Dollar spot suppression and performance of fertility programs on creeping bentgrass fairway turf - 2010 season.

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The objective of this research project was to determine the effects of the sponsor's fertilizer programs on dollarspot disease and general performance of creeping bentgrass putting green turf maintained at fairway height.

Data collected included the duration and strength of the color response following application(s) of the tested products, turf quality, uniformity, and density, and resistance of the turf to disease and drought stress.

MATERIALS/METHODS

Two experiments were involved in this trial. The first included 9 treatments (fertility programs as per Table 1). An unfertilized check treatment was also included. The second involved three treatments and an untreated control (Table 2). Treatments were applied to 1 x 2 m plots of creeping bentgrass turf maintained as a fairway at the Guelph Turfgrass Institute (mowing at 9 mm, irrigation to prevent stress) (Figures 1 and 2). Treatments were replicated four times in a randomized complete block design.

Color response of the turf to treatments was assessed regularly, both visually and using instrumental color (canopy reflectance). Uniformity of the color response was assessed visually. Plots were rated regularly for turf quality, density and uniformity. Dollarspot inoculum was added (5 g m-2) on June 21, 2010 to ensure a source

Table 1. Dollarspot disease suppression trial (part 1): treatments

	Product	Rate	Application	
Fertility a	Tru-prill 16-2-15	22.8 g m^{-2}	May 10, June 7, July 5	
	Tru-prill 16-2-15	15.3	August 17, September 14	
	8-16-16	48.8	September 9	
Fertility b	CSN	22.8 g m^{-2}	May 10, June 7, July 5	
	CSN	15.3	August 17, September 14	
				Threshold
Fungicide a	Daconil / Enfoss / Protocal	1.27 / 0.64 / 1.27 ml m^{-2}	Biweekly	>15% dollarspot (July 26)
Fungicide b	Daconil	1.27 ml m^{-2}	Biweekly	
Fungicide c	Daconil	0.64 ml m^{-2}	Biweekly	First sign of dollarspot
Fungicide d	Daconil / Enfoss / Protocal	0.64 / 0.81 / 1.91 ml m^{-2}	Biweekly	(June 23, 2010)
Fungicide e	Daconil / Enfoss / Protocal	1.27 / 0.81 / 2.55 ml m^{-2}	Biweekly	

Treatment	Fertility programme	Fungicide programme
1 Tru-prill	Fertility a	—
2 Tru-prill + fung 1	Fertility a	Fungicide a
3 Tru-prill + fung 2	Fertility a	Fungicide b
4 Tru-prill + fung 3	Fertility a	Fungicide c
5 CSN	Fertility b	—
6 Fungicide 1	—	Fungicide d
7 Fungicide 2	—	Fungicide b
8 Fungicide 3	—	Fungicide c
9 Fungicide 4	—	Fungicide e
10 Untreated control	—	—

Figure 1. Plot area, part 1, June 3, 2010.

Figure 2. Plot area, part 2, June 3, 2010.

Table 2. Dollarspot disease suppression trial (part 2): treatments (all applied May 10, 2010).

Treatment	Product	Rate (g m-2)
1	CSN	10.35
2	UMAXX	10.35
3	Tru-Prill 16-2-15	30.52
4	Control	—

for dollarspot disease. Other stresses were measured as they occurred (disease, weed, drought). Spring greenup will be assessed in April 2010.

All data were analysed statistically using the SAS package of statistical software.

An anecdotal photographic record was kept of the progress of the trial.

RESULTS

Environmental data. Rainfall and temperature data were recorded at the Environment Canada weather station in the research ranges at the GTI (Figures 2 and 3). The season was wetter than average, with ~500 mm of rainfall during the course of the experiment. Temperatures were slightly below normal for summer in Guelph, with only four days above 30°C.

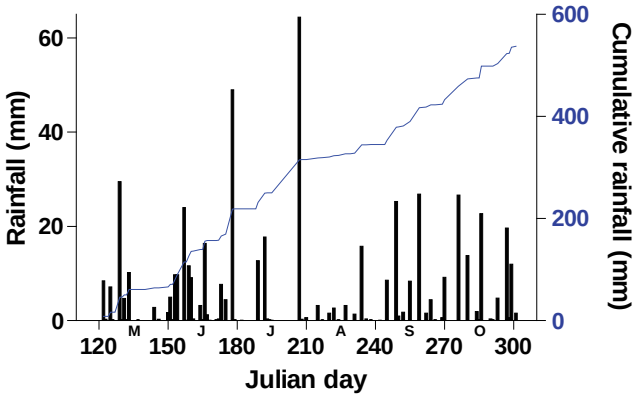

Figure 2. Daily and cumulative precipitation - summer 2010 Data are from the Environment Canada weather station at the GTI.

