

Creeping Bentgrass Turf Responses to Summer Applied Fungicides

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Abstract

Creeping bentgrass is seasonally stressed from high summer temperatures and high humidity conditions in the desert southwest from June to mid-September. Golf greens typically show decreased stand density and poor performance by the end of this time. A preventative fungicide application program was evaluated for the prevention of summer stress typical under summer conditions. Four tank mixes composed of Alliete Signature mixed with either Chipco 26019, EXP10790A, EXP10702B, or Daconil Ultrex fungicides were applied every fourteen days from June 10 to September 17, 1997, on a 'Penncross' creeping bentgrass green maintained at 5/32". The Daconil Ultrex tank mix caused some initial injury and in general, the lightest turfgrass color and the lowest turfgrass quality. EXP10702B treated turf produced, on average, the darkest turf with the leading rank score for quality. The Chipco 26019 tank mix produced the largest seasonal clipping totals, which was greater than the check. No diseases occurred on treated or untreated turf. Root dry weights in mid-October varied as much as 40% among treatments, but was not statistically significant.

Introduction

Creeping bentgrass is the preferred golf green putting surface due to its tolerance of close mowing and ability to provide a hard and smooth surface when managed properly. Being a cool season grass, it often suffers in mid-to-late summer from accumulated heat stress during the summer months. Responses include a decrease in shoot density (stand thinning), loss of color, decreased rooting, and generally an unthrifty turf condition. In the eastern U.S., where disease pressure is very prominent, a preventative fungicide program has been developed by N.C. State University in order to indirectly improve summer bentgrass performance by (1) eliminating the fungal diseases (mainly *Pythium* and *Rhizoctonia* species) and (2) perhaps providing a growth regulator effect for bentgrass turf. Thus, the "summer decline" of creeping bentgrass may be avoided by regular applications of fungicide(s) before and during the summer stress period. A test was conducted at the University of Arizona in order to assess the applications of four tank mixes of fungicides, applied at two week intervals from early July to mid-September, in order to prevent summer decline symptoms typical of closely mowed creeping bentgrass turf.

Materials and Methods

A six year old "Penncross" creeping bentgrass green, mowed six times a week at 5/32" was the study site for this test. Four fungicide tank mixes of Alliete Signature with either Chipco 26019 flowable, EXP10790A, EXP10702B, or Daconil Ultrex were applied on 5'x10' plots every two weeks from June 10 to September 17, 1997. Each treatment appeared four times in a RCBD. Applications were made using a three nozzle boom, with a CO₂ back-pack sprayer using 8004 nozzles at 28-30 psi, delivering a final solution rate of 47-51 gpa. Applications were made between 0500 and 0700 hours and were watered in fifteen hours later. Turfs were not mowed the day of application.

Turfgrass plots (including four control plots) were evaluated 5-8 days after each application for turfgrass color, quality, injury (if and when present), and for turfgrass clipping production for a twenty-four hour period between mowing events. Clippings were taken from a 22" wide single pass of the greens mower for the ten foot length of the plot. Alleys between plots were triple mowed before clipping sampling. Clippings were dried in an air convection dryer at 35°C for one week and weighed to the accuracy of 0.01 gram. Clipping production is expressed in terms of gms. dry weight/plot. Data were analyzed using the ANOVA technique using SAS software. Mean separation techniques were performed via Tukey's honest LSD value.

Results and Discussion

At six days after the initial application (June 16), treatment effects were statistically significant for turfgrass injury, the percent of plot injury, and for turfgrass color and quality. However, clipping weight was not affected. Degree of injury scores ranged from 1.5 (none or trace) to 3.0 (slight to moderate) among treated plots (Table 1). The tank mix of Alliete/Ultrex showed the most injury on the turf in the form of mild discoloration. Note that the check showed some discoloration, demonstrating the onset of initial high temperature stress by June 16. All other tank mixes showed no appreciable difference when compared to the control. The percent plot injury (0-100%) ranged from 4% to 34% with only the Alliete/Ultrex tank mix showing noticeable injury (as discoloration)(Table 1). Differences in turfgrass color were noticeable by one week after the first applications. Alliete/EXP10702B had the darkest green color score (mean = 7.5) followed by the tank mix with EXP10790A (mean = 7.0). The turfgrass with the lightest color was the Alliete/Ultrex tank mix (mean = 4.5) at one week after the first application (Table 2). Overall turfgrass quality scores for treated turfs were similar to that of the control, with the notable exception to that of the Alliete/Ultrex tank mix. This plot received a mean quality score of 4.5 (6.0 = acceptable), due to the fact that the turf was discolored and splotchy from the treatment (Table 3). Clipping production was not affected by chemical treatments, as mean dry clipping weights ranged from 4.0 to 5.0 gms/plot sample (Table 4). The second application was made on June 25, 1997.

