Update on Root Rot Research: *Aphanomyces* and *Rhizoctonia*

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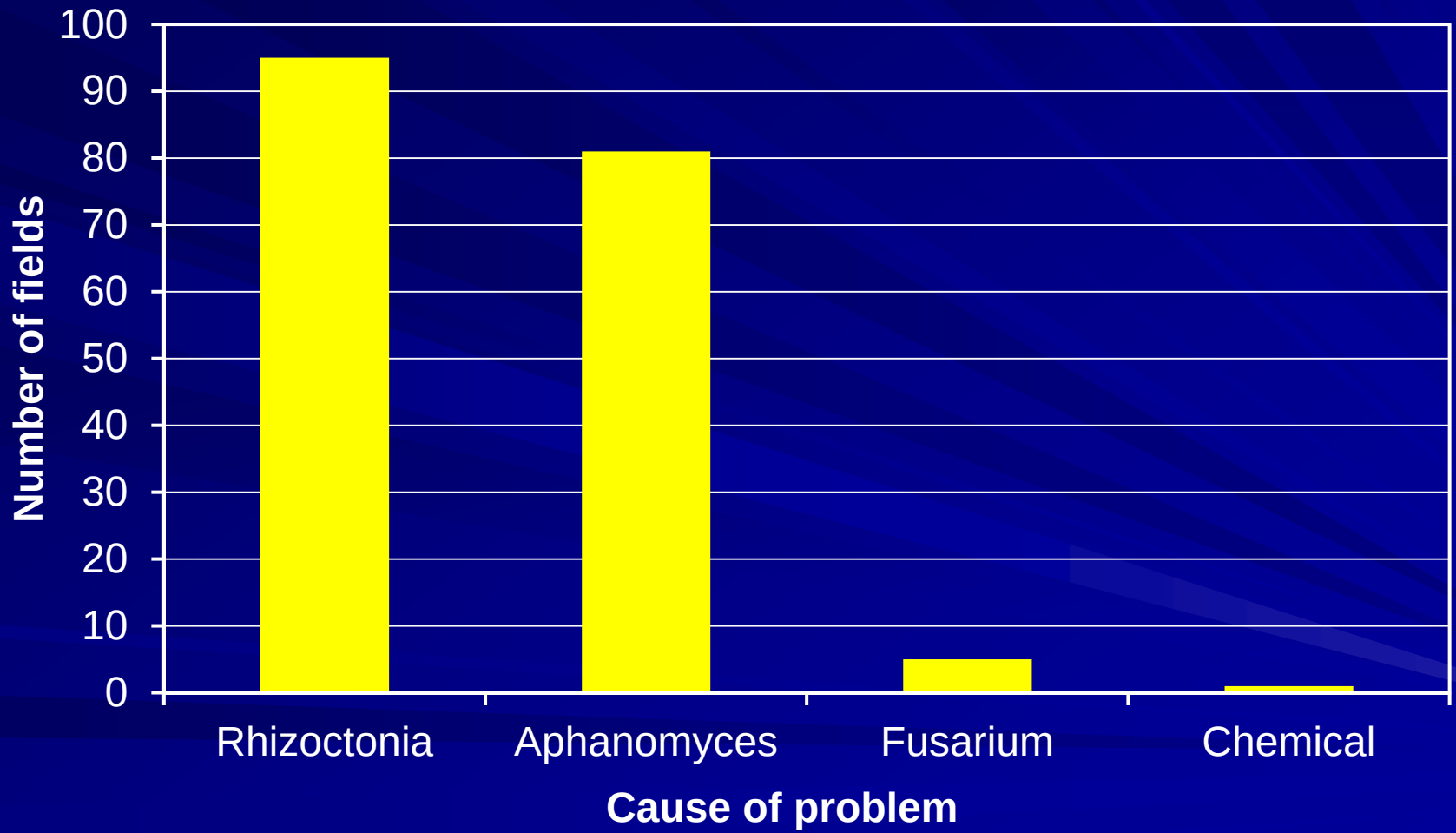
2011 Sugarbeet samples (183 total)



Outline of topics

- Compare: *Aphanomyces* vs. *Rhizoctonia*
- Infection: *Aphanomyces* vs. *Rhizoctonia*
- *Aphanomyces*
  - Disease management options
  - Long-term lime trials
- *Rhizoctonia solani* AG 2-2
  - Fungicides (seed, in-furrow, post-emergence)

Aphanomyces vs *Rhizoctonia*

Species:	*A. cochloiodes*	*R. solani* AG 2-2
Pathogen:	Oomycete, “water mold”	True fungus
Host range:	Sugarbeet Some weeds	Sugarbeet, beans, sunflowers, corn; Numerous weeds
Temperature:	55-95° F (68-86° F)	50-95° F (68-86°F)
Moisture:	Wet	Dry – wet (25-100% MHC)
Seedling:	Lab analysis	Lab analysis
Older roots:	Root tip, lateral roots	Crown to tip, usually

Aphanomyces

Rhizoctonia

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Movement:	Moving soil & plant parts	Moving soil & plant part

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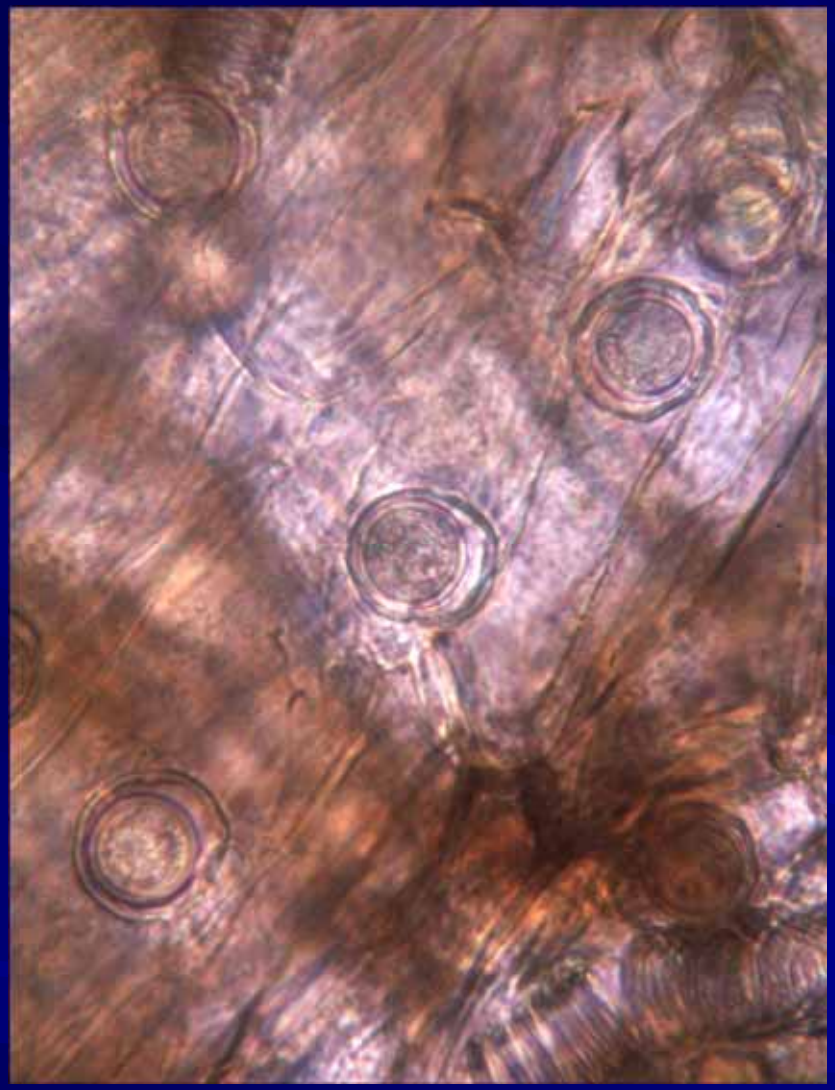
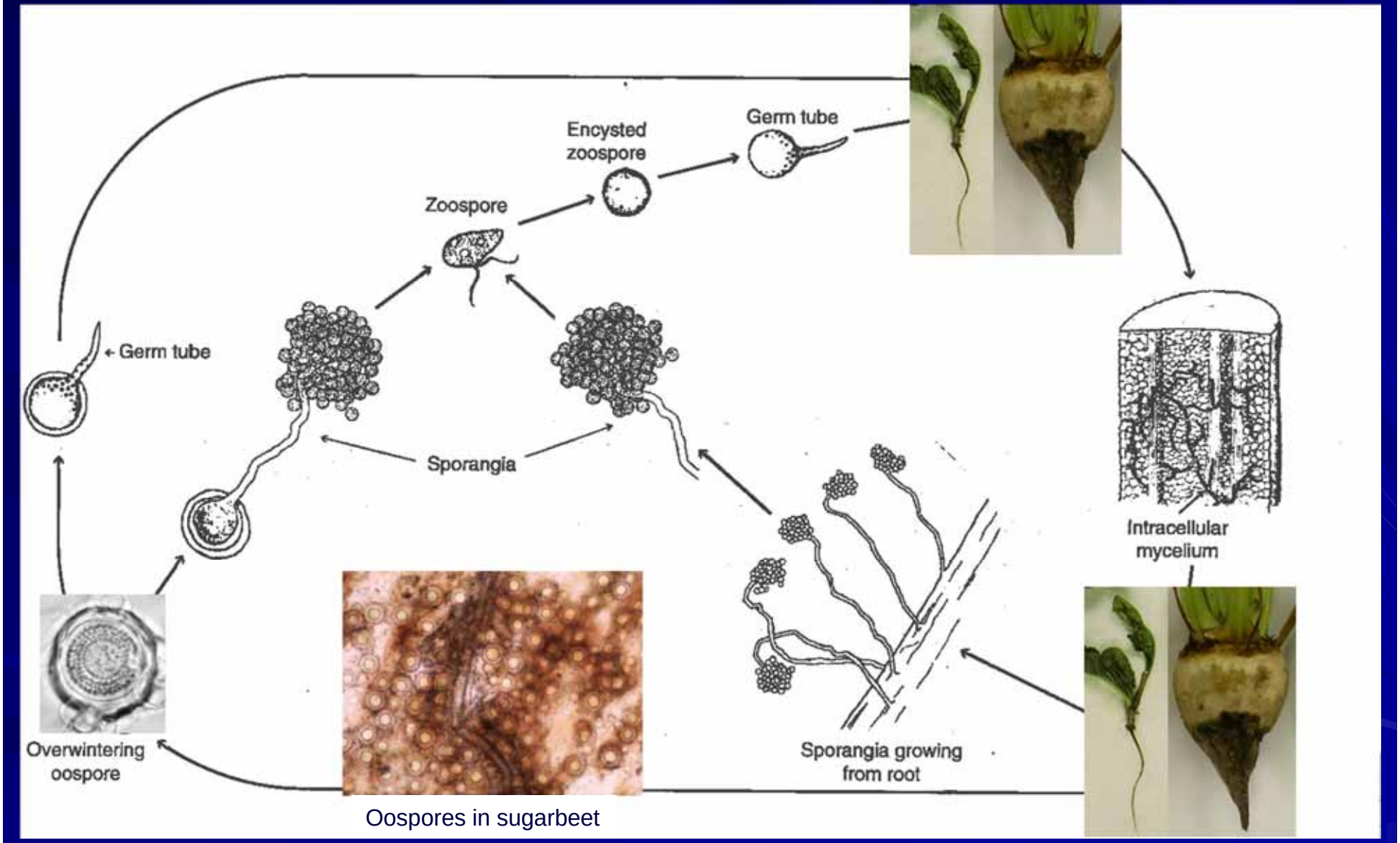
Seedling:	Lab analysis	Lab analysis
Older roots:	Root tip, lateral roots	Crown to tip, usually
Movement:	Moving soil & plant parts	Moving soil & plant part
Survives:	Oospores	Mycelium, hyphae
Infection:	Zoospores	Mycelium, hyphae



