Hello WTA Members:

Part of the Wisconsin Turfgrass Association's mission is to "Disseminate research findings to turfgrass professionals." With the many challenges that 2020 has brought to all of us, the WTA Board of Directors recently voted to have four (December thru March) supplemental newsletters that will focus on the research that our own University of Wisconsin-Madison professors conducted this year.

We have access to some of the world's leading turfgrass researchers at the University of Wisconsin-Madison. In partnering with these researchers, the WTA will be sending these research publications to our membership. These publications will include a plethora of information about new and existing products, turfgrass management strategies and agronomics. Look for these publications in your inbox and on our website. Thank you for your continued support of the WTA and enjoy the continued education!

Cheers,

Brad DeBels

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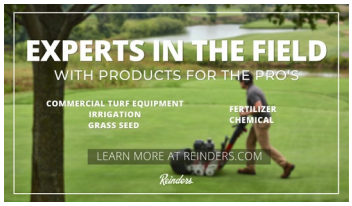
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Dollar Spot Suppression on Golf Course Putting Greens

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OBJECTIVE

To determine the efficacy of standard and experimental fungicides for controlling dollar spot caused by the fungus *Clarireedia jacksonii* on a creeping bentgrass putting green.

MATERIALS AND METHODS

The study was conducted at the O. J. Noer Turfgrass Research and Education Facility on a stand of 'Penncross' creeping bentgrass (*Agrostis stolonifera*) maintained at 0.125 inches. Individual plots measured 3 feet by 10 feet and were arranged in a randomized complete block design with four replications. Treatments were applied at a nozzle pressure of 40 psi using a CO_2-pressurized boom sprayer equipped with two Teejet AI8004 VS nozzles. All fungicides were agitated by hand and applied in the equivalent of 1.5 gallons of water per 1000 ft^2. All treatments were initiated on May 29th, 2020 and subsequent applications were made at 7- or 14-day intervals. Number of dollar spot foci per plot and turfgrass quality (1-9, 9 being excellent, 6 acceptable, and 1 bare soil) were visually assessed every 2 weeks. Turf quality and disease severity were subjected to an analysis of variance and means separated using Fisher's LSD (P = 0.05). Results of disease severity and turfgrass quality ratings can be found in Table 1 and 2, respectively.

RESULTS AND DISCUSSION

Dollar spot pressure was moderate throughout the summer, and the highest pressure was recorded during the Aug 19 rating date with over 47 dollar spot foci per plot in the non-treated control. On Aug 19, 10 of the 24 fungicide treatments provided 100% disease control and an additional 13 treatments provided statistically similar control to the best performing treatments. This means that a full 23 of 24 fungicide treatments provided excellent dollar spot control under moderate disease pressure. Turf quality mostly mirrored disease severity and 17 of 24 fungicide treatments provided acceptable turf quality (>6) on the Aug 19 rating date. Phytotoxicity was observed with all four of the potassium hydroxide treatments, especially at higher rates, though this phytotoxicity typically recovered within 3 to 4 days of the application.

Table 1. Mean number of dollar spots per treatment at greens height at the OJ Noer Turfgrass Research Facility in Madison, WI during 2020.

	Treatment	Rate	Application Interval	Application Code[b]	Dollar Spot Severity[a]		
					Jul 8	Jul 22	Aug 19
1	Non-treated control				22.0 a	34.8 ab	47.5 a
2	Lexicon	0.47 FL OZ/1000 FT2	14 day	BDFHJLN	0.0 d	0.0 d	0.0 b
3	Ascernity	1.0 FL OZ/1000 FT2	14 day	BDFHJLN	2.5 bcd	0.3 d	0.0 b
4	Briskway	0.5 FL OZ/1000 FT2	14 day	BDFHJLN	5.8 bcd	9.3 cd	6.0 b
5	Posterity XT	2.25 FL OZ/1000 FT2	14 day	BDFHJLN	0.0 d	0.0 d	0.0 b
6	Secure Action Daconil Action	0.5 FL OZ/1000 FT2 3.5 FL OZ/1000 FT2	14 day	BDFHJLN BDFHJLN	0.5 cd	2.3 d	0.0 b
7	Posterity Forte	0.42 FL OZ/1000 FT2	14 day	BDFHJLN	0.0 d	0.0 d	0.3 b
8	Posterity XT	1.5 FL OZ/1000 FT2	14 day	BDFHJLN	0.0 d	0.0 d	0.5 b
9	Secure Action Daconil Action	0.5 FL OZ/1000 FT2 2.0 FL OZ/1000 FT2	14 day	BDFHJLN	2.5 bcd	3.8 d	0.0 b
10	A22835A	1.44 FL OZ/1000 FT2	14 day	BDFHJLN	3.5 bcd	15.3 cd	4.5 b
11	A22835A	2.87 FL OZ/1000 FT2	14 day	BDFHJLN	0.5 cd	0.3 d	0.0 b
12	Briskway	0.9 FL OZ/1000 FT2	14 day	BDFHJLN	0.5 cd	1.8 d	0.5 b
13	Briskway	1.2 FL OZ/1000 FT2	14 day	BDFHJLN	0.0 d	0.5 d	0.0 b
14	A20744D	0.5 OZ/1000 FT2	14 day	BDFHJLN	0.0 d	1.3 d	0.5 b
15	Traction	1.3 FL OZ/1000 FT2	14 day	BDFHJLN	0.0 d	0.0 d	0.0 b
16	Traction Ammonium Sulfate	1.3 FL OZ/1000 FT2 2 OZ/1000 FT2	14 day	BDFHJLN BDFHJLN	0.0 d	0.0 d	0.0 b
17	NUP-19022	0.159 FL OZ/1000 FT2	14 day	BDFHJLN	0.0 d	0.3 d	0.3 b
18	NUP-19022 Spectro 90	0.159 FL OZ/1000 FT2 3 OZ/1000 FT2	14 day	BDFHJLN BDFHJLN	0.0 d	1.0 d	0.0 b
22	Potassium Hydroxide	0.2 LB K2O/1000 FT2	7 day	BCDEFGHIJK LMN	20.8 a	37.5 a	43.0 a
23	Potassium Hydroxide	0.4 LB K2O/1000 FT2	7 day	BCDEFGHIJK LMN	5.8 bcd	12.3 cd	5.8 b
24	Potassium Hydroxide	0.6 LB K2O/1000 FT2	7 day	BCDEFGHIJK LMN	3.0 bcd	1.3 d	5.5 b
25	Potassium Hydroxide	0.8 LB K2O/1000 FT2	7 day	BCDEFGHIJK LMN	12.0 abc	11.0 cd	8.5 b
				LSD P=.05	11.56	18.55	20.13

[a]Dollar spot rated as number of dollar spot infection centers. Means followed by the same letter do not significantly differ (P=.05, Fisher's LSD).

[b]Application Code B = May 29, C = Jun 3, D = Jun 10, E = Jun 17, F = Jun 24, G = Jun 30, H = Jul 8, I = Jul 14 J=Jul 22, K = Jul 29, L = Jul 31, N = Aug 14.

Table 2. Mean turfgrass quality per treatment at greens height at the OJ Noer Turfgrass Research Facility in Madison, WI during 2020.

	Treatment	Rate	Application Interval	Application Code[b]	Turfgrass Quality[a]		
					Jul 8	Jul 22	Aug 19
1	Non-treated control				5.3 e	4.8 g	5.0 c
2	Lexicon	0.47 FL OZ/1000 FT2	14 day	BDFHJLN	7.0 a	7.0 a	7.0 a
3	Ascernity	1.0 FL OZ/1000 FT2	14 day	BDFHJLN	7.0 a	6.8 ab	6.8 a
4	Briskway	0.5 FL OZ/1000 FT2	14 day	BDFHJLN	6.5 abc	5.8 cde	5.8 b
5	Posterity XT	2.25 FL OZ/1000 FT2	14 day	BDFHJLN	7.0 a	7.0 a	7.0 a
6	Secure Action Daconil Action	0.5 FL OZ/1000 FT2 3.5 FL OZ/1000 FT2	14 day	BDFHJLN BDFHJLN	6.8 ab	6.3 bc	7.0 a
7	Posterity Forte	0.42 FL OZ/1000 FT2	14 day	BDFHJLN	7.0 a	7.0 a	7.0 a
8	Posterity XT	1.5 FL OZ/1000 FT2	14 day	BDFHJLN	7.0 a	7.0 a	7.0 a
9	Secure Action Daconil Action	0.5 FL OZ/1000 FT2 2.0 FL OZ/1000 FT2	14 day	BDFHJLN	6.3 a-d	6.0 cd	7.0 a
10	A22835A	1.44 FL OZ/1000 FT2	14 day	BDFHJLN	6.0 b-e	5.3 efg	6.0 b
11	A22835A	2.87 FL OZ/1000 FT2	14 day	BDFHJLN	6.8 ab	6.8 ab	7.0 a
12	Briskway	0.9 FL OZ/1000 FT2	14 day	BDFHJLN	7.0 a	6.0 cd	7.0 a
13	Briskway	1.2 FL OZ/1000 FT2	14 day	BDFHJLN	7.0 a	7.0 a	7.0 a
14	A20744D	0.5 OZ/1000 FT2	14 day	BDFHJLN	7.0 a	6.3 bc	7.0 a
15	Traction	1.3 FL OZ/1000 FT2	14 day	BDFHJLN	7.0 a	7.0 a	7.0 a
16	Traction Ammonium Sulfate	1.3 FL OZ/1000 FT2 2 OZ/1000 FT2	14 day	BDFHJLN BDFHJLN	7.0 a	7.0 a	7.0 a
17	NUP-19022	0.159 FL OZ/1000 FT2	14 day	BDFHJLN	7.0 a	7.0 a	7.0 a
18	NUP-19022 Spectro 90	0.159 FL OZ/1000 FT2 3 OZ/1000 FT2	14 day	BDFHJLN BDFHJLN	7.0 a	6.8 ab	7.0 a
22	Potassium Hydroxide	0.2 LB K2O/1000 FT2	7 day	BCDEFGHIJK LMN	5.3 e	5.0 fg	5.0 c
23	Potassium Hydroxide	0.4 LB K2O/1000 FT2	7 day	BCDEFGHIJK LMN	6.0 b-e	5.5 def	5.5 bc
24	Potassium Hydroxide	0.6 LB K2O/1000 FT2	7 day	BCDEFGHIJK LMN	6.0 b-e	6.0 cd	6.0 b
25	Potassium Hydroxide	0.8 LB K2O/1000 FT2	7 day	BCDEFGHIJK LMN	5.5 de	5.8 cde	5.8 b
				LSD P=.05	0.82	0.74	0.64

[a]Turfgrass quality was rated visually on a 1 – 9 scale with 6 being acceptable. Means followed by the same letter do not significantly differ (P=.05, Fisher's LSD).

