THE EFFECT OF BOLSTER® ON DROUGHT RECOVERY OF KENTUCKY BLUEGRASS AS DETERMINED IN SLOPED TRAYS

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Sponsor: Suståne, Natural Fertilizer of America, Inc.

OBJECTIVE

The purpose of this trial was to determine the impact of Bolster® on Kentucky bluegrass subjected to drought by measuring:

1. Plant photochemical activity as determined with chlorophyll index measurements and visual ratings.
2. Plant recovery differences between treatments as the plant is subjected to watering after being stressed.

EXPERIMENTAL DESIGN/METHODS

The treatments consisted of an untreated control (water only) and Bolster® biostimulant applied at three rates: 47.7, 95.4, and 191.0 ml Bolster® 100 m^{-2}. All treatments were replicated four times and arranged in a randomized experimental design. Treatments were applied to mature Kentucky bluegrass sod (containing d” 6 mm soil) , rooted in topsoil in 30 cm by 60 cm by 15 cm deep trays with sloping bottoms (Figure 1).

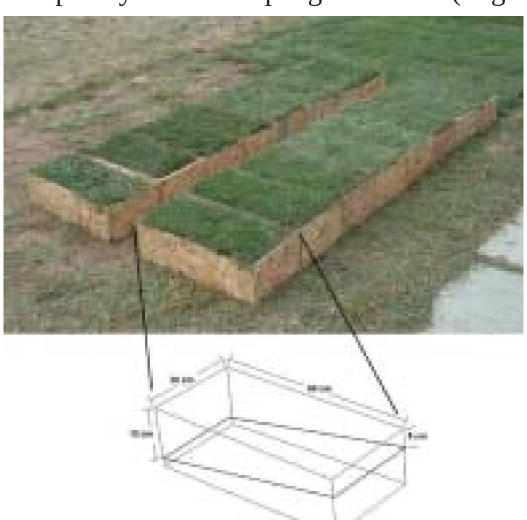

Figure 1. Slope bottomed boxes used to impose drought stress gradient in Kentucky bluegrass sod.

This design permitted roots to develop to a depth potential range of 5 cm to 15 cm along the length of the tray. Treatments were applied 1 and 4 weeks after the sod was transplanted to the trays. A complete fertilizer was applied to supply 1 kg N per ha at week one and week five after the initiation of the experiment. Irrigation was applied to insure sod establishment.

Irrigation was stopped after 6 weeks. Plants in the trays were left unirrigated until most of the grass had reached a visual wilt stage.

Photosynthetic activity was determined with chlorophyll index measurements (Spectrum CM1000 chlorophyll meter) of the treated grass at 3-inch intervals from the shallow rooting medium of the trays weekly as the turfgrass was subjected to drought. Visual evaluations were made as well at the time chlorophyll measurements were made. Soil moisture status (volumetric water content) was measured with a Theta–probe (frequency domain reflectometry) and a TDR probe.

Leaf moisture content was estimated during the dry down phase by determining the temperature of the turf canopy with an infrared thermometer.

Irrigation was resumed after the conclusion of the drought period. The rate and percent of the turf recovery was assessed by visual means and chlorophyll index measurements.

All data were analysed statistically for treatment main effects and interactions. Statistically significant differences between the product treatments and the controls would be indicative of effects of the product on turf performance. An anecdotal photographic record of the progress of the trial was maintained.

RESULTS

Drought stress as measured by soil moisture content developed very uniformly during the experiment (Table 1, Figure 2). The sloped box produced a drought stress gradient by day 6 (Figure 3), but the 5 cm depth was drier, while there was less difference between the 10 and 15 cm depths.

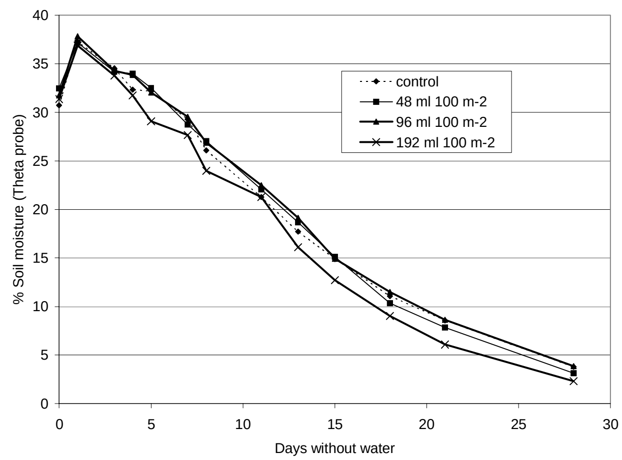

Figure 2. Effects of rate on development of drought estimated by volumetric water content.

