

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



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Climate Change

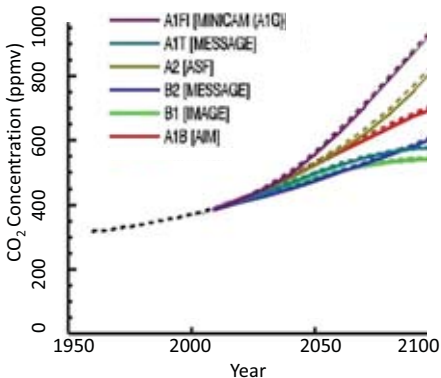


Climate Change



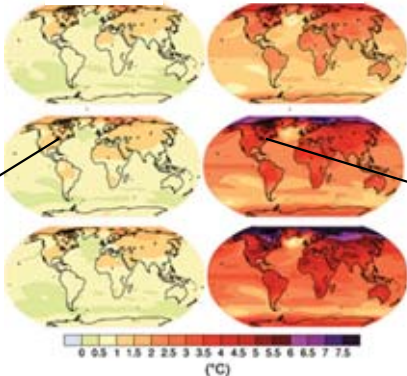
Carbon Dioxide

Projections of Carbon Dioxide Concentrations



Temperature Increases

Projections of Surface Temperatures
2020-2029 2090-2099



+ 2°C
+ 3.6 °F

+ 5 °C
+ 9 °F

Temperature Fluctuations



Spring and fall
temperatures
are less stable

Cold Hardening

Cold hardening is the physiological and biochemical process by which an organism prepares for cold weather



Effects of Climate Change

- Increasing CO₂ 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



Pink Snow Mold



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 Heritage

Iprodione Tourney Premis Chipco
Concert **Medallion** Insignia

Nivalis Eagle **Prophecy**

Daconil **Banner**

Instrata Trilogy Rovrol

Headway

Trianium **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



Induction



The plant's defenders are given an
"extra shot of caffeine"

Priming



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*)



Cultivars commonly
used in Norway



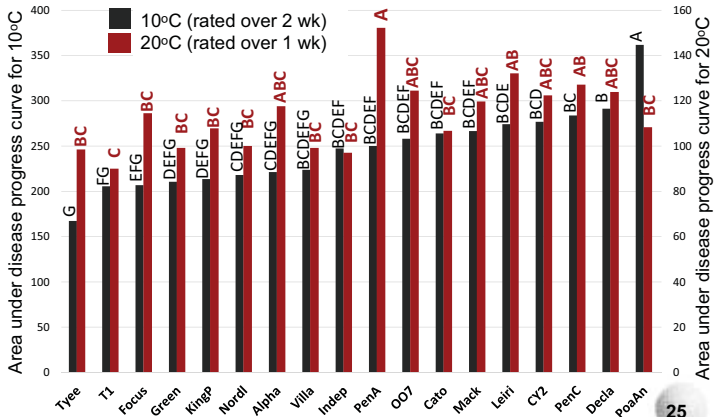
Disease Ratings



0%

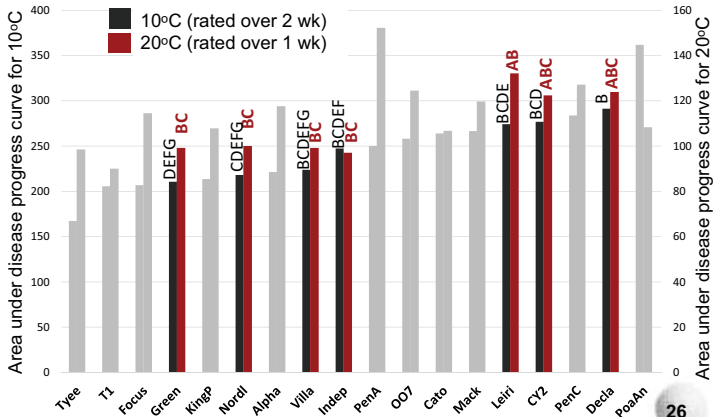
100%

Disease Severity at 10°C and 20°C



Values with a letter in common are not significantly different within treatment.

