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Disease risks associated with cover crops in corn and soybean production

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Introduction

Cover crops have numerous environmental benefits, for example reducing erosion, improving infiltration, mitigating nutrient loading in surface waters, and improving soil health (Kaspar et al 2001, Kaspar and Singer 2011, Schnepf and Cox 2006). Still, some farmers are reluctant to introduce cover crops into their production systems. In a 2016 Cover Crop Survey, approximately 30 percent of the respondents stated that "increased disease potential" was a minor or major challenge to using cover crops on their farm (SARE, 2016). Of the respondents, 20 percent had been growing cover crops for 2-3 years, 30% for 4-5 years, and 19% for more than 10 years.

The goal of our research is to understand how cover crop may affect disease potential in the following cash crop and thereby recommend actions that may be taken to mitigate disease risk.

Effect of cover crops on corn diseases

Seedling diseases

Cover crops, especially grass cover crops, can be hosts of the same pathogens that infect corn seedlings. Cover crops also can serve as a 'green bridge' for pathogens by maintaining pathogen populations over the winter between harvest and planting of cash crops when pathogen numbers normally decline (Smiley et al 1992; Acharya et al 2017). Recently Bakker et al (2016) demonstrated that the dying roots of winter rye cover crops hosted high populations of corn seedling pathogens. Acharya et al (2017) went on to show that corn following a winter rye cover crop that had been terminated with herbicide within 10 days of planting had greater seedling disease than corn following a winter fallow or longer termination intervals (Table 1). In one of the two years of this field study, lower corn yields could be partly explained by reduced stands and poor plant vigor caused by soil-borne pathogens (Acharya et al 2017; Bakker et al 2017). However, because no N fertilizer was applied until 32 days after corn planting in that year for sampling reasons and a cereal rye cover crop takes up a lot of nitrogen, it was assumed that nitrogen availability also affected yield. Acharya et al (2017) also found that Pythium species were more often associated with corn seedling disease and reduced stands after a cover crop of winter rye, than *Fusarium* or *Rhizoctonia*.

Table 1. Effect of rye termination date before planting (DBP) corn on corn seedling root rot, the incidence of *Pythium* and Fusarium species recovered from rotted corn roots, the number of barren corn plants per acre and corn yield in 2015.

	Root rot incidence (%)	*Pythium* incidence (%)	*Fusarium* incidence (%)	Barren plants/A	Yield (bu/A)
No rye, check	8.3 b	2.8 c	61.1	1,170 c	224.5 a
Rye, spray 21 DBP	25.0 b	19.4 b	69.4	1,170 c	209.7 b
Rye, spray 14 DBP	25.0 b	13.9 bc	47.2	2,356 c	208.2 b
Rye, spray 10 DBP	80.6 a	38.9 a	75.0	6,486 b	200.7 bc
Rye, spray 3 DBP	80.6 a	19.4 b	77.8	6,787 b	191.8 cd
Rye, spray 1 DAP	83.3 a	25.0 b	50.0	12,691 a	182.9 d
P-value	<0.01	<0.01	0.25	<0.01	<0.01

Stalk rot

Farmers who are incorporating winter rye cover crops into their production systems have observed that the corn "stands better" in fields that were planted to cover crops and the crops are easier to harvest, suggesting that stalk rots may be less prevalent. There are a couple of reasons why this may occur: (i) cover crop residue conserves soil moisture through the growing season (Clark et al 1997), thus the risk of stalk rot may be lower in fields where cover crops are grown because of reduced plant stress due to limited soil moisture; and (ii) cover crop residue acts as a physical barrier and prevents inoculum of stalk rot pathogens from being dispersed from surface corn residue to young corn seedlings where infection could occur.

However, fields planted to cover crops may be more at risk for stalk rot because nitrogen is often limited due to immobilization as the rye residue decomposes. Even if farmers apply nitrogen at planting, denitrification and leaching may increase the risk of stalk rot. White et al (1979) suggested a steady, balanced supply of nitrogen reduced stalk rot.

In 2017, we evaluated stalk rot in two of our cover crop trials. In one trial, we detected no effect of cover crop on stalk rot. In the other trial, the stalk rot index was lower in plots where a winter rye cover crop had been planted. In addition, plots where a winter rye cover crop had been planted that had received 30 pounds of nitrogen at planting had reduced stalk rot compared to the cover crop plot where no nitrogen was applied at planting.

Effect of cover crops on soybean diseases

White mold of soybean

Cover crops may reduce the incidence of white mold and protect yield of soybean. Maloney and Grau (2001) counted apothecia and assessed white mold incidence in soybean after a cover crop treatment of either winter wheat, spring planted barley, or spring planted oats, and compared this to a check of soybean planted following no cover crop. They reported greater numbers of apothecia in the soybean following cover crops in early spring compared to the check (soybean following no cover crop). Apothecia were observed in the check in mid-summer when the soybean was flowering; no apothecia were observed in

mid-summer in the soybean following the cover crop treatments. Although environmental conditions were not favorable for white mold development, final disease incidence was greatest in the soybean following no cover crop treatment. These data suggest that cover crops may encourage an early "flush" of apothecia before soybean flowering and therefore reduce the risk of infection and white mold development in soybean.

Sudden death syndrome

Field studies conducted in Illinois, showed an inconsistent effect of a winter rye cover crop on SDS over multiple years and locations (Eastburn, 2014). In some years and location, SDS indices were lower in soybean plants grown following the rye cover crop than those following no cover crop.

In Iowa, a corn silage-soybean rotation field trial near Ames, plots with and without a rye cover crop was established in 2002. In 2015 and 2016, soybean plots were inoculated with *F. virguliforme* at planting, and SDS disease parameters were assessed during reproductive growth. No effect of cover crop was detected on foliar disease severity, root rot or yield.

Several cover crop species were evaluated in a greenhouse test for susceptibility to *Fusarium virgiliforme*. Root rot and reduced biomass were detected on alfalfa, crimson clover, pea and hairy vetch, and consequently these hosts were all host of the fungus. False flax, millet, mustard, oat, rye, ryegrass, triticale and wheat were categorized as non-hosts since little to no root rot was observed and low to no DNA of *F. virguliforme* was detected in the roots of these plants. This suggests that the grass cover crops are unlikely to increase inoculum of the SDS pathogen in soil.

Rhizoctonia root rot

In plots inoculated with *Rhizoctonia solani*, stand counts were greater in soybean plots planted following a rye cover crop than in soybean plots planted following no rye cover crop (Eastburn, 2014). Moreover, disease severity was lower on the soybean plants grown following the rye cover crop than those following no cover crop.

Seedling diseases

Several leguminous, grass and brassica cover crops were evaluated in the greenhouse for susceptibility to seedling disease pathogens *Pythium sylvaticum* and *Fusarium graminearum*. All developed root rot, suggesting that soybeans following a cover crop may be more susceptible to seedling diseases caused by *P. sylvaticum* or *F. graminearum* when conditions allow the cover crop roots to significantly increase inoculum to the soil. However, in cover crop field trials in 2016 and 2017, we did not detect an increase root rot or reduced stands on soybean following a winter rye, camelina or hairy vetch cover crop.

Summary

There are many benefits to planting cover crops, and risks associated with disease that could affect yield are few. Based on our research, we recommend terminating a cover crop at least 10 days before planting corn. In very cool, wet springs and/or if considerable cover crop biomass is present, planting corn 14 or more days after cover crop termination may be more prudent. Timing of termination of a cover crop may be less critical prior to planting soybean.

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