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INTERNATIONAL YEAR OF PLANT HEALTH 2020

Management of Rhizoctonia, Aphanomyces and Fusarium Diseases in Sugarbeet

2020 ACSC Growers' Seminar

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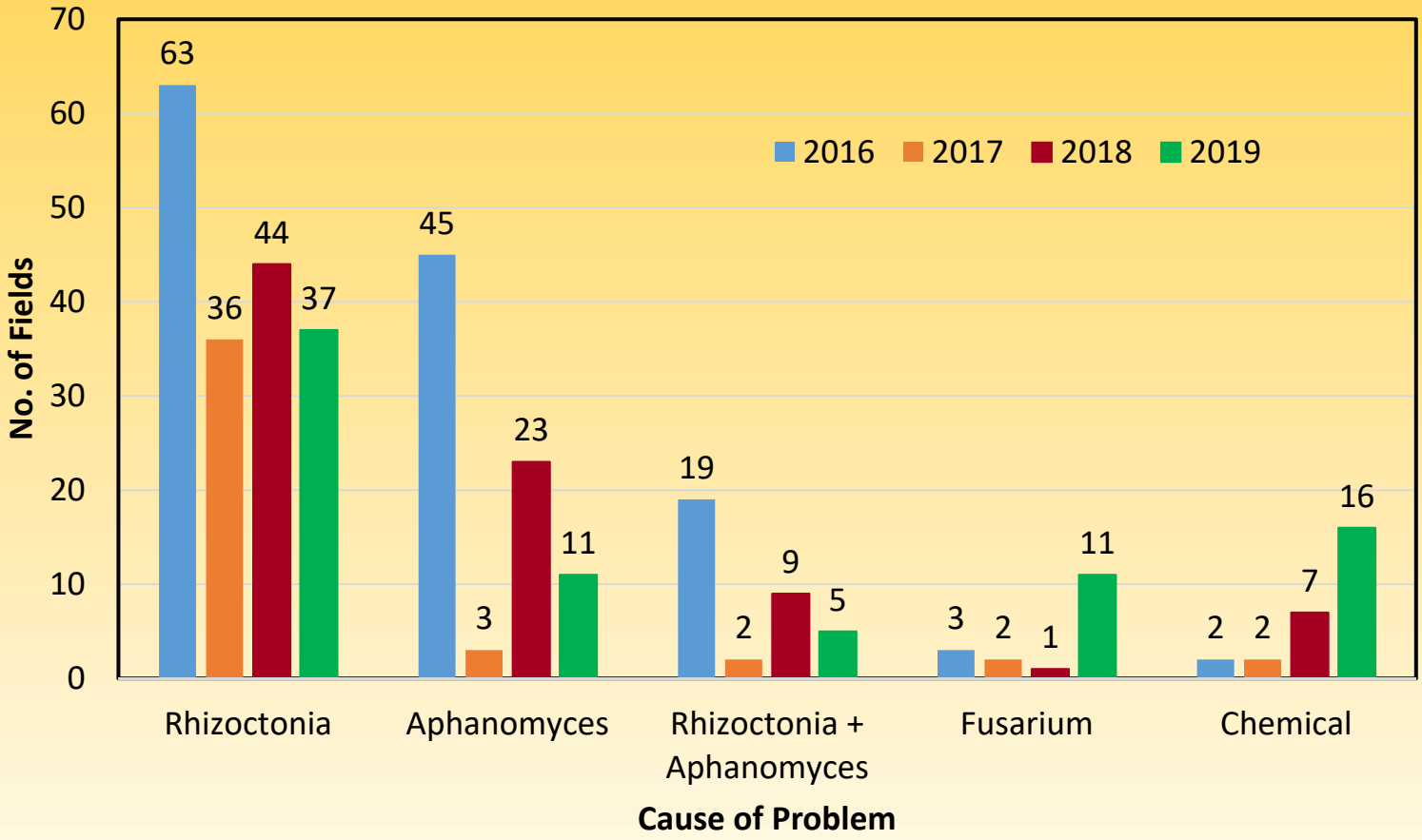
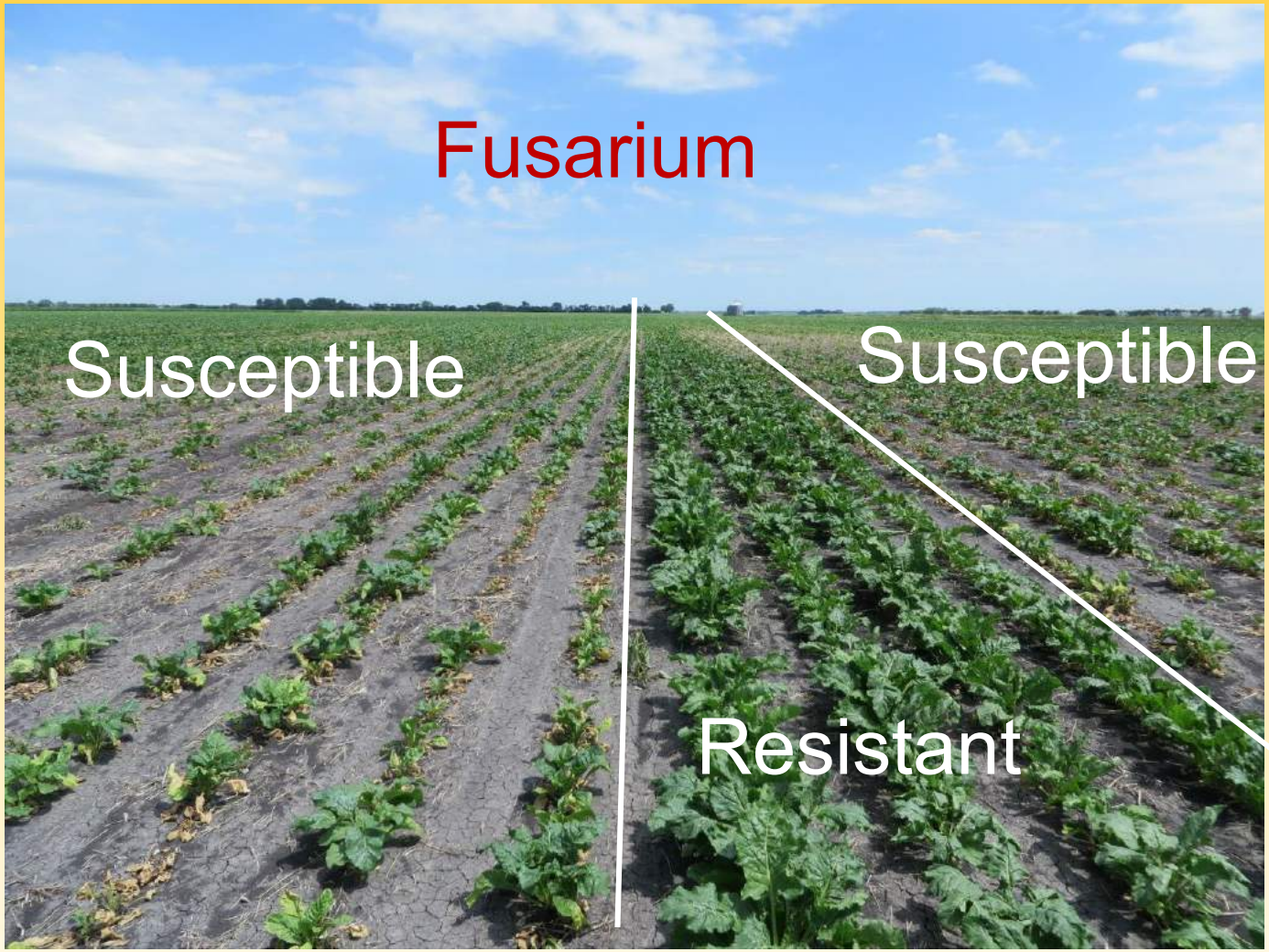
Summary of Field Samples 2016 - 2019



Accurate Diagnosis is critical!



Uninvited Guests!

July 21, 2015

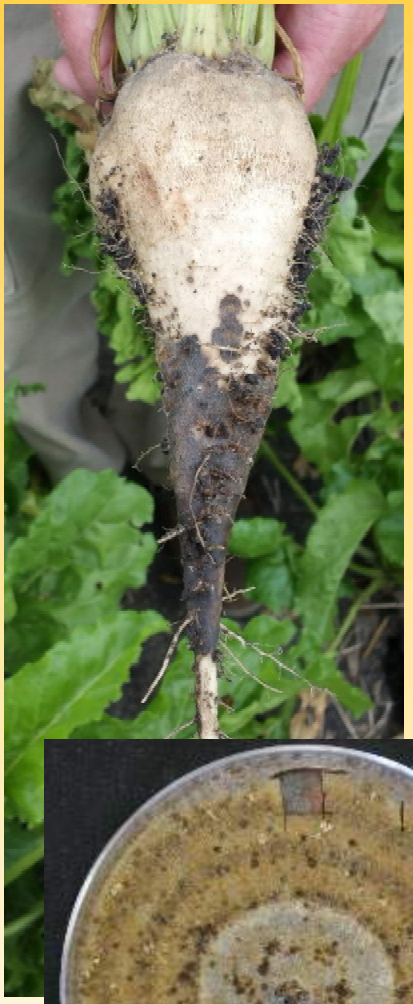
Rhizoctonia + Aphanomyces

Damping-off

Crown and Root Rot

Crown and Root Rot

Crown and Root Rot

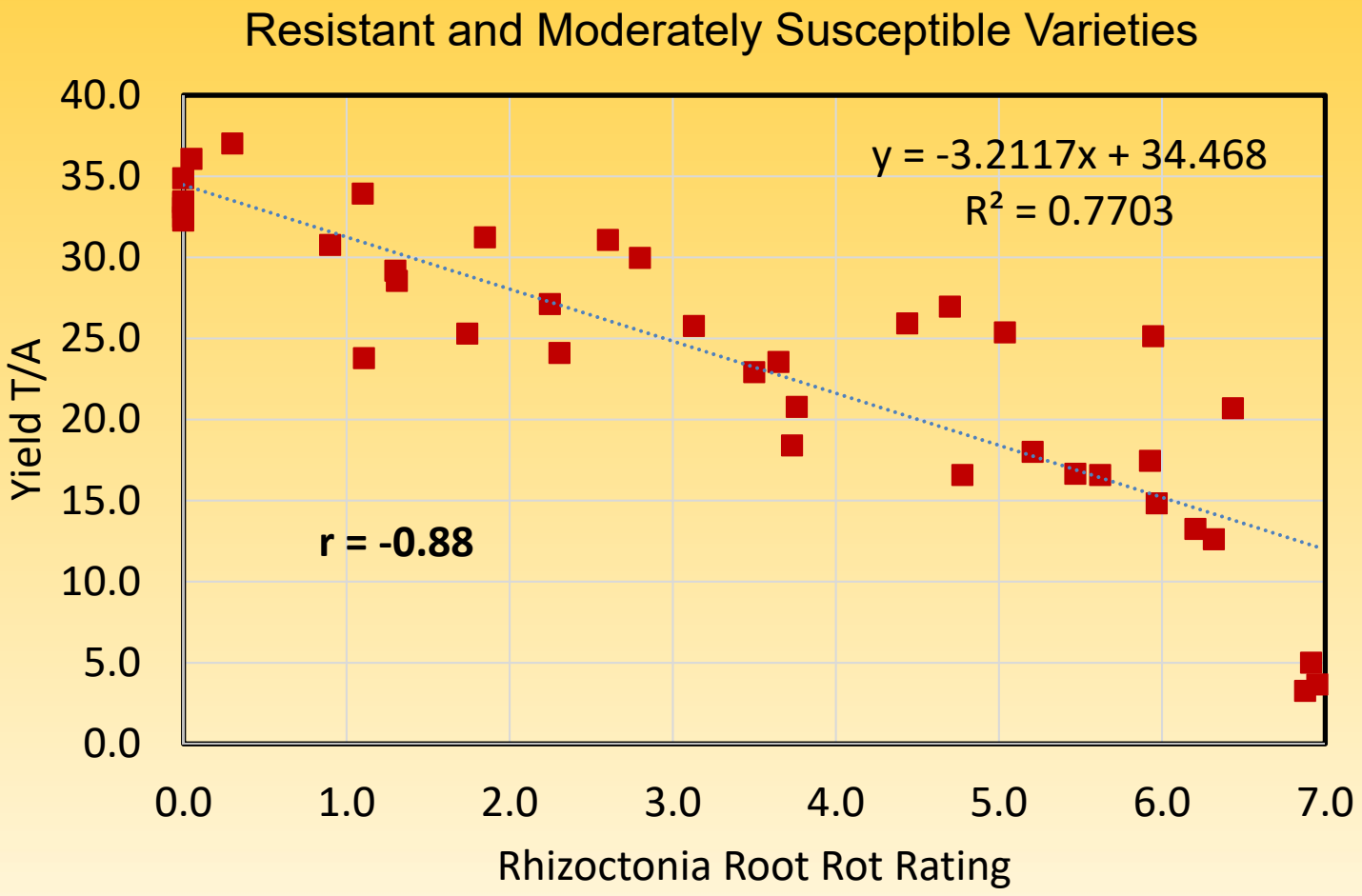


INNESOTA
cover℠

Rhizoctonia rating scale

Photo Credit: Greg Reynolds

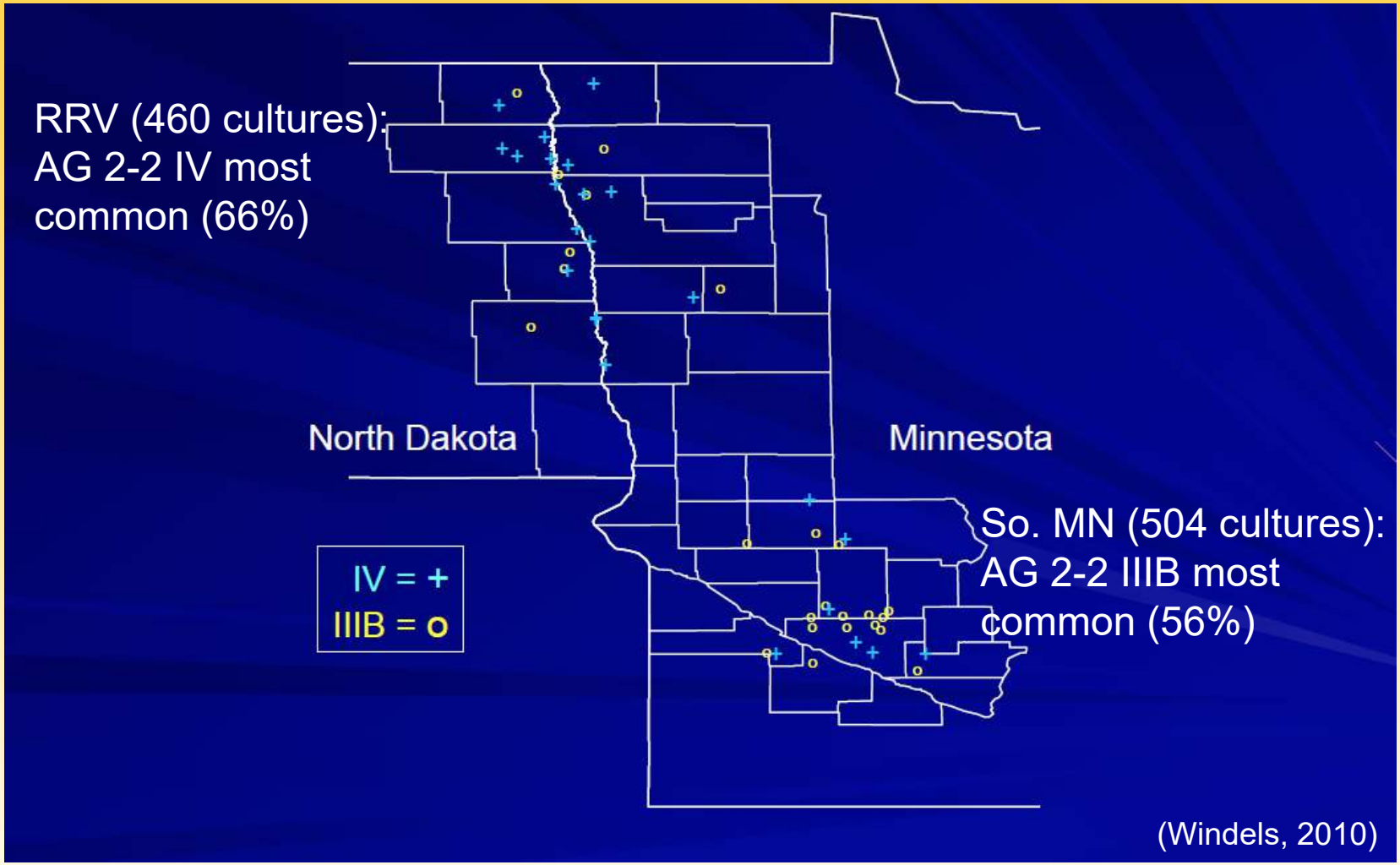
Rhizoctonia affects Yield



Rhizoctonia

- Fungus – *Rhizoctonia solani*
- 13 Anastomosis groups
- Sugarbeet- Anastomosis groups AG 2-2 (seedling and adult) and AG 4 (seedling)
- AG 2-2 has intraspecific groups (ISGs)
  - AG 2-2 IIIB and AG 2-2 IV
- Both ISGs cause same symptoms on sugarbeet
- Both occur in MN/ND (Windels, 2009)

