Effect of Temperature on Microdochium Disease Severity

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WARNING:

Some of the following images
are graphic in nature and
might be disturbing to some viewers.

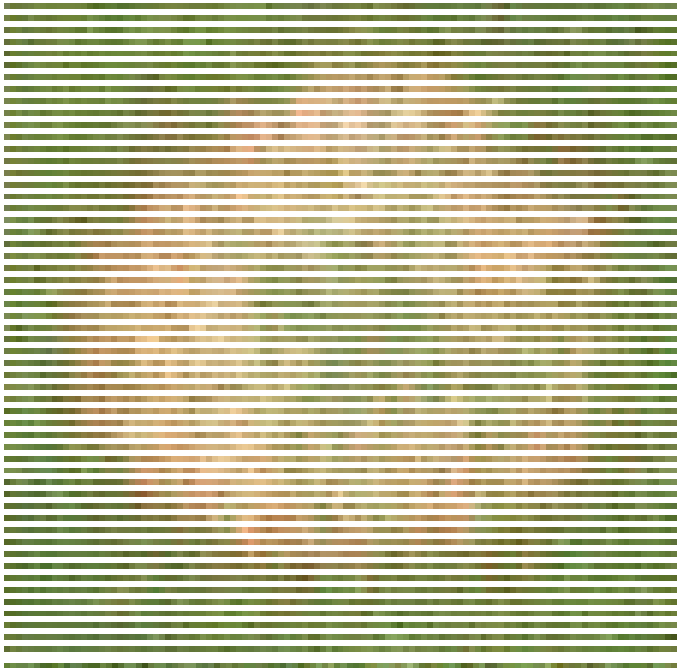

Stricker, 2016


Hsiang, 2007


Hsiang, 2007


Hsiang, 2006

Microdochium nivale



- Fungal plant pathogen
- Hosts include barley, oats, wheat, and cool-season turfgrasses

- Turfgrass diseases:
  - Pink snow mold after snowmelt
  - Fusarium patch/ Microdochium patch in spring and fall

Fusarium or Microdochium patch?

