

# DATCP Agricultural Development & Diversification (ADD) Grant Final Report

**Grant # 19039**

November 30, 2004

**Project Title:** Field Trials of Streptomyces Biocontrols to Prevent Common Scab of Potato

**Amount of Funding:** \$20,000

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## Description of Project Aim and Anticipated Benefits

Common scab of potato is causes significant economic losses and production limitations in the state of Wisconsin. For example, Heartland Farms in Waushara and Adams counties estimates that more than 20% of their potato production is adversely affected by a high level of potato scab, resulting in more than 50% of the tubers showing scab symptoms ranging from superficial blemishes to deep-pitted scab. Processors such as Frito-Lay, Inc. have systems in place to monitor the quality of delivered potatoes at manufacturing plants. If defects exceed 6%, deductions are made to grower revenues.

An objective of TFX Bioscience through the DATCP grant was to identify a grower cooperator and to test patented (#6,074,638) Streptomyces biocontrol strains in current season fields known to have high scab pressure. Heartland Farms was selected because of their history of significant losses due to defects caused by scab. Through a randomized complete block design to test five treatments (four single biocontrol strains and a mixture of the same four biocontrol strains), we anticipated efficacy data to be used in selection of a strain or strains for scale up and commercial application.

## Changes to Work Plan

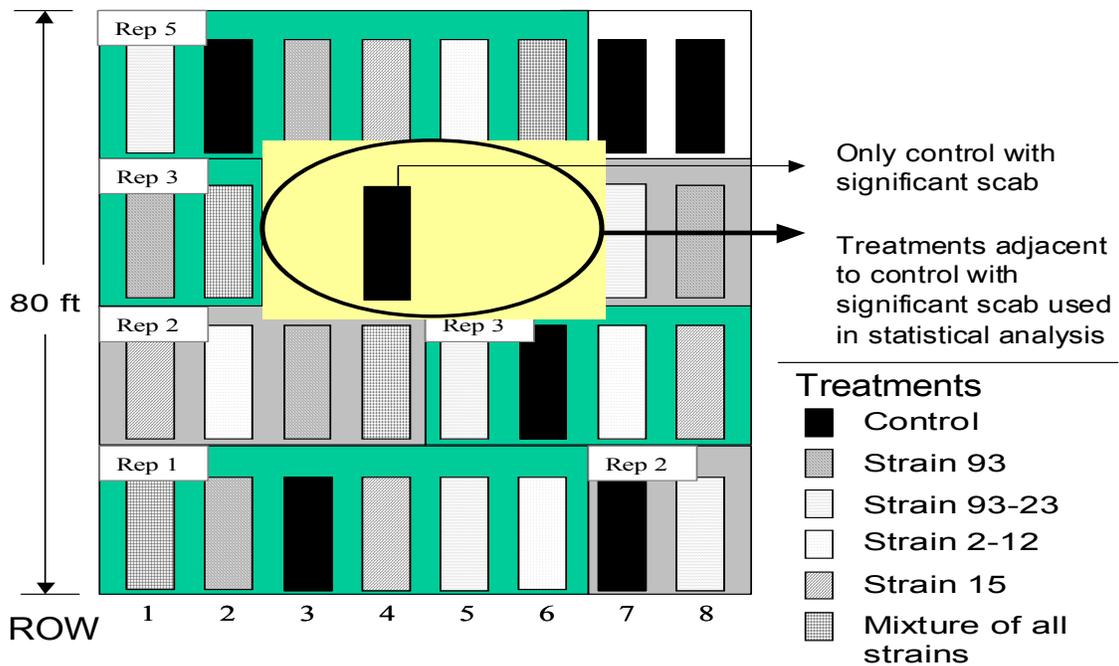
Three changes were made to the work plan after submission of the proposal:

1. *Biocontrol treatments were defined and increased from three to five.* Our proposal described testing three biocontrol treatments. This plan was slightly revised upon consultation with Dr. Linda Kinkel at the University of Minnesota. The five treatments developed for testing at Heartland Farms were: Strain 15, Strain 93, Strain 93-23, Strain 2-12, and a mixture of all strains.
2. Number of replications in randomized complete block design was increased from four to five.
3. *The number of fields to select sites for the randomized complete block design was decreased from three to one.* Because the proposal timeline extended to late spring, commercial fields were planted and not amenable to further tillage and planting research trials. Through consultation with the grower, a field was selected that was one of the last planted where we could integrate the planting of our research trial in synchrony with the agricultural practices for that commercial field.

