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

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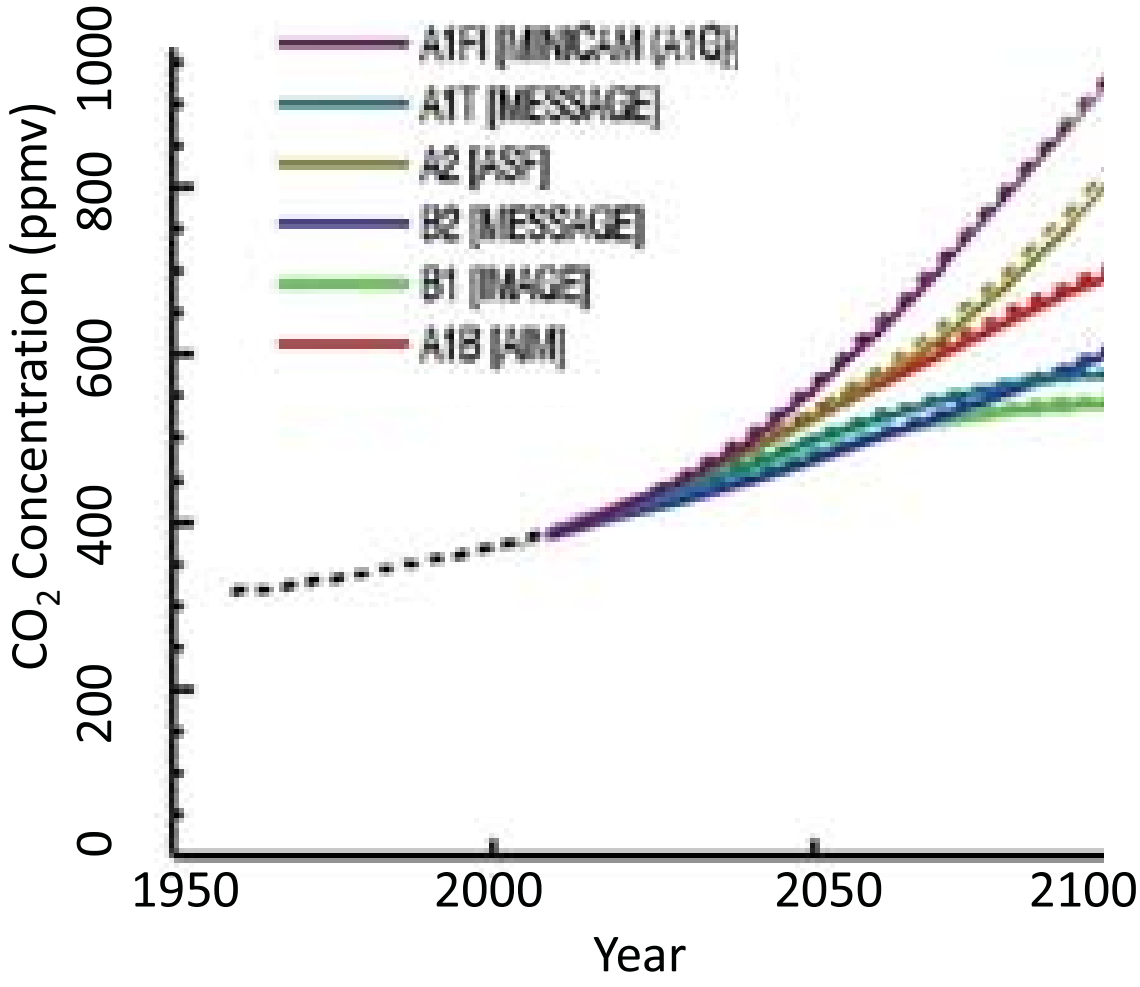
Climate Change