Fusarium spores

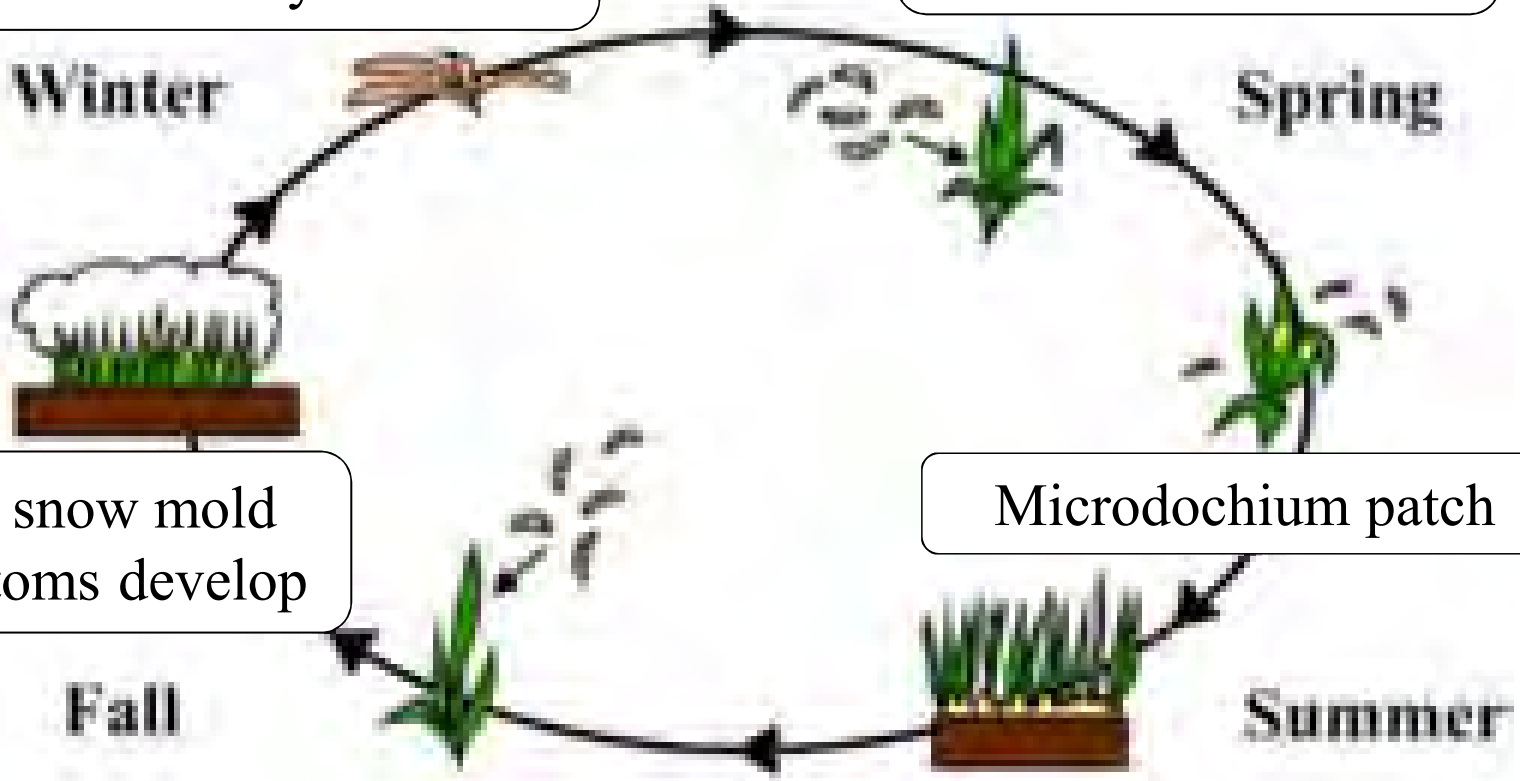
Foot cell

Spores from pink snow mold

Life Cycle of *Microdochium nivale*

Large bleached patches
Pink-white mycelium

Spores or mycelium
infect new hosts



Pink snow mold
symptoms develop

Microdochium patch

Infects new hosts,
Microdochium patch

Oversummers in
soil and thatch

Adapted from Tronsmo et al. 2001

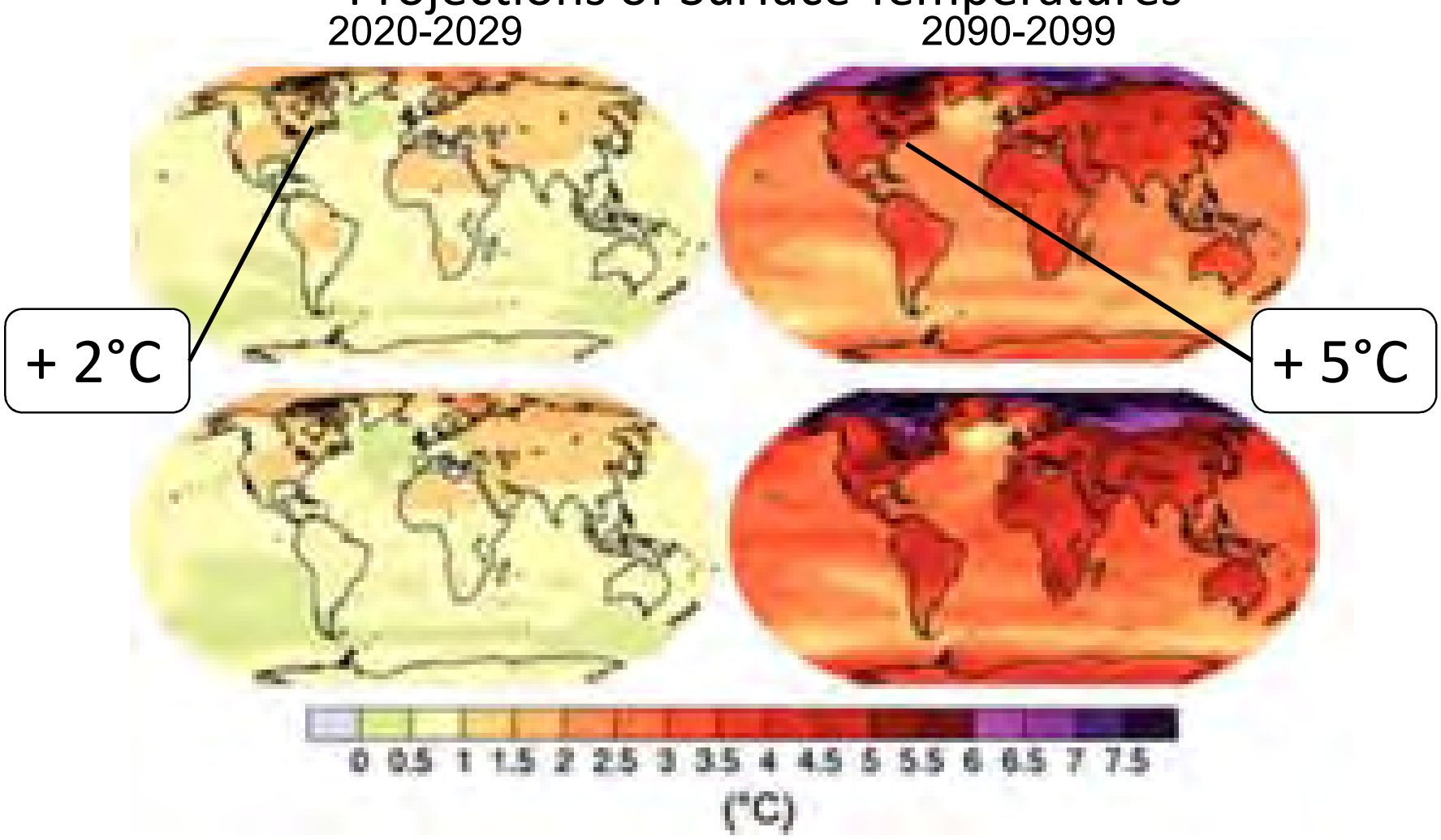
Creeping Bentgrass (*Agrostis stolonifera*)