[b]Application Code B = May 29, C = Jun 3, D = Jun 10, E = Jun 17, F = Jun 24, G = Jun 30, H = Jul 8, I = Jul 14 J=Jul 22, K = Jul 29, L = Jul 31, N = Aug 14.

Precision Dollar Spot Management

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OBJECTIVE

To determine if using weather stations embedded with the Smith-Kerns dollar spot prediction model scattered around the same golf course can result in different fungicide application timings and fungicide savings relative to a traditional calendar method of fungicide application.

MATERIALS AND METHODS

The study was replicated at 3 locations: the O.J. Noer Turfgrass Research and Education Facility in Madison, WI and the 7th and 18th holes at University Ridge Golf Course in Madison, WI. At all sites the study was conducted on creeping bentgrass (*Agrostis stolonifera* 'Pencross') maintained at a 0.5 inch cutting height. The individual plots measured 6 ft X 10 ft and were arranged in a randomized complete block design with four replications. Individual treatments were applied at a nozzle pressure of 40 p.s.i. using a CO2-pressurized boom sprayer equipped with two XR Teejet AI8004VS nozzles. All fungicides were agitated by hand and applied in the equivalent of 1.5 gallons of water per 1000 ft^2. Three fungicide programs were tested in addition to the non-treated control. One was a standard fungicide program based off the program of a local golf course, the second based the application timing on the Smith-Kerns dollar spot prediction model, and the third based the application timing on the Smith-Kerns dollar spot model but used an adjustment we call the 'Clarke Correction'. This adjustment states that spray intervals should be lengthened when the Smith-Kerns model is over 20% and the overall slope of the Smith-Kerns model forecast is generally negative. The Clarke Correction treatment was only tested at the OJ Noer site. The custom weather stations were developed by Walker Olson and Josh Friell of Toro. Number of dollar spot infection centers per plot and turfgrass quality (1-9, 9 being excellent, 6 acceptable, and 1 bare soil) were assessed every two weeks. Results were subjected to an analysis of variance and means were separated using Fisher's LSD (P = 0.05). Disease severity, turfgrass quality, and Smith-Kerns model numbers from all locations can be found in the following tables.

RESULTS AND DISCUSSION

Due to disease pressure being similar between the three weather stations, there were no differences in application timings among the three locations. However, there were clearly differences in dollar spot pressure among the three locations that indicates that precision dollar spot management could be an effective way to more efficiently manage dollar spot. Hole 18 had the most dollar spot during much of the first part of the season and had the highest SK Model numbers during those periods. Due to the Smith-Kerns model being above 20% for most of the season there was no difference between the application timings of treatments 2 and 3. Treatment 4, which was only conducted at the OJ Noer site and utilized the Clarke Correction, gave a few small windows of reapplication extension. These small windows only added up to 13 days over the course of the summer.

Table 1. Mean number of dollar spot infection centers on nontreated controls in all 3 locations.

	Jul 8	**Aug 5**	**Sep 2**
OJ Noer	270.0	485.0	541.0
7 Fwy	49.0	320.8	714.3
18 Fwy	223.0	5.5	74.5

Table 2. Mean number of dollar spot infection centers per treatment at the OJ Noer Turfgrass Research and Education Facility in Madison, WI in 2020.

	Treatment	Rate	Application Date/Interval	Dollar spot severity[a]		
				Jul 8	Aug 5	Sep 2
1	Non-treated control			270.0a	485.0a	541.0a
2	Standard Program			27.3b	5.3b	7.8b
	Emerald	0.18 OZ/1000 FT2	May 29			
	Banner Maxx	2.0 FL OZ/1000 FT2	Jun 25			
	Interface	4.0 FL OZ/1000 FT2	Jul 16			
	Velista	0.5 OZ/1000 ft2	Jul 30			
	Secure	0.5 FL OZ/1000 FT2	Jul 30			
	Xzemplar	0.26 FL OZ/1000 FT2	Aug 13			
	Pinpoint	0.31 FL OZ/1000 FT2	Sep 10			
	26 GT	4.0 FL OZ/1000 FT2	Oct 8			
	Banner Maxx	2.0 FL OZ/1000 FT2	Oct 22			
3	Smith-Kerns model: Standard			75.3b	5.5b	8.5b
	Emerald	0.18 OZ/1000 FT2	28 day			
	Banner Maxx	2.0 FL OZ/1000 FT2	21 day			
	Interface	4.0 FL OZ/1000 FT2	14 day			
	Velista	0.5 OZ/1000 ft2	14 day			
	Secure	0.5 FL OZ/1000 FT2				
	Xzemplar	0.26 FL OZ/1000 FT2	28 day			
	Pinpoint	0.31 FL OZ/1000 FT2	28 day			
	26 GT	4.0 FL OZ/1000 FT2	14 day			
	Banner Maxx	2.0 FL OZ/1000 FT2	14 day			
4	Smith-Kerns model: Clarke Correction			57.8b	29.0b	8.5b
	Emerald	0.18 OZ/1000 FT2	28 day			
	Banner Maxx	2.0 FL OZ/1000 FT2	21 day			
	Interface	4.0 FL OZ/1000 FT2	14 day			
	Velista	0.5 OZ/1000 ft2	14 day			
	Secure	0.5 FL OZ/1000 FT2				
	Xzemplar	0.26 FL OZ/1000 FT2	28 day			
	Pinpoint	0.31 FL OZ/1000 FT2	28 day			
	26 GT	4.0 FL OZ/1000 FT2	14 day			
	Banner Maxx	2.0 FL OZ/1000 FT2	14 day			
			LSD P=.05	54.31	115.31	167.55

[a]Dollar spot was visually assessed as number of dollar spot infection centers per plot. Means followed by the same letter do not significantly differ (P=.05, Fisher's LSD). Means followed by dashes indicate no significant differences were observed among any of the treatments.

Table 3. Mean turf quality ratings per treatment at the OJ Noer Turfgrass Research and Education Facility in Madison, WI in 2020.

		Treatment	Rate	Application Date/Interval	Turf Quality[a]		
					Jul 8	Aug 5	Sep 2
1		Non-treated control			4.0c	3.8b	4.0b
2	Standard Program	Emerald	0.18 OZ/1000 FT2	May 29	6.8a	7.0a	6.8a
		Banner Maxx	2.0 FL OZ/1000 FT2	Jun 25			
		Interface	4.0 FL OZ/1000 FT2	Jul 16			
		Velista	0.5 OZ/1000 ft2	Jul 30			
		Secure	0.5 FL OZ/1000 FT2	Jul 30			
		Xzemplar	0.26 FL OZ/1000 FT2	Aug 13			
		Pinpoint	0.31 FL OZ/1000 FT2	Sep 10			
		26 GT	4.0 FL OZ/1000 FT2	Oct 8			
		Banner Maxx	2.0 FL OZ/1000 FT2	Oct 22			
3	Smith-Kerns model: Standard	Emerald	0.18 OZ/1000 FT2	28 day	5.3b	7.0a	6.5a
		Banner Maxx	2.0 FL OZ/1000 FT2	21 day			
		Interface	4.0 FL OZ/1000 FT2	14 day			
		Velista	0.5 OZ/1000 ft2	14 day			
		Secure	0.5 FL OZ/1000 FT2				
		Xzemplar	0.26 FL OZ/1000 FT2	28 day			
		Pinpoint	0.31 FL OZ/1000 FT2	28 day			
		26 GT	4.0 FL OZ/1000 FT2	14 day			
		Banner Maxx	2.0 FL OZ/1000 FT2	14 day			
4	Smith-Kerns model: Clarke Correction	Emerald	0.18 OZ/1000 FT2	28 day	5.3b	6.8a	7.0a
		Banner Maxx	2.0 FL OZ/1000 FT2	21 day			
		Interface	4.0 FL OZ/1000 FT2	14 day			
		Velista	0.5 OZ/1000 ft2	14 day			
		Secure	0.5 FL OZ/1000 FT2				
		Xzemplar	0.26 FL OZ/1000 FT2	28 day			
		Pinpoint	0.31 FL OZ/1000 FT2	28 day			
		26 GT	4.0 FL OZ/1000 FT2	14 day			
		Banner Maxx	2.0 FL OZ/1000 FT2	14 day			
				LSD P=.05	0.77	0.6	0.67

[a]Turfgrass quality was rated visually on a 1 – 9 scale with 6 being acceptable. Means followed by the same letter do not significantly differ (P=.05, Fisher's LSD). Means followed by dashes indicate no significant differences were observed among any of the treatments.

Table 4. Mean number of dollar spot infection centers per treatment at University Ridge 7 fairway in Madison, WI in 2020.

		Treatment	Rate	Application Date/Interval	Dollar spot severity[a]		
					Jul 8	Aug 5	Sep 2
1		Non-treated control			49.0a	320.8a	714.3a
2	Standard Program	Emerald	0.18 OZ/1000 FT2	May 29	5.5a	131.0a	2.8b
		Banner Maxx	2.0 FL OZ/1000 FT2	Jun 25			
		Interface	4.0 FL OZ/1000 FT2	Jul 16			
		Velista	0.5 OZ/1000 ft2	Jul 30			
		Secure	0.5 FL OZ/1000 FT2	Jul 30			
		Xzemplar	0.26 FL OZ/1000 FT2	Aug 13			
		Pinpoint	0.31 FL OZ/1000 FT2	Sep 10			
		26 GT	4.0 FL OZ/1000 FT2	Oct 8			
		Banner Maxx	2.0 FL OZ/1000 FT2	Oct 22			
3	Smith-Kerns model: Standard	Emerald	0.18 OZ/1000 FT2	28 day	18.5a	160.8a	6.3b
		Banner Maxx	2.0 FL OZ/1000 FT2	21 day			
		Interface	4.0 FL OZ/1000 FT2	14 day			
		Velista	0.5 OZ/1000 ft2	14 day			
		Secure	0.5 FL OZ/1000 FT2				
		Xzemplar	0.26 FL OZ/1000 FT2	28 day			
		Pinpoint	0.31 FL OZ/1000 FT2	28 day			
		26 GT	4.0 FL OZ/1000 FT2	14 day			
		Banner Maxx	2.0 FL OZ/1000 FT2	14 day			
				LSD P=.05	66.88	266.31	145.14

[a]Dollar spot was visually assessed as number of dollar spot infection centers per plot. Means followed by the same letter do not significantly differ (P=.05, Fisher's LSD). Means followed by dashes indicate no significant differences were observed among any of the treatments.

Table 5. Mean turf quality ratings per treatment at University Ridge 7 fairway in Madison, WI in 2020.