Climate Change

Carbon Dioxide

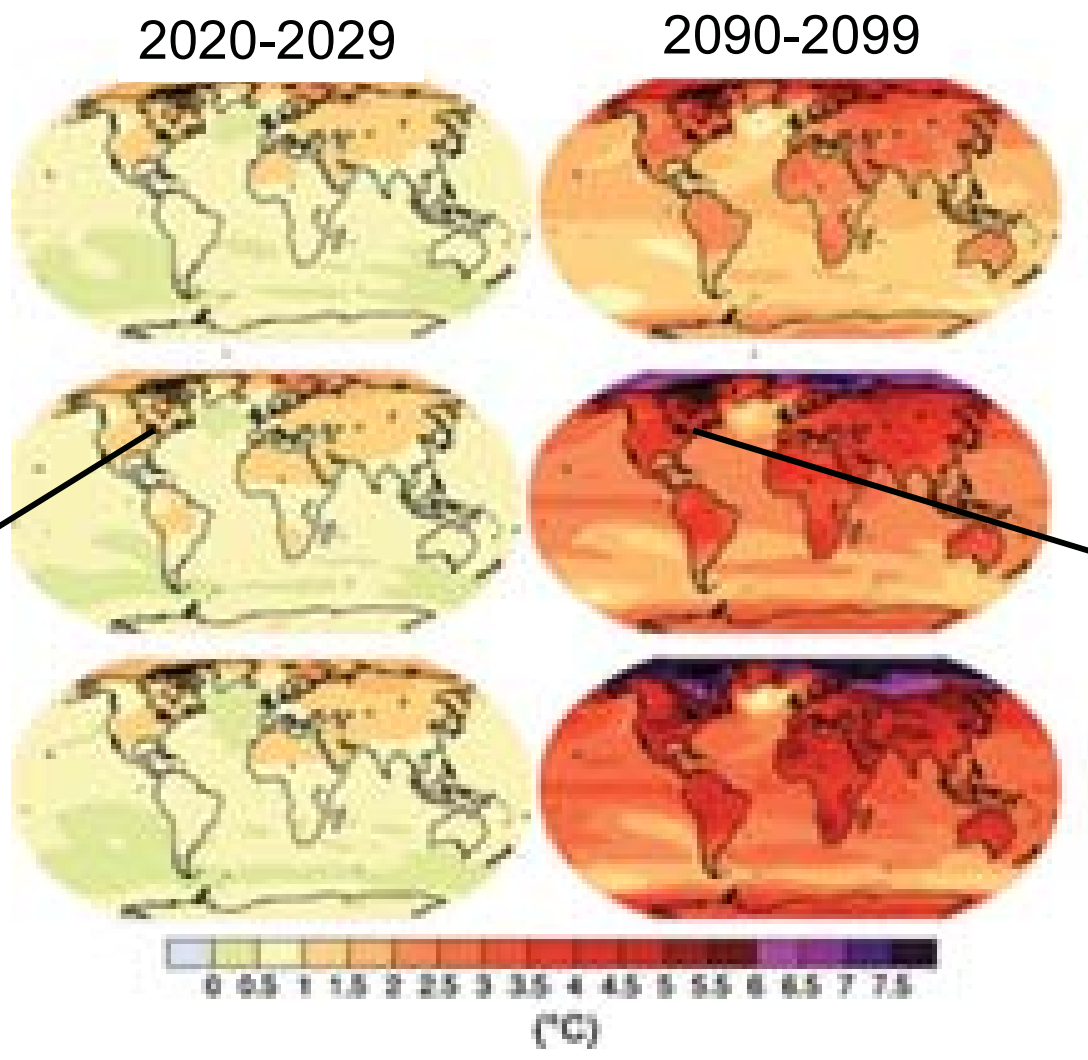
Projections of Carbon Dioxide Concentrations



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

Temperature Increases

Projections of Surface Temperatures



+ 2°C
+ 3.6 °F

+ 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

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

Pink Snow Mold

Microdochium Patch

Creeping Bentgrass

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

Chemical Control Methods

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?

