CTRF Progress Report (covering the period Oct 1, 2016 to February 28, 2017)

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PROJECT TITLE: Testing lower risk fungicides for activity against turfgrass diseases (Oct 1, 2015 to Sept 30, 2018) [new items since last report (Oct 2016) are shown in yellow shading]

PURPOSE: The purpose of the proposed work is to investigate the use of lower risk fungicides against turfgrass diseases. The specific practical objective is to quantify the extent by which common diseases such as dollar spot, Fusarium patch and snow moulds can be reduced in lab and field tests, using different application regimes of chemicals such as acetic acid (vinegar), borax, citric acid, garlic powder, hydrogen peroxide, iron sulphate, lime sulphur, phosphites, soaps, sodium chloride, and sulphur. These are all products classified by the Ontario Ministry of the Environment (OME) as Class 11, and available for cosmetic use against turfgrass pests in Ontario, and not on the "banned" list for cosmetic use that is found in OME Class 9. This issue should be of concern to turfgrass managers across Canada since most provinces in Canada have some sort of ban on chemicals for cosmetic use on turf. The subsequent scientific objective would be to determine the mode of action with efficacious treatments, since such compounds may possibly affect diseases by directly inhibiting the pathogens, or indirectly through effects on the plant (e.g. activated resistance) or effects on microbial components which affect either the plant or the pathogen or both. The benefits of this type of research would be replacement of "higher risk" synthetic fungicide applications, by ones already deemed to be "lower risk", via a scientific assessment of how such substances are able to decrease disease. The deliverables from this project is the development of a disease control management regime (application rate, application timing) for important turfgrass diseases using lower risk fungicides that are available for use in Canada.

LAYMAN SUMMARY: There are strong societal pressures against the use of synthetic pesticides in our modern urban society, and this has lead governments to pass legislation which makes it more difficult to use such chemicals without administrative hurdles. In Ontario, there is a class of compounds available for cosmetic use again turfgrass pests, and not on the "banned" list. Similar listings are found in other Canadian provinces. The purpose of this work is to test the efficacy of the selected disease control substances considered to be less risky to the environment and human health for their ability to control the common turfgrass diseases, dollar spot and Fusarium patch, in lab and field tests. During this first year of this project, we have been comparing garlic powder, hydrogen peroxide, iron sulphate, acetic acid, borax, citric acid, dishwashing soap, sodium chloride, sulphur and phosphite on *Agrostis stolonifera* cv. Penncross in pots in the growth chamber for assessing dollar spot disease. We tested at least four different concentrations of each substance. In most cases, inoculated Penncross without treatment had the highest level of yellowing except for some rates of garlic powder and borax (Table 1). The yellowing levels for citric acid, sodium chloride and sulphur treatments were noticeably less (Table 1). These trials were repeated again with similar results. From these lab tests, we selected the lowest rate that provided highest efficacy for each of the compounds, and tested these in the field (Figure 1). The results for 12 products at single rates against dollar spot on a creeping bentgrass putting green are presented in Table 2. These results demonstrated that weekly applications of the products gave results ranging from 1.5% to 10.5% area diseased compared to 17.5% for the inoculated control on 24 Aug 2016. In order of efficacy, these were as follows: Iron sulfate, Standard fungicide (Banner), Citric acid, Hydrogen peroxide, Sulfur, Phosphite, Soaps, Sodium chloride, Garlic powder, Borax, and Acetic acid. These results demonstrated that most "home remedies" may have some suppressive effect, but not at levels to satisfactorily control the disease. We continued field trials in Fall 2016 testing activated resistance against Microdochium patch, as well as against Pink Snow Mold and Grey Snow

Mold over the winter (2016-2017). The results from the fall trials were inconclusive since there was insufficient Fusarium Patch disease pressure (fall 2016 was much too warm). Similarly, winter 2016-2017 started off well with abundant snow in December 2016, but this melted by January and we saw record high temperatures. The inconsistent snowfall and snowcover has not allowed for grey snow mold development, but Pink Snow Mold and Fusarium Patch are visible on the field plots. These are being rated and a report will be provided for the fall annual report. We are continuing to test different rates of these compounds against other turfgrass diseases, and will conduct further field tests through 2017 and 2018.

