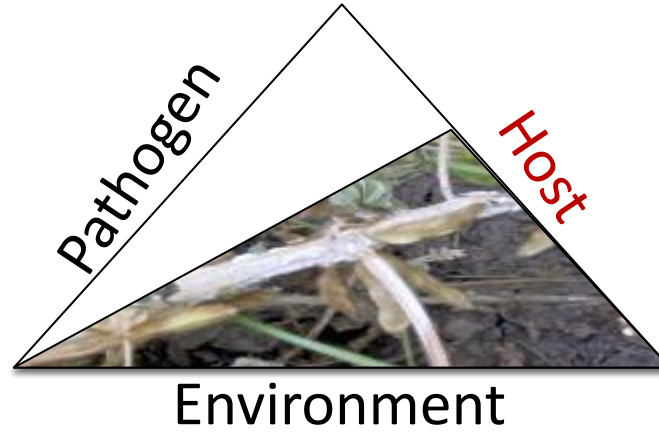
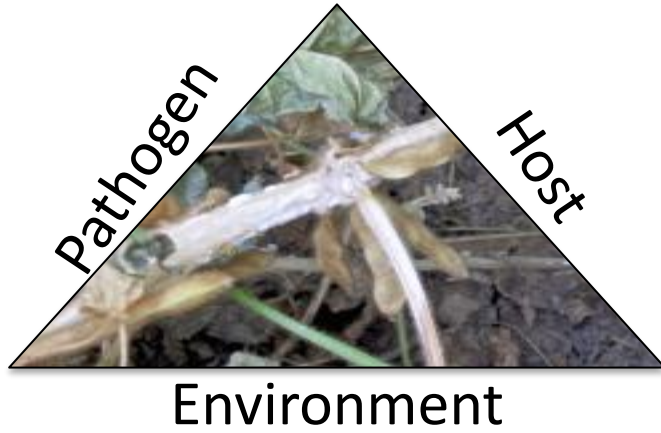
# What is a Fungus?

A group of unicellular, multicellular, or syncytial spore-producing **organisms feeding on organic matter due to the lack of chlorophyll**

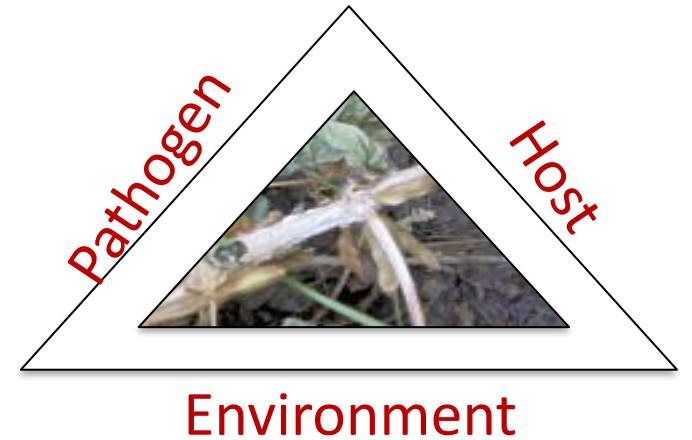
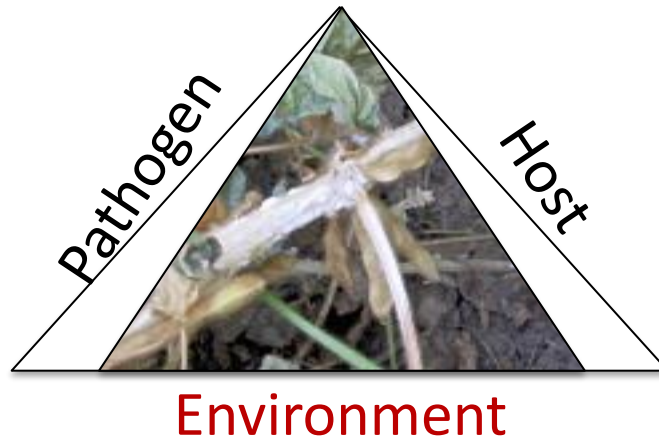
Attack crops **above and below soil** surface

**Spread** by wind, rain, insects, birds, machinery and contaminated seed

# Plant Disease Triangle



- Disease only occurs if three things exist all at the same time
  - Pathogen
  - Host
  - Environment
- Manipulating a component or combinations of triangle components influences the incidence and severity of disease





# Resistance (Genetic)

The prevention or **slowing down of a successful infection by the pathogen in the host**. The parasite coexists with the host.

Most economically-efficient and environmentally friendly way to control disease

Highly desirable and ideal; may be difficult to find

In the pathogen, pathogenicity factors such as toxins, enzymes, hormones, etc, are under genetic control

**In the host, susceptibility/resistance is usually controlled by the genetics of the host**



# Protection (Chemical)

**Prevention of infection and establishment of a pathogen** in a susceptible host.

The pathogen coexists in the area with the host; contact between pathogen and host is made.

**Protection usually happens before infection.**



# What is a fungicide and why are they needed?

A fungicide is an agent that destroys fungi or inhibits their growth

**Why** are they needed?

- // **To control** a disease during the establishment and development of a crop
- // **To increase** productivity of a crop
- // **To improve** the storage life and quality of harvested material










# *Fungicidal seed treatments*

**What is their value?**

# Soybean seedling diseases



Disease	Causal agent	Symptoms	Conditions favoring development	Notes	
Pythium	<i>Pythium spp.</i>	Damping off	cool and wet	Resistance to metalaxyl and mefenoxam has been documented.	
Phytophthora	<i>Phytophthora sojae</i>	Damping off	cool and wet	Resistant genetics aid in control.	
Rhizoctonia	<i>Rhizoctonia solani</i>	Damping off	warm and dry	Usually occurs in early to mid summer.	
Fusarium	<i>Fusarium spp.</i>	Damping off	cool and wet	Same genus as SDS.	
Phomopsis	<i>Diaporthe longicola</i>	moldy, shrivelled seeds	warm and wet	More of a problem in seed fields.	



