Seed Treatments for Management Sudden Death Syndrome in Soybean

Daren Mueller
**Iowa State University Extension**

Acknowledgements

- Nabin Dangal, Yuba Kandel, Max Ernat, Daniel Sjarpe, Leonor Leandro: Iowa State University
- Colleagues from Arkansas, Delaware, Illinois, Indiana, Kansas, Kentucky, Michigan, Missouri, Nebraska, North Dakota, South Dakota, Wisconsin and Ontario, Canada

Soilborne pathogen – *Fusarium virguliforme*
Two phases – root rot, foliar symptoms
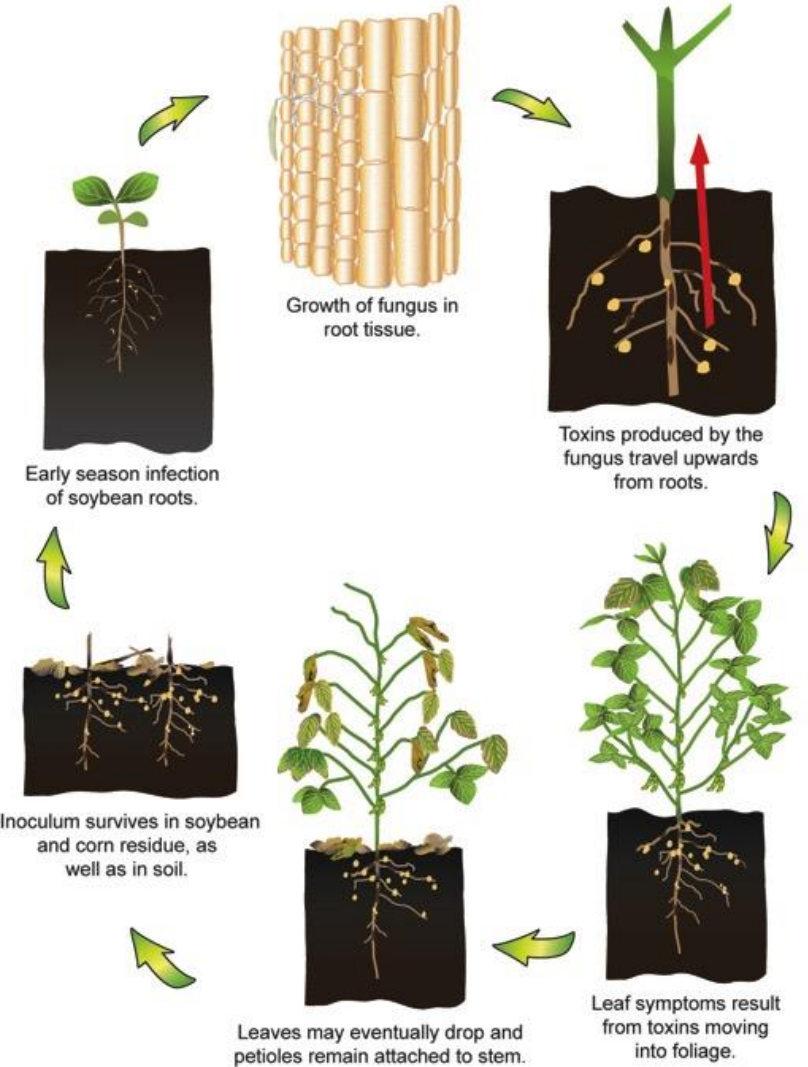

Fv culture
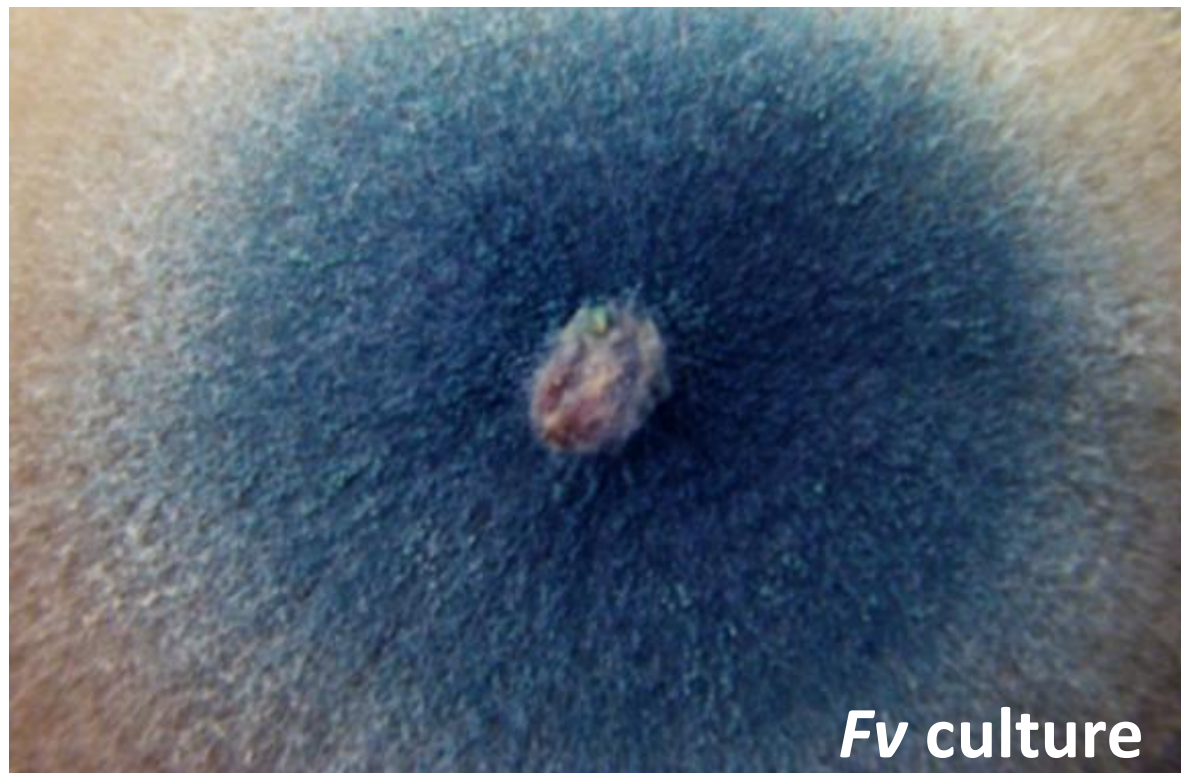
Chlorotic spots

Interveinal chlorosis and necrosis

Premature defoliation

SDS can cause:

Flower abortion
Poor pod set
Fewer seeds per pod
Small seed size

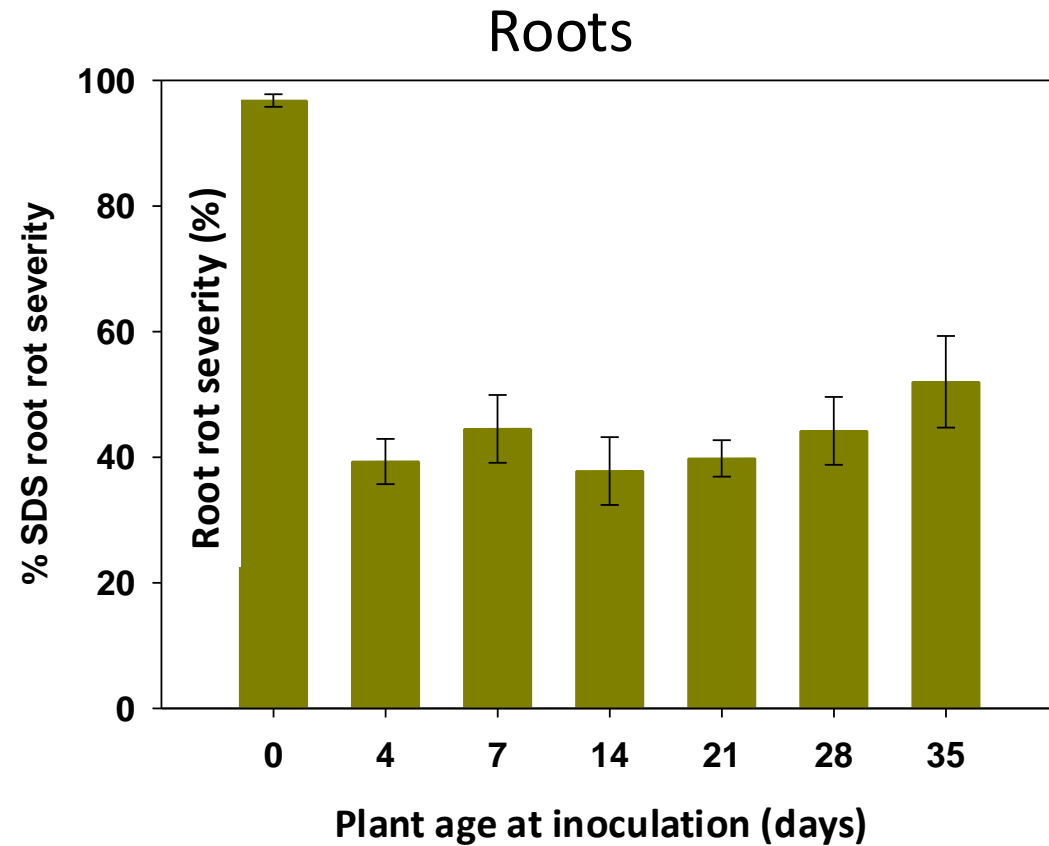# Plant age at time of inoculation

Inoculation at different plant ages

10^3 spores/g soil

Rating root and foliar severity

17°C / 7 days
24°C/30 days

18 and 38 days after inoculation

Leandro, ISU

SDS symptoms 38 days after inoculation

Leandro, ISU

Leaf symptoms occur when xylem is colonized

Vascular tissue

Cortex

Root hair

Intercellular space

Passage cell
Endodermis
Sieve tubes of phloem
Tracheary tubes of xylem
Pericycle
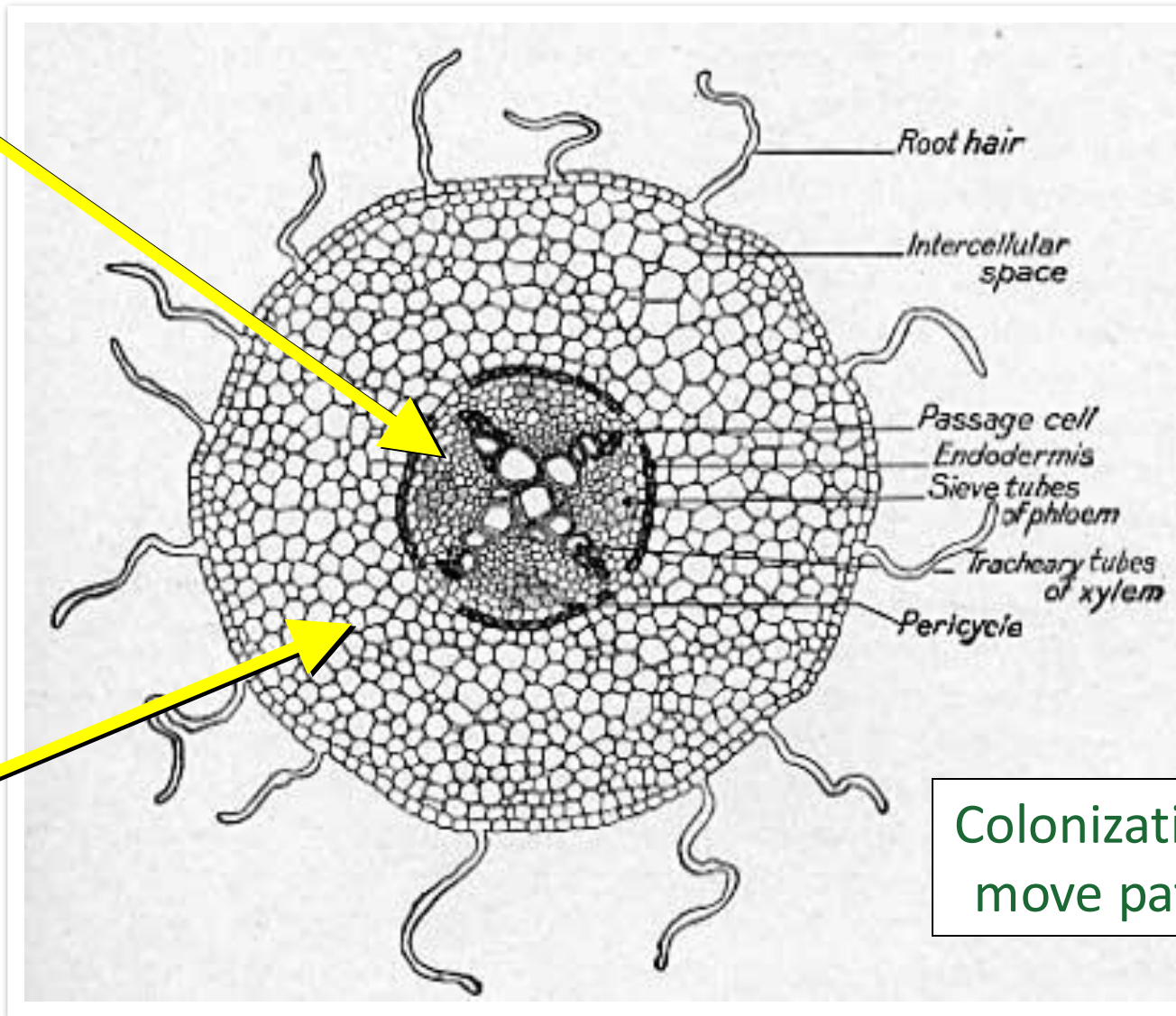
Colonization of xylem needed to move pathogen toxin to leaves

IOWA STATE UNIVERSITY
Extension and Outreach

Yang, ISU

- Collected roots at V2 or R4/R5

- Washed and rated using a visual 0-100% scale

- Compared to foliar symptoms, yield, root weight, Fv in roots
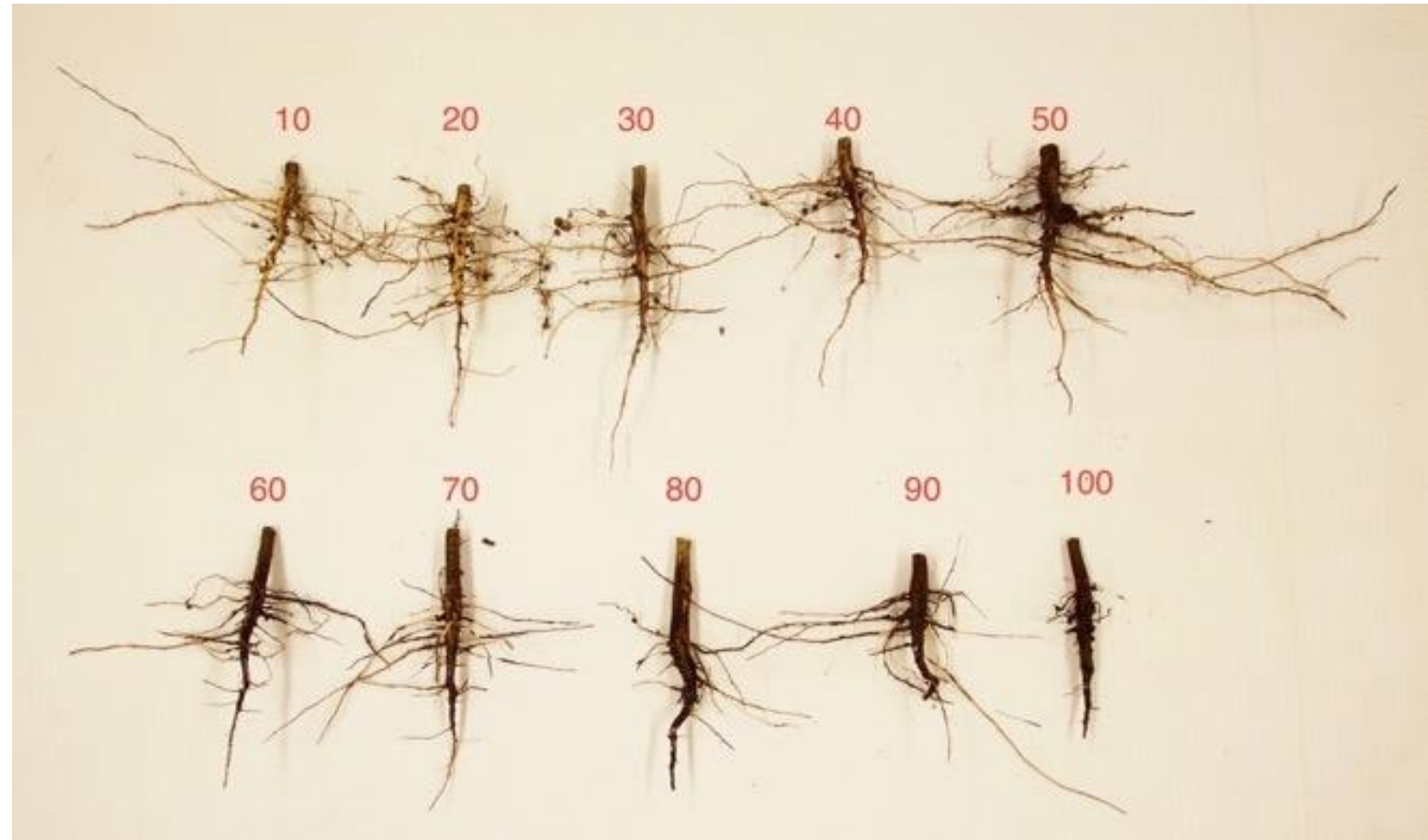
Correlation between root rot and FDX/yield

		Root Rot at R4/R5	FDX
Year 1	RR at R4/R5		
	FDX	0.50 (<0.01)	
	Yield	-0.29 (<0.01)	-0.36 (<0.01)
Year 2	RR at R4/R5		
	FDX	0.28 (<0.01)	
	Yield	-0.67 (<0.01)	-0.44 (<0.01)

CropProtectionNetwork.org

CROP PROTECTION NETWORK

Defending Fields. Protecting Yields.

SDS-SCN interactions

- SDS may appear earlier and can be more severe with SCN

- Pathogens may spread together

Greg Tylka, ISU

- SCN-resistant soybean varieties vary greatly in yield and in ability to suppress SCN reproduction in the field.

