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Management of Velvet Bentgrass Putting Greens

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Abstract

Velvet bentgrass (*Agrostis canina* L.) is a fine-textured, high-density forming turfgrass ideal for golf course putting greens. Our objective was to evaluate the effect of N and Fe fertilizer, N:K_2O ratio, and vertical mowing and topdressing on velvet bentgrass (VBG) performance on a silt loam soil and two sandy soils. Nitrogen was applied at 0 to 243 kg/ha/year in 1:1 and 1:2 N:K_2O ratios. Surface cultivation treatments were: no treatment, topdressing only, and vertical mowing + topdressing. Turfgrass color, density, recovery from vertical mowing, and thatch depth were measured. Each increasing increment of N resulted in higher color scores and higher-density VBG. Lower N rates on silt loam soil produced better color and higher-density turf than the same N treatments on the sand soils. Thatch accumulation was not affected by treatments. Results indicated that VBG putting greens on sandy soils will require a minimum of 196 to 243 kg of N per ha/year to maintain adequate vigor, color, and density. Velvet bentgrass turf can be excellent quality with minimal intervention, however, VBG putting greens will require higher maintenance practices in some situations to meet high quality expectations.

Introduction

Velvet bentgrass is a fine-textured, dense turfgrass that is ideal for golf course putting greens. Historically, this grass has not been used or studied as much as creeping bentgrass (*Agrostis palustris* Huds.) and the scientific literature contains very little information about management and care of VBG. Much of the existing information about VBG is very old and mostly anecdotal. Velvet bentgrass has been labeled as a "low-maintenance" grass for some time, but little is known about how the grass responds in different environments and management situations. More research is needed to produce information showing how this turfgrass responds to various management conditions.

In the early 1900s turf managers began propagating VBG in the US; however, these older cultivars lost popularity because commercial seed was difficult to produce and the grass was primarily established by vegetative methods (1). Historically, VBG has earned high rankings in university turf trials for its aesthetic characteristics (1). In recent years, VBG has regained popularity because improved cultivars are now available that demonstrate heat and drought tolerance, in addition to excellent disease resistance (2,3). VBG is also known to be tolerant of shade and low pH soils (5,6). Turf managers still may not consider using this grass because its basic management requirements are still poorly understood.

Brilman & Meyer (3) noted that VBG was often overfertilized with N prior to the 1970s, with rates as high as 391 kg of N per ha/year. In 1975, Dr. C. Richard Skogley determined that VBG survives much better in high-maintenance situations if lower rates of N fertilizer are used — less than or equal to 146 kg of N per ha/year (7). Currently, 97 to 196 kg of N per ha/year is generally recommended for VBG in addition to frequent vertical mowing and topdressing to reduce thatch accumulation (8). Turfgrass quality expectations are much higher today than they were at the times of previous VBG management studies. VBG has been neglected for several years, and today's turf managers are mostly unaware of this turfgrass's benefits and management requirements. The main objectives of this study were to develop management recommendations for VBG putting greens on silt loam and sandy soils based on observations of turfgrass color, density, cultivation recovery, and thatch accumulation.

Experimental Site and Design

Three experiments were conducted on two VBG putting greens located at the University of Rhode Island in Kingston, RI from April 2004 through September 2005. The experiment location is classified as a coastal temperate climate, which receives approximately 129 cm of annual precipitation.

Each experiment was done on a different soil type or VBG cultivar. The first two experiments took place on a 100% 'SR7200' VBG green, which was split in half with the root zone on one side comprised of 80:20 sand:sphagnum peat and that on the other a 70:30 sand:sphagnum peat soil texture. The third experiment was conducted on a green composed of Bridgehampton silt loam soil (well-drained, coarse-silty, mixed, mesic Typic Dystrochrept) with 'SR7200' VBG. The 80:20 and 70:30 sand green was constructed to United States Golf Association (USGA) putting green standards. The soil profile consisted of a 10-cm gravel base overlaid by a 5-cm (2-inch) layer of coarse sand topped with 30.5 cm of the sand and peat mixture. The sand soils each contained approximately 1% to 2% organic matter and soil pH ranged 6 to 7. Baseline P and K levels in the sand soils was 4 ppm and 28 ppm, respectively. The silt loam soil was native to the experiment location and this soil profile was not altered. The silt loam contained approximately 5% to 6% organic matter and soil pH ranged 5 to 6. Baseline P and K levels in the silt loam soil was 9 and 76 ppm, respectively.