AG 2-2 IV vs AG 2-2 IIIB



Management of Rhizoctonia

- Early planting

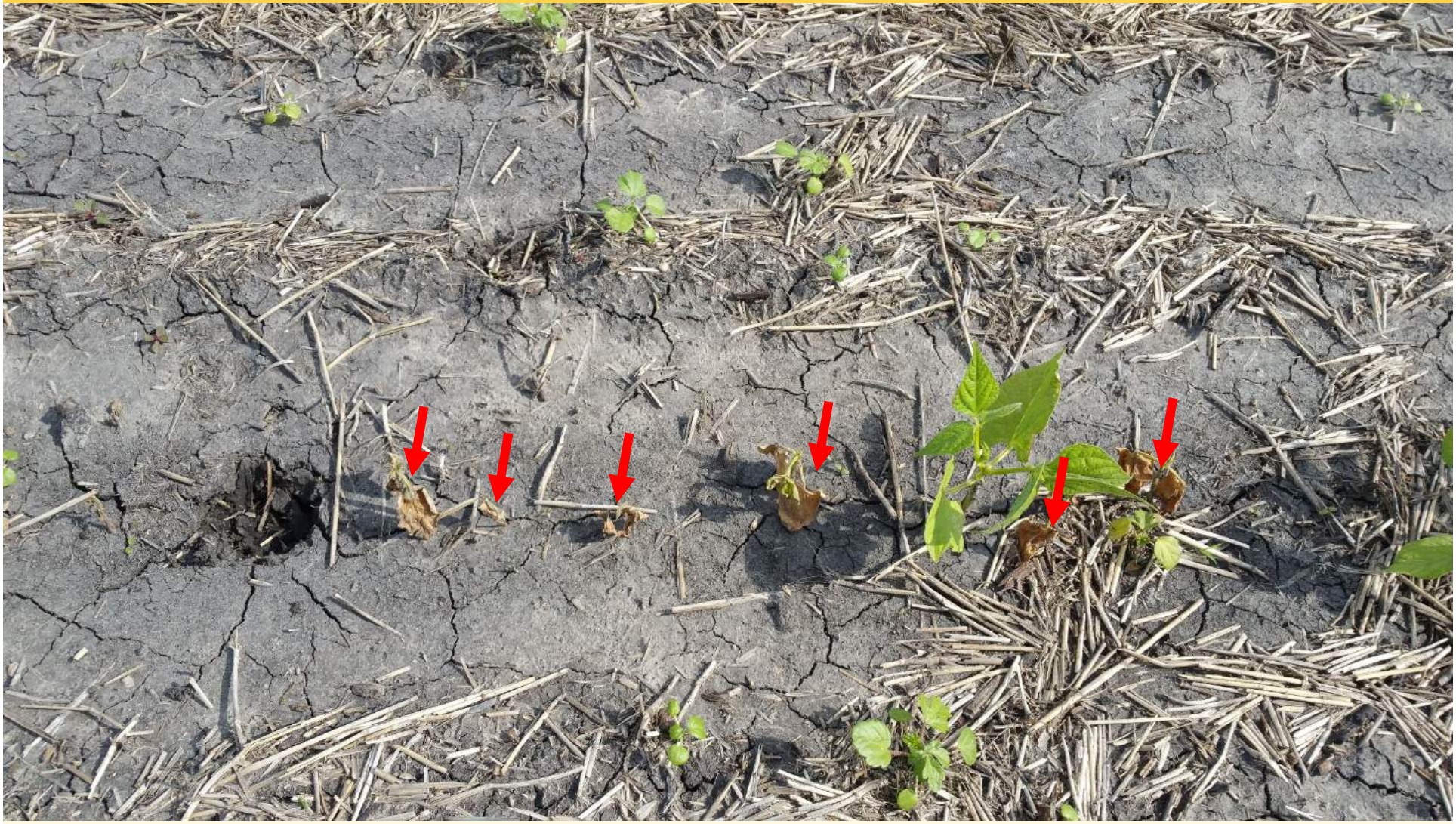
Management of Rhizoctonia

- Early planting
- Crop Rotation
  - Length of rotation
  - Weed control
  - Crop choice

Soybeans

Soybeans

Navy beans



Navy beans

Navy beans

Corn

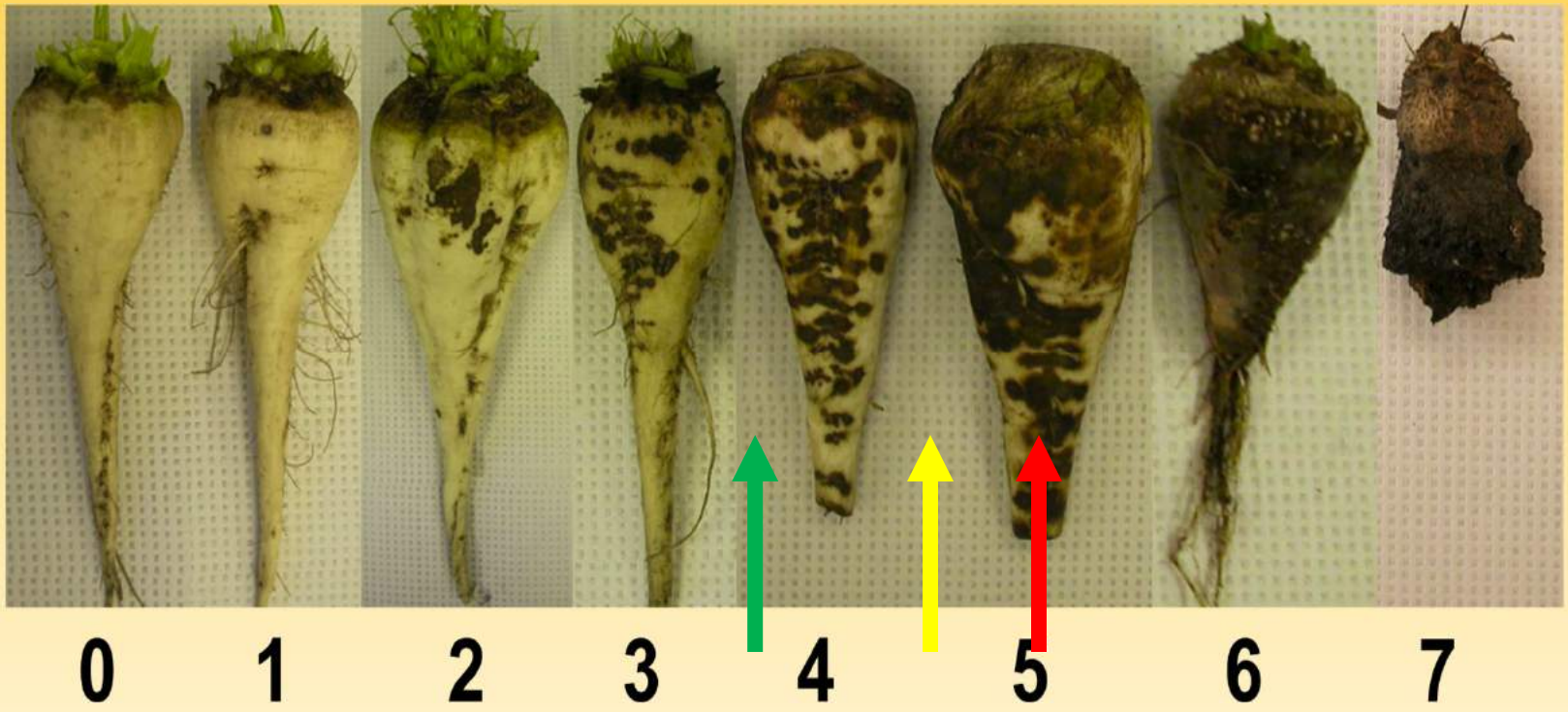
https://cropwatch.unl.edu/corn-seedling-diseases-2015

Amber Buzzard, Corteva agriscience
https://www.youtube.com/watch?v=DPvfnQVaKCI

Management of Rhizoctonia

- Early planting
- Crop Rotation
  - Crop choice
  - Length of rotation
  - Weed control
- Resistant varieties

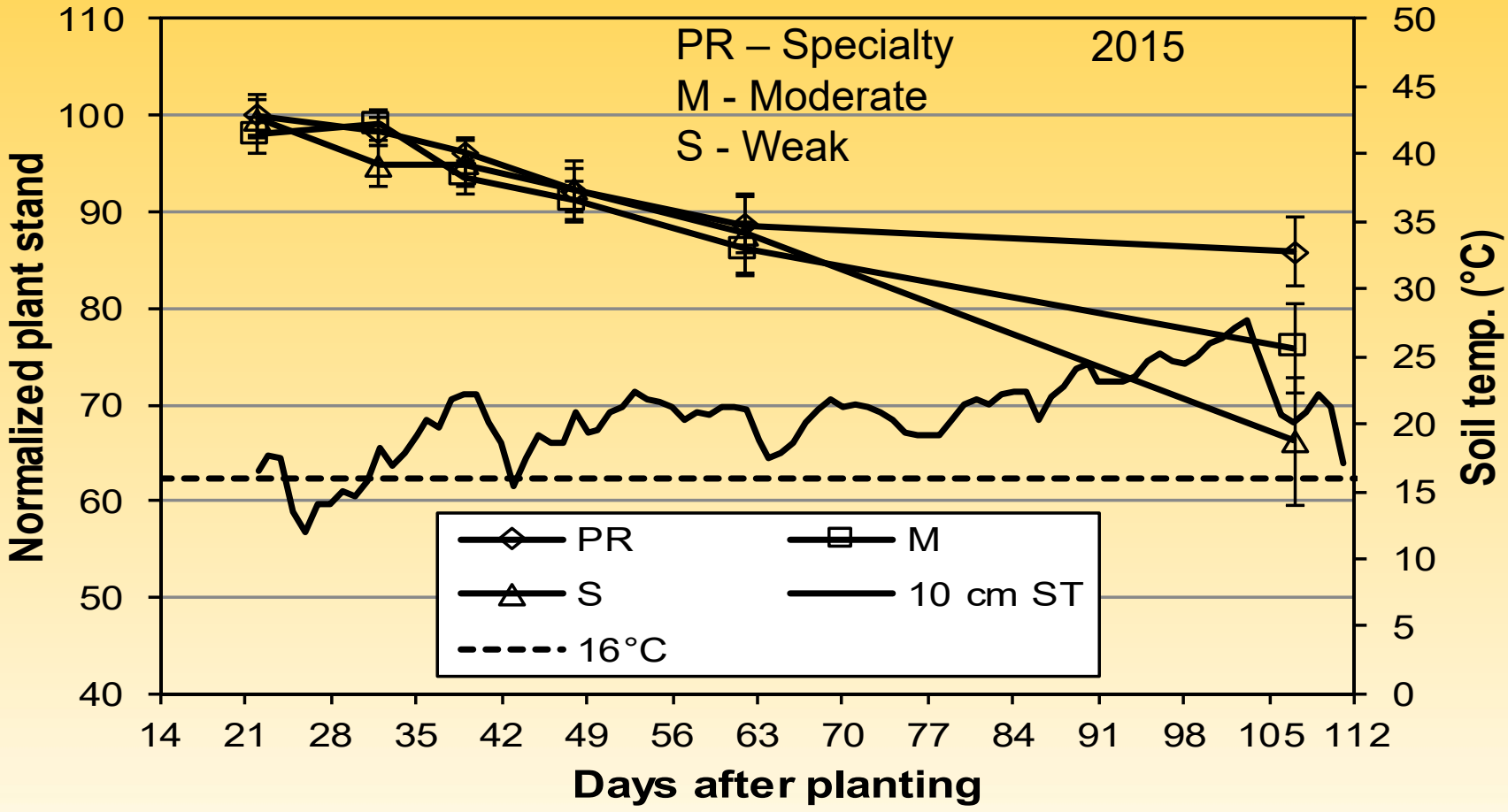
Rhizoctonia varieties



Specialty
Moderate
Weak

Photo Credit: Greg Reynolds

Rhizoctonia & Varietal Selection



Management of Rhizoctonia

- Early planting
- Crop Rotation
  - Crop choice
  - Length of rotation
  - Weed control
- Resistant varieties
- At-planting fungicides
  - Seed treatment

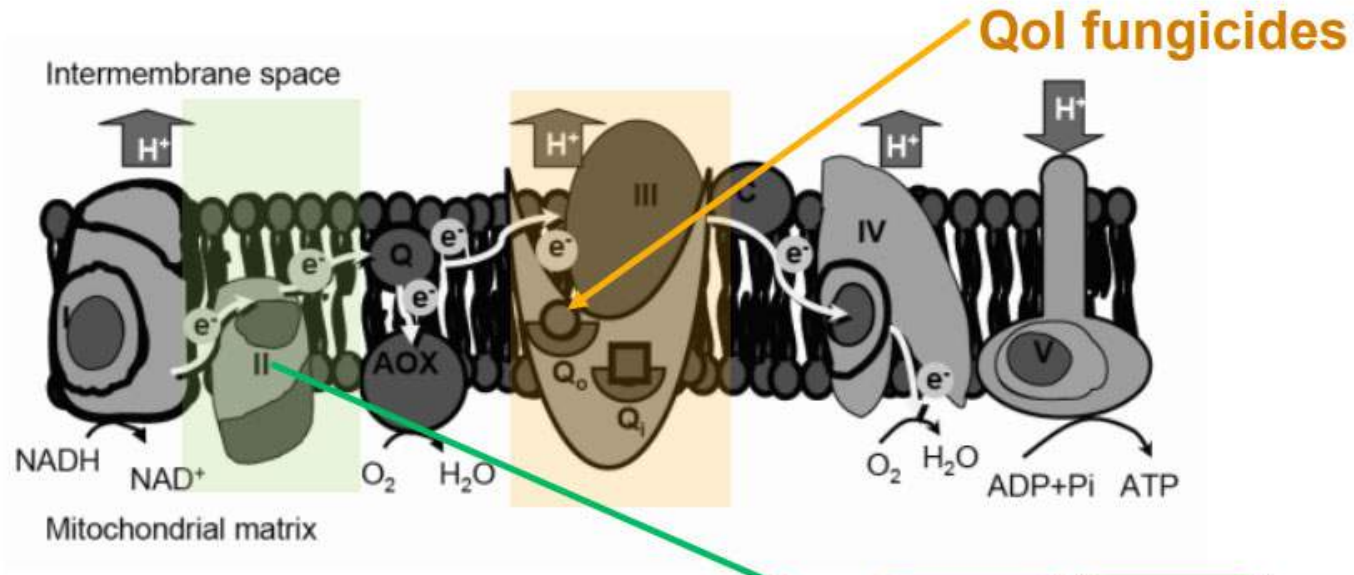
Seed treatments

- SDHI class of fungicides
- Single site of action (**S**uccinate **D**e**H**ydrogenase **I**nhibitor)
- Inhibit fungal respiration

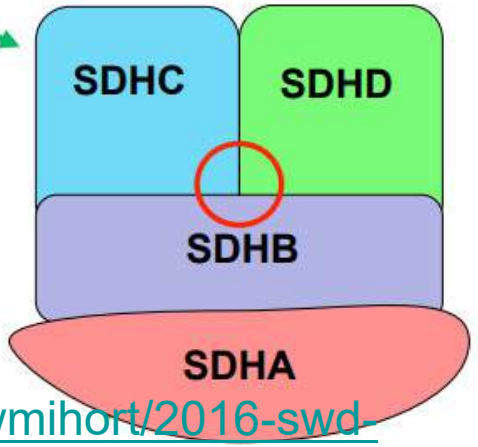
MOA	TARGET SITE AND CODE	GROUP NAME	CHEMICAL OR BIOLOGICAL GROUP	COMMON NAME	COMMENTS	FRAC CODE
C. respiration	C1 complex I NADH Oxido-reductase	pyrimidinamines	pyrimidinamines	diflumetorim	Resistance not known.	39
		pyrazole-MET1	pyrazole-5-carboxamides	tolfenpyrad		
		quinazoline	quinazoline	fenazaquin		
	C2 complex II: succinate-dehydro-genase	SDHI (Succinate-dehydrogenase inhibitors)	phenyl-benzamides	benodanil flutolanil mepronil	Resistance known for several fungal species in field populations and lab mutants. Target site mutations in sdh gene, e.g. H/Y (or H/L) at 257, 267, 272 or P225L, dependent on fungal species. Resistance management required. **Medium to high risk.** **See FRAC SDHI Guidelines for resistance management.**	7
			phenyl-oxo-ethyl thiophene amide	isofetamid		
			pyridinyl-ethyl-benzamides	fluopyram		
			furan- carboxamides	fenfuram		
			oxathiin-carboxamides	carboxin oxycarboxin		
			thiazole-carboxamides	thifluzamide		
			pyrazole-4-carboxamides	benzovindiflupyr bixafen fluindapyr fluxapyroxad furametpyr inpyrfluxam isopyrazam penflufen penthiopyrad sedaxane		
			N-cyclopropyl-N-benzyl-pyrazole-carboxamides	isoflucypram		
			N-methoxy-(phenyl-ethyl)-pyrazole-carboxamides	pydiflumetofen		
			pyridine-carboxamides	boscalid		
			pyrazine-carboxamides	pyraziflumid		

https://www.frac.info/docs/default-source/publications/frac-code-list/frac-code-list-2019.pdf

SDHI Fungicide Overview



- **SDHI fungicides: Respiration inhibitors: Target succinate dehydrogenase reductase enzyme**
  - **4 subunits**



Sara Villani, NCSU; https://www.canr.msu.edu/nwmihort/2016-swd-summit/22SM%20Villani%20IPM%20School%20SDHI%202017.pdf

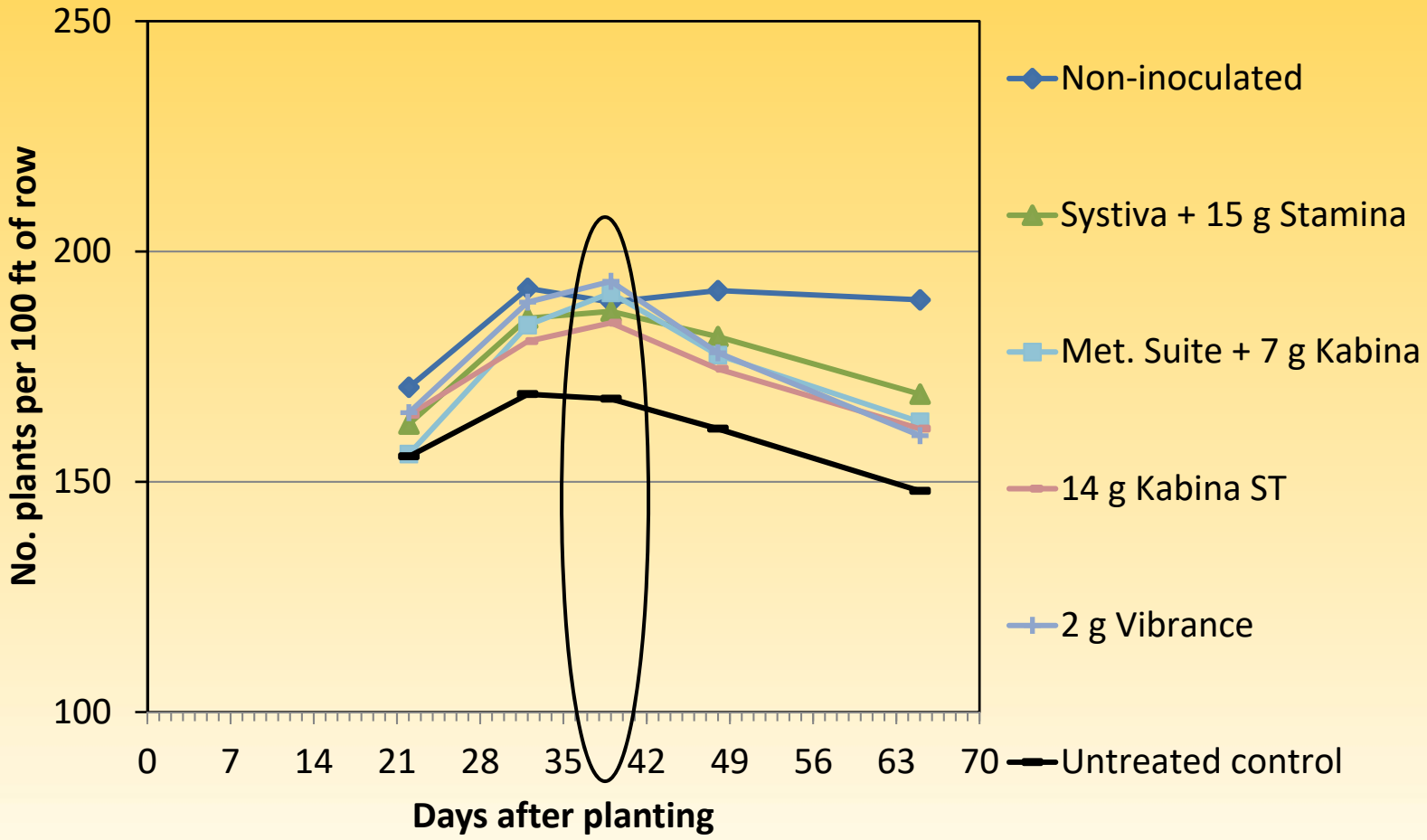
Seed treatments

- Kabina 14 g (Penthiopyrad, 2014)
- Vibrance 1.5 g (Sedaxane, 2016)
- Systiva 5 g (Fluxapyroxad, 2017)
- Metlock Suite [Metconazole + Rizolex) + Kabina 7g (Penthiopyrad), 2014)
- From 2017, 100% seed is treated for Rhizoctonia and treatment depends on the seed companies' choice