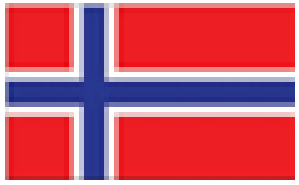
Objective 1

Screen commonly used cultivars for inherent disease resistance

Materials

18 Grass Cultivars

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

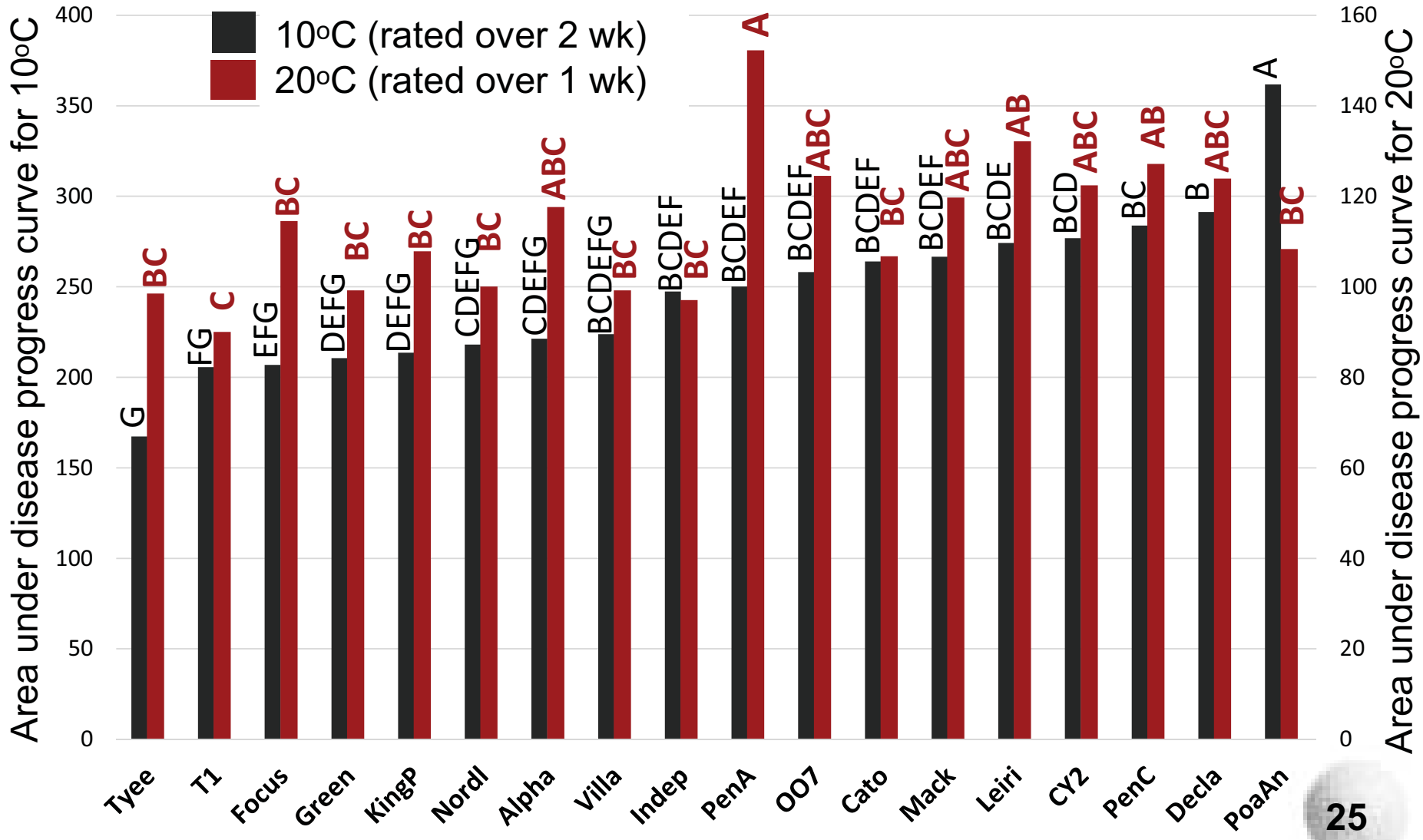


Cultivars commonly used in Norway

Disease Ratings

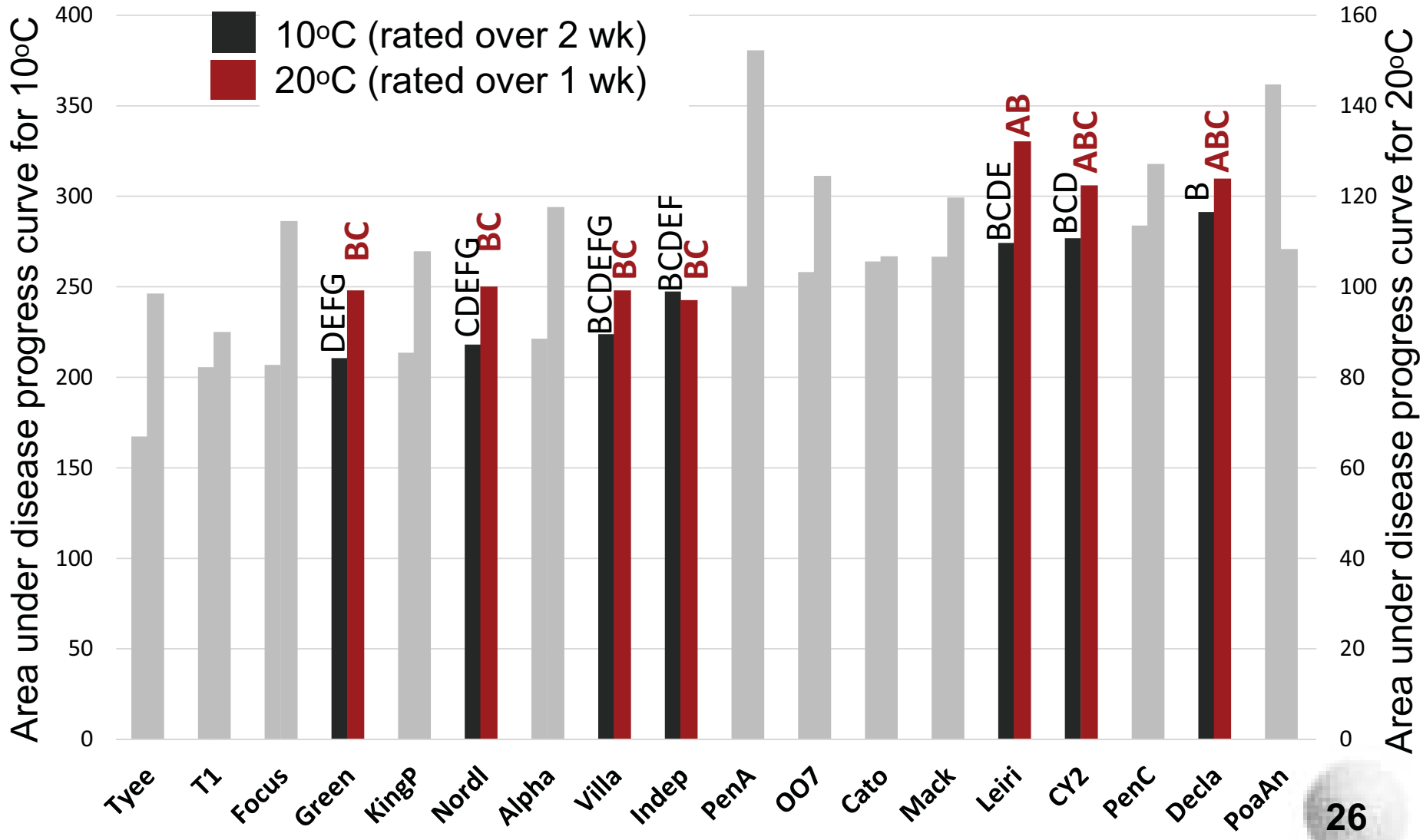