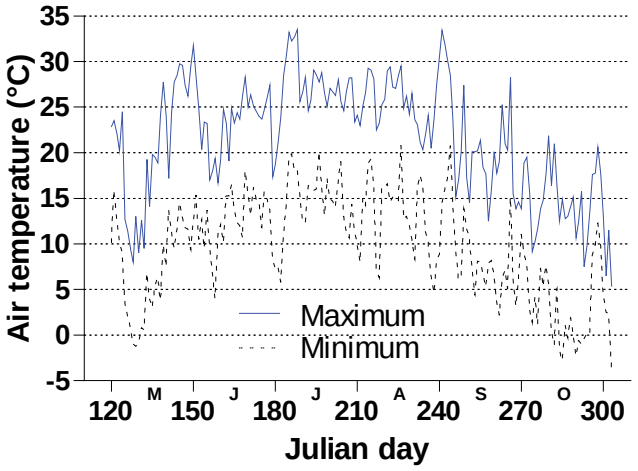

Figure 3. Daily maximum and minimum air temperatures - summer 2010. Data are from the Environment Canada weather station at the GTI.

Turf performance - canopy reflectance. There were significant differences among the treatments for normalized-difference vegetation index on all measured dates both for Part 1 (Table 3) and Part 2 (Table 4). The absolute differences in NDVI in Part 1 were quite small, and apart from the dollarspot infection, the quality of the turf was acceptable, even in the untreated control. The differences among treatments in Part 2 were also relatively small on any particular date, but all treatments began to suffer from lack of fertility by August.

While the treatments in Part 1 with NPK fertility included generally performed better with respect to canopy reflectance than fungicide, fungicide/amendment, or untreated control, the difference was not strong. The rank order of the treatments taking the seasonal mean of canopy reflectance was: Tru-prill+fung 2, Tru-prill+fung 1 > CSN, Fungicide 3 > Fungicide 1 >Tru-prill > Tru-prill+fung 3, Fungicide 2, Untreated control > Fungicide 4.

All treatments in Part 2 had significantly better canopy reflectance than the control by one week after application. This pattern persisted for about a month, at which point the CSN and particularly the Mineral Builder treatments began to be not statistically different from the control. The rank order of these treatments taking the seasonal mean of canopy reflectance was: UMAXX, CSN > Mineral Builder > Untreated control.

The pattern of change in canopy reflectance in the trials can be visualized by correcting the canopy reflectance against the means of the untreated control plots. The treatments in Part 1 are shown in Figure 5, and those in Part 2 are shown in Figure 6.

The relationship between NDVI and number of dollar spot infection centres (Figure 7), percent of plot area covered by dollar spot lesions (Figure 8), and dollar spot disease severity ratings (Figure 9) showed an association, indicating that at least a component of NDVI is a useful estimator of the effect of dollar spot on turf quality.

Table 2. Canopy reflectance of treated plots, Part 1.

