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CULTIVATION AND TOPDRESSING REQUIREMENTS FOR THATCH MANAGEMENT IN A, G BENTGRASSES AND CREEPING BLUEGRASS (*POA ANNUA* VAR. *REPTANS*)

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Abstract. Empirical observations suggest certain new cultivars of creeping bentgrass (*Agrostis stolonifera* L.) with high shoot density require more intensive topdressing and aeration to control thatch compared to less dense cultivars such as ‘Penncross’. In addition, a variety of *Poa annua* var. *reptans*, ‘DW-184’, has recently been released for putting green use but management requirements are undocumented. The objective of our project was to determine the aeration and topdressing requirements for thatch management of creeping bentgrass cultivars ‘A-4’, ‘G-2’, and Penncross as compared to DW-184. Plots were established on a sand-based root zone and maintained as putting green turf for 3 years. A factorial treatment arrangement was used to assess the affects of aeration and topdressing on thatch, topdressing removal, turf quality, and disease. Both A-4 and G-2 produced more organic matter as thatch/mat than Penncross and DW-184. Grass type, aeration frequency, and topdressing regime affected the amount of topdressing removed by mowing. An interaction between grass type and topdressing regime showed biweekly topdressing with verticutting resulted in less topdressing removal from all grasses except G-2 compared to monthly topdressing without verticutting. Since no more than 3% of the topdressing applied was removed from any single treatment, however, the overall impact of grass type, aeration frequency, or topdressing regime are unlikely to affect turf response. Both A-4 and G-2 provided consistently better quality turf than Penncross or DW-184 at 3.2 mm mowing height, though A-4 was more susceptible to dollar spot disease than Penncross or G-2. Cultivation and topdressing methods for management of A-4 and G-2 bentgrasses do not differ substantially from Penncross or DW-184 creeping bluegrass.

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Turfgrass Management

Cultivation and Topdressing Requirements for Thatch Management in A, G Bentgrasses and Creeping Bluegrass (*Poa annua* var. *reptans)*

Additional index words. Aeration, thatch, DW-184, A-4, G-2, Penncross

Introduction

Creeping bentgrass (*Agrostis stolonifera* L.) , epitomized by ‘Penncross’, has become the preferred putting green turf since the mid-1950s due in part to its high turf quality and ability to tolerate golf-related traffic. In the early 1980s plants were chosen out of existing Penncross and Penneagle greens from the southern U.S. and used to produce several new varieties of bentgrasses. The new varieties, ‘A-1’, ‘A-2’, ‘A-4’, ‘G-1’, ‘G-2’, and ‘G-6’, were notable for their upright growth, high shoot density, and narrow leaves (Fraser, 1998). Shoot densities exceed 2000 shoots dm^{-2} compared to less than 1500 shoots dm^{-2} for Penncross, allowing the A and G series bentgrasses to resist invasion by *P. annua* (Beard et al., 2001). The A and G bentgrasses have good disease resistance (Fraser, 1997) and better summer stress tolerance than Penncross and other conventional bentgrasses (Landry and Schlossberg, 2001) . Their aggressive growth, however, may require a more rigorous management regime than is typically used for Penncross and other less aggressive varieties. Anecdotal data from the southeastern U.S. indicate A and G bentgrasses require a lower mowing height and more frequent topdressing and aeration than older cultivars (Fraser, 1998). Some concern has been expressed that the high shoot density may prevent incorporation of topdressing below the canopy (Fraser, 1998). A survey of 18 golf course superintendents revealed management practices included a range of topdressing regimes from biweekly to monthly and aeration from two to six times annually (Fraser, 1998). Unfortunately no peer-reviewed data have been published to confirm the additional management requirements.

The ubiquitous presence of *P. annua* in putting greens has resulted in breeding efforts to produce perennial biotypes (*P. annua* var. *reptans* Hausskn.) suitable for use on putting greens (Huff, 1998; White, 1997). In 1997 the first variety of *P. annua* var. *reptans* 'DW-184'was released for commercial use (White, 1997). Its stoloniferous growth habit earned it the moniker creeping bluegrass (Beard, 1999). Unfortunately little is known about its performance and management requirements because it is such a new grass type and many superintendents are reluctant to use it due to lack of information and its stigma as a weed species. Miltner et al. (2000) have investigated establishment methods for creeping bluegrass. Dudek and Anderson (1999) reported DW-184 compared similarly to rough bluegrass (*Poa trivialis*) for overseeding winter-dormant bermudagrass golf greens. Beard (2002) has suggested a generic management regime for *P. annua* var. *reptans* on putting greens.