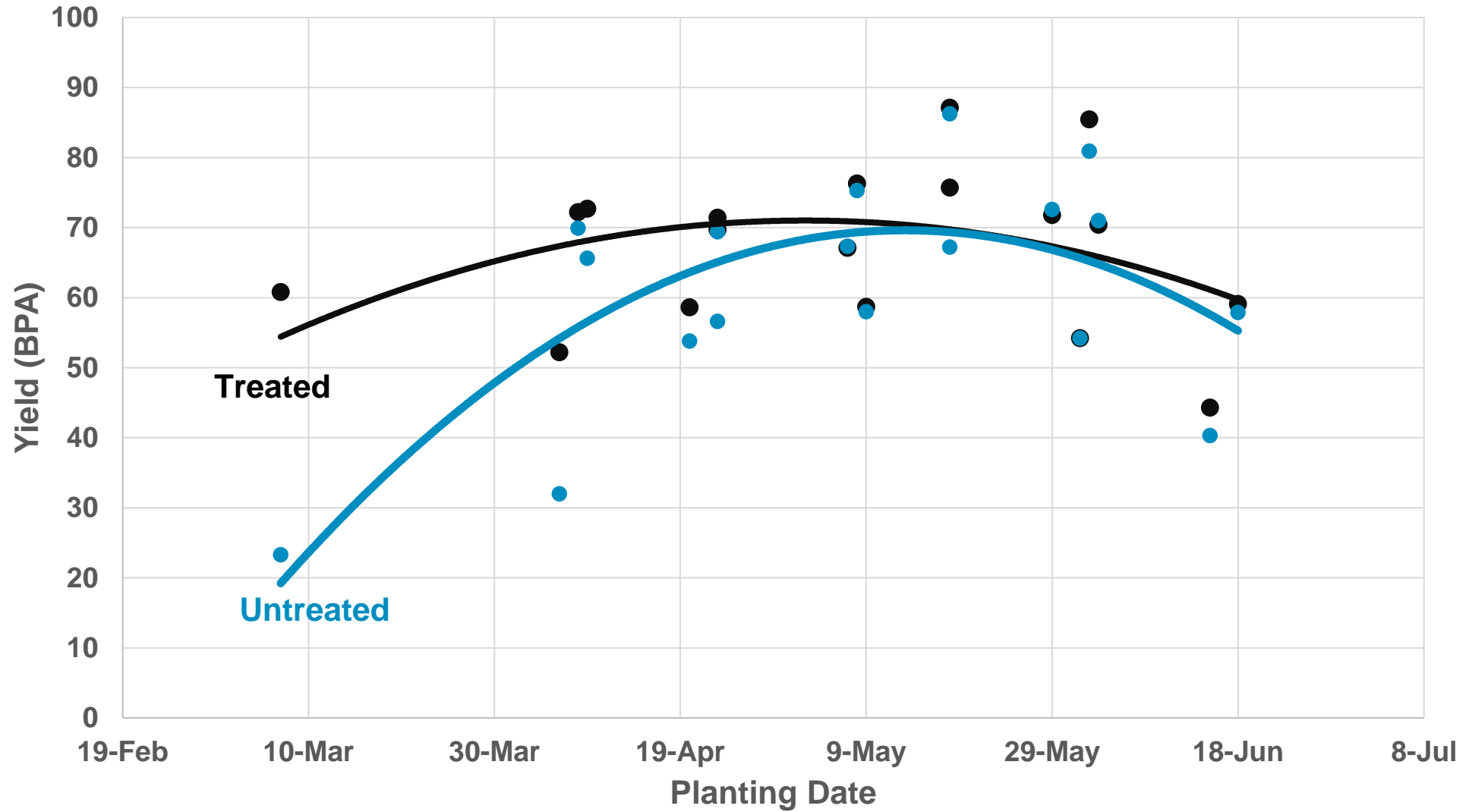
# Fungicidal seed treatments

Fungicidal components of Acceleron® seed treatment

Fungicide Active Ingredient	<i>Pythium</i>	<i>Phytophthora</i>	<i>Rhizoctonia</i>	<i>Fusarium</i>	Sudden Death Syndrome (SDS)	<i>Phomopsis</i>
Azoxystrobin	P-G	N	VG	F-G	N	P
Carboxin	U	U	G	U	N	U
Ethaboxam	E	E	N	N	N	N
Fludioxonil	N	N	G	F-VG	N	G
Fluopyram	N	N	N	N	VG	N
Fluxapyroxad	U	U	E	G	N	G
Ipconazole	P	N	F-G	F-E	N	G
Mefenoxam	E	E	N	N	N	N
Metalaxyl	E	E	N	N	N	N
Oxathiapiprolin	P-G	E	N	N	N	N
PCNB	N	N	G	U	N	G
Penflufen	N	N	G	G	N	G
Prothioconazole	N	N	G	G	N	G
Pyraclostrobin	P-G	N	F-G	F	N	G
Sedaxane	N	N	E	N	N	G
Thiabendazole	N	N	N	N	P	G
Trifloxystrobin	P	P	F-E	F-G	N	P-F

Source: University of Illinois (2019) [http://cropdisease.cropsciences.illinois.edu/wp-content/uploads/2019/06/2019-Soybean-Seed-Treatment-Fungicide-Efficacy-Table\\_final.pdf](http://cropdisease.cropsciences.illinois.edu/wp-content/uploads/2019/06/2019-Soybean-Seed-Treatment-Fungicide-Efficacy-Table_final.pdf)

# Yield performance of treated vs. untreated seed 2019-2020





# *Foliar Fungicide Treatments*

- **Benefits**
- **Choosing the correct product**
- **Timing**
- **Application method**





# Fungicides are Important Agronomic Tools

- **Value of fungicides** has been proven
- Many of the popular varieties, hybrids, and cultivars with the most yield potential respond dramatically to fungicide applications
- Higher plant populations – **denser canopy**
- Reduced tillage – more **crop residue**
- **Increase ROI** on increasingly expensive inputs
- Even so, still many **untreated acres that would benefit from a fungicide treatment**





# Contact vs. Systemic Fungicides

## Contact/Protectant

- Adsorbed
- Immobile
- Preventive
- Multi site of action
- Few problems with resistance

## Systemic

- Absorbed
- Mobile
- Preventive + Curative
- Single site of action
- Resistant fungi strains could develop



## Fungicide classes used as foliar fungicides for field crop production

Quinone outside inhibitors (QoIs; strobilurins)

11

Demethylation inhibitors (DMIs; triazoles)

3

Succinate dehydrogenase inhibitors (SDHIs)

7



# Qol fungicides (FRAC Code 11)

11

Qol = quinone outside inhibitor

Strobilurin fungicides are in this group:

- // Azoxystrobin (Quadris<sup>®</sup>; 1 a.i. in Quilt Xcel<sup>®</sup>)
- // Pyraclostrobin (Headline<sup>®</sup>; 1 a.i. in Headline AMP<sup>®</sup>)
- // Trifloxystrobin (Gem<sup>®</sup> and Flint<sup>®</sup>; 1 a.i. in Stratego<sup>®</sup> YLD, Delaro<sup>®</sup>, and Delaro<sup>®</sup> Complete)
- // Fluoxastrobin (Evito<sup>®</sup>)
- // Picoxystrobin (Aproach<sup>®</sup>)

Work best when applied preventatively

- // Very good activity on germinating spores



# Some things strobilurins do

Broad spectrum fungal activity

Interfere with mitochondrial electron transport

Primarily inhibit spore germination

Preventive with very limited curative activity

Trigger physiological reactions in the plant

// Inhibit ethylene production, slowing stress reactions

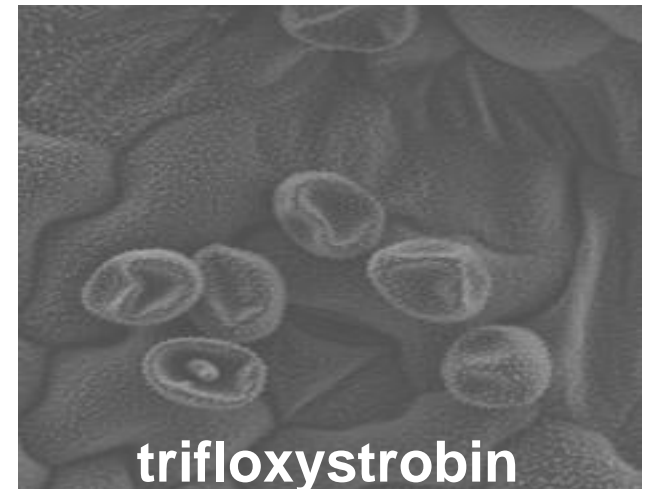
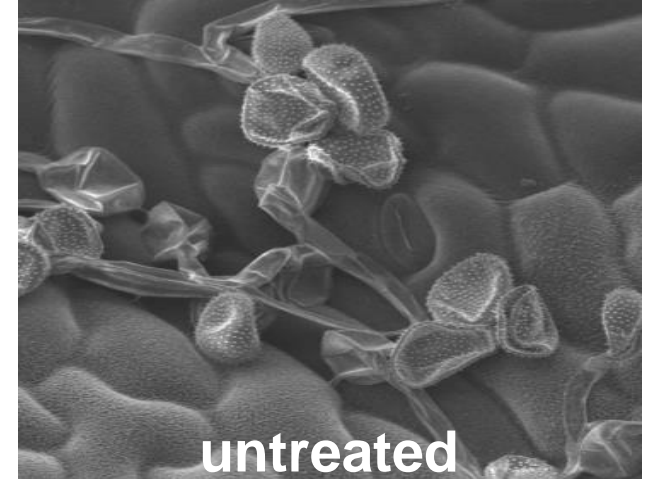
// Promote lignification of cell walls