Treatment	05/10	05/12	05/16	05/17	05/19	05/20	05/25	05/27	05/28
Tru-prill + fung 2	0.538 de[1]	0.530 d	0.565 bc	0.573 bc	0.577 bc	0.554 a	0.629 a	0.594 a	0.605 ab
Tru-prill + fung 1	0.588 a	0.583 a	0.596 a	0.597 a	0.598 a	0.528 cd	0.609 ab	0.580 ab	0.595 abc
CSN	0.549 cd	0.550 bc	0.579 b	0.585 ab	0.589 ab	0.537 abc	0.620 a	0.591 a	0.611 a
Fungicide 3	0.510 f	0.507 e	0.531 d	0.543 d	0.550 de	0.511 de	0.597 bc	0.570 bcd	0.580 cd
Fungicide 1	0.563 bc	0.546 bcd	0.567 bc	0.569 c	0.579 bc	0.551 bc	0.597 bc	0.573 bc	0.594 bc
Tru-prill	0.581 ab	0.563 b	0.577 bc	0.579 bc	0.577 bc	0.502 e	0.582 cd	0.555 de	0.560 ef
Tru-prill + fung 3	0.539 de	0.527 d	0.542 d	0.547 d	0.542 e	0.459 f	0.539 e	0.539 e	0.553 f
Fungicide 2	0.587 a	0.560 b	0.578 b	0.575 bc	0.574 bc	0.511 de	0.585 cd	0.559 cd	0.574 de
Untreated control	0.551 cd	0.545 bcd	0.562 c	0.566 c	0.562 cd	0.532 bc	0.573 d	0.554 de	0.567 def
Fungicide 4	0.527 ef	0.532 cd	0.537 d	0.539 d	0.541 e	0.493 e	0.569 d	0.553 de	0.566 def
msd p=0.05	0.019	0.020	0.016	0.016	0.017	0.019	0.022	0.018	0.017
	05/29	05/31	06/01	06/04	06/05	06/10	06/11	06/14	06/16
Tru-prill + fung 2	0.594 a	0.616 a	0.596 a	0.667 a	0.591 a	0.557 ab	0.558 ab	0.613 a	0.595 a
Tru-prill + fung 1	0.589 a	0.601 abcd	0.592 ab	0.658 ab	0.587 ab	0.522 de	0.543 bcd	0.588 b	0.570 bc
CSN	0.592 a	0.607 abc	0.592 ab	0.657 ab	0.588 ab	0.571 a	0.564 a	0.587 bc	0.581 ab
Fungicide 3	0.583 ab	0.593 cde	0.580 bc	0.640 cd	0.579 abc	0.542 bc	0.546 bcd	0.577 bcd	0.565 cd
Fungicide 1	0.593 a	0.610 ab	0.594 a	0.649 bc	0.591 ab	0.569 a	0.556 ab	0.569 de	0.555 de
Tru-prill	0.567 c	0.586 def	0.563 d	0.634 d	0.574 cd	0.525 de	0.531 de	0.569 de	0.562 cde
Tru-prill + fung 3	0.549 d	0.567 g	0.552 d	0.611 e	0.565 d	0.511 e	0.519 e	0.543 g	0.550 e
Fungicide 2	0.571 bc	0.597 bcde	0.576 c	0.652 b	0.579 bc	0.527 de	0.538 cd	0.562 ef	0.550 e
Untreated control	0.559 cd	0.575 fg	0.562 d	0.617 e	0.568 cd	0.533 cd	0.537 cd	0.549 fc	0.551 de
Fungicide 4	0.568 c	0.585 ef	0.562 d	0.630 d	0.575 cd	0.544 bc	0.550 abc	0.573 cde	0.558 cde
msd p=0.05	0.014	0.016	0.013	0.012	0.012	0.016	0.016	0.015	0.014
	06/21	06/28	07/02	07/06	07/12	07/14	07/19	07/23	07/27
Tru-prill + fung 2	0.591 a	0.659 a	0.616 abc	0.609 ab	0.691 a	0.625 a	0.698 a	0.628 a	0.648 a
Tru-prill + fung 1	0.583 ab	0.641 b	0.618 abc	0.613 a	0.666 bc	0.609 b	0.685 b	0.614 bc	0.628 b
CSN	0.564 cde	0.653 a	0.610 abc	0.602 bcd	0.681 a	0.596 cd	0.686 b	0.620 ab	0.625 bc
Fungicide 3	0.574 bc	0.653 a	0.623 a	0.598 cde	0.684 a	0.613 b	0.690 b	0.629 a	0.655 a
Fungicide 1	0.568 cd	0.654 a	0.594 de	0.592 cde	0.668 b	0.605 bc	0.677 c	0.617 bc	0.615 cd
Tru-prill	0.562 def	0.626 c	0.571 f	0.590 e	0.654 de	0.598 cd	0.676 c	0.615 bc	0.636 b
Tru-prill + fung 3	0.561 def	0.637 b	0.604 cd	0.590 e	0.647 ef	0.589 d	0.675 c	0.612 bc	0.630 b
Fungicide 2	0.551 fg	0.641 b	0.583 ef	0.591 de	0.655 cde	0.589 d	0.670 cd	0.609 c	0.603 d
Untreated control	0.541 g	0.623 c	0.619 ab	0.579 f	0.643 f	0.587 d	0.672 cd	0.615 bc	0.629 b
Fungicide 4	0.555 ef	0.642 b	0.606 bcd	0.603 abc	0.660 bcd	0.591 d	0.668 d	0.610 c	0.609 d
msd p=0.05	0.011	0.011	0.015	0.011	0.011	0.011	0.007	0.009	0.012
	08/03	08/09	08/19	08/26	09/07	09/14	09/23	09/27	Season
Tru-prill + fung 2	0.577 bc	0.609 bc	0.582 abcd	0.596 ab	0.578 c	0.580 ab	0.638 a	0.664 a	0.609 a
Tru-prill + fung 1	0.594 a	0.637 a	0.594 abc	0.608 a	0.593 bc	0.579 ab	0.601 de	0.637 bc	0.605 a
CSN	0.568 c	0.597 cd	0.552 e	0.587 bc	0.574 cd	0.574 b	0.619 bc	0.649 ab	0.601 b
Fungicide 3	0.586 ab	0.618 b	0.603 a	0.612 a	0.607 ab	0.592 a	0.630 ab	0.649 ab	0.600 b
Fungicide 1	0.550 d	0.610 bc	0.569 cde	0.585 bc	0.576 c	0.550 cd	0.599 de	0.631 bcd	0.595 c
Tru-prill	0.576 bc	0.614 b	0.575 bcde	0.573 cd	0.582 c	0.563 bc	0.587 def	0.623 cd	0.588 d
Tru-prill + fung 3	0.578 bc	0.607 bc	0.598 ab	0.600 ab	0.622 a	0.580 ab	0.602 cd	0.629 cd	0.584 e
Fungicide 2	0.569 c	0.586 d	0.559 de	0.560 d	0.553 de	0.543 d	0.584 ef	0.615 d	0.584 e
Untreated control	0.568 c	0.609 bc	0.561 de	0.572 cd	0.573 cd	0.563 bc	0.577 f	0.616 d	0.583 e
Fungicide 4	0.564 cd	0.607 bc	0.570 cde	0.561 d	0.535 e	0.545 d	0.577 f	0.613 d	0.578 f
msd p=0.05	0.016	0.017	0.027	0.018	0.022	0.017	0.018	0.019	0.004