## Summary of Tangible Accomplishments

It is known that the scab organism, *Streptomyces scabies*, is non-uniform in its distribution in soils within a field. Our strategy was to harvest all of the control replications first to assess whether there was significant scab incidence in controls. Only when scab incidence in controls is high can meaningful statistics be used to show biocontrol treatments reduced scab. Upon harvesting all control plots in the replicated trial, we found only one control with significant scab (Figure 1). The presence of scab in this plot was evidence that scab was spacially distributed to this part of the field and that adjacent rows planted with the biocontrol treatments (strain 15, 2-12, and a mixture of all strains) could be analyzed.

Figure 1. Experimental design for biocontrol strain efficacy against common scab of potato, resultant infection of one replication of controls and strategy for statistical analysis.



A good working relationship with Heartland Farms was established. Excellent cooperation was provided to TFX in planting the trial and in its harvest. Heartland Farms wishes to continue testing TFX's technology in 2005 and through its seed-supplier network, has also offered to coordinate trials with seed growers near Antigo, WI.

## Data Analysis

The control illustrated in Figure 1 had 26.6% scabby tubers (> 5% scab per each tuber harvested) while the treatments in the adjacent flanking rows ranged from zero to 4.06% scab (Table 1).

Table 1. Percent scab in three biocontrol treatments and in control in localized portion of field where scab was severe.

Strain	Weight (lbs) of Tubers with Scab			Total Weight	Weight of tubers > 5% scab	Pct Scabby Tubers
	0 - < 5%	5-15 %	15-50%			
2-12	42.5	0	0	42.5	0	0
mixture	47.75	0	0	47.75	0	0
Control	36.5	8.5	4.75	49.75	13.25	26.6
15	47.2	2	0	49.2	2	4.06

Not all treatments could be compared to this control. Due to the randomized nature of the trial, some treatments were too far away for meaningful comparison.

A robust statistical analysis to show which strain is most effective at reducing scab cannot be performed due to the low scab level in controls. We are confident, that the localized severe scab in one control described above taken with the absence of scab in all harvested treatments, that we can make the following conclusions:

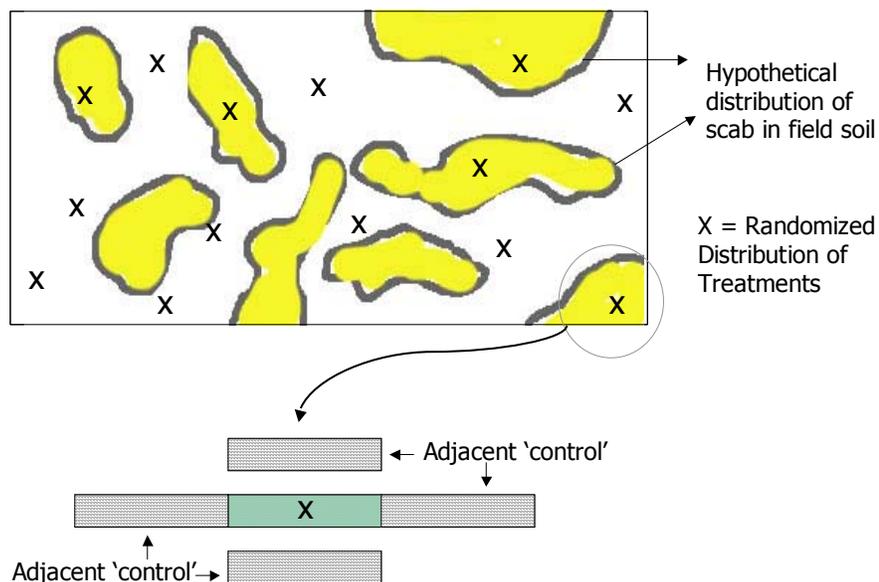
1. Biocontrol strains 2-12, 15, and a mixture of strains protected potatoes from scab in a small section of the field where scab pressure was high.
2. Biocontrol strains throughout the trial did not have scab and yielded the same as controls (data not shown).

