Title: Evaluating GreenActivator on creeping bentgrass rooting tubes

Protocol No. : Greenhouse Study

Researcher: Adam Thoms, Iowa State University

Objective:
How does GreenActivator compare as a fertilizer to other commercially available fertilizers for rooting?

Methods & Materials:
Four replications with each rooting tube constituting a rep with creeping bentgrass. Applications to be initiated in fall and repeated monthly for four months.

Rates & Application Method: all rates are in ounces per square foot

	TREATMENT	RATE	INTERVAL
1	Control	N/A	N/A
2	GreenActivator	2 oz/1,000 sq ft	28 days
3	GreenActivator	4 oz/1,000 sq ft	28 days
4	Liquid 8-27-5 Fertilizer	12 oz/1,000 sq ft	28 days
5	Urea 46-0-0 Liquid	98.7 g/1,000 sq ft	28 days

All normal turf maintenance and agronomic practices should remain in place to prevent disease and insects if needed. Plots will not be mowed. Irrigation will be added as needed to promote growth.

Requested Data Collection: Digital images will be taken bi-weekly for color, quality, and cover. Above-ground biomass and rooting will be tested at the end of the study. Rooting will be tested with WinRhizo to determine changes in root length, area, and volume.

Deliverable: Cooperator will provide a written summary report containing methods, materials, results, and conclusions in addition to raw data if requested. Cooperator may provide an electronic copy of the replicate data in EXCEL or Word.

Results:

Table 1. Mean effects for creeping bentgrass color, quality, cover and average longest root length (cm) in Ames, IA in 2022.

	Color	Quality	Cover	Length (cm)
Control	2.9	3.9	12.5	31.5
GreenActivator 2 oz/1000 sq. ft.	4.3	4.9	65.2	36.6
GreenActivator 4 oz/1000 sq. ft.	3.4	5.1	77.7	38.0
Liquid 8-27-5 Fertilizer	4.3	4.7	65.2	33.7
Urea 46-0-0 Liquid	4.8	4.3	23.6	31.6
LSD (0.05)	1.5	0.9	13.2	3.8

Turfgrass color is rated on a 1-9 scale with 1 being light green and 9 being dark green with a camera and Turf Analyzer software. Urea offered a higher mean color (4.8) rating for the study with a 65%

increase compared to the unfertilized control (2.9). There were no other statistical differences between treatments.

Turfgrass quality is a combined rating for color, density, uniformity, and cover on a 1 to 9 scale with higher numbers being better turfgrass quality. GreenActivator at 2 oz/1000 sq. ft. (4.9) and 4 oz/1000 sq. ft. (5.1) had greater mean turfgrass quality than the unfertilized control (3.9). The 2 oz/1000 sq. ft. was a 25% increase in quality while the 4 oz/1000 sq. ft. was a 31% increase in turfgrass quality over the unfertilized control.

Mean turfgrass cover for the study differed for treatments. The unfertilized control (12.5%) and urea (23.6%) had the lowest cover compared to GreenActivator 2 oz/1000 sq. ft. (65.2%), GreenActivator 4 oz/1000 sq. ft. (77.7%), and the Liquid 8-27-5 fertilizer (65.2%).

Turfgrass longest root length was measured during the study and the mean turfgrass root length was as follows: GreenActivator at 4 oz/1000 sq. ft. (38 cm) had 20% longer mean root length than the unfertilized control (31.5 cm), urea (31.6 cm), and 13% greater than the liquid 8-27-5 fertilizer (33.7 cm).

Table 2. Creeping bentgrass color ratings by week for various fertilizer treatments in Ames, IA in 2022.

Weeks after initial application	0	2	4	6	8	10	12
Control	2.88	2.83	3.86	2.41	2.28	2.64	3.61
GreenActivator 2 oz/1000 sq. ft.	3.31	5.12	3.69	5	3.39	5.41	4.47
GreenActivator 4 oz/1000 sq. ft.	2.55	5.42	1.94	4.38	3.71	4.78	3.19
Liquid 8-27-5 Fertilizer	2.89	5.39	3.93	4.2	4.16	4.96	4.23
Urea 46-0-0 Liquid	2.53	6.16	3.72	4.73	4.79	6.07	5.71
LSD (0.05)	1.52	3.12	2.68	1	3.1	2.22	2.63

Turfgrass color ratings are described in the mean color section. These results are broken out for each week of the study. There were no differences between treatments for turfgrass color at the initial application. Urea (6.16) had a 117% higher color rating than the unfertilized control (2.83) two weeks after the initial application. There were no differences in the fourth week after initial application. All treatments had greater turfgrass color six weeks after the initial application than the control with GreenActivator at 2 oz/1000 sq ft. (107% increase) at 4 oz/1000 sq. ft. (78% increase) urea (96% increase), and liquid 8-27-5 fertilizer (74% increase) all had over 70% increase in color compared to the unfertilized control four weeks after the initial fertilizer application. There were no differences between treatments at the eight weeks after initial fertilizer application for turfgrass color. At 10 weeks after initial fertilizer application, urea (130% increase), GreenActivator 2 oz/1000 sq. ft. (105% increase), and Liquid 8-27-5 fertilizer (88% increase) all had increased color ratings compared to the unfertilized control. There were no differences at 12 weeks after the initial fertilizer treatment.