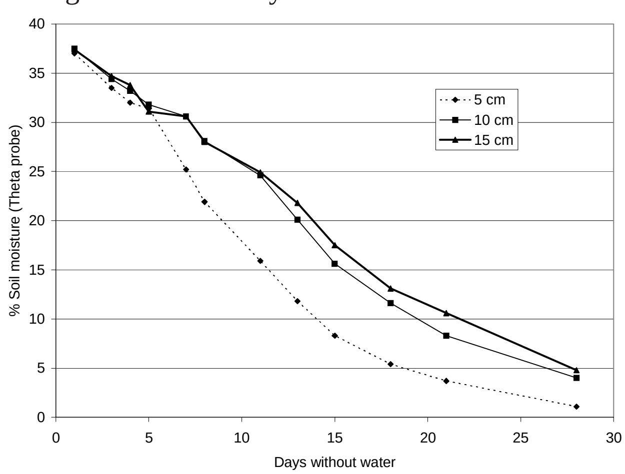

Figure 3. Effect of soil depth on development of drought estimated by volumetric water content. The shallowest soil (5 cm) developed drought stress significantly faster than the deeper depths.

There were significant differences among the rate treatments in development of drought symptoms and recovery (Figure 4), but they could not be attributed to the directly to the rates, since the highest rate had the most severe symptoms and recovered most slowly, while the second highest rate had the least severe symptoms and recovered most quickly (not significantly different from the control).

The effect of soil depth on drought symptom development and recovery was as expected (Figure 5), with the shallow depths developing symptoms quickly and recovering slowly (in fact, there was significant turf death in the 5 cm of soil).

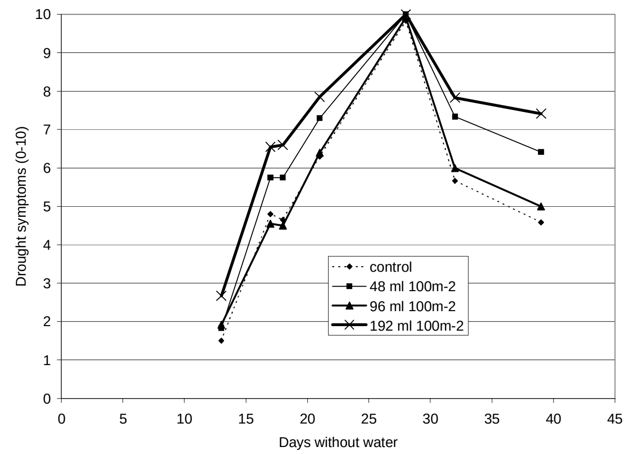

Figure 4. Effects of rate on drought symptom development and recovery.

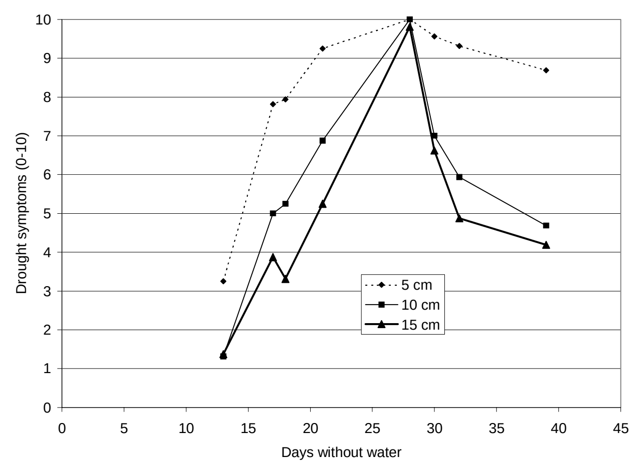

Figure 5. Effects of soil depth on drought symptom development and recovery.

The canopy temperature data recorded during the drought and recovery phases (Table 3) showed a similar pattern to the soil moisture and drought symptom data, with the 48 and 192 ml rates having slightly higher canopy temperatures as the drought stress developed. There was also a direct inverse relationship between soil depth and canopy temperature.

Table 1. Volumetric water content of treated rootzone gradient plots (% VWC, ThetaProbe).