On each soil type, an experiment was conducted using a 3 × 2 × 6 split-plot factorial design. There were 3 levels of surface treatments: no treatment, sand topdressing only, and vertical mowing with sand topdressing. There were 2 levels of nitrogen:K_2O ratio treatments: 1:1 and 1:2. There were six levels of nitrogen/iron fertilizer (NIF) treatments: N at 0, 48, 97, 146, 196, and 243 kg/ha/year. There were 3 replicates for each treatment; individual plots measured 1.2 × 1.2 m.

Each green was exposed to full sunlight. Soil pH was measured each year on each soil by pooling 10 random samples of 16-mm-diameter soil cores approximately 13 cm deep. Velvet bentgrass was sodded on the silt loam soil 16 months prior to the start of this study. The VBG on the sand soils were established from seed (approximately 48 kg/ha/year) 9 months prior to beginning experimental treatments.

Turf Maintenance Practices

The following maintenance practices were applied across all treatment blocks when appropriate, unless otherwise specified. Mowing was performed every other day with a Greensmaster Flex-21 reel mower (Toro, Bloomington, MN). Mower bench-settings were adjusted between 2.5 and 2.8 mm throughout the entire study. All treatments were irrigated with approximately 1.3 cm of water per week in the absence of equal or greater precipitation. Hand watering was performed as needed to prevent wilting in hot and dry conditions. All experiments were aerified in October 2004 with 13-mm diameter tines to a depth of 10 cm. Fungicides were applied only if turf diseases were observed. The primary diseases observed were: pythium root disease (*Pythium spp*.), brown patch (*Rhizoctonia solani*), and fusarium blight (*Fusarium spp*.). The fungicides we utilized included Heritage (azoxystrobin, Syngenta Crop Protection Inc., Greensboro, NC); Banner Maxx (propaconazole, Syngenta); Cleary's 3336 (thiophanate-methyl, Cleary Chemical Corp., Dayton, NJ); Banol (propamocarb, Bayer Enviromental Science, Research Triangle Park, NC); and Chipco Signature (fosetyl-Al, Bayer). Sevin SL (carbaryl, Bayer) was sprayed in late summer and fall of 2005 to suppress black cutworm damage. Quicksilver (carfentrazone-ethyl, FMC, Philadelphia, PA) was used 1 to 2 times each year to suppress silvery thread moss (*Byrum argenteum* Hedw.) on the sand soils. Speedzone (carfentrazone-ethyl, 2,4-D 2-ethylhexyl ester, mecoprop-p, dicamba, PBI/Gordon, Kansas City, MO) was used to spot-treat birdseye pearlwort (*Sagina procumbens* L.) on the sand soils. All pesticide treatments were applied using labeled rates for curative control.

