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Shrishail S. Navi
Iowa State University, ssnavi@iastate.edu

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Abstract
The foliar, stem and root diseases of soybean are significant components of yield loss for crop producers. Use of fungicides is one of the options in management of soybean diseases. Fungicide use in soybean has increased from <1 percent in 2002 to 11 percent of soybean planted acres in 2012 in 20 soybean-producing states>(Arkansas, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Michigan, Minnesota, Mississippi, Missouri, Nebraska, North Carolina, North Dakota, Ohio, South Dakota, Tennessee, Virginia and Wisconsin) (USDA-NASS). The objective of these trials was to test the efficacy of various foliar fungicides on disease control and yield during 2012 and 2013 growing seasons.

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Efficacy Tests of Foliar Fungicides on Soybean Diseases and Yield during 2012 and 2013 Growing Seasons in Northeast Iowa

By Shrishail S. Navi, Department of Plant Pathology and Microbiology

The foliar, stem and root diseases of soybean are significant components of yield loss for crop producers. Use of fungicides is one of the options in management of soybean diseases. Fungicide use in soybean has increased from <1 percent in 2002 to 11 percent of soybean planted acres in 2012 in 20 soybean-producing states (Arkansas, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Michigan, Minnesota, Mississippi, Missouri, Nebraska, North Carolina, North Dakota, Ohio, South Dakota, Tennessee, Virginia and Wisconsin) (USDA-NASS). The objective of these trials was to test the efficacy of various foliar fungicides on disease control and yield during 2012 and 2013 growing seasons.

Materials and methods

Two trials were conducted in each growing season, 2012 and 2013. Trials were set up in a randomized complete block design with four replications each with 10-ft-wide (four 30-inch rows) × 45.5-ft-long plots at the Northeast Research and Demonstration Farm, Nashua, IA. Trial-1 assessed the efficacy of various fungicides for disease control and yield (Tables 1 and 2) and Trial-2 assessed the efficacy of several fungicides and application timings for control of soybean diseases during 2012 and 2013 cropping seasons (Tables 3 and 4).

Table 1. Effect of foliar fungicides application at R3 growth stage on soybean diseases, defoliation and yield during 2012, Nashua, IA[1]

Products tested	Application Rate/Ac	SDS (%)		WM (%)		SVN (%)		Defoliation%	Yield Bu/Ac
		Inc	Sev	Inc	Sev	Inc	Sev		
Priaxor+NIS[2]	4 fl oz + 0.25%v/v	0.00a	0.0a	0.00b	0a	15a	5a	12.5bc	69.81a
Headline SC+NIS	5.3 oz + 0.25%v/v	0.16a	17.5a	0.00b	0a	15a	5a	15.0bc	69.12ba
Gem 500 SC+NIS	1 oz + 0.25%v/v	0.34a	20.0a	0.00b	0a	15a	5a	12.5bc	67.63bac
Quadris + NIS	6 oz + 0.25%v/v	0.19a	17.5a	0.00b	0a	15a	5a	22.5ba	66.17bac
BAS700 04+NIS	2.2 oz + 0.25%v/v	0.18a	7.5a	0.01b	20a	15a	5a	10.0c	65.96bac
Stratego YLD + NIS	4 oz + 0.25%v/v	0.13a	17.5a	0.04ba	30a	15a	5a	15.0bc	64.20bac
Tilt 3.6E+NIS	3 oz + 0.25%v/v	0.24a	12.5a	0.00b	0a	15a	5a	18.0bc	63.86bac
Unsprayed control	0	0.00a	0.0a	0.08a	35a	15a	5a	30.0a	63.49bac
Quilt Xcel + NIS	10.5 oz + 0.25%v/v	0.09a	7.5a	0.01b	20a	15a	5a	17.5bc	62.09bc
Proline 480SC+NIS	1.05 oz + 0.25%v/v	0.22a	8.8a	0.00b	0a	15a	5a	20.0bac	60.23c

Means with the same letter are not significantly different (P<0.05). [1]Values are mean of four replications, Inc= incidence, Sev= severity, [2]NIS = Non-ion surfactant Activator 90 from Loveland Industries. Severities of bacterial leaf blight and frogeye leaf spot was <1% in all the treatments. SDS= Sudden death syndrome, WM= white mold. SNV= Soybean vein necrosis. Note: Application rate of Proline was lower in this trial than in 2013.