- Used as turfgrasses for fairways, tees and putting greens
- At low mowing heights, often invaded by Annual bluegrass (*Poa annua)*
- Susceptible to Microdochium patch
  - Inherent resistance genes vary by cultivar

Microdochium nivale

- In lab studies, the optimal growth temperature for *M. nivale* is 22°C
- The observed optimal temperature for infection is between 0 and 15°C
- (Brennan et al., 2003; Snider et al., 2000)

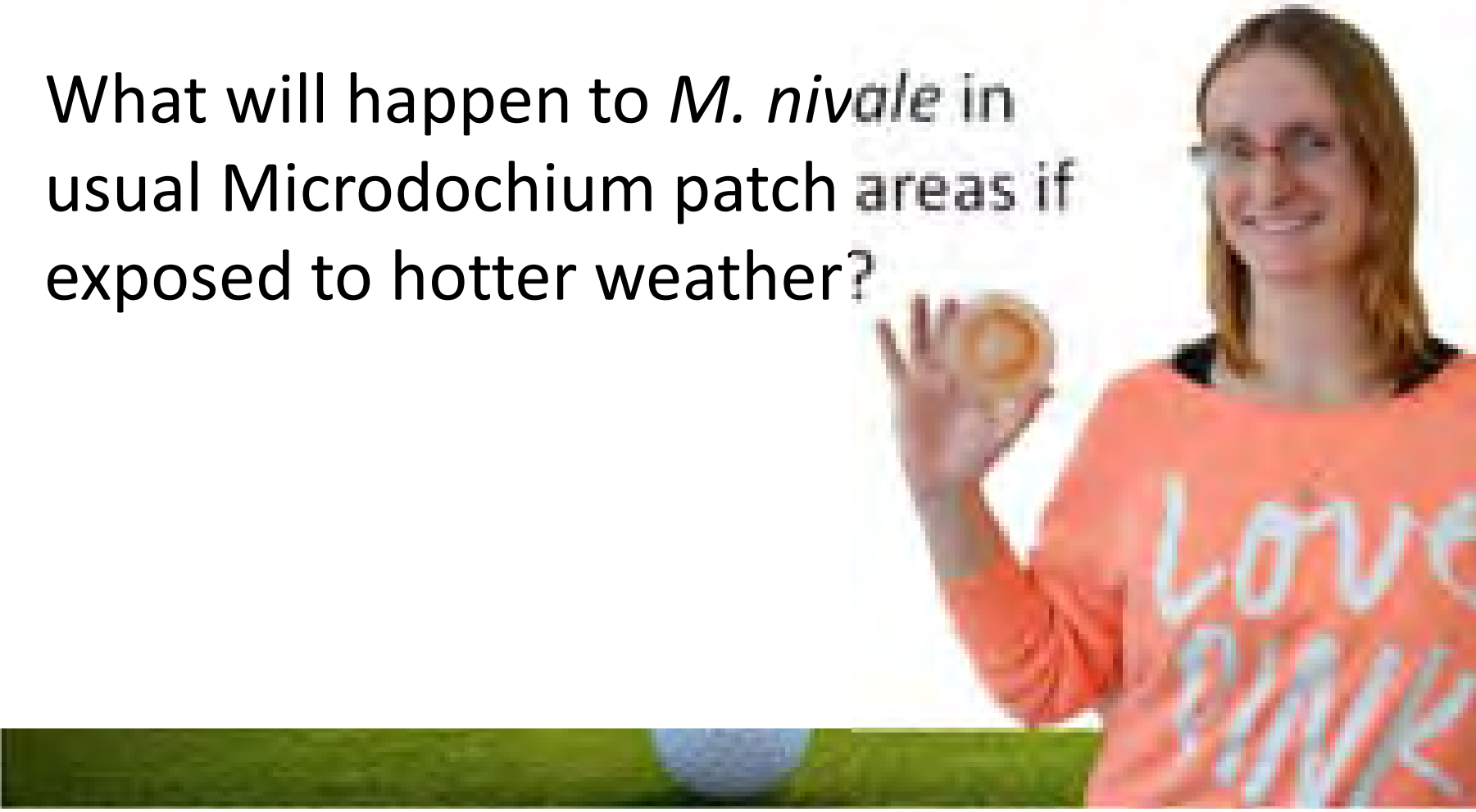
Climate Change



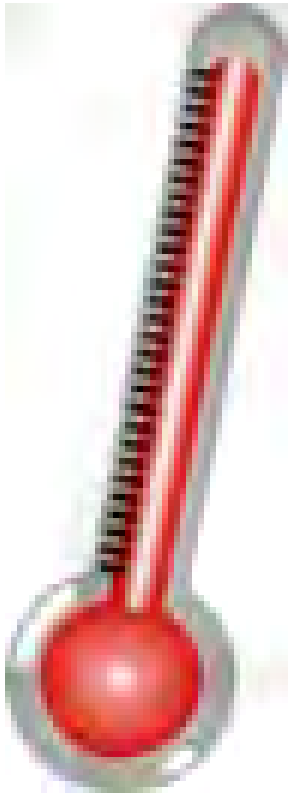
https://www.ipcc.ch/publications_and_data/ar4/wg1/en/fig/figure-spm-6-l.png

How might climate change affect *Microdochium nivale*?

What will happen to *M. nivale* in usual Microdochium patch areas if exposed to hotter weather?