Metconazole and Rizolex are not SDHI

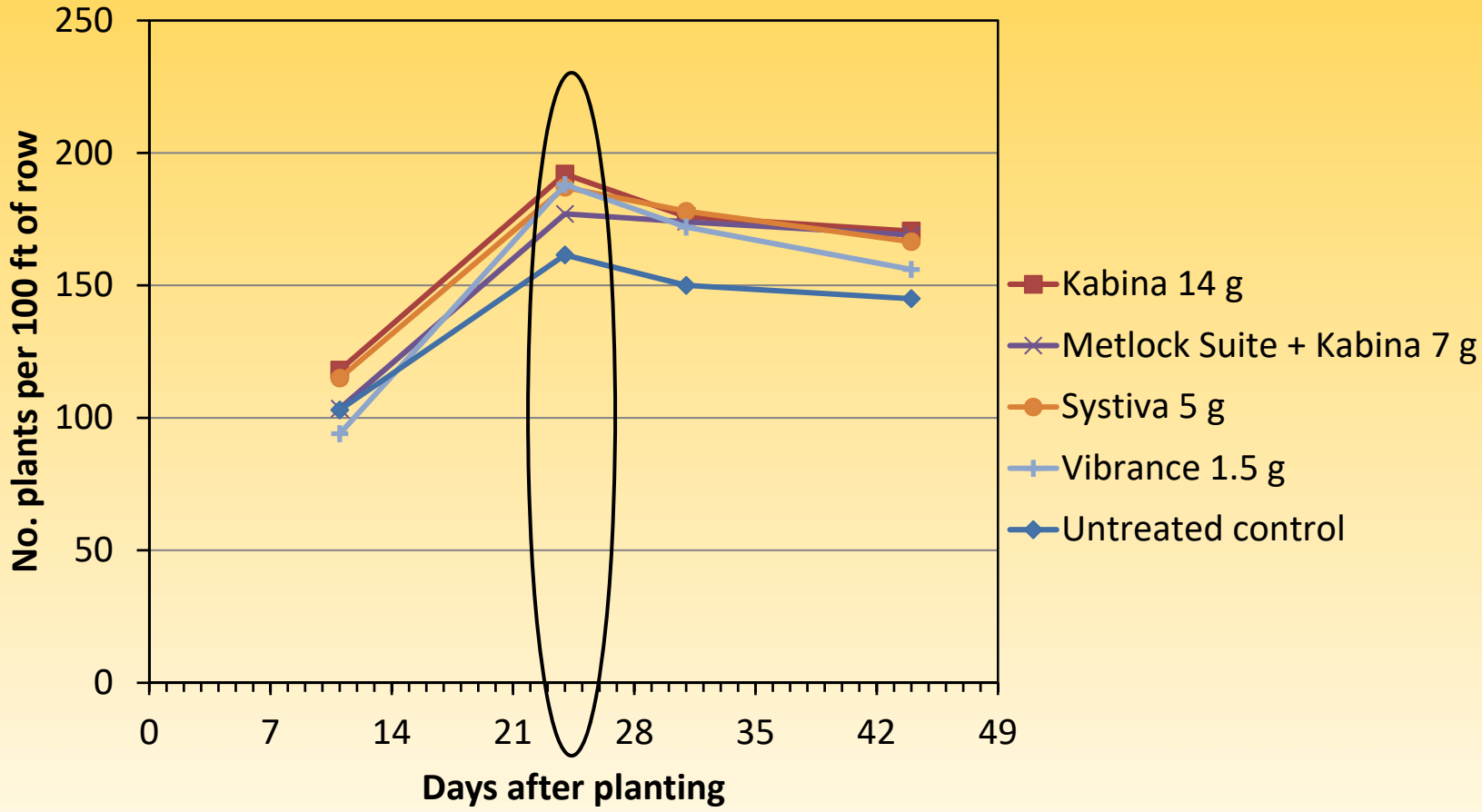
Seed treatments - 2015

Planting date: May 04



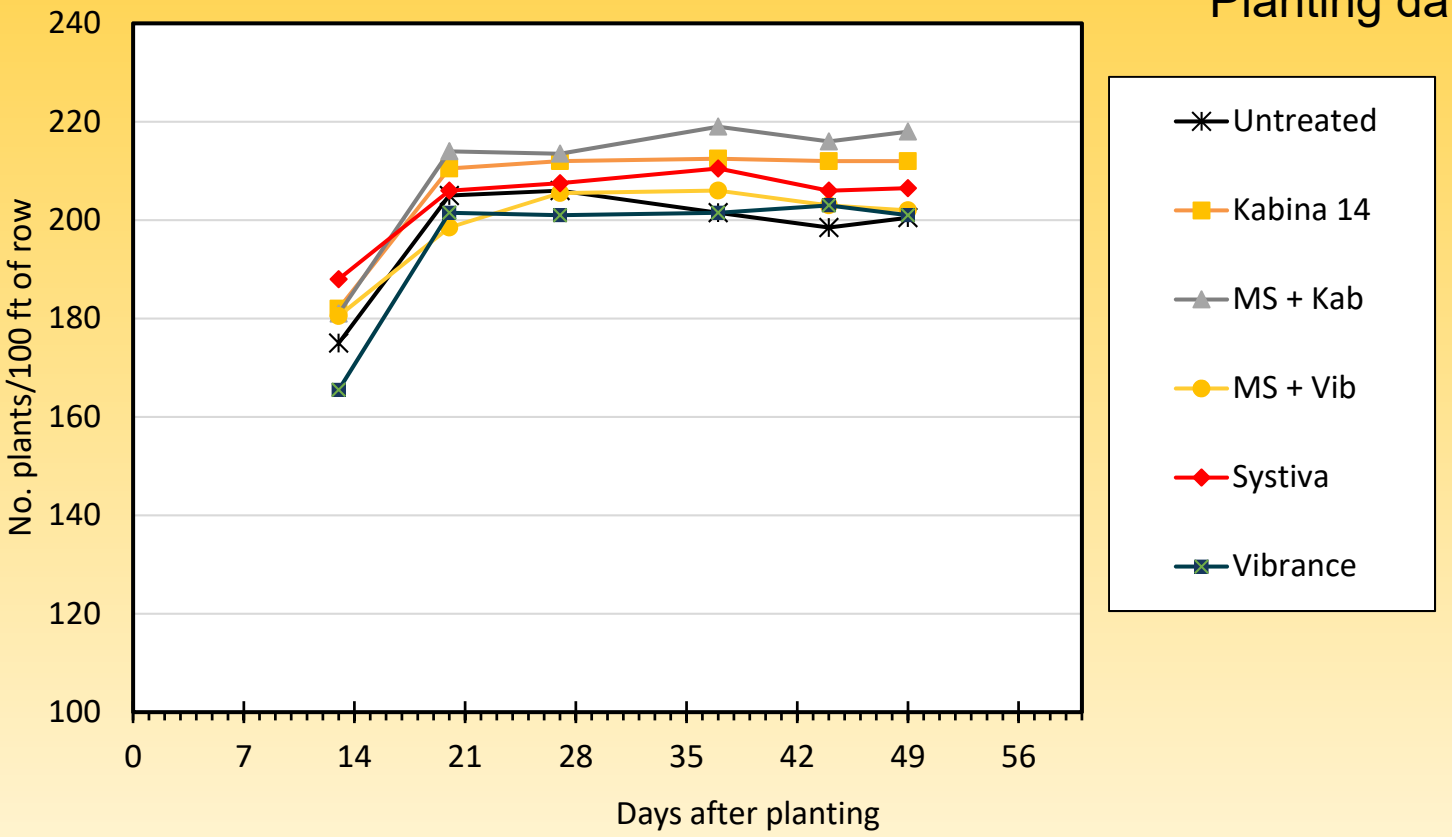
Seed treatments – 2016

Planting date: June 24



2019 Seed Treatments –Susceptible Variety (4.5 rating)

Planting date: May 15



Benefits of seed treatments

- Sugarbeet seedlings are very susceptible to Rhizoctonia early on
- Genetic resistance is not expressed until 6-8 leaf stage
- Effective protection of seedling (4-5 weeks)
- Ease of use -It comes with seed
- Safety
- No plugged nozzles

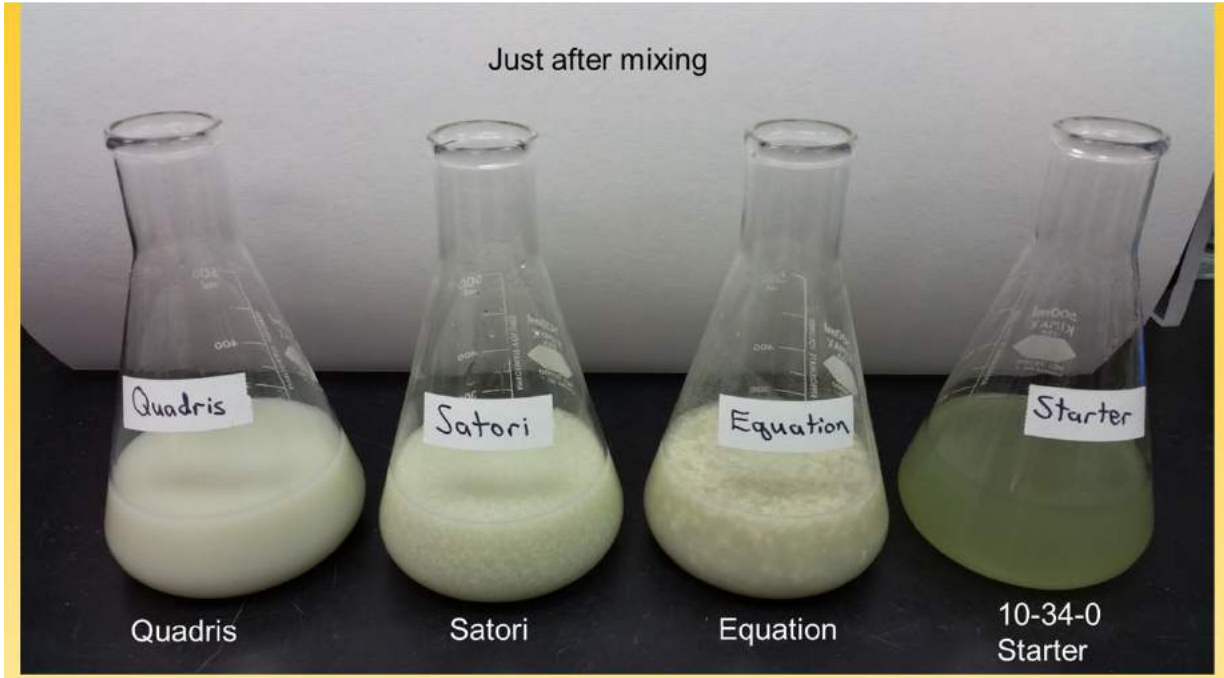
Management of Rhizoctonia

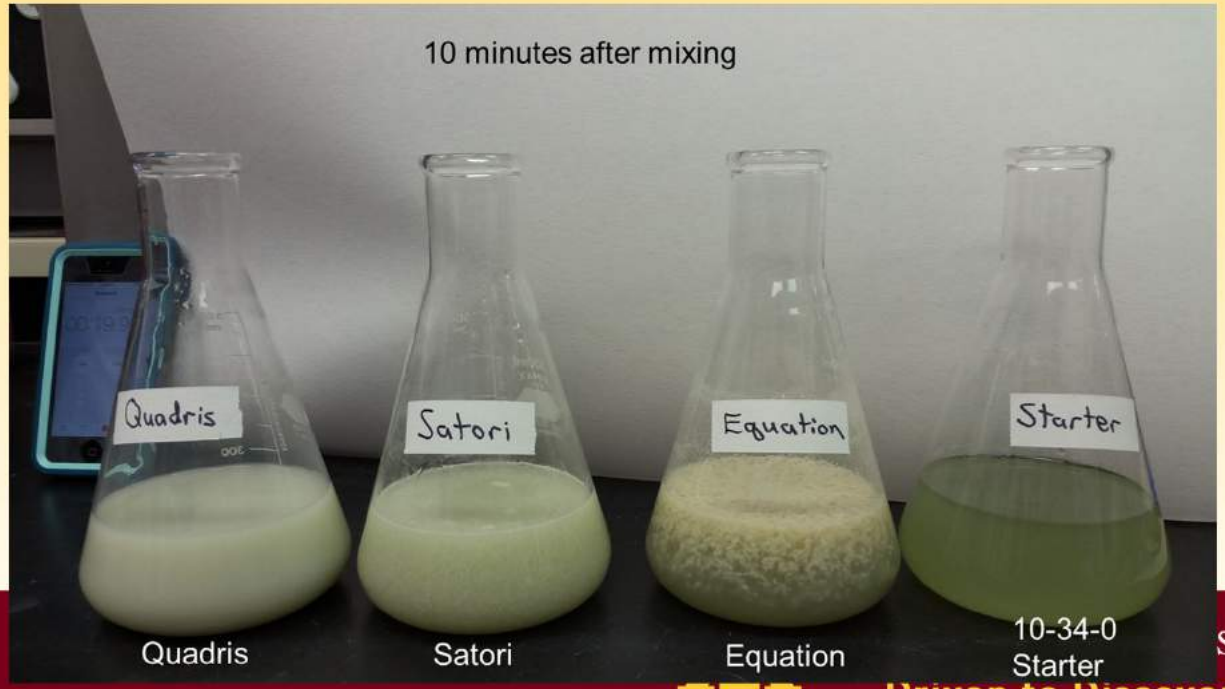
- Early planting
- Crop Rotation
  - Crop choice
  - Length of rotation
  - Weed control
- Resistant varieties
- At-planting fungicides
  - Seed treatment
  - In-furrow application

In-furrow application

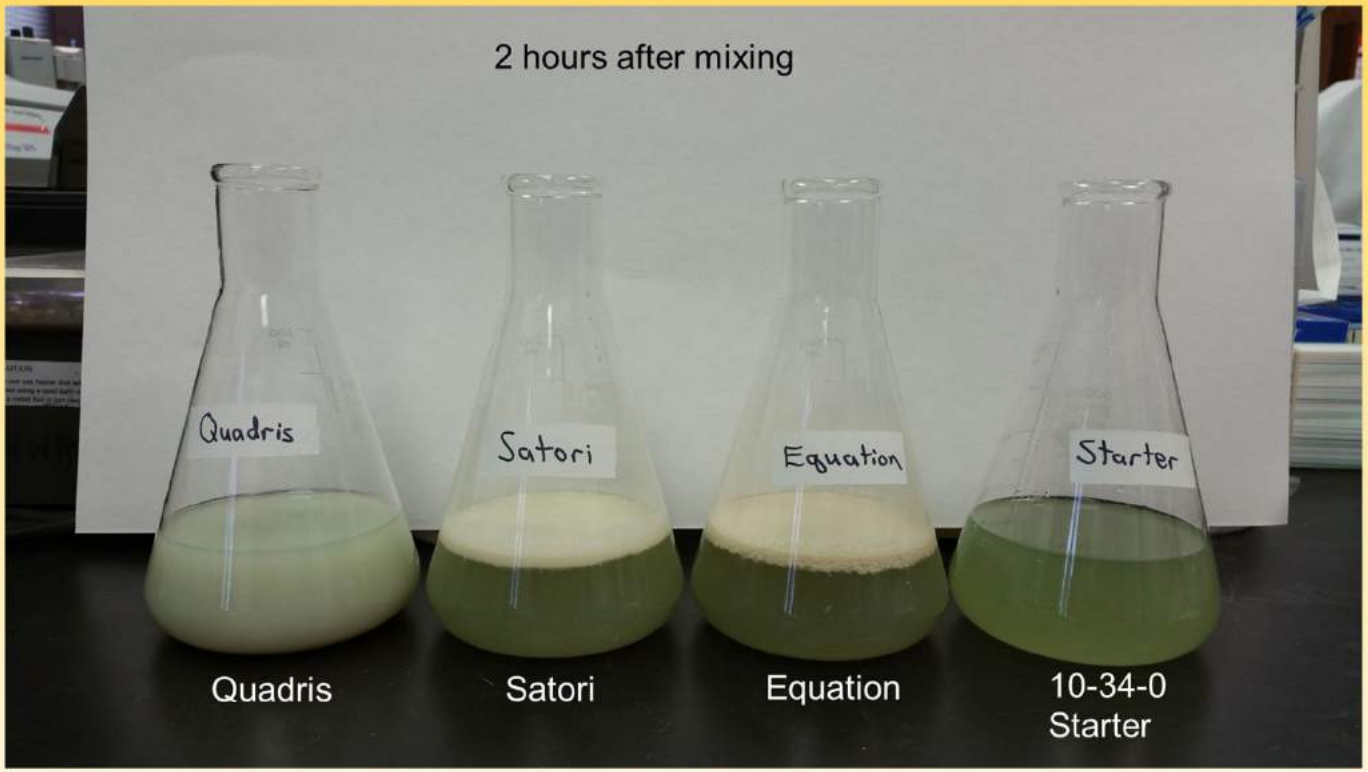
Fungicide in 3 gal water + 10-34-0
3gal. applied via drip tube

