

IMPACT OF VARIOUS NUTRIENT PRODUCTS ON PLAYABILITY AND PLANT HEALTH ON A CREEPING BENTGRASS RESEARCH PUTTING GREEN

J.E. Kaminski and T. Lulis

Department of Plant Science
The Pennsylvania State University

INTRODUCTION

Putting greens are the most critical playing surface on golf courses. During a typical round of golf, a large percentage of a player's strokes will be on the playing surface of a green. Ball roll distance, often referred to as green speed by golfers, and trueness of the ball's roll across a green have a major impact on the game of golf. Many cultural practices have been shown to have an impact on ball roll distance, but these practices often come at the cost of decreased plant health. Little information is available that examines the use of plant health products to reduce stress while maintaining the fast green speeds desired during a golf tournament. The objective of this study was to evaluate various products' ability to improve plant health during a period of stressful cultural practices surrounding the preparation of a tournament.

MATERIALS & METHODS

This one-year field study was initiated at the Valentine Turfgrass Research Center located in University Park, PA. Soil was a loamy sand that was capped with a 4" layer of USGA sand. Turfgrass used for the green speed evaluation was a 3-year old stand of 'Penn A-4' creeping bentgrass (*Agrostis stolonifera*). The area was maintained as a golf course putting green and mowed five times per week to a height of 0.110 inch prior to trial initiation. All treatments were applied with a CO₂ pressurized (45 psi) sprayer equipped with an air-induction flat fan nozzle (TeeJet, AI9508EVS) calibrated to deliver 2.0 gal of water 1000 ft⁻². The experiment was initiated on 30 Jun and repeated weekly. All treatments and application dates are listed in the data tables.



Figure1. Overhead photo during mowing and rolling stress, 2016.

From 20 Jul to 5 Aug the trial was subjected to stress through reductions in mowing height (0.100" for 7 days and 0.085" for the remaining days), mowing four times per day, and lightweight rolling (2 times per day).

Plots measured 3 ft x 8 ft and were arranged as a randomized complete block design with four replications. Ball roll distance (BRD) was assessed using the "2x" notch of a USGA Stimpmeter. Results were multiplied by a factor of 2 and converted to feet for all analyses. Turfgrass quality and/or color were visually rated on a 1 to 9 scale where 1 = entire plot brown or dead and 9 = optimum greenness and/or density. Normalized difference vegetation index was collected using a Field Scout TCM 500 NDVI. Chlorophyll index was collected using a Field Scout CM 1000. Soil volumetric water content was collected using a Field Scout TDR 300. All data were subjected to analysis of variance and means were separated at $P \leq 0.05$ according to Fisher's Protected least significant difference test.

RESULTS & DISCUSSION

At the initiation of the trial, all plots had acceptable quality and color (≥ 6) (Tables 1 & 2). When the stress component of the trial commenced, reductions in both the quality and color of the plots were observed. The negative impact of stress on quality and color peaked 4 days (9 Aug) after stress operations were completed. All plots had recovered to acceptable levels of color and quality by 16 Aug (11 days after stress operations were completed). Initial ball roll distances of 10.7 to 11.1 feet were observed at the beginning of the study, but no significant differences in BRD were observed on any dates among treatments throughout the trial (Table 3). However, BRD increased during the stress operations for all treatments. Ball roll distance peaked on 5 Aug with measurements ranging from 12.7 to 13.5 feet.

Quality: With few exceptions, turfgrass quality within all plots had acceptable quality for the duration of the study. On one or two rating dates, plots treated with Ammonium Sulfate (both rates) and the untreated control had unacceptable quality, respectively (Table 1). These reductions in turfgrass quality were associated with the peak period of stress.

Turfgrass within plots treated with all Grigg Brother Programs resulted in equal or higher turfgrass quality when compared to the nontreated control on all rating dates (Table 1). Of all the Grigg programs, Program 3 (Gary's Green + PK Plus + Manni-plex Eagle + Manni-plex Ca) consistently resulted in the highest quality ratings on all rating dates. However, this program was not significantly different from the two other Grigg Brothers Programs. When compared to the nontreated control plots, Grigg Brothers Programs 1, 2 and 3 resulted in higher quality ratings on 60%, 70% and 80% of the rating dates, respectively. Turfgrass quality in plots treated with ammonium sulfate (both rates) was equivalent to that within the nontreated control on all rating dates.