[1]Normalized-difference vegetation index: mean of ~50 readings x 4 replicates; means within columns followed by the same letter are not significantly different (Tukey's HSD test, p=0.05).

Table 3. Canopy reflectance of treated plots, Part 2.

Treatment	05/10	05/12	05/16	05/17	05/19	05/20	05/25	05/28	05/29
UMAXX	0.615 b[1]	0.614 ab	0.649 a	0.660 a	0.644 b	0.650 ab	0.667 a	0.645 a	0.630 a
CSN	0.612 b	0.619 a	0.638 bc	0.648 b	0.644 b	0.644 b	0.671 a	0.642 a	0.628 a
Mineral Builder	0.617 ab	0.617 a	0.643 ab	0.655 a	0.654 a	0.656 a	0.675 a	0.644 a	0.619 b
Untreated control	0.624 a	0.608 b	0.634 c	0.638 c	0.628 c	0.613 c	0.636 b	0.626 b	0.610 c
msd p=0.05	0.007	0.007	0.006	0.006	0.006	0.008	0.008	0.007	0.006
	05/31	06/01	06/04	06/05	06/10	06/11	06/14	06/21	06/28
UMAXX	0.642 a	0.627 a	0.698 a	0.616 ab	0.609 b	0.603 a	0.592 a	0.570 b	0.636 ab
CSN	0.646 a	0.627 a	0.693 b	0.622 a	0.617 a	0.612 a	0.594 a	0.586 a	0.643 a
Mineral Builder	0.644 a	0.617 b	0.693 b	0.613 b	0.601 c	0.574 c	0.570 b	0.540 c	0.614 c
Untreated control	0.613 b	0.607 c	0.675 c	0.611 b	0.587 d	0.590 b	0.574 b	0.566 b	0.631 b
msd p=0.05	0.008	0.006	0.004	0.007	0.006	0.011	0.011	0.013	0.009
	07/02	07/06	07/12	07/14	07/19	07/23	07/27	08/03	08/09
UMAXX	0.604 a	0.589 a	0.657 a	0.601	0.646 a	0.619 a	0.591 a	0.493	0.494
CSN	0.560 b	0.579 b	0.656 a	0.602	0.647 a	0.616 ab	0.583 a	0.499	0.506
Mineral Builder	0.566 b	0.559 c	0.643 b	0.601	0.642 a	0.612 b	0.577 a	0.497	0.496
Untreated control	0.563 b	0.565 c	0.639 b	0.599	0.627 b	0.610 b	0.561 b	0.491	0.490
msd p=0.05	0.011	0.008	0.005	NS	0.008	0.008	0.016	NS	NS
	08/19	08/26	09/07	09/14	09/23	09/27	Season		
UMAXX	0.396 a	0.371 a	0.286 ab	0.380 a	0.396 a	0.447 b	0.556 a		
CSN	0.392 a	0.364 a	0.292 a	0.391 a	0.412 a	0.467 a	0.555 a		
Mineral Builder	0.381 ab	0.363 a	0.262 c	0.338 c	0.358 b	0.412 c	0.544 b		
Untreated control	0.360 b	0.334 b	0.271 bc	0.357 b	0.399 a	0.448 b	0.537 c		
msd p=0.05	0.029	0.016	0.017	0.015	0.017	0.016	0.006		