The degree of more intensive management for A and G bentgrasses has not been proven. In addition, no management requirements have been published for DW-184, and information is needed on its ability to perform similarly to new and conventional bentgrasses. The objective of the study was to determine the aeration and topdressing requirements for creeping bentgrass varieties 'A-4', G-2, and Penncross and DW-184 creeping bluegrass.

Materials and Methods

Plot preparation. Plots of Penncross, A-4, G-2 creeping bentgrasses and DW-184 creeping bluegrass were established with 4.8 g seed m^{-2} on 10 September 1998. Plots had a sand based root zone constructed in 1992 based on United States Golf Association (USGA) specifications (USGA, 1989). The organic matter content was 1% (by mass), pH 7.8, phosphorus content was 61 kg ha^{-1}, and potassium content was 54 kg ha^{-1}. Mowing height was reduced from 8.9 mm during establishment to achieve a final mowing height of 3.2 mm during spring of 1999. Turf was mowed six times weekly with a walking greensmower with clippings removed. Plots were fertilized biweekly with 2.4 g N m^{-2} until 15 November 1998 (six applications). Plots were fertilized 10 times in 1999 to aid establishment, using equal increments of N to supply an annual total of 24 g N m^{-2}. In 2000 and 2001 turf was fertilized four times annually to provide a total of 17 g N m^{-2}. Only granular fertilizer was used with nitrogen sources a mixture of water-soluble (urea) and insoluble (methylene urea) forms. Plots were irrigated daily to replenish 100% estimated evapotranspiration (ET) rate. Iprodione [3-(3,5-dichlorophenyl)-N-(1-methylethyl)2,4-dioxo-1-imadazolidinecarboximide] and chlorothalonil (tetrachloroisophthalonitrile) were applied as needed to suppress diseases. Once in both 2000 and 2001 dollar spot disease (caused by *Sclerotinia homeocarpa* F.T. Bennett) was allowed to develop to determine susceptibility of the grasses to the disease.

Treatment applications. The experimental design was a split-split plot, randomized complete block with three replications. Treatments were applied in a factorial arrangement with grass type as whole plots (16.7 m^2). Plots were split for aeration and topdressing beginning in May 1999. Aeration was conducted using core cultivation either once (October) or four times annually (May, July, September, October). Small diameter (0.6 cm) tines were used except for the October aeration which used 1.3 cm diameter tines. Cores were removed and each aeration was followed by topdressing. Topdressing was with an 80:20 mixture (sand:peat) which met USGA particle size specifications for putting green construction. Topdressing was applied either monthly, biweekly (two-week intervals), or biweekly immediately following verticutting. Topdressing was applied with a drop spreader calibrated to apply 0.8 mm depth, equivalent to 0.07 m^3 $100m^{-2}$ or 0.54 kg m^{-2}, for monthly treatments and at half-rate for biweekly treatments. The topdressing was brushed in after application and the turf was irrigated during the evening. Data collection began in 2000 once plots had fully matured.

Data Collection. Thatch production was measured using three cores (2.5 cm diam x 5 cm depth) collected from each plot in the fall of 2000 and 2001. The cores were compressed with a 185-g weight, and the depth of the organic layer (thatch/mat) was measured at three equidistant points around the core. Measurements were averaged to provide one mean per replicate. Once verdure was removed, the 2000 and 2001 cores were combusted at 600 C for two hours to determine by weight loss the mass of organic matter present.

Topdressing particles removed by mowing the day following application were separated from clippings by adding water and decanting off the clippings. Topdressing samples were oven-dried at 60°C for 24 h then weighed. Once in 2001 the collected and dried particles were segregated by passing through a nest of sieves to determine if the treatments affected particle size distribution of the sand removed. The mass of each particle size passing through a particular sieve size was divided by the fraction of that particle size in the original topdressing material to determine the percent fraction of topdressing removed by mowing. Particle size distribution of the original topdressing sand was determined from the average of sieving triplicate samples of 600 g each.

Plots were visually rated on a monthly basis for color, quality and disease severity. Color and quality were rated on a visual scale from one to nine, with one equal to 100% necrotic turf and nine equal to ideal turf. A rating of six was considered acceptable. Quality was based on turf uniformity, density, and overall appearance without regard to color. A color rating of nine was equivalent to dark forest green and a color rating of one was equivalent to light green, almost yellow color.