	Days without water											
	1	**3**	**4**	**5**	**7**	**8**	**11**	**13**	**15**	**18**	**21**	**28**
Bolster rate												
0	37.3	34.5	32.4	32.2	29.3	26.1	21.3	17.7	14.9 a	11.1 a	8.6 a	3.8 a
48	37.2	34.2	34.0	32.5	28.7	27.0	22.1	18.7	15.1 a	10.3 ab	7.8 a	3.1 ab
96	37.8	34.3	33.8	32.0	29.5	26.9	22.5	19.1	14.9 a	11.5 a	8.6 a	3.9 a
192	36.9	33.8	31.8	29.1	27.7	24.0	21.3	16.1	12.7 b	9.0 b	6.1 b	2.3 b
lsd p=0.05	NS	NS	NS	NS	NS	NS	NS	NS	1.7	1.5	1.4	1.1
Depth												
2”	37.0	33.5	32.0	31.4	25.2 b	21.9 b	15.9 b	11.8 b	8.3 d	5.4 d	3.7 d	1.1 b
3”									12.9 c	8.7 c	6.4 c	
4”	37.5	34.4	33.2	31.8	30.6 a	28.1 a	24.6 a	20.1 a	15.6 b	11.6 b	8.3 b	4.0 a
5”									17.9 a	13.5 a	9.9 a	
6”	37.4	34.7	33.8	31.1	30.6 a	28.0 a	24.9 a	21.8 a	17.5 ab	13.1 ab	10.6 a	4.8 a
lsd p=0.05	NS	NS	NS	NS	2.4	2.9	3.0	2.6	1.9	1.7	1.5	1.0
Block												
1	36.9	34.6	33.9	33.5	30.1	27.8	24.0	19.5	16.4 a	12.3 a	9.0 a	4.1 a
2	37.3	34.3	32.7	29.3	28.6	25.6	20.8	18.2	14.5 b	10.6 b	7.9 a	3.3 ab
3	37.2	33.5	32.6	31.3	27.5	24.9	20.3	16.1	12.7 c	9.5 b	6.4 b	2.4 b
4	37.7	34.4	32.8	31.8	28.9	25.8	22.0	18.0	14.0 bc	9.5 b	7.8 a	3.3 ab
lsd p=0.05	NS	NS	NS	NS	NS	NS	NS	NS	1.7	1.5	1.4	1.1

Table 2. Drought symptoms in treated rootzone gradient plots (0 – 10, 0=no drought, 3=beginning to wilt, 10=dormant/dead).

	Days without water							
	Drought					Recovery		
	13	**17**	**18**	**21**	**28**	**(30)***	**(32)***	**(39)***
Bolster rate								
0	1.5	4.8 bc	4.7 b	6.3 b	9.8	6.9 c	5.7 b	4.6 b
48	1.8	5.8 ab	5.8 a	7.3 a	10.0	8.1 ab	7.3 a	6.4 a
96	1.9	4.6 c	4.5 b	6.4 b	9.9	7.2 bc	6.0 b	5.0 b
192	2.7	6.6 a	6.6 a	7.9 a	10.0	8.8 a	7.8 a	7.4 a
lsd p=0.05	NS	1.0	1.1	0.9	NS	1.1	1.3	1.3
Depth								
2”	3.3 a	7.8 a	7.9 a	9.3 a	10.0	9.6 a	9.3 a	8.7 a
3”		6.3 b	6.4 b	7.9 b				
4”	1.3 b	5.0 c	5.3 c	6.9 c	10.0	7.0 b	5.9 b	4.7 b
5”		4.1 cd	3.9 d	5.5 d				
6”	1.4 b	3.9 d	3.3 d	5.3 d	9.8	6.6 b	4.9 b	4.2 b
lsd p=0.05	0.7	1.1	1.2	1.0	NS	0.9	1.1	1.1
Block								
1	1.3 b	4.7 b	4.4 c	6.6	9.8	6.9	5.4 b	5.0
2	1.9 ab	5.2 ab	4.9 bc	7.2	10.0	7.7	6.6 ab	5.6
3	2.3 a	6.2 a	6.3 a	7.2	10.0	8.3	7.7 a	6.5
4	2.4 a	5.6 ab	6.0 ab	7.0	10.0	8.0	7.2 a	6.3
lsd p=0.05	0.8	1.0	1.1	NS	NS	NS	1.3	NS

*Irrigation resumed on day 28 after drought readings were taken.

The chlorophyll index data also followed the same pattern (Figures 6 and 7, Table 4).

CONCLUSIONS

While the experimental design reliably provided a gradient in drought stress in time and space, which was reflected in the development of drought symptoms in the Kentucky bluegrass, there was no significant improvement provided by the biostimulants treatments, either in prevention of symptom development or recovery from drought. The best treatment, 96 ml 100 m^{-2}, was not significantly different from the untreated control.

