Evaluation of various soil surfactants for creeping bentgrass summer fairway management. Purdue University, 2006

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Objective:

To evaluate the effects of various commercially available and experimental soil surfactants for improving creeping bentgrass summer fairway performance.

Experimental Procedures:

This field experiment was located at the W.H. Daniel Turfgrass Research and Diagnostic Center (West Lafayette, IN) on a three year-old mature mixed creeping bentgrass/annual bluegrass stand consisting primarily of 'Penncross' creeping bentgrass grown on a Starks-Fincastle silt-loam (fine-silty, mixed, mesic Aeric Ochraqualf) with pH of 7.2 and 1.6 % organic matter. Throughout the study the area was maintained at ½ inch with clippings returned, fertilized with approximately 2.5 lbs N/1000 ft^2 yr^{-1} and received irrigation in the absence of significant rainfall to prevent severe turf stress. Treatments were initiated on 22 June 2006 and subsequently applied as specified by the research protocol. All treatments were applied with a pressurized CO_2 (35 psi) sprayer equipped with TeeJet XR 8010E tips calibrated to deliver 2.0 gallons of spray volume per 1000 ft^2. Two additional treatments were added to further evaluate the mild chemical phytotoxicity observed following the initial applications of PX7004 and PX26638. These treatments were applied on 15 July and reapplied on 22 July. The exact chemical rates of all treatments and dates of all applications are also footnoted in each data table. Plots were 5 ft x 5 ft and arranged in a randomized complete block with three replications of each treatment. Each set of treatments were applied in the morning and the entire study area was then irrigated that evening to supply approximately 0.25 inches of water via an overhead irrigation system. The soil moisture status prior to each application was considered adequate and the turf was never under severe environmental stress at treatment application.

Plots were visually assessed throughout the study for turfgrass quality using a 0-10 scale with 0=brown dead turf, 10=optimum greenness, density and uniformity and $\geq$7 = acceptable fairway turf. Chemical phytotoxicity was visually rated on a 1-9 scale where 1 = severe injury and substantial turf yellowing and 9= no injury. Canopy greenness was quantified using a hand-held reflectance meter (FieldScout CM-1000, Spectrum Technologies Inc.). Five measurements were taken per plot using a systematic grid pattern which included the four corners and center portions of each plot. The five measurements were averaged to produce a single plot rating and are reported as a color index. The soil water content in the upper 2 inches of soil was measured weekly throughout the study using a portable moisture sensor (Pogo Soil Moisture Sensor, Stevens Water Monitoring Systems, Inc., Beaverton, OR). Five measurements were recorded per plot using a systematic grid patter described previously and averaged into a single value. All data was subjected to analysis of variance using the SAS system (Statistical Analysis Systems Institute Inc., Cary, N.C.) and treatment means separated using Fisher's protected least significant difference (LSD) test at the (p=0.05) level.

Results:

Turfgrass quality (TQ) values ranged from 3.5 to 9.0 throughout the study which varied by surfactant treatment and rating date (Table 1). For the study average there was no difference among those treatments initially applied on 22 June. The only surfactant that was superior to the untreated control was PX7004 with study average TQ values of 8.3 and 7.1 respectively. Among the treatments initially applied a slight decline in TQ was observed for PX26638 from 27 June through 13 July and on 9 July the TQ value for this treatment fell below the acceptable threshold value of 7.0. By 21 July all treatments initially applied had superior TQ, however, the second set of treatments were significantly lower due to moderate chemical phytotoxicity which occurred during the summer stress period of mid-July (Figure 1). This trend of lower TQ for these treatments persisted for the remainder of the study. The TQ values in the untreated control plots fell below the unacceptable level on 19 Aug. and stayed below that level for the remainder of the study. On 26 Aug. all treatments had unacceptable TQ values which ranged from 3.5-6.0, most likely due to the onset of severe environmental heat stress. There was no difference between those plots initially treated with surfactants. Both PX26638 and PX7004 were, however, significantly better than the untreated control.

The TQ treatment differences during this study were attributed to differential responses in chemical phytotoxicity, localized dry spot, percentage brown and canopy greenness values (Table 2). The decline in TQ due to initial surfactant application for PX26638 was observed on the 27 June and 9 July ratings with significantly higher phytotoxicity for this treatment relative to the other treatments which manifested itself as a mild to moderate yellowing of the turf canopy. This was also observed in the supplementary study to validate this response which was initiated on 15 July. By 21 July both PX7004 and PX26638 exhibited significant turf yellowing. Although treatment means ranged from 2.3-11.7 % of the plot area affected, there was no difference among treatments for localized dry spot. However, the treatments with the lowest area affected were PX26638 and PX7004 with only 3.0 and 2.3 %, respectively. For canopy greenness there was generally no significant difference among treatments except for those surfactants applied on 13 July which had lower greenness values. By 31 Aug. all treatments had similar greenness values. Although PX26638 initially caused temporary turf yellowing, during the period of most intense environmental stress, 26 Aug., turf treated with this surfactant provided some of the highest TQ values, 6.0, and were superior to the untreated control which had a TQ value of 4.2 (Table 1 and Figure 2).

