Optimizing Sugar Beet Production Through Soil Quality Management

Project GREEEN No.: GR02-043

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Statement of Challenge

Producing high yielding sugar beets of superb quality is the goal of all sugar beet growers. Many problems in beet production, which hinder growers from obtaining their goals, are reflected in the multifaceted nature of soil quality. The proposed research seeks to find answers to several beet production problems that ultimately impact soil quality.

Objectives

1. Develop Nitrogen management recommendations that maximize early season vigor, yield, and quality by accounting for site-specific conditions; specifically by focusing on soil testing methods. (*Laboski*)
2. Evaluate the effect of sugar beet cyst nematode (SBCN) trap crops on SBCN population dynamics, soil quality, and sugar beet yield. (*Bird*)
3. Determine the most effective fungicide application timing and rate for control of *Rhizoctonia* crown and root rot using an empirical model based on the accumulation of soil disease severity values. (*Kirk*)
4. Determine how *Rhizoctonia* infection progresses at the cellular level and how this relates to future opportunities for genetic intervention in limiting pathogen infection. (*McGrath*)
5. Demonstrate that timing herbicide application by growing degree days will reduce crop injury, control weeds, and reduce costs; continue research with Amistar + herbicide applications. (*Sprague*)
6. Extend the knowledge gained during the course of this research to sugar beet growers and those that advise the growers such that beet production practices can be changed to improve farm profitability. (*Poindexter*)

Results and Objectives

1. Various nitrogen (N) rates were applied to sugar beet at ten locations over three years. At 30% of the locations, increased N-fertilization decreased sucrose content but did not change yield. Response to N-fertilizer was moderately correlated to the Illinois Nitrogen Soil Test (INST), and was well correlated to soil organic matter (OM). Optimal N-fertilizer rates were determined to be 100 – 120 pounds of nitrogen per acre, including N present in OM. Growers often apply more N than needed for optimal harvested sucrose per acre.

The **impact** of this result is to reduce N fertilizer by at least 25%, resulting in savings to growers for fertilizer and increased sucrose yield and recovery at the sugar factory of up to 5%.

2. The sugar beet cyst nematode (SBCN) research focused on the use of oilseed radish cv. Adagio and comparing six different cover crop systems with and without oilseed radish for their impacts on this nematode. The best cover crop system with cv. Adagio had a positive impact on beet yield, stand and beet size. Yield was significantly increased from 6.7 to 18.1 tons per acre.

   The **impact** is to gain $400 per acre of increased revenue on the estimated 40,000 acres that have SBCN problems.

3. The timing of effective fungicides for optimal control of Rhizoctonia crown rot was clarified. Fungicides applied at emergence had outstanding control of stand persistence and crown and root rot, and in-furrow fungicides applications did not negatively affect emergence. Risk assessment for damping-off by location would benefit growers.

   The **impact** of preserving emerged seedlings and preventing crown and root rot through chemical control of Rhizoctonia infections has resulted in gains of at least $200 per acre on the 20,000 acres affected by Rhizoctonia problems.

4. Three distinct phases of root infection by Rhizoctonia were observed during seedling emergence, whether the disease developed or not, indicating all seedlings are at risk. Six genes related to disease progression were isolated and their expression during disease development were followed, and most showed decreased expression relative to healthy plants. Genetic resistance to seedling Rhizoctonia was found for the first time in the germplasm release EL51.

   The **impact** of this basic research has been to develop methods, identify specific genetic targets, and discover a source of genetic resistance Rhizoctonia seedling disease, which for the first time allows breeding to prevent loses to Rhizoctonia seedling disease worldwide.

5. Micro-rates herbicides applied at 225 growing degree days (GDD) provided good to excellent control of several weed species. Sugar beet response from the micro-rate applications was similar to standard split applications, and is a viable option for good weed control and less crop response than frequently applying micro-rates. Timing of fungicide applications for Rhizoctonia management in relation to micro-rate herbicide applications can cause significant sugar beet response. There needs to be a minimum of 3 days between applications of these two pest management strategies to reduce the negative impact that the combination of these two strategies have on sugar beets.

   The **impact** of this research is that growers can apply weed control in a biologically relevant manner, resulting in fewer applications while achieving excellent weed control.

On average grower's who have used GDD to time their micro-rate herbicide applications have reduced the number of applications needed for optimum weed control by three resulting in a savings of $78 per acre over 150,000 acres in weed control costs.

6. Two sugar beet short courses were held with a total of 147 participants. GREEEN research was emphasized at the sessions. Formal evaluation of the courses indicated a high satisfaction with course content. 77% of the surveys indicated most skills/concepts taught would be useful to them. Tour was held at the Bean and Beet Farm for 150 growers and emphasized GREEEN projects. Additional tour was held for agriculturist on farm locations with current GREEEN research on weed control and Rhizoctonia Crown Rot research. Over 350 farmers and agricultural professionals attended Extension-sponsored educational activities related to sugar beet production.

   The **impact** for future grower cost savings and increased revenue based on this research is approximately $3 million.

Impacts

The impact of the research covered under this specific proposal is conservatively estimated at $5 million net farm profit per year, stemming from improved pest control practices, better attention to beet quality as the economic generator of profit to growers, and increased stand establishment and persistence. Additionally, the sugar processing co-operative benefits from processing more beets with higher sugar content and beet quality. Environmental benefits are obtained by reduced fertilizer and pest-control applications. Each of these activities benefit improved soil quality as evidenced by the increased awareness on the importance of soil organic matter in promoting reduced nematode populations, as in the case radish as a green manure trap crop, or providing nitrogen to a balanced soil biological community, including the sugar beet crop. Agricultural research by nature is a multiyear endeavor, and funding by Project GREEEN and others has resulted in generation and dissemination of knowledge that has coincided with yields of less than 15 ton of beets per acre in the mid-1990's to over 20 tons per acre in 2004, among the best in Michigan's long history of sugar beet cultivation. Clearly a great deal of the credit goes to growers, who have listened and acted upon insights provided by application of sound agricultural principles supported by solid research results.

Summary Statement

Optimizing sugar beet production requires a systematic approach to the management of fertility, weed control, disease and pest control, and variety choice that will each impact the yield of sucrose. Research conducted here using diverse areas of scientific expertise each uncovered aspects to improving the sugar beet agricultural system, and ultimately the sustainability of the industry and the soil on which it is based.

Funding Partnerships

Christy Sprague, PI; "Furthering the Adoption and Development of Postemergence Herbicide Applications Based on Growing Degree Days (GDD) in Sugar Beet"; Submitted to Sugarbeet Advancement; $4,000

J. Mitchell McGrath, PI; “Genetics and Breeding for Sugarbeet Seedling Disease Resistance”; Beet Sugar Development Foundation; $7,500

George W. Bird, PI: “Sugar Beet Cyst Nematode Research”; Specific Cooperative Agreement USDA-ARS; $7,500

“Genetics and Genomics of Sugar Beet Seedling Vigor Related to Temperature,” MAES Multi-State Project W-1168, $30,000

USDA Special Grant, Bean and Beet, “Safeguarding the Supply of Specialty Crops,” $18,000

“Genetics and Genomics of Sugar Beet Seedling Vigor Related to Utilization of Storage Reserves and Central Metabolism,” Sugarbeet Advancement (Michigan Sugar), $12,500

“Physical Framework of Sugar Beet Genes,” Sugarbeet Advancement (Michigan Sugar), $2,500

“Genetic Analysis of Sugar Beet to Study Genes Responsible for Sucrose Accumulation,” Beet Sugar Development Foundation, $5,700