0% 100%

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 µmol/m^2/s light

Activator

5% Civitas + 0.3% Harmonizer

Inoculation

1 wk after Activator

Rating

Percent Yellowing

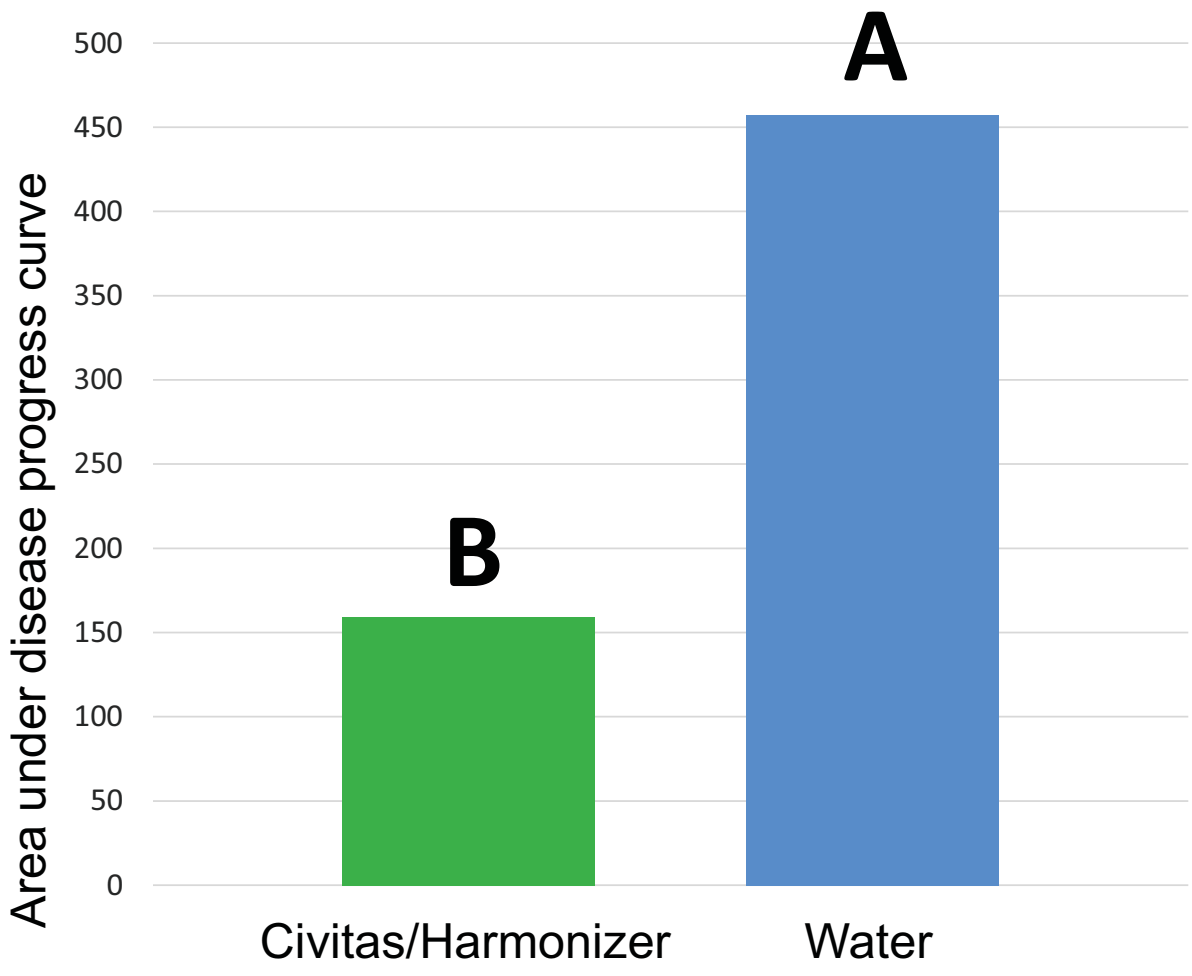
Cold Hardening

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	R	19
R	21	R	23	R	25	26
R	28	29	30	31	1	2