Soil water content in the upper two inches of soil ranged from 19.7 - 40.3 % (Table 3). There was generally no difference among treatments during the study with the lowest soil water contents, ranging from 19.7-25.6 %, measured on 26 July and 2 August. From 11 through 31 Aug. some subtle but inconsistent treatment separation occurred. Several treatments were superior to the untreated control including PX7004 on 11 and 31 August. In summary, there were some mild benefits of applying these soil surfactants for improving creeping bentgrass TQ, especially during severe summer stress (e.g. mid-August). However, where phytotoxicity is not tolerable, an application timing of the third week of June is not advisable. Thus, an earlier application when the air temperatures are cooler and the turf is growing actively growing will enable the turf to quickly recover from any potential discoloration.

Figure 1. Creeping bentgrass fairway turf possessing a slight yellowing as a result of the PX26638 application, 9 July, 2006.

Figure 2. Creeping bentgrass fairway turf possessing a higher visual quality as a result of previous PX26638 applications, 26 Aug., 2006.

Table 1. Creeping bentgrass fairway visual turfgrass quality as affected by various surfactants.

Trt ‡	Treatment Description	Application Rate	Turfgrass Quality†						
			23 June	27 June	9 July	13 July	21 July	28 July	3 Aug.
		-- 1000 ft^2 --	----------Visual rating (0-10 scale)----------						
1	Duplex	32 oz/Acre	8.5 a*	8.2 a	8.2 a	8.3 a	9.0 a	8.0 a	8.0 ab
2	Dispatch	32 oz/Acre	8.5 a	8.3 a	8.5 a	8.5 a	9.0 a	8.3 a	8.5 a
3	PX26638	8 + 8 oz	8.5 a	7.3 b	6.8 b	7.7 b	9.0 a	8.5 a	8.7 a
4	PX7004	4 oz	8.2 a	8.2 a	8.2 a	8.3 a	9.0 a	8.3 a	8.7 a
5	Untreated	---	8.5 a	8.3 a	8.3 a	8.3 a	9.0 a	7.5 ab	7.5 bc
6	PX7004	8 + 8 oz	---	---	---	---	7.0 b	7.0 bc	7.0 c
7	PX26638	8 + 8 oz	---	---	---	---	6.7 b	6.2 c	6.7 c

† Turfgrass quality was visually assessed on a 0 to 10 scale where 0=bare soil, brown turf, 10=optimum greenness, density and uniformity and values $\geq$ 7 = acceptable fairway turf.

‡ Treatments 1-4 were initially applied on 22 June, treatment 3 was reapplied on 28 June, treatments 1 and 2 were reapplied every 21 days on 12 July, 2 and 23 Aug., treatment 4 was reapplied every 28 days on 20 July and 17 August. Treatments 6-7 were initially applied on 15 July and reapplied on 22 July. All treatments were applied in 2 gallons spray volume per 1000 ft^2.

* Means in the same column followed by the same letter are not significantly different according to Fisher's protected LSD t-test (p=0.05).

Table 1 cont.

Trt	Treatment Description	Application Rate	Turfgrass Quality†				
			11 Aug.	19 Aug.	26 Aug.	31 Aug.	Study Mean
		-- 1000 ft^2 --	----------Visual rating (0-10 scale)----------				
1	Duplex	32 oz/Acre	7.7 ab	7.7 ab	4.8 abc	7.0 a	7.6 ab
2	Dispatch	32 oz/Acre	8.5 ab	8.3 a	5.5 ab	7.0 a	8.0 ab
3	PX26638	8 + 8 oz	8.7 a	8.7 a	6.0 a	7.5 a	7.9 ab
4	PX7004	4 oz	8.7 a	8.7 a	6.0 a	8.7 a	8.3 a
5	Untreated	---	7.0 bc	6.5 bc	4.2 bc	5.7 b	7.1 bc
6	PX7004	8 + 8 oz	6.0 c	6.0 c	4.0 bc	6.3 b	6.2 cd
7	PX26638	8 + 8 oz	5.7 c	5.8 c	3.5 c	5.7 b	5.7 d

Table 2. Creeping bentgrass phytotoxicity, localized dry spot, percentage brown turf and canopy greenness as affected by various surfactants.