- Natural SCN populations vary greatly in ability to reproduce on resistant soybean varieties.

- Most resistant soybean varieties grown in the Midwest have PI 88788 SCN resistance, and SCN populations with elevated reproduction on PI 88788 are now common.

IOWA STATE UNIVERSITY
Extension and Outreach

Integrated management

- Resistance to SDS

- Managing SCN

- Cultural practices

- Maintaining proper pH and fertility levels

- Seed treatments

FDX and relative yield loss

FDX = Disease incidence (%) x Disease severity of symptomatic plants (1-9) / 9

Every FDX unit increase at R5/R6 = ~ **0.5% yield reduction** or, ~ 50% reduction in yield expected if FDX is 100% at R5/R6
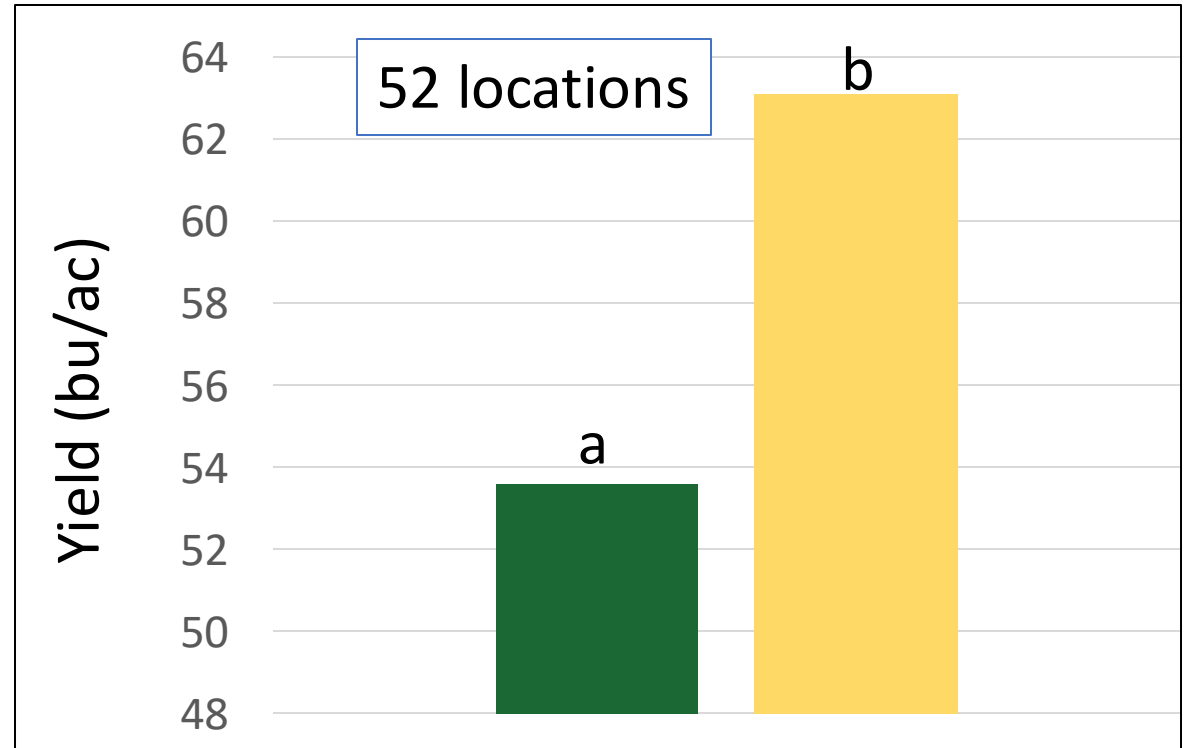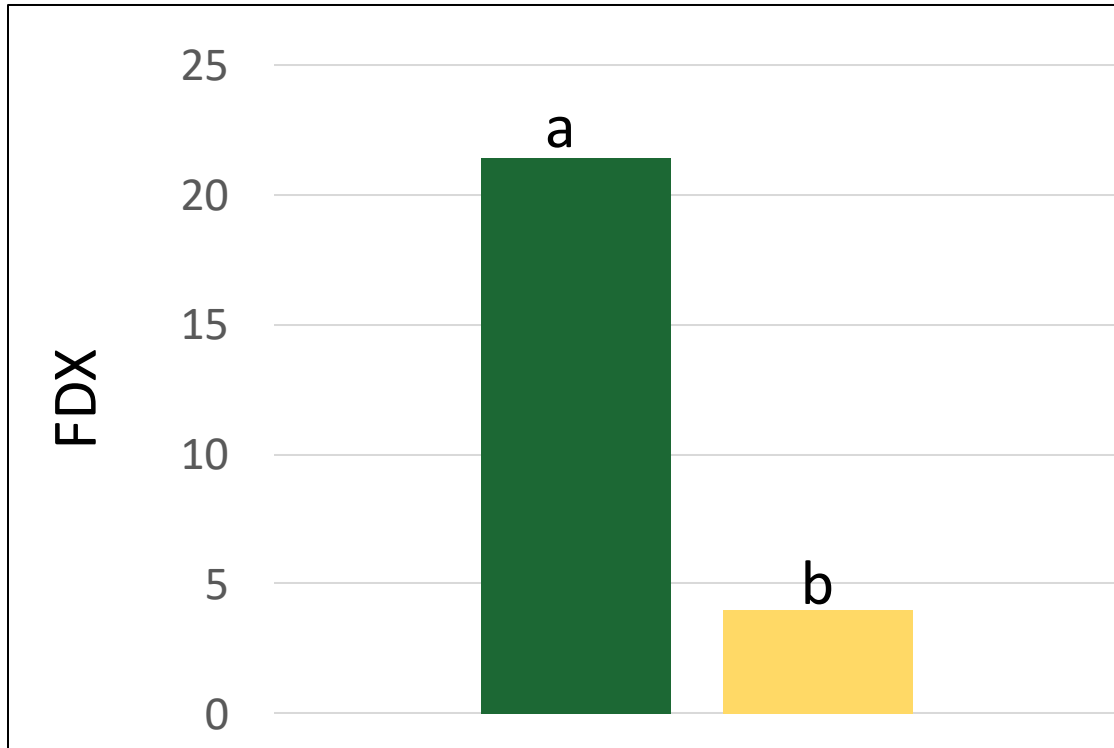

FDX 10-20

FDX 25-30

FDX 50 - 60

Resistance to SDS

- Management starts with a resistant variety

- Resistance may be to foliar symptoms and/or root rot

- Still many susceptible varieties on the market

- As new germplasm (e.g., traits) enters the market, consistent levels of SDS resistance are not always retained

Expectations of resistant cultivars

Susceptible   Resistant

52 locations

Resistant varieties
81.3% less FDX; 15.1% more yield

CropProtectionNetwork.org

CROP PROTECTION
NETWORK

Defending Fields. Protecting Yields.