	20ºC/ 16 h light, 8 h dark
	10ºC/ 12 h light, 12 h dark

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

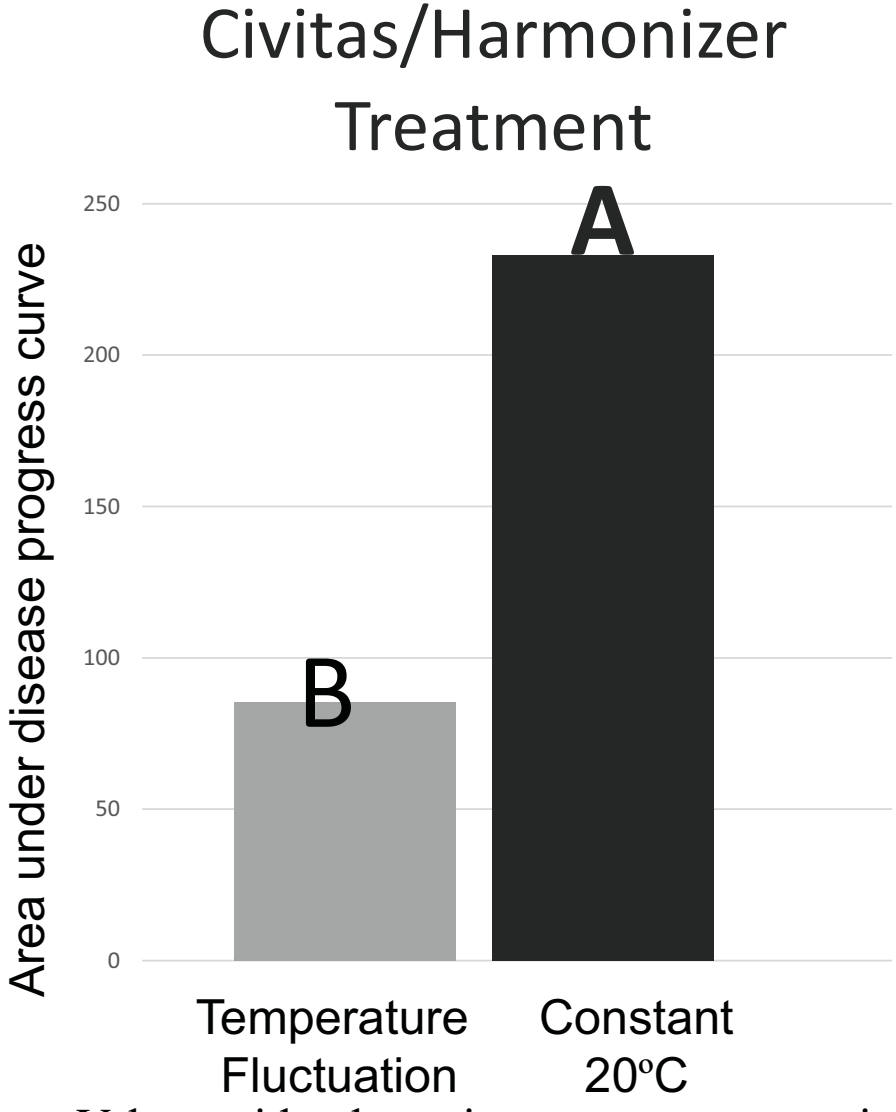
Overall Effect of Civitas/Harmonizer

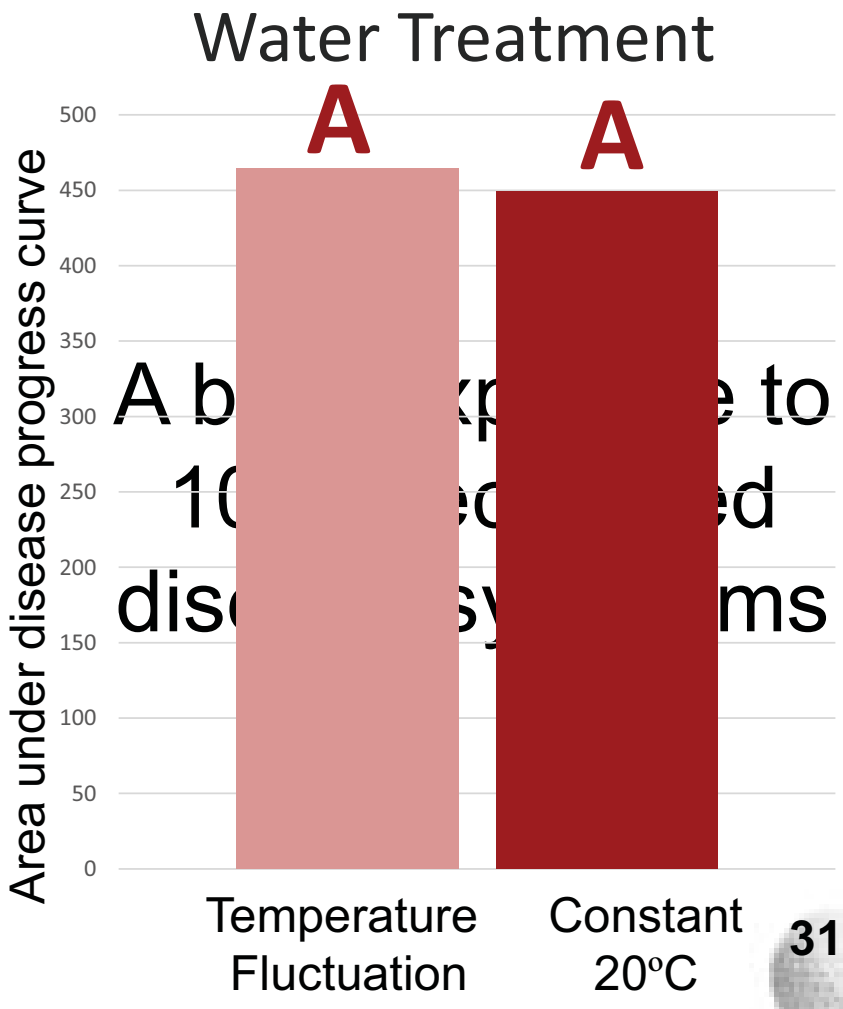


Symptoms
64%

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

