The REAL story behind SDS-glyphosate interactions

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Sudden Death Syndrome (SDS)

- Caused by fungus *Fusarium virguliforme*
- Primarily a problem in Midwest
- First reported in U.S. in 1971
  - Indiana in 1985
- Can severely impact yield

Symptoms

- First appears in patchy areas in field
- Yellowing or dieback common
- Often first noticed in low areas or heavy soils
  - Compacted fields

Symptoms

- Chlorotic leaf tissue can become necrotic

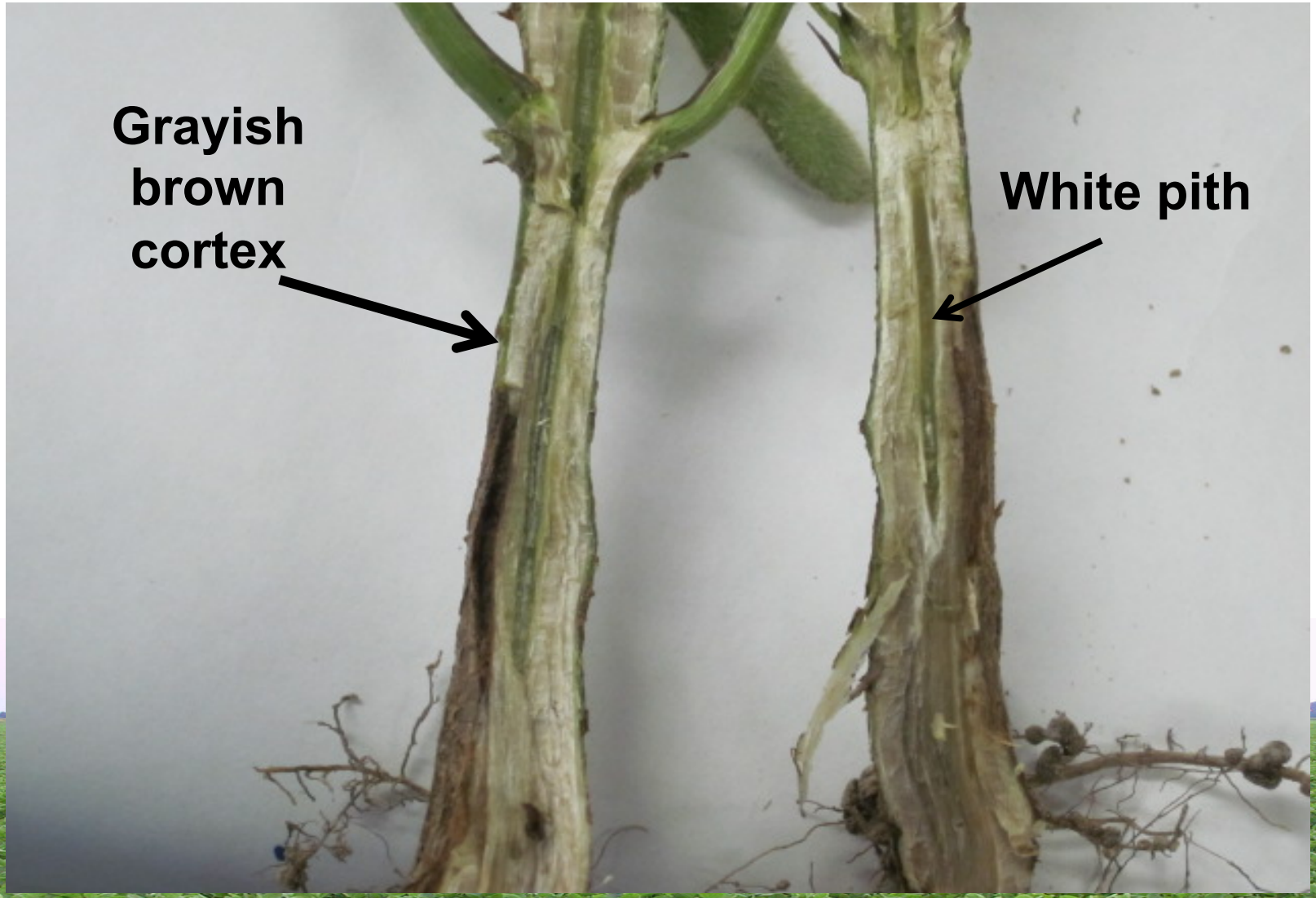
- Younger leaves are affected first, usually have most pronounced symptoms

