Progress Report (September 30, 2016 to Feb 15, 2017)

Project Title: Management of bentgrass cultivars for improved resistance to Fusarium patch under climate change

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Summary of Proposal: Atmospheric CO_2 concentrations are expected to reach between 500 to1000 ppm by the end of the century and, as a consequence, Canada and other northern countries may experience a seasonal temperature increase between 1.5 and 4°C. These changes will affect the survival of turfgrasses and fungi as well as affecting their interactions, with a potential for greater disease severity. From among widely used bentgrass cultivars worldwide, or those with particular potential for cold environments, we plan to screen for ones which show the greatest resistance to Microdochium patch. We will study the turfgrass and fungal interactions under current and predicted future climatic conditions (CO_2 and temperature increases). In addition, we will test the efficacy of resistance activators such as Civitas/Harmonizer which are sustainable alternatives to chemical fungicides, under altered climatic conditions in atmosphere-control growth chambers and in the field. The grass cultivars will first be tested in the lab, and a select few will be tested in the field in both Canada and Scandinavia. Cultivars that perform well in one or both locations will be further analyzed for their pathogen-associated and activator-induced molecular responses under current climatic and some predicted future climatic conditions, to shed light on the genes and pathways that may be involved. The project will provide recommendations for turfgrass managers on the choice of cultivars and on improved management practices to face the challenges and opportunities of climate change. This research will also generate new scientific information of great interest for stakeholders represented by the Turf Research Association partner, CTRF, which includes turgrass seed companies and turfgrass managers, and of benefit to the other industry partner, PetroCanada, for commercial and R&D purposes.

Funding Sources: (REVENUE) for three year study starting Jan 1 2015 - Dec 31 2017:
CTRF: $40k/yr cash to Univ. Guelph [TF52198] plus $10k/yr from CTRF directly to AAFC-Quebec
PetroCan: $20k/yr cash + $20k/yr in-kind for provision of services [TF52143]
NSERC: $78k/yr cash [TF400986]

Expenditures from CTRF portion

Item	Jan 2015 - Mar 2016	April 2016 - Sept 2016	Oct 2016 - Jan 2017	TOTAL
Personnel	21, 175	888	1317	22,064
Travel & Field Work	3,586	883	0	4,470
Supplies + Lab Work	2,097	7,732	0	9,830
GTI space charges	1,040	0 (so far)	0	1,040
TOTAL	27,899	9,504	0	37,403

Total Revenue from CTRF: $60,000 [can you confirm that this is the total sent to UoG since start?]
NOTE: The check for $20,000 came in from CTRF in January 2017, so we did not make expenses on this account in fall 2016.

Objectives

1) Assess the resistance of turfgrass cultivars to Microdochium nivale at 10C and 20C
2) Assess the efficacy of Civitas/Harmonizer™ as a control agent of M. nivale at 10C and 20C
3) Conduct trials to assess the ability of different cultivars to initiate disease resistance through hardening
4) Conduct field trials using Civitas/Harmonizer™ to control M. nivale
5) Assess the resistance of turfgrass cultivars to M.nivale under scenarios of increased CO2 concentrations (400 ppm vs. 800 ppm)
6) Assess the efficacy of Civitas/Harmonizer™ as a control agent of M. nivale using a variety of turfgrass cultivars at two CO2 levels (400 ppm vs. 800 ppm)
7) Extract RNA for RNA sequence analysis under scenarios of increased CO2 concentrations with and without Civitas/Harmonizer™

Methods and Materials

- Turfgrass grown in Vials (15ml), Pots (370ml) or Conetainers (160ml)
- Fungi grown on artifical media in tubes (15cm long)
- Field trials (Fall 2015 & 2016) at GTI
- Growth chambers at 10C and 20C in Quebec and Guelph
- Growth chambers at 400ppm and 800ppm CO2 in Quebec
- 15 creeping bentgrass cultivars (*Agrostis stolonifera*)
- 2 colonial bentgrasses (*Agrostis capillaris*)
- 2 velvet bentgrasses (*Agrostis canina*)
- 2 annual bluegrasses (*Poa annua*)

Results [new results highlighted in yellow]

The following shows results by objectives, but these results are pictorially illustrated in the previously submitted file called "161001_hsiang_climate_results.pdf". This was a presentation given in summer 2016 summarizing the project and results to date. As for new results since the last report in October 2016, these are summarized in the upcoming Ontario Turfgrass Symposium presentation (Feb 22, 2016) called " 170222_stricker_OTS2017presentation.pdf". It is attached for this report.