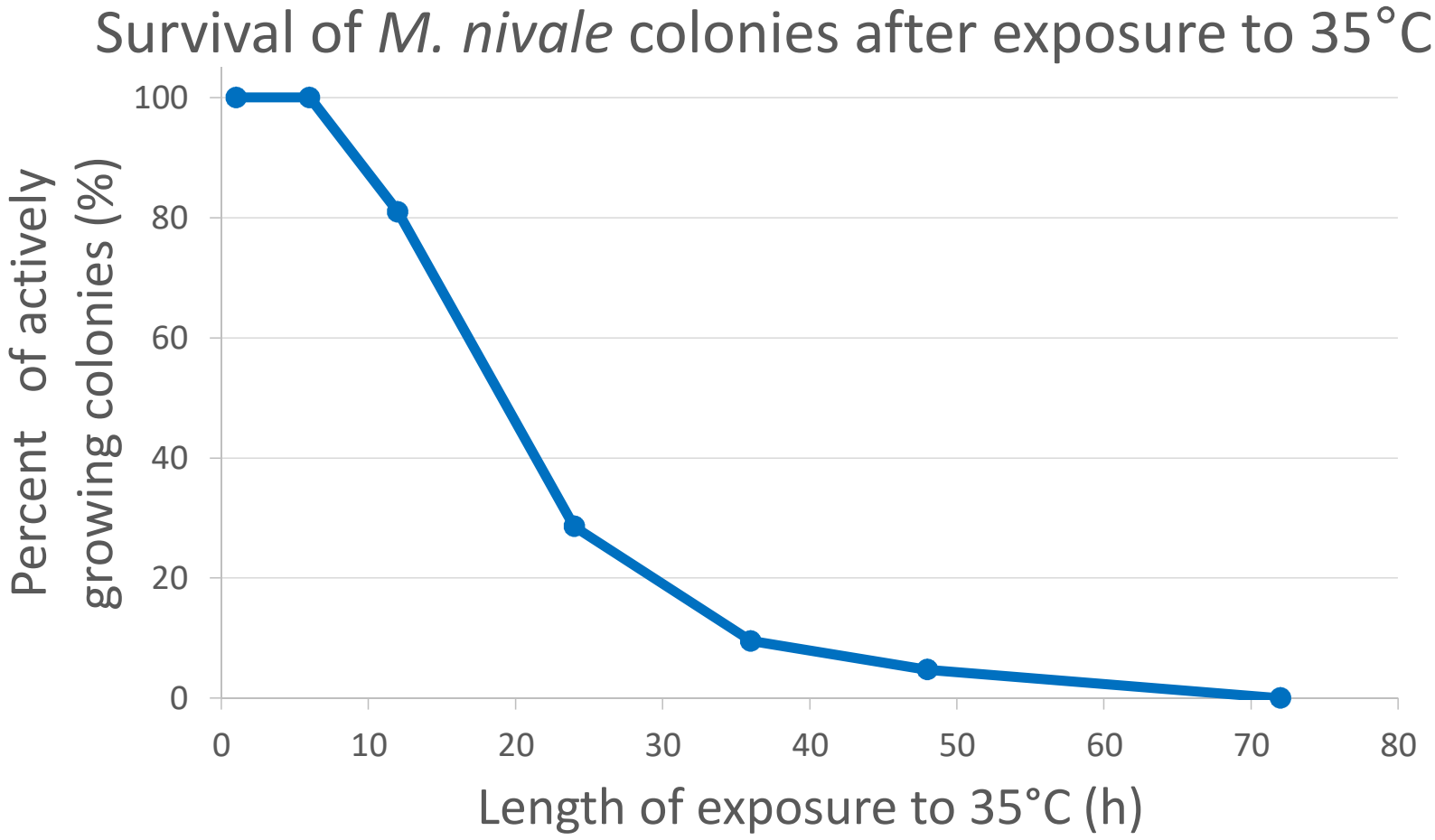


Effect of temperature on *M. nivale*

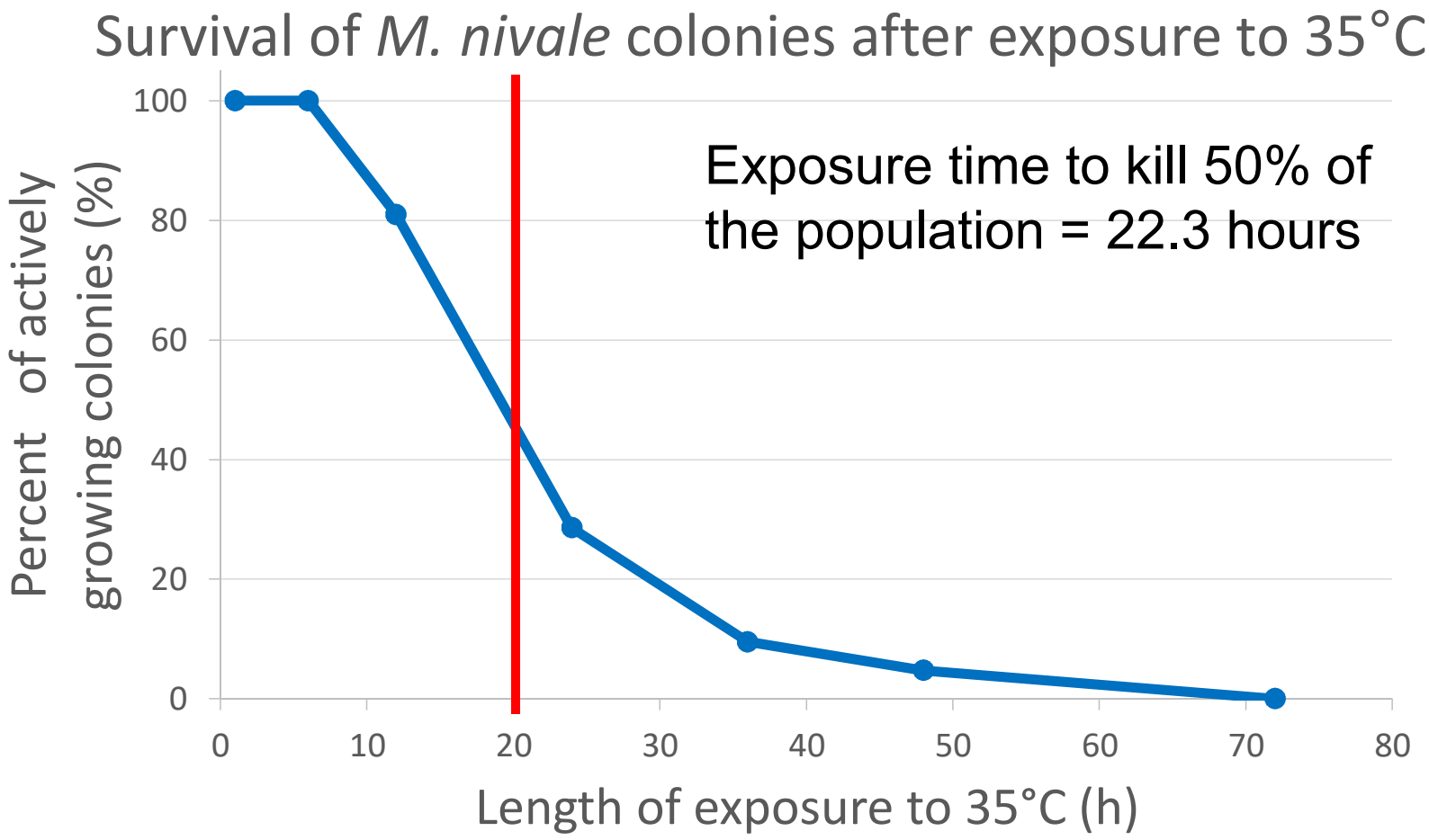


- Seven isolates of *M. nivale* grown in Petri dishes, then exposed to 35°C for various length of time
  - 1, 6, 12, 24, 36, 48, and 72 hours
- Returned to 20°C and monitored if they continued to grow

Effect of exposure to 35°C



Effect of exposure to 35°C

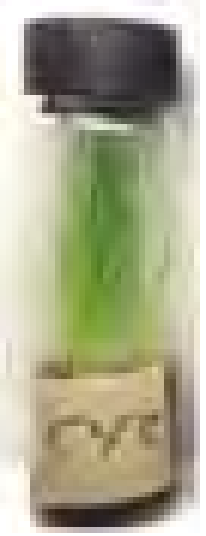


Conclusions

- What will happen to *M. nivale* in usual Microdochium patch areas if exposed to hotter weather?
  - Longer exposure to high temperatures may kill actively growing *M. nivale* hyphae

How does Microdochium Patch disease severity vary by cultivar?