// Improve utilization of limited resources

Promote yield increases, even without diseases

Prone to resistance development

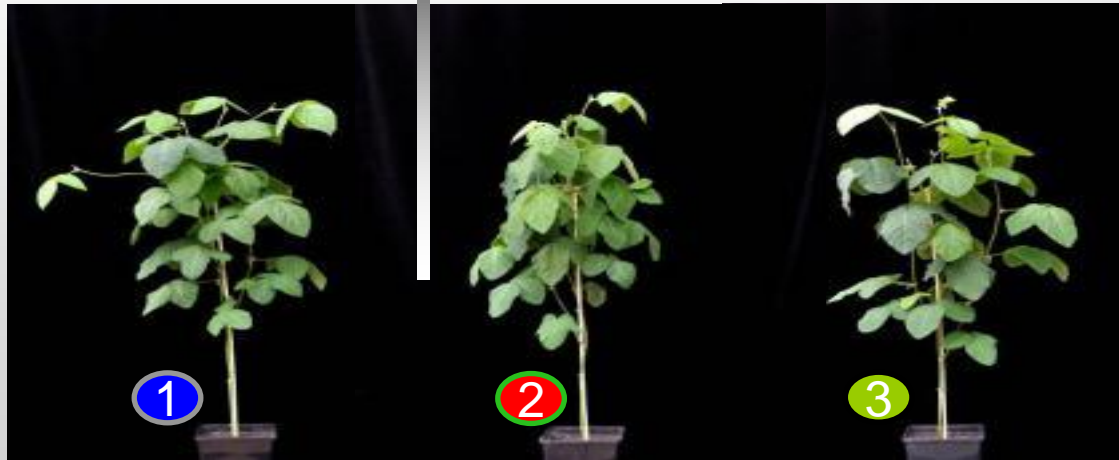
11



Electron micrographs of Asian Soybean Rust in plant tissue



- ① well-watered
- ② restricted water supply  
4 days of  
severe moisture stress
- ③ restricted water supply + Stratego<sup>®</sup> YLD



▶ Example: Stratego<sup>®</sup> YLD improves the moisture stress tolerance of soybeans



# DMI fungicides (FRAC 3)

3

DMI = demethylation inhibitors

**Preventative, Curative, Protective, Penetrant**

Includes the triazole fungicides:

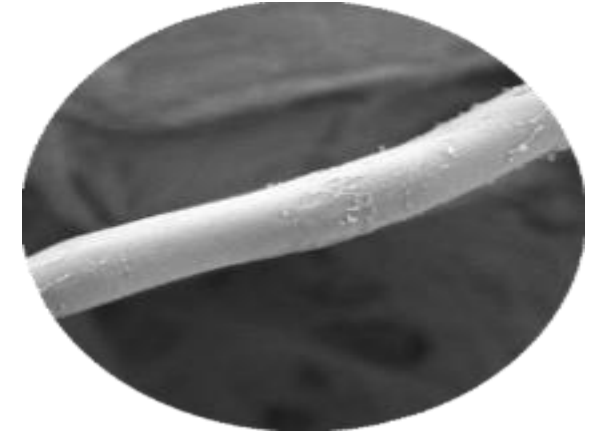
- // Prothioconazole (Proline<sup>®</sup>; a.i. Stratego<sup>®</sup> YLD/Delaro<sup>®</sup>)
- // Tebuconazole (Folicur<sup>®</sup>, multiple generics)
- // Propiconazole (Tilt<sup>®</sup>; a.i. Quilt<sup>®</sup>/Trivapro<sup>®</sup>)
- // Metconazole (Caramba<sup>®</sup>; a.i. Headline<sup>®</sup> AMP)
- // Tetraconazole (Domark<sup>®</sup>)
- // Flutriafol (Topguard<sup>®</sup>; a.i. Fortix<sup>®</sup>)
- // Cyproconazole (Alto<sup>®</sup>; a.i. Aproach<sup>®</sup> Prima)



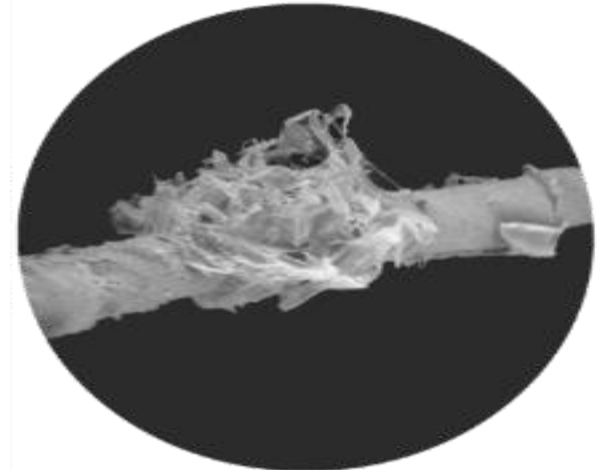
# Some things triazoles do

- **Broad spectrum** fungal activity
- Interferes with **sterol production**
- Primarily **disrupts membrane production**
- **Preventive and curative activity**
- Can also trigger physiological reactions
- Yield increases mostly related to **disease control**
- **Moderate risk of resistance** development
  - // Higher rates can compensate
  - // Population shifts to normal sensitivity distribution when triazole use discontinues

3



**untreated**



**prothioconazole**



# Succinate Dehydrogenase Inhibitors (SDHIs) (FRAC Code 7)

7

SDHI = Succinate Dehydrogenase Inhibitors

// **Preventative, w/ some Curative**

Includes the SDHIs fungicides:

- // Boscalid (Endura<sup>®</sup>)
- // Fluxapyroxad (a.i. Priaxor<sup>®</sup>)
- // Bensovindiflupyr (Solatenol<sup>®</sup>; a.i. Trivapro<sup>®</sup>)
- // Fluopyram (Luna<sup>®</sup>, Propulse<sup>®</sup>, Delaro<sup>®</sup> Complete)

Have locally systemic to systemic properties through the xylem

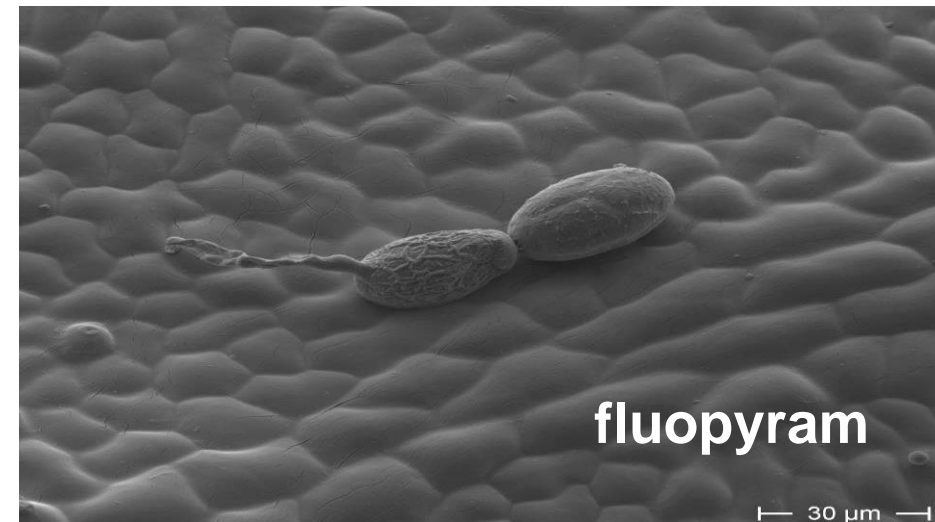
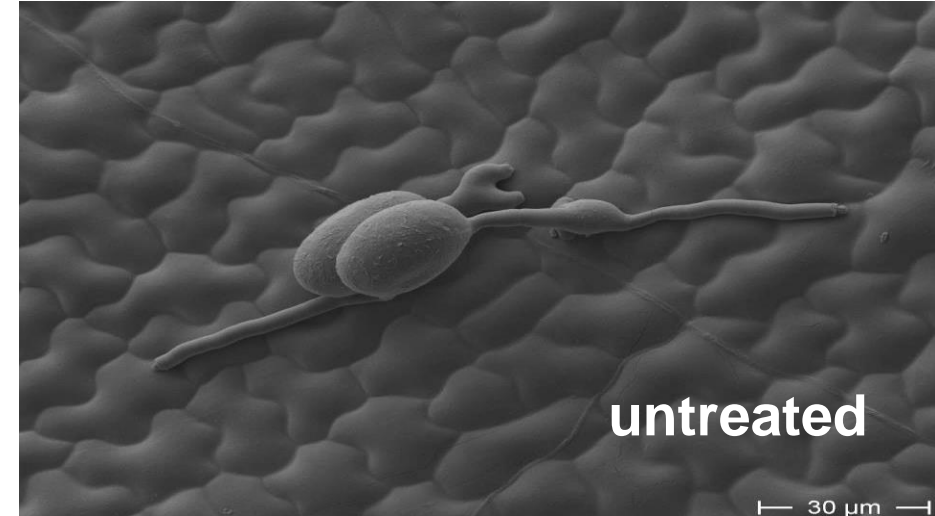
Inhibit fungal respiration