10-34-0 + azoxystrobin

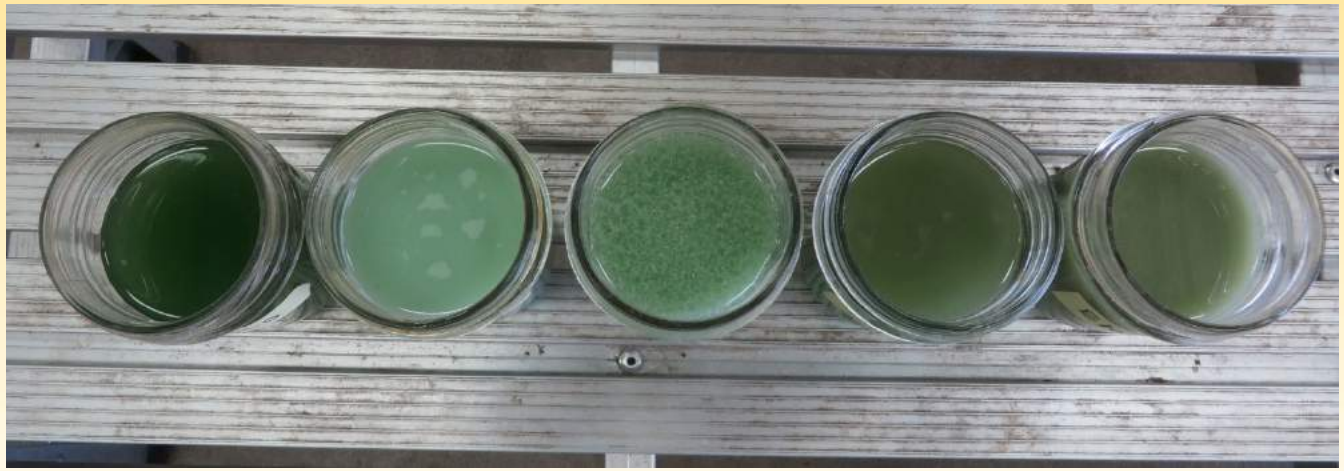




10-34-0 + azoxystrobin

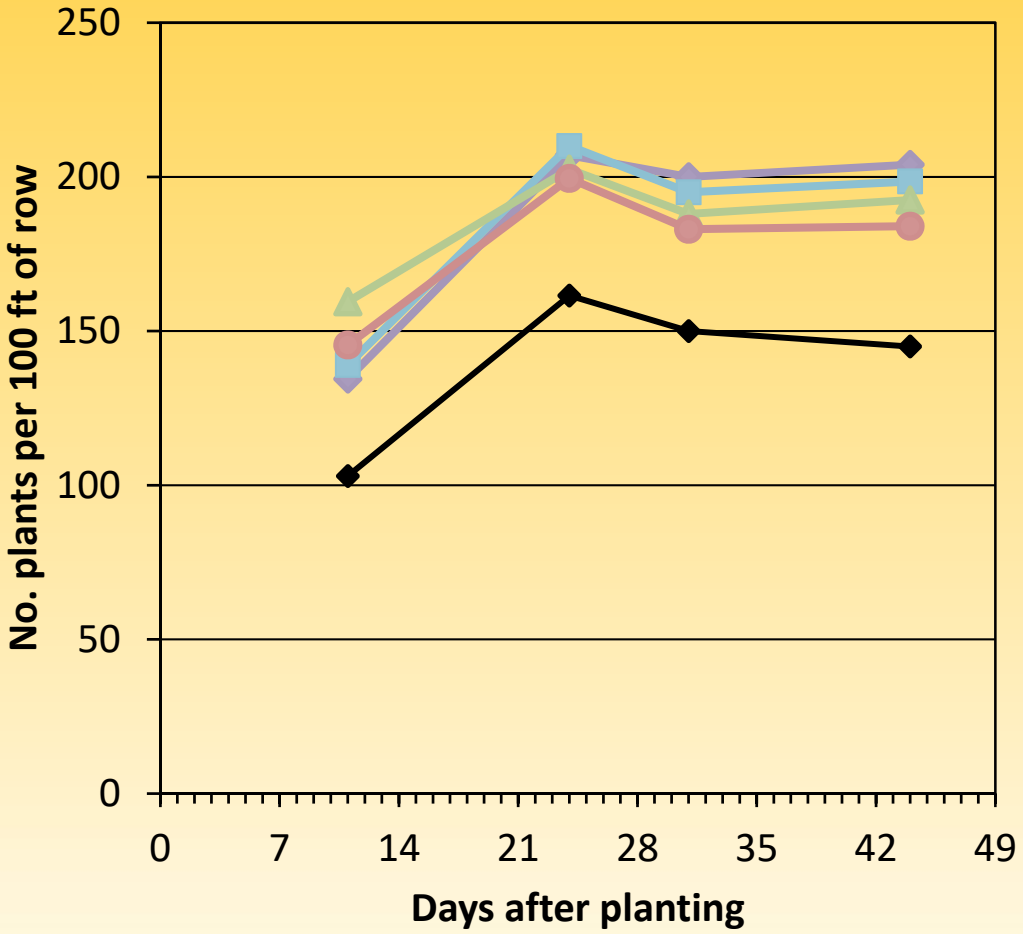


10-34-0 + Fungicides: 0 minutes (shaken and poured in to a jar after sitting for 6 hours after mixing and application in the field)



10-34-0 + Fungicides: 10 minutes

In-furrow treatments – 2016



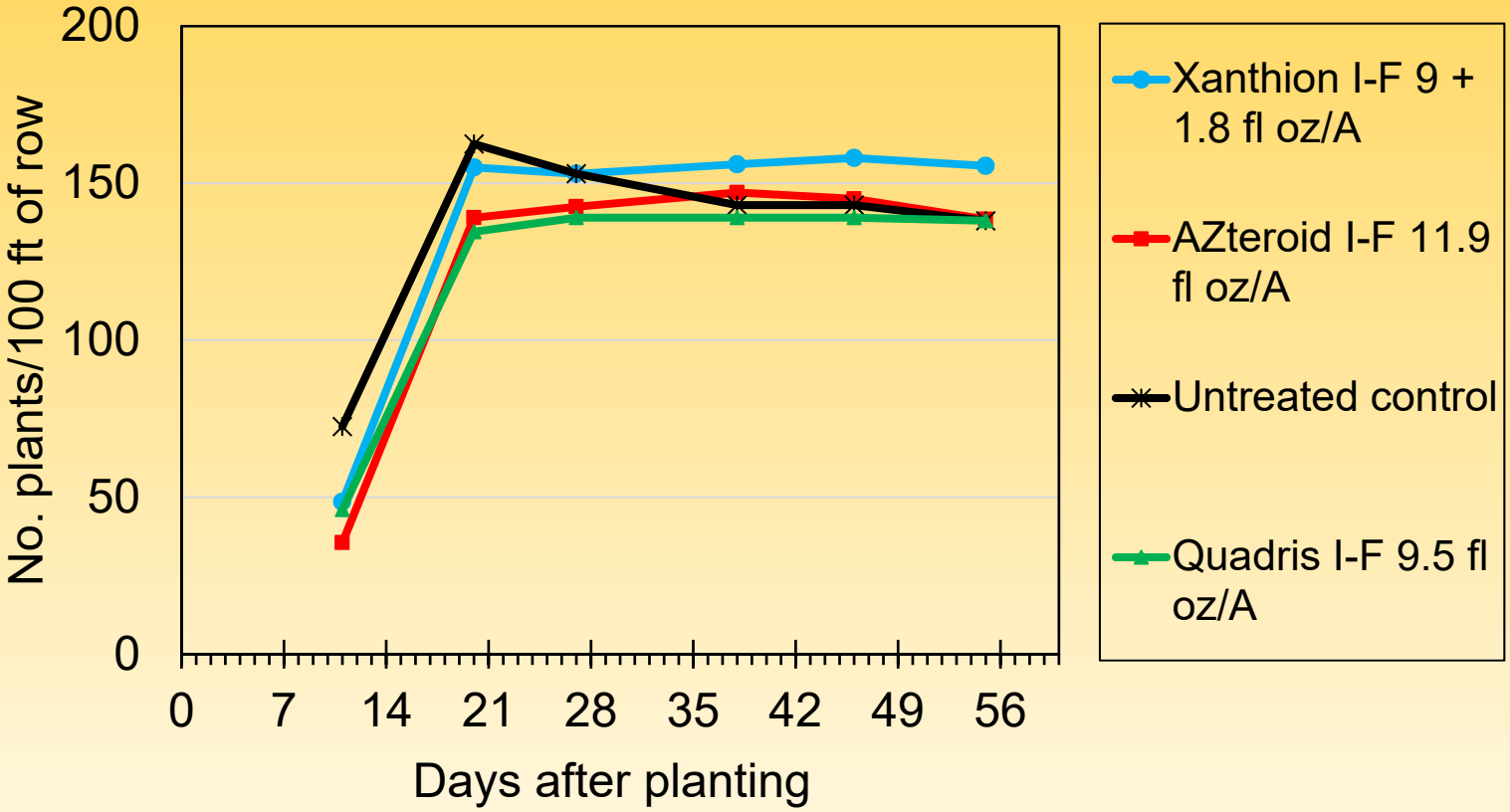
Planting date: June 24

- Quadris I-F 10 fl oz
- Satori I-F 10 fl oz
- Xanthion I-F 9 + 1.8 fl oz
- Headline I-F 9 fl oz
- Untreated control

In-furrow fungicide applied via drip tube

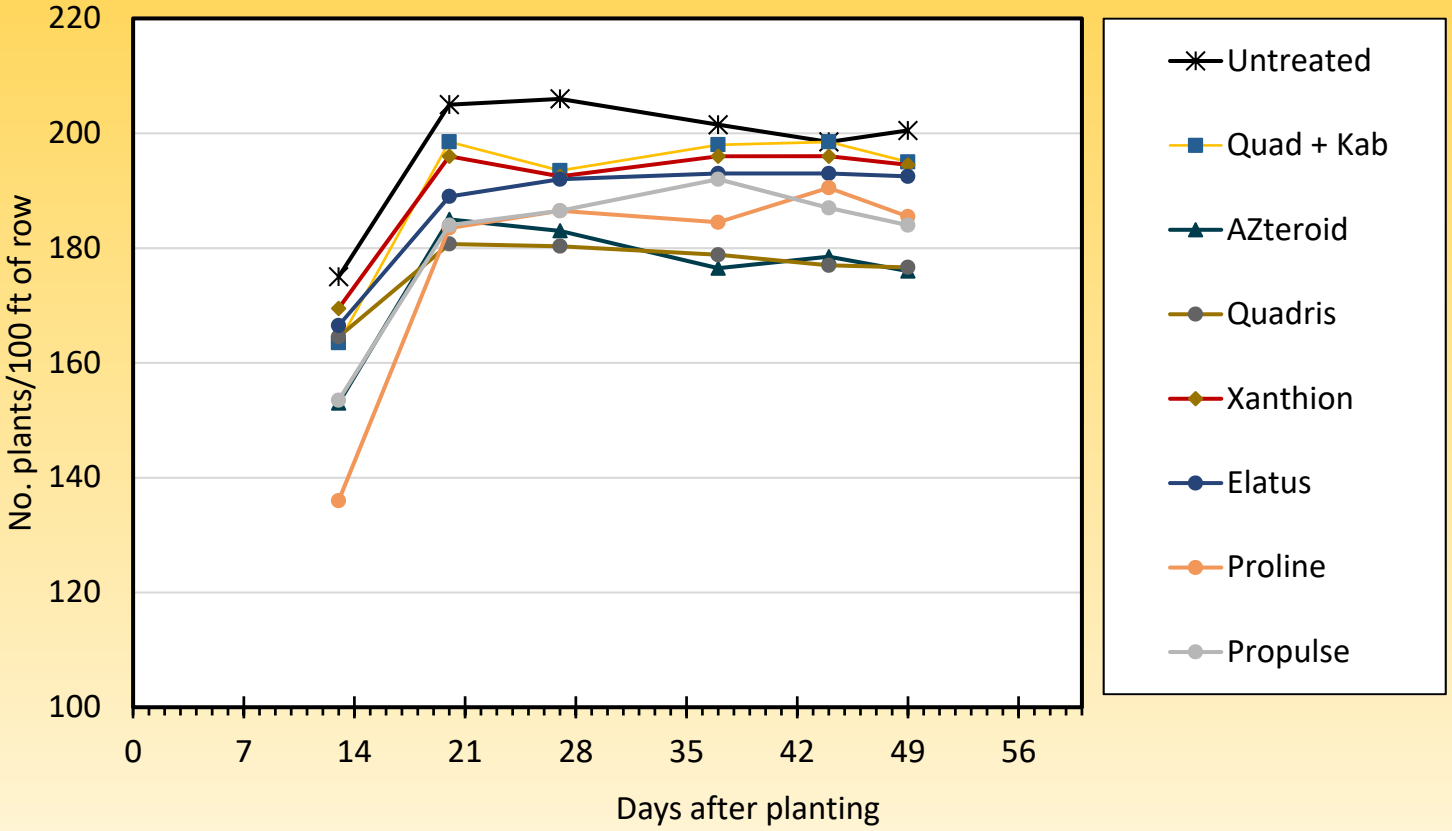
In-furrow treatments – 2018

Planting date: May 11



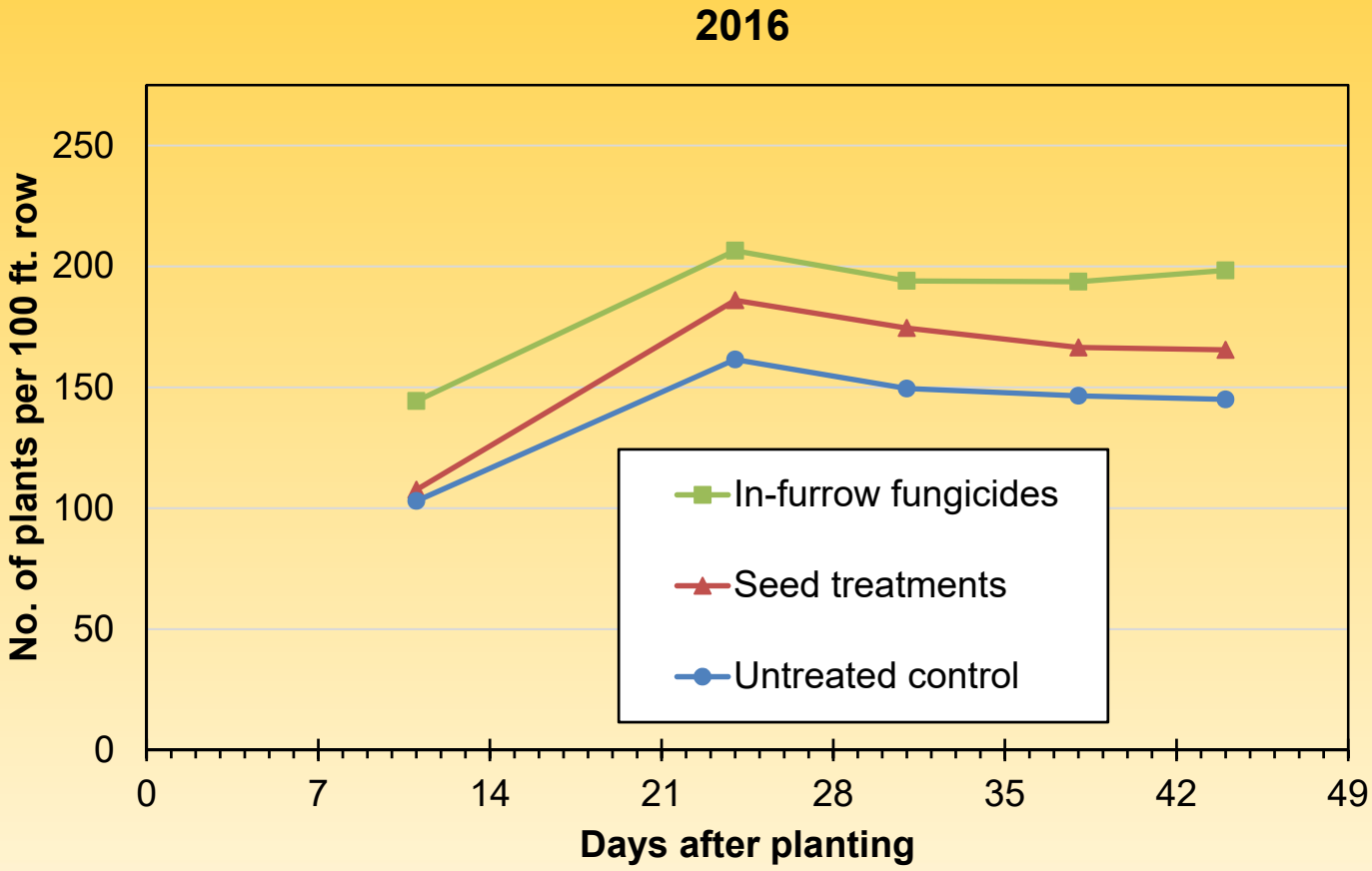
In-furrow treatments – 2019

Planting date: May 15



Susceptible Variety (4.5 rating)