Funding Sources: (REVENUE) for three year study starting October 1 2015 - September 30 2018
CTRF: $35,000/yr to Univ. Guelph [TF52548], total $105,000

Expenditures

Item	Jan16 - Sept 16	Oct 16 - Feb 17	TOTAL
Personnel	0	4,430	4,430
Travel & Field Work	0	0	0
Supplies + Lab Work	5,231	390	5,621
Growth room charges	200	0	200
TOTAL	5,820	4,820	10,208

Total Revenue from CTRF: $52,250 (since Oct 1, 2015). First funds were received Jan 2016.

NOTE: Because of problems getting the Trust Fund established at the University of Guelph, there were no charges to this project in 2015, although I had labour and other experimental costs incurred. In 2016, I had to spent funds from another grant which was ending, and hence many expenses (including labour costs) were directed to the other grant. At this rate of expenditure, we will have a surplus by the end of this grant period (Oct 2018). I propose that we change the payment schedule and lengthen the duration of this grant (same total amount, but we will work on this project for a longer period, particularly adding another field season in 2019).

Current payment & report schedule	Amount	Proposed payment & report schedule	Amount
October 1, 2015 (no report)	17,500	October 1, 2015 (no report)	17,500
February 15, 2016 (progress report)	17,500	February 15, 2016 (progress report)	17,500
September 15, 2016 (annual report)	17,500	September 15, 2016 (annual report)	17,500
February 15, 2017 (progress report)	17,500	February 15, 2017 (progress report)	none
September 15, 2017 (annual report)	17,500	September 15, 2017 (annual report)	17,500
February 15, 2018 (progress report)	none	February 15, 2018 (progress report)	none
September 30, 2018 (final report)	17,500	September 30, 2018 (annual report)	17,500
		February 15, 2019 (progress report)	17,500
		Dec 31, 2019 (final report)	none
TOTAL	$105,000		$105,000

As well, we propose to place the end date of this project for Dec 31, 2019 with a final report to be submitted at that time (and no payment).

I took on a new student in January 2017 (Katherine Stone) who is working full time on this project. There is the potential for this turn into a Ph.D. project, and hence another reason for the request to lengthen the project (but at no additional cost to CTRF).

RESULTS TO DATE

Table 1: Effect of dollar spot infection on yellowing of *Agrostis stolonifera* cv. Penncross following treatment at 7 and 14 days after seeding with various lower risk fungicides. The plants were inoculated with *Sclerotinia homoeocarpa* at 21 days after treatment, and rated over the next 3 weeks for yellowing. For each chemical, the means for the different rates followed by a letter in common indicates that they are not significantly different at p=0.05.