At one week after the second applications (June 30), the turfgrass exhibited significant difference for color, quality, and percent injury. The Alliete/Ultrex tank mix showed the largest percent plot injury (24%) as all other plots had 2% or less, plot area injury (Table 1). Again, the injury was in the form of discolored turf. Mean turfgrass color scores ranged from 4.0 to 7.3 at this time, with the Alliete/Ultrex tank mix having the lightest green color (mean = 4.0) Note that at this time, the other three tank mixes had a darker turfgrass color than the control (Table 2). The Alliete/EXP10702B tank mix had a mean color score of 7.3. Turfgrass quality scores were acceptable for all bentgrass plots, with the exception of the Alliete/Ultrex tank mix which exhibited a mean treatment score of 4.0. All other turfs had mean color scores of 6.0 to 6.8 (Table 3). Mean clipping production (Week 2) decreased dramatically at this time, compared to two weeks previously, but once again there were no differences between treatment. Clippings ranged between 1.1 and 1.3 gms/plot sample (Table 4). The third application was made on July 9, 1997.

At one week after the third application (July 11), turfgrass plots were statistically significantly for color, quality, and percent injury. Percent plot injury (from discoloration) ranged from 26% (Daconil tank mix) to 1% for other turfs (Table 1). Mean color scores ranged from 5.0 to 7.0 among all plots. The Alliete/Ultrex tank mix was now more similar looking to that of the control, which had mean color scores of 5.0 and 5.8, respectively, The tank mix with EXP10702B had the darkest green color of 7.0 (Table 2).

Turfgrass quality scores were identical in rank for color among plots. The EXP10702B turf had the highest quality score (7.0) while the overall quality of the Alliete/Ultrex tank mix was lowest (mean = 4.0) (Table 3). Note the slight (but non-statistically significant) increase in quality of the other three tank mixes, over the control. Turfgrass clippings were not affected by treatments (Table 4), and ranged from 6.6 to 7.3 gms./plot. Clippings from week three to week eight were collected using a grooved roller greens mower, while clippings for weeks one and two were taken with a tournament roller which featured a smooth roller and skates. The fourth application was made on July 21, 1997.

By one week after the fourth sequential applications(July 22), differences occurred among treatments only for turfgrass color. Turfgrass mean color scores ranged from 7.8 to 4.8, with the control having the lowest mean score. The

Alliete/EXP10702B tank mix had the best turfgrass color score of 7.8, followed by the EXP10790A tank mix (mean = 6.8), and the Daconil Ultrex tank mix (mean = 6.8) (Table 2). This was the first time that the Alliete/Ultrex tank mix ranked higher than another tank mix for turfgrass color. Note that the control had the lowest turfgrass color score of 4.8 (Table 2). Turfgrass quality scores were not assigned to plots on this date, due to a severe wind storm which arrived

during the rating period. Mean clipping values ranged from 4.2 to 5.3 gms, with significant differences occurring only between the control (5.3 gms/plot/sample) and that of the EXP10702B tank mix (4.2 gms/plot/sample) (Table 4). The fifth applications were made on August 6, 1997.

The turfs did not statistically differ for turfgrass color or quality at one week after the fifth application (August 14). However, clipping production did. Mean color scores ranged from 5.3 to 6.0 (Table 2) and quality mean scores ranged from 5.5 to 6.3 (Table 3). Hot and humid conditions now decreased the over all appearance of the bentgrass turf, as performance scores were now slightly lower, with a decreased performance range between treatments (Table 2,3). Clipping production ranged from 2.6 to 3.5 gms/plot/sample. The control (non-treated) and Chipco 26019 treated turfs had the highest mean clipping production values (3.5 and 3.4, respectively) (Table 4). The Alliete/Ultrex tank mix had the lowest clipping production (2.6 gms.). The sixth application was made on August 21, 1997.

