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# Controlling Soil-Borne Disease in Soybean With a Mustard Cover Crop

## Cover Page Footnote

This research is supported by funding from the Kansas Soybean Commission and the U.S. Department of Agriculture National Institute of Food and Agriculture, Hatch project 1003478.

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# Controlling Soil-Borne Disease in Soybean With a Mustard Cover Crop

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## Summary

Charcoal rot is a soil-borne disease that is prevalent in southeast Kansas. The disease infects multiple crops, including soybean, and causes yield reductions. A high-glucosinolate mustard with biofumigant properties reduced the population levels in soil and in soybean plants of the fungus (*Macrophomina phaseolina*) that causes charcoal rot. In this study, management practices that incorporate use of mustard as a cover crop in soybean production systems were tested. Results indicate that tillage increases the charcoal rot fungus. The mustard cover crop was tested in field studies for its impact on soil health, fungal disease and propagules, and soybean growth and yield.

## Introduction

Charcoal rot is a plant disease caused by the fungus *Macrophomina phaseolina* (Tassi) Goid. It infects many plants, including soybeans. The disease limits yield and performance of soybean and reduces yield an average of more than 5% per year. The fungus is present in crop fields in southeast Kansas, and is particularly prevalent in hot, dry weather. The fungus infects plant stems, reducing the flow of water and nutrients through the root and stem, creating a charcoal-grey growth that gives the disease its name (Figure 1). As the disease progresses, the plant roots atrophy and die, and yield is lost because of the lack of nutrients and water transferred to the developing seeds.

Certain plants produce chemicals that act as biofumigants that control or reduce harmful soil pathogens including the charcoal rot fungus. These natural chemical agents have been shown to control bacterial diseases in potato production (Larkin et al., 2011) and cacao (Melnick et al., 2008). Mengistu et al. (2009) showed some suppression of charcoal rot infestation with altered tillage and use of cereal rye as a cover crop. Mustard, *Brassica juncea*, produces chemical compounds called glucosinolates. This mustard is used to make the brown mustard condiment; it is not the weedy mustard common to Kansas (Peterson, 2017). While mustard is related to canola, canola has been bred to reduce the amount of glucosinolates to improve its palatability. The high glucosinolate content in *B. juncea* can control soil-borne pathogens such as nematodes and the charcoal rot fungus, *M. phaseolina*.

The research outlined here tested the ability of the mustard plant to control charcoal rot in soybean production under different management systems. Incorporating a cover

crop into the crop rotation may be a simple method of controlling soil-borne diseases, reducing the use of fungicides that may contaminate the environment.

## Experimental Procedures

Mustard seed, cv. Mighty Mustard Pacific Gold (Johnny's Select Seed, Winslow, ME), was planted in early spring after the soil temperature was consistently above 55°F in replicated field plots at the Southeast Research and Extension Center research field near Columbus, KS, and at the Kansas State University farm plots in Ashland Bottoms, near Manhattan, KS. The plants were allowed to grow until flowering (Figure 2). Alternative methods of managing the mustard residue were tested to determine the best production method for controlling the soil-borne fungal pathogen. Prior to planting soybeans, the field received a herbicide burndown to terminate the mustard cover crop. Four different cover crop treatments and one control with no cover crop were used to determine how to manage the mustard residue for optimal pathogen control, including:

- *control:* no mustard cover crop
- *no incorporation*: plant into standing mustard
- *no incorporation*: cover crop rolled
- *no incorporation*: cover crop mowed
- *incorporation*: cover crop disked (tillage)

Soil samples were collected prior to soybean planting and after cover crop termination for determination of the pathogen as measured by the number of colony forming units (CFUs). Soybeans (MG 4.1) were planted and grown to maturity. Soil and soybean plant samples were collected at the R7-R8 growth stage and measured for the amount of fungal infection. The numbers of CFUs from the fungi in the plant and soil samples were measured at the Department of Plant Pathology at K-State. Final yield was measured at harvest.

## Results and Discussion

Previous research demonstrated that the mustard plant reduces charcoal rot pressure. The number of CFUs were reduced in soil by 8%, and in plants by 50% in plots treated with mustard seed cover crop compared to the untreated control (Sassenrath et al., 2017). In this study, results from Ashland Bottoms and Columbus, KS, indicate that the method of managing the cover crop also impacted the number of CFUs in the soil (Figure 3). Changes in CFUs were similar for both locations, though Columbus had a greater disease pressure and a greater reduction in disease with the mustard cover crop. Tillage (disking) increased the CFUs of the charcoal rot fungi, while planting directly into standing mustard cover crop or mowing the cover crop reduced the CFUs. The greatest reduction in CFUs was observed when soybeans were planted in rolled mustard cover crop. For both locations, the more intact the mustard cover crop plants remained, the greater the control of the charcoal rot fungus.

Treatments impacted soybean yields (Figure 4), but in very different ways for the two locations. Soybean yield was reduced at Ashland Bottoms for all cover crop treatments, most likely because of limited rainfall in 2018. Soybean yield showed the greatest reduction at Ashland Bottoms in the tilled plots, indicating insufficient soil moisture was most likely responsible for the reduced yields. Conversely, tillage increased yield at

Columbus by slightly more than 6 bu/a over the other treatments. No differences in yield were observed for the other treatments at Columbus. The mustard cover crop did not reduce yield in any of the plots at Columbus.