Norwegian Cultivars



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 $\mu\text{mol}/\text{m}^2/\text{s}$ light

Activator



5% Civitas + 0.3% Harmonizer

Inoculation



1 wk after Activator

Rating



Percent Yellowing

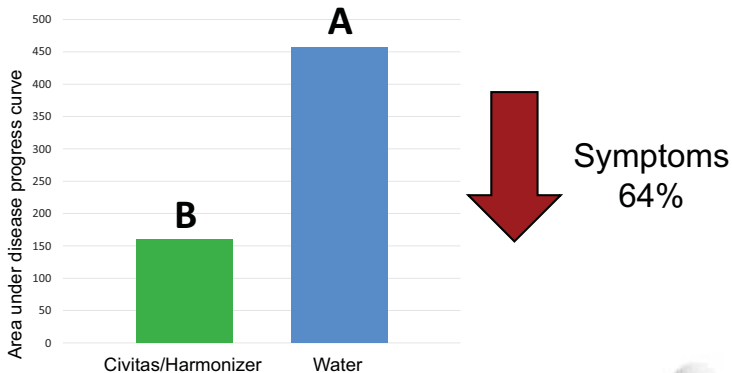
Cold Hardening

M	T	W	T	F	S	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
14	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	1	2	3	4	5
C/H	7	8	9	10	11	12
i	14	15	16	17	18	19
R	21	R	23	R	25	26
R	28	29	30	31	1	2

	20°C/ 16 h light, 8 h dark
	10°C/ 12 h light, 12 h dark

C/H- Civitas/harmonizer
I- inoculation
R-rating

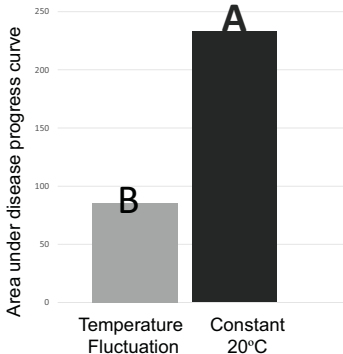
Overall Effect of Civitas/Harmonizer



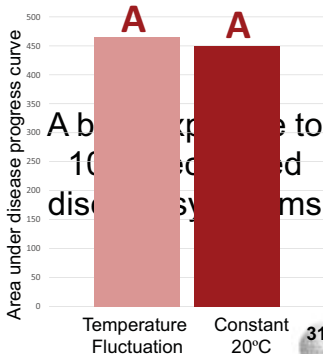
Values with a letter in common are not significantly different within treatment.

Effect of Temperature Regimen

Civitas/Harmonizer
Treatment



Water Treatment



Values with a letter in common are not significantly different within treatment.

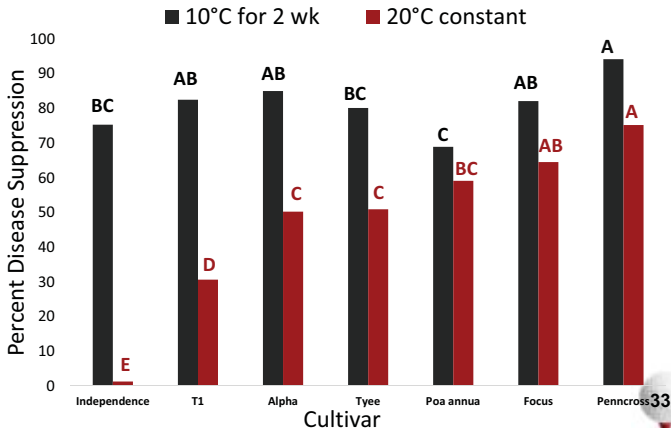
Variation by Cultivars

Area under disease progress curve of turfgrass cultivars inoculated with *M. nivale* by temperature treatment

Cultivar	Civitas/Harmonizer		Water	
	10°C for 2 wk	20°C constant	10°C for 2 wk	20°C constant
Alpha	88.3 a	250.0 b	589.2 a	501.7 a
Tyee	112.5 a	261.7 b	565.0 a	533.3 a
Focus	98.3 a	171.7 c	549.2 ab	484.2 a
T1	89.2 a	250.0 b	509.2 ab	360.0 a
Independence	100.8 a	426.7 a	407.5 abc	431.7 a
<i>Poa annua</i>	20.0 b	95.0 a	345.0 bc	382.5 a
Penncross	89.2 a	175.8 c	286.7 c	430.0 a

Within a column, values with a letter in common are not significantly different .
Means are based on three replicates.