Expectations of resistant cultivars
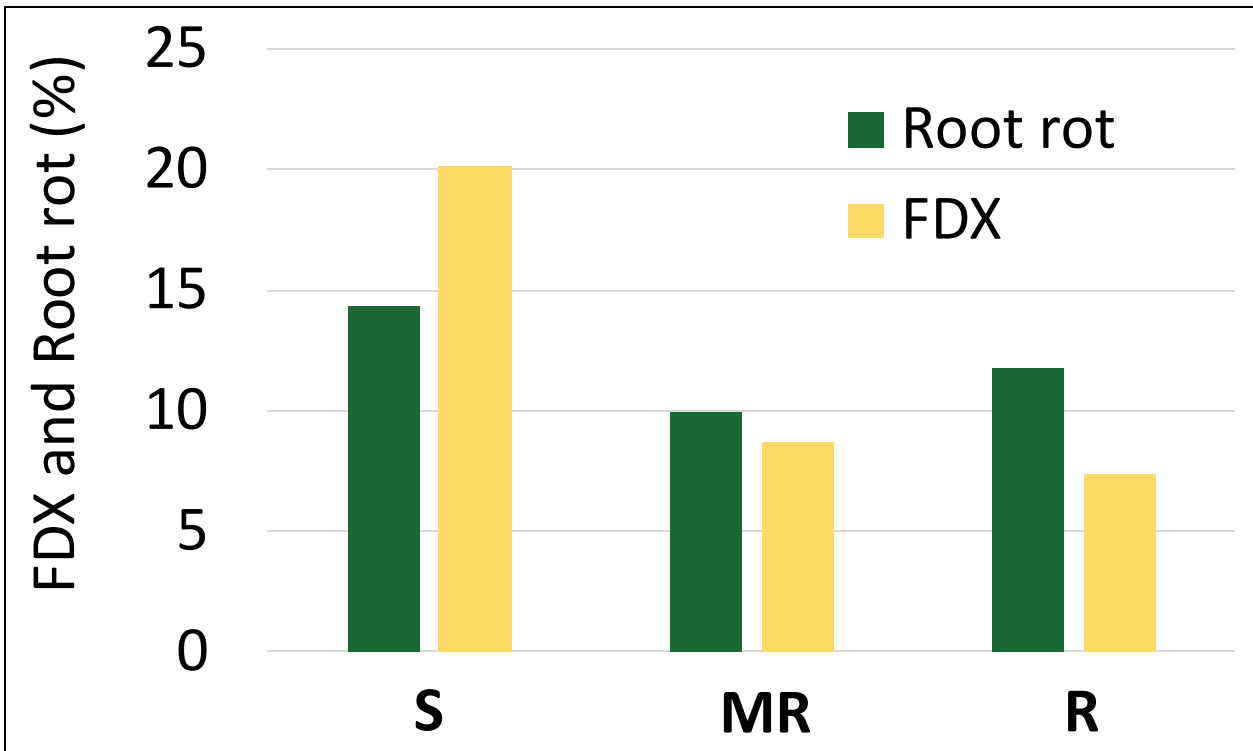
Mod. resistant varieties
37.4% less RR, 56.8% less FDX, 7.4% more yield
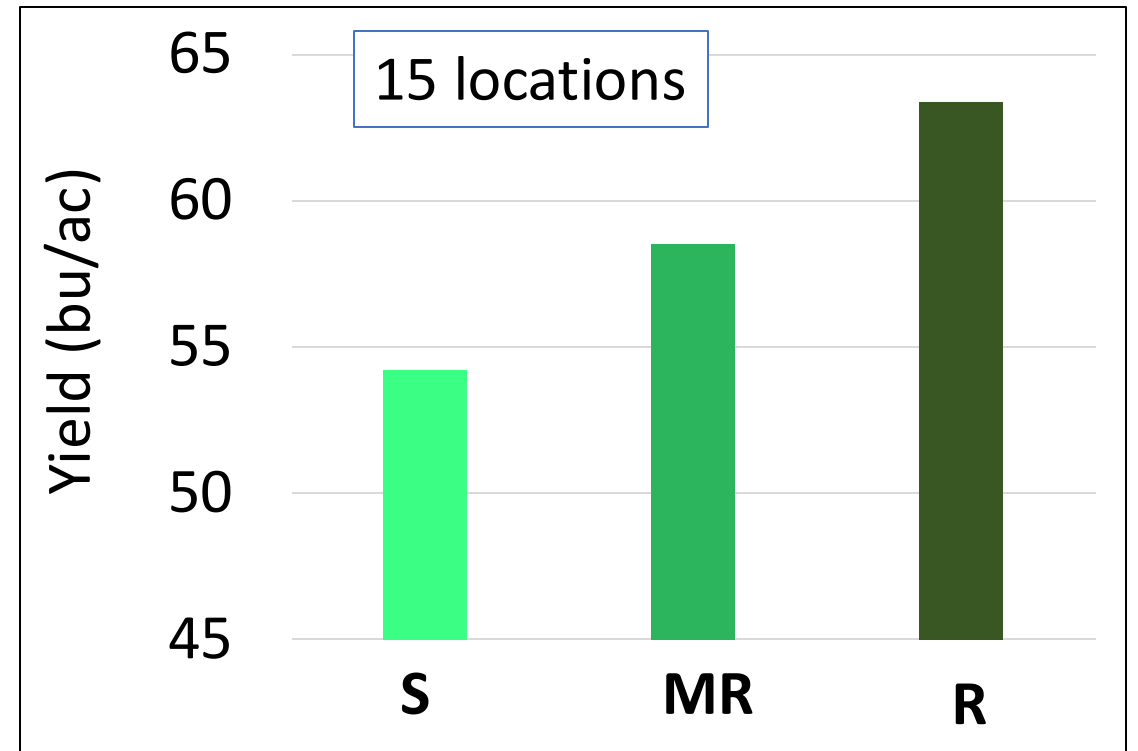
Resistant varieties
17.5% less RR, 63.5% less FDX, 14.9% more yield

CropProtectionNetwork.org

CROP PROTECTION
NETWORK

Defending Fields. Protecting Yields.

Managing SCN reduces SDS
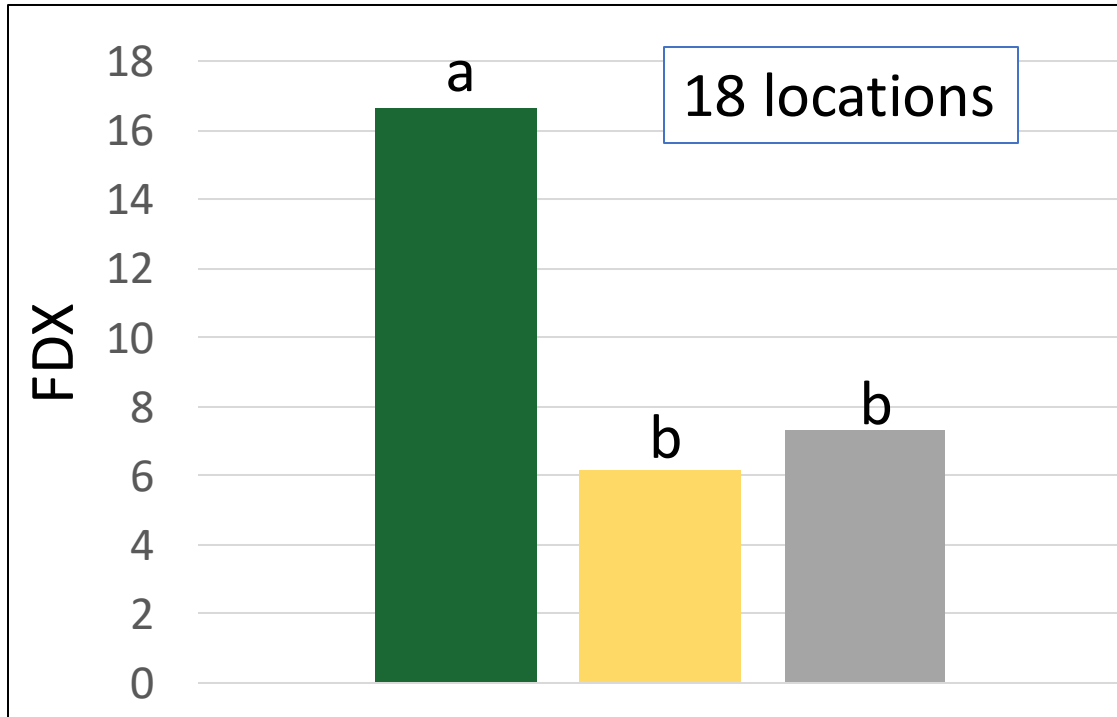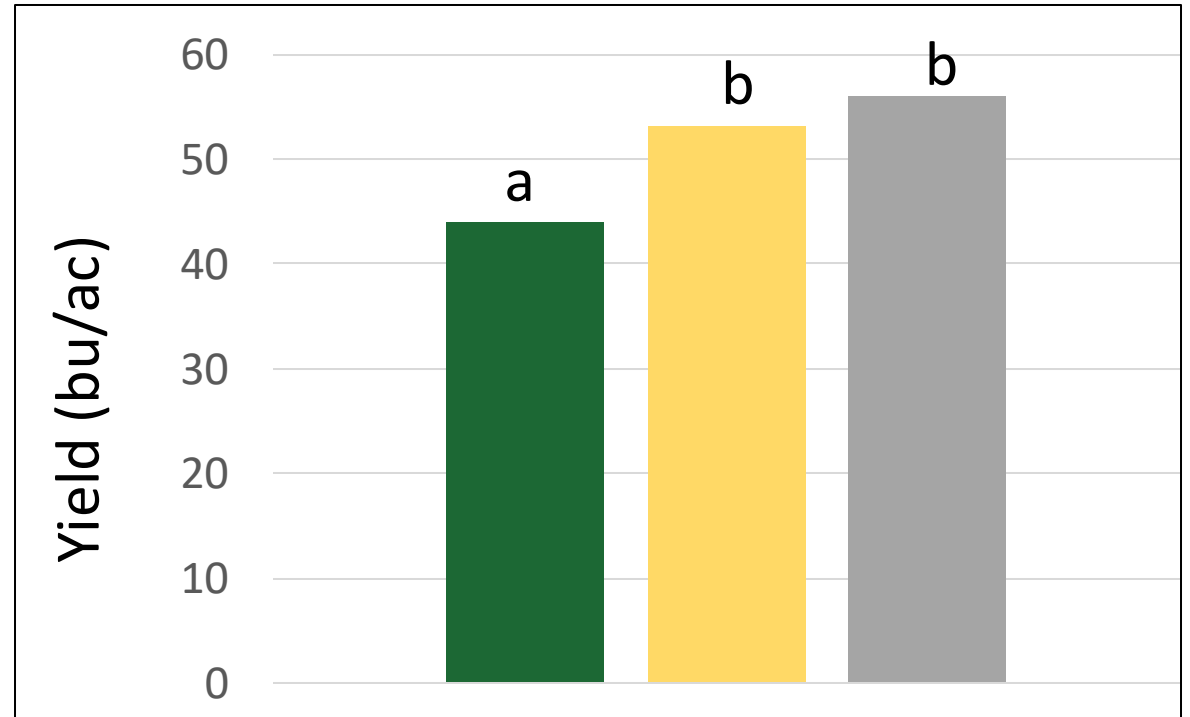
Different varieties with sources of SCN resistance
SCN-resistant cultivars decreased FDX

CropProtectionNetwork.org

CROP PROTECTION NETWORK

Defending Fields. Protecting Yields.