At one week after the sixth application (August 21), the turfgrass showed statistically significant treatment affects for turfgrass color, quality and clipping production. Mean color scores ranged from 4.8 to 7.0. The Alliete/Ultrex tank mix again had the lowest mean color score of 4.8, with the EXP10702B tank mix having the darkest mean color of 7.0 (Table 2). Note that this color was not significantly darker than the other three tank mix treatments. At this time the Chipco 26019 and EXP10702B tank mixes had mean quality scores of 6.8 and 7.3, respectively. These treatments were followed by the EXP10790A tank mix and the control, which each had mean quality scores of 7.0 and 6.0, respectively (Table 3). Mean dry clipping production ranged from 2.7 to 3.4 gms/plot/sample, with the control and the Chipco 26019 tank mix having the largest production values of 3.4 and 3.2 gms./plot/sample, respectively (Table 4). The Daconil Ultrex along with the EXP10702B tank mix had the lowest clipping production of 2.7 gms./plot/sample. At this time, the EXP10702B treated turf showed better color and quality than that of the untreated control, but not for clipping production. The seventh application was applied on September 3, 1997.

At one week after the seventh application (September 9), plots showed significant differences for turfgrass quality and color, but not for clipping production. Turf quality scores ranged from 5.5 to 7.8. The Alliete/Ultrex tank mix had the lowest mean numerical quality (score = 5.5), followed by that of the control. The Alliete tank mixes, with 26019 and EXP10702B, had quality scores of 7.8 and 7.3, respectively (Table 3). Turfgrass color scores were generally low, as a result of accumulated summer stress (high night temperatures and relative humidity) (Table 2). The Alliete/EXP10702B tank mixture had the darkest green color (6.8), while all other treatments had mean color scores of 5.8, or less. Turfgrass clippings ranged from 4.0 to 4.7 gms./plot/sample (Table 4). The eighth and final application of fungicide treatments was applied on September 17, 1997.

At one week after the final application (September 23), the treatment effect was statistically significant for turf quality. However, the treatment effect for turfgrass color, visual density, and clipping production was not. Mean color scores ranged from 5.0 (Alliete/Ultrex) to 6.0 (control). The tank mix of Alliete/EXP10702B was identical to that of the control (Table 2). At this time (September 23) mean turfgrass quality scores ranged from 5.3 to 7.0 (Table 3). The untreated control and the Alliete/EXP10702B tank mix had the best quality scores of 7.0 and 6.8, respectively. The remaining three treatments had mean quality scores of 5.3 to 5.5. At the close of the test visual density scores were assigned to plots using a scale of 1-9, 1 = no turf, and 9 = dense turf. All treated turf seemed to have a decreased density at the end of the test, when compared to the untreated control. However, field results using this visual scale could not statistically demonstrate this (Table 5). In terms of mean ranking, the Alliete/Ultrex tank mix had the lowest visual density (5.0), while the control had the highest numerical score (7.5).

Three weeks previous to these final ratings, Ironite fertilizer was applied at the recommended label rate of 15.0 lbs./product/1000 ft². This application did injure the turf by causing some foliar burning. The plots were aerified with 1/4 solid tines and received extra irrigation during the last three weeks of the test. Although it proved non-significant, the relative

injury (at three weeks after the iron application), was most evident among the turf which received fungicide treatments. Plots received scores of visual damage (1 = none, 4 = moderate, 6 = severe) at the end of the test (September 28). The Alliete/Ultrex tank mix showed the most injury after the iron application (3.3), followed by the Alliete/EXP10702B treatment (3.0). Both the Alliete/EXP10790A and the Alliete/26019 tank mixes had mean injury scores of 2.8 (Table 1). For greens, a score of 3.3 would be noticeable by the average golfer. Clipping production ranged from 4.7 to 5.8 gms./plot/sample, with the control plots producing the largest amount, followed in rank by Alliete/EXP10790A at 5.7 gms./plot/sample (Table 4).