## Some things SDHI's do

- High specific activity on selected pathogens, chemistry dependent
- Interferes with energy production
- Primarily preventive with some curative activity on surface infections
- High risk of resistance development

7





# Importance of Multiple Modes of Action

## Broaden performance

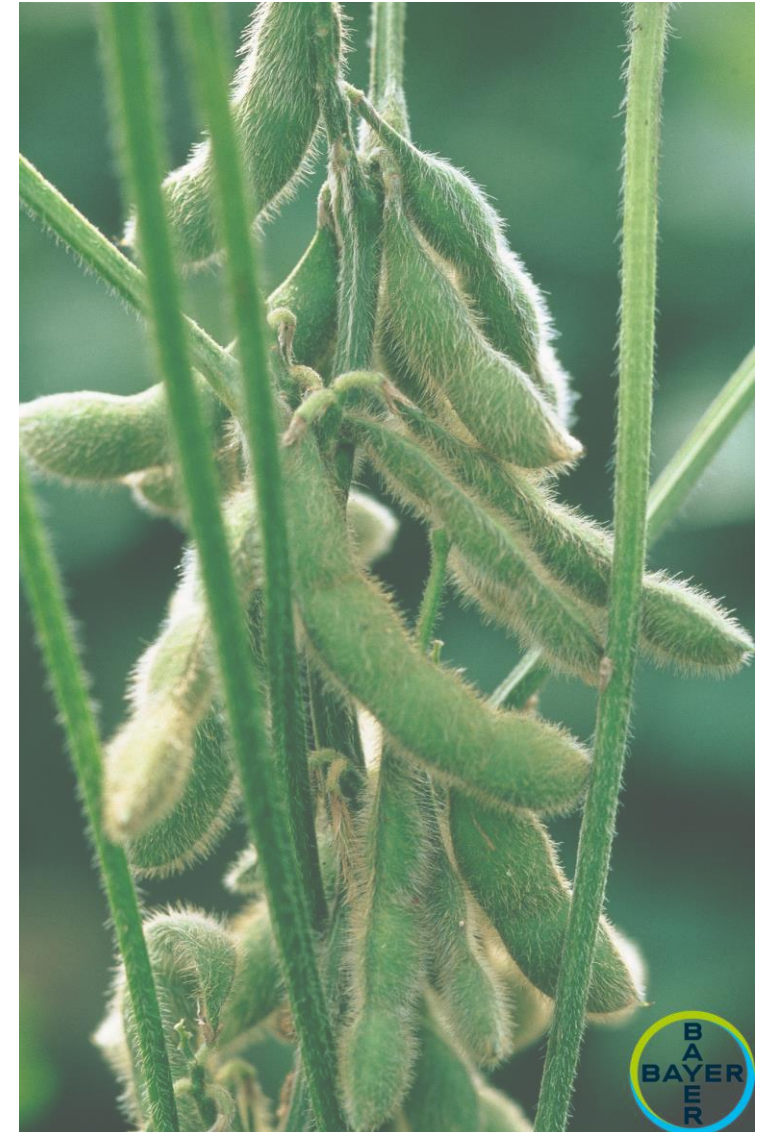
- // Combine strengths
- // Increase consistency across weather conditions

## Attack the fungi in multiple ways

- // e. g., strobilurins and SDHI's inhibit respiration (spore germination), while triazoles affect sterol biosynthesis (membrane production)
- // Both preventive and curative is good

## Critical for resistance management

- // More than one must have activity on pathogens
- // Mixtures are better than solos





# What does an active ingredient actually contribute?

**DELARO<sup>®</sup> Complete**

**PROTHIOCONAZOLE GROUP 3 FUNGICIDE**  
**TRIFLOXYSTROBIN GROUP 11 FUNGICIDE**  
**FLUOPYRAM GROUP 7 FUNGICIDE**

For: control of certain diseases and plant health in Corn, Soybean, Sweet corn and Wheat.

**ACTIVE INGREDIENT:**  
 Prothioconazole, 2-[2-(1-Chlorocyclopropyl)-3-(2-chlorophenyl)-2-hydroxypropyl]-1,2-dihydro-3H-1,2,4-triazole-3-thione: 14.90%  
 Trifloxystrobin, (E,E)-alpha-(methoxyimino)-2-[[[1-[3-(trifluoromethyl)phenyl]ethylidene]amino]oxy]methyl-methyl ester: 13.10%  
 Fluopyram: N-[2-[3-chloro-5-(trifluoromethyl)-2-pyridinyl]ethyl]-2-(trifluoromethyl)benzamide: 10.90%  
**OTHER INGREDIENTS:** 61.10%  
**TOTAL: 100.00%**

Contains 1.47 pounds Prothioconazole, 1.29 pounds Trifloxystrobin and 1.07 pound Fluopyram per U.S. gallon  
 EPA Reg. No. 264-1207

**KEEP OUT OF REACH OF CHILDREN CAUTION**

For **MEDICAL** And **TRANSPORTATION** Emergencies **ONLY**  
 Call 24 Hours A Day 1-800-334-7577

For **PRODUCT USE** Information Call 1-866-99BAYER  
 (1-866-992-2937)

See Back Panel for First Aid Instructions and Booklet for Complete Precautionary Statements and Directions for Use.

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 St. Louis, MO 63167  
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**PROLINE<sup>®</sup> 480 SC Fungicide**

Net Contents: 2.5 Gallons

**ACTIVE INGREDIENT:**  
 Prothioconazole, 2-[2-(1-Chlorocyclopropyl)-3-(2-chlorophenyl)-2-hydroxypropyl]-1,2-dihydro-3H-1,2,4-triazole-3-thione: 41.0%  
**OTHER INGREDIENTS:** 59.0%  
 Contains 4 pounds Prothioconazole per gallon TOTAL: 100.0%

**FLINT<sup>®</sup> Extra**

Net Contents: 1 Gallon

**ACTIVE INGREDIENT:**  
 Strobilactone, 2-(2-chlorophenyl)-2-(2,4-dichlorophenyl)-1,3-dioxane-5-carboxamide: 42.0%  
**OTHER INGREDIENTS:** 58.0%  
 Contains 4.0 pounds Strobilactone per U.S. gallon TOTAL: 100.0%

**Luna PRIVILEGE**

Net Contents: 2.5 Gallons

**ACTIVE INGREDIENT:**  
 Fluopyram, 2-[2-(3-chloro-5-(trifluoromethyl)-2-pyridinyl)ethyl]-2-(trifluoromethyl)benzamide: 41.8%  
**OTHER INGREDIENTS:** 58.2%  
 Contains 1.07 pounds Fluopyram per U.S. gallon TOTAL: 100.0%

What do the products do on their own?