Symptoms

- Leaves can drop—will still have petiole attached to the stem

- Reduced seed size and pod abortion common with severe infections

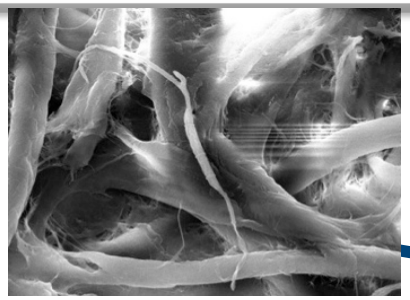
Stem symptoms of SDS



SDS disease cycle

Overwinters in soil, plant residue, cysts of SCN

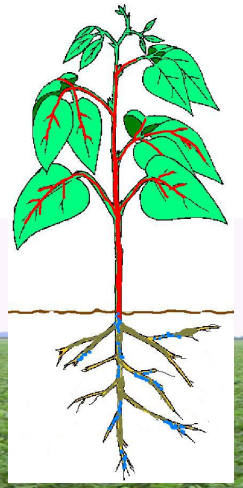
Spores infect roots of young plants



Fungus colonizes roots and crowns

Low soil T; high moisture

Fungus produces toxins



High soil moisture

Symptoms develop; plants deteriorate

Slide modified from D. Mueller

Increasing levels of SDS?

- Farmers have reported more SDS in recent years
  - 2010 especially severe across Midwest

- Reports of disease even in dry years

- Reports of disease on varieties rated as moderately resistant or resistant to disease

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Does Glyphosate Cause SDS?

DECEMBER 28, 2012

By: **Pam Smith**, Farm Journal Seeds and Production Editor

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Interactions between herbicides and plant diseases aren't something you read a lot about. However, a persistent rumor that links glyphosate and the mysterious soybean disease called sudden disease syndrome (SDS) begs discovery.

What prompted this question?

(Image: Sudden Death Syndrome in soy where the right field was sprayed the previous year with glyphosate. Iowa, 2010. Photo by Don Huber)

This is because "glyphosate stimulates the growth of fungi and enhances the virulence of pathogens." In the last 15-18 years, the number of plant pathogens has increased, he told the Non-GMO Report. "There are more than 40 diseases reported with use of glyphosate, and that number keeps growing as people recognize the association (between glyphosate and disease)."

http://www.thepeoplesvoice.org, Feb. 20th, 2011

Claims and concern by food safety and environmental organizations about the impact of glyphosate on plant disease development were renewed in 2011.

Agricultural sector needs answers

Research on plant-disease interactions

Field Response of Glyphosate-Tolerant Soybean to Herbicides and Sudden Death Syndrome

S. Sanogo, X. B. Yang, and **P. Lundeen,** Department of Plant Pathology, Iowa State University, Ames 50011

ABSTRACT

Sanogo, S., Yang, X. B., and Lundeen, P. 2001. Field response of glyphosate-tolerant soybean to herbicides and sudden death syndrome. Plant Dis. 85:773-779.

Three-year field experiments were conducted to assess the development of sudden death syndrome (caused by *Fusarium solani* f. sp. *glycines*) in three soybean cultivars, tolerant (P9344 and A3071) and nontolerant (BSR101), to glyphosate following foliar application of four herbicides (acifluorfen, glyphosate, imazethapyr, and lactofen) commonly applied to soybeans in the north-central region of the United States. Cultivar A3071 is resistant to sudden death syndrome, whereas cultivars P9344 and BSR101 are susceptible to this disease. There was no statistically significant cultivar–herbicide interaction with respect to the severity of foliar symptoms of the disease and the frequency of isolation of *F. solani* f. sp. *glycines* from roots of soybean plants. Across all herbicide treatments, the level of sudden death syndrome was lower in the disease-resistant cultivar than in the susceptible ones. There was an increase in the disease levels under application of acifluorfen, glyphosate, and imazethapyr compared with nontreated or lactofen-treated plants. The results obtained indicate that the response of glyphosate-tolerant soybeans to sudden death syndrome is not different from the response of conventional soybeans to this disease following application of the selected herbicides, and the resistance of soybean to sudden death syndrome was not changed with application of glyphosate.