Dollar spot severity was evaluated on 5 July 2000 and 5 Sept 2001 following several days of intentionally uncontrolled disease development. Disease incidence was measured as the number of infection centers in each plot.

Data analysis. The amount of topdressing material removed by mowing was converted to percent of applied and averaged across all application dates for each year. Means of each replicate were used for statistical analysis. All data, including thatch and ratings, were analyzed as a randomized complete block design with grass types as main plots, aeration frequency as sub-plots, and topdressing regimes as sub-sub-plots (MSTAT, 1988). Treatment differences were separated by Fisher's Protected LSD when F-tests were significant at $P \leq 0.05$.

Results and Discussion

Thatch production. Both bimonthly and monthly topdressing regimes effectively diluted the thatch, resulting in mat (Beard, 2002). Grass types were the only treatment variable that affected thatch production (Table 1). Both A-4 and G-2 had greater than 15 mm thatch in 2000 and greater than 23 mm thatch 2001 compared to ≤ 13 mm in 2000 and less than 21 mm in 2001 for Penncross and DW-184. Differences in thatch mass among grass types was less dramatic than depth measurements but followed similar trends with A-4 and G-2 having greater mass than Penncross in 2000 and DW-184 in 2001. Thatch/mat mass differences between the A and G bentgrasses and Penncross were not as dramatic as those reported by Landry and Schlossberg (2001). Engel (1967) reported that high N fertility and aggressive growth produce excessive thatch in golf greens. In our study, plots received 17 g N m^{-2} annually, an amount similar to that discussed by Landry and Schlossberg (2001) as contributing to less thatch development than 30 or more g N m^{-2}. Data from spring and fall measurements of mat/thatch depth in a single year showed that G-2, G-6, and A-1 did not necessarily produce deeper mat/thatch layer than Penncross (Sifers et al., 2001).

Topdressing removal. Grass type, aeration frequency, and topdressing regime each affected the amount of topdressing removed by mowing, although only approximately 1% to 3% was removed from any single treatment. Mowing did not remove sufficient topdressing material for measurement following the first mowing after application. Statistically ($P \leq 0.05$) more topdressing was removed from A-4 than DW-184 (approximately 2% versus 1 %) while losses from G-2 and Penncross were intermediate (data not shown). Biweekly topdressing with verticutting resulted in significantly ($P \leq 0.05$) less topdressing loss (1.3% ± 0.2) than either biweekly or monthly applications without verticutting (1.7% ± 0 and 2.0% ± 0.3, respectively). Frequent aeration resulted in 0.2% more topdressing loss than annual aeration in both years, though this was likely due to the root zone mix being picked up by mowing following core aeration as there were no differences on dates when there was no aeration. Grass type and topdressing method produced a significant interaction on topdressing removal in both years (Fig. 1A and 1B). Monthly topdressings resulted in significantly more loss than biweekly applications with verticutting for all cultivars except G-2. Biweekly topdressing had intermediate results.

Grass type and topdressing method each significantly affected the distribution of particle sizes of topdressing removed by mowing in 2001. There were no interactions and aeration did not affect size distribution of topdressing removal. Both A-4 and G-2 had approximately 2% to 4% more of the larger-sized topdressing (0.5 to 2 mm) particles removed than Penncross or DW-184 (Table 2). Significantly ($P \leq 0.05$) more of the 0.25 to 0.5 particle size was removed from Penncross turf (35%) than from either A-4 or G-2 turf (both approximately 32%). Monthly topdressing resulted in more of the intermediate sizes (0.25 to 1 mm) being removed than biweekly topdressing.

The slight differences in topdressing removal among grass types and topdressing treatments, though statistically significant, were minor enough to be unlikely to have any practical impact on turf management. Our topdressing rates were near the 50th percentile for typical topdressing rates on greens (Beard, 2002) and our monthly application rates were half those used in a previous trial when topdressing was performed four times annually (Sifers et al., 2001). In our study, the depth of topdressing applied during monthly applications was approximately 25% that of the mowing height, while biweekly applications were only 12.5% that of the mowing height. Information on topdressing removal by mowing could not be found for comparative purposes. It is probable, however, that a greater percentage of topdressing would be removed when applied at higher rates, or if the topdressing was not brushed and irrigated into the canopy prior to mowing.