		Treatment	Rate	Application Date/Interval	Turf Quality[a]		
					Jul 8	Aug 5	Sep 2
1		Non-treated control			5.5b	4.5b	4.3b
2	Standard Program	Emerald	0.18 OZ/1000 FT2	May 29	7.0a	7.0a	7.0a
		Banner Maxx	2.0 FL OZ/1000 FT2	Jun 25			
		Interface	4.0 FL OZ/1000 FT2	Jul 16			
		Velista	0.5 OZ/1000 ft2	Jul 30			
		Secure	0.5 FL OZ/1000 FT2	Jul 30			
		Xzemplar	0.26 FL OZ/1000 FT2	Aug 13			
		Pinpoint	0.31 FL OZ/1000 FT2	Sep 10			
		26 GT	4.0 FL OZ/1000 FT2	Oct 8			
		Banner Maxx	2.0 FL OZ/1000 FT2	Oct 22			
3	Smith-Kerns model: Standard	Emerald	0.18 OZ/1000 FT2	28 day	6.5a	7.0a	7.0a
		Banner Maxx	2.0 FL OZ/1000 FT2	21 day			
		Interface	4.0 FL OZ/1000 FT2	14 day			
		Velista	0.5 OZ/1000 ft2	14 day			
		Secure	0.5 FL OZ/1000 FT2				
		Xzemplar	0.26 FL OZ/1000 FT2	28 day			
		Pinpoint	0.31 FL OZ/1000 FT2	28 day			
		26 GT	4.0 FL OZ/1000 FT2	14 day			
		Banner Maxx	2.0 FL OZ/1000 FT2	14 day			
				LSD P=.05	0.82	0.58	0.5

[a]Turfgrass quality was rated visually on a 1 – 9 scale with 6 being acceptable. Means followed by the same letter do not significantly differ (P=.05, Fisher's LSD). Means followed by dashes indicate no significant differences were observed among any of the treatments.

Table 6. Mean number of dollar spot infection centers per treatment at University Ridge 18 fairway in Madison, WI in 2020.

		Treatment	Rate	Application Date/Interval	Dollar spot severity[a]		
					Jul 8	Aug 5	Sep 2
1		Non-treated control			223.0a	5.5a	74.5a
2	Standard Program	Emerald	0.18 OZ/1000 FT2	May 29	18.3a	0.0a	0.0b
		Banner Maxx	2.0 FL OZ/1000 FT2	Jun 25			
		Interface	4.0 FL OZ/1000 FT2	Jul 16			
		Velista	0.5 OZ/1000 ft2	Jul 30			
		Secure	0.5 FL OZ/1000 FT2	Jul 30			
		Xzemplar	0.26 FL OZ/1000 FT2	Aug 13			
		Pinpoint	0.31 FL OZ/1000 FT2	Sep 10			
		26 GT	4.0 FL OZ/1000 FT2	Oct 8			
		Banner Maxx	2.0 FL OZ/1000 FT2	Oct 22			
3	Smith-Kerns model: Standard	Emerald	0.18 OZ/1000 FT2	28 day	33.8a	0.0a	0.0b
		Banner Maxx	2.0 FL OZ/1000 FT2	21 day			
		Interface	4.0 FL OZ/1000 FT2	14 day			
		Velista	0.5 OZ/1000 ft2	14 day			
		Secure	0.5 FL OZ/1000 FT2				
		Xzemplar	0.26 FL OZ/1000 FT2	28 day			
		Pinpoint	0.31 FL OZ/1000 FT2	28 day			
		26 GT	4.0 FL OZ/1000 FT2	14 day			
		Banner Maxx	2.0 FL OZ/1000 FT2	14 day			
				LSD P=.05	175.93	10.99	55.18

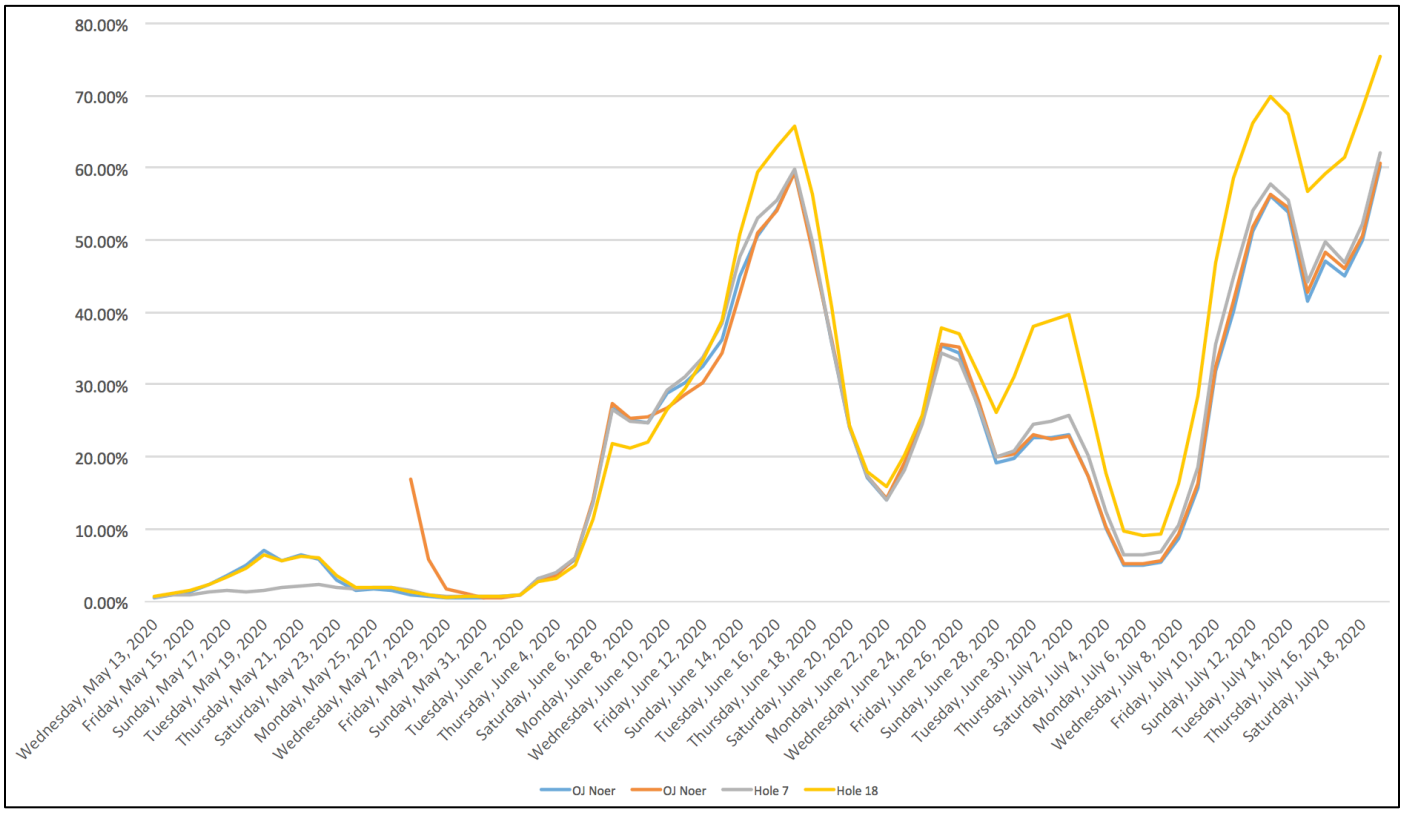
[a]Dollar spot was visually assessed as number of dollar spot infection centers per plot. Means followed by the same letter do not significantly differ (P=.05, Fisher's LSD). Means followed by dashes indicate no significant differences were observed among any of the treatments.

Table 7. Mean turf quality ratings per treatment at University Ridge 18 fairway in Madison, WI in 2020.

	Treatment	Rate	Application Date/Interval	Turf Quality[a]		
				Jul 8	Aug 5	Sep 2
1	Non-treated control			4.5b	5.5b	5.8b
2	Standard Program			6.8a	7.0a	7.0a
	Emerald	0.18 OZ/1000 FT2	May 29			
	Banner Maxx	2.0 FL OZ/1000 FT2	Jun 25			
	Interface	4.0 FL OZ/1000 FT2	Jul 16			
	Velista	0.5 OZ/1000 ft2	Jul 30			
	Secure	0.5 FL OZ/1000 FT2	Jul 30			
	Xzemplar	0.26 FL OZ/1000 FT2	Aug 13			
	Pinpoint	0.31 FL OZ/1000 FT2	Sep 10			
	26 GT	4.0 FL OZ/1000 FT2	Oct 8			
	Banner Maxx	2.0 FL OZ/1000 FT2	Oct 22			
3	Smith-Kerns model: Standard			6.5a	7.0a	7.0a
	Emerald	0.18 OZ/1000 FT2	28 day			
	Banner Maxx	2.0 FL OZ/1000 FT2	21 day			
	Interface	4.0 FL OZ/1000 FT2	14 day			
	Velista	0.5 OZ/1000 ft2	14 day			
	Secure	0.5 FL OZ/1000 FT2				
	Xzemplar	0.26 FL OZ/1000 FT2	28 day			
	Pinpoint	0.31 FL OZ/1000 FT2	28 day			
	26 GT	4.0 FL OZ/1000 FT2	14 day			
	Banner Maxx	2.0 FL OZ/1000 FT2	14 day			
			LSD P=.05	1.38	0.58	0.5

[a]Turfgrass quality was rated visually on a 1 – 9 scale with 6 being acceptable. Means followed by the same letter do not significantly differ (P=.05, Fisher's LSD). Means followed by dashes indicate no significant differences were observed among any of the treatments.

Figure 1. Smith-Kerns Dollar Spot Model Probabilities at the OJ Noer Center and Hole 7 and 18 at University Ridge GC in Madison, WI during the summer of 2020.



Evaluation of a Mycorrhizal Product on Creeping Bentgrass Putting Green Health and Phosphorus Uptake

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Objective: This experiment evaluated the effect of a mycorrhizal inoculant and phosphorus fertilization on several performance characteristics of a creeping bentgrass putting green with low soil phosphorus content.

Materials and Methods: This study was conducted at the O.J. Noer Turfgrass Facility in Madison, WI to evaluate the efficacy of a mycorrhizal product from Mycorrhizal Applications on several performance characteristics of a creeping bentrass putting green on a sand root zone with low available phosphorus content. The study was designed and executed as a randomized complete block design with four replications of and four treatments (Table 1). Individual plots measured 10 x 10 feet, with 3-foot non-treated boarders between plots. The experimental putting green was mowed approximately 5 days a week at 0.125 inches with a Jacobsen Triplex greens mower. All treatments were applied using a CO_2-powered backpack sprayer calibrated to deliver 43 gallons per acre. Initial applications were made on 23 June 2020.