Effect of Temperature Regimen





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

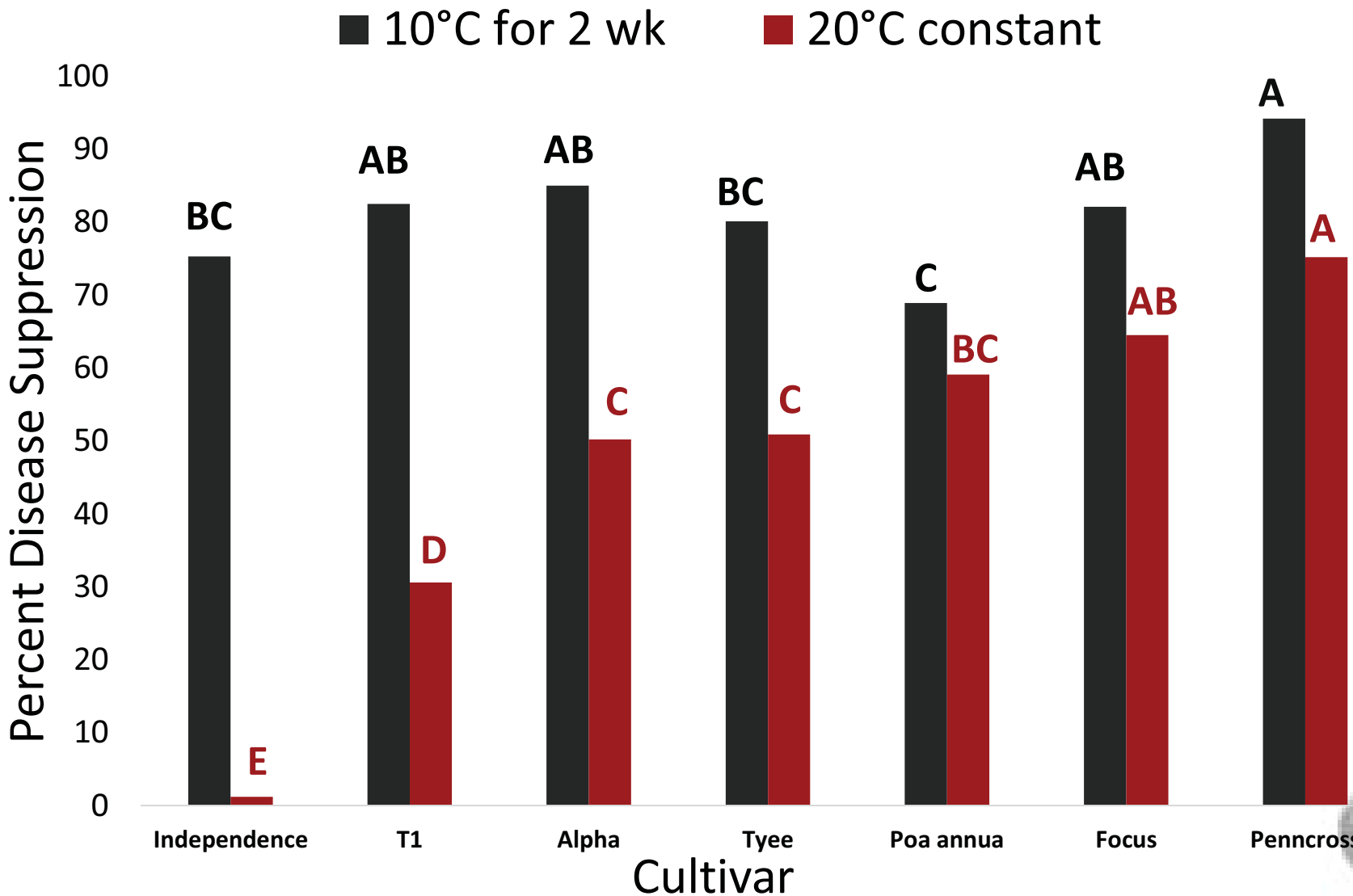
Variation by Cultivars

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**
Poa annua	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