Concentrations	Visual Yellowing Percentage (by DPI=days after inoculation)				
	Dpi 3	Dpi 7	Dpi 10	Dpi 14	Dpi 21
5% Garlic powder	23 a	32 a	41 a	48 a	56 a
1% Garlic powder	15 b	24 b	33 b	50 a	54 a
0.5% Garlic powder	3 d	8 d	15 d	33 b	38 b
0.1% Garlic powder	0 d	2 e	6 e	15 c	24 c
Water	8 c	18 c	28 c	38 b	44 b
10 mM Hydrogen peroxide	1 b	5 c	9 d	15 d	20 c
1 mM Hydrogen peroxide	2 b	6 bc	11 cd	21 c	28 c
0.5 mM Hydrogen peroxide	4 b	10 b	15 bc	28 b	48 a
0.1 mM Hydrogen peroxide	3 b	9 bc	17 b	31 b	38 b
Water	8 a	18 a	28 a	38 a	44 ab
200 mM Iron sulphate	3 b	8 bc	18 b	27 b	35 ab
100 mM Iron sulphate	3 b	9 b	16 bc	30 ab	36 ab
50 mM Iron sulphate	2 b	8 bc	17 bc	34 ab	41 a
10 mM Iron sulphate	1 b	4 c	11 c	25 b	31 b
Water	8 a	18 a	28 a	38 a	44 a
1% Acetic acid	15 a	30 a	36 a	46 a	45 ab
0.1% Acetic acid	12 ab	24 ab	28 ab	30 ab	47 ab
0.05% Acetic acid	9 b	20 b	25 b	35 ab	50 ab
0.01% Acetic acid	8 b	16 b	19 b	21 b	41 b
Water	15 a	30 a	36 a	43 a	72 a
0.05% Borax	16 bc	35 bc	42 b	46 b	53 a
0.01% Borax	18 bc	36 bc	44 ab	49 ab	59 a
0.002% Borax	24 a	48 a	52 a	64 a	64 a
0.001% Borax	20 ab	39 b	44 ab	52 ab	72 a
Water	15 c	30 c	36 b	43 b	72 a
4% Citric acid	28 a	34 a	36 a	36 b	14 b
3% Citric acid	19 b	23 b	26 bc	31 bc	21 b
1% Citric acid	16 b	22 b	23 c	24 c	16 b
0.05% Citric acid	25 a	28 ab	30 b	32 b	19 b
Water	16 b	25 b	36 a	52 a	51 a
0.5% Soaps (Dawn dishwashing)	20 ab	23 a	28 b	36 b	35 ab
0.1% Soaps	12 c	15 b	16 c	19 c	22 b
0.01% Soaps	15 bc	20 ab	23 bc	30 b	32 b
0.001% Soaps	21 a	23 a	26 b	30 b	21 b
Water	16 abc	25 a	36 a	52 a	51 a
2% Sodium chloride	18 a	20 ab	23 b	27 b	21 b
1% Sodium chloride	16 a	19 ab	24 b	29 b	23 b
0.5% Sodium chloride	17 a	19 ab	21 b	23 b	19 b
0.1% Sodium chloride	16 a	18 b	22 b	28 b	16 b

Water	16 a	25 a	36 a	52 a	51 a
2% Sulphur	13 a	19 b	16 b	20 cd	19 c
1% Sulphur	15 a	25 ab	17 b	19 d	18 c
0.5% Sulphur	17 a	29 a	23 b	27 b	28 b
0.2% Sulphur	15 a	24 ab	21 b	26 bc	25 b
Water	15 a	25 ab	58 a	60 a	81 a
$2*10^{-3}$ g/mL phosphite	8 b	14 b	13 b	22 c	23 b
$5*10^{-4}$g/mL phosphite	8 b	15 b	14 b	21 c	22 b
$5*10^{-5}$g/mL phosphite	10 b	18 b	18 b	20 c	20 b
$1*10^{-5}$g/mL phosphite	11 ab	18 b	12 b	30 b	24 b
Water	15 a	25 a	58 a	60 a	81 a

Table 2: Effect of dollar spot infection on yellowing of *Agrostis stolonifera* and *Poa annua* at greens height (GTI California Green) with weekly treatments from 04 Aug 2016 onwards. The plants were inoculated with *Sclerotinia homoeocarpa* a day after first treatment (05 Aug), and the 0.5 m x 0.5 m plots were rated weekly for percent area affected. An ANOVA followed by a protected LSD was based on four replicate plots per treatment.

