CPN 5002 December 2019

RESEARCH UPDATE

Seed Treatment and Foliar Fungicide Impact on Sudden Death Syndrome and Soybean Yield

INTRODUCTION

Sudden death syndrome (SDS) is caused primarily by the fungal soilborne pathogen (*Fusarium virguliforme*) and frequently causes soybean yield loss in the United States and Canada. Researchers estimate that SDS caused more than 209 million bushels of soybean yield loss (an estimated $2.4 billion) in the United States and Ontario, Canada from 2010-14 (Allen et al., 2017; USDA-NASS, 2019).

Fusarium virguliforme can survive in the soil for multiple seasons and infect emerging roots of soybean seedlings early in the growing season. Infection may result in root rot, and if conditions are favorable for fungal growth during the growing season, the causal fungus produces toxins that will move from the roots to the foliage. This results in the characteristic foliar symptoms on leaves (Figure 1).

Varieties with moderate resistance against SDS exist (Figure 2). Although they are an effective management tactic, resistance may not be complete and yield loss may still occur. A few seed treatments which vary in efficacy and cost are marketed for protection against SDS.

Researchers often test products in SDS management trials across the soybean-growing region. According to research conducted prior to 2019, fluopyram provided the best overall management of SDS foliar symptoms compared to other registered SDS management products (Kandel et al. 2019).

Summary

- We performed multiyear and multi-location evaluations of seed treatments, in-furrow, and foliar products for management of sudden death syndrome (SDS) of soybean.
- Among the seed treatments we evaluated in our trials, **only** fluopyram seed treatment reduced SDS severity compared to a commercial base seed treatment.
- We found a 35 percent reduction in foliar disease index (FDX) of SDS and a yield increase of 4.4 bushels per acre (7.6 percent) with fluopyram (ILeVO) seed treatment relative to a commercial base seed treatment that consisted of fungicide, insecticide, and biological nematicide products.
- When SDS symptoms were severe (>10 FDX in the base seed treatment), fluopyram protected grain yield more than 80 percent of the time compared to the commercial base seed treatment. The probability of seeing a yield advantage from seed treatment in the absence of SDS symptoms was very low (Figure 5).
- Effective use of fluopyram seed treatment can complement resistant varieties for management of SDS.

Figure 1. Characteristic sudden death syndrome foliar symptoms include interveinal chlorosis and necrosis.

Figure 2. Soybean varieties with differing levels of resistance to sudden death syndrome.

Table 1. List of treatments with application timings and rates that were applied in field experiments performed at Illinois, Indiana, Iowa, Michigan, South Dakota, and Wisconsin in the U.S. and Ontario, Canada, during 2015 and 2016.

Treatments[z]	Application method	Rate
Syngenta commercial base (SB)[y]	Seed treatment	...
SB + Clariva + Mertect	Seed treatment	...
Bayer commercial base (BB)[y]	Seed treatment	...
BB + Poncho VOTiVO + ILeVO	Seed treatment	...
BB + Heads Up	Seed treatment	...
BB fb Cobra	Foliar at R1	6 fl oz/acre
BB fb Fortix	Foliar at R1	5 fl oz/acre
BB fb Procidic	Foliar at R1 and R4	3 then 6 fl/acre

[z]Treatments were commercial base fungicide from Syngenta and Bayer CropScicence, *Pasteuria nishizawae* + thiabendazole (Clariva + Mertect), clothianidin + *Bacillus firmus* + fluopyram (Poncho VOTiVO + ILeVO), saponins extracted from *Chenopodium quinoa* (Heads Up), Bayer commercial base (BB) followed by (fb) lactofen (Cobra), fluoxastrobin + flutriafol (Fortix), and citric acid (Procidic).

[y]Syngenta commercial base: CruiserMaxx Vibrance (thiamethoxam + mefenoxam + fludioxonil + sedaxane); Bayer commercial base: Evergol Energy (prothioconazole + penflufen + metalaxyl), Allegiance (metalaxyl), and Gaucho (imidacloprid + ethoxylated polyarylphenol)