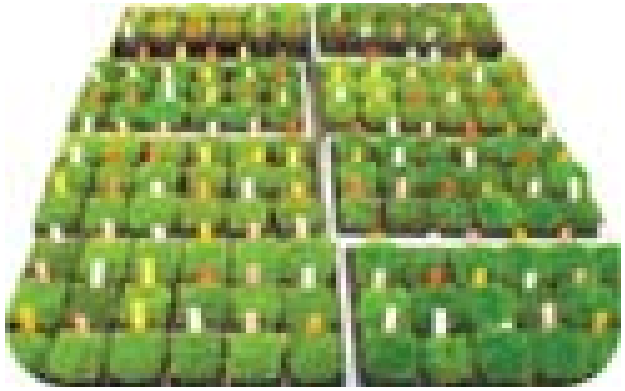


Values with the same **letter** are not significantly different within treatment.

Objective 3

Investigate the impact of CO_2 on disease development combined with the efficacy of a resistance activator

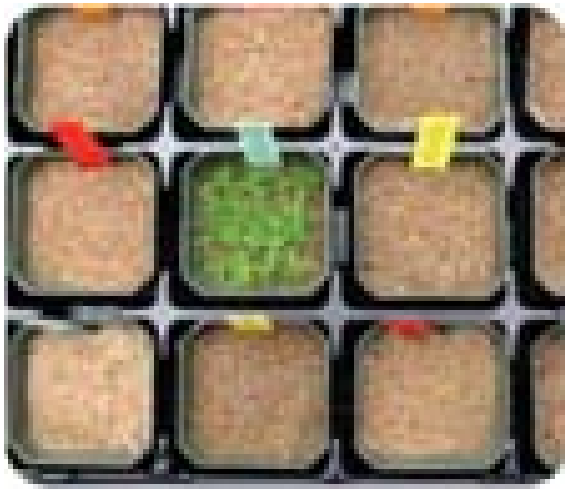
CO_2 Growth Chambers



- Soils and Crops Research and Development Centre Quebéc City, Quebéc

Agriculture and Agri-Food Canada

Growth Procedure



Seeding

12 g/m^2 seeding rate
Poa annua propagated

Growth

20C day / 15C night
16 h photoperiod
500 µmol/m^2/s light
8 wk
400 and 800 ppm CO_2