		Percent Area affected				
Treatments	Rate	05-Aug	09-Aug	17-Aug	24-Aug	30-Aug
Standard fungicide (Banner)	26 g/100m2	0.0	0.0	3.0	2.0	2.8
Iron sulfate	100 mM	0.0	0.0	1.8	1.5	8.0
Citric acid	3.0%	0.0	0.0	4.0	6.8	9.8
Hydrogen peroxide	10 mM	0.0	0.0	3.0	7.3	12.8
Phosphite	0.002%	0.0	0.0	3.3	7.8	13.8
Sulfur	1%	0.0	0.0	2.8	7.8	13.8
Soaps	0.50%	0.0	0.0	3.5	8.0	14.5
Garlic powder	1.0%	0.0	0.0	3.5	8.3	15.0
Borax	0.01%	0.0	0.0	4.3	10.0	16.3
Sodium chloride	0.10%	0.0	0.0	3.5	8.0	16.5
Acetic acid	0.1%	0.0	0.0	2.8	10.5	18.5
Inoculated Check	--	0.0	0.0	8.0	17.5	27.5
LSD (p=0.05)		0.0	0.0	1.9	3.8	4.9

The shaded cells are significantly less than the Inoculated Check

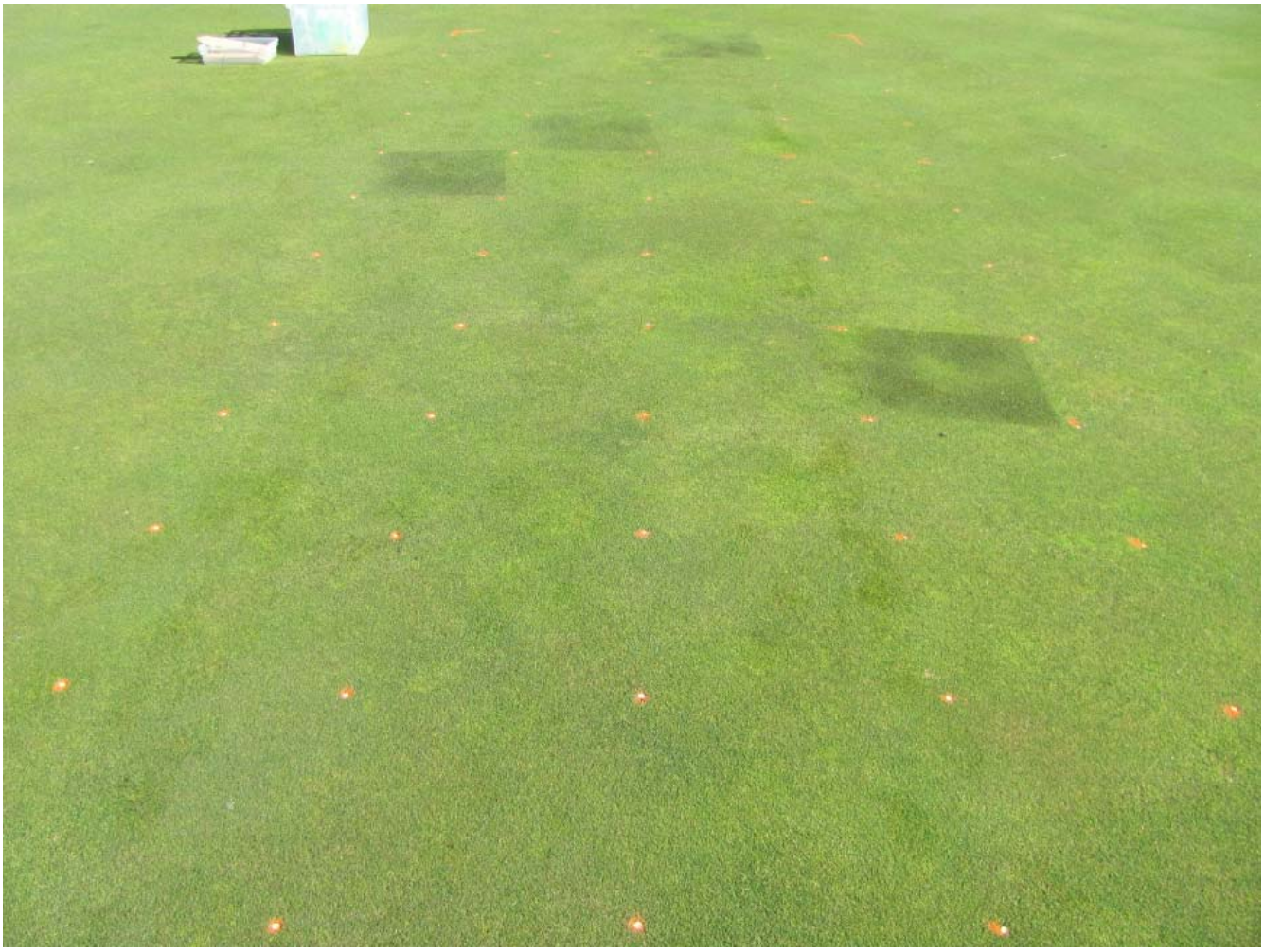

Figure 1: Dollar spot field trial with 12 different treatments in early August 2016 at the Guelph Turfgrass Institute. The greener plots are Iron Sulfate.

Conclusions from 2016 testing

These results to date are very promising, but they are generally not as efficacious as standard fungicides. We still need to test these products against other turfgrass pathogens using this lab system, and also during the next growth season, we will test different rates of select chemicals in the field.

RECENT RESULTS

Table 3: Effect of dollar spot infection on yellowing of *Agrostis stolonifera* cv. Penncross following treatment at 7 days after seeding with various lower risk fungicides. The plants were inoculated with *Sclerotinia homoeocarpa* at 14 days after treatment, and rated over the next 11 days for mycelial growth (mycel) and yellowing (yellow). For each treatment, means which were significantly less than the inoculated control ($p<0.05$) are shown with green shading. This was the first test done complete by the new student (K. Stone).