Turfgrass quality was assessed on a 1-9 scale, with 1 being completely brown or dead turf, 6 representing the minimally acceptable turf quality, and 9 representing the greatest possible quality. To compliment the visual quality assessment (which has a degree of subjectivity to it), the Normalized Difference Red Edge (NDRE) index was recorded with the Holland Scientific CS-45 to quantify the relative health of the vegetation using reflectance data. Clippings were collected approximately every two weeks using a Toro 1000 walking greens mower to assess the treatments effect on growth and nutrient content of the clippings. Clippings were dried, cleaned of debris, weighted, and sent to Rock River Laboratory (Watertown, WI) for N and P analysis. At the end of the trial soil cores were collected to 3" depth from each plot were composited for Mehlich-3 phosphorus analysis at Rock River Laboratory. Four soil cores from each plot were taken to rooting depth just prior to the onset of the study and again at the final rating date of 2020. These cores were used to assess the prevalence of mycorrhizal association with bentgrass roots. Briefly, the roots were separated from soil cores with water, then boiled for three minutes in a 10% KOH solution, and then stained by boiling in 1% trypan blue solution for one minute. The stained roots were then rinsed in distilled water three times to remove the residual dye and placed on microscope slides. The arbuscles in the root cells were counted manually under the microscope. Treatment means were separated using Fisher's Least Significant Difference at alpha = 0.05.

Table 1. Treatments and application rates for the products used in the trial.

Treatment Description	Application Rate	Application Date(s)
	mL or lbs per 1000 sqft.	
MA 10075 Only	2.8 mL	23 June 2020
MA 10075 + Phosphorus	2.8 mL + 0.1 lbs	MA 10075 on 23 June 2020, P biweekly
Phosphorus Only	0.1 lbs	biweekly
Control	n/a	n/a

Results:

Mycorrhizal Infection: We found some evidence that application of MA 10075 affected the root arbuscules (Table 2). Initially, prior to treatment applications, the plots ranged from 6 to 20 arbuscules per cm of root. This is consistent with previous observations that we commonly find natural mycorrhizal associations even on plots not previously inoculated with a product. At the end of the trial, we did not find a significant difference in infection from the MA10075 treatments compared to the control. However, it appeared that within the P-treated plots, the MA 10075 increased the infection by a factor of 3, while the phosphorus only treatment only increased by a factor of 1.3. The MA 10075 only and control both increased at a rate of approximately 3-fold from the beginning to the end of the trial. It may be that the MA 10075 helped form mycorrhizal associations in a P rich environment. More work would be required to say this definitively.

Table 2. Count of mycorrhizal arbuscles at the beginning and end of the study period. Different letters indicate statistically significant differences (p = 0.05).

#	Treatment Description	Prior to study	End of study
		# of arbuscules per cm of root	
1	MA 10075	17.5 ab	46.4 a
2	MA 10075 +P	6.7 b	18.0 b
3	Phosphorus Only	20.4 a	34.2 ab
4	Control	10.1 ab	33.5 ab

Performance Characteristics: Unfortunately, despite the root zone having very low soil P and even signs of P deficiency in the turf (Figure 1), we did not observe any significant performance improvements with turf treated with MA 10075. Table 3). This may be partially explained by the relative lack of differences in mycorrhizal infection between the control and the treated plots. Averaged over the season, turfgrass visual quality, NDRE, clipping mass, and tissue N were all statistically similar. We observed greater soil P levels in the MA 10075+P treatment compared to the control, and we observed significantly greater plant tissue P in the plots treated with P, but no differences between the MA 10075 only and the control (Table 3).

Data for performance characteristics are presented for each individual rating date for turfgrass visual quality (Table 4, Figure 2), NDRE (Table 5, Figure 3), clipping yield (Table 6, Figure 4), and tissue phosphorus content (Table 7, Figure 5). We did observe that MA 10075 had significantly greater clipping yield on August 4th compared to the non-treated control. However, this result did not occur consistently. Weather data for the duration of the study are presented in Figure 6.

In conclusion, the results did not strongly support the hypothesis that mycorrhizal applications improve the characteristics of a creeping bentgrass putting green on a soil with low available P content. This may be because natural mycorrhizal infections were sufficient, or that the applied inoculant did not produce an infection level great enough to make a difference.

Table 3. Average visual quality, color reflectance (NDRE), clipping mass, and P content through the study period. Soil P was assessed once at the end of the study. Different letters indicate statistically significant differences.

Treatment	Quality	NDRE	Clipping mass	Soil P	Plant Tissue N	Plant Tissue P
	1-9, 9=best	0-1, 1=greenest	g / m^2	ppm	---------- % ----------	
MA 10075	6.57 a	0.332 a	8.35 a	13.0 ab	4.6 a	0.26 b
MA 10075 +P	6.68 a	0.324 a	8.89 a	15.0 a	4.6 a	0.34 a
Phosphorus Only	6.64 a	0.324 a	8.27 a	12.3 ab	4.6 a	0.34 a
Control	6.46 a	0.332 a	8.26 a	9.9 b	4.6 a	0.28 b

Figure 1. A photograph from October 29, 2020 of the plot area showing purple discoloration associated with phosphorus deficiency. Alleys of P deficient turf can be seen between P treated plots near the top of the picture.

Table 4. Turfgrass visual quality through the study period. Different letters indicate statistically significant differences (p = 0.05).

Treatment	23 June*	6 July	21 July	4 August	17 August	31 August	14 Sept	28 Sept
				1-9 (1 is death, 9 is ideal)				
MA 10075	6.0 a	7.0 a	6.3 a	7.3 a	6.3 a	6.3 a	6.5 a	6.5 a
MA 10075 +P	5.5 a	7.0 a	6.5 a	7.3 a	6.8 a	6.5 a	6.3 a	6.5 a
Phosphorus Only	5.3 a	7.3 a	6.5 a	7.3 a	6.8 a	6.3 a	6.0 a	6.5 a
Control	6.3 a	7.0 a	6.0 a	6.8 a	6.3 a	6.3 a	6.5 a	6.5 a

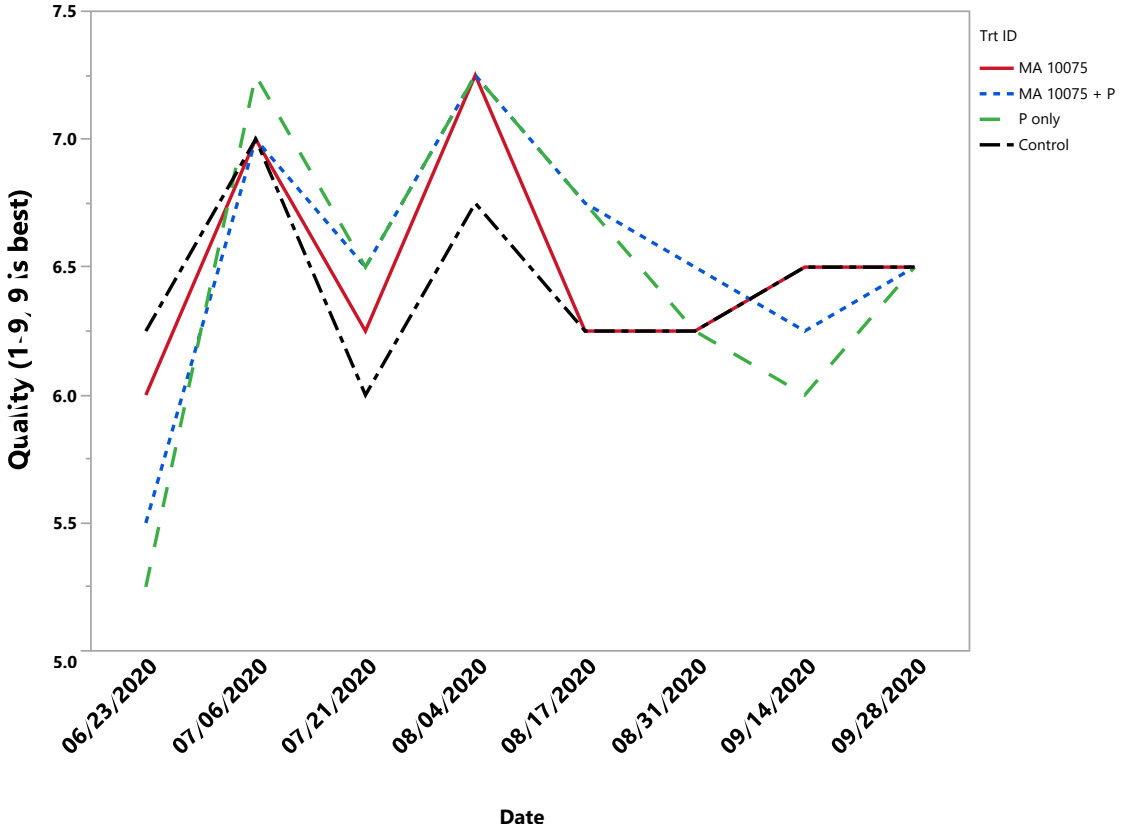

Figure 2. Visual turfgrass quality during study period.

Table 5. Turfgrass reflectance (NDRE) at each rating date during the study. * application date. Different letters indicate statistically significant differences (p = 0.05)

Treatment	23 June*	6 July	21 July	4 August	17 August	31 August	14 Sept	29 Sept
				Index is from 0 to 1, greater is greener				
MA 10075	0.336 a	0.337 a	0.343 a	0.340 a	0.360 a	0.323 a	0.330 a	0.288 a
MA 10075 +P	0.348 a	0.340 a	0.347 a	0.334 a	0.341 a	0.310 a	0.314 a	0.283 a
Phosphorus Only	0.339 a	0.335 a	0.346 a	0.336 a	0.344 a	0.315 a	0.315 a	0.274 a
Control	0.334 a	0.334 a	0.337 a	0.339 a	0.355 a	0.320 a	0.340 a	0.301 a

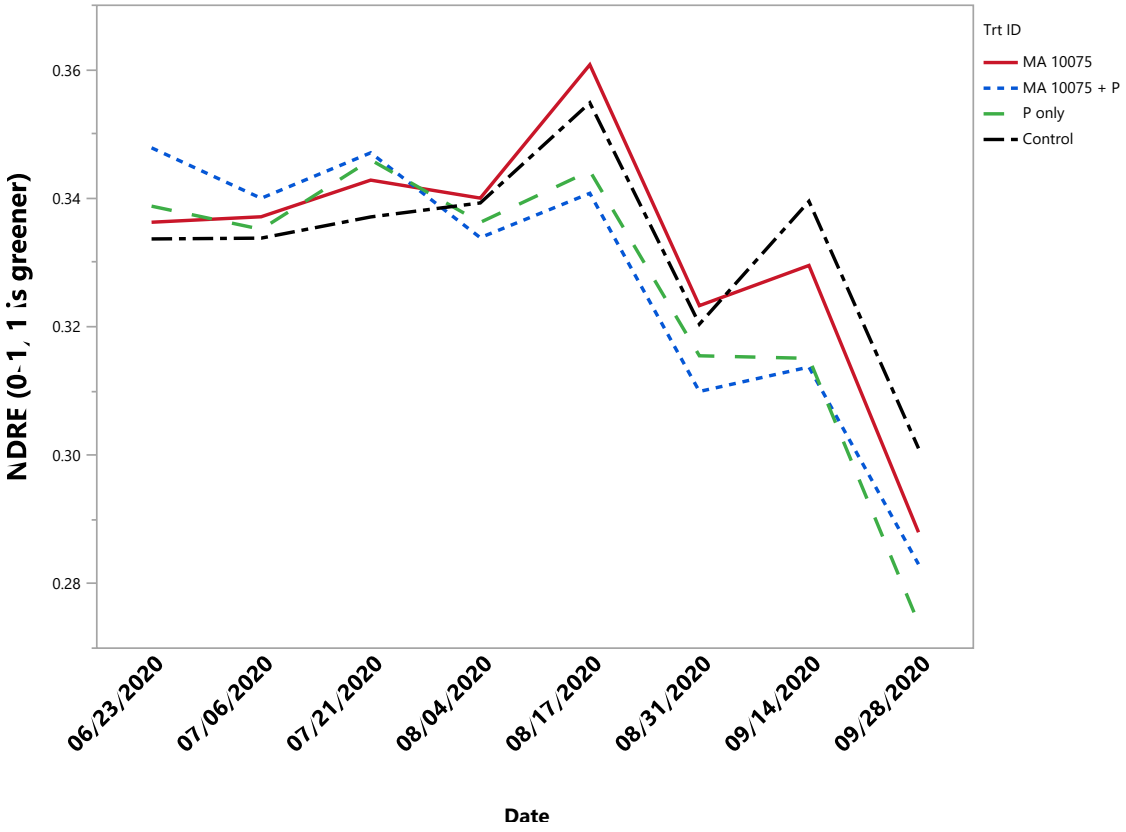

Figure 3. Turfgrass color reflectance (NDRE) during study period.

