FIELD TRIAL OF EFFECTS OF HYDRALOGIC ORGANIC AMENDMENT ON PERFORMANCE OF ESTABLISHED CREEPING BENTGRASS PUTTING GREEN TURF ON A USGA GREEN

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Sponsor: Hydralogic Systems Inc.

OBJECTIVE

The objective of this research project was to compare the effects of the sponsor's organic amendment products on performance, root and shoot growth of established creeping bentgrass on a USGA specification putting green

Data collected will include:
1. turf performance (color , quality, density, uniformity) estimated visually and by full-spectrum colorimetry and chlorophyll index measurement
2. rate of growth of shoot system
3. total root system growth
4. disease pressure from dollar spot and other diseases as they occur

EXPERIMENTAL DESIGN / METHODS

The experimental design included 6 management treatments (sponsor's product at 5 and 10 ml m^{-2} , an industry standard N-P-K fertilizer at 5 g actual N m^{-2}, sponsor's product at 5 and 10 ml m^{-2} + N-P-K fertilizer to total 5 g actual N m^{-2}, and an unfertilized control – see Table 1). Each treatment was replicated four times in 1 x1 m plots on a 'Penncross' creeping bentgrass USGA green at the Guelph Turfgrass Institute (Figures 1 and 2). Treatments were arranged in a randomized complete block design. Treatments were applied once in Sept. 2004, then monthly on the following dates: 06/09/05, 07/06/05, 08/05/05, and 09/01/05.

Table 1. Treatments

Treatment	Application rate (m^{-2})
1 Untreated control	—
2 NPK control (Andersons 18-6-15)	27.78 g
3 Hydralogic 1	5 ml
4 Hydralogic 2	10 ml
5 Hydralogic 1 + NPK	5 ml + 27.50 g
6 Hydralogic 2 + NPK	10 ml + 27.22 g

Colour was assessed visually and with the Spectrum CM1000 chlorophyll meter and the Minolta CR310D full spectrum colorimeter. Other performance features (quality, uniformity, density) were assessed visually. Rootzone moisture levels (percent volumetric water) were recorded regularly. Assessments of other stresses as may occur naturally (insect, disease) were made as they occurred.

Plots were maintained on a normal greens program, with mowing at 4 mm and irrigation to prevent stress. Pesticides were applied only to prevent loss of the turf. Clippings were collected periodically to determine shoot growth rates.

Root systems were sampled prior to the beginning of the experiment and again at the end of the season. Core samples were collected, root systems washed free of soil, length (depth) and density were measured, and root systems were dried (60°C for 48 hours) and weighed for dry matter accumulation.

Figure 1. Turfgrass plots on USGA green - June 10, 2005.

Table 2. Visual color ratings of treated plots, fall 2004 through fall 2005

Treatment	10/22	10/29	5/4	6/14	6/21	6/28	7/6	7/8	7/13	7/25	8/5	8/18	9/30
Control	6.1 b[1]	6.6 b	3.0 b	5.0 b	6.0 bc	6.0 c	5.3 b	4.3 c	4.0 b	4.5 b	6.4 b	5.0 c	4.0 b
Hydralogic 1x	6.3 b	6.6 b	3.5 b	5.8 b	6.5 b	7.3 b	5.8 b	5.3 b	4.3 b	5.0 b	6.5 b	6.3 b	4.0 b
Hydralogic 2x	6.4 ab	6.6 b	3.3 b	5.3 b	5.8 c	6.3 c	5.3 b	4.3 c	4.0 b	4.5 b	6.0 b	5.0 c	4.0 b
Hydralogic 1x + NPK	6.4 ab	7.9 a	7.0 a	8.8 a	8.0 a	9.0 a	8.5 a	8.6 a	8.4 a	7.6 a	8.0 a	8.0 a	8.9 a
Hydralogic 2x + NPK	6.9 a	8.0 a	7.0 a	9.0 a	8.0 a	8.8 a	8.6 a	8.8 a	8.6 a	7.9 a	8.0 a	8.0 a	8.9 a
NPK control	6.9 a	7.9 a	7.0 a	8.8 a	8.0 a	9.0 a	8.9 a	8.6 a	7.5 a	7.5 a	8.0 a	8.0 a	9.0 a
lsd p=0.05	0.52	0.34	0.68	0.78	0.68	0.72	0.67	0.92	1.51	0.81	0.76	0.91	0.21

[1] Visual ratings from 0-9, 9=best, 6=acceptable. Means of 4 replicates; means within columns followed by the same letter are not significantly different (Fisher's protected LSD, p=0.05)