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Table 2. Effect of fungicide application at growth stage R3 on white mold incidence and yield during 2013, Nashua, IA[1]

Products tested	Application rate/Ac	White mold Inc%	Yield Bu/Ac
Headline SC + NIS[2]	5.3 oz+0.25%v/v	1.08a	62.73a
Proline 480 SC + NIS	4 oz+0.25%v/v	0.49b	62.58a
Priaxor + NIS	4 fl. oz+0.25%v/v	0.41b	61.70a
Gem 500 SC + NIS	5 oz+0.25%v/v	0.46b	61.25a
Quadris + NIS	6 oz 0.25%v/v	0.35b	61.12a
Stratego YLD + NIS	4 oz+0.25%v/v	0.64ba	60.63a
Quilt Xcel + NIS	10.5 oz +0.25%v/v	0.25b	60.29a
BAS 700 04 + NIS	2.2 oz+0.25%v/v	0.52b	59.98a
Tilt 3.6L + NIS	5 oz 0.25%v/v	0.71ba	59.77a
Unsprayed control		0.59ba	58.91a

Means with the same letter are not significantly different (P=0.05). [1]Values are mean of four replications. Inc%= Incidence %. [2]NIS= Non-ion surfactant Activator 90 (Loveland Industries, 0.25%v/v). Note: Application rate of Proline was higher in this trial than in 2012.

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Table 3. Effect of Domark® and Topguard SC® at various application timings on downy mildew and soybean vein necrosis (SVN) and yield during 2012, Nashua, IA[1]

Products Tested	Application		Downy mildew		SVN		Yield
	Rate/Ac	time	Inc%	Sev%	Inc%	Sev%	Bu/Ac
Topguard SC	7+7oz	1st fl+28dap	10-15	10-15	5-10	1-5	57.92a
Topguard SC	7oz	1st fl/R1	10-15	10-15	5-10	1-5	56.85a
Domark	5+5oz	R1+21dap	10-15	10-15	5-10	1-5	51.95a
Unsprayed control			10-15	10-15	5-10	1-5	59.54a

Means with the same letter are not significantly different (P=0.05). [1]Values are mean of four replications. dap = days after previous spray.

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Table 4. Effect of Domark® and Topguard SC ® at various application timings on white mold, sudden death syndrome (SDS) and yield in 2013, Nashua, IA[1]

Product tested	Application		White mold	SDS	Yield
	Rate/Ac	time	Inc%	Inc%	Bu/Ac
Topguard SC	7 oz	R3	1.08a	0.15a	50.47a
Topguard SC	7+7 oz	R1+R3	1.29a	0.10a	49.78a
Topguard SC	7 oz	R1	1.19a	0.11a	48.73a
Domark	5 5 oz	R3+R5	0.77a	0.11a	48.53a
Unsprayed control			1.03a	0.27a	47.94a

Means with the same letter are not significantly different (P=0.05). [1]Values are mean of four replications. Inc%= Incidence%.