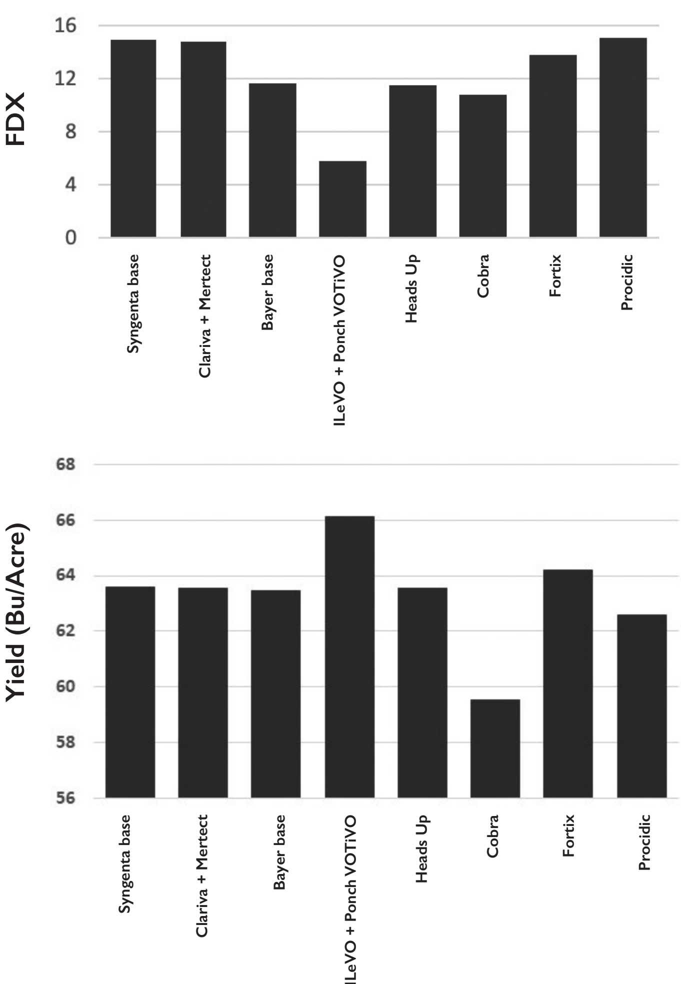

Figure 3. Effect of products on severity of sudden death syndrome (SDS) (top) and yield (bottom). Clariva + Mertect was combined with the Syngenta base treatment. Poncho VOTiVO + ILeVO, Heads Up, Cobra, Fortix and Procidic were combined with the Bayer base treatment. Results are combined from 14 locations in Illinois, Indiana, Iowa, Michigan, South Dakota, and Wisconsin in the U.S., and Ontario, Canada, from 2015 and 2016.

THE RESEARCH

For this publication, we will discuss two different studies. The first is a two-year product evaluation study examining multiple pesticides, while the second is a meta-analysis of results focused only on fluopyram (ILeVO).

These studies consisted of seed treatment efficacy studies from across the North Central U.S. and Ontario, Canada to:

- Evaluate products for their ability to manage SDS and their effect on soybean yield
- Estimate the probability of a positive economic response to specific treatment use

In the product evaluation study, seed treatments (Poncho/VOTiVO + ILeVO and Clariva + Mertect), a biochemical seed treatment (Heads Up), a biochemical foliar treatment (Procidic), a foliar fungicide (Fortix), and an herbicide (Cobra) were evaluated in seven locations in Illinois, Indiana, Iowa, Michigan, South Dakota, and Wisconsin in the U.S., and Ontario, Canada, for SDS management in 2015 and 2016. Products were evaluated using label-recommended rates and timings on a resistant and susceptible variety at each location. Active ingredients and rates are listed in Table 1.

In the second study, data were compiled from over 200 field trials to evaluate fluopyram for SDS management and yield response using a meta-analysis approach. Field evaluations for the meta-analysis were from 2013-15 in Arkansas, Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, South Dakota, Tennessee, and Wisconsin in the U.S., and in Ontario, Canada. Locations were chosen based on previous SDS severity and represented a variety of disease levels. A standard commercial base seed treatment (CB) and the commercial base in addition to ILeVO (CB + ILeVO) were compared on several soybean varieties. Selected varieties had differing levels of resistance to SDS and fluopyram was applied at the rate of 0.15 mg active ingredient per seed.

Pesticide efficacy trials generally evaluate treatments by measuring disease severity or incidence and yield. For SDS, researchers record foliar disease incidence and severity data using a rating scale and combine these into a SDS disease severity index (FDX). For each trial, disease FDX was determined, location and field plot specific variables were recorded, and seed treatment costs and soybean prices were determined for economic analysis.

FDX AND YIELD

In 2015, ILeVO reduced FDX by over 50 percent in both resistant and susceptible varieties compared to the commercial base seed treatment. Yield increased by 8.9 percent in susceptible varieties and 3.5 percent in resistant varieties with ILeVO compared to the base seed treatment alone. In 2016, ILeVO reduced FDX in both cultivars by over 40 percent compared to the base seed treatment. Treatment did not affect yield in the susceptible variety in 2016, but fluopyram increased yield by 3.5 percent compared to the base seed treatment in the resistant variety. Over the two years of the product evaluation study, ILeVO provided the highest level of control of SDS among all the treatments tested. Foliar application of lactofen reduced SDS foliar symptoms in some cases but produced the lowest yield due to crop injury. **No other products reduced foliar symptoms of SDS** (Figure 3).