- Proline (Triazole/DMI):
  - White Mold
  - Rust
  - Septoria (Brown Spot)
  - Cercospora (FLS)
- Flint (strobi):
  - Cercospora (FLS)
  - Rust
  - Fusarium
- Luna Privilege (SDHI)
  - Cercospora (FLS)
  - Septoria (Brown Spot)
  - White Mold





# Fungicide applications protect yield potential by helping soybeans manage stress.



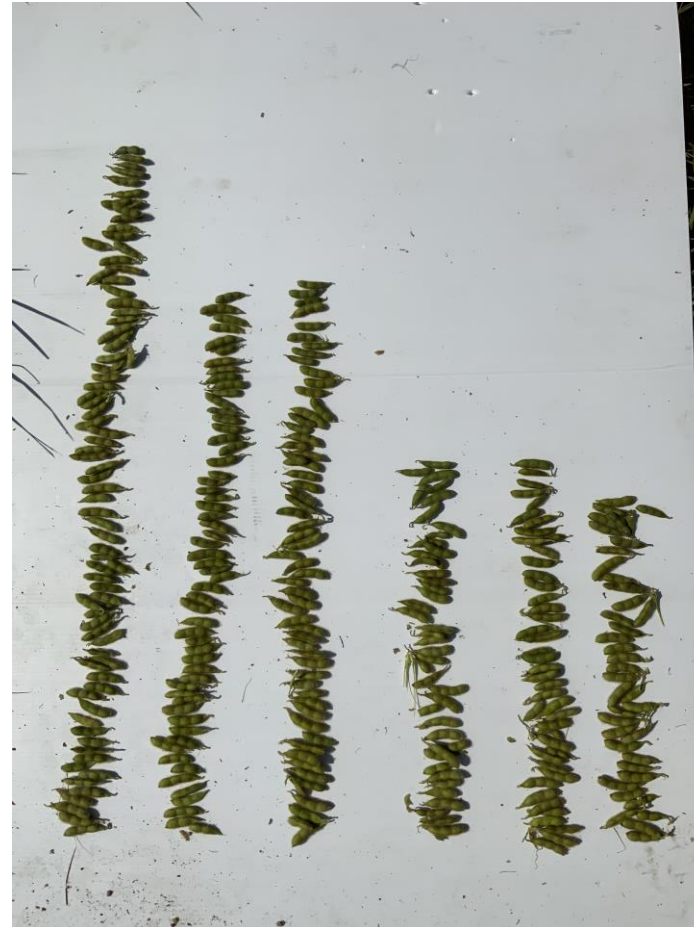
Wayne County Soybean Side by Side



# Wayne County Soybean Side by Side



Treated vs. untreated



Treated vs. untreated





Untreated

Delaro +  
Leverage 360








# How do I know whether or not to spray?

## Fungicide Spray Checklist

- // Frequent rainfall, dew and humidity (free moisture on leaf surface for 10+ hours)
- // Crop rotation (corn-on-corn, soybean-on-soybean)
- // Reduced or no-till practices
- // Late planting date (more important in corn)
- // Disease-susceptible hybrid / variety
- // Field subjected to stress (hail, dryness, etc.)
- // Early evidence of diseases in the field
- // History of disease or lodging issues in the field
- // Grain sold for seed or premium market

**The more criteria met, the more likely you will see a yield bump.**

## Weekly Disease Forecast

### Corn Gray Leaf Spot Risk Forecast

For period of July 9 – Aug 7, Issue Date: July 10, 2016

#### One-Month Weather Outlook

Over the next 30 days temperatures are to be generally above normal with normal precipitation. Higher rainfall is predicted for the southwestern areas of the forecast map (northern Missouri, southern Iowa and eastern Nebraska).

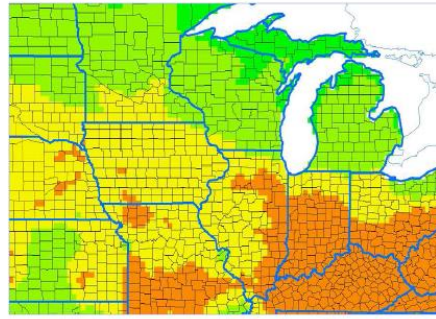
#### Gray Leaf Spot Risk Summary

The risk of gray leaf spot is high in the eastern Corn Belt and parts of NE, KS, IA and MO.

#### Next two-week risk interpretation

The risk of this disease is high for KY, most of IN, and large parts of OH, MO, and IL. Most of the remainder of the Corn Belt is at moderate risk. For fields located in high risk areas for consecutive weeks or are showing GLS symptoms, treatment is advised, even if the plants have not yet reached reproductive stages.


#### One-month risk map



What to do?	
High	Treat susceptible hybrids and weigh risk factors for other fields
Moderate	Scout fields and treat as conditions warrant
Low or Very low	Monitor risk forecasts

**DISCLAIMER**  
The forecast herein is made with state of the art computer modeling technology. However, the models do not guarantee accuracy or certainty of information because of the uncertainty in climate forecast which is used for disease modeling and because of environmental variation. We specifically disclaim all warranties expressed or implied with respect to the use of this information.

**Risk Level**  
Very-low Low Moderate High



Science For A Better Life



# Timing and method of fungicide application

- In general, soybeans should be sprayed R2-R4.
  - Normally a wide window in which we see a yield response.
  - Exception for certain diseases such as White Mold.
- Better efficacy in conditions of higher humidity.
  - Mid-day can have higher evaporation = less absorption.
- Our research shows similar responses to aerial and ground application.