Root samples were taken on October 25, by sampling two plugs/plot using a O.J. Noer greens sampler. The samples were washed from 0-3 inches after the turf was removed at the crown layer. No roots were visible on any treatments below 3.0 inches. After screen washing, samples were air dried for ten days at 35EC. Root production was expressed in terms of gm. dry wt./plug, and represent the average of both sub-samples/plot. Although mean root production ranged almost 40% between treatments, there was no significant effect from fungicide treatments for root production by mid-October (40 days after application #8). The Alliete/26019 tank mix ranked first in average root production (0.052 gms.), followed by the control (0.046 gms.) (Table 5). The Alliete/EXP10702B tank mix and the Alliete/Ultrex tank mix ranked lowest, with gram dry weights of 0.03 gm. Large variances are typical when sampling roots. A greater number of sub-samples would need to be taken to minimize experimental error and increase statistical precision for root mass.

Season averages were calculated for overall turfgrass color and quality, while total clipping production was summed for all eight sampling dates. For the entire summer stress period, mean treatment color scores ranged from 5.0 (Alliete/Ultrex) to 6.9 for the Alliete/EXP10702B tank mix. Note that all tank mixes without Daconil/Ultrex ranked greater in mean color than the control (Table 2). The control had lack luster color (generally) and produced a season average of 5.7. The Alliete/Ultrex tank mix produced a season color average of 5.0. Generally, a score of 6.0 is considered acceptable. The two remaining tank mixes (Alliete/26019, Alliete/EXP10790A) had season average color scores of 6.1 and 6.2, respectively. Season average color scores were significant at the P=0.01 level.

Mean turfgrass quality scores were similar in rank to that of color. All treatments had season average quality scores of 6.0, or greater, except for that of the Alliete/Ultrex tank mix, which scored 4.9 (Table 3). This treatment consistently appeared lighter in color (from the Daconil Ultrex), yet the color difference would last 10-12 days. It did cause initial injury in June and early July, and although there was no loss of turf, it appeared to cause textural changes in the turf (not measured directly). The result was a turf which was slightly blotchy which detracted from its textural uniformity. Mean seasonal quality performance scores were significant at the P = 0.05 level.

Total accumulated clippings ranged from 31.1 to 35.5 gms./plot/sample (12% difference) and was significant at the P=0.06 level (Table 4). The control produced the greatest amount of clippings (35.5 gms.) followed by the Alliete/26019 and Alliete/EXP10790A tank mixes, each with 33.8 and 33.3 gms./plot, respectively. The darkest colored turf, Alliete/EXP10702B had the lowest numerical value for total clipping production at 31.1 gm./plot.

It is noted that no disease symptoms were seen on any and all Penncross creeping bentgrass plots during the summer of 1997, which could be characterized as having high temperatures overall, and high relative humidity from July 10 to September 10. A nearby green, containing twenty-eight varieties of bentgrass became infected in mid-August with a sudden and severe outbreak of foliar blighting, synonymous with symptoms of brown patch (*Rhizoctonia solani*).

Conclusions

1. Alliete Signature fungicide applied as a tank mix with Daconil Ultrex, caused initial discoloration of turf in early June, up to and after two (bi-monthly) treatments applied at the 4.0/4.0 ounce/1000 ft² product rate.
2. Turfgrass color scores for the Alliete/Daconil Ultrex tank mix were less than that of the control plots on seven of eight evaluation dates (approximately one week after treatment).
3. The tank mix of Alliete/EXP10702B ranked first for turfgrass color on Penncross creeping bentgrass mowed at 5/32".
4. The tank mix of Alliete/EXP10702B ranked first for overall turfgrass quality. The Alliete/Daconil Ultrex generally ranked lowest for overall turfgrass quality.
5. Based on the sum of eight clipping removals, dry weight production of clippings varied by 5% for treatments. All treatments had slightly less seasonal clipping totals when compared to the untreated control. On a sampling date basis, clipping production was only significant due to treatment application on two of eight collection dates (approximately one week after treatment).
6. Root dry weights, sampled in mid-October, were not significantly affected by fungicide treatments. The Alliete/26019 program did produce the largest root mass, which was numerically greater than that of the untreated control by 10%. All other tank mixes produced rooting less than that of the control.