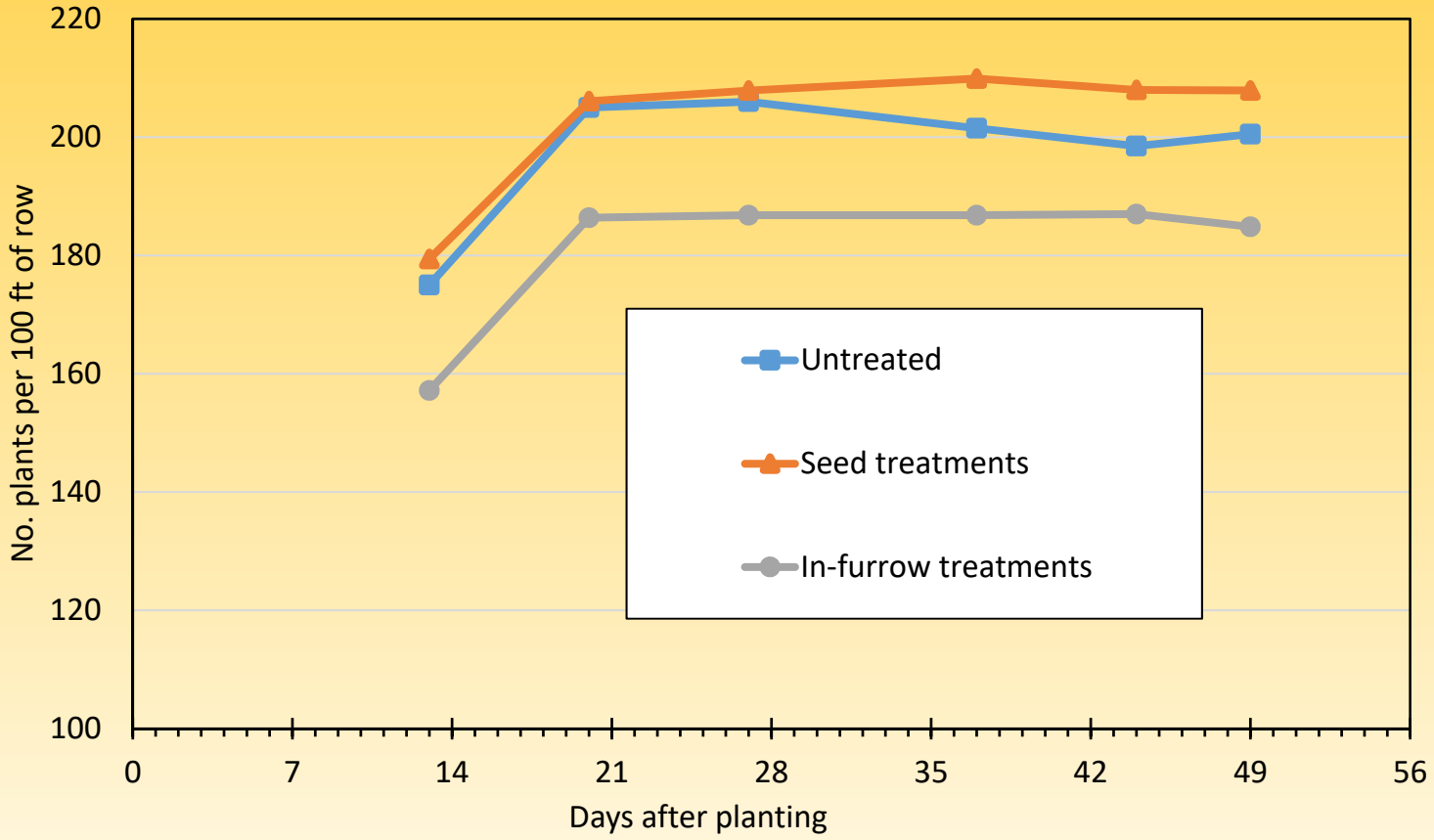
Seed vs In-furrow fungicides - 2016



Planted late June

Seed vs In-furrow fungicides - 2019

Planting date:



Seed vs In-furrow fungicides - 2015

Treatment	No. harv. Roots/100 ft.	RCRR (0-7)	Yield	RSA
Seed treatments	98	3.9	20.1	6181
In-furrow treatments	127	2.7	25.5	7772
Contrast analysis *p*-value	0.001	0.006	0.0032	0.0148

Seed Treatments	**In-furrow**
14 g Kabina ST	12 fl oz Headline IF
Metlock Suite	10 fl oz Quadris IF
Met. Suite + 7 g Kabina	10 fl oz Equation IF
7 g Kabina ST	10 fl oz Satori IF
2 g Vibrance	

RSA = ESA

Seed vs In-furrow fungicides - 2018

Treatment	No. harv. roots/100 ft	RCRR (0-7)	Yield ton A^{-1}	RSA
Seed treatments	151	0.7	32.8	10440
In-furrow treatments	141	0.4	32.2	10528
Contrast analysis P-value	0.01	0.01	0.5	0.5
			NS	NS

Seed Treatments

14 g Kabina ST

Met. Suite + 1 g Vibrance

Met. Suite + 7 g Kabina

5 g Systiva

1.5 g Vibrance

In-furrow

9.5 fl oz Quadris

11.9 fl oz AZteroid

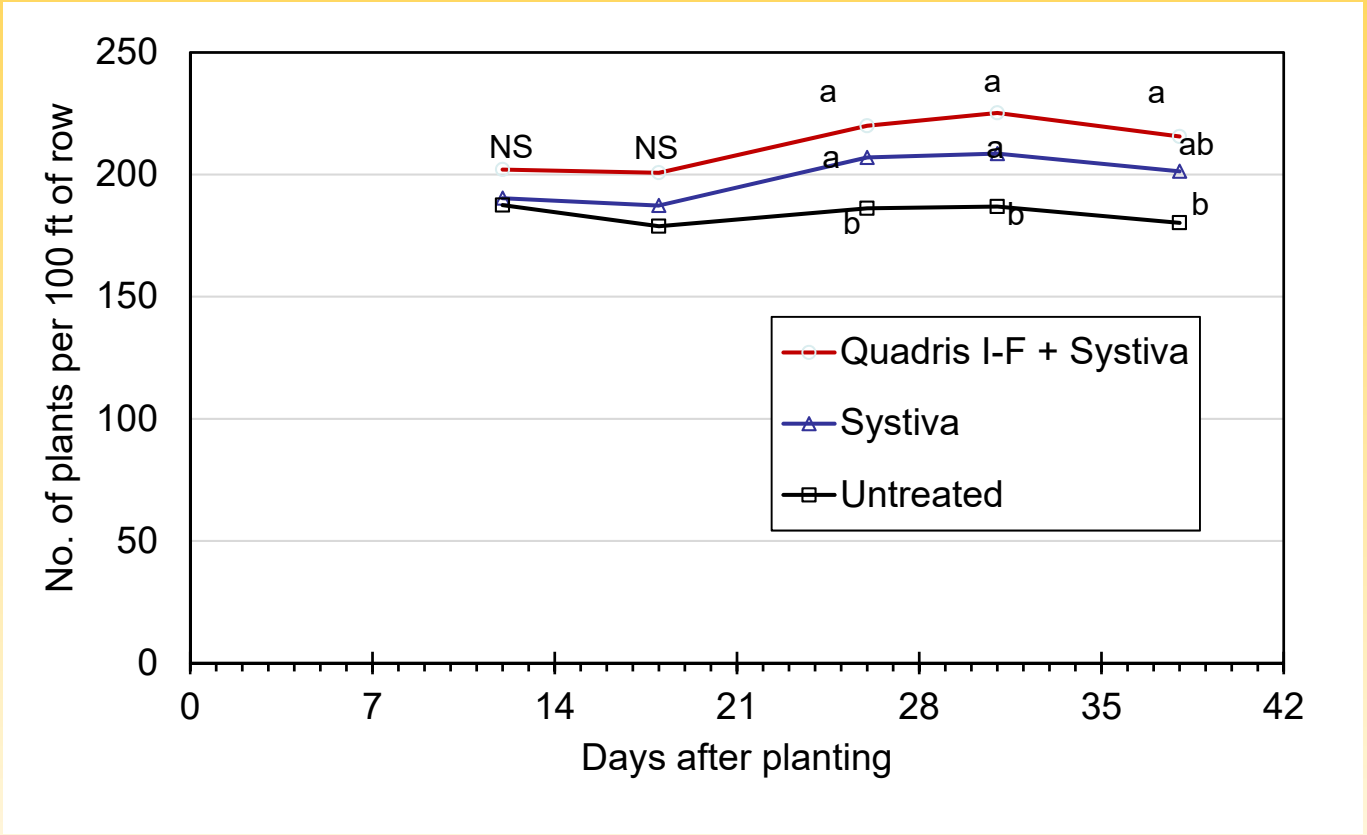
Xanthion (Headline + Integral, 9 + 1.8 fl oz/A)

Elatus 9.5 fl oz (* not registered for sugarbeet)

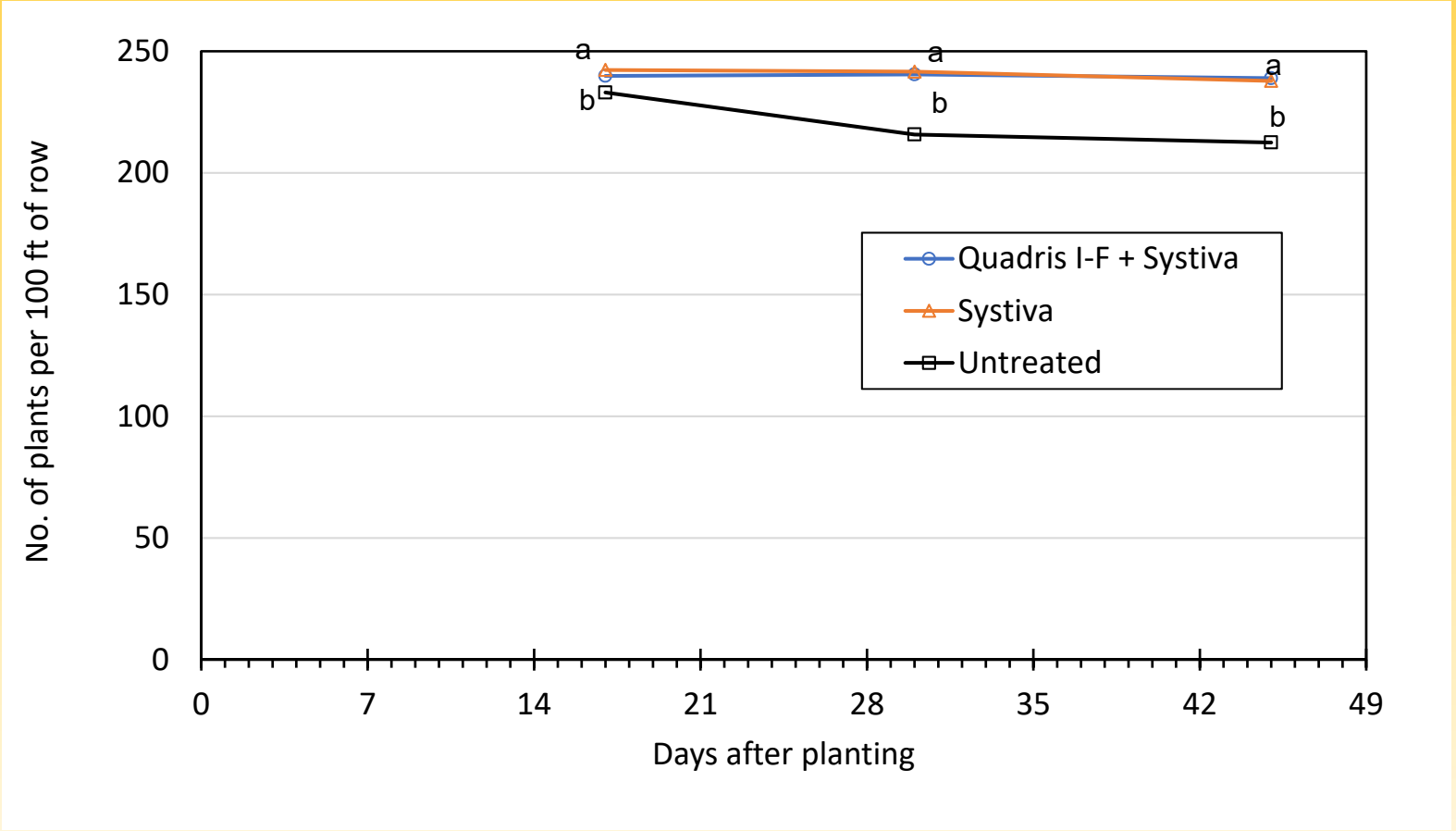
RSA = ESA

NS = not significantly different

Plant Stand – MDFC, 2019



Renville, MN - 2019



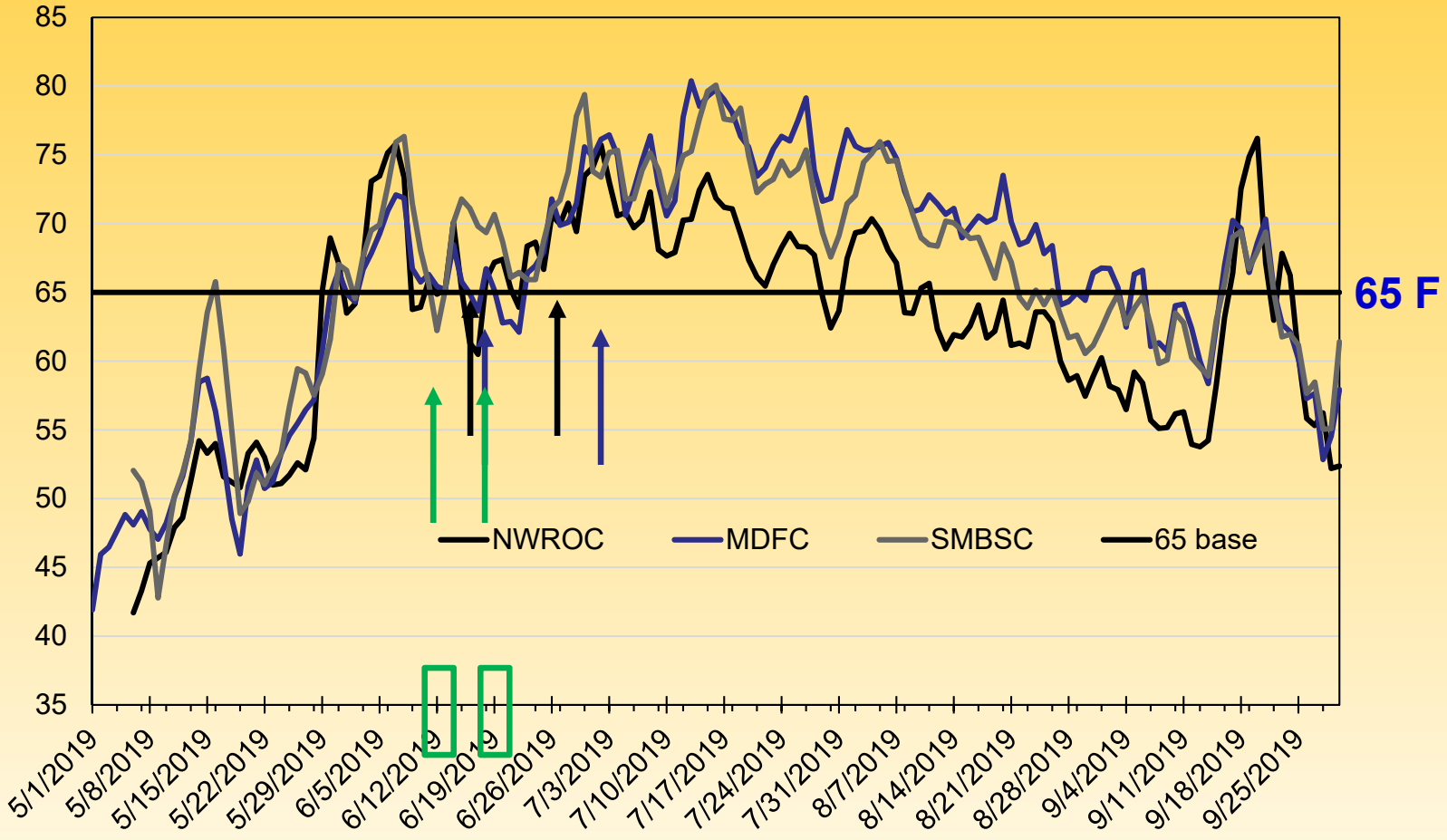
In-furrow treatments

- Benefits
  - Sanitizing the furrow (seedling + soil)
  - More effective than seed treatments – longevity up to 8-10 weeks (Windels, 2010)
- Risks
  - Phytotoxicity
    - cool weather and light soils
    - Mixing with starter fertilizer and other chemicals
  - Plugged nozzles

Management of Rhizoctonia

- Early planting
- Crop Rotation
  - Crop choice
  - Length of rotation
  - Weed control
- Resistant varieties
- At-planting fungicides
  - Seed treatment
  - In-furrow application
- Postemergence fungicides

Mean daily 4-inch soil temp. (2019)



MDFC Source: NDAWN Center, NDSU

Postemergence Application – SMBSC 2019

Planting date: May 14

7 inch band

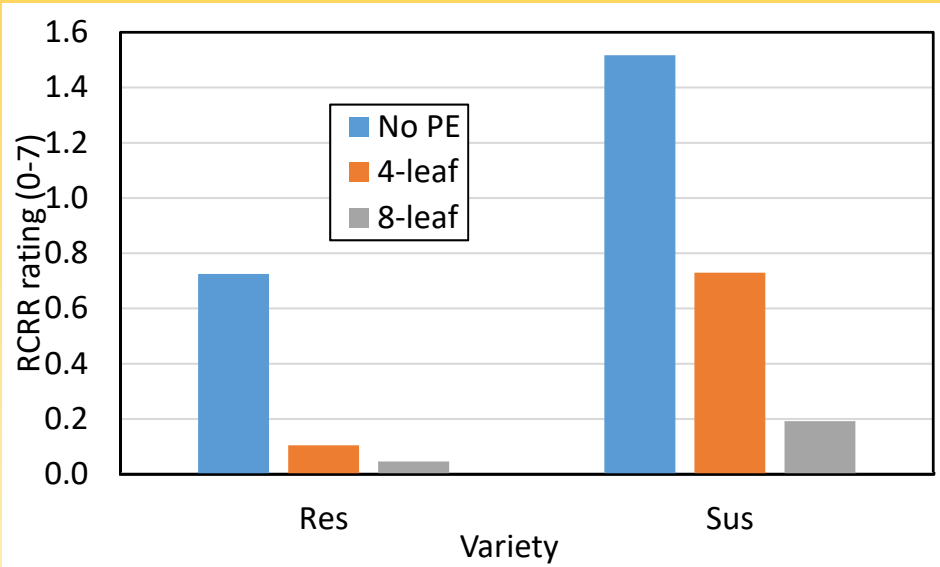
4-leaf stage
June 10

8-leaf stage
June 19

SMBSC - Variety x Post

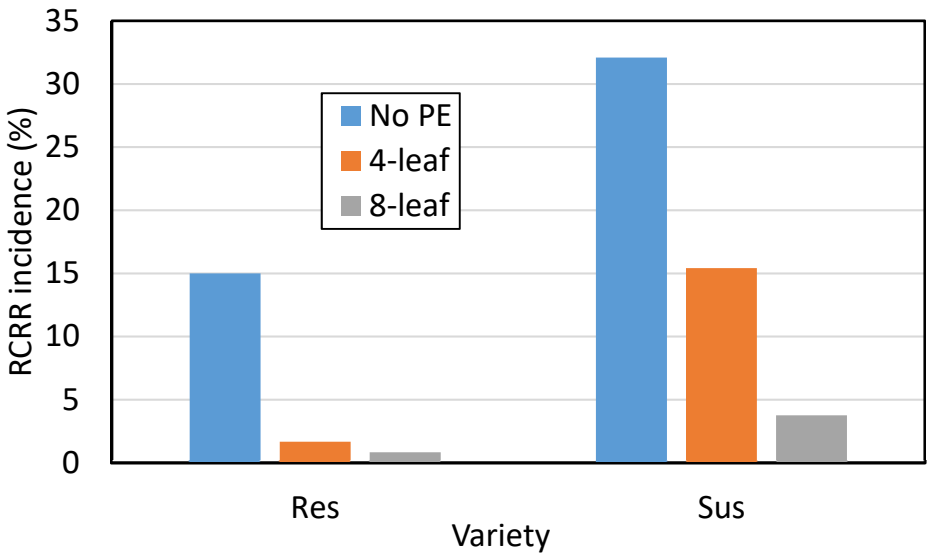
Planting date: May 14
4-leaf POST: June 10
8-leaf POST: June 19