Oospores in diseased root

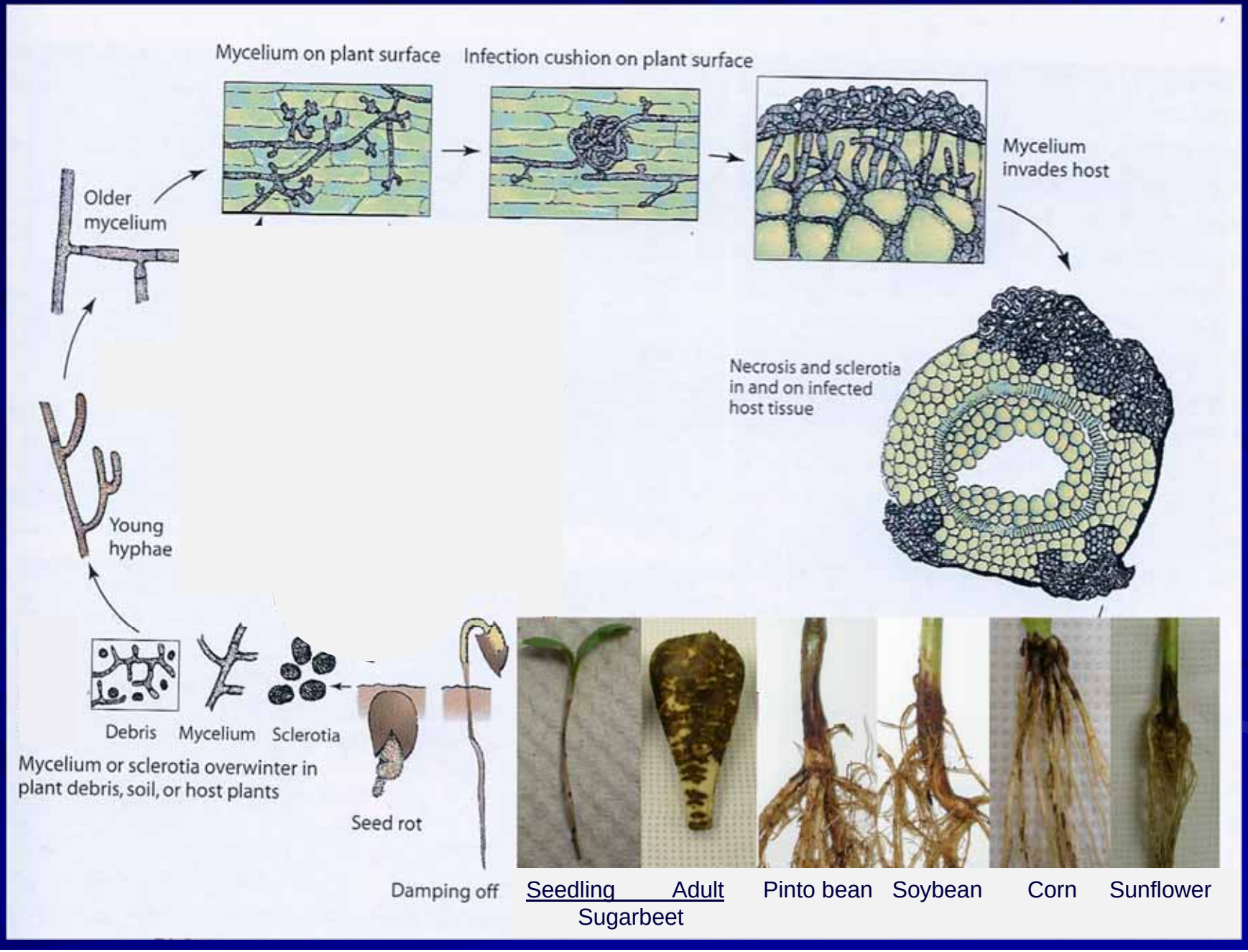
Zoospores at end of sporangia

Aphanomyces life cycle



Oospores in sugarbeet

Rhizoctonia life cycle (adapted from Agrios, 2005)



Control of Aphanomyces

- Avoid planting severely infested fields
- Plant early
- Plant Tachigaren-treated seed (45g)
- Select partially resistant variety
- Cultivate to keep soil dry & aerated
- Apply factory “spent” lime

Eighth Growing Season After a Single Field Application of Spent Lime: Aphanomyces & Sugarbeet Yields

