Investigating alternative fertilizers for herbaceous biomass crops grown in southern Ontario to improve yields and soil health

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Introduction

Biomass Crops are perennial crops grown to harvest their aboveground biomass for use in various value-added industries, including bio-products, bio-energy (combined heat and power), animal bedding, soil mulch, and more. Switchgrass ( Panicum virgatum) and miscanthus (Miscanthus x giganteus) are two herbaceous biomass crops commonly grown in Ontario

Benefits and Services

• Sustainable products
• Successful on marginal land
• Environmental benefits (soil, water, and climate change)

Challenge: To Improve Yields

• Inorganic nitrogen (N) fertilizer has increased yields in both species, but are associated with negative environmental impacts
• Further yield increases are required to achieve competitive pricing for biomass products

Alternative Fertilizer Options

1. Biosolids: treated municipal sewage
2. Biofertilizers: inoculants of beneficial microbes

Goals

Study Goal: Compare the effects of five different fertilizer treatments, including one biosolids-based organic fertilizer and two biofertilizers, on (1) plant growth and yield and (2) soil health under field conditions for switchgrass and miscanthus in southern Ontario.


Experimental Design

Design: All treatments were applied in a completely randomized block design at 3 field sites (one research site and two farmer’s properties) with 3 or 4 replicates per site.

Treatments: (1) control — no inputs, (2) chemical fertilizer — crop-specific rates of chemical N (60 kg N/ha), (3) LysteGro — biosolids applied according to recommended N rates, (4) JumpStart® — biofertilizer for P-solubilizing fungus, Penicillium biliaire, with a ½ rate of N, and (5) MYP® — biofertilizer for arbuscular mycorrhizal fungus Glomus intraradices, with a ½ rate of N.

Plant Growth and Yield

Components

1. Plant Growth Curves were created to assess effects on individual plant growth
2. Final Yield and Tiller Counts were quantified assess effects on yields which affect profits

Methods: Plant Growth Curves

• Biweekly plant sampling of 5 randomly selected plants per plot (treatment day to late October, 2019)
• Measurement of plant height, leaf number, leaf area, and dry weight of stems, leaves, and full plant
• Model comparisons to check for significant effects of each fertilizer on individual plant growth

Soil Health

Components

1. Soil Fertility: assessed treatment effects on nutrient availability for plant uptake
2. Soil Microbial Communities: assessed treatment effects on bacterial and fungal abundance
3. ViTells Soil Health Score: a comprehensive soil health score as determined

Methods: Fertility

• Two random 30 cm-deep soil samples were taken from each plot to assess macronutrient levels
• Plant tissue samples were taken at peak season (early August, 2019) to quantify plant uptake of nutrients

Methods: Microbial Communities

• Composite of eight 10 cm-deep soil samples in an x fame across each plot
• Extract DNA and use qPCR to quantify the bacterial and fungal communities

Methods: ViTells Soil Health Score

• 30 cm-deep soil sample at a random location in each plot
• Sent to A&L Canada Laboratories for analysis and calculation of ViTells soil health score

Results and Current Progress

Yield

• No significant differences among treatments at the Guelph Switchgrass and Milton Miscanthus sites (p = 0.846 and p = 0.341, respectively)
• Average yields (with standard deviation bars) at the Guelph Switchgrass and Milton Miscanthus sites in 2019.

• No significant relationship between tiller density and yield at the Guelph Switchgrass site (p = 0.2181)
• Significant positive relationship between tiller density and yield at the Milton Miscanthus site (p = 0.0056)

Tiller-Yield Relationship

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Significance

Scientific: Improve understanding of different types of fertilizers’ responses on soil health and biomass yields

Environmental: Recommend the best fertilizer types for Ontario-grown biomass crops in order to enhance soil health and reduce negative environmental impacts

Policy: Inform best management recommendations and policies

Economic: Promote a thriving and sustainable biomass economy in Ontario

Note: final conclusions regarding scientific, environmental, policy, and economic significance of this study will be made at the end of the second field season (2020).

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