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Winter rye cover crop effect on corn seedling pathogens

Abstract:

Scientists conducted laboratory and field studies to find out what effects cereal rye cover crops might have on corn yield under different conditions and different management tactics.

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Budget:

\$29,052 for year one
\$29,052 for year two
\$29,052 for year three

Q Cereal rye cover crops occasionally cause yield decreases in a corn crop that follows. Is this corn yield decline caused by corn seedling root pathogens that originate from the roots of dying rye cover crop plants?

A Spraying a rye cover crop with glyphosate 10 to 14 days before corn planting can reduce the risk of root infections in corn seedlings following a rye cover crop.



ECOLOGY

Background

Cover crops are an excellent management tool that can increase soil organic matter, recycle nutrients, reduce erosion, and minimize nitrate losses in tile drainage water and runoff. In Iowa, the predominance of corn-soybean rotations, late harvests, and long, cold winters limit the potential cover crop species that will grow enough to provide any benefits. One cover crop species used successfully in Iowa corn-soybean rotations is winter rye. Unfortunately, a winter rye cover crop occasionally causes a yield decrease of the following corn crop.

One potential cause of the corn yield decrease is that glyphosate-killed rye cover crops may be hosts for corn seedling pathogens and may increase their inoculum levels in the soil. If soil inoculum levels of these pathogens are high enough and environmental conditions (cold and wet) are favorable for them to infect corn plants, then these pathogens can reduce corn plant population, slow and reduce growth, and possibly decrease final yield. However, when conditions are warm and dry, when pathogen inoculum levels are low, or when the more virulent pathogen species are not present, then the pathogens following a rye cover crop may have little or no effect.

Objectives for the project were to:

- Determine whether a winter rye cover crop increases infection of corn seedlings by soil borne pathogens, such as *Pythium* and *Fusarium*.
- Investigate whether the corn yield depression and reduced shoot growth and population sometimes observed following a winter rye cover crop are caused by increased corn seedling infection.
- Investigate strategies such as seed-applied fungicides, corn planting date, or non-grass cover crop species to reduce infection of corn seedlings following winter cover crops.

Approach and methods

The investigators conducted a series of studies that progressed from potted plants in a controlled laboratory environment to field-scale. They began in a controlled environment because by keeping soil temperature cold and the soil wet, they were



Corn seedling root system following winter rye from controlled environment showing diseased primary root.

able to keep conditions favorable for infection of corn plants by these pathogens. They found that corn planted immediately after spraying a rye cover crop with glyphosate does develop more root infections than corn planted without a rye cover crop. Later studies were able to isolate and identify corn fungal pathogens on dying rye roots and showed that these pathogens then could infect corn roots. In some of the field studies, planting corn after winter rye also reduced shoot growth, population, and yield. However, environmental conditions had to be favorable for infection or plant stress for corn growth or yield reductions to occur as evidenced by a yield reduction in only one of two years of the first field study.

Results and discussion

Preliminary results seem to indicate the current commercial corn seed fungicides do not prevent root infection following a rye cover crop. However, winter canola and hairy vetch cover crops preceding corn caused much less root infection than cereal rye. Supplemental studies conducted by the researchers found that increasing the interval between spraying rye with glyphosate and planting corn reduced the risk of seedling root infection.

This study initially found corn seedling pathogens on rye roots after the rye plants were sprayed with herbicides like glyphosate. Second, when corn is planted following a rye cover crop, corn seedling roots can become infected by these pathogens. Third, in field studies corn planted following rye showed more root infection. This sometimes resulted in diminished shoot growth, decreases in plant population, and reduced yield when conditions were conducive for infection. Fourth, other cover crop species such as winter canola or hairy vetch do not cause as much infection of corn seedling roots as rye does. Finally, spraying a rye cover crop with glyphosate 10 to 14 days before corn planting can reduce the risk of corn seedling root infections following a rye cover crop.