Experimental Procedures

Fertilizers were applied as liquids using a 3-nozzle hand boom attached to a CO_2 pressurized liquid tank. A 2-1-2 ratio fertilizer was prepared by mixing together equal parts of 20-20-20 w/UMAX {3.9% ammoniacal N, 5.8% nitrate N, 10.3% urea N [5.2% urea N stabilized by dicyandiamide and N-(n-butyl) thiophosphoric triamide]} and 25-0-25 w/UMAX {1.5% ammoniacal N, 7.6% nitrate N, 15.9% urea N [8.0% urea N stabilized by dicyandiamide and N-(n-butyl) thiophosphoric triamide]} soluble fertilizers (Simplot Partners Inc., Darien, CT). UMAX refers to dicyandiamide and N-(n-butyl) thiophosphoric triamide, which stabilizes or slows decomposition of urea. A 2-1-4 ratio fertilizer was prepared by adding 0-0-25 liquid fertilizer (Lesco GREEN-FLO, Cleveland, OH) to the 2-1-2 fertilizer mix to double the K_2O content. Chelated iron sulfate (XX-Iron 9% 6-0-0, Growth Products LTD, White Plains, NY.) was incorporated into the fertilization program in June, July, and August each year to increase turf color as nutrient application rates were reduced for these months. Each NIF application rate was applied by adjusting the spray volume to the appropriate treatment block. Fertilizers were irrigated into the turf with approximately 0.25 cm of water. Spring and fall months (April, May, September, and October) received greater percentages of total annual NIF than summer months (June-August) to adjust for seasonal nutrient requirements of cool-season turfgrasses. Table 1 shows specific NIF application rates applied bi-weekly in each month.

Table 1. Biweekly N and Fe application rates are shown for each month and NIF level. Fertilizer application rates are expressed as kg of N per ha and kg of Fe per ha. Seasonal and annual totals are also shown.

	NIF level				
	1	2	3	4	5
Month	N rate (Fe rate) in kg/ha				
April	3.0[x]	9.8	12.2	18.3	24.4
May	3.0	7.3	12.2	15.1	18.3
Spring total	12.0	34.2	48.8	66.8	85.4
June	3.0 (0.8)	3.2 (0.8)	3.9 (1.2)	6.4 (1.5)	10.0 (2.7)
July	3.0 (0.8)	3.2 (0.8)	3.9 (1.2)	6.4 (1.5)	10.0 (2.7)
August	3.0 (0.8)	3.2 (0.8)	3.9 (1.2)	6.4 (1.5)	10.0 (2.7)
Summer total	18.0 (4.8)	19.2 (4.8)	23.4 (7.2)	38.4 (9.0)	60.0 (16.2)
September	4.6	13.4	21.5	24.4	24.4
October	4.6	8.3	15.4	21.2	24.4
Fall total	18.4	43.4	73.8	91.2	97.6
Annual total	48.4 (4.8)	96.8 (4.8)	146.0 (7.2)	196.4 (9.0)	243.0 (16.2)

[x] These rates were applied twice per month.

Vertical mowing and topdressing were done on 11 May, 10 June, 10 July, and 2 October in 2004; 17 May, 30 June, and 6 September in 2005. All vertical mowing treatments were performed using a V-Star vertical mower (Smithco Inc., Wayne PA) with blades spaced 2.54 cm apart and 3 to 6 mm deep. Topdressing sand was applied at a 1.6- to 3.2-mm depth using a DAKOTA mechanical topdresser (Dakota Peat & Equipment, Grand Forks, ND). The sand used (Holliston Sand Co., Slatersville, RI) was specified for a standard #40 sieve size and USGA specification.

Data Collection and Analysis

Plots in each study were visually rated by the same researcher approximately once per month between April and October over the 2004 and 2005 seasons.

Data were collected on turf color (relative greenness of entire plot), turf density, damage recovery from vertical mowing, and thatch depth. Plot color and turf density were rated on a 1 to 9 scale. The 1 to 9 turf quality rating scale employed in these trials was similar to standards adopted by the National Turfgrass Evaluation Program (4). Damage recovery from vertical mowing was visually rated on a 1 to 5 scale (1 = 0% recovery and 5 = 100% recovery). Thatch depth was measured from 16-mm diameter soil cores by measuring the distance from the turf surface to the soil/thatch interface.

Statistical analysis of the data was performed using SPSS (SPSS Inc., Chicago, IL) statistical software. Plot color, turf density, and thatch depth measurements were analyzed with general linear model multivariate ANOVA statistics. Differences between means were analyzed using Tukey's honestly significant difference.