Carol E. Windels, Jason R. Brantner, Albert Sims and *Carl Bradley

Univ. Minn., NW Res. Outreach Ctr., Crookston & *Univ. Illinois, Urbana

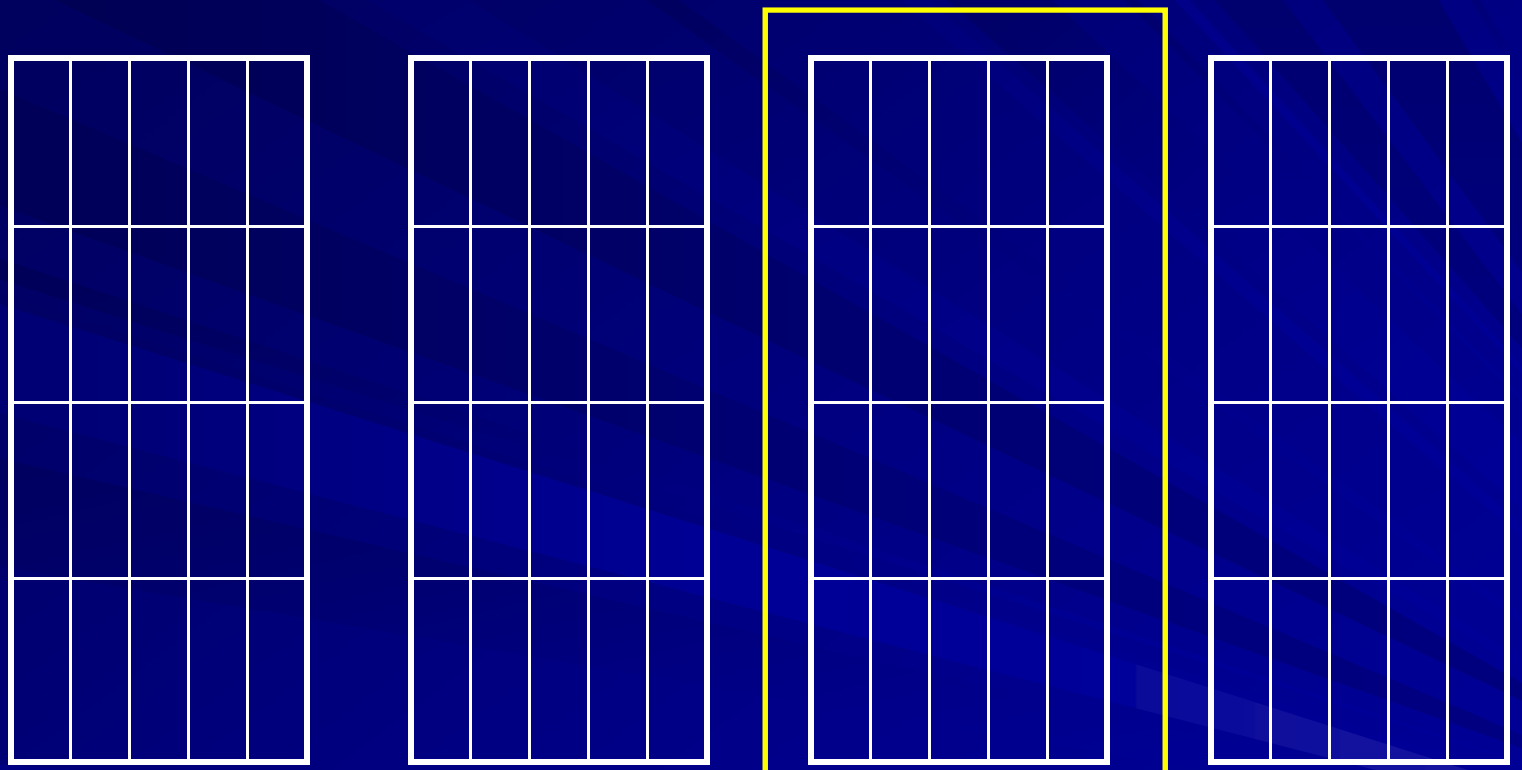
Research site information

Factor	Hillsboro, ND
Soil type	Fargo sicl (fine, smectitic, frigid, Typic Epiaquert)
Aph Soil Index Value	48
Soil pH	7.0
Date limed	October, 2003
Rates (Ton wet wt/A)	0, 5, 10, 20, 30
Rates (Ton dry wt/A)	0, 3.3, 6.5, 13, 19.5

Research site information

Factor	Hillsboro, ND	Breckenridge, MN
Soil type	Fargo sicl (fine, smectitic, frigid, Typic Epiaquert)	Doran cl (fine, smectitic, frigid Aquertic, arqiudoll)
Aph Soil Index Value	48	98
Soil pH	7.0	6.3
Date limed	October, 2003	April, 2004
Rates (Ton wet wt/A)	0, 5, 10, 20, 30	0, 5, 10, 15, 20
Rates (Ton dry wt/A)	0, 3.3, 6.5, 13, 19.5	0, 2.7, 5.3, 8, 10.6

Experiments (2005 – 2012)



2005 (2 yr)
2009 (6 yr)

2006 (3 yr)
2010 (7 yr)

2007 (4 yr)
2011 (8 yr)

2008 (5 yr)
2012 (9 yr)

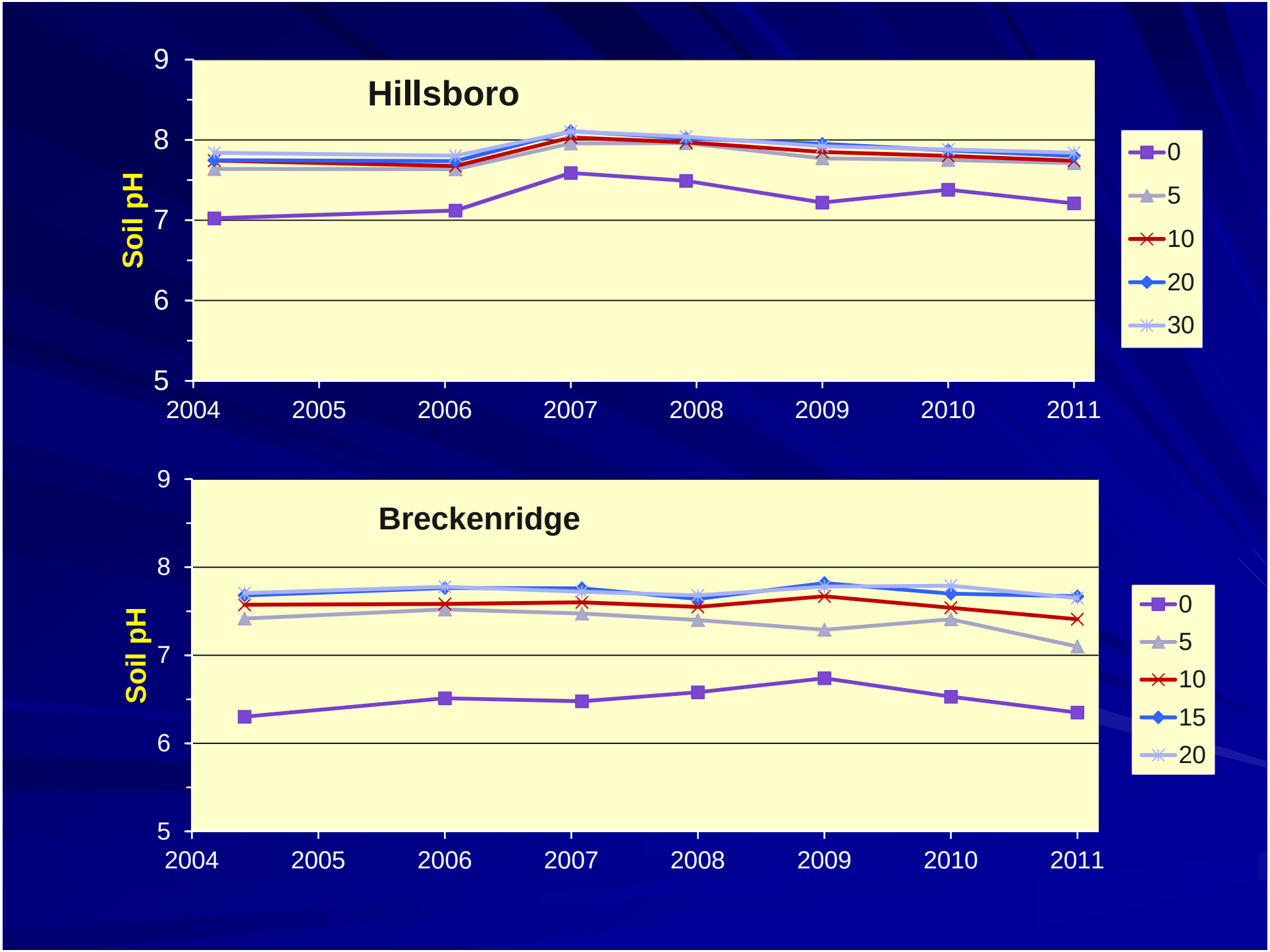
Sugarbeet sown in 1 experiment/year
Rotation crops sown 3 experiments/year