			Chemical Phytotoxicity†				LDS‡	Brown	Canopy Greenness §			
Trt #	Treatment Description	Application Rate	27 June	9 July	13 July	21 July	26 July	26 Aug	30 July	11 Aug.	19 Aug.	31 Aug.
		-- 1000 ft^2 --	-------- Visual rating (1-9 scale) --------				------- (%) -------		---------- spectrum units ----------			
1	Duplex	32 oz/Acre	8.2 a*	8.2 a	9.0 a	9.0 a	5.7 a	27.7 a	328 a	295 a	293 ab	271 a
2	Dispatch	32 oz/Acre	9.0 a	9.0 a	9.0 a	9.0 a	5.7 a	19.8 a	347 a	307 a	298 ab	289 a
3	PX26638	8 + 8 oz	7.3 b	6.8 b	8.3 b	9.0 a	3.0 a	12.3 a	351 a	330 a	315 a	327 a
4	PX7004	4 oz	9.0 a	9.0 a	9.0 a	9.0 a	2.3 a	5.5 a	354 a	326 a	315 a	319 a
5	Untreated	---	8.8 a	8.8 a	9.0 a	9.0 a	11.7 a	36.7 a	308 a	283 a	273 bc	277 a
6	PX7004	8 + 8 oz	---	---	---	6.0 b	10.0 a	35.0 a	238 b	208 b	256 c	278 a
7	PX26638	8 + 8 oz	---	---	---	6.0 b	11.7 a	36.7 a	241 b	240 b	262 bc	321 a

† Chemical phytotoxicity was visually assessed on a 1 to 9 scale where 1 = worst and 9 = least damage.

‡ Localized dry spot and percentage brown turf were visually assessed on a 0-100 linear scale where 0 = none present and 100 = complete plot area affected.

§ Canopy greenness was measured as canopy reflectance with the CM-1000 with five measurements per plot recorded.

Treatments 1-4 were initially applied on 22 June, treatment 3 was reapplied on 28 June, treatments 1 and 2 were reapplied every 21 days on 12 July, 2 and 23 Aug., treatment 4 was reapplied every 28 days on 20 July and 17 August. Treatments 6-7 were initially applied on 15 July and reapplied on 22 July. All treatments were applied in 2 gallons spray volume per 1000 ft^2

* Means in the same column followed by the same letter are not significantly different according to Fisher's protected LSD t-test (p=0.05).

Table 3. Soil water content of a creeping bentgrass research fairway as affected by various soil surfactants.

Trt ‡	Treatment Description	Application Rate	23 June	26 June	28 June	3 July	7 July	12 July	24 July	26 July
		-- 1000 ft^2 --	---------- Volumetric water content (%) † ----------							
1	Duplex	32 oz/Acre	38.4 a*	39.4 a	39.6 a	37.8 a	37.1 a	39.4 a	26.0 a	23.7 a
2	Dispatch	32 oz/Acre	38.6 a	39.4 a	39.6 a	38.4 a	37.2 a	38.2 a	30.3 a	23.4 a
3	PX26638	8 + 8 oz	37.8 a	39.2 a	39.4 a	39.1 a	36.2 a	40.3 a	31.6 a	23.7 a
4	PX7004	4 oz	38.3 a	39.4 a	39.8 a	37.9 a	37.1 a	39.1 a	30.4 a	25.1 a
5	Untreated	---	38.1 a	39.1 a	39.3 a	35.7 a	35.7 a	38.3 a	24.2 a	20.9 a
6	PX7004	8 + 8 oz	---	---	---	---	---	---	25.2 a	19.7 a
7	PX26638	8 + 8 oz	---	---	---	---	---	---	27.5 a	21.9 a

† Soil water content across the upper 2 inches was determined using a portable soil moisture probe recording five measurements per plot.
‡ Treatments 1-4 were initially applied on 22 June, treatment 3 was reapplied on 28 June, treatments 1 and 2 were reapplied every 21 days on 12 July, 2 and 23 Aug., treatment 4 was reapplied every 28 days on 20 July and 17 August. Treatments 6-7 were initially applied on 15 July and reapplied on 22 July. All treatments were applied in 2 gallons spray volume per 1000 ft^2.
* Means in the same column followed by the same letter are not significantly different according to Fisher's protected LSD t-test (p=0.05).

Table 3 cont.

Trt #	Treatment Description	Application Rate	31 July	2 Aug.	11 Aug.	15 Aug.	19 Aug.	27 Aug.	31 Aug.
		-- 1000 ft^2 --	---------- Volumetric water content (%)† ----------						
1	Duplex	32 oz/Acre	28.5 a	22.0 a	36.1 ab	32.7 ab	28.8 ab	28.4 ab	34.1 b
2	Dispatch	32 oz/Acre	30.8 a	23.6 a	36.8 ab	32.9 ab	29.8 ab	29.4 a	35.2 ab
3	PX26638	8 + 8 oz	31.4 a	23.6 a	37.6 a	35.7 a	32.2 a	27.7 ab	36.3 ab
4	PX7004	4 oz	31.8 a	25.6 a	38.5 a	35.2 a	32.0 ab	26.0 ab	35.9 ab
5	Untreated	---	27.2 a	19.8 a	34.5 b	29.5 a	27.0 b	24.8 b	34.0 b
6	PX7004	8 + 8 oz	30.1 a	20.9 a	35.9 a	34.8 a	29.9 ab	25.5 b	37.0 a
7	PX26638	8 + 8 oz	29.3 a	20.1 a	35.6 ab	34.0 ab	30.1 ab	29.6 a	36.0 ab