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

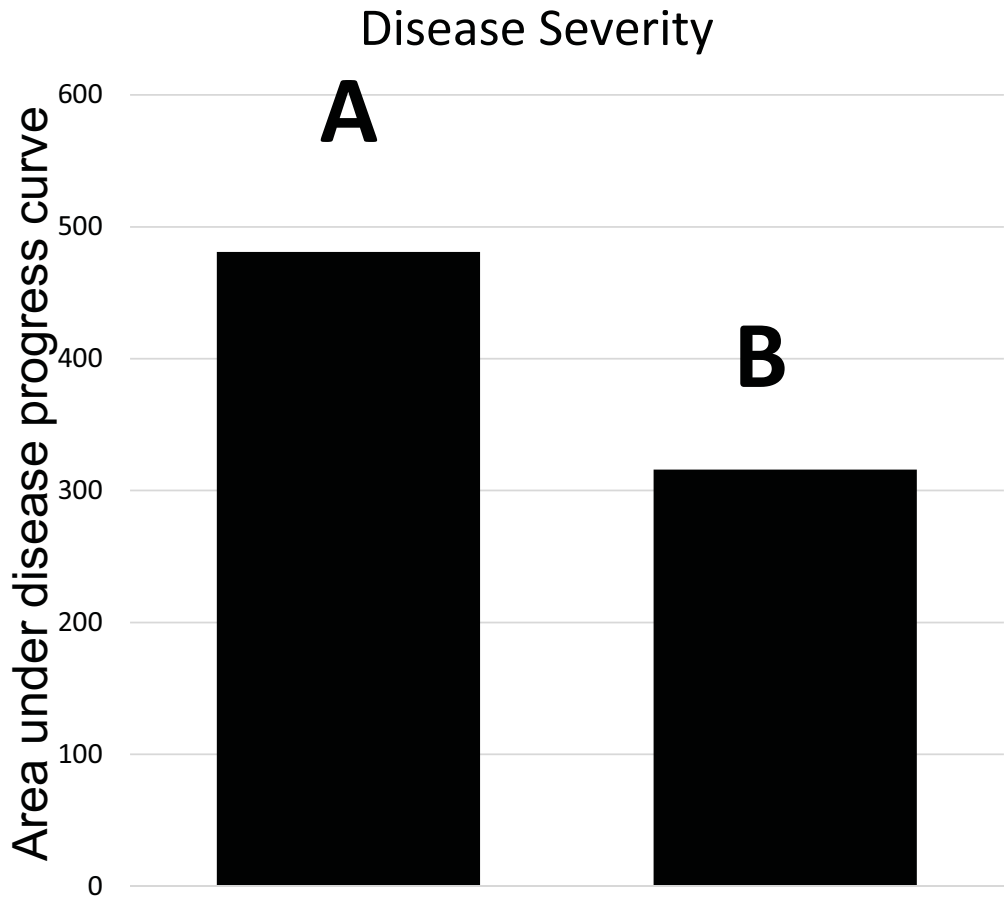
Civitas/Harmonizer

Effect of Carbon Dioxide

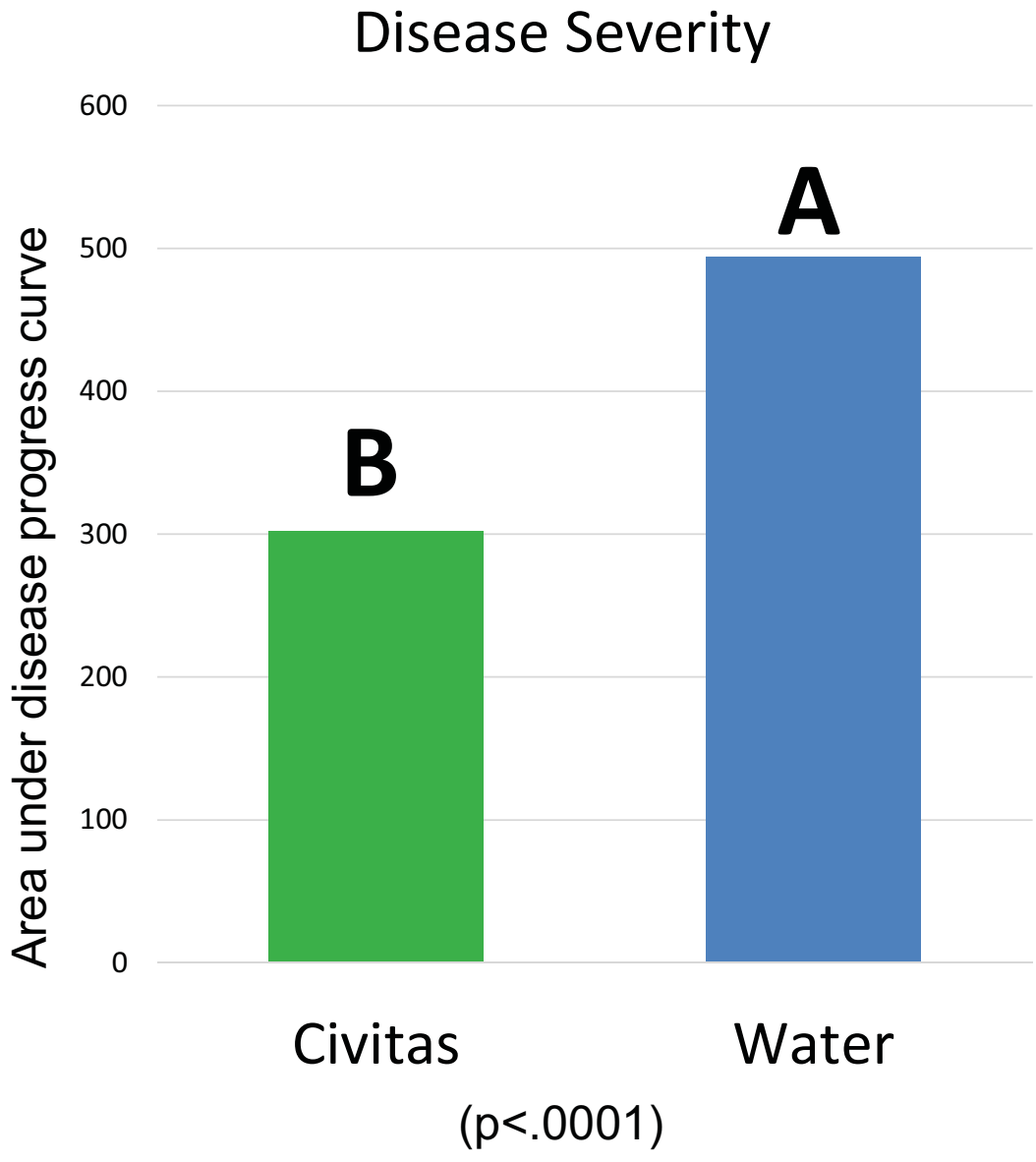
CO_2

Symptoms

34%



Overall Effect of Civitas/Harmonizer



Symptoms
39%

Variation by Cultivar

Disease Severity (AUDPC) of turfgrass cultivars inoculated with *M. nivale* by CO_2 treatment

	400 ppm CO_2		800 ppm CO_2	
Cultivar	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**
Poa annua	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
- CO_2 experiment
  - Increasing CO_2 suppresses symptoms
  - Even greater effect of Civitas/Harmonizer at increased CO_2

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

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

Any Questions?

Thank you for your time