Recommendations

Because cereal rye is one of the few cover crop species known to successfully overwinter in Iowa, it can be planted after corn or soybean harvest in many parts of Iowa. Because cereal rye cover crops protect soil from erosion and nutrient loss, and provide many benefits to soil health, the investigators do not recommend that its use be discontinued before corn. Even though this research has identified a potential problem with using a cereal rye cover crop before corn, management practices will be developed to reduce this risk. In fact, on-farm studies of cereal rye cover crop use by experienced farmers do not show a yield reduction following cereal rye, suggesting that farmers either have already adapted their management to account for this, or that continued use of a cereal rye cover crop changes soil conditions and soil microbiology enough to avoid the problem.

Although further research is needed, project researchers offer some preliminary suggestions or ideas from this study.

The common recommendation for a 10- to 14-day interval between rye spraying and corn planting may be effective because it allows for pathogen populations to decrease after rye termination. Further studies could refine the length of this interval in



Farmers and NRCS personnel look at rye cover crop growth during a spring field day at a cover crop experimental site near Ames, Iowa.

relation to soil temperature or how rapidly the rye cover crop dies after application with glyphosate or other herbicides.

Another viable management option for drilled cereal rye cover crops is to precision plant the rye in the inter-rows and not where the corn rows will be placed in the following spring. This approach is much more feasible today with GPS and autosteer common on tractors. The project researchers had used this technique for many years, even before they were aware of the potential for pathogens on dying rye roots. Two other approaches to accomplish this would be to use late fall or early spring strip-till or banded herbicide application to remove rye from the row

where corn will be planted.

Environmental conditions in some years, the resident pathogen population in some fields, or fields that have had rye cover crop use for multiple years do not seem to be conducive to development of corn infections or yield reductions following rye. Further studies could identify conditions or planting dates when the risks of problems following a rye cover crop are higher.

Study results showed that commercial seed fungicide treatments were not effective in preventing or reducing corn radicle infection following a rye cover crop. However, there may be other seed fungicides that would be more effective because they have a more systemic defense against soil pathogens, have a larger zone of influence around the corn seedling, or are specific to the pathogens present following a rye cover. Further studies on different fungicide treatments may be especially important because this study found some pathogens following rye that were not commonly known.

Another option would be to explore other non-grass species that could serve as cover crops before corn in Iowa. At least the two cover crop species tested for this project supported smaller populations of pathogens that target corn. As noted earlier, few cover crop species are as effective or overwinter as well as cereal rye in Iowa's corn-soybean rotations. In the short term, one option would be to over-seed cover crop species like oats, rapeseed, radishes, or mustards into standing soybeans before harvest. Cool-season cover crop species that winterkill in Iowa may produce enough growth to be of some benefit, but would not present a disease risk to corn. Another option would be to find a winter-hardy, non-grass cover crop species that can be planted late in the fall. Finally, it may be possible to select different winter rye cultivars that are poor hosts for corn pathogens.

Impact of results

Strip trials by Iowa Learning Farms and Practical Farmers of Iowa indicate that farmers rarely have yield reductions following a cereal rye cover crop after the first few years. Thus, rather than preventing yield decreases by understanding and managing a rye cover crop to reduce the risk of increased corn pathogens, farmers may be able to expand the potential for corn yield increases due to improved soil conditions over time by reducing this risk.

This work should result in new research into how individual cover crops and cover crop mixtures affect crop pathogens, both positively and negatively, and how cover crops impact the soil microbial community dynamics in general. In the future, Iowa farmers may be able to use cover crops and cover crop species selection to suppress

pathogens and to promote beneficial soil microorganisms. This will allow them to reach the full potential of cover crops to improve yields and sustainability.

Education and outreach

Publications:

Fisher, B., et al. *Midwest Cover Crops Field Guide*. p. 136. 2012 1st edition; 2014 2nd edition (book). Available at: <https://ag.purdue.edu/agry/dtc/pages/ccfg.aspx>

Nair, A., Kaspar, T.C. 2015. "Cover Crops in Vegetable Production Systems." ISU Extension Publications: HORT 3026.