Materials and Methods



- 18 Grass Cultivars
  - Creeping bentgrass (*Agrostis stolonifera*)
  - Colonial bentgrass (*Agrostis capillaris*)
  - Velvet bentgrass (*Agrostis canina*)
  - Annual bluegrass (*Poa annua*)
- Inoculated with five isolates of *M. nivale*
- Assessed for percent yellowing every 3 days

Disease Severity Ranking

- Average disease severity of 18 cultivars was ranked
- Average rank of 4 repeated experiments was calculated
- Low rank #= Low disease

Cultivar	Average Rank from 1 to 18	
Greenspeed	6	D
Focus	6	D
Tyee	6	D
Independence	6	D
Kingpin	7	CD
T1	7	CD
Villa	7	CD
Alpha	8	BCD
Cato	9	ABCD
Nordlys	10	ABCD
Leirin	10	ABCD
Declaration	10	ABCD
Mackenzie	11	ABCD
OO7	12	ABC
Poa annua	13	AB
Penncross	13	AB
PennA4	14	A
CY2	14	A
LSD (p<0.05)	5	

Values with a letter in common are not significantly different.

Cultivar	Average Rank from 1 to 18	
Greenspeed	6	D
Focus	6	D
Tyee	6	D
Independence	6	D
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- Creeping bentgrass
- Colonial bentgrass
- Velvet bentgrass
- Annual bluegrass

How might climate change impact Microdochium Patch disease?