Table 3. Creeping bentgrass quality for various fertilizers in cm measured cover seven weeks after initial fertilizer application in Ames, IA in 2022.

Weeks after initial application	0	2	4	6	8	10	12
Control	3.99	3.77	3.82	3.59	4.05	3.89	4.63
GreenActivator 2 oz/1000 sq. ft.	3.99	4.63	4.82	4.56	5.94	6.04	4.35
GreenActivator 4 oz/1000 sq. ft.	3.91	5.31	5.05	5.52	5.61	5.99	4.36
Liquid 8-27-5 Fertilizer	4.06	4.94	4.32	4.73	5.35	5.08	4.45
Urea 46-0-0 Liquid	4.03	4.37	3.65	4.1	4.79	4.96	4.50
LSD (0.05)	NS	1.41	1.3	NS	1.67	1.86	NS

Turfgrass quality is a combined rating discussed under Table 1 of density, uniformity, color and cover on a 1-9 scale with 9 being higher quality than smaller numbers. There were no differences to start the study for turfgrass quality. At two weeks after initial application, GreenActivator at 4 oz/1000 sq. ft. (5.31) had a 41% higher turfgrass quality than the unfertilized control (3.77). At four weeks after the initial application, both the GreenActivator at 2 oz/1000 sq. ft. (4.82) and GreenActivator at 4 oz/1000 sq. ft. (5.05) had 26% and 32% higher quality respectively, than the unfertilized control (3.82). At six weeks after the initial treatment there were no differences between treatments. For both the eight and ten weeks after initial fertilizer treatment there were treatment differences. At eight weeks after initial treatment, GreenActivator at 2 oz/1000 sq. ft. (5.94) had a 46% greater turfgrass quality than the unfertilized control (4.05). While at 10 weeks after the initial treatment, both GreenActivator at 2 oz/1000 sq. ft. (6.04) and GreenActivator at 4 oz/1000 sq. ft. (5.99) had 55% and 54% greater turfgrass quality than the untreated control (3.89). There were no treatment differences at 12 weeks after the initial application of fertilizer.

Table 4. Creeping bentgrass cover for various fertilizers measured over 12 weeks after initial fertilizer application in Ames, IA in 2022.

Weeks after initial fertilizer application	0	2	4	6	8	10	12
Control	8.3	8.9	9.7	13.9	13.9	12.5	19.4
GreenActivator 2 oz/1000 sq. ft.	6.9	20.1	22.2	75	81.9	120	123
GreenActivator 4 oz/1000 sq. ft.	6.9	26.1	30.5	100	81.9	140	148
Liquid 8-27-5 Fertilizer	8.3	26.0	29.2	56.9	69.4	122	155
Urea 46-0-0 Liquid	8.3	9.8	12.5	29.7	33.3	33.3	40.2
LSD (0.05)	NS	17.1	NS	41.7	19.5	21.2	32.6

There were no differences in percent green cover at the start of the study (0 weeks after initial fertilizer application. At two weeks after application, GreenActivator at 4 oz/1000 sq. ft. had a 11.2% increase in percent green cover compared to the unfertilized control. At four weeks after the initial treatment, there were no differences in percent green cover. At six weeks after initial fertilizer application, GreenActivator at 4 oz/ 1000 sq. ft. (21.6%), GreenActivator at 2 oz/1000 sq. ft. (12.5%), and the liquid 8-27-5 fertilizer (20.3%) had increases of percent green cover compared to the unfertilized control. Similar results were present at eight weeks after the initial treatment with GreenActivator at 2 oz/1000 sq. ft. (68%), GreenActivator at 4 oz/1000 sq. ft. (68%), Liquid 8-27-5 (51%) increases in percent green cover compared to the unfertilized control. At 10 weeks after the initial treatment, GreenActivator at 4 oz/1000 sq. ft. (107.5%), GreenActivator at 2 oz/1000 sq. ft. (127.5%) and Liquid 8-27-5 fertilizer (109.5%) greater percent green cover than the unfertilized control. GreenActivator at 2 oz/1000 sq. ft. (86.7%), GreenActivator at 4 oz/1000 sq. ft. (106.7%), and Liquid 8-27-5 fertilizer (88.7%) had increased percent green cover compared to urea. At 12

weeks after the initial fertilizer application, GreenActivator at 2 oz/1000 sq. ft. (103.6%, 82.8%), GreenActivator at 4 oz/1000 sq. ft. (128.6%, 107.8%), and Liquid 8-27-5 fertilizer (135.6%, 114.8%) increase in percent green cover than the unfertilized control and urea.

Table 5. Longest root length (cm) for various fertilizers in cm measured cover 12 weeks after initial fertilizer application in Ames, IA in 2022.