Table 6. Clipping mass at each rating date during the study. Different letters indicate statistically significant differences (p = 0.05)

Treatment	6 July	21 July	4 August	17 August	31 August	14 Sept
			grams per m^2			
MA 10075	10.37 a	9.16 a	6.56 a	7.96 a	7.43 ab	8.61 a
MA 10075 +P	11.43 a	10.20 a	6.34 ab	8.08 a	8.17 a	9.10 a
Phosphorus Only	10.44 a	8.64 a	5.55 ab	8.16 a	7.46 ab	9.37 a
Control	11.18 a	10.12 a	4.74 b	7.32 a	7.17 b	9.04 a

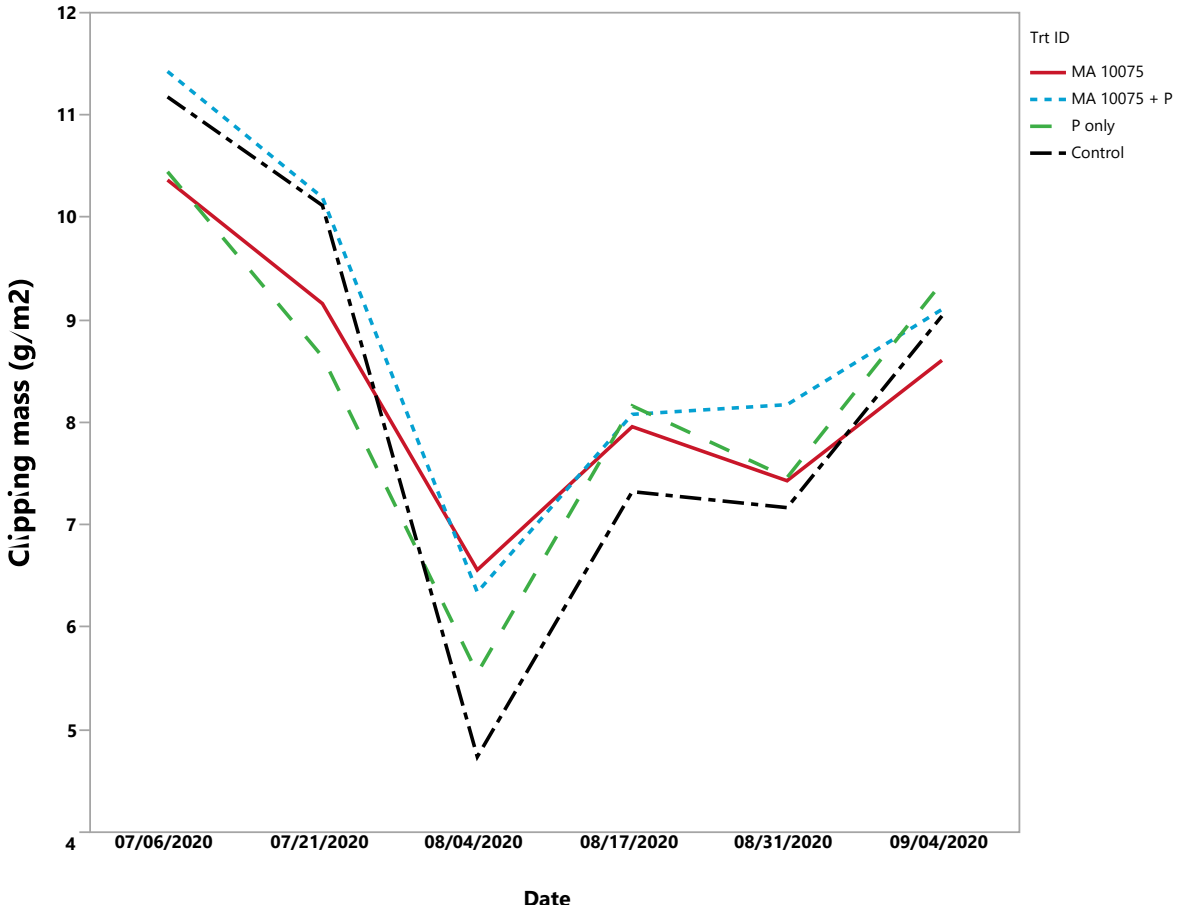

Figure 4. Clipping mass during study period.

Table 7. Phosphorus content of clippings at each rating date during the study. Different letters indicate statistically significant differences (p = 0.05)

Treatment	6 July	21 July	4 August	17 August	31 August	14 Sept
	---------- ppm (to convert to %, divide by 10,000) ----------					
MA 10075	2652 a	2650 a	2610 a	2651 b	2586 b	2681 b
MA 10075 +P	2750 a	3257 a	3228 a	3482 a	3561 a	4068 a
Phosphorus Only	2840 a	3388 a	3005 a	3680 a	3431 a	4182 a
Control	2625 a	2987 a	2547 a	2963 ab	2628 b	2764 b

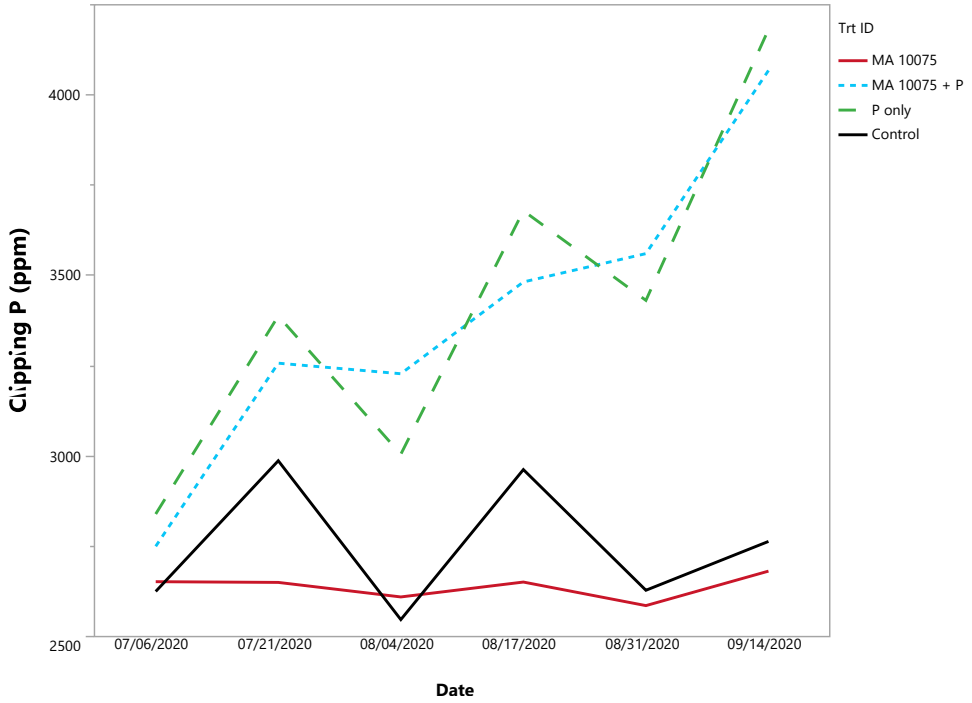

Figure 5. Phosphorus content of clippings at each rating date during the study.

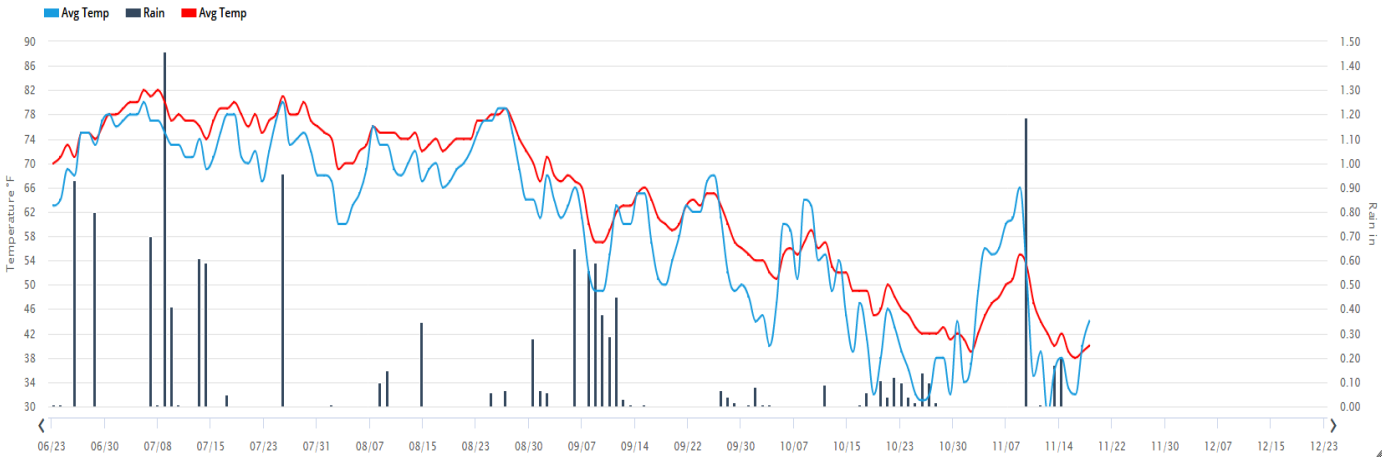

Figure 6. Average air temperature (blue line), daily precipitation total (bars), and 1 inch soil temperature (red line) at the O.J. Noer Turfgrass Research Facility in Verona, WI for the study period.