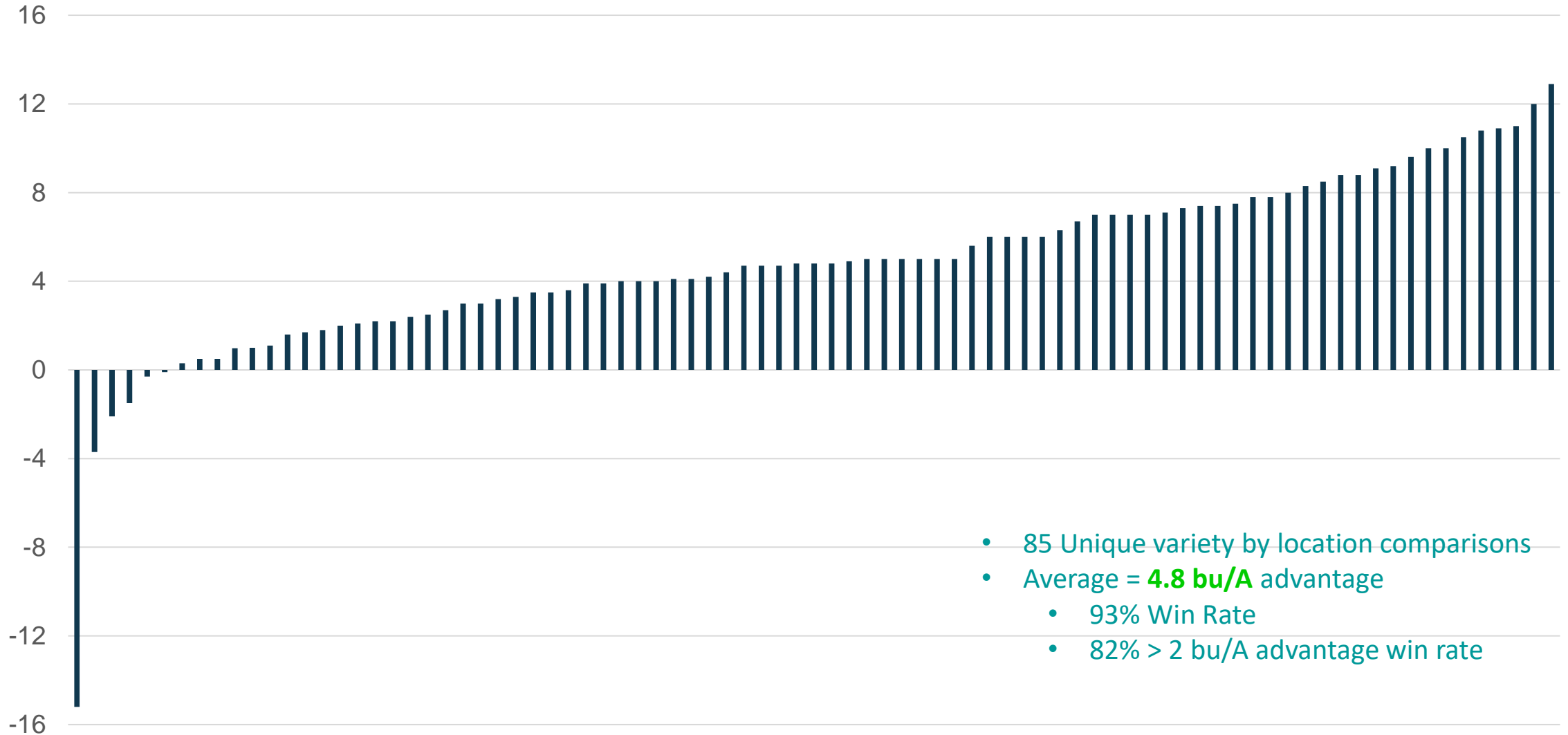




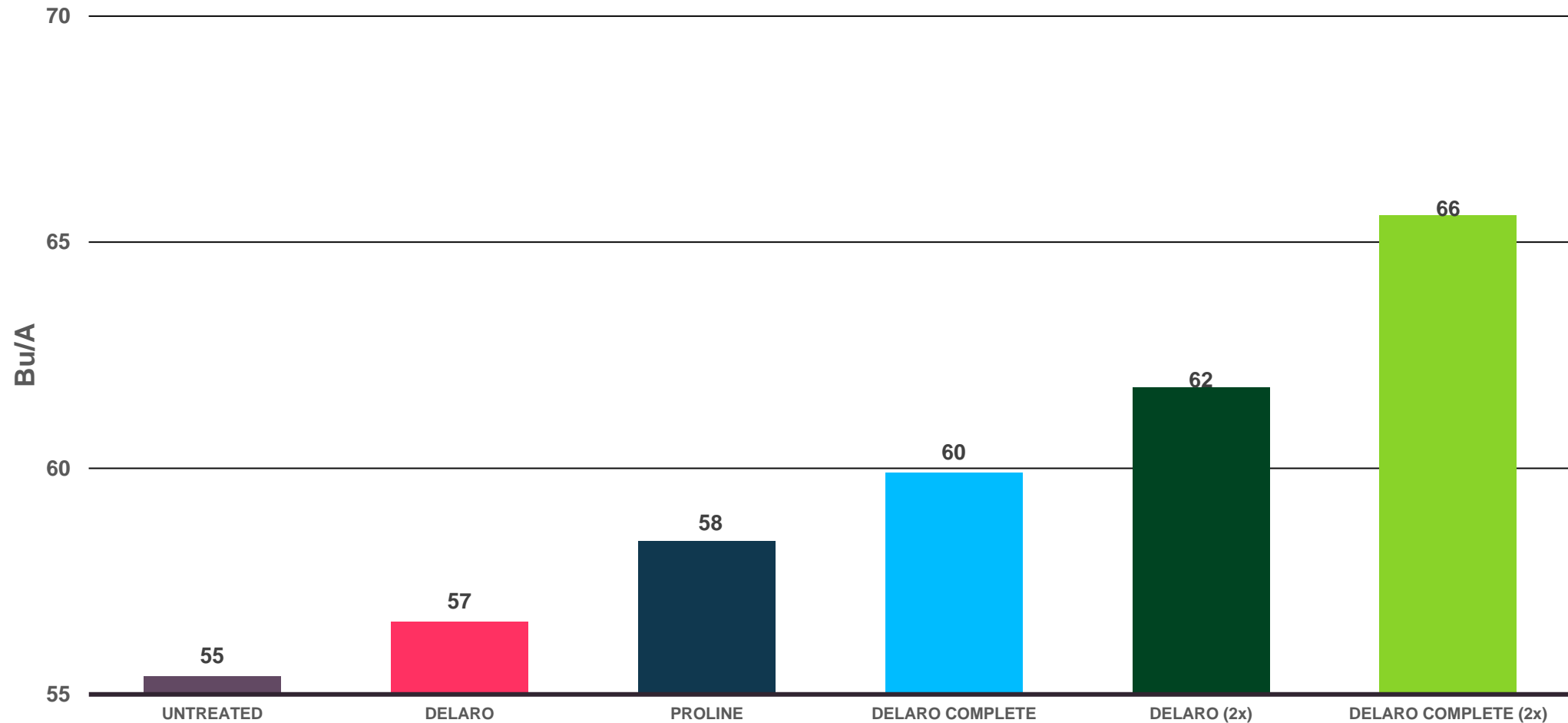
# *Local research*

**Results from local FOCUS site trials**

### 2020 Delaro® Complete vs Untreated on Soybean



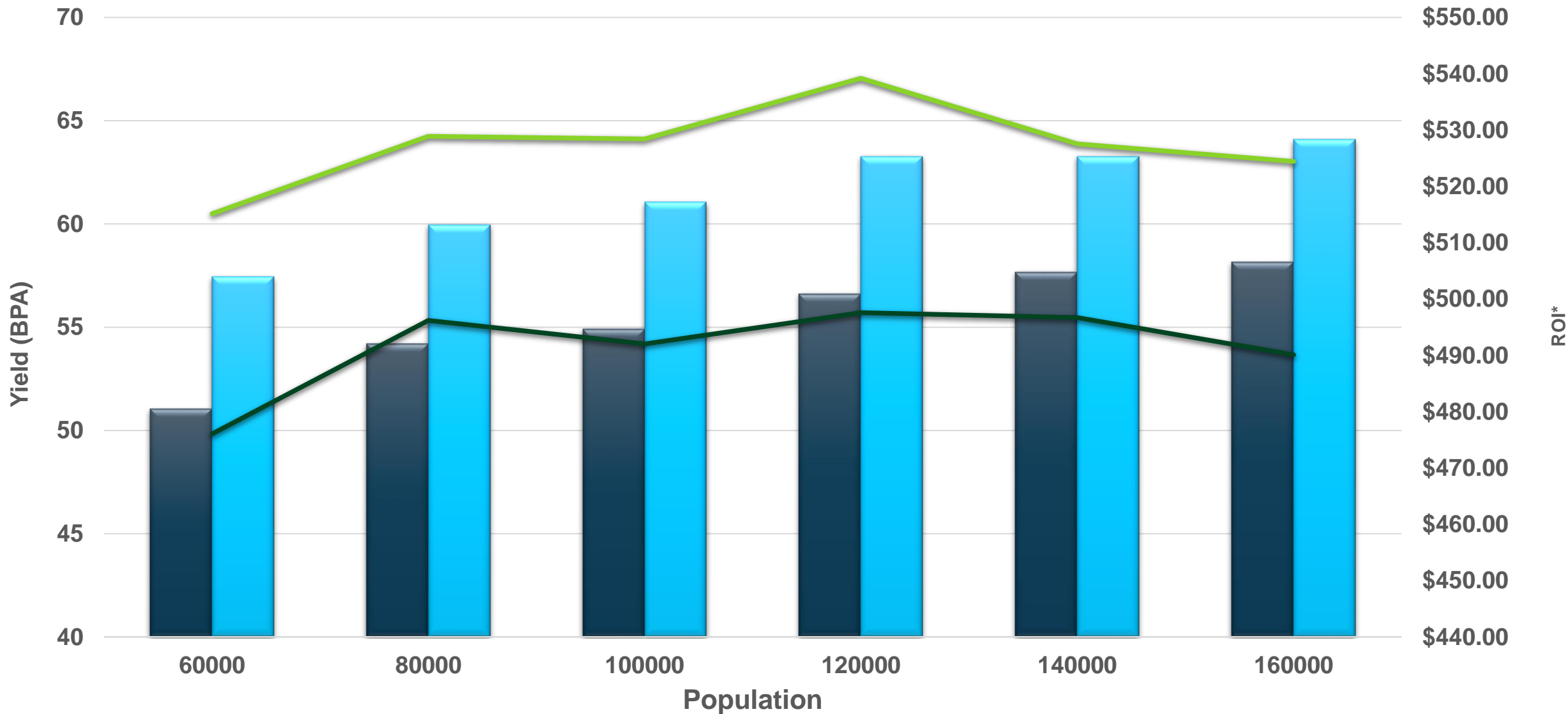
## 2019 Yield response to fungicide in fields with heavy white mold pressure



Data represented within this page were derived from Bayer internal small plat trials across Midwestern states.