Weeks after initial application	0	2	4	6	8	10	12
Control	0	0	32.8	45.0	46.3	48.0	48.3
GreenActivator 2 oz/1000 sq. ft.	0	0	43.8	47.5	51.8	55.8	57.5
GreenActivator 4 oz/1000 sq. ft.	0	0	46.8	50.5	54.0	57.3	57.5
Liquid 8-27-5 Fertilizer	0	0	40.7	50.0	53.0	56.0	56.0
Urea 46-0-0 Liquid	0	0	41.0	43.3	42.8	46.8	47.5
LSD (0.05)	NS	NS	8.2	NS	8.0	6.8	7

The longest turfgrass root was measured each week, with no differences at the start of the study and two weeks after the initial fertilizer application. At four weeks after the initial application, GreenActivator at 2 oz/1000 sq. ft. (33%), GreenActivator at 4 oz/1000 sq. ft. (42%), and urea (25%) all had increased longest roots compared to the unfertilized control. There were no differences at six weeks after the initial treatment for longest root measurement. At eight weeks after the initial treatment, GreenActivator 2 oz/1000 sq. ft. (21%), GreenActivator at 4 oz/1000 sq. ft. (26%), and liquid 8-27-5 fertilizer (23%) had a longer root than urea. At 10 weeks after the initial treatment GreenActivator at 2 oz/1000 sq. ft. (16%, 19%), GreenActivator at 4 oz/1000 sq. ft. (18%, 22%), and Liquid 8-27-5 fertilizer (17%, 20%) all had longer roots than the unfertilized control and urea. At the 12 weeks after initial application, GreenActivator 2 oz/1000 sq. ft. (19%, 21%), GreenActivator 4 oz/1000 sq. ft. (19%, 21%), and Liquid 8-27-5 (16%, 18%) had longer roots than the unfertilized control and urea.

Table 6. Creeping bentgrass total root length, root area, root volume, above ground dry biomass, dry root weight, and tallest shoot measurements for various fertilizers in Ames, IA in 2022.

	Total root length (cm)	Root area (cm2)	Above ground dry biomass	Dry root wtg. (g)	Volume (cm3)	Tallest shoot (cm)
Control	350.66	21.73	0.05	0.04	0.54	5
GreenActivator 2 oz/1000 sq. ft.	392.79	23.27	0.91	0.32	2.6	6.3
GreenActivator 4 oz/1000 sq. ft.	402.85	23.43	0.88	0.34	2.7	7.6
Granular 8-27-5	388.04	22.79	0.69	0.34	3.1	3
Urea 46-0-0 Liquid	330.16	20.89	0.15	0.08	0.79	6.3
LSD (0.05)	NS	NS	0.61	0.23	2	NS

At the end of the study roots were washed and scanned with WinRhizo to determine root length (cm), root area, and root volume. There were no differences in root length and root area between treatment. Root volume did have a difference between treatments, with GreenActivator 2 oz/1000

sq. ft. (381%) GreenActivator 4 oz/1000 sq. ft. (400%), and liquid 8-27-5 fertilizer (474%) all having greater root volume than the unfertilized control, and the liquid 8-27-5 (292%) also had greater root volume than urea. All above ground biomass was collected at the end of the study, dried, and then weighed. GreenActivator 2 oz/1000 sq. ft., GreenActivator 4 oz/1000 sq. ft. had greater dry above ground biomass than the unfertilized control and urea, while the liquid 8-27-5 fertilizer had greater above ground biomass than only the unfertilized control. After scanning the roots were then dried and weighed. GreenActivator 2 oz/1000 sq. ft. (700%, 300%) and GreenActivator 4 oz/1000 sq. ft. (750%, 325%) and liquid 8-27-5 fertilizer (750%, 325%) all had increased roots compared to the unfertilized control and urea. The tallest shoot was measured at the end of the study, and there were no differences between treatments.

Conclusion:

GreenActivator at 2 and 4 oz/1000 sq. ft. provided increased longest root length, more root volume, greater root biomass and dry root weight than an unfertilized control. They also performed similar to a competitive 8-27-5 fertilized on all of the variables tested. On many of the ratings, GreenActivator at both rates and the liquid 8-27-5 did better than urea. There were no differences between the rates of GreenActivator, this concludes that the label is correct for this product.

28 Days after treatment harvest:

Treatment	Harvest	Longest shoot length (cm)	Above ground Biomass (g)	Root Biomass (g)	Root volume (cm3)	Root Length cm
Control	28	2	0.026	0.019	0.194	359.2
GreenActivator 2 oz/1000 sq. ft.	28	5.5	0.043	0.039	0.454	347.42
GreenActivator 4 oz/1000 sq. ft.	28	5	0.033	0.027	0.325	366.57
Liquid 8-27-5 Fertilizer	28	8	0.051	0.034	0.445	342.87
Urea	28	4	0.072	0.045	0.513	353.6
Humic 2 oz/1000 sq. ft.	28	2.5	0.014	0.021	0.301	260
Humic 4 oz/1000 sq. ft.	28	2.5	0.031	0.02	0.35	230.56