Turf quality. Turf quality was dependent on grass types in both years and occasionally on topdressing method. A-4 and G-2 creeping bentgrasses had similar turf quality and both consistently provided better turf quality than either Penncross or DW-184 (Fig. 2A and 2B). Turf quality of DW-184 was significantly less than that of Penncross during spring of 2000 but improved and was similar to Penncross turf quality during the latter half of 2000 and all of 2001. Neither Penncross or DW-184 provided acceptable turf quality (rating 6.0 or above) at 3.2 mm mowing height. DW-184 may have suffered from contamination with annual *P. annua*. Plots of DW-184 exhibited profuse seedheads throughout the spring and summer of 1999, a characteristic of annual biotypes while DW-184 has only seasonal flowering (Johnson et al., 1993). By late autumn the seedheads were largely gone, and there were relatively few seedheads in 2001. Due to the difficulty of producing DW-184 free of wild type *P. annua* (Pepin, 2001), it is likely the original seed lot was contaminated with annual type *P. annua* var. *annua*. The shift from season-long to spring-only flowering between 1999 and 2001 indicated the DW-184 perennial biotype was able to outcompete the suspected annual types on these closely mowed putting greens. This phenomenon has been reported by Lush (1989).

Verticutting occasionally reduced turf quality 0.1 rating point compared to topdressing without verticutting when rating occurred within seven days of verticutting (data not shown). Aeration did not affect turf quality and there were no regular interactions between or among grass type, aeration, and topdressing method.

Creeping bentgrass A-4 consistently had darker green color (approximately 8.0 rating) compared to all other grasses. G-2 often, but not always, exhibited darker color (approximately 7.0) than Penncross (6.0 to 7.0) and DW-184. Color of DW-184 was consistently lighter green in the spring than in the fall, changing from approximately 4.0 to 6.0. As expected, aeration and topdressing did not affect color of any turf cultivars.

Dollar spot susceptibility. Dollar spot was readily controlled with fungicides. Dollar spot disease quickly developed when preventive applications ceased in both years. Significant differences in dollar spot incidence existed among the grass types while neither aeration or topdressing had any effect. DW-184 was significantly more susceptible to dollar spot than Penncross and G-2 (Table 3). Previously, DW-184 was depicted as having dramatically superior dollar spot resistance compared to other creeping bluegrass clones (White, 1997), though it has not previously been compared to bentgrasses. A-4 had significantly more dollar spot in both years than either Penncross and G-2 and was similar to DW-184 in 2001. The dramatic differences in occurrence of dollar spot among the bentgrasses disagreed with results from the southeastern U.S. which reported A-4, G-2, and Penncross all had relatively good dollar spot resistance (Bruneau et al., 2001). Our results may have differed due to different strains of the pathogen, though the limited evidence available suggests pathogenicity of *S. homeocarpa* isolates varies according more to host species rather than cultivar (Hsiang et al., 2000). However, data from trials in various regions of the U.S. have also noted less and similar dollar spot resistance in A-4 compared to Penncross (NTEP, 1997), while seasonal variations of *S. homeocarpa* pathogenicity in creeping bentgrass have also been reported (Powell and Vargas, 2001).

Conclusions

Core aeration and topdressing requirements for A-4 and G-2 do not seem to deviate significantly from traditional regimes for bentgrasses. Both A-4 and G-2 produced more thatch than Penncross or DW-184, but the thatch was diluted similarly among grass species by both bimonthly and monthly topdressing applications. The amount of topdressing removed from any grass type was minimal, rebutting concerns that the density of A and G bentgrasses affects topdressing removal. Both A-4 and G-2 provided consistently better turf quality at 3 mm cutting height than either Penncross or DW-184 creeping bluegrass.

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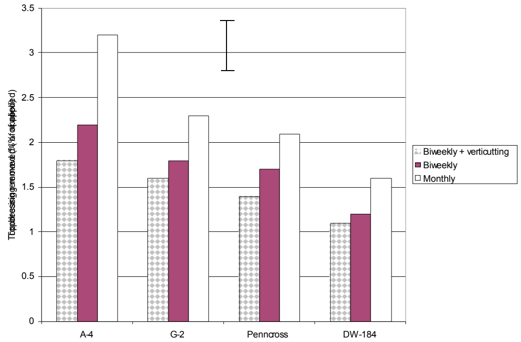