"Did the pathogen host the party or just show up?" *ICM News*. Meaghan Anderson and Alison Robertson. May 2016

"Reducing the Risk of Corn Seedling Disease, Yield Loss After Cereal Rye Cover Crop." *ICM News*. Alison Robertson, Jyotsna Acharya, Tom Kaspar, and Matt Bakker. December 2016

Presentations on cover crops:

2012: Iowa Learning Farms field days.

2013: Practical Farmers of Iowa annual conference, ISU Extension and Outreach Crop Advantage Series meetings (2), PFI field days (3)

2014: ISU Extension Crop Advantage Series meetings (3); ILF/PFI field day, Practical Farmers of Iowa annual conference; Iowa Water Conference, ILF workshops (2); ASA-CSA-SSSA annual meetings; National Conference on Cover Crops and Soil Health Omaha, NE; Minnesota Crop Production Retailers 2014 CPM Short Courses and Trade Show, Minneapolis, MN

2015: Practical Farmers of Iowa annual conference; ISU Extension and Outreach Agriculture and Natural Resources In-Service Training; NRCS Soil Health In-Service Training; Agribusiness Showcase and Conference Summer Workshop, Ames; field tour for 2015 ISU Extension and Outreach Crops Team Fall In-Service Training, Ames.

2016: Practical Farmers of Iowa annual conference; Midwest Cover Crops 2016 annual meeting, Madison, WI; The Celebration Farm, Iowa City; Polk County Extension Office, Altoona; ISU Southwest Iowa Research Farm, Lewis; Iowa Pork Producers Association Nutrient Management Task Force; ISU Northeast Iowa Research Farm, Nashua; Crop Ecology Tour/Agtron 594 ISU Agricultural Engineering and Agronomy Research Farm, Boone

2017: ISU Extension Crop Advantage Series meeting; ISU Southeast Research and Demonstration Farm annual meeting; Iowa State Extension, Iowa City; ISU Extension and Outreach Field Agronomists In-Service Training at Field Extension Education Laboratory (FEEL), Boone

Webinars/Videos:

Cover Crops in Iowa, Natural Resources Conservation Services (Aug. 2012)

The Impact of Winter Rye Cover Crops on Soil and Water Quality in Iowa. <https://sustainablecorn.org/> (February 2014).

Reaching the Full Potential of Cover Crops in Iowa. Iowa Learning Farms (Aug. 2015)

Cover Crops Effect on Soil Health in Corn-Soybean Rotations in Iowa. Iowa Farm Bureau (March 2016)

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Iowa State University Agronomy Department supported one half-time Teaching Assistant Lara Schenck, who worked on this project as part of her requirements for the research component of her MS degree (\$22,000/yr for three years).

“Stimulation or suppression of corn seedling pathogens by winter cover crops.”
T.C. Kaspar. USDA-ARS Postdoctoral Research Associate Program, 2013-2015 (\$150,000).

“Investigating the Causes of Corn Yield Decreases Following Cereal Rye Winter Cover Crop.” Kendall Lamkey, Agronomy; Alison Robertson, Plant Pathology and Microbiology; Andy Lenssen, Agronomy, Iowa State University. Tom Kaspar and Tom Moorman, USDA-ARS, NLAE. Iowa Nutrient Research Center Grant, 2013-2015 (\$60,000).

“Cover Crops Influence Nutrient Cycling, Yield and Diseases of Corn and Soybeans.” Alison Robertson and Leonor Leandro, Plant Pathology and Microbiology; Andy Lenssen, Agronomy; Iowa State University. Tom Kaspar and Tom Moorman, USDA-ARS, NLAE. Iowa Nutrient Research Center Grant, 2015-2017 (\$60,000).

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