(26,38), in non-glyphosate-tolerant crops this herbicide has been shown to increase populations of various fungal pathogens in soil (9,27,29,42) and to suppress plant defenses and enhance disease susceptibility in various crops and weeds (5,19,21,22, 24,25,30,40,45).

The goal of this study was to assess the field response of glyphosate-tolerant and conventional soybeans to sudden death syndrome following application of selected herbicides commonly used in soybean in the north-central region of the United States.

MATERIALS AND METHODS

Herbicides and cultivars. Four herbicides were tested in this study: acifluorfen (Blazer), glyphosate (Roundup Ultra), imazethapyr (Pursuit 2AS), and lactofen (Cobra 2EC). The recommended field application rates (1×) used for each formu-

Effects of Herbicides on Sudden Death Syndrome – 2011-2013

States/provinces involved:

- Illinois – Carl Bradley
- Indiana – Kiersten Wise, Bill Johnson
- Iowa – Daren Mueller, Alison Robertson, Yuba Kandel
- Michigan—Marty Chilvers
- Ontario—Albert Tenuta
- Wisconsin – Vince Davis, Paul Esker, Damon Smith

Trial set-up

- Common herbicide programs selected
  - Included standard glyphosate programs compared to programs with no glyphosate applications
- Some trials were inoculated with *F. virguliforme,* some conducted under natural disease pressure
- Disease severity, yield, nutrient analysis data collected and analyzed

Summary – SDS Severity 2011

Herbicide Treatments	Timing	Rates (fl oz/A)	IL	IN	IA	WI
Roundup PowerMAX 2 applications	V2/V3 then 3 weeks later	43 then 21	2.8	0.0	<0.1	0.0
Preemergence then Roundup PowerMAX	Pre then V3/V4	Pre then 43	1.1	0.0	<0.1	0.0
Preemergence then Flextstar + Select	Pre then V3/V4	Pre then 1 pt + 16	1.2	0.0	<0.1	0.0
Preemergence then Pursuit	Pre then V3/V4	Pre then 4	2.3	0.0	0.0	0.0
Burndown of RoundupPowerMAX then Roundup PowerMAX	Planting then V3/V4	43 then 21	2.0	0.0	0.0	0.0
Roundup PowerMAX	V3/V4	86	1.4	0.0	<0.1	0.0
LSD (0.05)			NS	NS	NS	NS

Preemergence applications were: Illinois--Valor XLT (4 fl oz/A), Indiana--Valor XLT 40.3% WG (4 fl oz/A), Iowa--Pursuit Plus (2.5 pints/A), Wisconsin--Valor (2.3 fl oz) + Firstrate (0.46 fl oz)

Summary – Yield 2011

Herbicide Treatments	Timing	Rates (fl oz/A)	IL	IN	IA	WI
Roundup PowerMAX 2 applications	V2/V3 then 3 weeks later	43 then 21	64.9	46.3	47.6	61.6
Preemergence then Roundup PowerMAX	Pre then V3/V4	Pre then 43	65.8	45.5	48.8	64.7
Preemergence then Flextstar + Select	Pre then V3/V4	Pre then 1 pt + 16	67.1	42.4	51.3	65.5
Preemergence then Pursuit	Pre then V3/V4	Pre then 4	71.2	45.2	47.5	61.4
Burndown of RoundupPowerMAX then Roundup PowerMAX	Planting then V3/V4	43 then 21	66.0	43.5	46.3	67.8
Roundup PowerMAX	V3/V4	86	66.6	41.5	46.8	63.9
LSD (0.05)			4.0	NS	NS	NS

[z] Preemergence application in Illinois was Valor XLT (4 fl oz/A), in Indiana was Valor XLT 40.3% WG (4 fl oz/A), in Iowa was Pursuit Plus (2.5 pints/A), and in Wisconsin was Valor (2.3 fl oz) + Firstrate (0.46 fl oz)

What prompted this question?