[1]Normalized-difference vegetation index: mean of ~50 readings x 4 replicates; means within columns followed by the same letter are not significantly different (Tukey's HSD test, p=0.05).

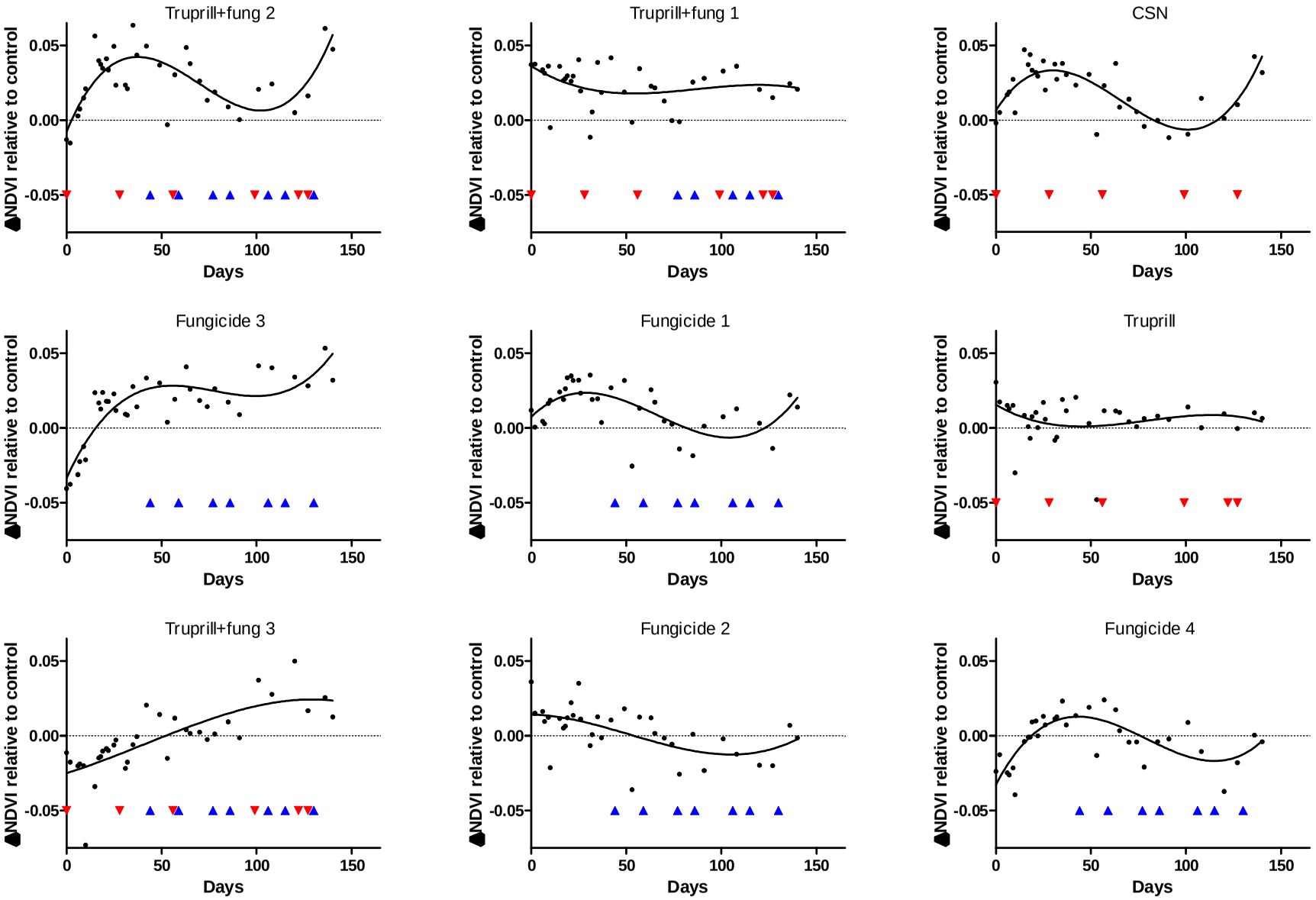

Figure 5. Change in canopy reflectance in Part 1 treated plots relative to untreated control (=0). Cubic polynomial