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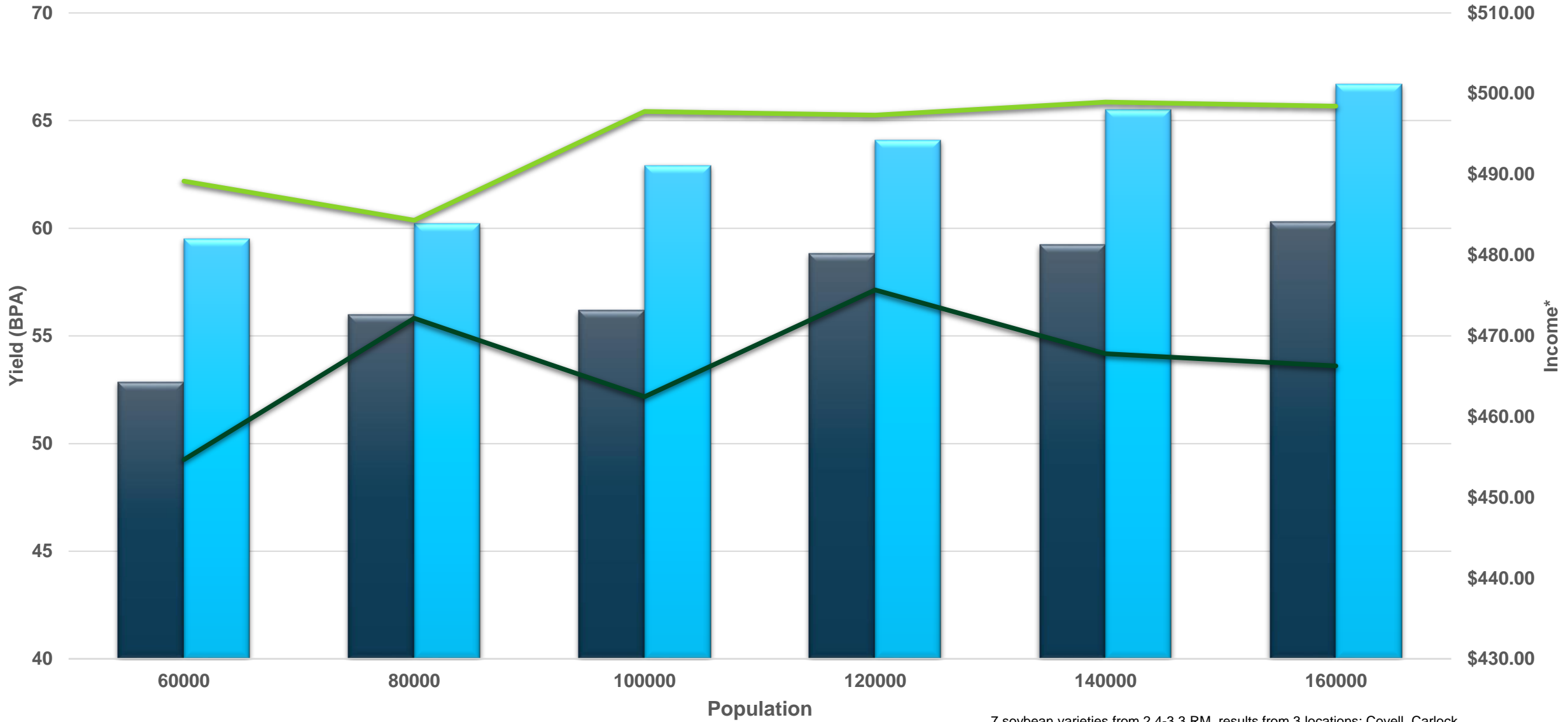
# Soybean yield response to fungicide and variable population 2019-2020



26 soybean varieties from 2.2-3.9 RM, results from 7 site years in central and northern Illinois.

\* Assumes seed cost of \$80/unit, application cost of \$25/acre, and grain value of \$10/bushel

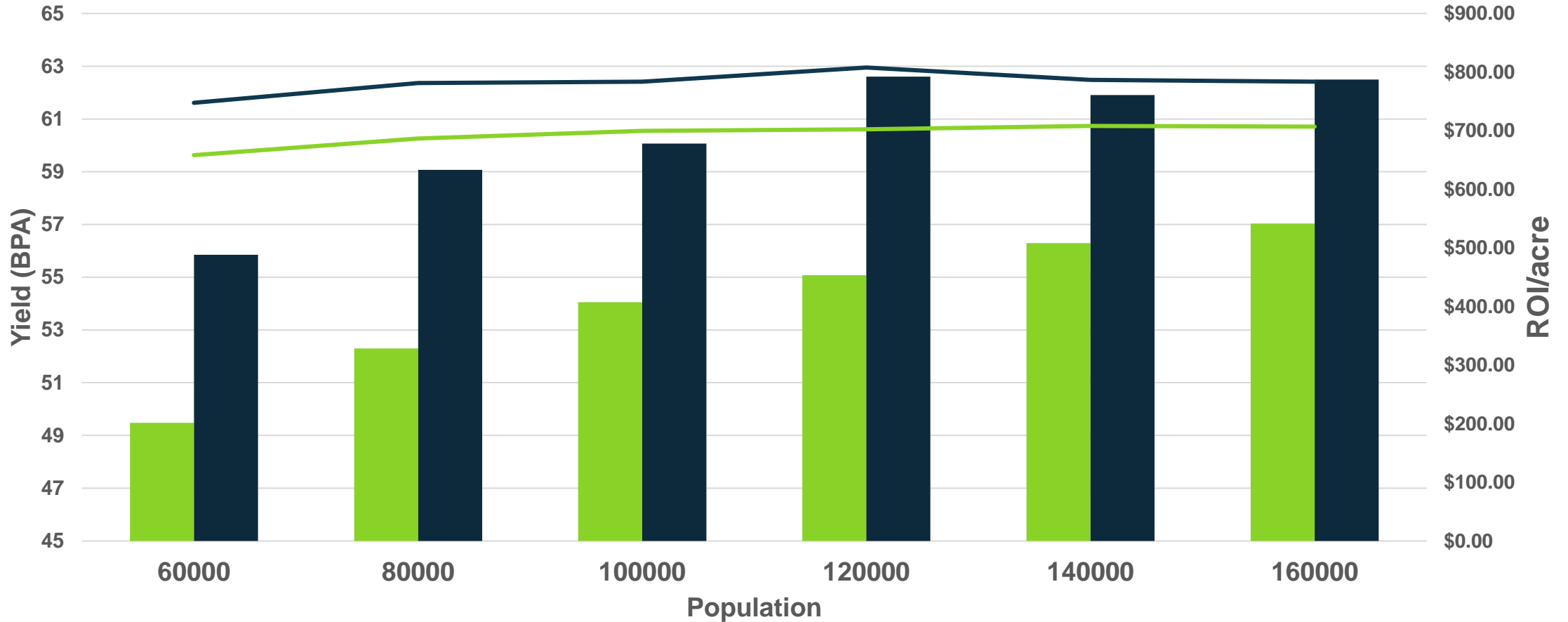
# Soybean yield response to fungicide and variable population in 2019



7 soybean varieties from 2.4-3.3 RM, results from 3 locations: Covell, Carlock, and Roanoke, IL planted May 20- June 4.