Percent Disease Suppression



Values with the same **letter** are not significantly different within treatment.

Objective 3

Investigate the impact of CO₂ on disease development combined with the efficacy of a resistance activator



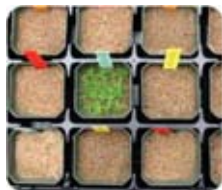
CO₂ Growth Chambers



- 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 $\mu\text{mol}/\text{m}^2/\text{s}$ 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)

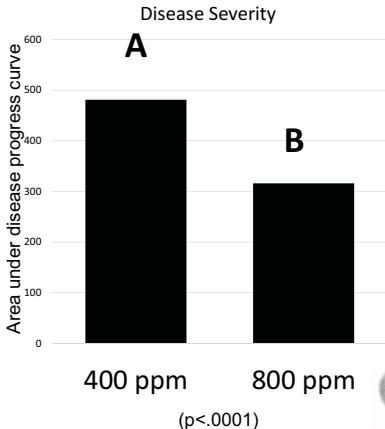
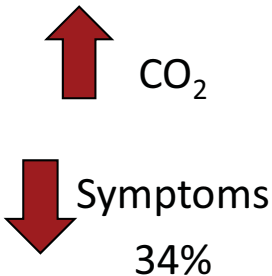
Percent Yellowing Ratings

Water

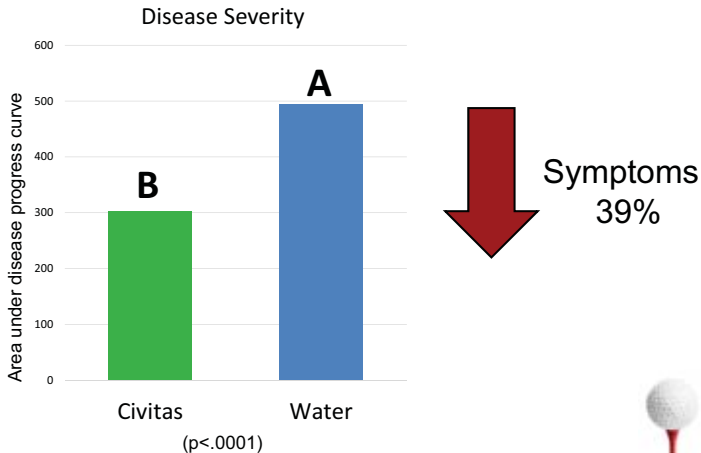
Civitas/Harmonizer



Effect of Carbon Dioxide



Overall Effect of Civitas/Harmonizer



Variation by Cultivar

Disease Severity (AUDPC) of turfgrass cultivars inoculated with *M. nivale* by CO₂ treatment

Cultivar	400 ppm CO ₂		800 ppm CO ₂	
	Civitas	Water	Civitas	Water
Focus	525 a	620 ab	232 a	586 a
Tyee	435 ab	619 ab	216 a	518 ab
Independence *	285 b	594 ab	256 a	483 abc
<i>Poa annua</i>	388 ab	720 a	264 a	378 abc
Penncross	325 ab	553 ab	240 a	354 abc
T1	378 ab	682 a	227 a	337 bc
Alpha	376 ab	552 ab	258 a	273 bc
Leirin *	289 b	423 b	166 a	270 c
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.

Overall Summary

- 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

- CO₂ experiment
 - RNA sequencing
 - Free amino acid composition
 - Sugars analysis
- Cold Hardening
 - More temperature fluctuation experiments
- *M. nivale*
 - Temperature dependent growth curve

Acknowledgments

Funding

- Petro Canada
- Natural Sciences and Engineering Research Council of Canada
- Canadian Turfgrass Research Foundation

People

- Hsiang Lab
- Bertrand Lab
 - Josée Bourassa
 - Sandra Delaney
- GTI Staff



NSERC
CRSNG

CTRF



Agriculture and
Agri-Food Canada
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Agroalimentaire Canada



Any Questions?

Thank you for your time