lines are fitted to means to visualize trends. Fertilizer treatments are indicated with red arrows ▼, fungicide +/- amendments with blue arrows ▲.

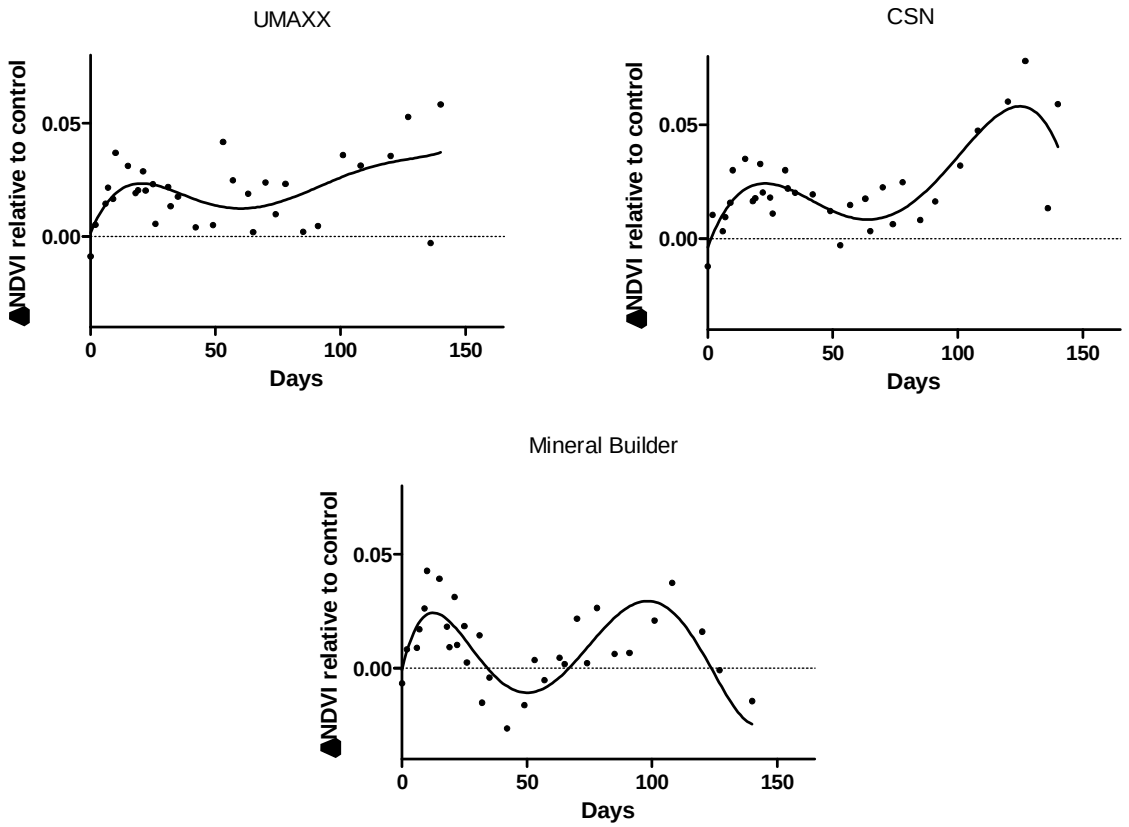

Figure 6. Change in canopy reflectance in Part 2 treated plots relative to untreated control (=0). Cubic polynomial lines are fitted to means to visualize trends.