- Trials in Arkansas, Delaware, Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Missouri, Nebraska, North Dakota, South Dakota, Wisconsin and Ontario, Canada

- Each trial had susceptible and resistant varieties; some fields inoculated and/or irrigated

- Different seed treatments evaluated for foliar symptoms, root rot and yield

Early product evaluation
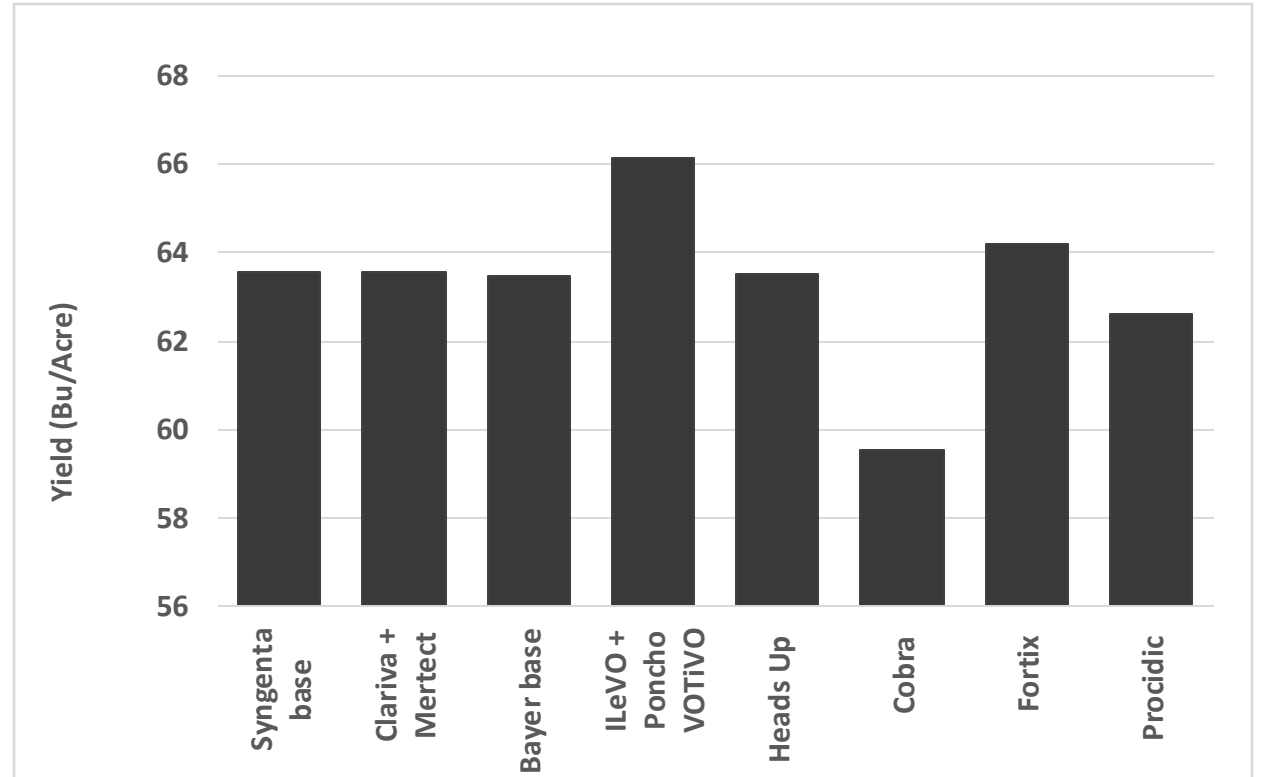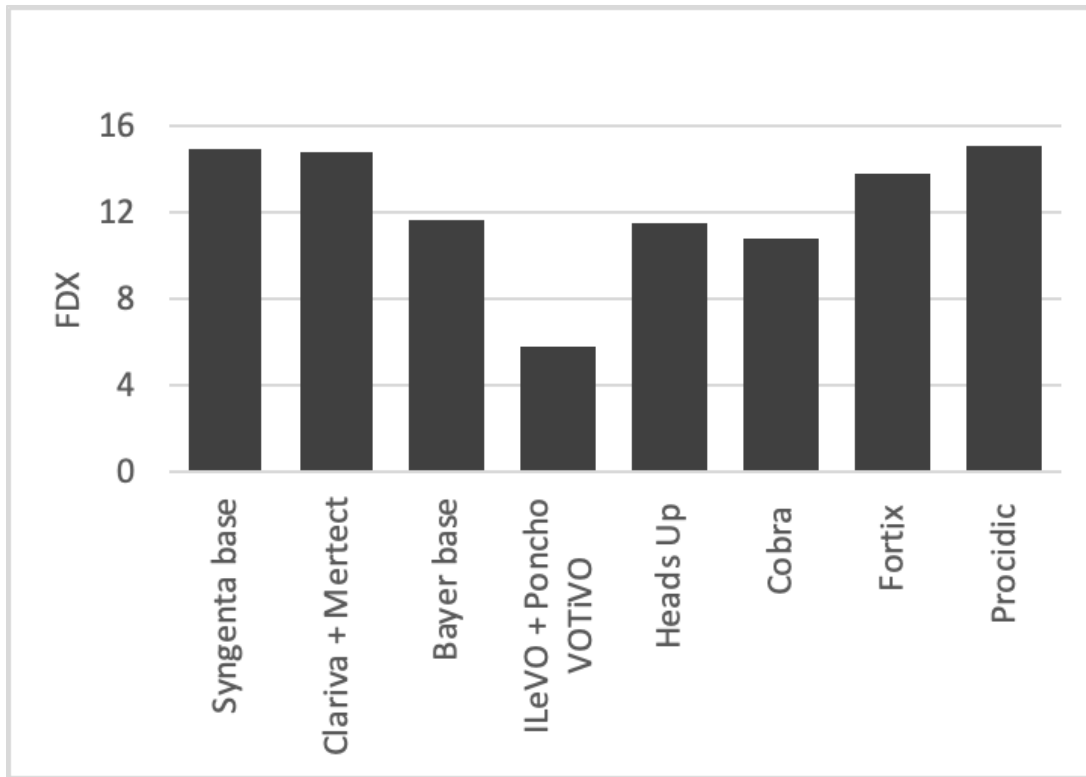
- Some seed treatment and in-furrow products effective
- All foliar products ineffective

CROP PROTECTION
NETWORK

Defending Fields. Protecting Yields.

Expectations of effective seed treatment

n = 209

n = 260
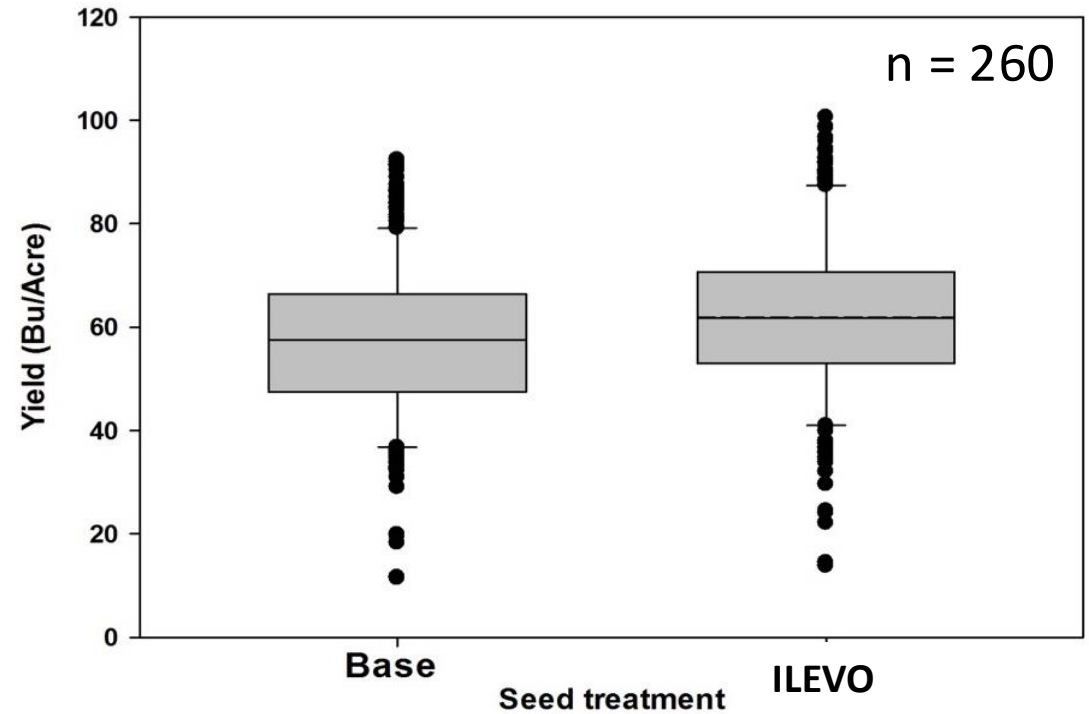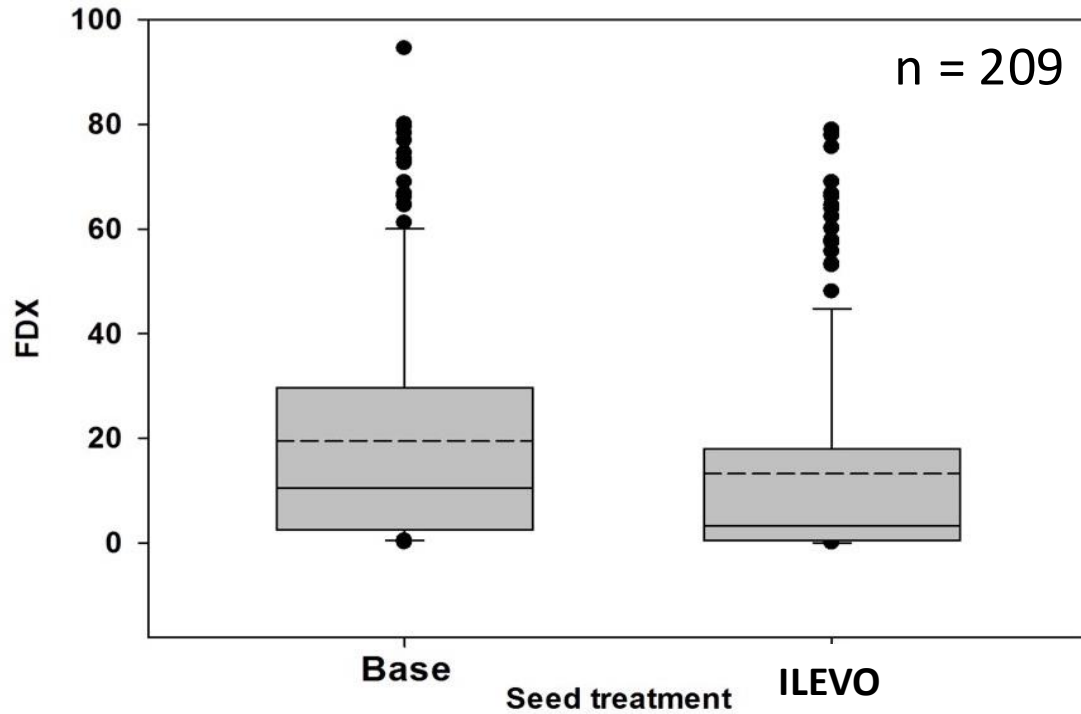
Effective seed treatment
32.0% less FDX, 7.3% more yield