Table 3. Visual quality ratings of treated plots, fall 2004 through fall 2005

Treatment	10/22	10/29	6/14	6/21	6/28	7/6	7/8	7/13	7/25	8/5	8/18
Control	6.3 b[1]	6.6 b	6.8 b	5.8 b	7.0 c	6.0 b	6.3 b	6.0 b	4.5 b	5.9 b	5.0 b
Hydralogic 1x	6.3 b	6.6 b	7.0 b	6.0 b	7.5 c	6.3 b	6.5 b	6.0 b	5.0 b	6.0 b	6.0 b
Hydralogic 2x	6.4 ab	6.6 b	6.8 b	5.8 b	7.0 c	6.0 b	6.3 b	6.3 b	4.5 b	5.8 b	5.0 b
Hydralogic 1x + NPK	6.4 ab	7.8 a	8.5 a	7.1 a	8.3 b	7.9 a	8.6 a	8.3 a	7.5 a	7.1 a	7.5 a
Hydralogic 2x + NPK	6.9 a	8.0 a	8.3 a	7.5 a	8.8 ab	8.3 a	8.5 a	8.6 a	7.9 a	7.3 a	7.5 a
NPK control	6.9 a	7.9 a	8.0 a	7.4 a	9.0 a	8.5 a	8.6 a	7.9 a	7.4 a	7.1 a	7.5 a
lsd p=0.05	0.53	0.43	0.63	0.64	0.55	0.67	0.64	1.21	0.77	0.50	1.05

[1] Visual ratings from 0-9, 9=best, 6=acceptable. Means of 4 replicates; means within columns followed by the same letter are not significantly different (Fisher's protected LSD, p=0.05)

Table 4. Visual uniformity ratings of treated plots, fall 2004 through fall 2005

Treatment	10/22	10/29	5/4	6/14	6/21	6/28	7/6	7/8	7/13	7/25	8/5
Control	6.3 b[1]	6.6 b	8.0	5.8 b	8.0 b	7.8	7.3 b	8.3	4.5 b	5.9 b	5.0 b
Hydralogic 1x	6.3 b	6.6 b	7.5	6.0 b	8.0 b	7.8	7.3 b	8.1	5.0 b	6.0 b	6.0 b
Hydralogic 2x	6.4 ab	6.6 b	7.8	5.8 b	8.0 b	7.8	7.5 b	8.5	4.5 b	5.8 b	5.0 b
Hydralogic 1x + NPK	6.4 ab	7.8 a	8.5	7.1 a	8.0 b	8.3	8.8 a	8.1	7.5 a	7.1 a	7.5 a
Hydralogic 2x + NPK	6.9 a	8.0 a	8.3	7.5 a	8.5 ab	8.3	8.5 a	8.8	7.9 a	7.3 a	7.5 a
NPK control	6.9 a	8.0 a	8.3	7.4 a	9.0 a	8.1	8.6 a	8.6	7.4 a	7.1 a	7.5 a
lsd p=0.05	0.53	0.40	NS	0.64	0.61	NS	0.69	NS	0.77	0.50	1.05

[1] Visual ratings from 0-9, 9=best, 6=acceptable. Means of 4 replicates; means within columns followed by the same letter are not significantly different (Fisher's protected LSD, p=0.05)

Figure 2. Turfgrass plots on USGA green – October 17, 2005.

An anecdotal photographic record of the experiment was kept. Winter survival and spring greenup will be assessed in spring of 2006.

All measurements were analysed by appropriate statistical analyses (general linear models) using the SAS software package.

RESULTS - TURF PERFORMANCE

Visual ratings

There was a consistent pattern in all the visual performance ratings of the treated turfgrass plots (Tables 2-5). For visual color, quality, uniformity, and density, the plots without NPK fertility were significantly poorer than the treatments with NPK. There was a seasonal decline in all performance ratings in all plots, but only the plots with NPK maintained adequate levels (6 or greater). There was no significant effect of the Hydralogic supplement at either level combined with NPK.

Table 6. Visual dollar spot disease ratings of treated plots.