Objective 1 Results

- Cultivars with significantly less yellowing at 10C (37-51% at 15 DPI) also were also less yellow at 20C (41-61% at 7DPI)
- Some cultivars exhibited differentially more yellowing at 20C than at 10C
- Variation between *M. nivale* isolates in growth rates with significantly slower growth at 10C vs 20C
- Some isolates grew differentially faster at 20C and could be favoured by higher global temperatures
- Effect of CO2 on M. nivale still in progress
- More tests ongoing with temperature growth rates

Objectives 2 & 3 Results

- Significant effect of Civitas & Harmonizer treatments with some creeping bentgrass cultivars showing increased resistance at 7 days after fungal treatment (but some not)
- Ongoing tests of the effects of varying pre-incubation temperature on resistance development and resistance activation
- Data being analyzed (target completion: August 2017)

Objective 4

- Field plots established at Guelph Turfgrass Instutite in large plots (12 m x 24 m) in Fall 2014

- Civitas/Harmonizer and fungal inoculum were tested in Fall 2015, Spring 2015, and are being tested for Winter 2016. Low disease levels in Fall 2015, Spring 2016 and Fall 2016 did not give significant results.

Objectives 5 & 6
- Effects of CO2 on turfgrass growth and fungal growth: data are still being analyzed. This is what is currently taking most time. (target completion: August 2017)

Objective 7
- Extracted RNA for RNA sequence analysis under scenarios of increased CO2 concentrations with and without Civitas/Harmonizer™
- RNA has been extracted, but since this is so expensive work and high levels of expertise are needed to analyze the data, this work has been held off for 2017

Future Work
- Repeated trials with conetainers at 10C and 20C (effect of cold hardening)
- Field Testing in Fall 2016, Spring 2017 & Fall 2017

Publications/Presentations Resulting from this research
NOTE: CTRF is acknowledged as a funding source for these publications/presentations

Hsiang T, Koch P.2017. Management and Biology of Snow Molds. GIS, GCSAA Education Seminar, Orlando, Florida, Feb 6, 2017. (Invited Speaker, Industry, paid for by GCSAA)

Hsiang T, Goodwin P. 2016. Aktivieren von Abwehrmechanismen gegen Rasenkrankheiten. Greenkeeper News 04/16: 3-6. [So impressed by the work that the Austrian Greenkeepers Association translated it into German for the Dec 2016 publication] ARTICLE ATTACHED, (Look for CTRF acknowledgement, in German!)

Hsiang T. 2016. Alternatives for turfgrass disease control without synthetic pesticides. National Golf and Green Symposium, Dreibergen, The Netherlands. Dec 9, 2016. [paid for by Dutch Greenkeepers]

Stricker S, Hsiang T, Bertrand A. 2016. Effect of a resistance activator and increased CO2 on turfgrassess inoculated with Microdochium nivale. Southwestern Ontario Regional Association of the Canadian Phytopathological Society, Vineland, Ontario. Nov 4, 2016.

Hsiang T, Goodwin P. 2016. The infection process and activation of disease resistance in turfgrasses. Golf Course Management 84(9):87-90 (Fall 2016). ARTICLE ATTACHED, CTRF listed

Hsiang T. 2016. Turfgrass defense activators vs. conventional fungicides. European Turfgrass Society Conference, Albufeira, Portugal, 8 June 2016. [paid for by European Turfgrass Society]

Stricker S, Hsiang T, Bertrand A. 2016. Management of bentgrass cultivars for improved resistance to Microdochium patch (Microdochium nivale) under climate change conditions. European Turfgrass Society Conference, Albufeira, Portugal, 8 June 2016. [paid for by European Turfgrass Society]

Stricker S, Hsiang T, Bertrand A. 2016. Management of bentgrass cultivars for activated resistance to Microdochium nivale under climate change conditions. Plant-Microbe Adaptations to Cold, Seattle, Washington, USA, 25 May 2016. [Paid from NSERC/PetroCan/CTRF funds]

Hsiang T. 2016. Modes of action of turfgrass defense activators. Ontario Turfgrass Symposium. Guelph, Ontario, 23 February 2016. [Ontario Turf Industry major participants here, no payments]

Stricker S, Hsiang T and Bertrand A. 2016. Management of Bentgrass Cultivars for Improved Resistance to Microdochium Patch (Microdochium nivale) under Climate Change Conditions.

Ontario Turfgrass Symposium. Guelph, Ontario, 23 February, 2016. [Ontario Turf Industry major participants here, no payments]

Hsiang T. 2016. Biology and Management of Turfgrass Snow Molds. Canadian Golf Course Management Conference, Toronto, Ontario, 11-14 January 2016. [Paid for by CGSA]

Hsiang T. 2016. Modes of action of turfgrass defense activators. Canadian Golf Course Management Conference, Toronto, Ontario, 11-14 January 2016. [[Paid for by SunCor]

Comments

This project is going along well but there is an overall underexpenditure for the NSERC/PetroCan/CTRF budgets. We are having an issue with NSERC right now threating to decrease funding because of this under-expenditure.

We plan to ramp up activity in 2017 since funds are coming in from CTRF as well as new personnel.