30 locations

CropProtectionNetwork.org

CROP PROTECTION NETWORK

Defending Fields. Protecting Yields.

Expectations of effective seed treatment
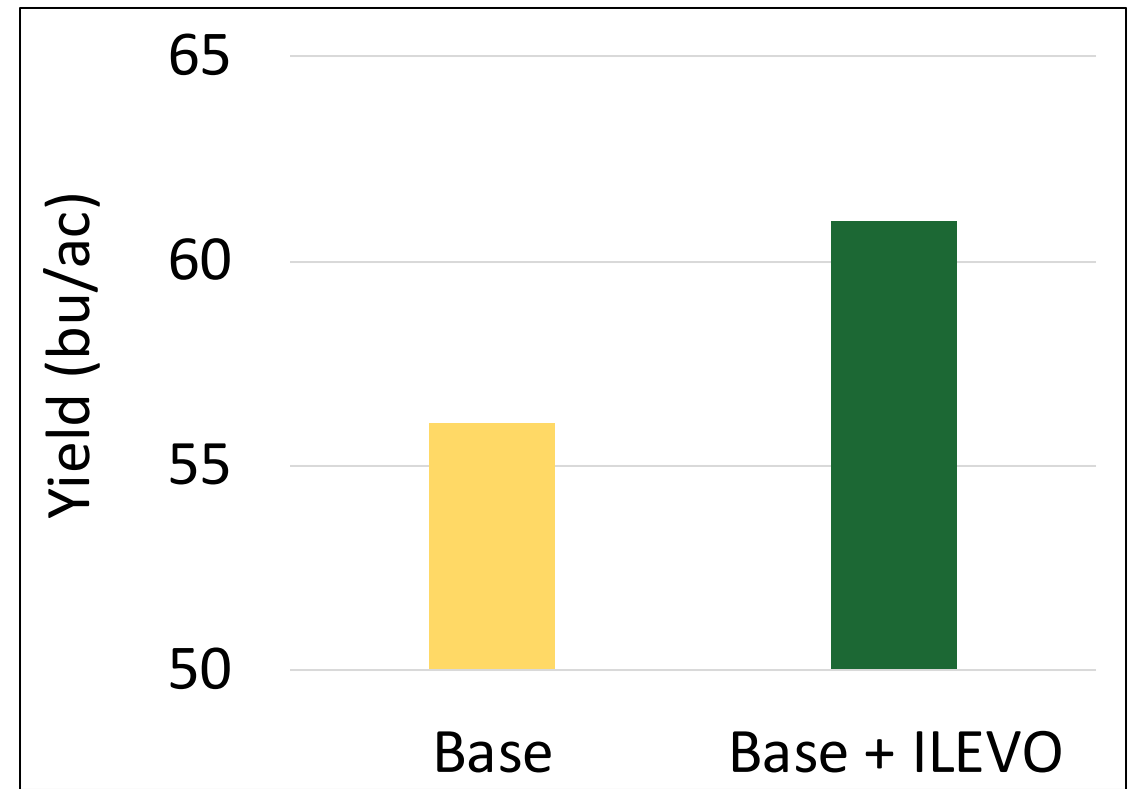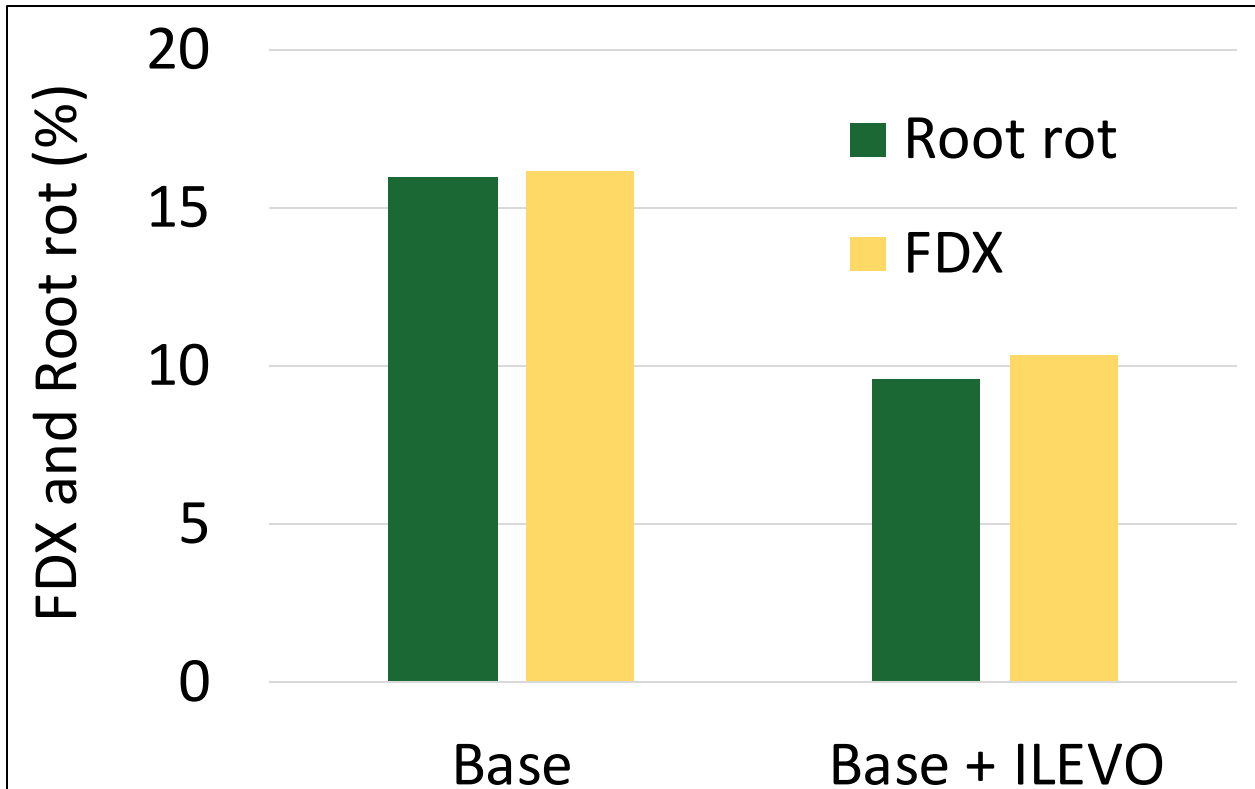
Effective seed treatment
38.2% less RR, 41.8% less FDX, 8.8% more yield

15 locations

CropProtectionNetwork.org

CROP PROTECTION NETWORK

Defending Fields. Protecting Yields.