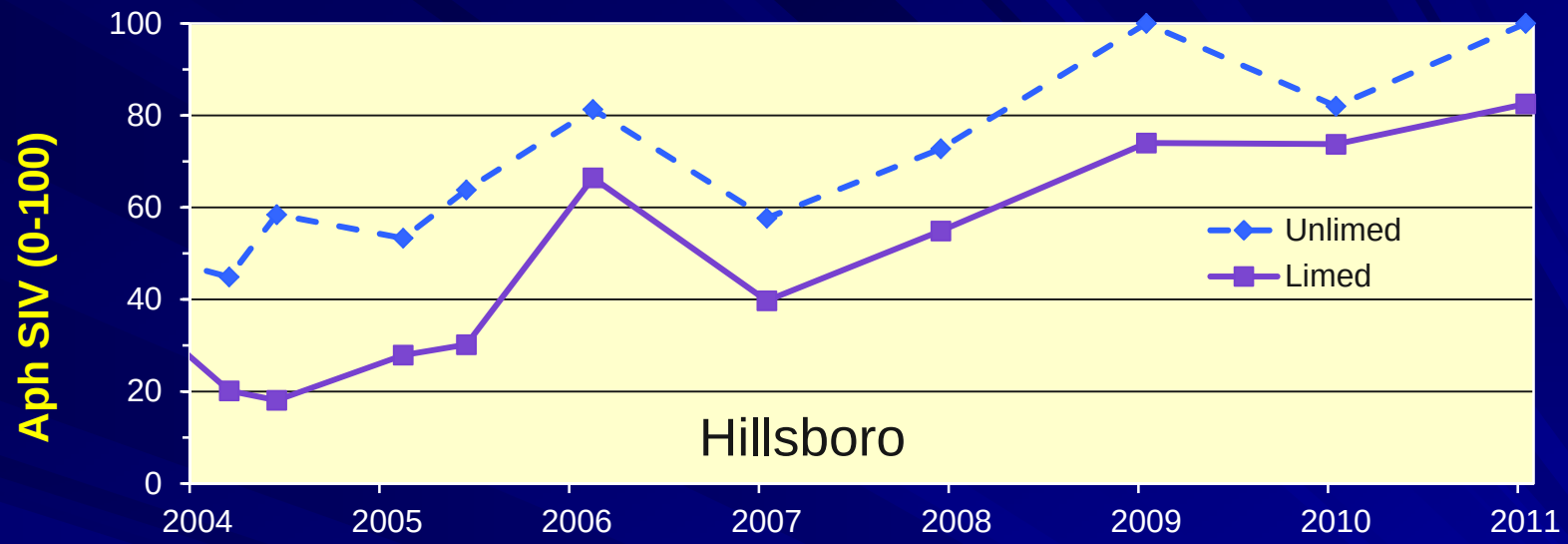
Objectives: Long-term

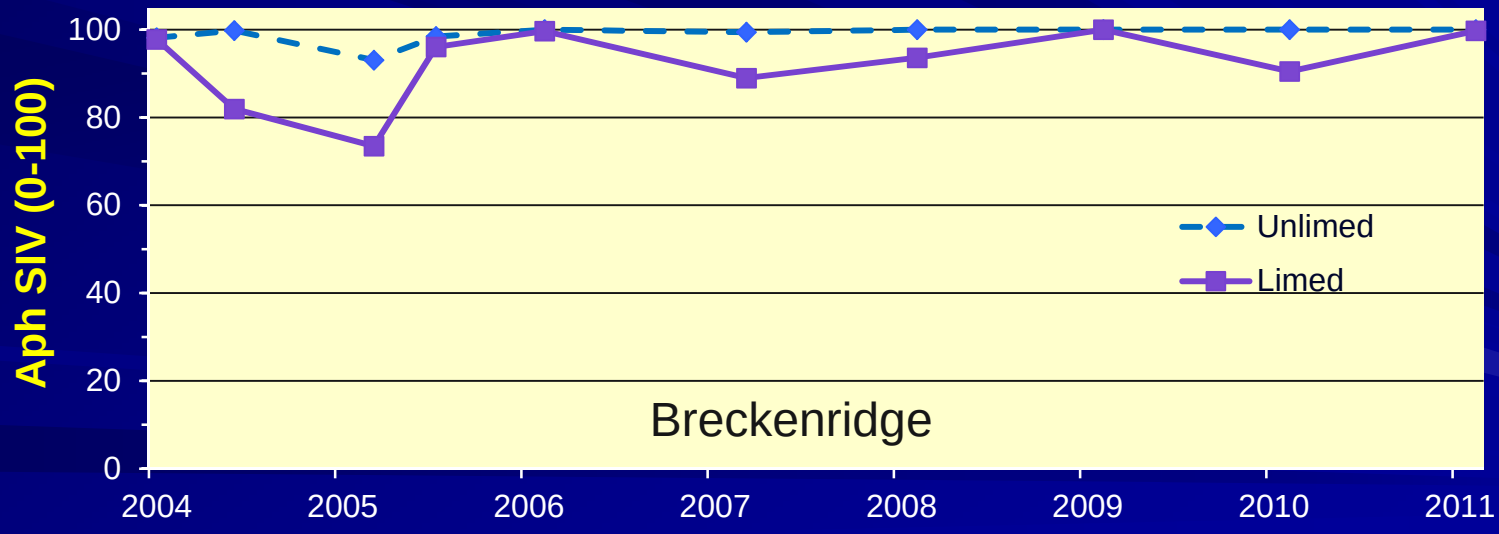
- Amount of spent lime needed to reduce Aphanomyces root rot on sugarbeet & improve sugarbeet yield & quality
- Duration of disease suppression
- Effects on other crops in rotation
- Mechanisms of disease suppression

Materials & Methods

- Sown May 6 – 7, 2011 (4-inch seed, 22-inch row)
  - Variety 1: Susceptible (Aph = 6.92)
  - Variety 2: MR (Aph = 4.14 + 45g Tachigaren)
- Soil samples collected (pH & SIV)
- Seedling stand counts 5-6 wk after pltg
- Harvested September 26, 2011
  - Rated for Aphanomyces root rot
  - Sugarbeet yield and quality


Hillsboro
Soil pH
9
8
7
6
5
2004
2005
2006
2007
2008
2009
2010
2011
0
5
10
20
30
Breckenridge
Soil pH
9
8
7
6
5
2004
2005
2006
2007
2008
2009
2010
2011
0
5
10
15
20


Aph SIV (0-100)
100
80
60
40
20
0
2004
2005
2006
2007
2008
2009
2010
2011
Unlimed
Limed
Hillsboro


Aph SIV (0-100)
100
80
60
40
20
0
2004
2005
2006
2007
2008
2009
2010
2011
Unlimed
Limed
Breckenridge

Hillsboro 2005-2011

Lime (T/A)	% Change RSA compared to no lime control						
	2005	2005	2007	2008	2009	2010	2011
No Lime	4602	9893	5215	7595	6935	8435	
5	+18	+7.4	-4.2	+5.6	+18	+2.7	
10	+20	+6.6	+10.8	+23	+17.1	+5.0	

Hillsboro: Moderate Aph Disease in 2011

Lime rate	Stand (100 ft row)	
(T/A)	5 WAP	Harvest
0	175	146
5	175	151
10	198	182
20	191	171
30	182	165
Linear[z]	NS	NS

[y] Aph root rot rating= 0-7 scale, 0= healthy, 7 = root completely rotted and foliage dead
[z] Significant at *P=0.05,* ** = Significant at *P=0.01*, NS = Not significant

Hillsboro: Moderate Aph Disease in 2011

Lime rate	Stand (100 ft row)		Aph
(T/A)	5 WAP	Harvest	RRR[y]
0	175	146	3.4
5	175	151	2.9
10	198	182	2.3
20	191	171	2.6
30	182	165	2.6
Linear[z]	NS	NS	*