Root Rot Severity



Res = 3.9 variety
Suc = 4.5 variety

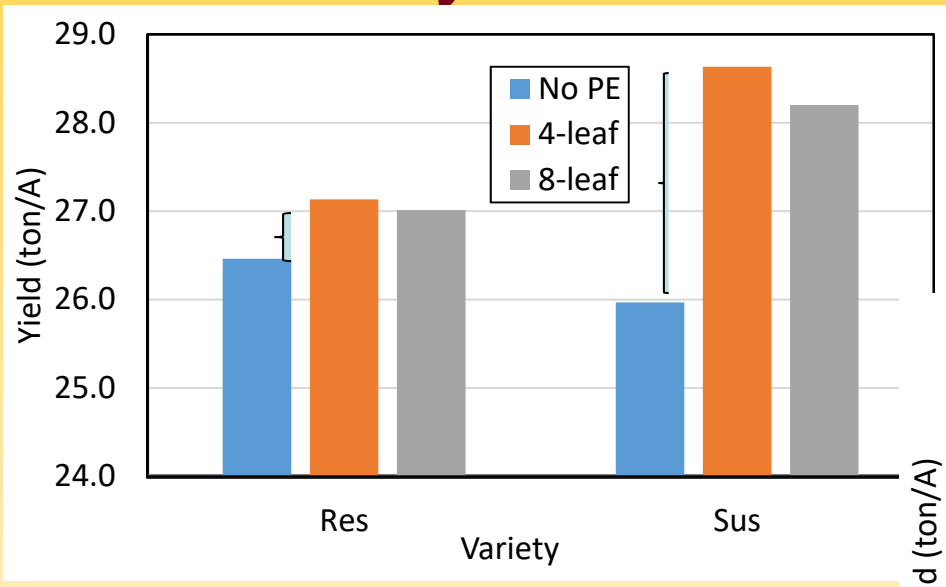
Root Rot Incidence (Rating > 2.0)



SMBSC

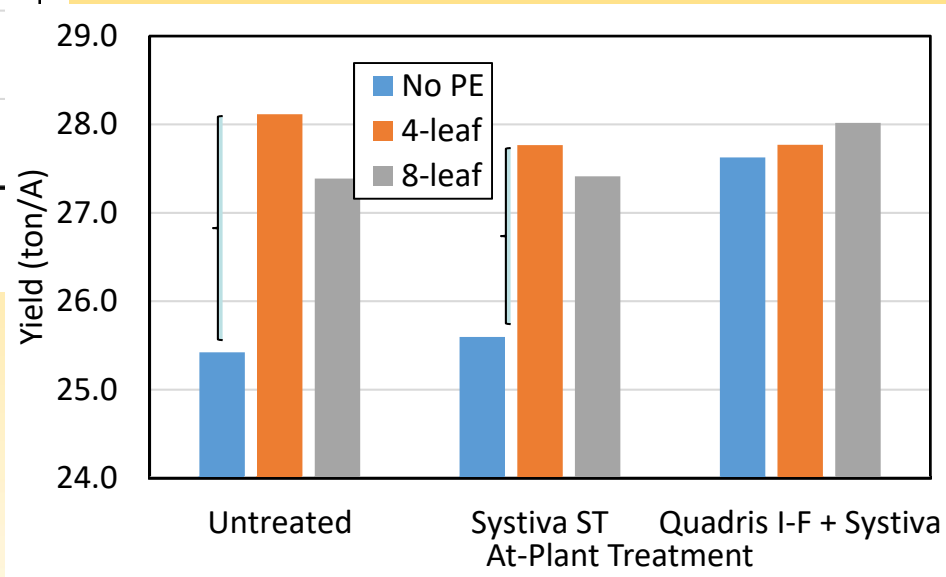
Planting date: May 14
4-leaf POST: June 10
8-leaf POST: June 19

Variety x Post



Res = 3.9 variety
Suc = 4.5 variety

At-Plant x Post



Postemergence Treatments (2019)
Susceptible Variety (4.5 rating)

Treatment	Day 36	# Harvested roots	Harv. loss	Rating	Incidence	Yield	Sugar	SLM	RST	RSA
Quadris 14.5 fl oz	193	179	14	0.2	3	24.8	17.5	1.04	330	8184 a
Elatus 7.1 oz	180	170	10	0.2	3	24.1	17.6	1.01	332	8021 a
Azteroid 9.2 fl oz	196	184	12	0.3	5	23.9	17.6	1	331	7912 a
Quadris 10 fl oz	196	178	18	0.5	8	23.5	17.7	0.98	333	7846 a
Propulse 13.6 fl oz	187	174	13	0.9	19	23.3	17.5	1.02	329	7676 ab
Proline 5.7 fl oz	197	174	23	0.8	14	23.2	17.6	1.03	330	7651 ab
Quadris broadcast 14.5 fl oz	191	173	18	0.4	5	23.2	17.4	1.02	328	7617 ab
Priaxor 6.7 fl oz	176	151	25	1.2	20	20.6	17	1.06	319	6582 b
Untreated	195	104	91	4.6	74	12.2	16.7	1.16	310	3867 c
ANOVA P-value		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.121	0.2291	0.1077	<0.0001
LSD (P = 0.05)		23.4	16.4	0.61	10.8	2.98	NS	NS	NS	1105

Postemergence fungicides – 2015
Quadris vs Generics

Treatment	RCRR (0-7)	Yield T/A	RSA
Non-inoculated			
No-fungicide control	3.4	24.3	6263
R. solani-inoculated			
Equation @ 14 fl oz/A	1.9 d	31.0 a	8066 a
Quadris @ 14 fl oz/A	2.4 d	29.9 a	7908 a
Satori @ 14 fl oz/A	2.4 d	29.6 a	7790 a
No-fungicide control	**5.5 a**	**14.0 c**	**3411 c**
ANOVA *P*-value	0.0001	0.004	0.002
LSD ($P = 0.05$)[Z]	1.4	8.3	2284

Postemergence fungicides – 2015 azoxystrobin Band vs Broadcast

Treatment (Rates per Acre)	RCRR (0-7)	RCRR % Incidence	Yield T/A	RSA
No fungicide control	**3.7 a**	**75 a**	**23.2 c**	**7324 c**
AZteroid @ 17.6 fl oz, band	0.7 b	15 b	33.6 ab	11084 ab
Quadris @ 10 fl oz, band	0.9 b	16 b	33.5 ab	11272 a
Quadris @ 14 fl oz, band	**1.2 b**	**25 b**	**31.9 ab**	**10659 ab**
Quadris @ 14 fl oz **broadcast**	1.1 b	21 b	33.4 ab	10944 ab
ANOVA *P*-value	<0.0001	<0.0001	<0.0001	0.0001
LSD ($P = 0.05$)[W]	0.92	18.4	3.86	1451

Postemergence fungicides

- Benefits
  - If you are doing a row cultivation--throwing soil onto crowns
  - Late season disease control (rain Aug-Sept)
  - If sugarbeets are following Rhizoctonia-susceptible crops in a rotation
  - **Band application (preferred)** – severe disease pressure
  - Broadcast application – low disease pressure
- Risks
  - Work better if applied before infection

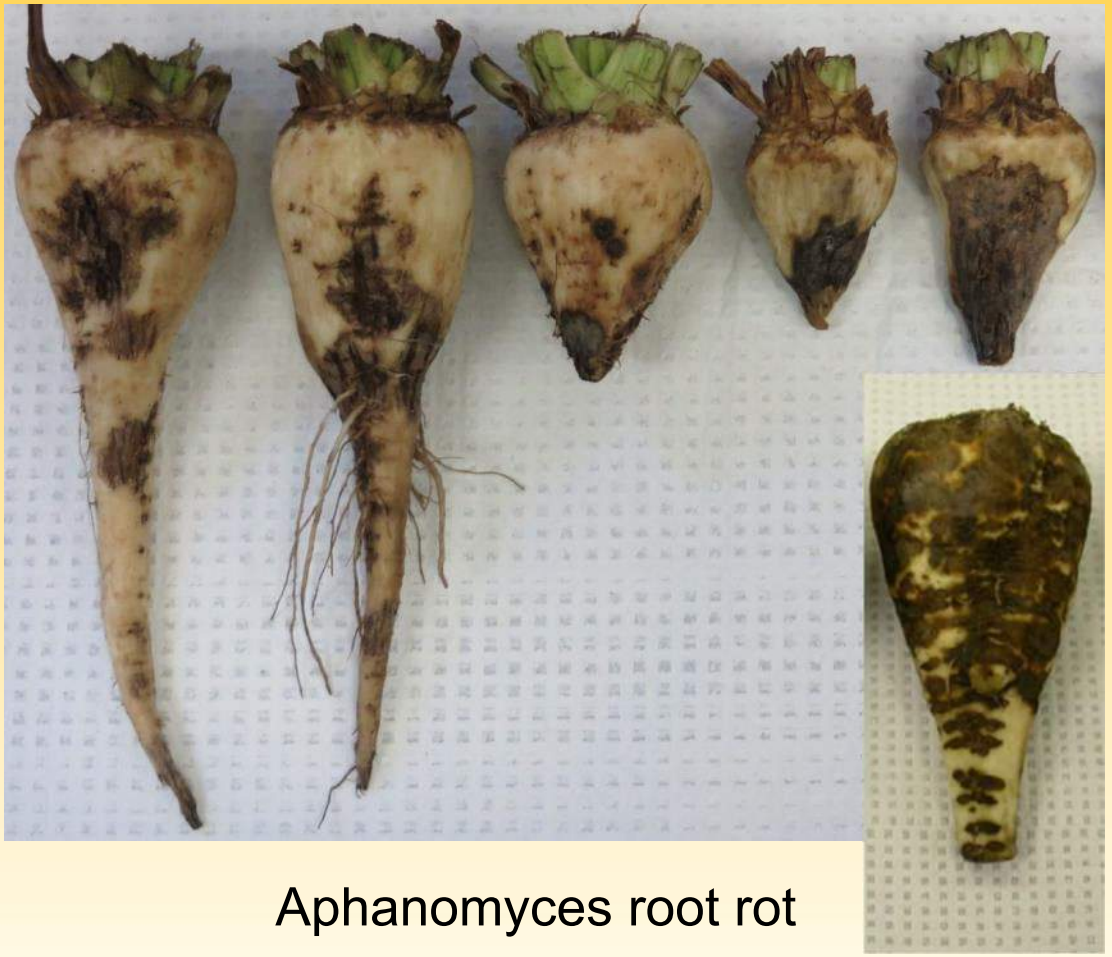
Summary

- Varietal Selection
  - Can make a difference under moderate to high disease pressure
- Seed treatments
  - Provide excellent early-season protection
- In-furrow applications
  - can reduce stands under dry and cool conditions
  - early to mid-season protection
- Postemergence fungicide application
  - 4-8 leaf stage window for application
  - Important for susceptible varieties
    - Seed treatment – beneficial postemergence
    - Seed treatment + in-furrow fungicide – may not be needed unless very severe field history

Management of Aphanomyces

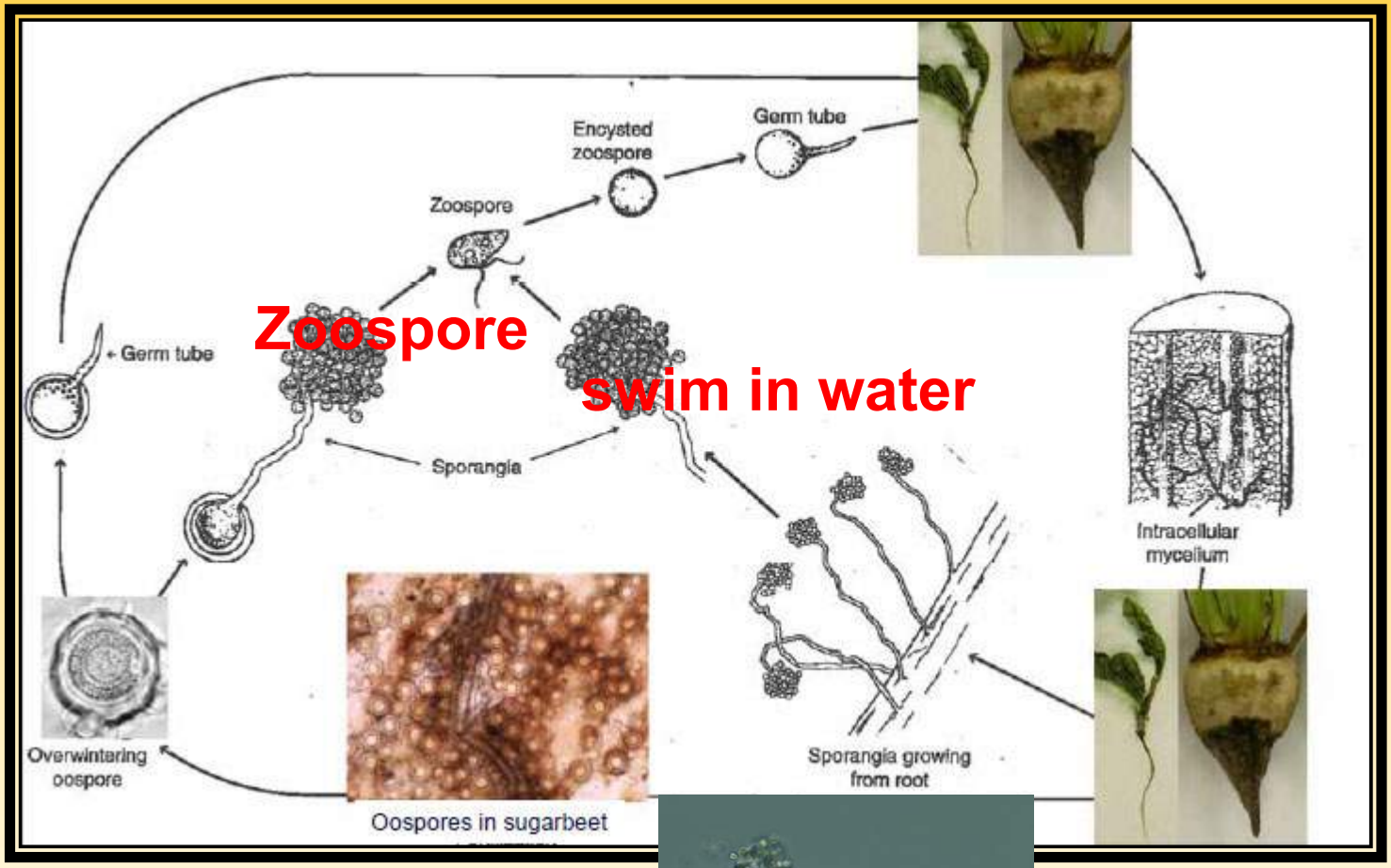
Aphanomyces can be a full-season pathogen