Economics of effective seed treatments

Probability of breaking even fungicide cost ($13/A) at soybean price ($10)

SDS severity

- High disease (> 10FDX) — 89
- Low disease (< 10FDX) — 73
- No disease — 43

Probability (%)
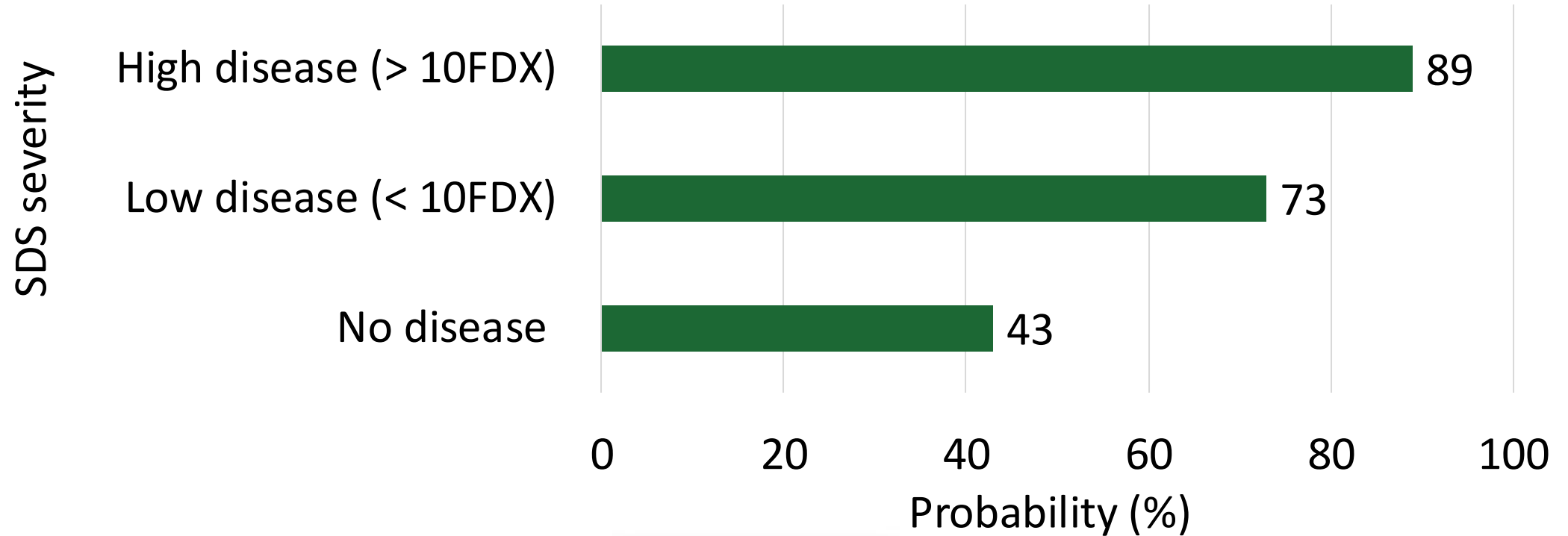
Previous work in the Chilvers lab found:

- Fv soil abundance and SCN eggs correlated with SDS disease index
- Yield was negatively correlated with Fv abundance and SCN counts
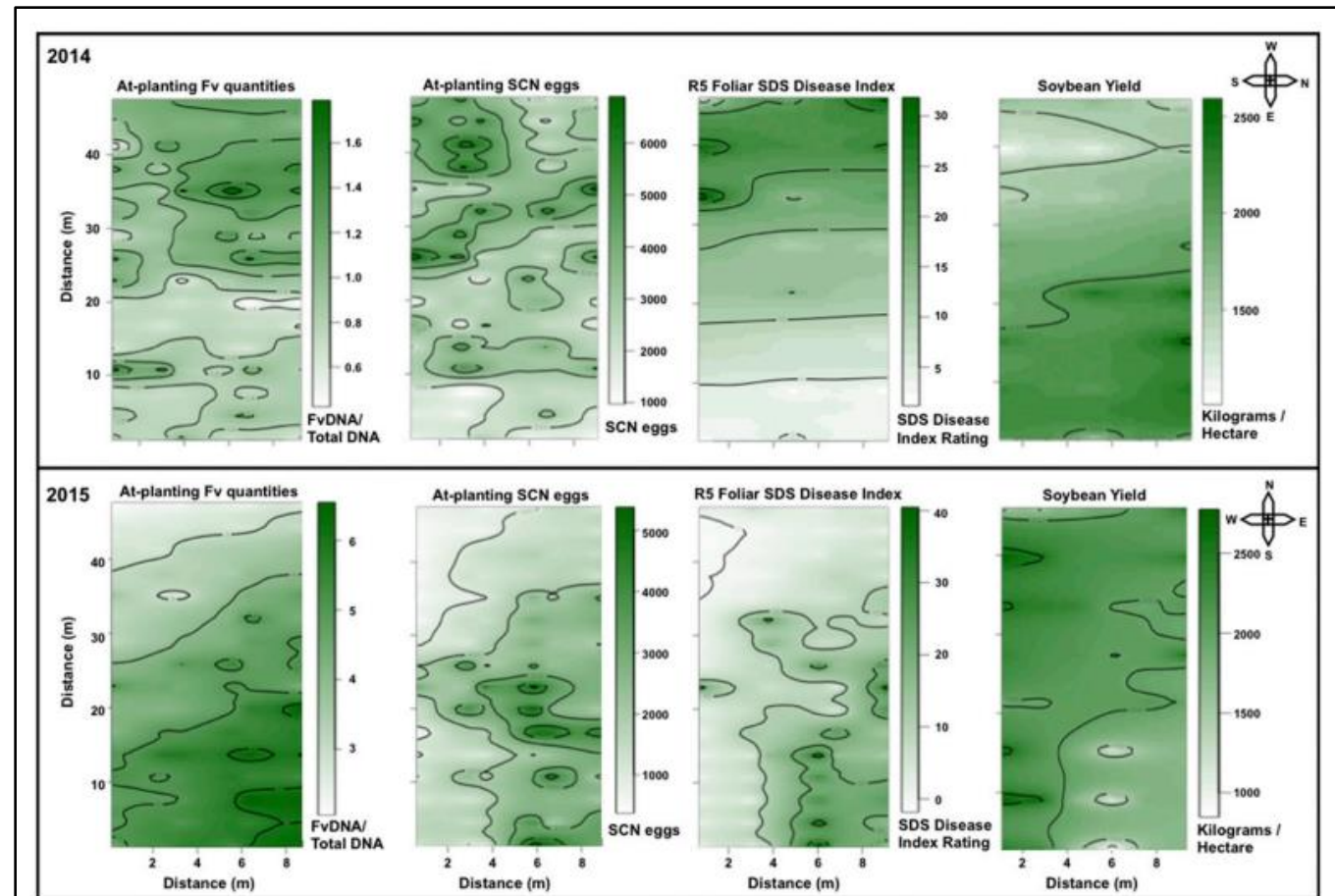
Fig. 1. Contour plots determined via kriging of the grid-sampled data representing *Fusarium virguliforme* (Fv) DNA quantities, soybean cyst nematode (SCN) egg quantities, soybean reproductive growth stage R5 foliar sudden death syndrome (SDS) disease index ratings, and soybean yield in 2014 (top) and 2015 (bottom). *F. virguliforme* quantities are shown as a proportion of *F. virguliforme* DNA detected (femtograms) from total DNA extracted (nanograms). SCN eggs are shown as the quantity of eggs detected per 100 cm³ of soil. R5 foliar SDS disease index is determined on a scale from 0 to 100. Yield is shown in kilograms per hectare. In all plots, white represents low values, and green represents high values.