(Image: Sudden Death Syndrome in soy where the right field was sprayed the previous year with glyphosate. Iowa, 2010. Photo by Don Huber)

This is because "glyphosate stimulates the growth of fungi and enhances the virulence of pathogens." In the last 15-18 years, the number of plant pathogens has increased, he told the Non-GMO Report. "There are more than 40 diseases reported with use of glyphosate, and that number keeps growing as people recognize the association (between glyphosate and disease)."

http://www.thepeoplesvoice.org, Feb. 20th, 2011

Summary – SDS Severity 2012

Herbicide Treatments	Timing	Rates (fl oz/A)	IL	IA	MI	ON
Roundup PowerMAX 2 applications	V2/V3 then 3 weeks later	43 then 21	2.3	0.0	44.2	1.3
Preemergence then Roundup PowerMAX	Pre then V3/V4	Pre then 43	2.4	0.0	42.2	1.9
Preemergence then Flextstar + Select	Pre then V3/V4	Pre then 1 pt + 16	3.4	0.0	47.3	1.6
Preemergence then Pursuit	Pre then V3/V4	Pre then 4	8.0	0.0	38.9	2.0
Burndown of RoundupPowerMAX then Roundup PowerMAX	Planting then V3/V4	43 then 21	6.5	0.0	34.0	2.3
Roundup PowerMAX	V3/V4	86	5.4	0.0	49.6	1.5
LSD (0.05)			NS	NS	NS	NS

Preemergence application was Valor XLT (4 fl oz/A)

Summary – Yield 2012

Herbicide Treatments	Timing	Rates (fl oz/A)	IL	IA	MI	ON
Roundup PowerMAX 2 applications	V2/V3 then 3 weeks later	43 then 21	61.3	57.8	26.3	52.2
Preemergence then Roundup PowerMAX	Pre then V3/V4	Pre then 43	57.6	54.5	29.4	49.2
Preemergence then Flextstar + Select	Pre then V3/V4	Pre then 1 pt + 16	63.4	60.4	28.4	53.9
Preemergence then Pursuit	Pre then V3/V4	Pre then 4	66.9	63.3	29.5	52.0
Burndown of RoundupPowerMAX then Roundup PowerMAX	Planting then V3/V4	43 then 21	67.7	59.3	28.3	56.5
Roundup PowerMAX	V3/V4	86	66.4	55.1	25.8	50.6
LSD (0.05)			NS	NS	NS	NS

Preemergence application was Valor XLT (4 fl oz/A)

Summary – SDS Severity 2013

Herbicide Treatments	Timing	Rates (fl oz/A)	IL	IN	IA	MI	ON	WI
Roundup PowerMAX 2 applications	V2/V3 then 3 weeks later	43 then 21	7.5	0.0	10.2	11.1	1.9	16.4
Preemergence then Roundup PowerMAX	Pre then V3/V4	Pre then 43	8.2	0.0	18.9	12.3	2.2	4.9
Preemergence then Flextstar + Select	Pre then V3/V4	Pre then 1 pt + 16	6.9	0.0	8.3	13.6	0.7	1.5
Preemergence then Pursuit	Pre then V3/ V4	Pre then 4	6.7	0.0	14.5	22.5	3.6	10.3
Burndown of RoundupPowerMAX then Roundup PowerMAX	Planting then V3/V4	43 then 21	8.2	0.0	13.1	13.5	2.8	9.4
Roundup PowerMAX	V3/V4	86	9.2	0.0	20.9	19.6	1.3	13.1
LSD (0.05)			NS	NS	NS	NS	NS	NS

Preemergence application was Valor XLT (4 fl oz/A)

Summary – Yield 2013

Herbicide Treatments	Timing	Rates (fl oz/A)	IL	IN	IA	MI	ON	WI
Roundup PowerMAX 2 applications	V2/V3 then 3 weeks later	43 then 21	51.3	60.4	39.2	52.6	51.4	75.2
Preemergence then Roundup PowerMAX	Pre then V3/V4	Pre then 43	51.6	57.8	28.5	54.1	47.7	73.1
Preemergence then Flextstar + Select	Pre then V3/V4	Pre then 1 pt + 16	50.1	57.8	19.7	48.7	44.9	72.4
Preemergence then Pursuit	Pre then V3/ V4	Pre then 4	50.5	54.4	26.1	44.3	45.7	73.4
Burndown of RoundupPowerMAX then Roundup PowerMAX	Planting then V3/V4	43 then 21	50.8	60.5	38.7	48.7	51.6	74.8
Roundup PowerMAX	V3/V4	86	52.0	60.4	32.2	47.8	50.0	71.9
LSD (0.05)			NS	4.1	11	NS	NS	NS

Preemergence application was Valor XLT (4 fl oz/A)

Conclusions

- Multi-year, location trial conducted under different environments and disease pressure
- SDS was not more severe in treatments where glyphosate was applied
- Glyphosate applications did not negatively impact yield across trial locations and years
- What about the micronutrient side?