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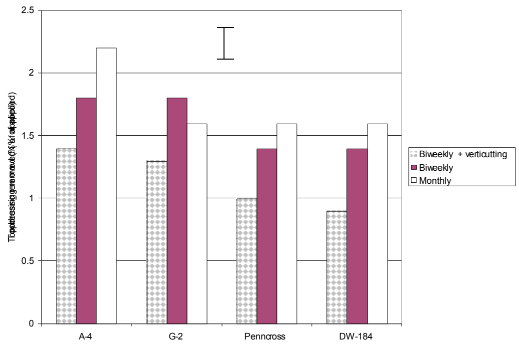

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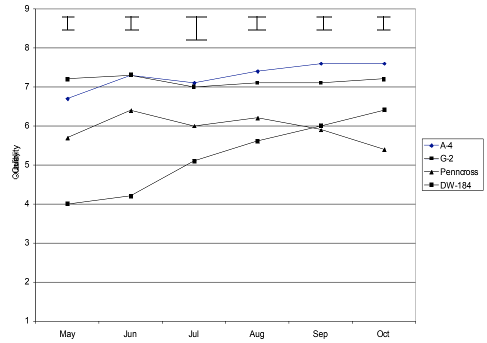
Fig. 1. Interaction of cultivar type and topdressing regime on topdressing loss by mowing. Creeping bentgrass cultivars are ‘A-4’, ‘G-2’, and ‘Penncross’; ‘DW-184’ is a commercial variety of Poa annua var. reptans. Vertical bars represent the LST values for comparing treatment means (P≤0.05) within and among cultivars.



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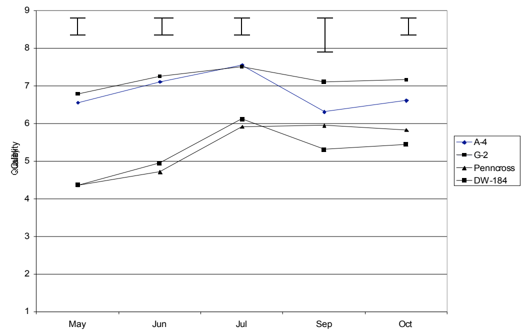

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Fig. 2. Quality of three creeping bentgrass cultivars and *P. annua* var. *reptans* ‘DW-184’ maintained at 3.2 mm height (Verona, WI). Quality was rated visually on a one to nine scale, with one equal to necrotic turf and nine equal to ideal turf; a rating of six was considered acceptable turf. Vertical bars represent the LSD value for comparing treatment means (P≤0.05).

Table 1. Thatch/mat produced by four grass types maintained as putting green turf, Verona, WI.

	Depth (mm)		Mass (g) [z]	
Grass type	2000	2001	2000	2001
A-4	15.9	23.0	1.51	1.38
G-2	16.5	23.5	1.45	1.41
Penncross	13.0	16.9	1.34	1.34
DW-184	12.2	20.9	1.45	1.29
LSD (0.05)	2.0	1.6	0.10	0.04

[z] Based on weight loss upon ignition of two cores, 2.5 cm diameter x 5 cm depth, from each of four replications.

Table 2. Particle size distribution of topdressing removed by mowing from four types of putting green turfgrasses and three topdressing regimes, 28 July 2001, Verona, WI.

	Particle size (mm)					
	>2	2-1	1-0.5	0.5-25	0.25-.15	<0.15[z]
	% Fraction in topdressing					
	0.94	3.30	17.99	65.62	12.15	---
Grass type	% Of fraction that was removed					
A-4	7.2	24.5	33.6	32.0	2.71	---
G-2	7.7	24.0	33.3	32.4	2.63	---
Penncross	8.8	21.1	31.7	35.4	2.88	---
DW-184	10.3	22.6	29.9	34.2	2.80	---
LSD (0.05)	ns	1.7	2.2	2.3	ns	---
Topdressing method						
Biweekly	9.3	24.7	30.4	32.7	2.9	---
Biweekly + verticutting	10.6	25.9	30.9	30.0	2.6	---
Monthly	5.6	18.5	35.1	37.9	3.0	---
LSD (0.05)	1.2	1.3	1.1	1.5	0.2	---

[z] There were no particles removed from this size range.

Table 3. Incidence of dollar spot (*Sclerotinia homeocarpa*) on turfs maintained as putting greens, Verona, WI.

Cultivar	5 July 2000	5 Sept. 2001
	----------------- No. of dollar spot patches per plot ---------------	
A-4	19.1	35.2
G-2	5.2	9.2
Penncross	0.3	6.8
DW-184	71.6	49.7
LSD (0.05)	7.9	26.3