Table 1. Injury scores of Penncross creeping bentgrass after applications¹ of select tank mixes of fungicides. Summer 1997, University of Arizona.

TREATMENTS	OZ PROD 1000 FT ²	DEGREE ² INJURY JUNE 16	PERCENT ³ INJURY JUNE 16	PERCENT ³ INJURY JUNE 30	PERCENT ³ INJURY JULY 11	DEGREE ⁴ INJURY SEPT 28
Alliete/26019	(4.0/4.0)	1.5	6	2	2	2.8
Alliete/EXP10790-a	(4.0/4.0)	1.8	4	1	1	2.8
Alliete/EXP10702-b	(4.0/4.0)	1.5	6	1	1	3.0
Alliete/Daconil Ultrex	(4.0/3.8)	3.0	34	24	26	3.3
Control	-----	1.8	4	1	3	1.3
TEST MEAN ⁵		1.9	11	6	7	2.6
LSD VALUE ⁶		0.8	7	6	4	NA

¹Applications made on 6/10, 6/25, 7/9, 7/21, 8/6, 8/21, 9/3, 9/17, 1997.

²Injury 1-6. 1 = none, 4 = moderate, 6 = severe. Mean of four replications. Responses taken approximately 7 DAT.

³Percent plot injury (0-100%)

⁴Injury 1-6. 1 = none, 4 = moderate, 6 = severe. Following application of Ironite fertilizer at label rate. Mean of four replications.

⁵Mean of all plots on each date.

⁶LSD values = Mean separation statistic value. Treatment mean differences larger than LSD value indicate a statistical difference between those treatments.

Table 2. Mean turfgrass color¹ response of Penncross creeping bentgrass after applications² of select fungicides. Summer 1997, University of Arizona.

TREATMENT	OZ PROD/1000 FT ²	JUNE 16	JUNE 30	JULY 11	JULY 22	AUG 14	AUG 21	SEPT 9	SEPT 23	SEASON AVG
Alliete/26019	(4.0/4.0)	6.5	6.5	5.8	6.5	6.0	6.0	5.8	5.8	6.1
Alliete/EXP10790-a	(4.0/4.0)	7.0	6.3	6.3	6.8	5.8	6.0	5.8	5.8	6.2
Alliete/EXP10702-b	(4.0/4.0)	7.5	7.3	7.0	7.8	6.0	7.0	6.8	6.0	6.9
Alliete/Daconil Ultrex	(4.0/3.8)	4.5	4.0	5.0	6.8	5.3	4.8	5.0	5.0	5.0
Control	-----	6.3	5.8	5.8	4.8	5.5	6.0	5.3	6.0	5.7
TEST MEAN ³		6.4	6.0	6.0	6.5	5.7	6.0	5.7	5.7	6.0
LSD VALUE ⁴		1.0	1.0	0.6	1.1	NA	1.1	1.0	NA	0.6

¹Color scores 1-9. 1 = dead, 9 = dark green. Values are the mean of four replications. Responses taken approximately 7 DAT.

²Applications made on 6/10, 6/25, 7/9, 7/21, 8/6, 8/21, 9/3, 9/17, 1997.

³Mean of all plots on each date.

⁴LSD values = Mean separation statistic value. Treatment mean differences larger than LSD value indicate a statistical difference between those treatments.

Table 3. Mean turfgrass quality¹ scores of Penncross creeping bentgrass after applications² of select fungicides. Summer 1997, University of Arizona.

TREATMENT	OZ PROD/1000 FT ²	JUNE 16	JUNE 30	JULY 11	JULY 22	AUG 14	AUG 21	SEPT 9	SEPT 23	SEASON AVG
Alliete/26019	(4.0/4.0)	6.5	6.0	5.5	---	6.3	6.8	7.8	5.5	6.3
Alliete/EXP10790-a	(4.0/4.0)	7.0	6.3	6.0	---	6.3	7.0	6.8	5.3	6.4
Alliete/EXP10702-b	(4.0/4.0)	7.3	6.8	7.0	---	6.3	7.3	7.3	6.8	6.9
Alliete/Daconil Ultrex	(4.0/3.8)	4.5	4.0	4.0	---	5.5	5.0	5.5	5.5	4.9
Control	-----	6.0	6.3	5.3	---	6.3	6.0	6.3	7.0	6.1
TEST MEAN ³		6.3	5.9	5.6	---	6.1	6.4	6.7	6.0	6.1
LSD VALUE ⁴		1.2	1.3	0.8	---	NA	0.9	1.0	1.1	0.4

¹Quality scores 1-9. 1 = dead, 9 = best possible. Values are the mean of four replications. Responses taken approximately 7 DAT.