Precision Growth Regulation for Athletic Fields

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Objective: The objective of this study was to evaluate the turfgrass growth and visual quality of a Kentucky bluegrass athletic field treated with a variety of precision growth regulators (PGRs) and placed under intense simulated traffic.

Materials and Methods: This study was conducted at the O.J. Noer Turfgrass Facility in Madison. A randomized complete block design was used with nine treatments (listed in Table 1) and three replications. Plots were split into two traffic regimes, no traffic and traffic. Individual plots measured 4 x 4 feet. The study site was on Kentucky bluegrass (2.25 inch mowing height). PGR treatments were applied using a CO_2-powered backpack sprayer calibrated to deliver 86 gallons per acre. Applications were begun on 1 June 2020 and reapplications were made based on growing degree day models from the GreenKeeper App. Products were watered in (or not) according to the label instructions.

Turfgrass visual quality was assessed using the NTEP standard 1-9 scale where 1 is dead or completely brown turf, 6 represents minimal acceptability, and 9 is associated with highest possible turfgrass quality. Turfgrass reflectance and color (NDRE) was assessed by a Holland Scientific CS-45 color reflectance meter. Clippings were collected approximately every two weeks, dried, and massed to determine the degree of growth regulation. Traffic was applied by a Brinkman traffic simulator which simulated three NFL games a week. Treatment means were separated using Fisher's Least Significant Difference at alpha = 0.05.

Table 1. Treatments and application rates for the products used in the trial.

Treatment Description	Application Rate	Reapplication Interval	Applications Made
	oz per 1000 sq. ft.	GDD base 0 ℃	
Primo Low	0.25	280	9
Primo High	0.75	353	8
Trimmit 2SC Low	0.5	300	9
Trimmit 2SC High	0.75	300	9
Cutless Low	0.55	300	9
Cutless High	1.1	300	9
Aneuw Low	0.3 (g)	294	9
Aneuw High	0.6 (g)	333	8
Control	n/a	n/a	n/a

Results: Table 2 summarizes the season-long averages of turfgrass quality, color, clipping yield, density, and crabgrass as affected by traffic and PGR treatment. Interestingly, for the non-treated control, we noticed higher turfgrass quality under traffic, than with no traffic. This can be partly attributed to the effect of traffic on reducing crabgrass. The greatest turfgrass quality was associated with the non-treated control and the Anuew treatment at the high label rate. These two treatments, along with Primo Maxx at the low label rate had the greatest color over the season as well. However, we found that the Anuew (high) and Primo Maxx (low) treatments produced over three times less clippings per mowing than the non-treated control (20 g/plot vs ~ 6 g/plot). This observation suggests that these two products can be used to maintain high quality turfgrass with substantially fewer clippings under intense traffic. The high rates of Anuew and Primo Maxx resulted in significantly greater tiller density at the end of the study. The low label rates for these two products had statistically similar density as the control treatment.

Turfgrass Quality: Upon inspection of Figure 1, the PGR treatments under traffic fell into three distinct groups for turfgrass quality. The previously mentioned top group included the control, Primo (low), and Anuew. The middle group (worse quality than the control) included Primo (high) and Cutless (low), and the bottom group for turfgrass quality included Trimmit and Cutless (high). These results suggest that Trimmit and Cutless and high rates of Primo Maxx may result in a significant decline in visual turfgrass quality when applied at the frequencies used in this study under traffic. Similar trends held for the non-trafficked plots, although the distinctions between the groupings was less clear (Figure 1). Data for turfgrass visual quality for each individual rating date is reported in Table 3.

Turfgrass Color (NDRE): Turfgrass NDRE is approximated by color, but is also an indication of healthy vegetation. Typically, turfgrass quality and NDRE results track together and that was case for this study as well. Figure 2 shows the NDRE trends over the season. For the trafficked plots, the top NDRE scores came from plots treated with Anuew, Primo Maxx, and the non-treated control. The Trimmit and Cutless treatments grouped together with the high rate of Trimmit producing very low NDRE, indicating that the turf was unhealthy. Individual scores and statistics are shown in Table 4.

Clipping Yield: PGRs are tools for reducing clipping yield and potentially mowing requirements. Figure 3 shows that all of the PGRs performed well for this criteria. It is interesting to note how much more growth reduction was achieved when the plots were under traffic. This suggests that one must be careful not to over-regulate the turf when heavy traffic is occurring. The Primo, Anuew, and low rate of Cutless reduced growth the least in the non-traffic plots, but still ranged between 50-75% reduction. The Trimmit and high rate of Cutless treatments reduced growth by a factor of about 6 in the no traffic scenario. However, under traffic, the Trimmit, Cutless, and Primo (high) treatments reduced growth by closer to 90%. The Anuew and Primo (low) treatments showed very strong reductions in yield, but were the least aggressive. It is not a conincidence that these three treatments resulted in the healthiest grass. When using PGRs, it is important to non over-regulate the turf, and this research has shown that the amount of growth regulation is related to the traffic level. Yield data and statistics from individual collection dates are shown in Table 5.

Conclusion: For Kentucky bluegrass athletic fields under traffic, using Anuew at any rate or Primo Maxx at the low label rate can maintain or increase visual turfgrass quality and color while substantially reducing clipping production. Use of Trimmit or Cutless or the high rate of Primo Maxx resulted in excessive yield reduction and decreases in turfgrass quality and color. For non-trafficked areas these same trends held, but Primo Maxx and Cutless at the low label rate also appeared to be effective tools.

Table 2. Average Quality, Color, and clipping mass through the study period. Different letters indicate statistically significant differences (p = 0.05).

Treatment	Quality	Color (NDRE)	Clipping Mass	Density	Crabgrass
	1-9, 9 is best	0-1, 1 is greenest	g/plot	Tillers/3 in^2	%
No Traffic					
Primo Low	5.94 cd	0.388 ab	16.6 bc	No data	14.7 ab
Primo High	4.61 e	0.358 defg	9.0 def	No data	26.7 a
Trimmit 2SC Low	4.30 ef	0.340 fgh	10.4 cdef	No data	4.0 b
Trimmit 2SC High	3.89 f	0.334 h	9.4 cde	No data	2.3 b
Cutless Low	5.50 d	0.364 cde	12.6 def	No data	8.3 ab
Cutless High	4.61 e	0.346 efgh	8.1 bc	No data	2.0 b
Aneuw Low	5.75 d	0.381 abc	17.1 cd	No data	13.3 ab
Aneuw High	5.86 cd	0.375 bcd	12.8 a	No data	2.7 b
Control	5.94 cd	0.375 bcd	33.0 def	No data	25.0 a
Traffic					
Primo Low	6.50 bc	0.401 a	6.3 f	52 bc	4.0 b
Primo High	5.56 d	0.372 bcd	4.3 def	66 ab	1.3 b
Trimmit 2SC Low	4.25 ef	0.360 cdef	6.3 def	73 ab	0 b
Trimmit 2SC High	3.92 f	0.336 gh	5.8 def	76 ab	0.3 b
Cutless Low	5.47 d	0.360 cdef	5.0 f	51 bc	1.0 b
Cutless High	4.72 e	0.355 defgh	5.6 ef	80 a	0 b
Aneuw Low	6.67 b	0.391 ab	5.9 def	53 bc	1.3 b
Aneuw High	6.72 ab	0.401 a	5.7 ef	66 ab	0 b
Control	7.36 a	0.403 a	20.2 b	37 c	0 b

Table 3. Visual estimate of turfgrass quality at each rating date during the study. Different letters indicate statistically significant differences (p = 0.05) * - initial application date

Treatment	6/1*	6/15	6/28	7/14	7/28	8/10
	---------- 1-9, 1 is death 9 is best ----------					
No Traffic						
Primo Low	7.7 a	7.0 ab	5.7 cd	4.7 cde	6.3 ab	5.7 bcd
Primo High	7.7 a	6.7 abc	5.0 de	3.0 f	3.0 f	4.3 def
Trimmit 2SC Low	7.3 a	7.0 ab	5.7 cd	3.7 ef	3.7 ef	3.7 ef
Trimmit 2SC High	7.3 a	7.3 a	5.7 cd	3.7 ef	3.0 f	3.0 f
Cutless Low	7.3 a	7.0 ab	6.7 ab	5.0 bcd	5.0 cd	5.3 bcd
Cutless High	7.3 a	7.0 ab	5.7 cd	3.7 ef	3.7 ef	3.7 ef
Aneuw Low	7.3 a	7.0 ab	6.0 bc	5.3 abc	6.0 bc	5.7 bcd
Aneuw High	7.7 a	6.0 c	4.7 ef	3.3 f	5.7 bcd	5.3 bcd
Traffic						
Control	7.3 a	6.7 abc	7.0 a	6.3 a	6.3 ab	4.7 cde
Primo Low	7.7 a	6.0 c	4.3 ef	3.7 ef	6.3 ab	6.3 ab
Primo High	7.7 a	6.7 abc	4.0 ef	3.0 f	5.0 cd	6.0 abc
Trimmit 2SC Low	7.3 a	6.3 bc	4.7 ef	3.0 f	3.3 f	3.7 ef
Trimmit 2SC High	7.3 a	6.7 abc	4.7 ef	3.0 f	3.3 f	3.3 ef
Cutless Low	7.3 a	6.0 c	5.0 de	4.0 def	5.7 bcd	5.7 bcd
Cutless High	7.3 a	6.3 bc	4.3 ef	3.7 ef	4.7 de	5.3 bcd
Aneuw Low	7.3 a	6.3 bc	4.7 ef	5.0 bcd	6.7 ab	7.3 a
Aneuw High	7.7 a	6.0 c	4.0 f	3.7 ef	7.3 a	6.7 ab
Control	7.3 a	7.3 a	6.3 a	6.0 ab	7.3 a	7.3 a

Table 3 (cont.)