## Description of Information or Educational Materials

The finding that scab is non uniform in its distribution in a field that was thought to be an optimal testing ground due to its history of high scab incidence has driven the need to develop new and novel test designs. Figure 2 illustrates a design that features randomly assigned treatments throughout a field with known scab history. At time of harvest, all treatments would be hand harvested and scored for scab incidence and severity. If adjacent, non-treated rows do not develop scab, that particular treatment would not be further evaluated. Only where high scab pressure and significant scab is present in adjacent rows would the biocontrol treatment be scored and used in a statistical analysis to confirm efficacy.

From an experimental design perspective, it is extremely difficult to predict where scab pressure is high. It is, of course, desirable for testing of biocontrol strain efficacy to place test plots in sites within the field with high scab pressure. The design shown in Figure 2 does not provide a predictive aspect as to where the high scab pressure areas are, however, due to the randomization of treatments throughout the field, it does increase the likelihood that some treatments will be in high scab pressure locations. It is then possible to obtain latitude and longitude coordinates with GPS to accomplish two longer objectives of TFX Bioscience: 1) Return to known high scab sites across multiple years to determine whether biocontrol strains provide reliable control, and, 2) Establish whether biocontrol strain populations are sustained through the winter and are present in subsequent years at a sufficient population level to provide protection against common scab.

Figure 2. Proposed improved field design to increase likelihood of finding sites with high scab pressure to facilitate biocontrol strain efficacy testing.



## **Future Research and Product Development**

Future research will focus on the demonstration of a biocontrol strain or strains across multiple grower locations. In conjunction with these efficacy trials, TFX Bioscience will pursue the development of a viable carrier for application of biocontrol strains to potato seed. A readily adaptable method of applying effective biocontrol inoculants to seed is key to our product's success.

The use of vermiculite and oatmeal broth (VOB) as a carrier for biocontrol strains is limited to greenhouse and small research plot trials. Efficacy trials using VOB have been done at the University of Minnesota. Because VOB is a moist product, potato growers have said that the equipment and handling of a VOB carrier would make logistics complicated and difficult for application to potato seed or to soil. Our contacts in the potato industry suggest that a dry powder formulation for use as a seed piece treatment would be acceptable and fit into current seed handling practices and systems. Once a viable dry powder carrier can be identified, larger and more meaningful field trials can be accomplished. TFX Bioscience has had preliminary discussions with growers about its plan to develop a dry powder carrier and to do large scale testing. Heartland Farms has expressed a desire to cooperate with TFX Bioscience in 2005; we plan on finalizing an experimental plan and site selection with Heartland Farms before February 2005.

## **Recommendations to Enhancing Benefits of the Project**

Benefits of potato scab biocontrol and this project will be shared with Wisconsin potato growers and industry experts at state meetings and grower groups such as the Wisconsin Vegetable and Potato Growers Association (WVPGA). We hope these meetings will germinate field testing partnerships with other Wisconsin growers.

In addition to advancing TFX's research mission, leading to large-scale field trials next year, this project has yielded several key contacts that have impacted the commercial viability of the *Streptomyces* biocontrol product. Through work on this project, we learned that the *Streptomyces* biocontrol might be eligible for assistance through EPA's IR-4 program, which would significantly reduce required capital. Overall, TFX Bioscience's incipient product is much more viable as a result of activities associated with the DATCP project.