In this study, planting resistant varieties and using ILeVO seed treatment were the most effective tools for SDS management. Planting a resistant variety provided an overall better yield advantage than using ILeVO seed treatment alone, which supports the need for an integrated SDS management program.

In the meta-analysis study of over 200 trials across 12 U.S. states and Ontario, Canada, fluopyram seed treatment reduced SDS by 35 percent and increased yield by 4.4 bushels per acre (7.6 percent) relative to commercial base seed treatments without ILeVO (Figure 4). The variation in yield response was explained partially by disease severity (19 percent), geographic region (8 percent), and planting date (10 percent), but not by variety resistance. This means that ILeVO was effective at reducing SDS and preserving yield for both resistant and susceptible varieties.

Probability analysis demonstrated that there was a high probability of observing an increase in yield with ILeVO when the disease level was high in any cost-price combinations tested. For example, the probability of getting a positive return was 89 percent when the cost of ILeVO was $13 per acre and the soybean price was $10 per bushel. However, the probability of economic return from ILeVO use was very low when SDS foliar symptoms were low or not present (Figure 5).

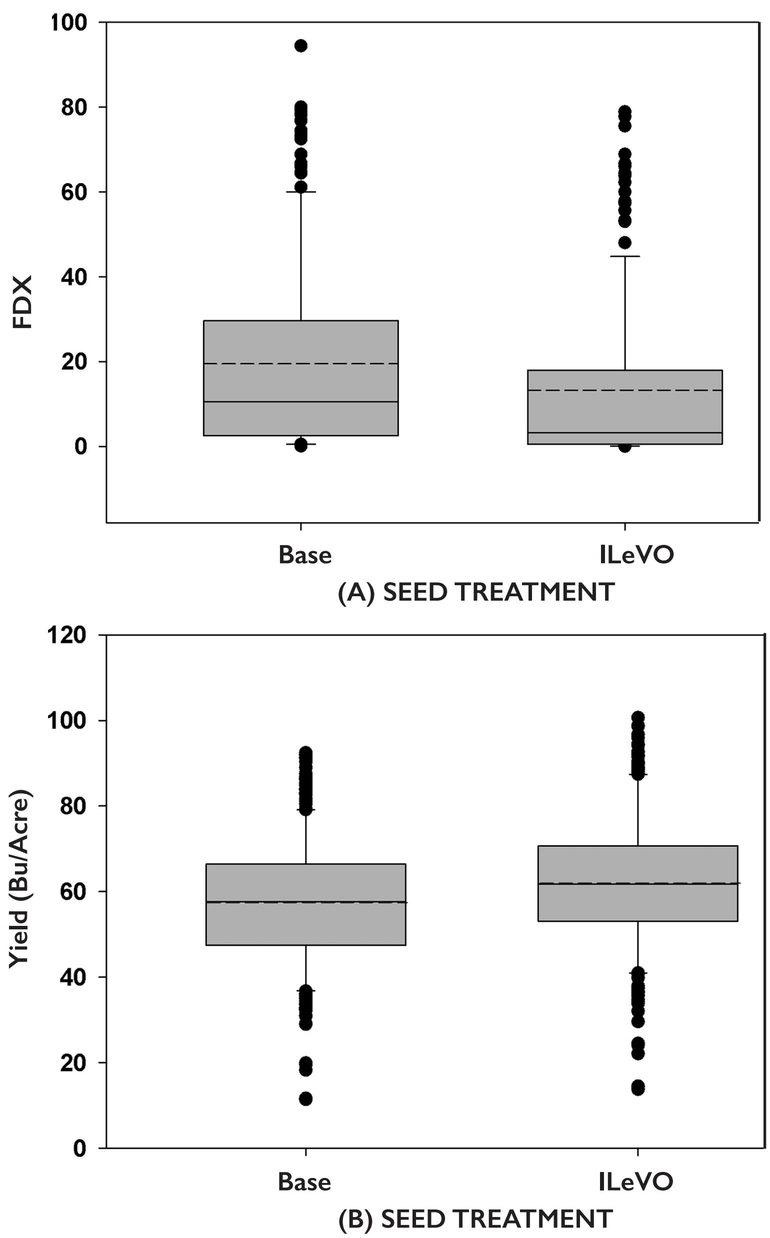

Figure 4. Effect of ILeVO on (A) sudden death syndrome foliar disease index (FDX) and (B) yield.