Dollarspot disease - Part 1. Natural dollarspot infection began in mid June in plots of Part 1. Dollarspot disease was assessed initially by counting number of infection centres in plots, then, when the number of centres were too numerous to count or started to overlap, by point quadrat estimation of percent cover, or by visual disease severity rating on a 0-10 scale. The relationship between the various estimates of disease development can be seen in Figure 10. All of the plots developed a heavy dollarspot infection by the end of July (Table 4). The natural infection was reasonably uniformly distributed over the plot area. Differences among the treatments were not statistically significant at any point in the season. The average rank order of the treatments from least to most dollarspot infection was similar to the rank order of the canopy reflectance.

CONCLUSIONS

Part 1. There was a significant amount of natural dollarspot disease development on plots in Part 1 of this trial, but no statistically significant treatment differences were evident by the end of the season. The canopy reflectance data, which appeared to be detecting differences based on dollarspot disease, showed a similar pattern, but with statistically significant differences. The Tru-prill+fungicide 1 and Tru-prill+fungicide 2 treatments had the best overall performance based on canopy reflectance. Because there are other factors that affect canopy reflectance (scalping and other stresses), the NDVI values should be taken as indirect estimates of dollarspot disease.

Part 2. All three treatments in Part 2 had better performance than the untreated control for

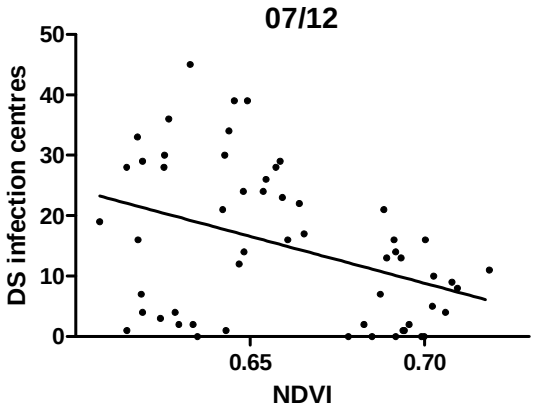

Figure 7. Association between NDVI and counts of dollar spot infection centres (per 2 m^2 plot). Correlation coefficient is 0.39.

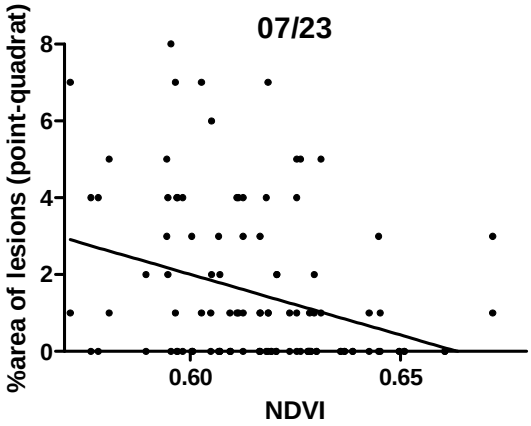

Figure 8. Association between NDVI and percent area covered by dollarspot lesions. Correlation coefficient is 0.32.

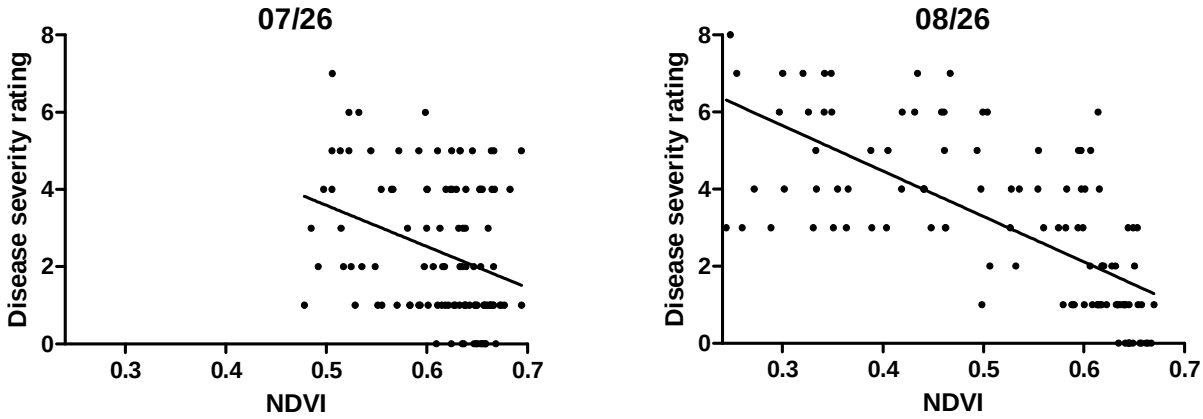

Figure 9. Association between NDVI and dollarspot disease severity ratings. Correlation coefficients are 0.32 (07/26) and 0.70 (08/26).