Treatment	7/8	7/13	9/30
Control	0.8[1]	0.8	5.0 a
Hydralogic 1x	0.3	0.8	4.0 ab
Hydralogic 2x	0.3	0.8	4.5 a
Hydralogic 1x + NPK	0.8	0.3	2.3 c
Hydralogic 2x + NPK	0.8	0.5	2.8 bc
NPK control	0.8	0.5	2.3 c
lsd p=0.05	NS	NS	1.4

[1] Visual ratings from 0-10, 10=most disease. Means of 4 replicates; means within columns followed by the same letter are not significantly different (Fisher's protected LSD, p=0.05)

Dollar spot disease

There was a moderate infection of dollar spot disease in the trial with levels reaching several hundred lesions per m^2 by the height of the infection. Early in the outbreak there were no significant differences among the treatments (Table 6), but later the treatments which included NPK fertility had significant reductions in dollar spot. There were no effects of the organic supplement.

Color (instrumental)

There were no significant differences in full-spectrum color among the treatments (Table 7), but there were significant differences detected by the chlorophyll meter (Table 8). There was an effect from the fall 2004 treatment observed in October, and a residual effect in the spring of 2005. The pattern was for all the treatments with NPK to have significantly higher chlorophyll index readings than the treatments without. There was some trend to higher readings in the Hydrologic treatments compared to the controls, but this was not statistically significant in the treatments without NPK, and the pattern was not consistent in the treatments with NPK.***Volumetric water content***

Measurement of the volumetric water content may detect treatment effects on the root systems of the turf. There were significant differences among the treatments on all observation dates (Table 9), but the pattern was not meaningful early in the season (6/28). On later dates, the pattern of volumetric water was similar to the patterns observed for other data, in that the treatments including NPK fertility had significantly higher volumetric water contents. Again, there was little treatment effect detectable for the Hydralogic amendment.

Dry matter accumulation

There was a significant difference between NPK fertilized treatments and non-fertilized for shoot growth (Table 10), but no significant treatment effects in root growth (Table 11). No treatment effects on dry matter accumulation were detected for the Hydralogic amendment.

Table 5. Visual density ratings of treated plots, fall 2004 through fall 2005

Treatment	10/22	10/29	6/14	6/21	6/28	7/6	7/8	7/13	7/25	8/5	8/18
Control	6.4[1]	6.6 b	9.0	6.3 b	9.0	9.0	8.8	8.6	5.5 b	5.9 b	5.0 c
Hydralogic 1x	6.4	6.6 b	9.0	6.3 b	9.0	9.0	8.8	8.8	5.8 b	6.0 b	6.3 b
Hydralogic 2x	6.4	6.6 b	9.0	6.0 b	9.0	9.0	8.8	8.8	5.5 b	5.8 b	5.0 c
Hydralogic 1x + NPK	6.4	7.9 a	9.0	7.5 a	9.0	9.0	8.9	8.5	7.5 a	7.1 a	7.5 a
Hydralogic 2x + NPK	6.9	8.0 a	9.0	7.5 a	9.0	9.0	9.0	8.9	7.9 a	7.3 a	7.5 a
NPK control	6.9	8.0 a	9.0	7.5 a	9.0	9.0	9.0	8.8	7.4 a	7.1 a	7.5 a
lsd p=0.05	NS	0.30	NS	0.74	NS	NS	NS	NS	0.67	0.50	1.09

[1] Visual ratings from 0-9, 9=best, 6=acceptable. Means of 4 replicates; means within columns followed by the same letter are not significantly different (Fisher's protected LSD, p=0.05)

Table 7. Instrumental color readings of treated plots (Minolta CR310 colorimeter).

	5/20/2005			6/10/2005		
Treatment	Lightness[1]	Chroma[2]	Hue angle[3]	Lightness	Chroma	Hue angle
Control	42.4[4]	15.7	113.9	41.8	13.8 a	113.1
Hydralogic 1x	43.4	14.8	105.0	39.0	11.9 bc	114.6
Hydralogic 2x	42.4	14.4	105.2	40.1	12.6 ab	116.9
Hydralogic 1x + NPK	42.3	14.7	110.2	39.8	12.2 b	115.8
Hydralogic 2x + NPK	42.5	15.0	111.6	39.2	12.6 ab	117.2
NPK control	42.7	14.9	110.0	37.4	10.7 c	121.1
lsd p=0.05	NS	NS	NS	NS	1.4	NS

[1] Lightness 0 (black) to 100 (white).
[2] Chroma (vividness or color saturation) 0 (grey) to 60 (fully saturated)
[3] Hue angle 0 to 360 degrees; in the range observed, lower values are yellower, higher are greener.
[4] Means of 4 replicates; means within columns followed by the same letter are not significantly different (Fisher's protected LSD, p=0.05)