Color and Density Results

Velvet bentgrass color and density data formed similar trends for each treatment group, which generally was consistent between monthly ratings (Table 2). Combinations of NIF, soil type and seasonal variations (temperature and rainfall data not shown) contributed to changes in color and density. Velvet bentgrass color scores typically increased in the early spring, peaked in the summer, and then declined slightly between mid-summer and fall in each year. In 2004, VBG density showed a monthly trend similar to color, except density declined more sharply in July. In 2005, turf density gradually increased through the spring and peaked in late summer/early fall. Spring greenup typically occurred throughout the entire month of April into early May. Mean color ($\bar{c}$) and density ($\bar{d}$) were very low for all treatments at the first rating in April 2004; 1.0 and 1.3 respectively. The turf was not fertilized in the fall of the year prior to beginning these experiments, and the turf remained dormant until mid April 2004.

Table 2. 'SR7200' VBG color and density score averages for each NIF level and year on each soil type.

Turf quality	NIF level	Silt loam		70:30		80:20	
		2004[x]	2005[y]	2004[x]	2005[y]	2004[x]	2005[y]
Color	0	3.0 a[z]	2.8 a	2.4 a	2.8 ab	1.6 a	1.8 a
	1	3.9 b	4.0 bc	3.4 b	4.1 c	2.9 b	3.7 c
	2	4.6 cde	4.5 bcd	4.1 c	4.5 cd	3.5 c	4.3 d
	3	5.0 def	4.9 def	4.6 cd	5.1 de	4.3 d	4.9 e
	4	5.4 fg	5.3 efg	5.1 de	5.6 ef	4.8 de	5.3 ef
	5	5.8 g	5.7 g	5.5 ef	6.0 f	5.6 f	5.8 f
Density	0	4.6 ab	3.9 a	2.7 a	3.7 b	1.6 a	2.3 a
	1	5.4 bc	5.4 bc	4.0 c	5.3 cd	3.7 b	4.7 cd
	2	6.2 cd	6.5 de	4.9 c	6.5 e	4.4 bc	5.8 ef
	3	6.4 de	7.1 ef	5.2 cd	7.5 f	5.2 de	6.9 g
	4	6.7 de	7.6 f	5.6 cd	8.1 fg	5.6 ef	7.6 gh
	5	7.0 de	7.7 f	6.0 de	8.4 g	6.2 f	8.1 h

[x] n = 72 for NIF level 0; n = 144 for other NIF levels.

[y] n = 54 for NIF level 0; n = 108 for other NIF levels.

[z] Among rows and columns within the same soil type, color or density means followed by the same letter are not statistically different ($P \geq 0.05$) using Tukey's HSD. Color and density ratings are based on a scale of 0 to 9.

Color and density scores increased incrementally with increasing NIF level. In each year, there were statistical differences in color and density between NIF levels on each soil type. Table 2 shows turf color and density means for each NIF level between 2004 and 2005. VBG color and density scores were fairly similar between different soils. However, at the lower NIF rates, especially 0 to 97 kg of N per ha/year appeared to have better color and density in the order of: silt loam > 70:30 > 80:20. The most visible differences in color and density occurred between the silt loam and 80:20 sand soils. In 2004, color scores averaged 0.8 points higher on the silt loam vs. the 80:20 sand, and density scores averaged 1.5 points higher on the silt loam vs. the 80:20 sand. In 2005 these differences were smaller. Color scores averaged only 0.2 points higher on the silt loam vs. the 80:20 sand, and density scores averaged only 0.5 points higher. In general, as NIF level increased for each soil type, VBG color and density was visibly more similar for each soil. In 2005 the 70:30 and 80:20 sand soils had slightly better color and density than the silt loam soil at the highest NIF rate (243 kg of N per ha/year).

Vertical mowing treatments caused a slight decline in color and density scores. The mean color and density of vertical mowing with topdressing treatments ($\bar{c}$ = 4.3, $\bar{d}$ = 5.5) were statistically lower than topdressing only surface treatments ($\bar{c}$= 4.6, $\bar{d}$ = 6.0) or no surface treatments ($\bar{c}$ = 4.6, $\bar{d}$ = 6.0).