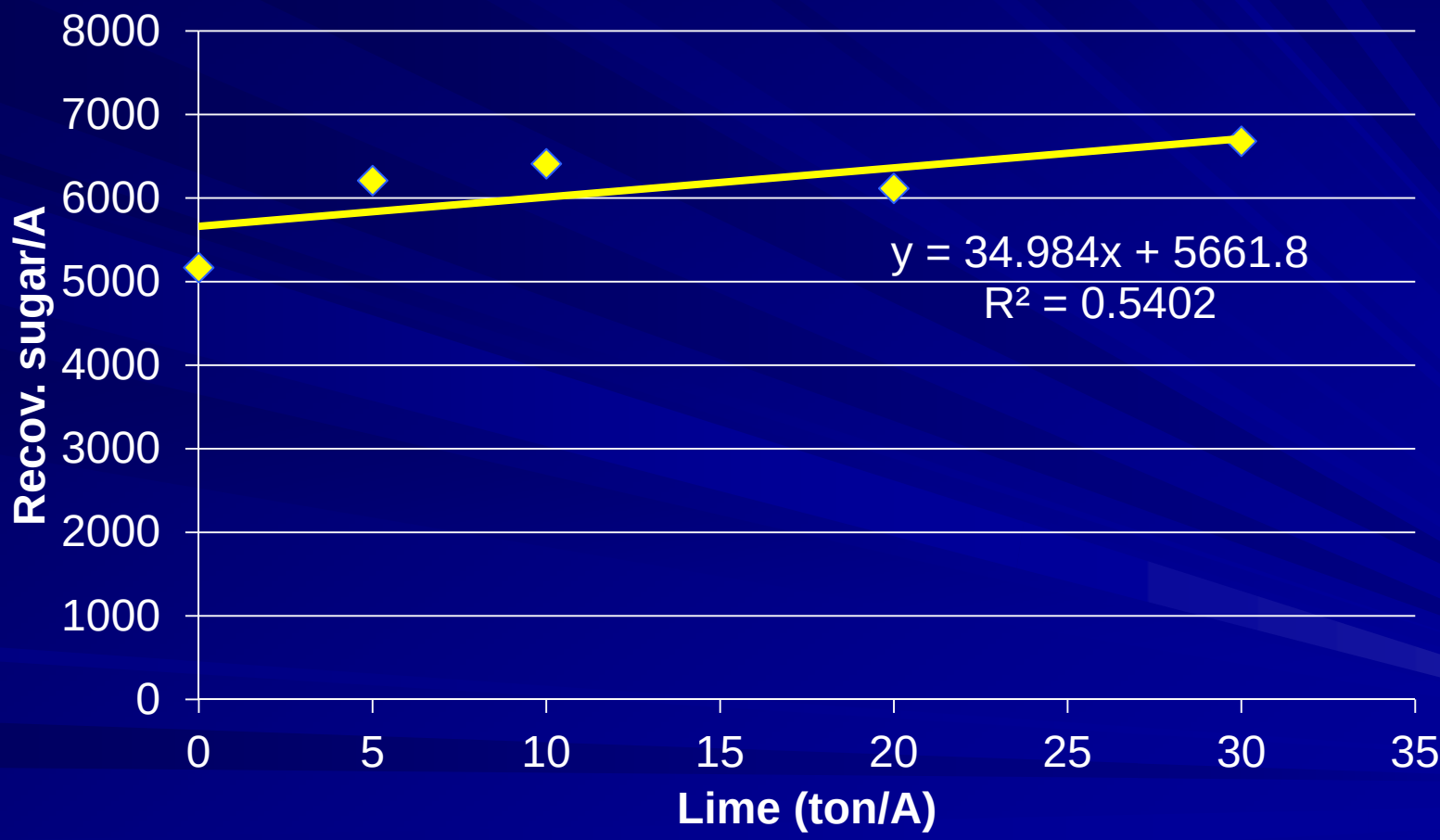
[y] Aph root rot rating= 0-7 scale, 0= healthy, 7 = root completely rotted and foliage dead
[z] Significant at *P=0.05,* ** = Significant at *P=0.01*, NS = Not significant

Hillsboro: Moderate Aph Disease 2011

Lime rate	Stand (100 ft row)		Aph	Yield	Lb Rec	Gross revenue
(T/A)	5 WAP	Harvest	RRR[y]	(T/A)	sucrose/A	($/A)
0	175	146	3.4	15.5	5167	903
5	175	151	2.9	18.1	6210	1116
10	198	182	2.3	18.0	6410	1191
20	191	171	2.6	17.5	6116	1118
30	182	165	2.6	19.8	6680	1180
Linear[z]	NS	NS	*	**	**	*

[y] Aph root rot rating= 0-7 scale, 0= healthy, 7 = root completely rotted and foliage dead
[z] Significant at *P=0.05,* ** = Significant at *P=0.01*, NS = Not significant

Hillsboro Across Varieties



Breckenridge 2005-2011

Lime (T/A)	% Change RSA compared to no lime control						
	2005	2005	2007	2008	2009	2010	2011
No Lime	1559	3911	2827	5546	3798	2675	
5	+65.7	+48.2	+41.8	+26.2	+8.4	+44.2	
10	+69.9	+55.8	+49.0	+24.3	+23.8	+56.5	

Breckenridge: Severe Aph Pressure in 2011

Lime rate	Stand (100 ft row)	
(T/A)	6 WAP	Harvest
0	178	33
5	177	77
10	176	95
15	186	126
20	180	133
Linear[z]	NS	***
Quadratic[z]	NS	NS

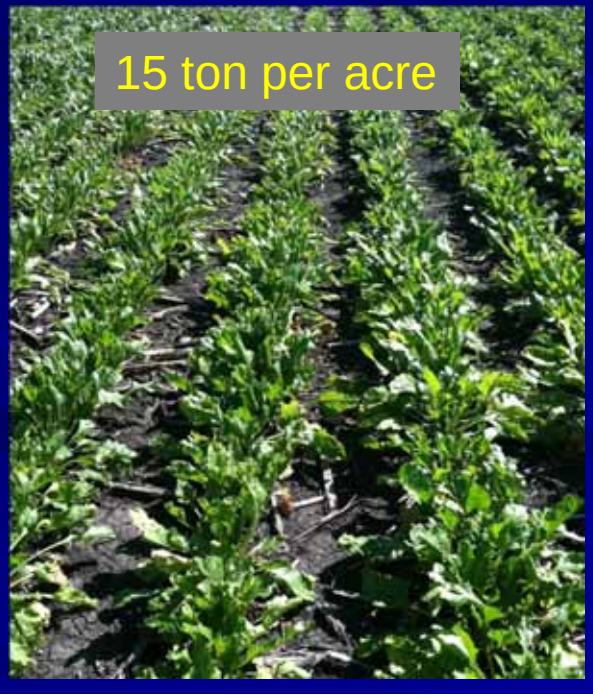
[y] Aph root rot rating= 0-7 scale, 0= healthy, 7 = root completely rotted and foliage dead

[Z] Significant at *P=0.05,* ** = Significant at *P=0.01*, *** = Significant at *P=0.001,* NS = Not significant


No Lime


5 ton per acre


10 ton per acre


15 ton per acre


20 ton per acre

Breckenridge: Severe Aph Pressure in 2011

Lime rate	Stand (100 ft row)		Aph
(T/A)	6 WAP	Harvest	RRR[y]
0	178	33	5.6
5	177	77	5.1
10	176	95	4.8
15	186	126	4.2
20	180	133	4.3
Linear[z]	NS	***	***
Quadratic[z]	NS	NS	*

[y] Aph root rot rating= 0-7 scale, 0= healthy, 7 = root completely rotted and foliage dead

[Z] Significant at *P=0.05,* ** = Significant at *P=0.01*, *** = Significant at *P=0.001,* NS = Not significant

Breckenridge: Severe Aph Pressure in 2011

Lime rate	Stand (100 ft row)		Aph	Yield	Lb Rec	Gross revenue
(T/A)	6 WAP	Harvest	RRR[y]	(T/A)	sucrose/A	($/A)
0	178	33	5.6	2.5	738	111
5	177	77	5.1	6.5	1966	311
10	176	95	4.8	7.8	2380	378
15	186	126	4.2	10.4	3258	537
20	180	133	4.3	10.9	3404	557
Linear[z]	NS	***	***	***	***	***
Quadratic[z]	NS	NS	*	NS	NS	NS

[y] Aph root rot rating= 0-7 scale, 0= healthy, 7 = root completely rotted and foliage dead