Treatment	8/24	9/2	9/14	9/29	10/6	10/29
	---------- 1-9, 1 is death 9 is best ----------					
No Traffic						
Primo Low	4.7 cde	5.0 cd	5.3 cde	6.3 bcd	6.0 abcd	7.0 abc
Primo High	3.7 ef	3.7 def	4.3 de	5.3 def	4.3 def	4.3 fgh
Trimmit 2SC Low	3.3 ef	3.7 def	4.0 de	3.3 g	3.7 ef	2.7 i
Trimmit 2SC High	2.7 f	2.0 f	3.3 e	3.0 g	2.7 f	3.0 hi
Cutless Low	5.0 bcde	4.7 cde	4.7 de	6.3 bcd	5.0 cde	4.0 ghi
Cutless High	4.0 def	4.7 cde	4.3 de	4.7 defg	3.7 ef	3.0 hi
Aneuw Low	5.0 bcde	5.0 cd	5.0 de	5.7 cde	5.7 bcd	5.3 defg
Aneuw High	5.7 bcd	6.0 abc	5.7 bcd	7.3 abc	7.0 ab	6.0 bcde
Control	4.7 cde	5.3 bcd	5.3 cde	6.3 bcd	5.7bcd	5.7 cdef
Traffic						
Primo Low	7.0 ab	6.3 abc	7.7 ab	7.7 ab	7.3 ab	7.7 a
Primo High	6.7 ab	5.3 bcd	6.0 abcd	6.3 bcd	5.0 cde	5.0 efg
Trimmit 2SC Low	4.3 def	3.7 def	4.7 de	3.7 fg	3.3 ef	3.0 hi
Trimmit 2SC High	3.3 ef	2.7 ef	4.0 de	3.3 g	2.7 f	2.7i
Cutless Low	6.3 abc	5.0 cd	5.7 bcd	6.0 bcd	4.7 de	4.3 fgh
Cutless High	5.7 bcd	3.7 def	5.0 de	4.0 efg	3.3 ef	3.3 hi
Aneuw Low	7.7 a	7.3 ab	7.3 abc	7.7 ab	6.7 abc	6.0 bcde
Aneuw High	8.0 a	7.7 a	7.7 ab	7.7 ab	7.0 ab	7.3 ab
Control	8.0 a	8.0 a	8.0 a	8.3 a	7.7 a	6.7 abcd

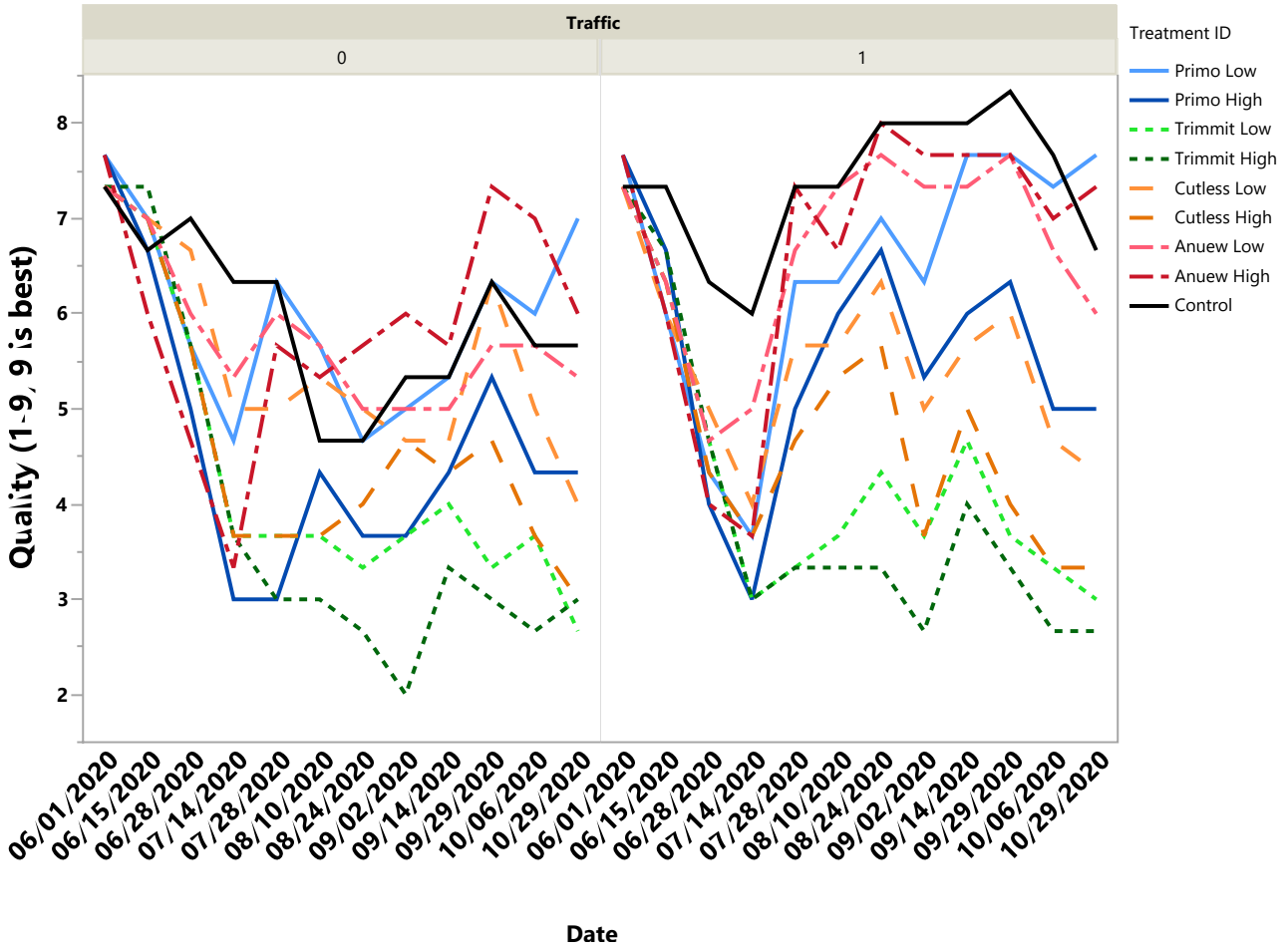

Figure 1. Visual estimate of turfgrass quality during the study period.

Table 4. Turfgrass color (NDRE) at each rating date during the study. Different letters indicate statistically significant differences (p = 0.05) * - initial application date

Treatment	6/1*	6/15	6/28	7/14	7/28	8/10
	---------- 0-1, 1 is greenest ----------					
No Traffic						
Primo Low	0.397 ab	0.360 abc	0.318 bcde	0.295 abcd	0.399 ab	0.413 ab
Primo High	0.398 ab	0.342 abcd	0.295 ef	0.271 cd	0.330 def	0.370 bcdef
Trimmit 2SC Low	0.390 abc	0.351 abcd	0.312 abc	0.290 bcd	0.338 cde	0.328 fg
Trimmit 2SC High	0.387 abc	0.369 a	0.337 ab	0.294 abcd	0.313 ef	0.307 g
Cutless Low	0.376 c	0.349 abc	0.327 abcd	0.302 abcd	0.381 abc	0.398 abcd
Cutless High	0.396 abc	0.349 abc	0.329 abcd	0.293 bcd	0.323 def	0.357 def
Aneuw Low	0.378 bc	0.336 cd	0.330 abcd	0.326 ab	0.414 a	0.423 a
Aneuw High	0.383 abc	0.333 cd	0.290 ef	0.281 bcd	0.386 ab	0.423 a
Control	0.386 abc	0.366 ab	0.356 a	0.340 a	0.406 a	0.404 abcd
Traffic						
Primo Low	0.399 a	0.352 abcd	0.293 ef	0.287 bcd	0.387 ab	0.398 abcd
Primo High	0.399 a	0.344 abcd	0.275 f	0.257 d	0.327 def	0.385 abcde
Trimmit 2SC Low	0.395 abc	0.349 abcd	0.312 bcde	0.284 bcd	0.320 def	0.343 efg
Trimmit 2SC High	0.386 abc	0.355 abcd	0.300 cdef	0.266 cd	0.288 f	0.298 g
Cutless Low	0.388 abc	0.354 abcd	0.300 cdef	0.285 bcd	0.361 bcd	0.362 cdef
Cutless High	0.389 abc	0.361 abc	0.294 ef	0.264 cd	0.314 ef	0.337 efg
Aneuw Low	0.386 abc	0.328 d	0.399 def	0.309 abc	0.403 ab	0.418 ab
Aneuw High	0.394 abc	0.337 bcd	0.280 f	0.277 cd	0.403 ab	0.408 abc
Control	0.383 abc	0.366 ab	0.331 abc	0.327 ab	0.419 a	0.404 abcd

Table 4 (cont.)

Treatment	8/24	9/2	9/14	9/29	10/6	10/29
	---------- 0-1, 1 is greenest ----------					
No Traffic						
Primo Low	0.422 abcde	0.433 abc	0.414 abcd	0.387 bcde	0.409 abcd	0.407 ab
Primo High	0.411 bcdef	0.428 abc	0.389 cdefg	0.366 de	0.357 de	0.339 def
Trimmit 2SC Low	0.348 gh	0.344 ef	0.351 fgh	0.359 de	0.336 e	0.312 f
Trimmit 2SC High	0.328 h	0.327 f	0.334 h	0.351 e	0.335 e	0.327 def
Cutless Low	0.399 cdef	0.387 cdef	0.363 defgh	0.365 de	0.375 cde	0.348 cdeff
Cutless High	0.369fgh	0.349 ef	0.344 gh	0.368 cde	0.358 de	0.320 ef
Aneuw Low	0.435 abcde	0.421 abcd	0.388 cdefg	0.363 de	0.379 bcde	0.383 abcd
Aneuw High	0.442 abcd	0.350 ef	0.401 cdef	0.387 bcde	0.416 abc	0.408 a
Control	0.416 abcdef	0.403 bcde	0.388 cdefg	0.352 e	0.342 e	0.338 def
Traffic						
Primo Low	0.463 a	0.457 ab	0.462 a	0.437 a	0.443 a	0.427 a
Primo High	0.436 abcde	0.430 abc	0.420 abc	0.403 abcd	0.408 abcd	0.384 abcd
Trimmit 2SC Low	0.394 adefg	0.401 bcde	0.409 bcde	0.389 bcde	0.381 bcde	0.340 def
Trimmit 2SC High	0.351 gh	0.364 def	0.356 efgh	0.364 de	0.365 bce	0.336 def
Cutless Low	0.392 efg	0.400 bcde	0.388 cdefg	0.370 bcde	0.381 bcde	0.344 def
Cutless High	0.390 efg	0.402 bcde	0.393 cdefg	0.386 bcde	0.376 bcde	0.348 bcdef
Aneuw Low	0.454 ab	0.438 abc	0.432 abc	0.413 abc	0.430 ab	0.377 abcde
Aneuw High	0.462 a	0.466 a	0.459 ab	0.440 a	0.458 a	0.426 a
Control	0.444 abc	0.458 ab	0.459 ab	0.415 ab	0.431 ab	0.405 abc