Damage Recovery from Vertical Mowing

Turf recovery increased linearly with increasing NIF (*recovery data is not shown*). Recovery typically was at least 80% within 1½ to 3 weeks after vertical mowing when 146 to 243 kg of N per ha/year was applied. The turf generally was completely recovered 3 to 4 weeks after vertical mowing, except for NIF treatments less than 97 kg of N per ha/year, which still showed 10% to 20% damage. There were no major differences in turf recovery between different soil types, although, in the 2005 season, some of the turf plots on the silt loam soil were heavily damaged by vertical mowing and never recovered. The persistent damage occurred most frequently within the 196 to 243 kg of N per ha/year treatments.

Thatch Accumulation

Mean thatch depth ($\bar{t}$) on the silt loam soil was 1.4 cm in May 2004 (initial measurement). The 70:30 and 80:20 sand soils did not have thatch at the onset of the experiment. Mean thatch accumulation on the silt loam soil from May to October 2004 was approximately 0.30 cm. In 2005, thatch was measured on each soil type only in May and August. Thatch accumulation was calculated from the difference between August 2005 and May 2004 thatch depths. There were no statistical differences in thatch accumulation between NIF or surface treatments on each soil type. Total thatch accumulation on the silt loam soil was approximately 0.60 cm and total thatch accumulation was approximately 0.90 cm and 0.60 cm on the 70:30 and 80:20 sand soils, respectively, across all NIF and surface treatments.

Conclusions

Nitrogen and iron treatments had the most immediate effects on turf quality in these experiments. Although we could not make statistical comparisons between soil types, we do believe that soil type had a profound influence on VBG turf quality and management requirements. Lower rates of NIF, i.e. 48 to 146 kg of N per ha/year on the silt loam soil produced acceptable color and density scores throughout most of the study. Higher rates of NIF, i.e. 196 to 243 kg of N per ha/year on silt loam soils produced excellent color and density. However, due to the dense-growing nature of VBG, these higher NIF rates on silt loam may be unnecessary, because these soils retain nutrient longer than sandy soils. Frequent Fe applications may help VBG retain a dark green color when lower N rates are used. We did not separate the individual effects of N and Fe on VBG in this experiment, however, supplemental Fe may be more important for VBG, especially when soil pH is neutral or alkaline. We have observed that VBG tends to become chlorotic when soil pH is neutral to alkaline, and supplemental Fe sometimes helps to restore normal color in these conditions. On the 70:30

or 80:20 sand soils, at least 196 to 243 kg of N per ha/year should be applied to produce excellent quality VBG turf. VBG on pure sand soils may require up to 293 to 342 kg of N per ha/year in regions where the growing seasons are longer than 6 to 7 months. Turf color and density was similar quality on each soil when NIF rate was as high as 243 kg of N per ha/year.

The data indicates thatch accumulation was insignificant between 0 to 243 kg of N per ha/year in this 2-year trial. However, longer-term trials may reveal significant thatch accumulation between the different rates of N. VBG turf on the sand soils accumulated similar quantities of thatch as the turf on the silt loam, even though the turf differed in age between these soil types. The results did not indicate if vertical mowing and topdressing improved turf quality or influenced thatch accumulation. However, we believe VBG should be topdressed and vertical mowed at least once per month to incorporate sand or soil media into the thatch and avoid softening or "puffy" putting greens. Thatch accumulation, arguably, may be the most significant management hurdle for VBG, since the turf grows very dense. Longer-term studies are needed to examine VBG thatch, and techniques to slow its accumulation without loss of quality to the turf.

Research by Skogley (7) showed that VBG growing on silt loam soils that receive more than 243 kg of N per ha/year may ultimately decline because of excess thatch, heat stress, or disease. In this experiment we observed similar results on the silt loam soil, most likely due to its elevated thatch levels. There are no previous studies that report VBG performance and quality growing on sand soils. Turf quality standards and management techniques have changed considerably since the previous research performed with this grass. The common conception that VBG is low maintenance may not always be true, especially when the turf is growing on sandy soils.

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