MSU EXTENSION

Roth et al. 2019

SDS risk prediction workflow

Soil sampling

DNA extraction

qPCR

Field Trial Data

Data analysis

Assign risk level
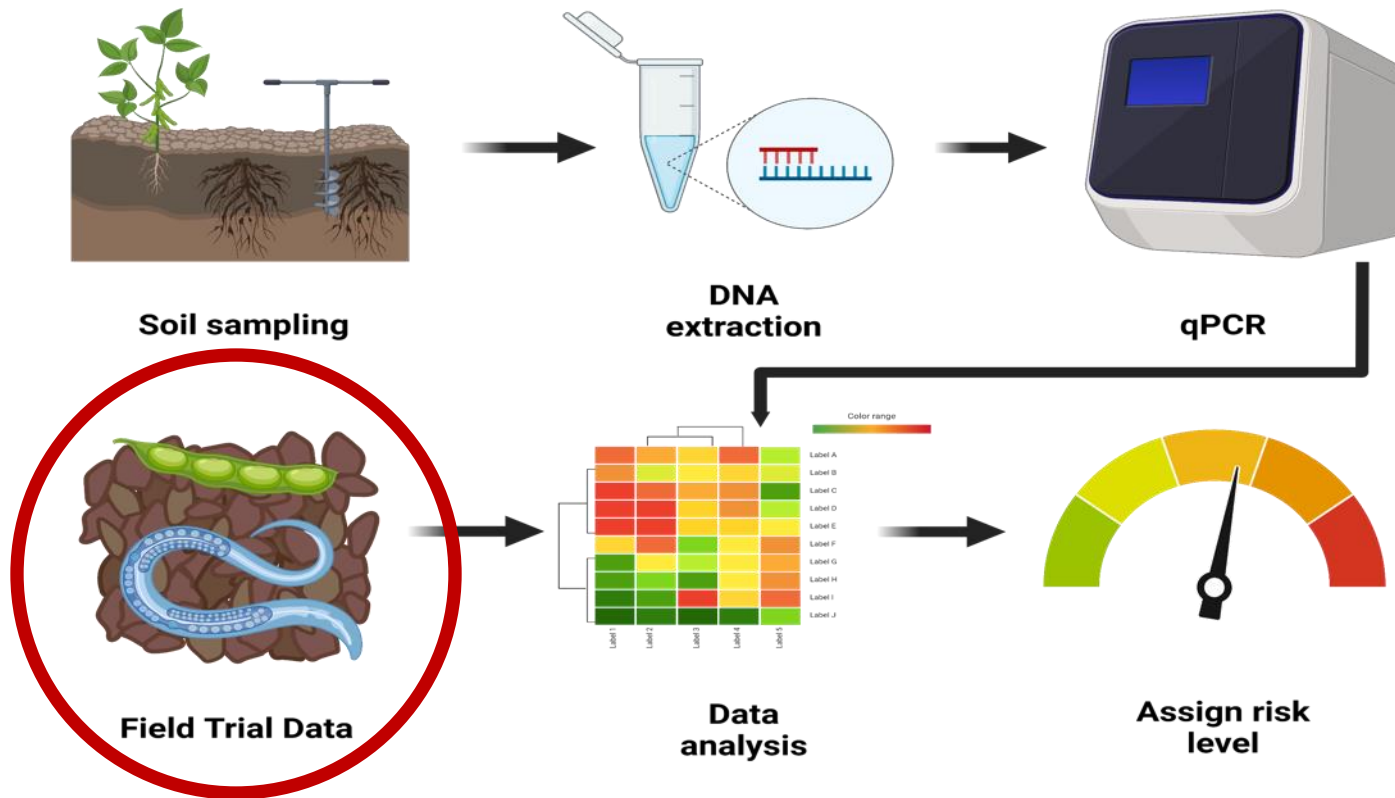
MSU EXTENSION

What conditions increase the risk of SDS?

- 121 locations in Arkansas, Delaware, Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Missouri, Nebraska, North Dakota, South Dakota, Wisconsin and Ontario, Canada
- Most fields had susceptible and resistant varieties
- All fields included 3 seed treatments: base, base + ILEVO, base + Saltro
- Measured foliar symptoms, root rot and yield
- Gathered info about field
  - *Fv* level (Michigan State University)
  - SCN egg counts spring 2020 & 2021, fall 2020 (ISU PIDC)
  - Soil analysis and nutrient testing (Midwest Labs)
  - Soil property quantifications (Pattern Ag)
  - Weather conditions

CROP PROTECTION NETWORK

Defending Fields. Protecting Yields.

Seed treatments and different SDS levels

	RR (%)	FDX	Yield (bu/ac)	% change from base		
All trials	**(59)**	**(85)**	**(121)**	**RR**	**FDX**	**Yield**
Base	7.18 b	0.64 b	63.3 a			
Base + fluopyram	6.25 a	0.45 a	64.3 b	-13.0	-29.7	1.5
Base + pydiflumetofen	6.29 ab	0.44 a	64.7 b	-12.4	-31.3	2.2
p-value	0.027	<0.001	<0.001			
FDX = 0	**(12)**	**(26)**	**(26)**			
Base	19.72 a	-	65.3 a			
Base + fluopyram	16.32 a	-	66.8 ab	-17.2	-	2.2
Base + pydiflumetofen	14.89 a	-	66.9 b	-24.5	-	2.4
p-value	0.080		0.032			

CROP PROTECTION
NETWORK

Defending Fields. Protecting Yields.

Seed treatments and different SDS levels

	RR (%)	FDX	Yield (bu/ac)	% change from base		
0 < FDX < 10	**(29)**	**(45)**	**(44)**	**RR**	**FDX**	**Yield**
Base	11.39 a	0.60 b	64.8 a			
Base + fluopyram	10.49 a	0.46 a	65.4 a	-7.9	-23.3	0.9
Base + pydiflumetofen	10.68 a	0.42 a	65.4 a	-6.2	-30.0	1.0
p-value	0.558	0.002	0.375			
FDX ≥ 10	**(11)**	**(14)**	**(14)**			
Base	17.73 b	23.90 b	61.0 a			
Base + fluopyram	13.90 a	6.17 a	65.3 b	-21.6	-74.2	7.0
Base + pydiflumetofen	13.88 a	6.86 a	66.5 b	-21.7	-71.3	9.0
p-value	<0.001	<0.001	<0.001			

CROP PROTECTION NETWORK

Defending Fields. Protecting Yields.

Seed treatments and different SCN levels

	RR (%)	FDX	Yield (bu/ac)	% change from base		
SCN ≤ 2000	**(40)**	**(48)**	**(75)**	**RR**	**FDX**	**Yield**
Base	7.8 b	0.7 b	62.8 a			
Base + fluopyram	6.2 a	0.5 a	63.6 ab	-20.5	-28.6	1.4
Base + pydiflumetofen	6 a	0.4 a	64.5 b	-23.1	-42.9	2.7
p-value	<0.001	<0.001	<0.001			
SCN > 2000	**(18)**	**(32)**	**(39)**			
Base	13.1 a	1.1 b	63.1 a			
Base + fluopyram	14.1 a	0.8 a	64.0 a	7.6	-27.3	1.4
Base + pydiflumetofen	15.5 a	0.9 ab	63.5 a	18.3	-18.2	0.7
p-value	0.447	0.016	0.215			

CropProtectionNetwork.org

CROP PROTECTION NETWORK

Defending Fields. Protecting Yields.

Seed treatments and different SCN/SDS levels

	RR (%)	FDX	Yield (bu/ac)	% change from base		
SCN < 2000 & FDX > 10	(7)	(7)	(7)	RR	FDX	Yield
Base	24.3 b	50.8 b	67.6 a			
Base + fluopyram	19.2 a	8.0 a	71.3 b	-21.0	-84.3	5.5
Base + pydiflumetofen	18.5 a	9.2 a	74.4 b	-23.9	-81.9	10.1
p-value	0.007	<0.001	<0.001			
SCN > 2000 & FDX ≥ 10	(4)	(6)	(6)			
Base	28.5 b	26.6 b	59.1 a			
Base + fluopyram	21.8 a	11.1 a	63.6 b	-23.5	-58.3	7.6
Base + pydiflumetofen	22.9 ab	14.5 ab	62.6 ab	-19.6	-45.5	5.9
p-value	0.013	0.011	0.012			

CROP PROTECTION
NETWORK

Defending Fields. Protecting Yields.

Top 10 predictors for SDS

Predictor	Description	Average Model Rank
pH	> 6.5 pH: high	1
Organic matter	> 1.5% OM: low	2
Clay particle %	> 20%: high	3
Precipitation total; weeks 1-4	> 100 mm: high	4
Spring SCN egg counts	> 2000 eggs/100cc: high	5
SDS seed treatment	Seed treatment: low	6.5
Potassium	> 160 ppm: high	6.5
Temperature avg; weeks 1-4	> 18°C: low	8
Previous crop	Corn: very high; soybean: high; other: low	9
SDS resistance	MR: low	10

2024 product evaluation

Treatments	Root Rot	FDX	Yield
Non-treated	11.5 bc	16.8 cd	51.7 a
Base	11.5 bc	17.8 d	56.0 b
Base + ILEVO	9.5 ab	11.9 ab	56.8 b
Base + Saltro	9.1 a	12.7 abc	56.6 b
Base + Zeltera	10.8 abc	17.2 cd	55.8 b
Base fb Xylem Plus (In-furrow fb foliar)	12.1 c	17.1 cd	55.3 ab
Base fb Xyway (2x2)	10.7 abc	16.4 bcd	54.4 ab
Base + Saltro + ILEVO	9.0 a	9.3 a	57.4 b
	<0.001	<0.001	<0.001

13 locations

CROP PROTECTION NETWORK

Defending Fields. Protecting Yields.

2024 product evaluation – biologicals

Treatment	RR (%)	FDX	Yield (Bu/A)
NTC	8.2a	13.9a	57.5ab
Base	9a	17.3a	58.4ab
Base + CeraMax + Germate Plus	7.6a	13.9a	57.2a
Base + Avodigen + Adaplan + Ethos.Elite	8.4a	15a	58.5ab
Base + TBZ + Headsup + Biost 2nd Gen + Ascribe SAR	8.1a	12.8a	58.3ab
Base + CeraMax + Germate Plus + Avodigen + Adaplan + Ethos.Elite + TBZ + Headsup + Biost 2nd Gen + Ascribe SAR	7.5a	12.0a	56.8a
Base + ILEVO	7.7a	12.5a	63.1b
p-value	0.843	0.283	0.033

4 locations (2 Iowa, 1 Ontario, 1 Indiana)

CropProtectionNetwork.org

CROP PROTECTION NETWORK

Defending Fields. Protecting Yields.

- SDS has two phases – root rot and foliar, both contribute to yield loss
- Management starts with resistant varieties
- Cultural practices can reduce risk, but not reliable for consistently reducing SDS
- Effective seed treatments can reduce both root rot and foliar symptoms of SDS
- Identifying fields with greater risk may help select fields and conditions more likely to require a SDS seed treatment

IOWA STATE UNIVERSITY
Extension and Outreach

CROP PROTECTION
NETWORK
A Product of Land Grant Universities

For more information on field crop diseases

CropProtectionNetwork.org

Thank you!

Daren Mueller
dsmuelle@iastate.edu

𝕏 @dsmuelle