North Central Soybean Research Program

Exploiting potential bio-control agents to manage seedling diseases of soybean

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The long-term objective of the proposed research was to characterize the bio-control activity of a collection of fungal species isolated from soybean production fields and study the potential of the bio-control agents to improve management of soybean diseases caused by *Fusarium* spp., *Phytophthora sojae*, and *Pythium* spp. This could be achieved either by introducing these bio-control agents to soybean production fields, and/or by fine-tuning existing management practices so that the prevalence and activity of bio-control agents native to production fields are enhanced.

Project objectives

- Test the effects of recently identified potential bio-control agents on soil-inhabiting fungal, oomycete, and nematode pathogens of soybean;
- Assess potential roles of these agents in eliciting defense mechanisms in soybean plants;
- Test the effect of fungicidal seed treatments on these organisms; and
- Follow the effect of commonly used management practices on the distribution and activity of these organisms in the soil.

Final research report

Previously, a multi-state survey that was funded by USB was done to collect and identify soil-inhabiting organisms associated with seedling diseases of soybean. In that survey, we detected the presence of several fungal species that could potentially affect the ability of soybean pathogens to cause disease.

In this current project, we investigated the direct effect of these species on the growth of a select number of soybean pathogens. We have also developed protocols to apply these bio-control agents to soybean seeds and we have conducted greenhouse and field assays conducted lab assays to determine the effect of these organisms (9 isolates) on the growth of several fungal, oomycete, and nematode pathogens of soybean.

The in-vitro screening of the activity of fifty-eight potential bio-control agents (BCA) against several soybean pathogens is complete. In many instances, several isolates of the BCA species were tested against several isolates of the pathogen. BCAs with consistent high activity against the tested pathogens have been identified.

Greenhouse experiments have been conducted to test the effectiveness of the BCAs against the pathogens and the best performing BCAs were used in field experiments. Field experiments were conducted in Iowa, Michigan and Illinois during the 2016 growing season. The experiments included five separate treatments of BCAs (individually or in mixture) that were selected based on the performance of the corresponding BCAs in lab, greenhouse or growth chamber assays. Data from 2016 included yield, stand count, and quantification of pathogens and BCAs in treated soybean plants. The experiments were repeated in 2017.

Another objective of our proposed research was to follow the effect of commonly used management practices on the distribution and activity of BCAs in the soil. Soil samples were collected from several soybean production fields in Illinois, Kentucky and Indiana with different histories of management practices such as crop rotation and tillage. We have developed molecular assays to detect and quantify the BCAs in soils, and are using the assays to assess the effect of different management practices on the presence of the BCAs in the collected soils. The objective is to be able to recommend management practices to soybean producers that would enhance the presence and activity in their soil improving thus the "health" of these soils in terms of their ability to limit the activity of soybean pathogens.

Finally, we proposed to investigate the ability of the BCAs to induce resistance in treated soybean plants. We ran several experiments to monitor whether treatment with BCAs affects the expression of soybean genes previously reported to be associated with resistance to disease. In other words, when these genes are turned on, defense mechanism are activated in soybean and the plants become more tolerant to pathogens. Our data shows that several of the soybean "resistance genes" were activated when soybean seeds were treated with BCAs. This indicates that the BCAs may have a dual mode of action in affecting disease; they directly inhibit the growth of potential pathogens, and they indirectly affect the ability of the pathogens to infect soybean plants by inducing resistance in those plants.

Summary of research progress:
(1) The activity of at least 13 potential bio-control agents was evaluated against several fungal and oomycete species as well as against nematodes.
(2) The activity of the bio-control agents to confer resistance against select fungal, oomycete, and nematode species continues to be assessed under controlled conditions.
(3) PCR probes specific to the most efficient bio-control species were developed.
(4) PCR probes continue to be used to assess the effect of commonly used management practices on the distribution and activity of these bio-control species in the soil.
(5) Sensitivity of the bio-control agents to commonly used seed treatments continue to be assessed to identify seed treatments that could be used effectively in conjunction with the bio-control agents.

Benefit to Soybean Farmers

The proposed research will result in the identification of bio-control agents that could effectively control major soybean pathogens. The generated data will also provide information regarding

the mechanisms these agents use to affect soybean pathogens. This information is crucial to exploit the activity of these bio-control agents against plant pathogens by using them as soil or seed amendments or by identifying management practices that enhance the activity of bio-control agents already present in soybean production fields. The ultimate goal is to provide soybean growers with cost-effective tools to increase and sustain profitability by managing diseases.