Color: Similar to turfgrass quality, plots treated with Grigg Brothers' Programs generally had the highest turfgrass quality. Turf within plots with Grigg Brothers' Program 3 had the highest or equivalent color ratings on all rating dates. Turf treated with Grigg Brothers Program 1 or 2 were among the highest in color on 8 of 10 rating dates. Plots treated with ammonium sulfate alone (either rates) were among the highest in color only on 20% of the rating dates. Furthermore, plots treated with 0.1 lb N and 0.15 lb N from ammonium sulfate had color ratings similar to the untreated control on 80% and 90% of the rating dates, respectively.

Overall, it appears that supplemental nutrients within the Grigg Brothers Programs evaluated in this study may play a role in improving turfgrass quality and color during periods of stress. Due to the limited separation of select products within each treatment, it is difficult to assess the impact of individual products used in this study. While nitrogen was included as an additional supplement in two of the three programs, Program 2 (Manni-plex Ca + Manni-plex Eagle) generally had the highest or equivalent to the highest color and quality ratings and had no unacceptable ratings on any date. Future research should investigate individual products in comparison to a wider range of tank-mixes and programs.

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Table 1. Quality on a creeping bentgrass putting green following the application of various products, 2016.

Treatments and rate per 1000 ft ^{2y}	Quality ^z									
	29 Jun	13 Jul	20 Jul	27 Jul	3 Aug	9 Aug	12 Aug	16 Aug	19 Aug	26 Aug
1 Gary's Green Ultra 6.0 fl oz PK Plus 6.0 fl oz Sili-Kal 3.0 fl oz Kelplex 2.0 fl oz	8.0 a ^x	7.5 ab	7.8 ab	7.5 a	7.8 a	6.3 abc	7.0 a	7.0 a	7.5 a	8.0 a
2 Manni-plex Eagle 16.0 fl oz Manni-plex Ca 6.0 fl oz	8.0 a	8.0 a	8.3 a	7.8 a	7.5 a	6.5 ab	7.0 a	6.5 a	7.0 ab	7.5 ab
3 Gary's Green Ultra 6.0 fl oz PK Plus 6.0 fl oz Manni-plex Eagle 11.0 fl oz Manni-plex Ca 6.0 fl oz	8.0 a	8.0 a	8.5 a	7.8 a	7.8 a	6.8 a	6.8 a	7.0 a	7.3 a	8.0 a
4 AmmSulfate 0.1 lb ai	8.0 a	7.5 ab	7.0 bc	6.8 ab	6.5 b	5.8 bc	6.5 ab	6.5 a	6.5 b	7.5 ab
5 AmmSulfate 0.15 lb ai	8.0 a	7.5 ab	7.0 bc	6.8 ab	6.5 b	5.8 bc	6.6 ab	6.5 a	6.5 b	6.8 bc
6 Nontreated.....	8.0 a	7.0 b	6.5 c	6.3 b	6.3 b	5.5 c	5.8 b	6.5 a	6.5 b	6.8 c

^z Quality was visually assessed on a 1 to 9 scale where 1 = entire plot brown and 9 = optimum uniformity and density.

^y Treatments (except Kelplex) were applied on 30 Jun, 7 Jul, 14 Jul, 21 Jul, 4 Aug, and 18 Aug. Kelplex applied on 30 Jun, 7 Jul, 14 Jul, and 21 Jul.

^x Means in a column followed by the same letter are not significantly different at $P \leq 0.05$ according to the Fisher's least significant difference test.

Table 2. Color on a creeping bentgrass putting green following the application of various products, 2016.