Aphanomyces damping-off



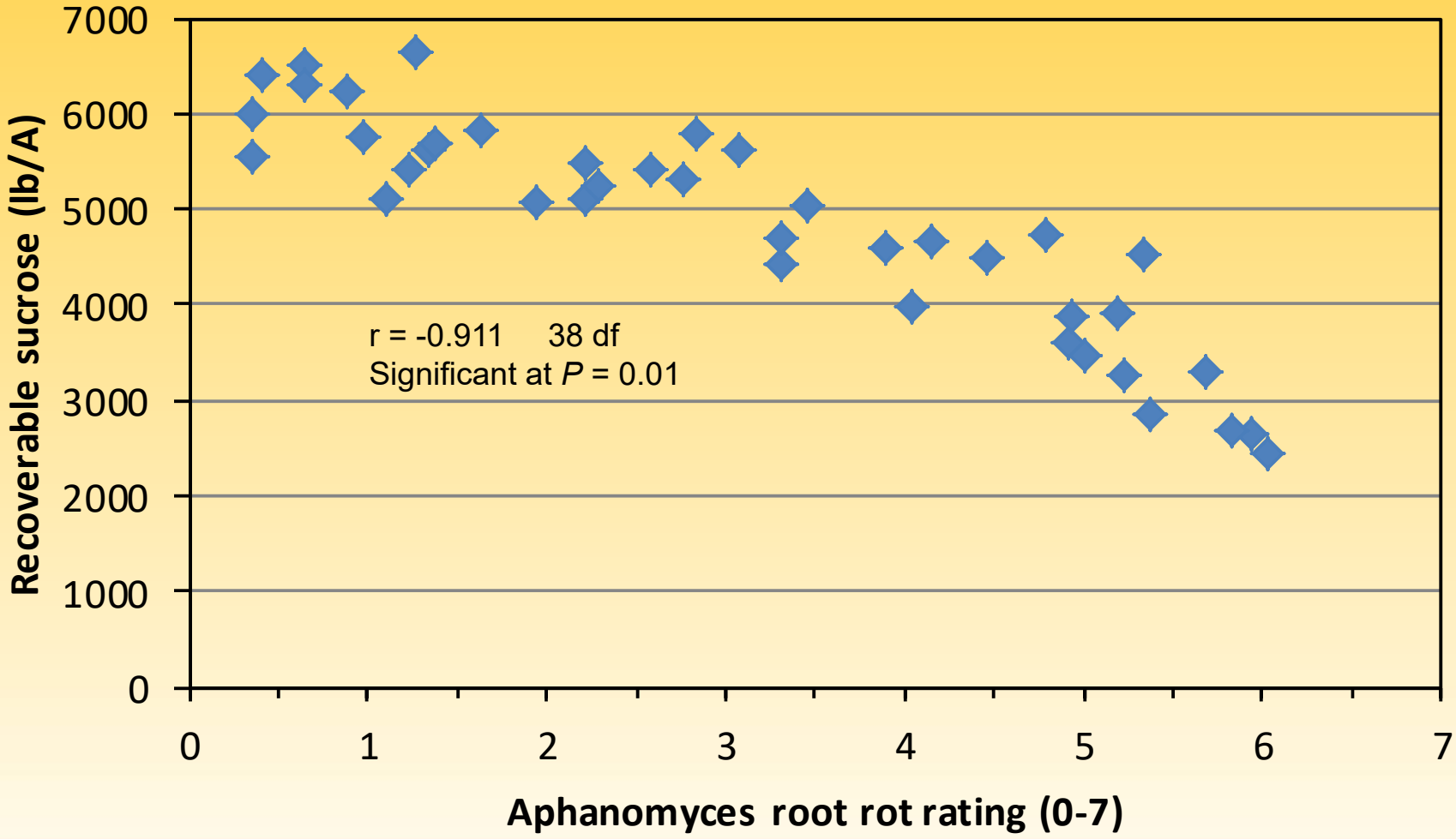
Aphanomyces root rot

Life Cycle of *Aphanomyces cochlioides*



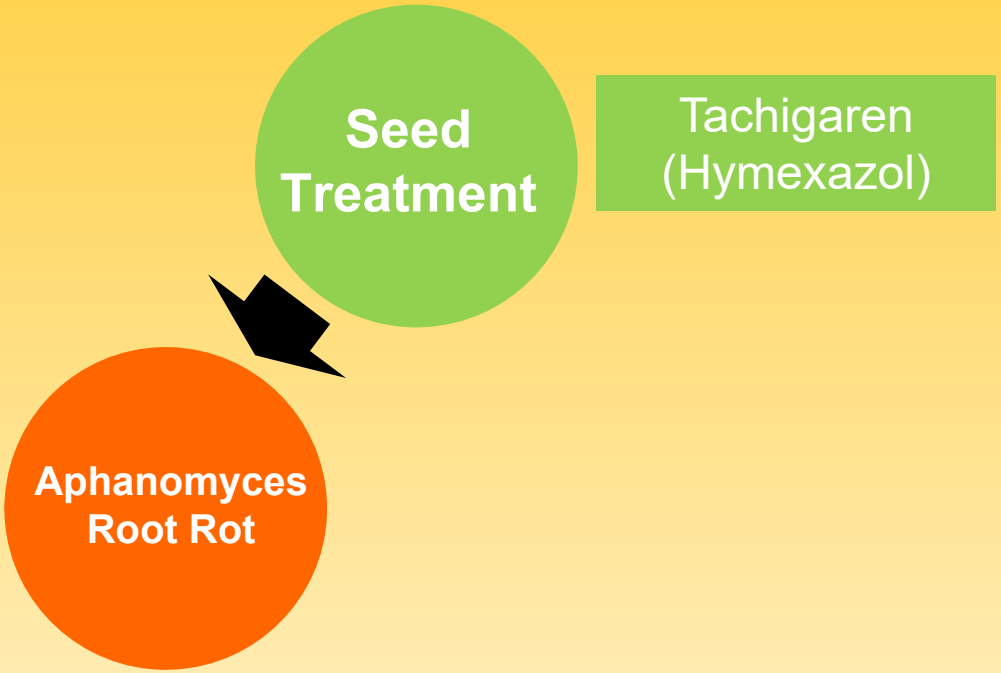
C. Windels, 2012

Correlation of sugar yield with Aphanomyces root rot

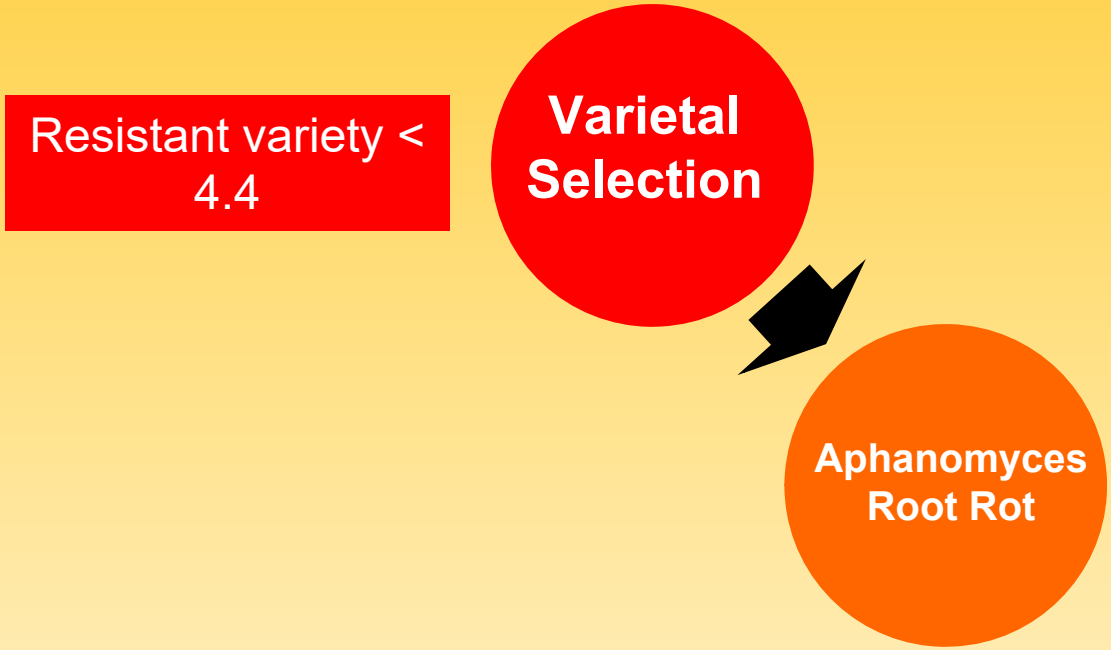


Management of Aphanomyces

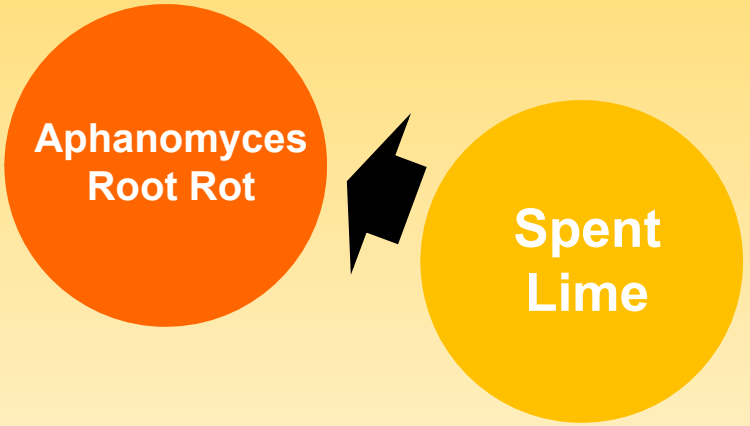
Early planting



Management of Aphanomyces



Management of Aphanomyces

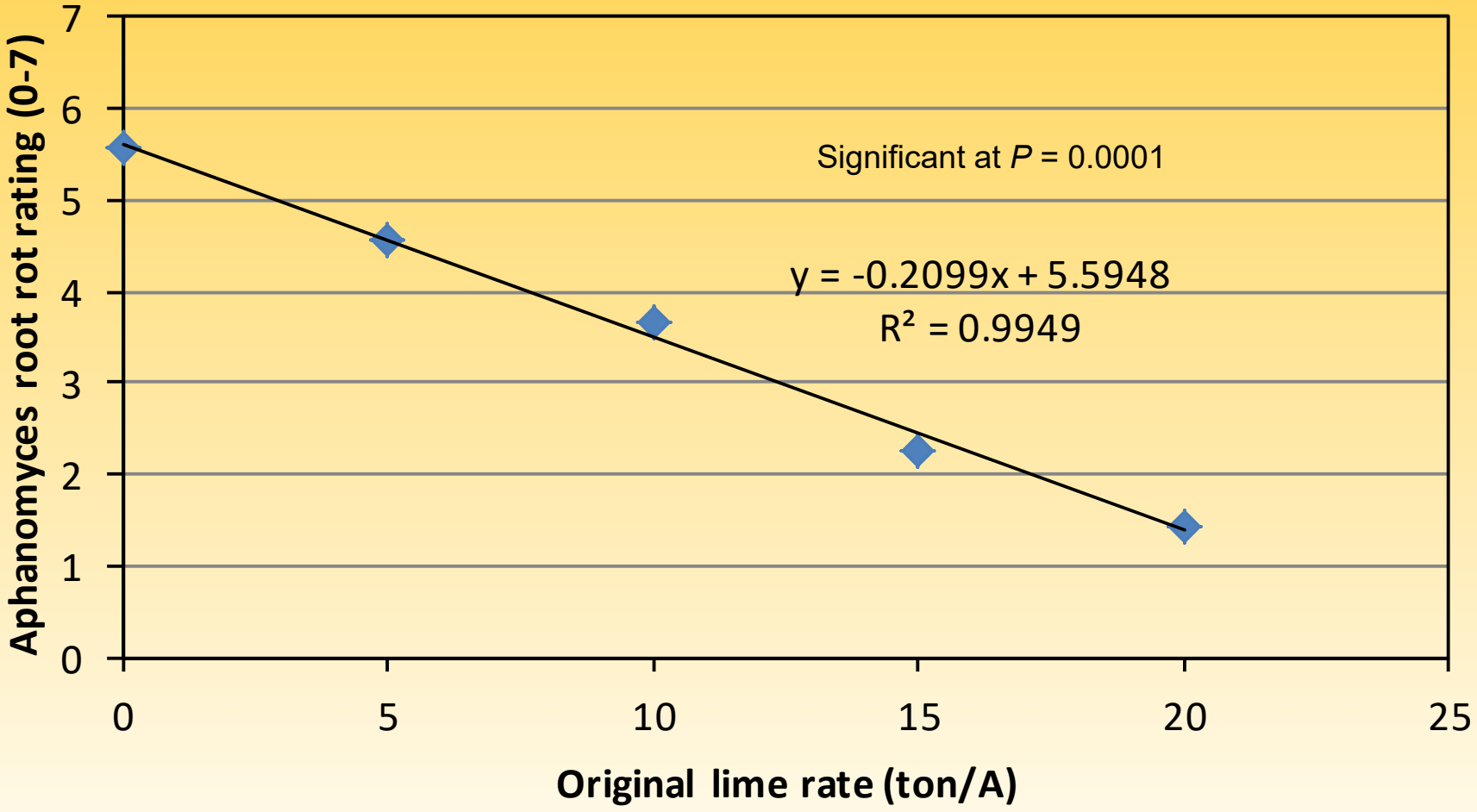



2016 - No lime

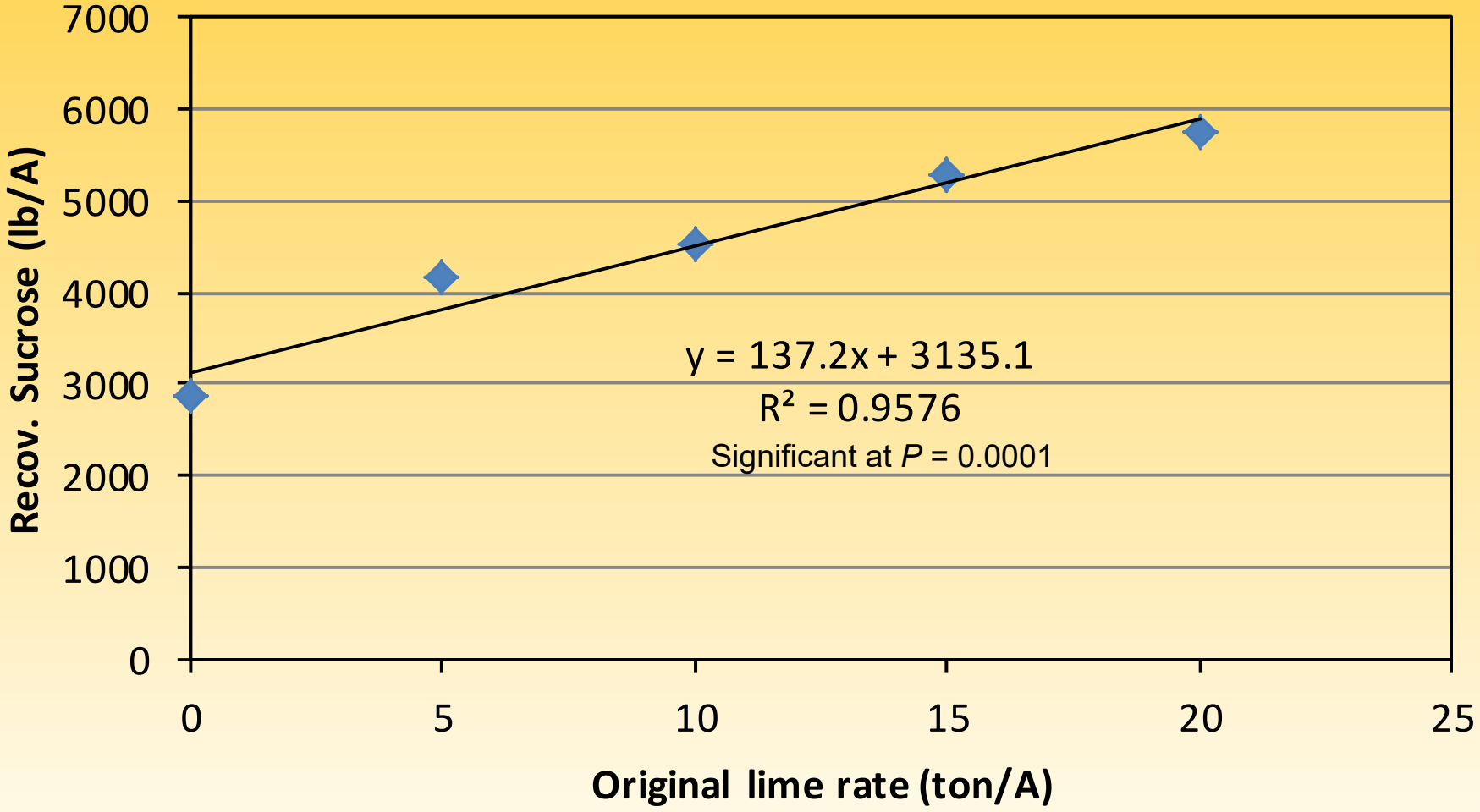

2016 - 10 ton/A lime


2016 - 20 ton/A lime

Original lime still reduced Aphanomyces in sugarbeet after 12 years (2016)