This research indicates the potential for use of the mustard as a cover crop to control soil-borne disease in soybean. The mustard cover crop can significantly reduce the disease pressure. Greater improvements in disease pressure are observed for management practices that maintain the cover crop residue. More research is needed to further delineate changes in soil health parameters with mustard cover crops and management practices.

## Acknowledgment

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**Figure 1. Charcoal rot, caused by the fungus *Macrophomina phaseolina* causes a grey, charcoal-colored growth in infected soybean roots. The plant on the left is highly infected. The plant on the right has minor infection. As the disease progresses, the roots atrophy and die, limiting seed development and reducing yield.**

**Figure 2. Might Mustard (*Brassica juncea*) planted as a cover crop prior to soybean planting.**

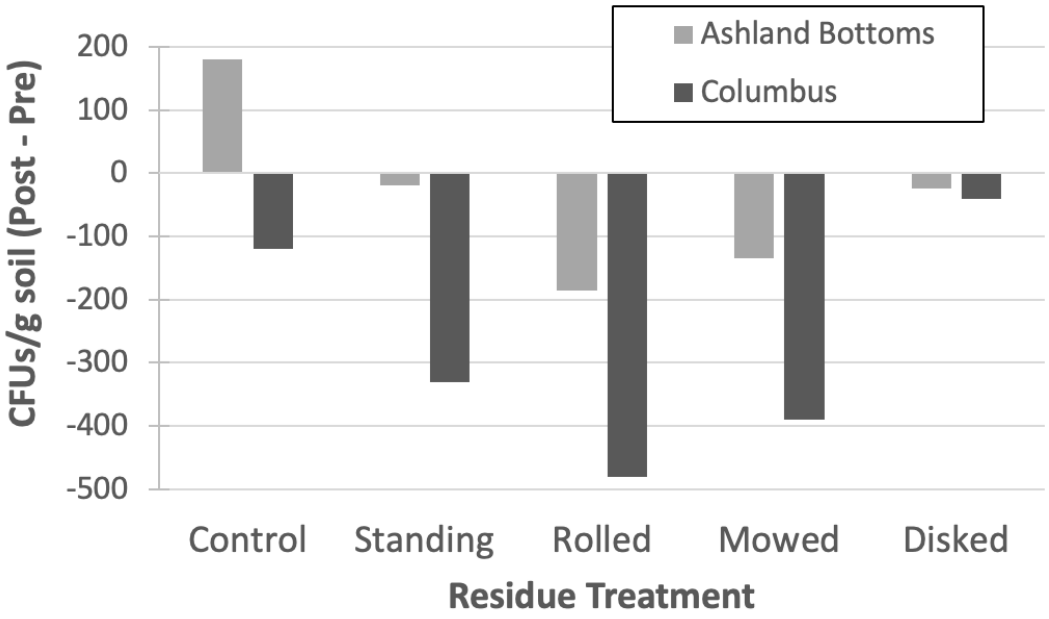


**Figure 3. Difference between number of colony forming units (CFUs) of charcoal rot fungus before and after soybean growth.**

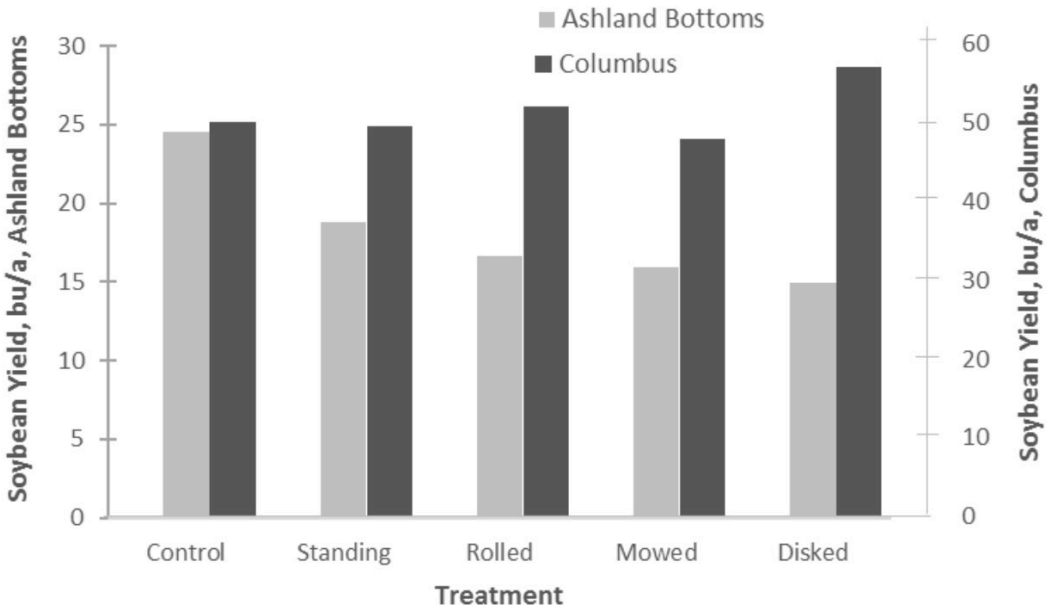


**Figure 4. Impact of cover crop residue management method on soybean yield at Ashland Bottoms, KS (left axis), and Columbus, KS (right axis). Note difference in scale between reported yields at Ashland Bottoms and Columbus.**