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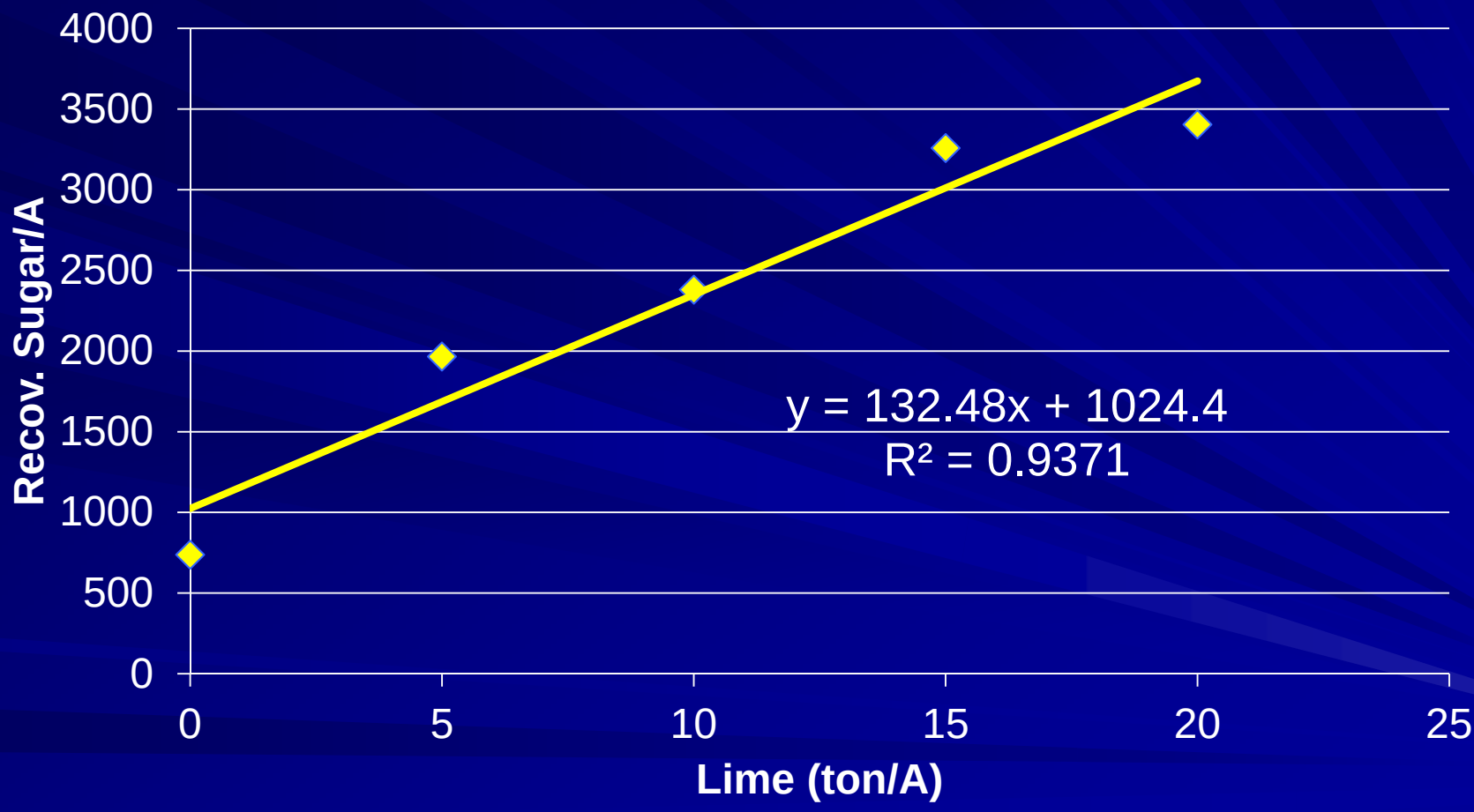
Breckenridge Across Varieties



What happened??

- Soil Moisture
  - Hillsboro: 11”, late June - mid August (103-147%)
  - Breckenridge: 9.2”, mid July to mid Aug(101-145% above normal)
- *Aphanomyces SIV’s*
  - *Hillsboro = 86; Breckenridge = 100*
- Prolonged soil moisture, poor soil drainage, hi SIVs
- Breckenridge: “Pathogen dominate” situation
  - High populations, means early infections
  - Continuous infections & re-infections in wet soil
  - Severe root rot, stand loss, stunted roots
  - Soil dries up, roots too severely diseased & small

Summary & Conclusions

- 8TH GROWING SEASON SINCE LIME APPLIED:
  - Soil pH: Increased with lime and remain relatively stable
  - Aphanomyces soil index values: High at both locations
  - Hillsboro (Moderate disease in 2011):

    Significant reduction in root rot & increased yields with increasing lime rates
  - Breckenridge (Severe, intense, prolonged disease 2011)

    Significant reduction in root rot & increased yields with increasing lime rates, but yields not economic

    "Pathogen dominant" situation: BMP failed
  - In a more typical year, management practices effective

About *Rhizoctonia*

- AG 2-2 has intraspecific groups (ISGs)
  - AG 2-2 IV and AG 2-2 IIIB
- Both occur in MN/ND
  - RRV: AG 2-2 IV most common (66%)
  - So. MN: AG 2-2 IIIB most common (56%)
- Both ISG's cause same symptoms on sugarbeet
- AG 2-2 IIIB tends to be more aggressive than AG 2-2 IV
  - Variability within AG 2-2 IIIB and AG 2-2 IV on rotation crops
- Most susceptible to least susceptible crops:
  - Seedlings: sugarbeet > beans > corn > sunflower
  - Adults: sugarbeet > beans > sunflower > corn
  - Nonhost = hard red spring wheat

Seed and In-furrow fungicides with and without postemergence Quadris for control of Rhizoctonia on sugarbeet

Control of Rhizoctonia crown and root rot with at-plant and postemergence fungicides

- Two sites: U of MN, NW Res Outreach Ctr, Crookston
- Randomized block design – 4 reps
- Site one: inoculated late summer 2010
  - Spread *R. solani* AG 2-2-infested barley
  - Planted soybean
  - Resulted in early disease pressure in 2011
- Site two: inoculated prior to planting
  - Spread *R. solani* AG 2-2-infested barley
  - Planted trial
  - Resulted in low and late disease pressure

At-plant treatments

Treatment	Seed treatment rate (g a.i. / unit)	In-furrow rate (fl. oz. product/A)
Control	-	-
Dynasty	0.25	-
Penthiopyrad	14	-
Sedaxane	0.05	-
Stamina	30	-
Headline	-	12
Quadris	-	14.3
Vertisan	-	38

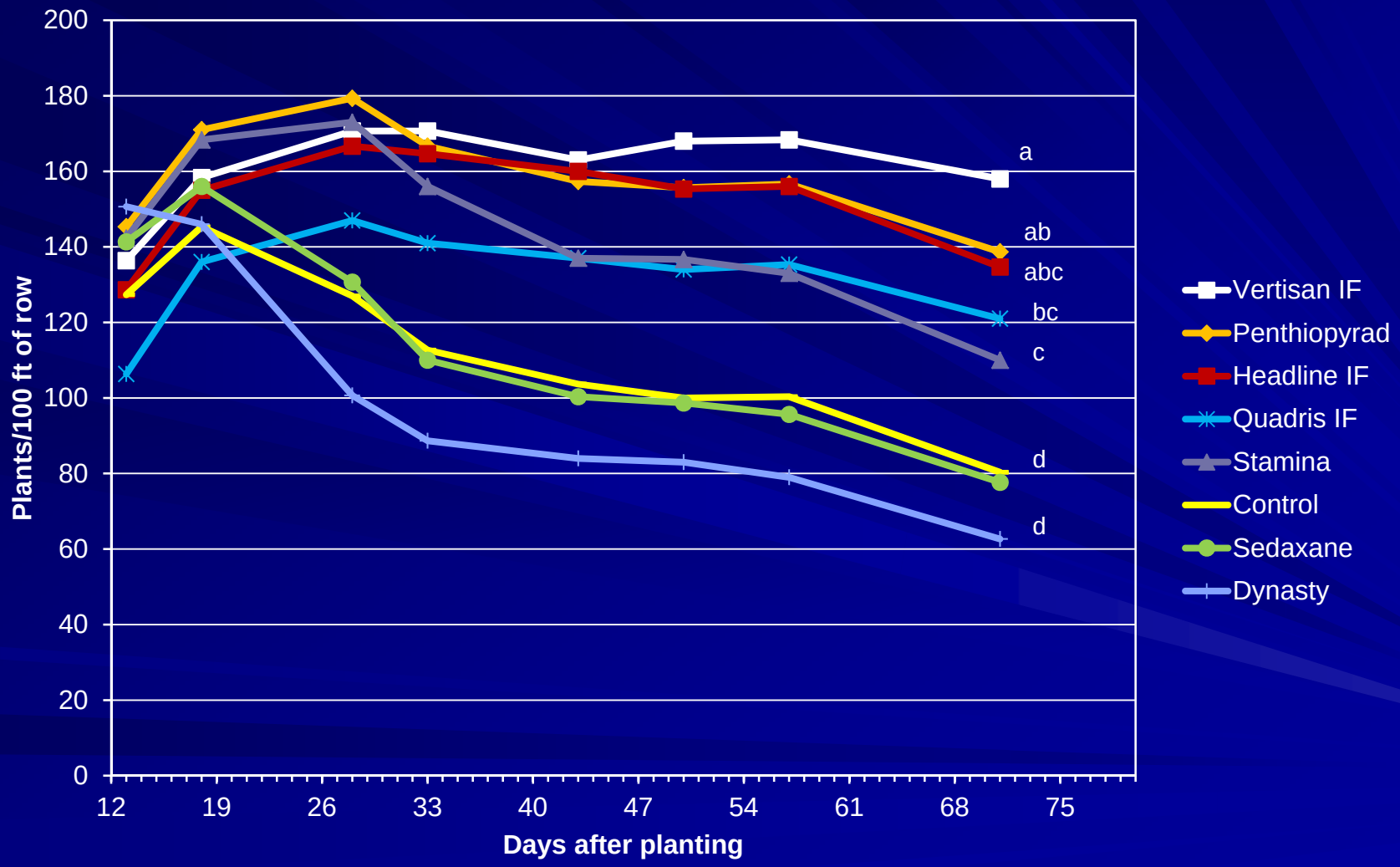
All of above treatments alone and with postemergence Quadris application