Treatments and rate per 1000 ft ^{2y}	Color ^z									
	29 Jun	13 Jul	20 Jul	27 Jul	3 Aug	9 Aug	12 Aug	16 Aug	19 Aug	26 Aug
1 Gary's Green Ultra 6.0 fl oz	7.0 a ^x	7.5 ab	7.8 b	7.3 b	7.0 ab	5.8 ab	6.5 a	7.5 a	7.3 ab	8.3 a
PK Plus 6.0 fl oz										
Sili-Kal 3.0 fl oz										
Kelplex 2.0 fl oz										
2 Manni-plex Eagle 16.0 fl oz	7.0 a	7.8 a	8.3 ab	7.8 ab	7.3 a	6.5 a	6.5 a	7.3 a	6.8 bc	7.5 bc
Manni-plex Ca 6.0 fl oz										
3 Gary's Green Ultra 6.0 fl oz	7.0a	8.0 a	8.8 a	8.0 a	7.0 ab	5.8 ab	6.3 ab	7.8 a	7.5 a	8.0 ab
PK Plus 6.0 fl oz										
Manni-plex Eagle 11.0 fl oz										
Manni-plex Ca 6.0 fl oz										
4 AmmSulfate 0.1 lb ai	7.0 a	6.8 bc	6.3 c	6.5 c	6.3 bc	5.0 b	5.8 ab	6.5 b	6.8 bc	7.3 cd
5 AmmSulfate 0.15 lb ai	7.0 a	6.8 bc	6.0 c	6.5 c	6.8 ab	5.3 b	5.8 ab	6.0 b	6.3 cd	6.8 de
6 Nontreated	7.0 a	6.0 c	6.3 c	6.3 c	6.0 c	5.0 b	5.5 b	6.0 b	5.8 d	6.3 e

^z Color was visually assessed on a 1 to 9 scale where 1 = entire plot brown and 9 = optimum greenness.

^y Treatments (except Kelplex) were applied on 30 Jun, 7 Jul, 14 Jul, 21 Jul, 4 Aug, and 18 Aug. Kelplex applied on 30 Jun, 7 Jul, 14 Jul, and 21 Jul.

^x Means in a column followed by the same letter are not significantly different at $P \leq 0.05$ according to the Fisher's least significant difference test.

Table 3. Ball roll distance on a creeping bentgrass putting green following the application of various products, 2016.

Treatments and rate per 1000 ft ^{2y}	Ball roll distance (ft) ^z				
	20 Jul	27 Jul	3 Aug	5 Aug	9 Aug
1 Gary's Green Ultra 6.0 fl oz..... PK Plus 6.0 fl oz Sili-Kal 3.0 fl oz Kelplex 2.0 fl oz	10.8 a ^x	12.7 a	11.4 a	12.7 a	10.8 a
2 Manni-plex Eagle 16.0 fl oz..... Manni-plex Ca 6.0 fl oz	10.8 a	12.7 a	11.2 a	12.9 a	11.0 a
3 Gary's Green Ultra 6.0 fl oz..... PK Plus 6.0 fl oz Manni-plex Eagle 11.0 fl oz Manni-plex Ca 6.0 fl oz	10.7 a	13.0 a	11.2 a	12.7 a	10.8 a
4 AmmSulfate 0.1 lb ai.....	11.0 a	12.8 a	11.3 a	12.8 a	11.3 a
5 AmmSulfate 0.15 lb ai.....	11.0 a	12.6 a	11.3 a	12.9 a	10.9 a
6 Nontreated	11.1 a	12.5 a	11.4 a	13.5 a	11.6 a

^z Ball roll distance (BRD) was assessed using a USGA Stimpmeter. Due to limitations in plot dimensions the "2x" notch on the Stimpmeter was used. Results were multiplied by a factor of 2 and converted to feet for all analyses.

^y Treatments (except Kelplex) were applied on 30 Jun, 7 Jul, 14 Jul, 21 Jul, 4 Aug, and 18 Aug. Kelplex applied on 30 Jun, 7 Jul, 14 Jul, and 21 Jul.

^x Means in a column followed by the same letter are not significantly different at $P \leq 0.05$ according to the Fisher's least significant difference test.

Table 4. Normalized Difference Vegetation Index on a creeping bentgrass putting green following the application of various products, 2016.