\* Assumes seed cost of \$80/ unit, and grain value of \$9.25/acre

# Soybean yield response to fungicide and variable population in 2020

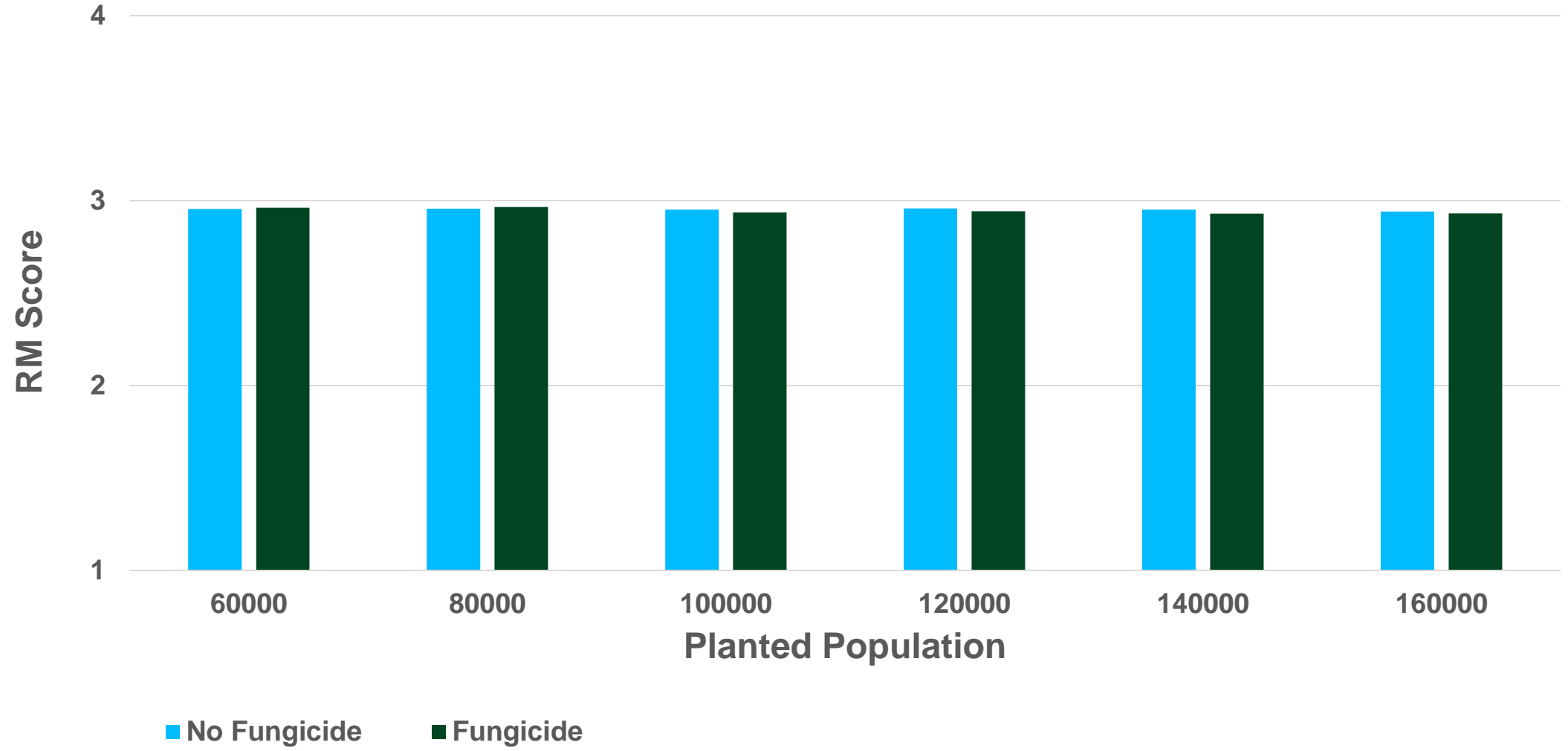


- No Fungicide
- Fungicide
- ROI - no Fungicide
- ROI - with Fungicide

ROI calculation based on seed cost of \$80/ unit, fungicide \$25/ acre, and soybean value of \$10/ bushel

12 varieties (2.2-3.6 RM) across 4 locations (Covell, Danvers, Roanoke, Newark) – small plots

## Fungicide effect on maturity in variable populations in 2020

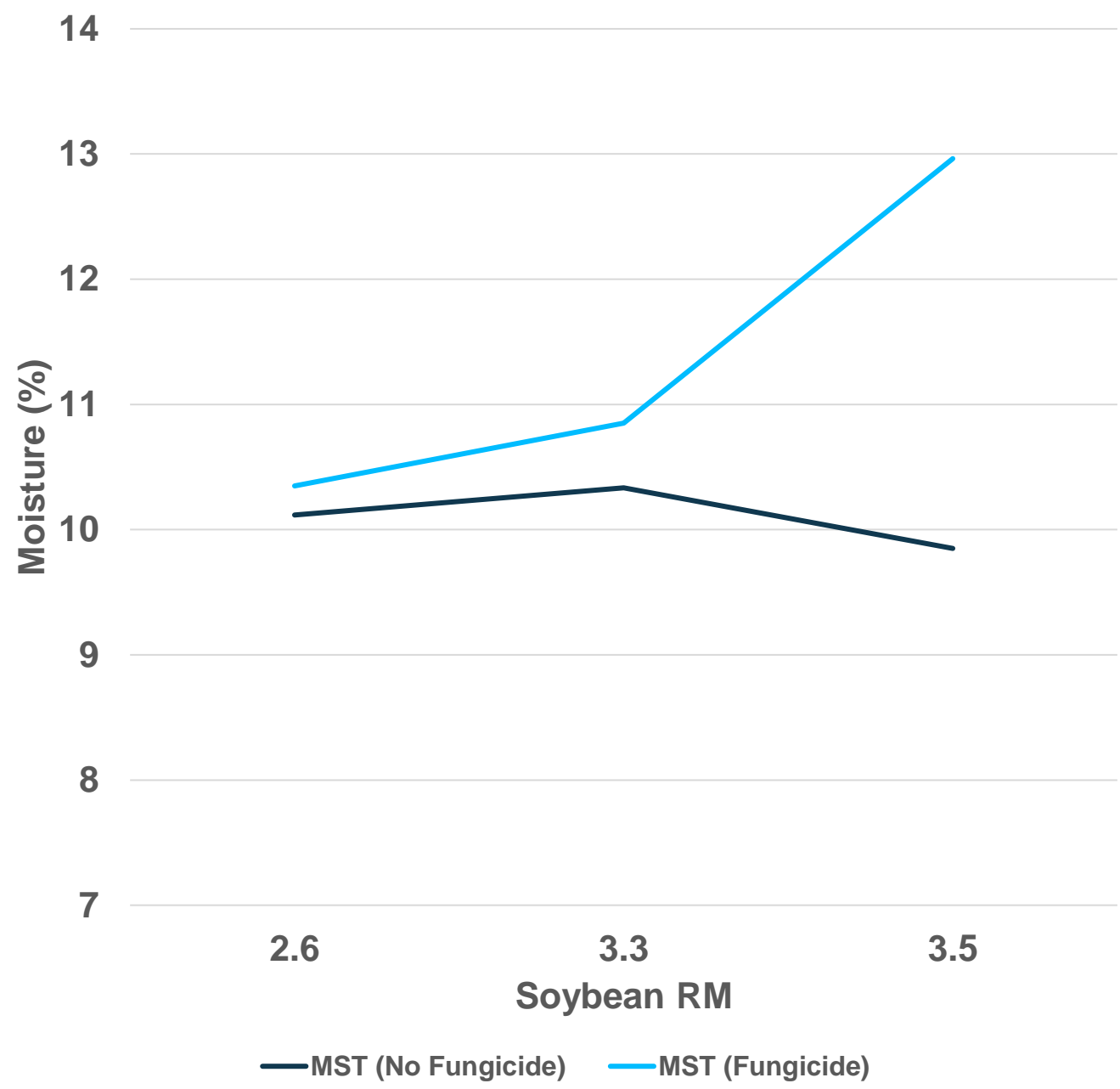


12 varieties (2.2-3.6 RM at 2 locations in 2020)





**Effect of Delaro application on moisture at harvest in 2020**







*Thank you!*



Questions?