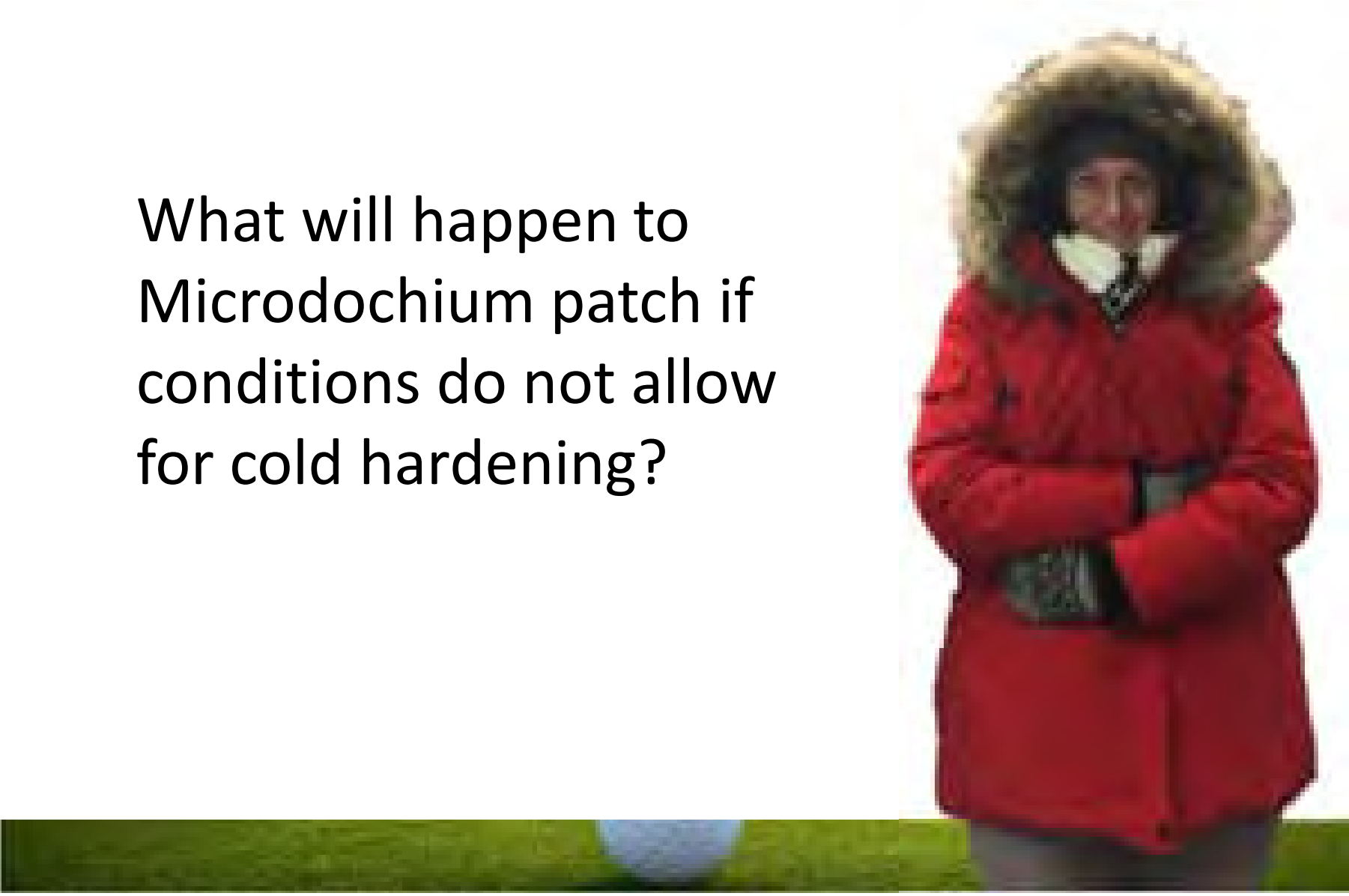
Impacts of Climate Change

- Plants in northern and temperate climates undergo cold hardening
  - Stockpiling nutrients
  - Producing defence mechanisms against pathogens

- Triggered by dropping temperatures and decreasing day length
  - Climate change may lead to a disconnect between temperature and day length

Effects of temperature

What will happen to Microdochium patch if conditions do not allow for cold hardening?



Conetainer Procedure

Seeding

0.04 g seed/cone
4 creeping bentgrass cultivars

Growth

20°C, 12 h photoperiod
2 wk

Temperature Treatments

4°C, 10°C, 15°C, 20°C
12 h photoperiod
2 wk

Conetainer Procedure

Inoculation

0.04 g dried inoculum
Incubated at 15°C

Disease Rating

% Yellowing assessed every 3rd day for 2 wk

Results

Treatment	Percent yellowing of turfgrass cultivars 9 days post inoculation with *M. nivale* after various pre-inoculation temperature treatments					
	Alpha	Focus	Pencross	Tyee	Row LSD	Treatment Mean
4°C	25 ab	4 b	28 a	14 a	20	18 b
10°C	17 b	22 b	31 a	26 a	23	24 b
15°C	13 b	22 b	27 a	17 a	18	20 b
20°C	45 a	50 a	37 a	22 a	27	39 a

Values with a lowercase letter in common are not significantly different within column

Conclusion

- Pre-inoculation treatments of temperatures <20°C decreased disease severity caused by *M. Nivale*

- What will happen to Microdochium patch if conditions do not allow for cold hardening?
  - Disease symptoms may be more severe

Resistance Activators

- A synthetic chemical that is non-toxic to plants and fungi that, when applied to a plant, activates natural resistance responses

- The plant defences become primed before the pathogen is present
  - Ready for battle!

Civitas/Harmonizer™

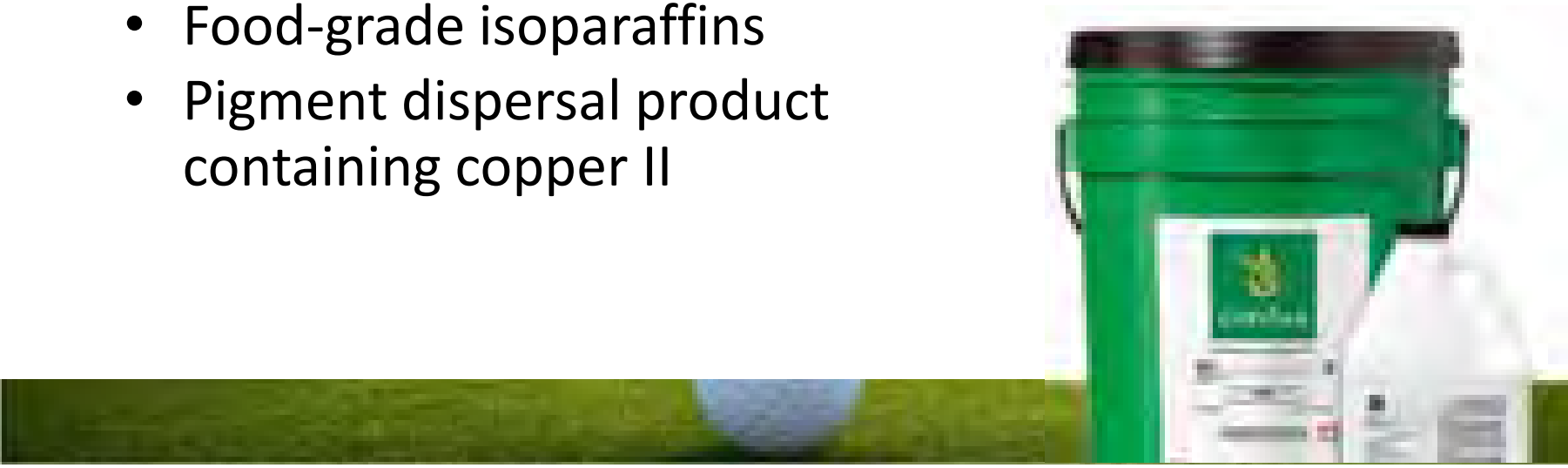
- Resistance Activator
- Not a fungicide, no fungicide resistance