Treatments and rate per 1000 ft ^{2y}	NDVI ^z			
	20 Jul	27 Jul	3 Aug	9 Aug
1 Gary's Green Ultra 6.0 fl oz	0.791 ab ^x	0.781 ab	0.788 a	0.719 ab
PK Plus 6.0 fl oz				
Sili-Kal 3.0 fl oz				
Kelplex 2.0 fl oz				
2 Manni-plex Eagle 16.0 fl oz	0.787 ab	0.785 a	0.786 a	0.729 a
Manni-plex Ca 6.0 fl oz				
3 Gary's Green Ultra 6.0 fl oz	0.797 a	0.783 ab	0.783 ab	0.723 ab
PK Plus 6.0 fl oz				
Manni-plex Eagle 11.0 fl oz				
Manni-plex Ca 6.0 fl oz				
4 AmmSulfate 0.1 lb ai	0.785 ab	0.770 b	0.776 ab	0.703 b
5 AmmSulfate 0.15 lb ai	0.787 ab	0.773 ab	0.779 ab	0.705 b
6 Nontreated	0.777 b	0.756 c	0.767 b	0.701 b

^z Normalized difference vegetation index was collected using a Field Scout TCM 500 NDVI.

^y Treatments (except Kelplex) were applied on 30 Jun, 7 Jul, 14 Jul, 21 Jul, 4 Aug, and 18 Aug. Kelplex applied on 30 Jun, 7 Jul, 14 Jul, and 21 Jul.

^x Means in a column followed by the same letter are not significantly different at $P \leq 0.05$ according to the Fisher's least significant difference test.

Table 5. Chlorophyll index on a creeping bentgrass putting green following the application of various products, 2016.

Treatments and rate per 1000 ft ^{2y}	Chlorophyll Index ^z			
	20 Jul	27 Jul	3 Aug	9 Aug
1 Gary's Green Ultra 6.0 fl oz	287 ab ^x	297 a	323 a	252 a
PK Plus 6.0 fl oz				
Sili-Kal 3.0 fl oz				
Kelplex 2.0 fl oz				
2 Manni-plex Eagle 16.0 fl oz	270 ab	301 a	325 a	256 a
Manni-plex Ca 6.0 fl oz				
3 Gary's Green Ultra 6.0 fl oz	299 a	309 a	334 a	279 a
PK Plus 6.0 fl oz				
Manni-plex Eagle 11.0 fl oz				
Manni-plex Ca 6.0 fl oz				
4 AmmSulfate 0.1 lb ai	273 ab	287 a	315 a	243 a
5 AmmSulfate 0.15 lb ai	275 ab	293 a	320 a	240 a
6 Nontreated	258 b	265 b	289 b	226 a

^z Chlorophyll index was collected using a Field Scout CM 1000.

^y Treatments (except Kelplex) were applied on 30 Jun, 7 Jul, 14 Jul, 21 Jul, 4 Aug, and 18 Aug. Kelplex applied on 30 Jun, 7 Jul, 14 Jul, and 21 Jul.

^x Means in a column followed by the same letter are not significantly different at $P \leq 0.05$ according to the Fisher's least significant difference test.

Table 6. Soil moisture on a creeping bentgrass putting green following the application of various products, 2016.

Treatments and rate per 1000 ft ^{2y}	Soil moisture (3.00'') ^z			
	20 Jul	27 Jul	3 Aug	9 Aug
1 Gary's Green Ultra 6.0 fl oz	17 a ^x	12 a	18 a	9 a
PK Plus 6.0 fl oz				
Sili-Kal 3.0 fl oz				
Kelplex 2.0 fl oz				
2 Manni-plex Eagle 16.0 fl oz	17 a	12 a	19 a	9 a
Manni-plex Ca 6.0 fl oz				
3 Gary's Green Ultra 6.0 fl oz	16 a	12 a	19 a	8 a
PK Plus 6.0 fl oz				
Manni-plex Eagle 11.0 fl oz				
Manni-plex Ca 6.0 fl oz				
4 AmmSulfate 0.1 lb ai	17 a	12 a	19 a	9 a
5 AmmSulfate 0.15 lb ai	17 a	13 a	19 a	9 a
6 Nontreated	16 a	12 a	19 a	8 a

^z Soil volumetric water content was collected using a Field Scout TDR 300.

^y Treatments (except Kelplex) were applied on 30 Jun, 7 Jul, 14 Jul, 21 Jul, 4 Aug, and 18 Aug. Kelplex applied on 30 Jun, 7 Jul, 14 Jul, and 21 Jul.

^x Means in a column followed by the same letter are not significantly different at $P \leq 0.05$ according to the Fisher's least significant difference test.