Original lime still improved sugar yield after 12 years

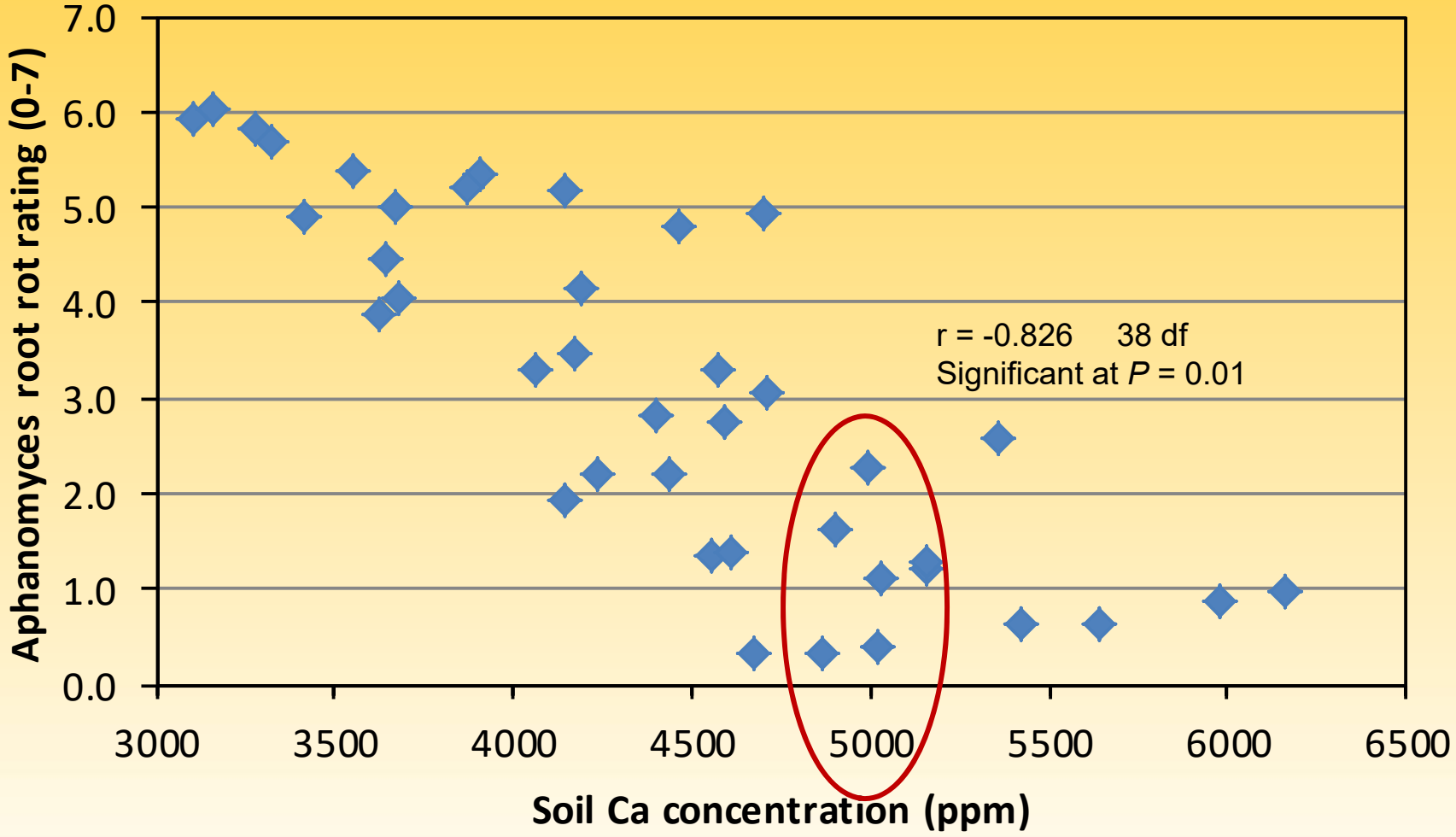


Effect of supplemental lime – across all original lime rates

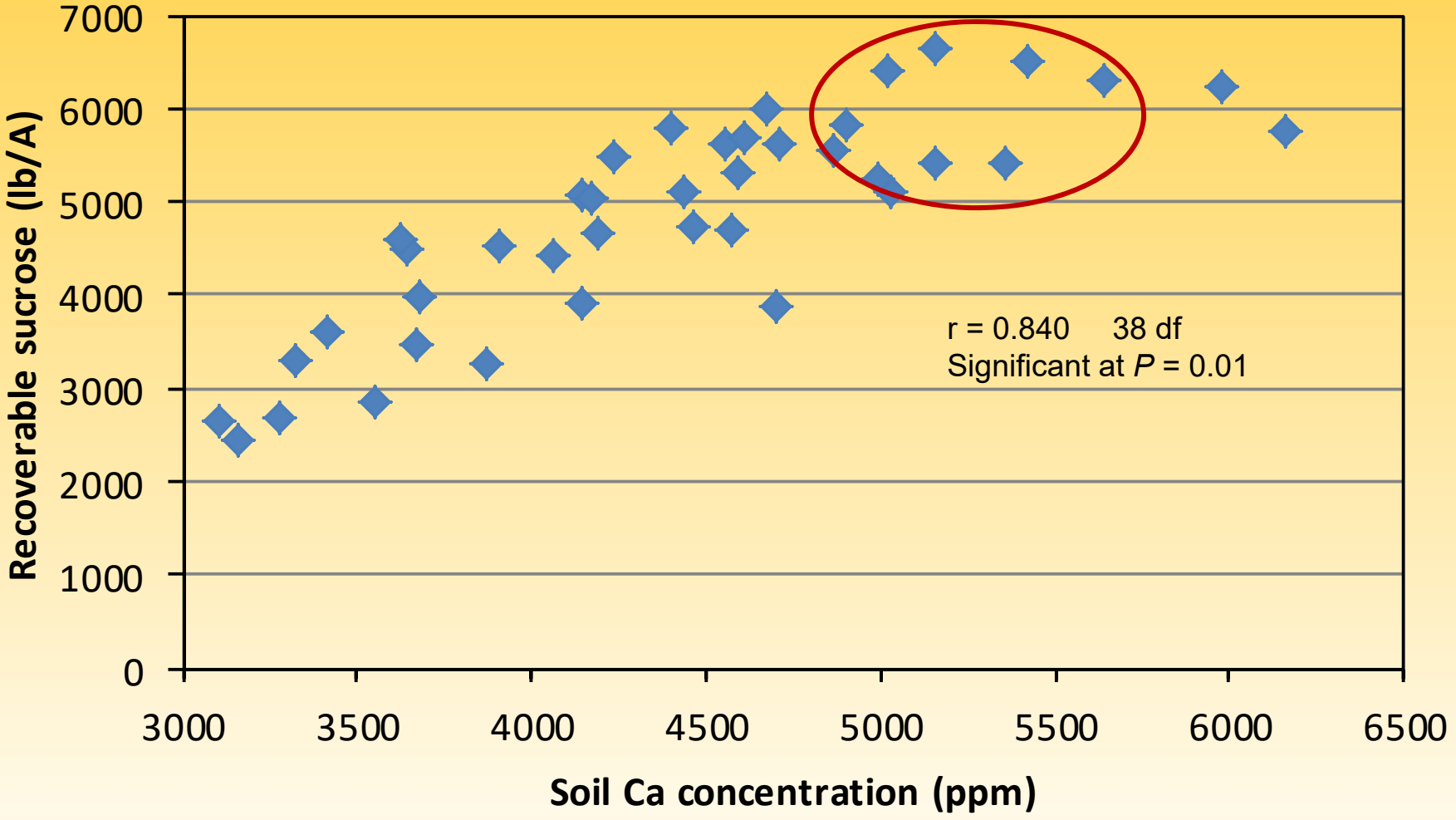
Supplemental lime	Soil Ca (ppm)	Stand at 7 weeks (per 100 ft)	Harvested roots (per 100 ft)	Aph RRR (0-7)	Yield (ton/A)	Sucrose (%)
None	4132	115	101	3.5	20.3	12.6
5 ton/A	4696	133	122	2.6	22.9	12.8
Significance	***	**	**	**	**	NS

* = Significant at *P* = 0.05
** = Significant at *P* = 0.01
*** = Significant at *P* = 0.001

Correlation of Aphanomyces root rot with soil extractable calcium



Correlation of sugar yield with soil extractable calcium

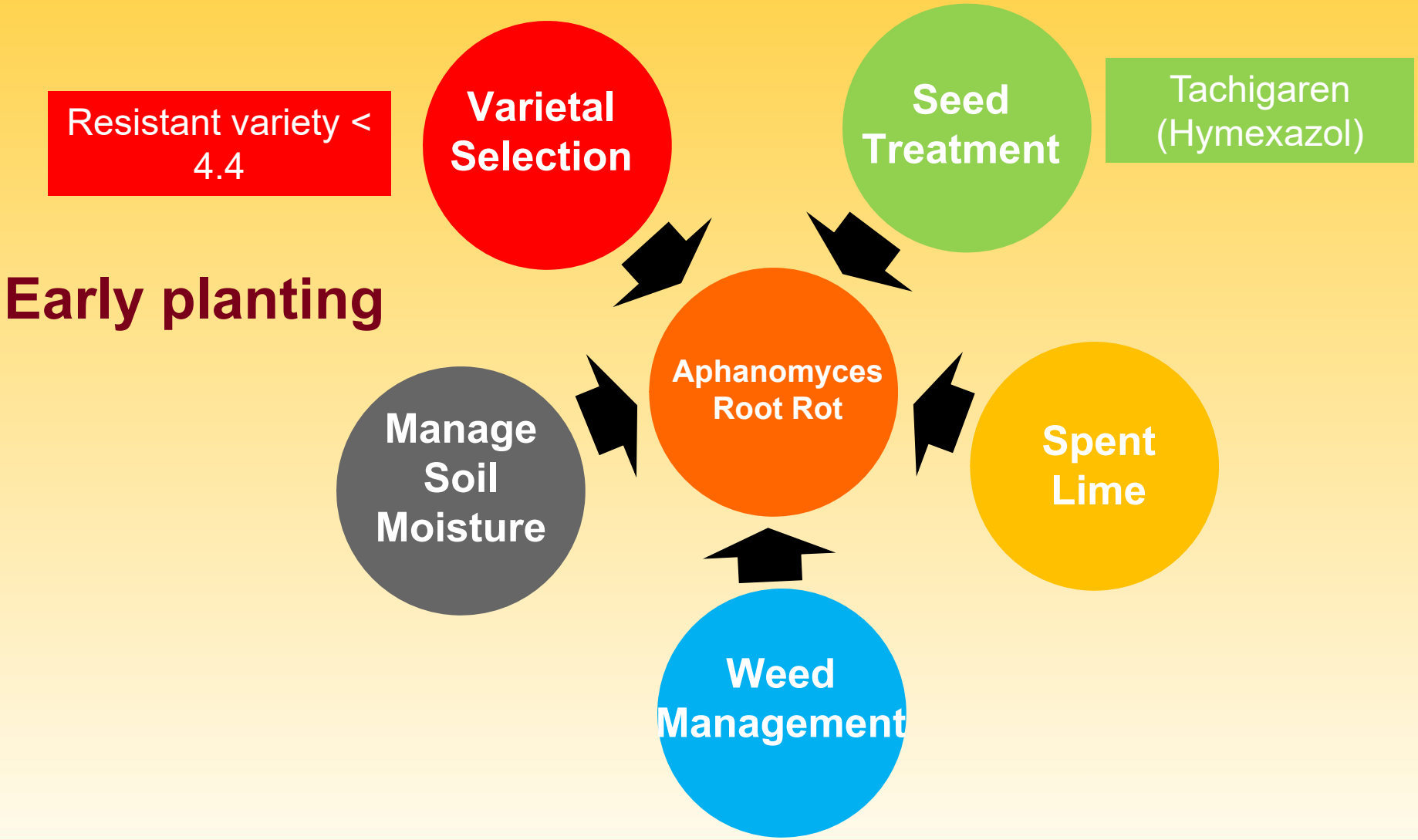


For fields with Aphanomyces:

Current lime rate

No lime	• Add 5-10 ton/A spent lime
5 ton/A	• Add 5 ton/A spent lime
10+ ton/A	• Apply based on field history

Integrated Management of Aphanomyces

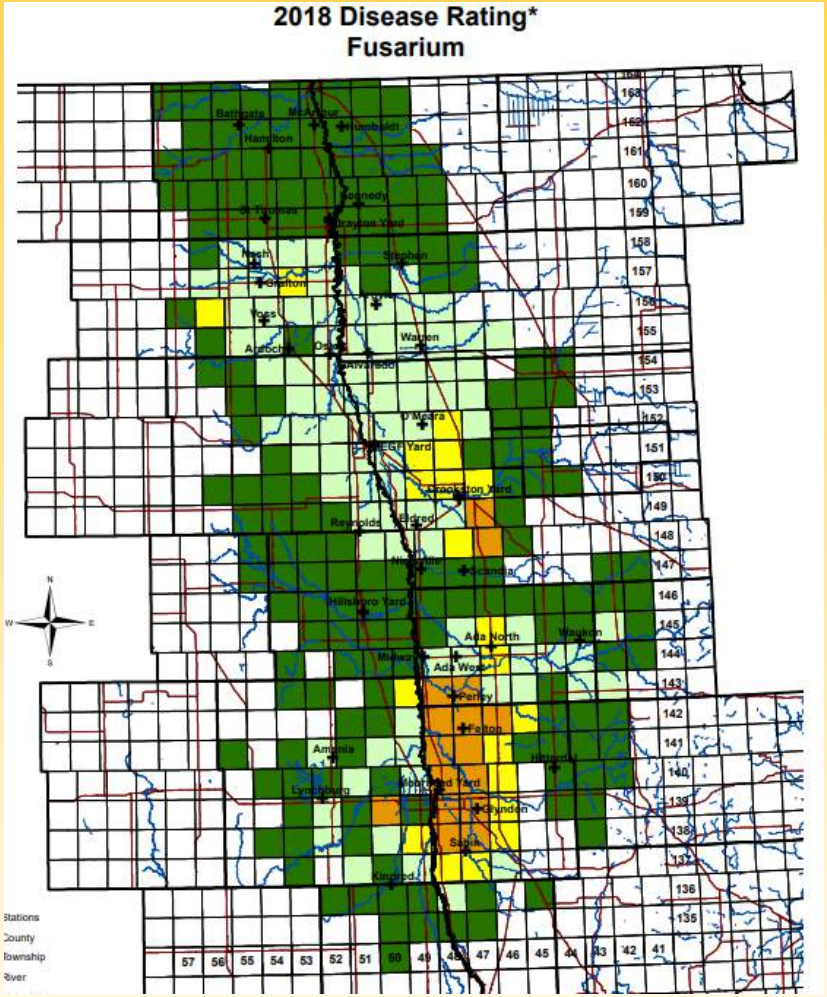


Management of Fusarium Yellows

Fusarium Yellows

- Moorhead, late 1990's
- 2004, 5 to 10% of fields
- 2018, ACSC

	# Townships
None	174
Slight	89
Moderate	20
Severe	16



Fusarium on Seedlings

Fusarium Yellows

5.7 variety
(06/17/2019)

5.7 variety
(06/17/2019)

Fusarium Yellows

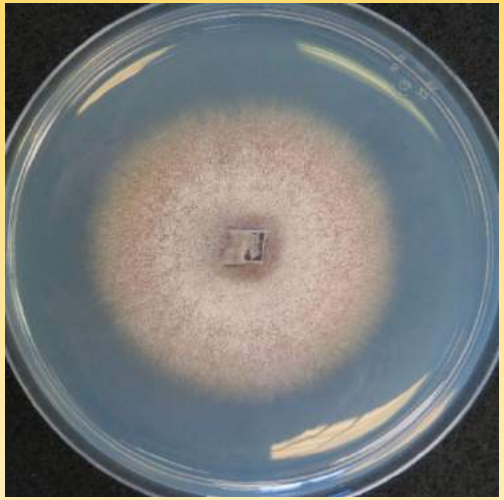
4.3 variety
(06/28/2019)

Fusarium Yellows

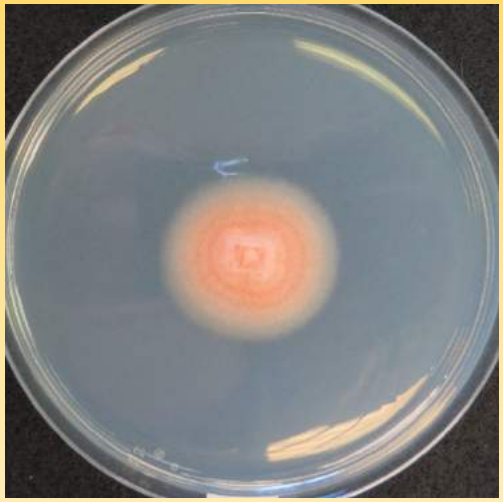
4.3 variety
(08/06/2019)

2.5 variety
08/14/2019

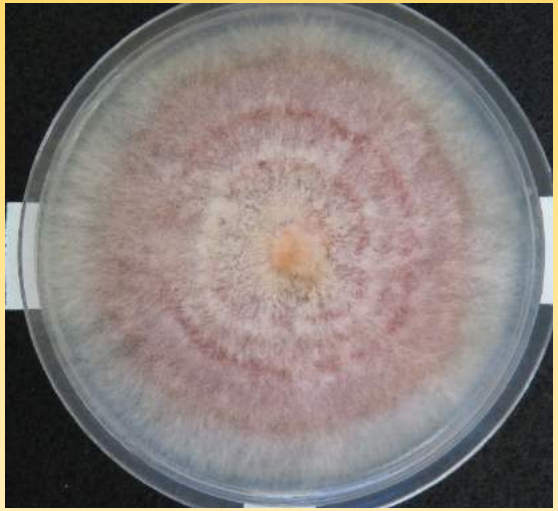
Fusarium Yellows



F. oxysporum



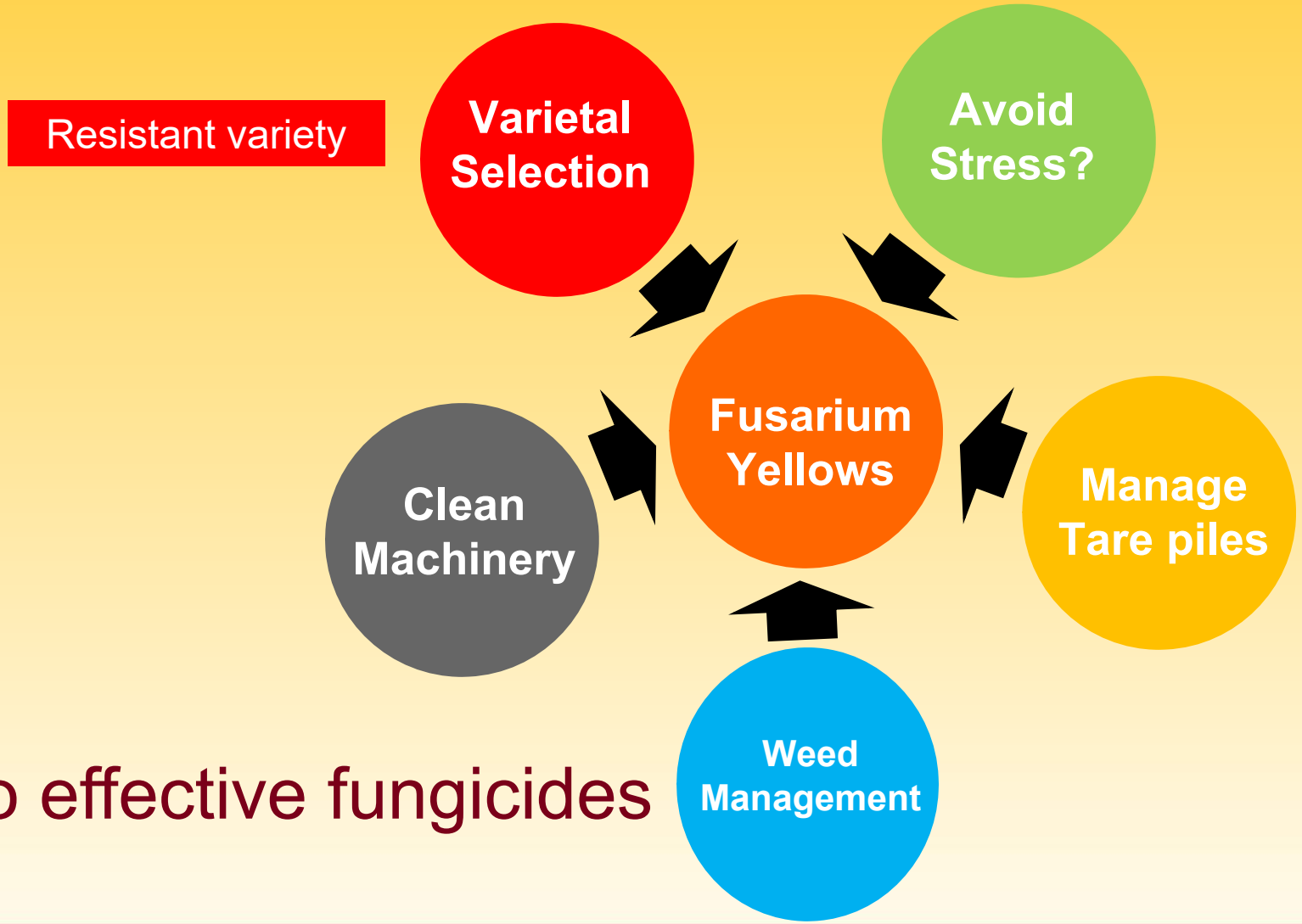
F. secorum



F. graminearum

Another F. spp recovered in 2019

Integrated Management of Fusarium

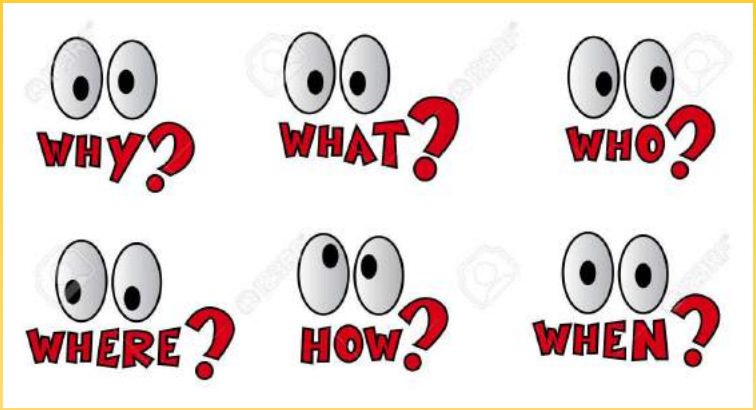


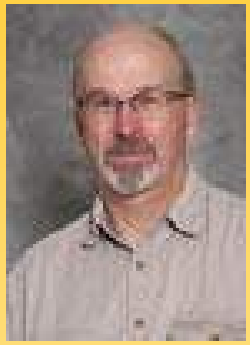
No effective fungicides

Acknowledgements

- Sugarbeet Research and Education Board of Minnesota and North Dakota
- Grower cooperators
- Scott Pahl, Germains Seed Technology
- Seed, chemical, and allied industries
- American Crystal Sugar Company quality lab
- Minn-Dak Farmers Cooperative
- Southern Minnesota Beet Sugar Cooperative

Jeff





Hal

Thank you!

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