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Field operations: Trial-1 in 2012 was no-till planted with Asgrow Brand AG24-31 and in 2013 was planted in a convention tillage system (fall chisel plow, spring field cultivate) with NK Brand S20-Y2 at 188.8k PPA in 30 in. row spacing with a Kinze 3000 planter on May 17 and June 17, respectively (previous crops were corn). Trial-2 in 2012 was no-till planted with NK Brand S25-R3 (previous crop was oats) and, in 2013, no-till planted to NK Brand S25-T8 (previous crop was corn) at 188.8k PPA in 30 in. row spacing with a Kinze 3000 planter on May 20 and June 17, respectively. In all trials, fungicides were applied using CO2 backpack (10 ft hand boom/ XR8003 tips) as per the treatment details and protocols provided by the companies (Tables 1 to 4). To maintain weed free (including glyphosate-resistant water hemp) plots, pre- or post-emergence herbicides (Outlook, Zidua, Roundup WeatherMax and Fusion) were sprayed at recommended rates. To control spider mites, Lorsban insecticide (1.5 pint/Ac) was used in 2012 and in 2013 soybean aphids were controlled with Warrior II insecticide (1.96 oz/Ac). Plots were harvested using a John Deere 4420 combine with Shivvers grain moisture meter and Avery-Weigh Tronix weigh scale indicator and yields were adjusted to 13% grain moisture (Tables 1-4).

Fungicides: Four Triazole products (Domark, Proline, Tilt and Topguard),

three Strobilurin (Gem, Headline and Quadris) and three mixtures of active ingredients of Strobilurin and Triazole (QuiltXcel, Stratego YLD and Priaxor) were tested (Tables 1-4).

Evaluation for diseases: Pre- and post-fungicide spray diseases ratings were recorded weekly from one week before application through one week before the harvest however, only mean final percent disease severity and incidence are presented in Tables 1 to 4.

Data analysis: Data was analyzed using SAS.

Results and discussion

The following diseases were observed in Trial-1 during the 2012 growing season: bacterial leaf blight (trace), frogeye leaf spot (trace), sudden death syndrome, white mold (trace) and Soybean vein necrosis (Table 1). Soybean vein necrosis (Fig 1) is a new disease (Smith et al., 2013). There was no evidence of an effect ($P<0.05$) of fungicide on disease incidence and severity, but some fungicides reduced ($P<0.05$) defoliation compared to the unsprayed control (Table 1). Although most fungicide treatments yielded greater than the unsprayed control, no significant ($P<0.05$) yield differences were noted when comparing sprayed versus the unsprayed control treatment (Table 1). The mean response to fungicides was 2 bu/ac (range -3.26 to 6.32 bu/ac) advantage over unsprayed control (Table 1). In Trial-1 during 2013, white mold was observed. There was no effect of treatment on yield ($P<0.05$) although mean yield response across all the fungicide treatments was 2.2 bu/ac yield advantage (range 0.86 to 3.82 bu/ac) compared to the unsprayed control (Table 2).

Fig 1. Symptoms of Soybean Vein Necrosis.

Diseases observed in Trial-2 during the 2012-growing season were downy mildew and Soybean vein necrosis (Table 3) and, in 2013, white mold and sudden death syndrome (Table 4). Downy mildew incidence and severities in all the treatments was 10-15 percent and that of Soybean vein necrosis 5-10 percent incidence with 1-5 percent severity. In both 2012 and 2013, no effect ($P<0.05$) of fungicide application timing on yield was evident (Table 3 and 4). Variation in yields may be due to various factors like weather conditions, crop rotation, disease pressure, variety planted and efficacy of the products.

Remarks: The 2012 (June – September) and 2013 (July – September) growing seasons in Iowa were very dry with below normal rainfall. Consequently, white mold, sudden death syndrome and foliar disease incidence and severity were low, and it was difficult to detect evidence of an

effect of fungicide on disease (Tables 1 to 4). Similarly, no effect of application timing or multiple application timings were detected (Tables 3 and 4). Although, some treatments have shown higher yield advantage of 4 to 6 bu/ac, on average, the mean yield of soybean to fungicide applications was approximately 2 bu/ac, which agrees with similar reports of Mueller, et al., (2014). Products tested in these studies do not imply endorsement of one company over another, nor did discrimination intended against any similar products.

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Shrishail S. Navi is an associate scientist working on soybean diseases.