In-furrow nozzle
Drip tube
No starter fertilizer

Things to remember

- Site 1 = very high disease pressure early
- Site 2 = low disease pressure beginning later
- Both sites: no at-plant x postemergence interaction so main effects shown

Site 1: stand establishment for at-plant trmt



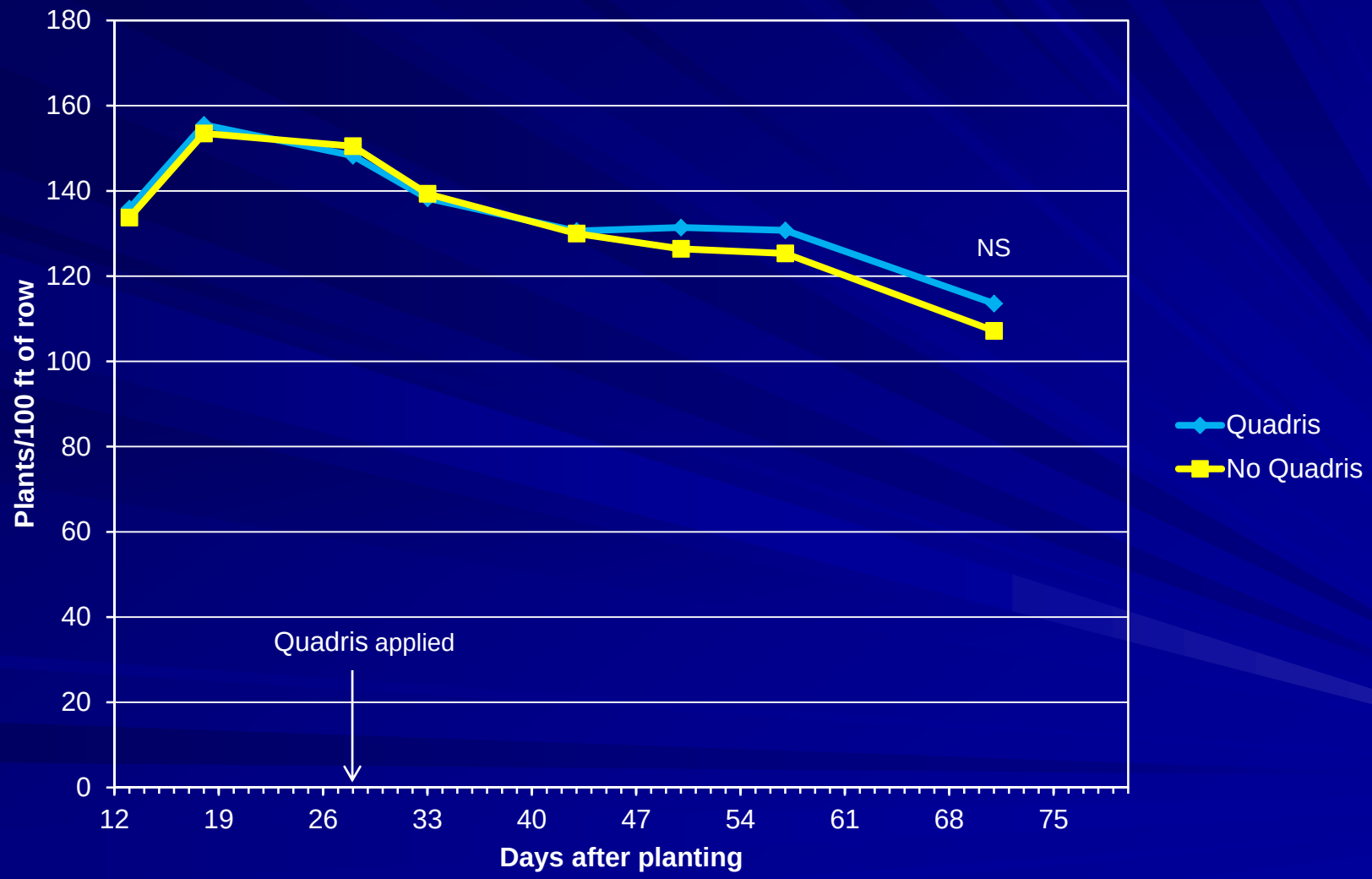
No fungicide at planting, No Quadris post-emergence

Penthiopyrad-treated seed, No Quadris post-emergence

Quadris in-furrow, No Quadris post-emergence

Vertisan in-furrow, No Quadris post-emergence

Site 1: stand establishment for postemergence trmt



Site 1: At-plant treatment harvest results

Treatment	RCRR (0-7)	Yield (T/A)	% Sugar	lb recov./A
Control	4.9 ab	16.8 bc	16.7 c	5081 bc
Dynasty	5.5 a	13.4 c	17.1 bc	4196 c
Penthiopyrad	3.8 cd	23.0 a	17.3 bc	7317 a
Sedaxane	5.1 ab	16.7 bc	16.7 c	5094 bc
Stamina	4.5 bc	19.9 ab	17.2 bc	6207 ab
Headline I-F	3.6 d	22.1 a	17.6 ab	7108 a
Quadris I-F	2.7 e	21.5 ab	17.6 ab	6926 a
Vertisan I-F	2.8 e	23.6 a	18.2 a	7942 a
ANOVA p-value	<0.0001	0.007	0.010	0.005
LSD (P = 0.05)	0.8	5.1	0.75	1785

Site 1: Quadris postemergence results

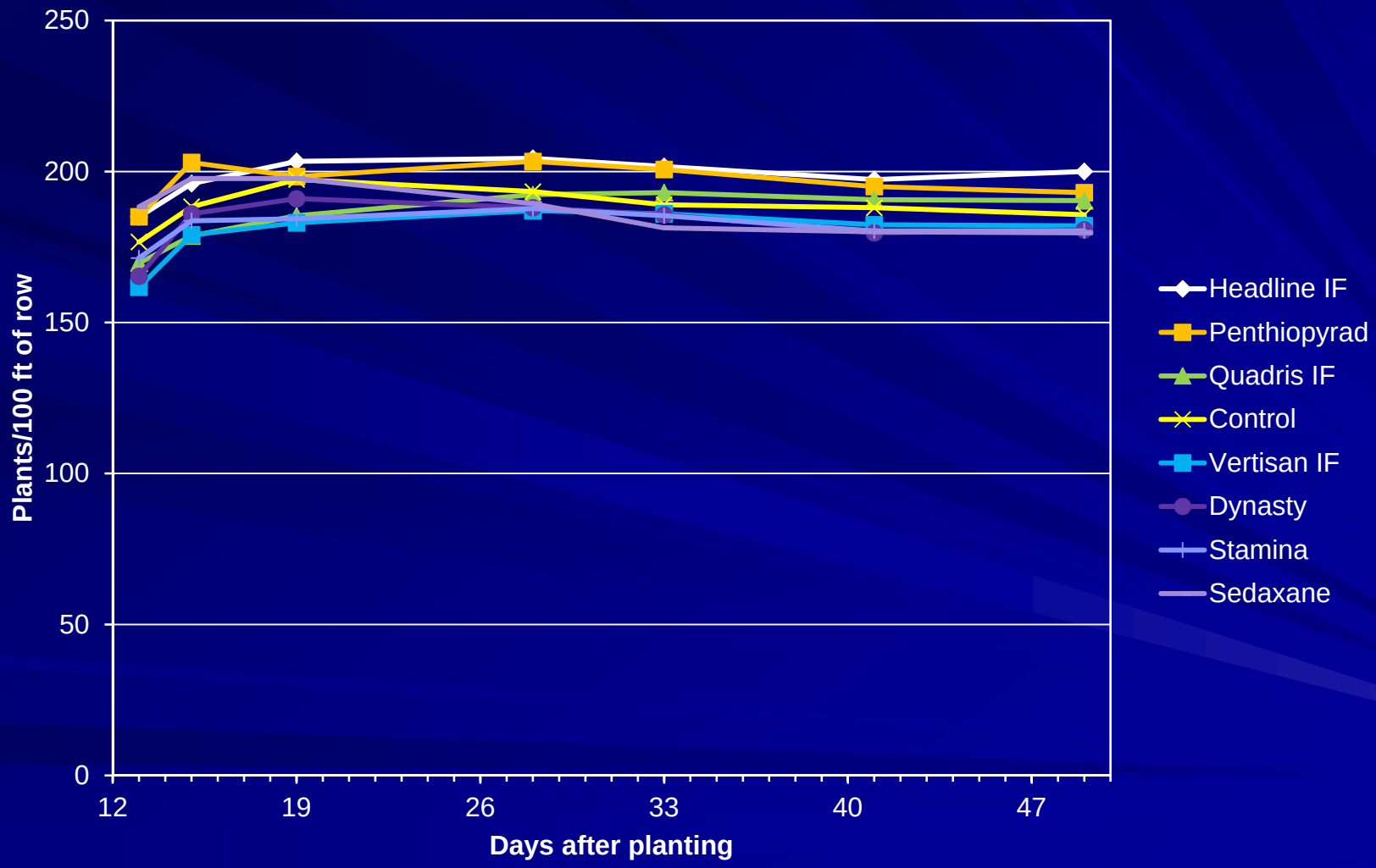
Treatment	RCRR (0-7)	Yield (T/A)	% Sugar	lb recov./A
No Quadris	4.1	19.6	17.2	6167
Quadris	4.1	19.7	17.4	6301
ANOVA p-value	1.0	0.903	0.299	0.774