Treatment	Rate	Mycel4	Mycel6	Mycel8	Mycel11	Yellow4	Yellow6	Yellow8	Yellow11
Banner (standard)	26 g/100m2	33.3	20.0	15.0	16.7	3.0	5.7	8.0	13.3
Iron sulfate	100 mM	23.3	20.0	16.7	15.0	3.0	8.0	11.7	16.7
Soap (Sunlight)	3.0%	16.7	14.0	10.0	10.0	4.3	15.0	16.7	16.7
Sodium chloride (salt)	10 mM	23.3	20.0	18.3	11.7	4.3	11.7	18.3	21.7
Hydrogen peroxide	0.002%	53.3	33.3	28.3	22.3	5.0	13.3	18.3	21.7
Sulfur	1%	18.3	15.0	12.3	9.7	4.3	20.0	21.7	21.7
Garlic powder	0.50%	30.0	21.7	16.7	14.0	4.3	20.0	23.3	25.0
Citric acid	1.0%	65.0	36.7	33.3	26.7	5.0	20.0	25.0	23.3
Phosphite	0.01%	60.0	51.7	45.0	40.0	4.7	21.7	25.0	28.3
Borax	0.10%	--	--	--	--	--	--	--	--
Acetic acid (vinegar)	0.1%	--	--	--	--	--	--	--	--
Inoculated Check	--	75.0	41.7	36.7	23.3	5.0	18.3	33.3	28.3
LSD (p=0.05)		34.0	29.8	28.0	23.7	12.5	13.7	16.0	17.9

FUTURE WORK:

We will continue to replicate this work, and also test other pathogens of other diseases in the lab (brown ring patch, brown patch, anthracnose, Microdochium patch...). In summer 2017, we will conduct field tests with these treatments against dollar spot disease, rust, red thread, and whichever other diseases might appear in the field. Although the 'home remedy' treatments do appear to be as efficacious as traditional synthetic pesticides, they might be able to reduce disease to levels that might become more acceptable in the future. We are also interested in how these compounds work, whether they have direct inhibitory activity against the pathogens or stimulate the plants to fight off disease or some other mechanisms.