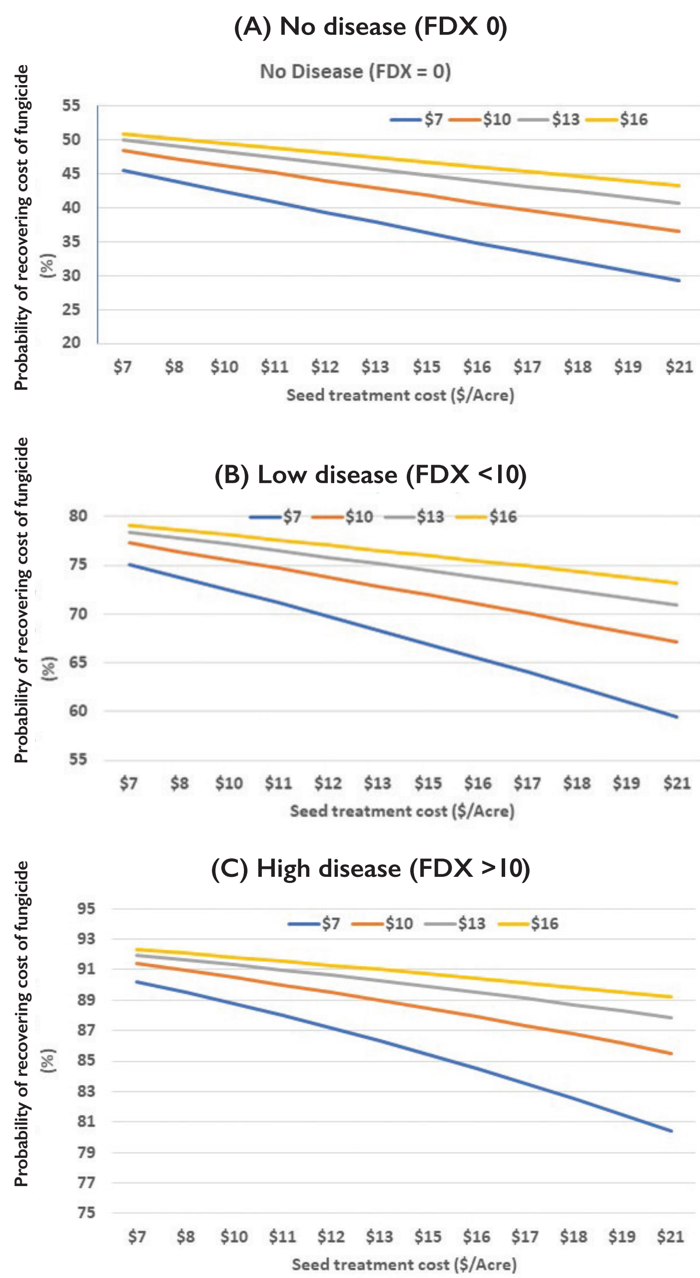

Figure 5. The return on investment (ROI) for ILeVO at different seed treatment costs with (A) no sudden death syndrome (SDS), (B) low SDS severity, and (C) high SDS severity.

This article was based on:

Kandel, Y. R., Bradley, C. A., Chilvers, M. I. Mathew, F. M., Tenuta, A.U., Smith, D. L., Wise, K. A., Mueller, D. S. 2019. Effect of seed treatment and foliar crop protection products on sudden death syndrome and yield of soybean. Plant Disease. 103: 1712-1720.

Kandel, Y. R., McCarville, M.T., Adee, E. A., Bond, J. P., Chilvers, M. I., Conley, S. P., Giesler, L. J., Kelly, H. M., Malvick, D. K., Mathew, F. M., Rupe, J. C., Sweets, L. E., Tenuta, A. U., Wise, K. A., and Mueller, D. S. 2016. Benefits and profitability of fluopyram-amended seed treatment for suppressing sudden death syndrome and increasing soybean yield: A meta-analysis. Plant Disease. 102:1093-1100.

FIND OUT MORE

Other publications in the *Research Update* series and the *Soybean Disease Management* series are available on the Crop Protection Network website (cropprotectionnetwork.org).

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ACKNOWLEDGMENTS

The authors wish to acknowledge the Soybean Checkoff through the North Central Soybean Research Program, Bayer CropScience, BASF, and The Grain Farmers of Ontario, which obtained funding through the Ontario Farm Innovation Program (OFIP), a component of Growing Forward. Products tested were provided by Heads Up, Syngenta Crop Protection LLC., Cheminova Inc., Greenspire Global Inc. Assistance with field trials came from K. Ames, J. Pike, and J. Weems from Illinois, N. Anderson and J. Ravellette in Indiana, S. Wiggs, C. Hunt and D. Sjarpe in Iowa, A. Byrne and J. Boyse in Michigan, N. Braun and P. Okello in South Dakota, S. Chapman and B. Mueller in Wisconsin, and C. Van Herk, G. Kotulak, and B. Jones in Ontario.

This publication was developed by the Crop Protection Network, a multistate and international collaboration of university/provincial extension specialists and public/private professionals that provides unbiased, research-based information to farmers and agricultural personnel. Design by Iowa State University.

United States Department of Agriculture

National Institute of Food and Agriculture