Table 8. Chlorophyll index of treated plots, fall 2004 through fall 2005

Treatment	10/22	10/28	4/29	5/18	6/7	6/28	7/6	7/13	7/18	7/25	8/5	8/16	9/30
Control	199.6 c[1]	211.0 d	121.0 d	119.3 c	132.3 c	139.8 c	151.4 c	140.8 b	146.8 b	128.8 b	131.4 b	151.3 c	159.1 c
Hydralogic 1x	213.7 b	214.3 d	126.5 d	121.4 c	137.6 c	148.1 c	157.0 c	147.1 b	156.9 b	135.4 b	140.5 b	159.7 c	165.0 c
Hydralogic 2x	205.1 c	214.7 d	126.2 d	122.7 c	134.1 c	142.3 c	151.1 c	142.0 b	146.3 b	130.0 b	129.4 b	152.7 c	163.1 c
Hydralogic 1x + NPK	212.5 b	252.3 c	155.9 c	140.7 b	150.8 b	193.8 b	192.0 b	234.8 a	241.5 a	208.8 a	211.0 a	268.2 a	262.1 a
Hydralogic 2x + NPK	232.5 a	284.0 a	169.0 a	150.5 a	160.8 a	209.8 a	207.9 a	245.7 a	251.3 a	218.0 a	209.6 a	251.3 b	249.9 b
NPK control	218.1 b	263.1 b	162.4 b	143.7 b	156.2 ab	211.8 a	209.1 a	240.7 a	248.5 a	216.5 a	214.7 a	260.7 ab	260.9 a
lsd p=0.05	5.94	7.36	6.15	4.04	6.06	9.47	10.13	13.01	13.23	10.64	11.77	10.36	9.10

[1] Index 0-1000, higher value representing higher chlorophyll content; values are means of 10 readings x 4 replicates. Means within columns followed by the same letter are not significantly different (Fisher's protected lsd, p=0.05).

Table 9. Volumetric water content of treated plots.

Treatment	6/28	7/20	8/22	9/22
Control	20.0 a[1]	23.1 abc	20.6 cd	22.2 b
Hydralogic 1x	18.1 ab	22.6 bc	20.8 bcd	22.3 b
Hydralogic 2x	16.7 bc	21.3 c	20.0 d	21.9 b
Hydralogic 1x + NPK	14.7 c	22.7 bc	21.5 abc	24.1 a
Hydralogic 2x + NPK	20.0 a	24.8 a	22.0 ab	24.2 a
NPK control	18.1 ab	24.3 ab	22.4 a	24.7 a
lsd p=0.05	3.13	1.88	1.27	1.05

[1] Volumetric water content (%) from ThetaProbe; values are means of 20 readings x 4 replicates. Means within columns followed by the same letter are not significantly different (Fisher's protected lsd, p=0.05).

Table 10. Shoot system growth in treated plots.

Treatment	6/30/2005	8/26/2005
Control	0.8 b[1]	1.1 b
Hydralogic 1x	0.7 b	1.4 b
Hydralogic 2x	0.7 b	1.3 b
Hydralogic 1x + NPK	2.9 a	4.3 a
Hydralogic 2x + NPK	2.8 a	3.9 a
NPK control	3.0 a	4.4 a
lsd p=0.05	0.41	0.91

[1] Leaf tissue dry weight (g) / 0.4 m^2 after 3 days growth (mowing height 5 mm). Means of 4 replicates; means within columns followed by the same letter are not significantly different (Fisher's protected LSD, p=0.05)

Table 11. Root system characteristics in treated plots.

Treatment	Length (cm)		Density (1-6)		Dry weight (mg)
	1-Jun	8-Nov	1-Jun	8-Nov	8-Nov
Control	16.8[1]	12.9	3.0	3.0	37.1
Hydralogic 1x	13.4	13.3	3.0	3.0	39.5
Hydralogic 2x	16.5	13.5	2.9	2.9	35.4
Hydralogic 1x + NPK	16.5	12.9	2.9	3.3	41.2
Hydralogic 2x + NPK	16.1	13.1	3.0	3.1	40.3
NPK control	17.0	14.0	3.0	3.1	39.4

[1] Means of 4 core samples x 4 replicates; means within columns followed by the same letter are not significantly different (Fisher's protected LSD, p=0.05)

CONCLUSIONS

Under the conditions tested (established creeping bentgrass putting green turf on a USGA sand rootzone), there were no significant effects of the organic amendment material on turf performance or growth, compared to similarly fertilized control treatments. Most of the significant treatment effects can be explained by the addition of NPK fertilizer.