²Applications made on 6/10, 6/25, 7/9, 7/21, 8/6, 8/21, 9/3, 9/17, 1997.

³Mean of all plots on each date.

⁴LSD values = Mean separation statistic value. Treatment mean differences larger than LSD value indicate a statistical difference between those treatments.

Table 4. Mean dry weight clipping¹ production of Penncross creeping bentgrass after applications² of select fungicides. Summer 1997, University of Arizona.

TREATMENT	OZ PROD/1000 FT ²	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 5	WEEK 6	WEEK 7	WEEK 8	SEASON AVG
Alliete/26019	(4.0/4.0)	4.0	1.1	7.3	4.7	3.4	3.2	4.7	5.5	33.8
Alliete/EXP10790-a	(4.0/4.0)	4.0	1.2	7.2	4.6	3.1	3.1	4.4	5.7	33.3
Alliete/EXP10702-b	(4.0/4.0)	4.4	1.3	6.6	4.2	3.0	2.7	4.4	4.7	31.1
Alliete/Daconil Ultrex	(4.0/3.8)	5.0	1.1	7.2	4.4	2.6	2.7	4.1	5.2	32.2
Control	-----	4.8	1.3	7.3	5.3	3.5	3.4	4.0	5.8	35.5
TEST MEAN ³		4.4	1.1	7.1	4.6	3.1	3.0	4.3	5.7	33.2
LSD VALUE ⁴		NA	NA	NA	NA	0.3	0.5	NA	NA	3.0

¹Clipping dry wt. in gms/plot. Sample area = 18.3 sq.ft. mow height = 5/32". Values are the mean of four replications.

²Applications made on 6/10, 6/25, 7/9, 7/21, 8/6, 8/21, 9/3, 9/17, 1997.

³Mean of all plots on each date.

⁴LSD values = Mean separation statistic value. Treatment mean differences larger than LSD value indicate a statistical difference between those treatments.

Table 5. Mean visual turfgrass density¹ values and mean root production² of Pennncross creeping bentgrass after applications³ of select fungicides. Summer 1997, University of Arizona.

TREATMENT	OZ PROD/1000 FT ²	TURFGRASS DENSITY ¹ (SEPT 23)	ROOT MASS GM. DRY WT ² (OCT 25)
Alliete/26019	(4.0/4.0)	5.8	0.051
Alliete/EXP10790-a	(4.0/4.0)	5.5	0.030
Alliete/EXP10702-b	(4.0/4.0)	5.8	0.037
Alliete/Daconil Ultrex	(4.0/3.8)	5.0	0.031
Control	-----	7.5	0.046
TEST MEAN ⁴		5.9	0.039
LSD VALUE ⁵		NA	NA

¹Turfgrass density 1-9. 1 = none, 9 = very dense. Values are the mean of four replications.

²Root mass = gm. dry wt. 0-3", O.J. Noer greens sampler. Values are the mean of eight samples.

³Applications made on 6/10, 6/25, 7/9, 7/21, 8/6, 8/21, 9/3, 9/17, 1997.

⁴Mean of all plots on each date.

⁵LSD values = Mean separation statistic value. Treatment mean differences larger than LSD value indicate a statistical difference between those treatments.

Appendix Table A. Selected fungicide treatments applied to Penncross creeping bentgrass, mowed at 5/32". Summer 1997, University of Arizona, Karsten Turfgrass Research Facility.

PRODUCTS	FORMULATION	OZ/PROD/1000 FT ²
Alliete Signature Chipco 26019	80 WG 2 SC	4.0 4.0
Alliete Signature R.-EXP-10790-A	80 WG 2 SC	4.0 4.0
Alliete Signature R.-EXP-10702-B	80 WG 2 SC	4.0 4.0
Alliete Signature Daconil Ultrex	80 WG 82.5 WG	4.0 3.8
Control	---	---