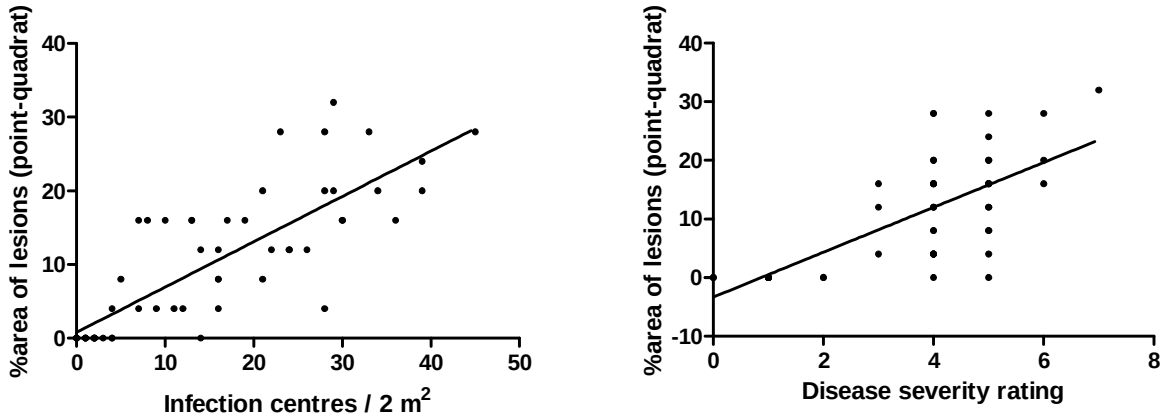

Figure 10. Association between various estimates of dollarspot disease development: (L) percent area (07/23) *vs* infection centre counts (07/12) (R=0.82); (R) percent area (07/23) *vs* severity rating (7/26) (R=0.73).

Table 4. Dollarspot disease development on treated plots – Part 1.

	Infection centre count			% area (point quadrat)	Disease severity	
Treatment	06/16	07/02	07/12	07/23	07/26	08/26
Fungicide 3	0.0[1]	0.5	4.5	1.5[2]	1.3[3]	1.5
Tru-prill + fung 2	0.3	0.5	6.3	2.5	1.6	2.1
Tru-prill + fung 1	0.3	4.8	8.0	4.5	1.8	2.1
Tru-prill + fung 3	0.3	2.0	9.8	3.5	2.1	2.4
CSN	2.0	2.3	9.3	3.0	2.4	2.4
Fungicide 1	0.3	2.5	11.0	6.5	2.8	1.9
Untreated control	1.5	3.5	11.3	6.0	2.0	2.4
Tru-prill	2.8	8.3	9.8	5.0	1.9	2.5
Fungicide 4	2.5	8.5	12.8	7.0	2.6	2.4
Fungicide 2	2.0	11.5	20.0	8.5	2.5	3.1
msd p=0.05	NS	NS	NS	NS	NS	NS

[1]Count of all separate infection centres in each 2 m^2 plot.
[2]Percent area covered by dollar spot lesions (25 points per plot).
[3]Visual disease severity rating 0-10, 0=no disease, 10=full coverage of lesions.
All values are means of four replicates; means within columns followed by the same letter are not significantly different (p=0.05, Tukeys HSD test).

the first month or so, based on canopy reflectance data. The UMAXX and CSN treatments performed slightly better than the Mineral Builder, and the effect lasted longer into the season. All treatments began to suffer from lack of fertility by August (12 weeks after treatment), but the decline was less in the treated plots than in the untreated controls. The rank order of these treatments taking the seasonal mean of canopy reflectance was: UMAXX, CSN > Mineral Builder > Untreated control.

Sponsor: Plant Science