Effective controls on creeping bentgrass of:

- Brown patch (*Rhizoctonia solani*)
- Dollar spot (*Sclerotinia homoeocarpa)*

Developed by PetroCanada

- Food-grade isoparaffins
- Pigment dispersal product containing copper II



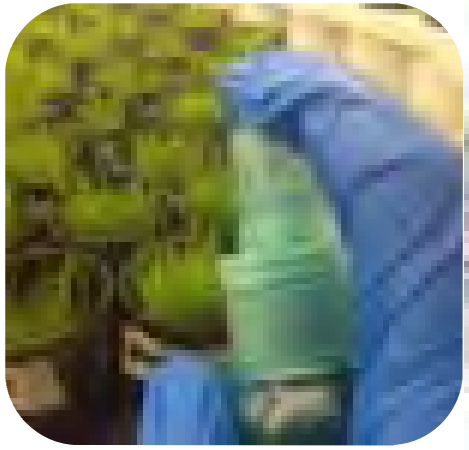
How it Works

- Induced systemic resistance (ISR)
  - **I**nduced- caused by the application
  - **S**ystemic- through the plant system
  - **R**esistance- *Defence response occurs faster when pathogen is present*

Materials and Methods

Growth

20°C
12 h photoperiod
3 wk



Activator

5% Civitas
0.3% Harmonizer
(label rate)
or Water

Inoculation

10°C or 20°C
12 h photoperiod
2 wk

Disease Rating

Results- Experiment 1

Percent yellowing of turfgrass cultivars 14 days post inoculation with *M. nivale*, treated with Civitas or water, under two temperature treatments

Treatment	Cato	Kingpin	L93	Mackenzie	OO7	PennA4	V8	Mean
10°C Civitas	0 a	0 a	2 a	0 a	0 a	0 a	0 a	0
10°C Water	0 a	2 a	2 a	3 a	2 a	12 a	2 a	3
20°C Civitas	83 a	80 a	77 ab	55 b	90 a	87 a	87 a	80
20°C Water	98 a	98 ab	100 a	98 ab	100 a	98 a	90 b	97
LSD (p<0.05)	6	6	15	24	9	16	10	5

- Values with a letter in common are not significantly different.
- Means are based on 3 replicates.

Results

Percent yellowing of turfgrass cultivars 12 days post inoculation with *M. nivale*, treated with Civitas or water, under two temperature treatments

Treatment	Alpha	Focus	Indep	Penn	*Poa annua*	T1	Tyee	Mean
10°C Civitas	1a	0a	5a	2a	7a	5a	2a	3
10°C Water	27ab	45ab	60a	20ab	13ab	28ab	7b	29
20°C Civitas	13a	22a	20a	12a	15a	12a	17a	16
20°C Water	47ab	37ab	63a	35ab	22b	55ab	47ab	44
LSD (p<0.05)	17	45	85	26	16	38	18	12

- Values with a letter in common are not different within row
- Means are based on 3 replicates.
- Indep= Independence, Penn= Penncross

Disease Suppression 12 days post inoculation

	Average percent disease suppression by Civitas + Harmonizer
10°C	83%
20°C	60%
LSD (p<0.05)	18

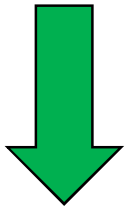
- Means are based on 7 cultivars
- Effect of cultivar was not significant (p>0.05)

Disease Suppression 12 days post inoculation

	Percent disease suppression by Civitas + Harmonizer	
	Experiment 1	Experiment 2
10°C	81	83
20°C	18	60
LSD (p<0.05)	31	18

- Means are based on 7 cultivars
- Effect of cultivar was not significant (p>0.05)

Results

- Most cultivars expressed less symptoms at 10°C than 20°C
- Civitas +Harmonizer →  Symptoms
- C+H suppressed more disease symptoms at 10°C
- Percent yellowing varied by cultivar

How does this apply to the future?

Global temperature increase ↓ *M. nivale* inoculum

Lack of cold hardening conditions ↑ Microdochium patch

Civitas+ Harmonizer ↓ Microdochium patch
(but works better at cool temp)

Future Work

- Continued Field Testing
- Analysis of data on increased CO_2 effect on *M. nivale* disease and turfgrass biochemistry
- Analysis of RNA expression in creeping bentgrass inoculated with *M. nivale*

Acknowledgments

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- GTI Staff

Any Questions?

Thank you for your time