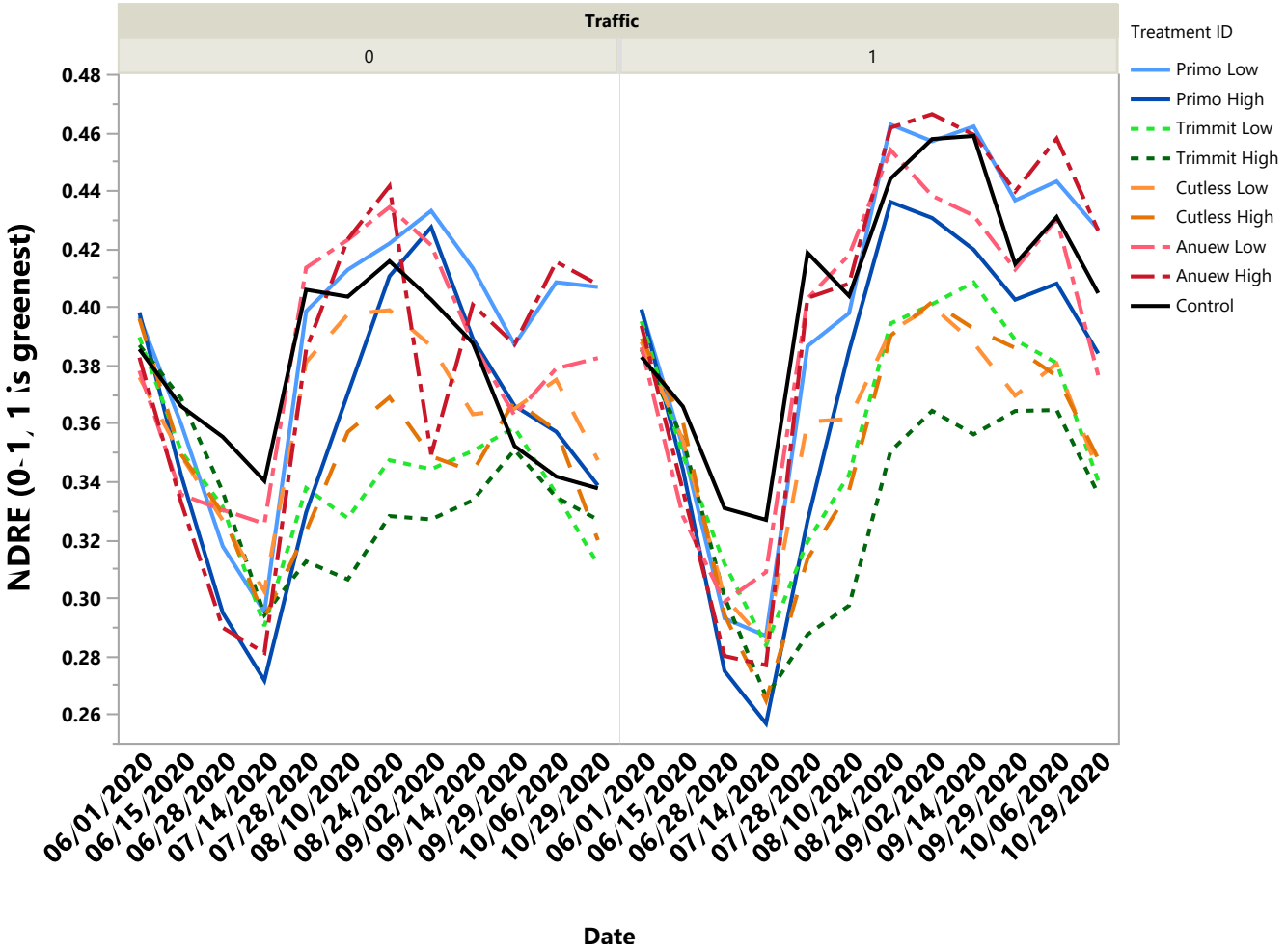

Figure 2. Turfgrass color reflectance (NDRE) during the study period.

Table 5. Clipping mass at each rating date during the study. Different letters indicate statistically significant differences (p = 0.05)

Treatment	6/16	6/28	7/14	7/27	8/10	8/24	9/14	10/29
	g m^{-2}							
No Traffic								
Primo Low	39.8 bcd	10.0 bc	4.9 b	17.2 b	16.4 bc	11.9 bcd	24.8 bc	8.25 abc
Primo High	32.4 defg	5.8 cd	5.6 b	6.4 cdef	8.7 cdef	5.1 bcde	6.4 de	1.7 cd
Trimmit 2SC Low	49.2 b	8.2 bcd	9.9 b	4.9 def	5.0 def	2.2 de	3.0 e	0.5 d
Trimmit 2SC High	48.2 bc	10.2 bc	11.1 b	1.8 ef	1.4 ef	0.7 de	0.8 e	0.5 d
Cutless Low	40.6 bcd	14.2 b	7.4 b	11.5 bcde	7.6 cdef	6.2 bcde	11.7 cde	1.4 cd
Cutless High	38.9 cde	9.5 bcd	5.6 b	3.4 ef	2.6 ef	2.4 de	2.3 e	0.3 d
Aneuw Low	40.9 bcd	10.5 bc	12.2 b	21.5 b	20.3 ab	16.0 abc	12.4 cde	3.1 bcd
Aneuw High	34.1 defg	7.5 bcd	4.7 b	14.0 bcd	13.9 bcd	6.8 bcde	18.9 bcd	2.5 cd
Control	61.5 a	30.2 a	29.9 a	35.3 a	26.9 a	15.7 a	40.8 a	14.0 a
Traffic								
Primo Low	27.9 fg	4.3 cd	2.8 b	2.2 ef	1.0 f	1.7 de	8.0 de	2.3 cd
Primo High	26.2 g	2.7 d	3.2 b	0.7 f	0.3 f	0.5 e	1.1 e	0.1 d
Trimmit 2SC Low	36.5 def	5.0 cd	5.6 b	0.9 f	0.6 f	1.0 de	0.5 e	0.2 d
Trimmit 2SC High	33.5 defg	3.9 cd	5.2 b	0.7 f	1.9 ef	0.4 e	0.4 e	0.2 d
Cutless Low	29.4 efg	4.1 cd	0.9 b	1.1 f	0.6 f	2.6 de	0.9 e	0.4 d
Cutless High	36.1 defg	3.6 cd	1.2 b	0.4 f	0.7 f	2.1 de	0.5 e	0.4 d
Aneuw Low	26.5 g	3.7 cd	3.2 b	2.9 ef	1.1 f	4.9 cde	4.4 de	0.6 d
Aneuw High	26.3 g	4.4 cd	2.1 b	2.3 ef	1.7 ef	2.6 de	4.5 de	1.4 cd
Control	47.9 bc	13.9 b	14.6 b	16.3 bc	11.1 bcde	16.2 ab	31.9 ab	10.4 ab

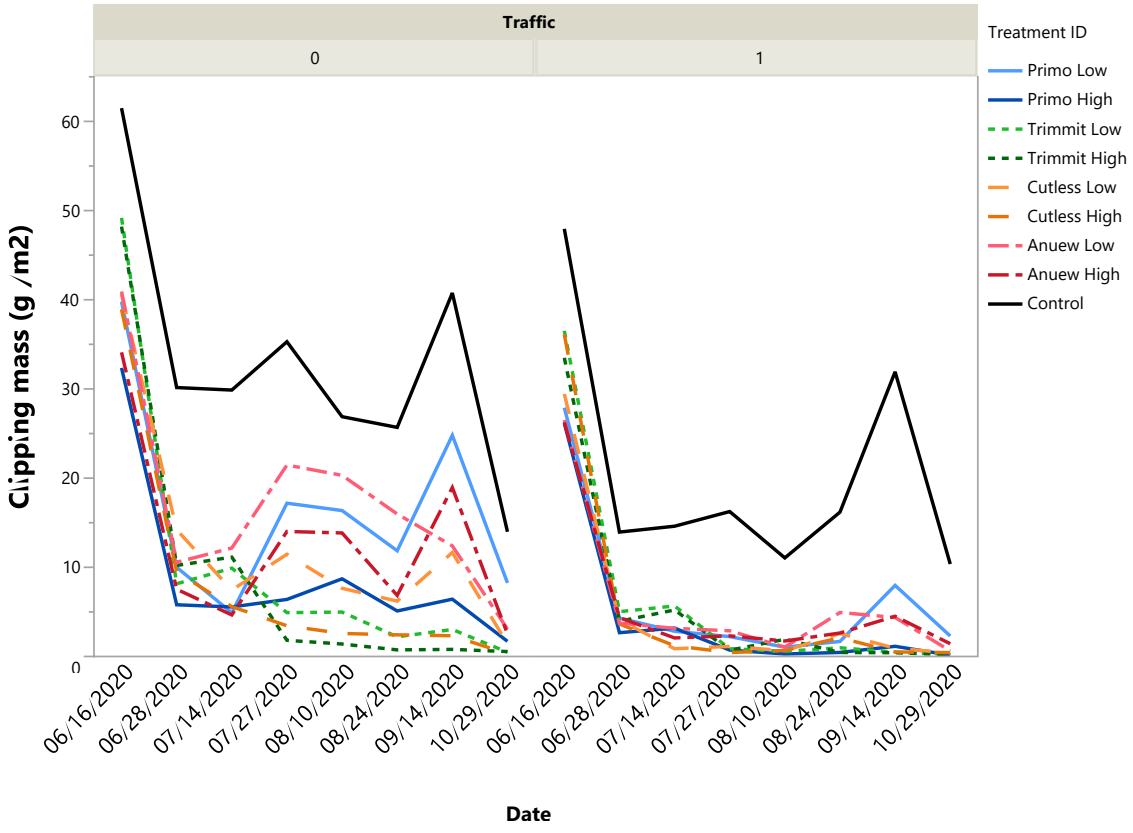

Figure 3. Clipping mass during the study period.

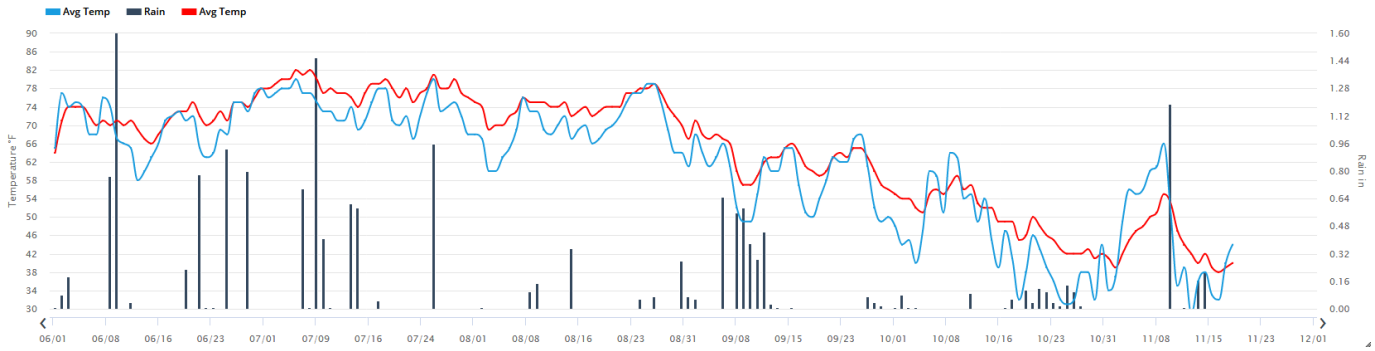

Figure 4. Average air temperature (blue line), daily precipitation total (bars), and 1 inch soil temperature (red line) at the O.J. Noer Turfgrass Research Facility in Verona, WI for the study period.