Glyphosate and Plant Nutrition

- 2013 analysis from this study still underway
- Results from IN indicate glyphosate did not reduce essential nutrients in soybean plants
  - Including manganese
- Reinforces results from similar studies in IN

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Impact Statement

Glyphosate's Effect Upon Mineral Accumulation in Soybean

R. S. Henry, K. A. Wise, and W. G. Johnson

October 2011

Research

Previous research and anecdotal reports have implicated glyphosate-induced nutrient deficiencies in agronomic and horticultural crops. Our experiment investigated the accumulation of necessary macro and micronutrients for two soybean cultivars when treated with a standard glyphosate weed management program throughout the growing season.

doi:10.1094/CM-2011-1024-01-RS

Glyphosate and Disease Considerations

- Previous research indicates that many herbicides (including glyphosate) can influence disease severity in soybean in greenhouse/laboratory studies

- No widespread increases in susceptibility observed in RR corn or soybean in the field

- **No consistent impact on yield has been observed**

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www.btny.purdue.edu/weedscience/

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Glyphosate's Impact on Field Crop Production and Disease Development

The U.S. Department of Agriculture's recent decision to approve Roundup Ready alfalfa renewed a debate about the safety of genetically modified crops and the use of glyphosate in the environment.

This is not a new controversy, but many statements released in recent weeks by groups opposed to the use of genetically modified (GM) crops have claimed that glyphosate use and Roundup Ready® technology will be disastrous and that glyphosate has damaged crop production by decreasing nutrient availability to plants, reducing nutrient content of food and livestock feed, and increasing plant susceptibility to disease (Zerbe, 2011). There also are claims that glyphosate is contributing to an increase in more than 40 plant diseases that may also affect human and animal health (Smith, 2011; Zerbe, 2011). However, evidence to support these claims has neither been presented to nor evaluated by the scientific community.

As scientists, we are equally concerned about the health of the environment and the sustainability of agricultural production. We have previously addressed questions on the impact of glyphosate and manganese (Mn) interactions on soybean (see http://www.btny.purdue.edu/weedscience/2010/GlyphosateMn.pdf). In this article, we discussed the limited research available on the impact of glyphosate and glyphosate-resistant crops on Mn nutrition of soybeans, and encouraged producers to avoid "insurance" applications of Mn for the sole purpose of counteracting perceived plant health damage due to glyphosate use. However, the most recent press releases around this issue are focused on the impact of glyphosate on plant and human disease development. This article is intended to clarify the relationship between glyphosate and plant disease development.

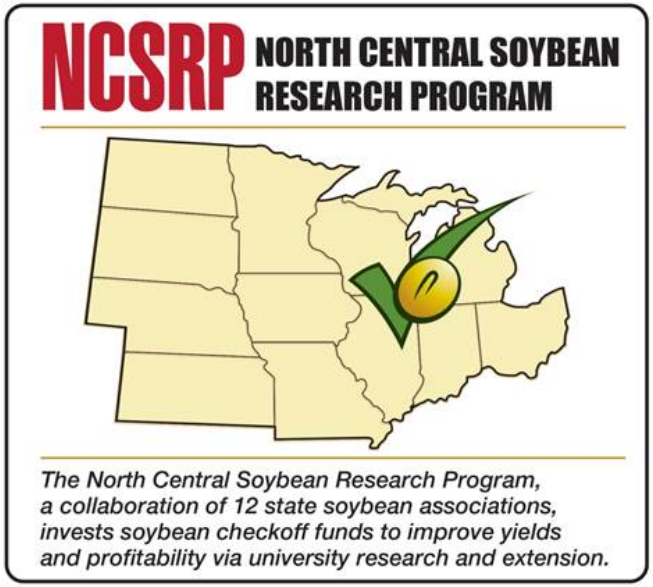
Best management practices for SDS

- Accurate diagnosis is key
- Manage through use of resistant varieties
- Plant fields with a history of disease last
- Rotate fields with history of disease
- Seed treatments with efficacy coming soon

Bottom Line

- Manage SDS with recommended management practices
- Recommendations for weed control have not changed
  - Continue judicious glyphosate use for weed control in areas where glyphosate-sensitive weeds occur
- Discuss concerns with University Extension personnel before making changes to crop production practices

Acknowledgments



Questions?