Management of Bentgrass Cultivars for Improved Resistance to Microdochium Patch (*Microdochium nivale*) under Climate Change Conditions

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Climate Change
Climate Change

21st Century

IF GLOBAL WARMING IS REAL, EXPLAIN THAT!
Projections of Carbon Dioxide Concentrations

http://www.ipcc-data.org/figures/ipcc_ddc_co2_scenarios.jpg
Temperature Increases

Projections of Surface Temperatures

2020-2029

+ 2°C
+ 3.6 °F

2090-2099

+ 5 °C
+ 9 °F

https://www.ipcc.ch/publications_and_data/ar4/wg1/en/fig/figure-spm-6-l.png
Temperature Fluctuations

Spring and fall temperatures are less stable.
Cold hardening is the physiological and biochemical process by which an organism prepares for cold weather.
Effects of Climate Change

- Increasing CO$_2$ concentrations
  - Increases in plant growth
  - Increased plant vigor to fight pathogens

Decrease in Disease
Effects of Climate Change

• Increasing temperatures
  – Less stable snow cover conditions
  – Increased survival of pathogens

Increase in Disease
Effects of Climate Change

• Temperature Fluctuations
  – Day length and temperature triggers don’t match
  – Decrease in hardening off

Increase in Disease
Microdochium nivale

- Hosts include barley, oats, wheat, and cool-season turfgrasses
- Turfgrass diseases:
  - Pink Snow Mold
  - Fusarium Patch AKA Microdochium Patch
Symptoms on turfgrass

[Images of Pink Snow Mold and Microdochium Patch]
Creeping Bentgrass

- *Agrostis stolonifera*
- Grown on golf courses (greens & tees)
- Susceptible to Microdochium Patch
Chemical Control Methods

Proturf
Thiophanate-Methyl
Compass
BannerMaxx
HeritageMaxx
Quali-Pro
Disarm
Propiconazole
Tourney
Premis
Chipco
Iprodione
Concert
Medallion
Insignia
Nivalis
Eagle
Prophesy
Daconil
Banner
Instrata
Trilogy
Rovrol
Headway
Trianum
Senator
Other Control Methods

Inherent resistance varies by cultivar
Resistance Activators

- Non-toxic to plants and fungi
- Activates natural resistance responses
- The plant defences are primed before the pathogen is present
- Speed of recognition and response is key

Ready to fight!
Civitas/Harmonizer™

- Developed by PetroCanada
  - Food-grade isoparaffins
  - Pigment dispersal product containing chelated copper
The plant’s defenders are given an "extra shot of caffeine"
After the signal, the weapons are locked and loaded
Resistance Genes Expressed

Microdochium nivale
Main Questions

• How will disease resistance of bentgrass cultivars be affected by climate change?

• How will the efficacy of Civitas/Harmonizer™ be affected?
Objective 1

Screen commonly used cultivars for inherent disease resistance
18 Grass Cultivars

- Creeping bentgrass (*Agrostis stolonifera*)
- Colonial bentgrass (*Agrostis capillaris*)
- Velvet bentgrass (*Agrostis canina*)
- Annual bluegrass (*Poa annua*)
Disease Ratings

0%  100%
Values with a letter in common are not significantly different within treatment.
Values with a letter in common are not significantly different within treatment.
Objective 2

Investigate the impact of cold hardening on disease development and resistance activation
Seeding:
0.04 g seed/cone

Growth:
50 μmol/m²/s light

Activator:
5% Civitas + 0.3% Harmonizer

Inoculation
1 wk after Activator

Rating
Percent Yellowing

28
**Cold Hardening**

<table>
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<th>T</th>
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<th>T</th>
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<td>R</td>
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**20°C/ 16 h light, 8 h dark**

**10°C/ 12 h light, 12 h dark**

C/H- Civitas/harmonizer
I- inoculation
R-rating
Overall Effect of Civitas/Harmonizer

Values with a letter in common are not significantly different within treatment.
A brief exposure to 10°C decreased disease symptoms.

Effect of Temperature Regimen

Civitas/Harmonizer Treatment

Water Treatment

Values with a letter in common are not significantly different within treatment.
### Area under disease progress curve of turfgrass cultivars inoculated with *M. nivale* by temperature treatment

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Civitas/Harmonizer</th>
<th>Water</th>
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<tr>
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<td>10°C for 2 wk</td>
<td>20°C constant</td>
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<td>88.3 a</td>
<td>250.0 b</td>
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<td>Tyee</td>
<td>112.5 a</td>
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<td>Focus</td>
<td>98.3 a</td>
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<td>T1</td>
<td>89.2 a</td>
<td>250.0 b</td>
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<td>Independence</td>
<td>100.8 a</td>
<td>426.7 a</td>
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<tr>
<td><em>Poa annua</em></td>
<td>20.0 b</td>
<td>95.0 a</td>
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<tr>
<td>Penncross</td>
<td>89.2 a</td>
<td>175.8 c</td>
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</table>

Within a column, values with a letter in common are not significantly different. Means are based on three replicates.
Values with the same letter are not significantly different within treatment.
Objective 3

Investigate the impact of CO$_2$ on disease development combined with the efficacy of a resistance activator
CO$_2$ Growth Chambers

- Soils and Crops Research and Development Centre Québec City, Québec
Growth Procedure

Seeding
12 g/m² seeding rate
Poa annua propagated

Growth
20C day / 15C night
16 h photoperiod
500 μmol/m²/s light
8 wk
400 and 800 ppm CO₂

Chill
15C day / 10C night
3 wk
Growth Procedure

Activator

5% Civitas
0.3% Harmonizer
(label rate)

Inoculation

1 wk after Activator
0.25 g dried inoculum/pot
% Yellowing assessed 7, 9, 15, 21 days post inoculation (DPI)
Effect of Carbon Dioxide

CO₂

Symptoms 34%

Area under disease progress curve

Disease Severity

A

400 ppm 800 ppm
(p<.0001)

B

39
Overall Effect of Civitas/Harmonizer

Area under disease progress curve

Disease Severity

Symptoms 39%

Civitas Water

B (p<.0001)

A
### Variation by Cultivar

Disease Severity (AUDPC) of turfgrass cultivars inoculated with *M. nivale* by CO$_2$ treatment

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>400 ppm CO$_2$</th>
<th>800 ppm CO$_2$</th>
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<td>Independence *</td>
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<td><em>Poa annua</em></td>
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<td>Alpha</td>
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<td>ab</td>
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<tr>
<td>Leirin *</td>
<td>289</td>
<td>b</td>
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</table>

LSD (p<0.05) 235.6 228.9 126.5 246.1

Within a column, values with a letter in common are not significantly different.

Means are based on four replicates.

*Cultivars selected by Scandinavian colleagues.*
• All trials show variation between cultivars

• Temperature experiment
  – Cold hardening increases disease resistance
  – Civitas/Harmonizer is more effective under cold hardening conditions

• CO₂ experiment
  – Increasing CO₂ suppresses symptoms
  – Even greater effect of Civitas/Harmonizer at increased CO₂
Future Work

• CO$_2$ experiment
  – RNA sequencing
  – Free amino acid composition
  – Sugars analysis

• Cold Hardening
  – More temperature fluctuation experiments

• *M. nivale*
  – Temperature dependent growth curve
Acknowledgments

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  – Sandra Delaney
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Any Questions?

Thank you for your time