Postemergence Quadris application too late = not effective

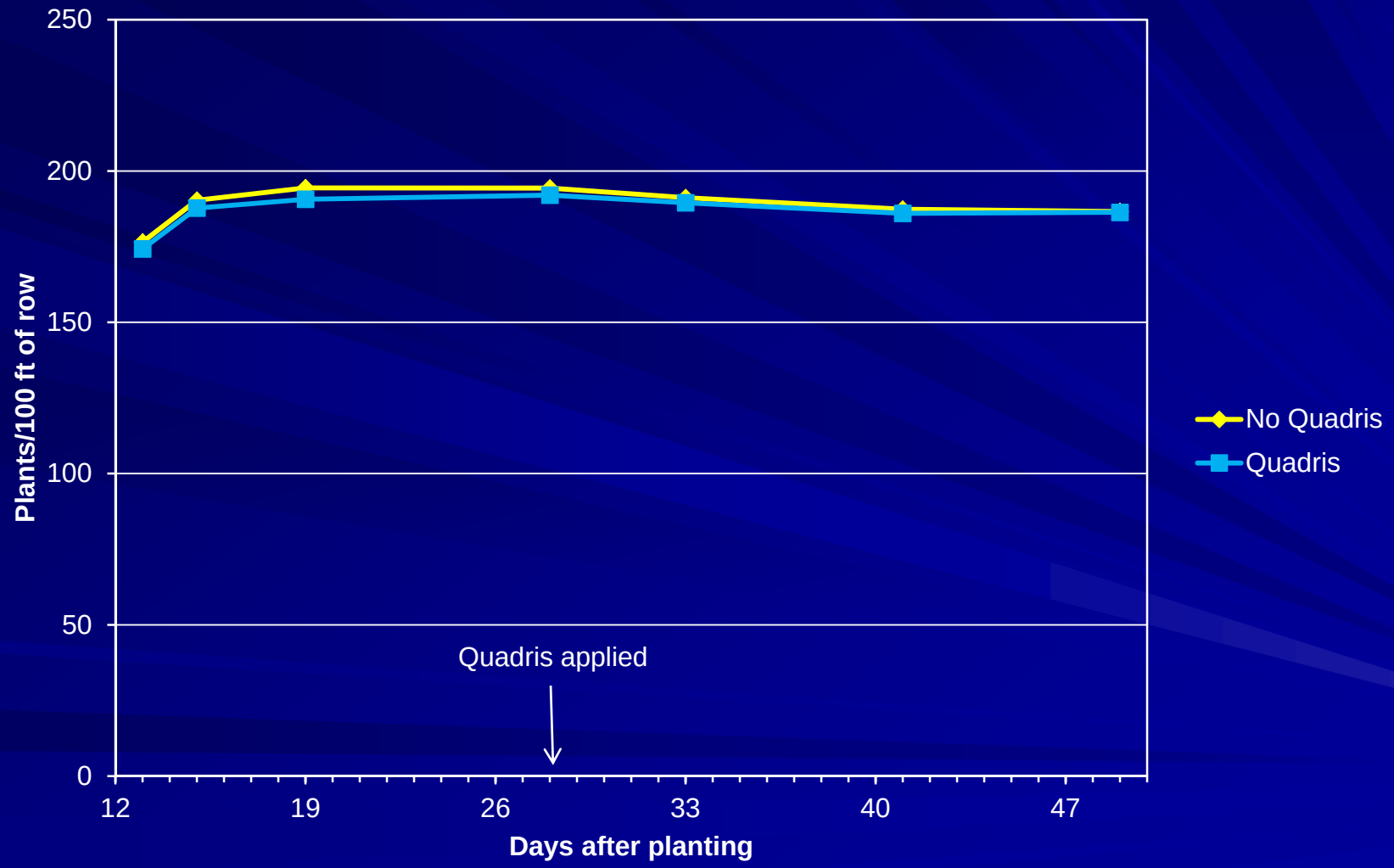
Things to remember

- Site 1 = very high disease pressure early
- **Site 2 = low disease pressure beginning later**
- Both sites: no at-plant x postemergence interaction so main effects shown

Site 2: stand establishment for at-plant trmt



Site 2: stand establishment for postemergence trmt



Site 2: At-plant treatment harvest results

Treatment	RCRR (0-7)	Yield (T/A)	% Sugar	lb recov./A
Control	3.0 a	22.8 abc	16.7	6818 b
Dynasty	3.2 a	22.0 c	16.9	6660 b
Penthiopyrad	3.0 a	23.3 abc	17.3	7253 ab
Sedaxane	3.4 a	22.6 bc	17.1	6950 b
Stamina	3.0 a	21.1 c	17.7	6718 b
Headline I-F	2.2 b	24.9 ab	17.3	7746 a
Quadris I-F	1.5 b	25.2 a	17.3	7824 a
Vertisan I-F	2.0 b	24.6 ab	17.3	7718 a
ANOVA p-value	0.0001	0.026	0.318	0.008
LSD (P = 0.05)	0.7	2.5	NS	742

Site 2: Quadris postemergence results

Treatment	RCRR (0-7)	Yield (T/A)	% Sugar	lb recov./A
No Quadris	3.2	22.4	17.2	6932
Quadris	2.1	24.2	17.2	7490
ANOVA p-value	<0.0001	0.009	0.688	0.007

Quadris postemergence application timely = effective

Conclusions

- Penthiopyrad seed treatment has potential when postemergence Quadris is used

Rank of penthiopyrad seed treatment out of 16 total treatments

	Postemergence Quadris application	
Site	Yes	No
One	2	9
Two	3	12

Conclusions

- Penthiopyrad seed treatment has potential when postemergence Quadris is used
- In-furrow treatments performed well under severe early-season and mild late-season disease pressure
- Postemergence Quadris must be put on prior to infection
  - Soil temperature, moisture, and pathogen population important

Population of *R. solani* in soil

- High population density:
  - Seedling damping-off, root rot can begin early in season, even if weather not ideal
  - Fungicide Control: at-plant fungicide
    - Seed treatment + postemergence fungicide
    - In-furrow fungicide +/- postemergence fungicide (<65 F)
- Low population density:
  - Onset of disease is later in the season, especially if weather becomes ideal
  - Fungicide Control: Postemergence (<65 F)

Quadris: Band vs. Aerial

L.J. Smith, Univ. MN, NWROC, Crookston

- Quadris applied: June 11, 2011 @ 4-6 lf stage
- Rate applied for both banded and aerial
  - 14.3 oz product/A in 22-inch rows
- Aerial (= 4.8 oz product/A in a 7-inch band)
  - Applied in 5 GPA
- Banded: 7-inch band
  - Applied in 7.1 GPA
- Moderate level of Rhizoctonia crown & root rot
- Harvested per treatment:
  - 4 truck loads (6 rows x 2,580 ft /load)

Quadris: Band vs. Aerial

L.J. Smith, Univ. Minn, NWROC, Crookston

Treatment	Yield (T/A)	Sugar (%)	RSA (lbs/A)	RST (lb/T)	Gross ($/A)	Benefit ($/A)
Control	25.3	19.24	9181	363	1691	0
Aerial	26.3	19.56	9704	369	1805	+114
Band (7”)	26.7	19.95	10063	377	1893	+202

- Band applications most effective for Rhizoctonia control
- Aerial applications may be necessary if fields are too wet

Thank you!

- Sugarbeet Research & Education Board MN and ND
- You – the growers!
- Grower-cooperators
- Sugarbeet cooperatives and personnel
- Allied sugarbeet industries and personnel
- Colleagues at NDSU, USDA-ARS, Univ. Minnesota
- Technical support staff, graduate students,
  high school & college student workers