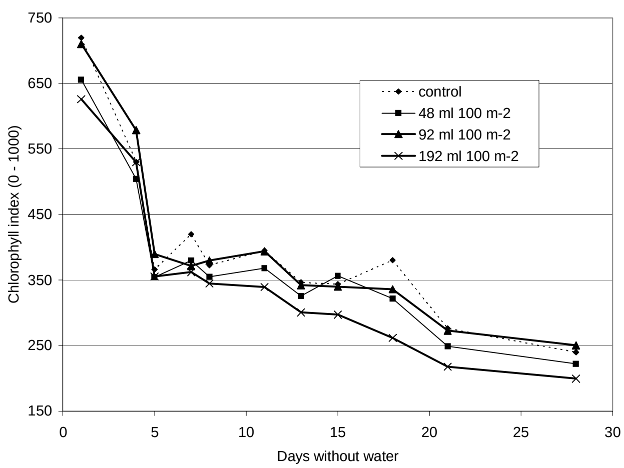

Figure 6. Effects of rate on photosynthesis as estimated by chlorophyll index.

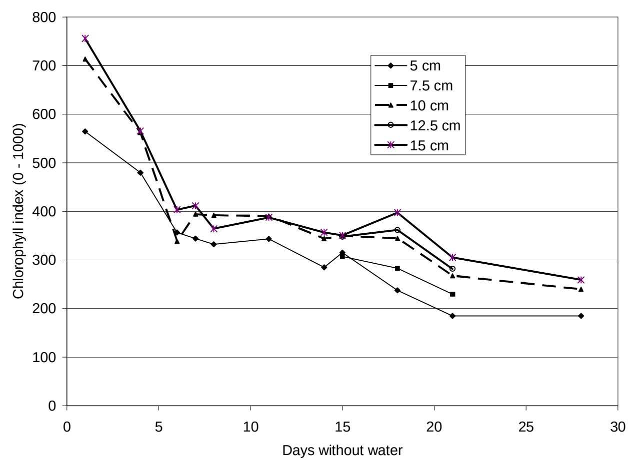

Figure 7. Effects of soil depth on photosynthesis as estimated by chlorophyll index.

Table 3. Canopy temperature in treated rootzone gradient plots (ºC, infrared thermometer).

	Days without water													
	1	**3**	**4**	**5**	**7**	**8**	**11**	**13**	**15**	**18**	**21**	**28**	**(30)***	**(32)***
Bolster rate														
0	17.4 a	17.7	20.1	18.1 a	18.3	17.2	19.6	17.3	18.5	19.2 ab	17.8 b	24.7 b	15.8 b	18.4
48	16.9 b	17.5	20.6	17.9 ab	18.1	17.2	19.3	17.1	18.0	18.6 c	17.8 b	24.2 c	16.3 ab	19.0
96	17.3 ab	17.4	20.3	17.7 bc	18.1	17.2	19.3	17.1	18.4	18.9 bc	17.9 b	24.7 b	15.7 b	18.9
192	16.8 b	17.3	20.6	17.6 c	18.1	16.9	19.4	17.6	18.4	19.6 a	18.7 a	25.4 a	16.8 a	19.4
lsd p=0.05	0.4	NS	NS	0.3	NS	NS	NS	NS	NS	0.6	0.5	0.5	0.6	NS
Depth														
2”	17.0	17.6 a	21.4 a	17.7 b	18.1	17.2 ab	19.6	18.9 a	19.3 a	20.3 a	19.9 a	25.7 a	17.4 a	20.1
3”										19.7 b	18.9 b	25.1 b		
4”	17.1	17.8 a	20.6 b	18.1 a	18.3	17.4 a	19.4	17.2 b	18.2 b	18.8 c	17.8 c	24.6 b	15.8 b	18.7
5”										18.7 c	17.0 d	24.6 b		
6”	17.2	17.1 b	19.2 c	17.7 b	18.1	16.8 b	19.3	15.8 c	17.4 c	18.0 d	16.5 d	23.8 c	15.3 c	18.1
lsd p=0.05	NS	0.3	0.7	0.3	NS	0.4	NS	0.8	0.5	0.6	0.5	0.5	0.6	NS
Block														
1	16.5 c	17.2 c	20.5 ab	17.2 b	17.4 c	16.1 c	18.7 b	17.1	17.0 c	19.0	16.5 c	23.8 b	15.8 c	19.1
2	16.9 bc	16.9 c	21.1 a	17.4 b	17.8 b	16.9 b	19.1 b	17.1	18.2 b	19.4	18.0 b	25.4 a	15.8 bc	18.5
3	17.0 b	17.7 b	20.0 b	18.2 a	18.6 a	17.8 a	20.0 a	17.5	19.0 a	18.9	18.8 a	25.8 a	16.4 ab	19.6
4	17.9 a	18.2 a	19.9 b	18.5 a	18.9 a	17.9 a	19.9 a	17.4	19.1 a	19.0	18.8 a	24.1 b	16.6 a	18.6
lsd p=0.05	0.4	0.4	0.8	0.3	0.3	0.5	0.4	NS	0.6	NS	0.5	0.5	0.6	NS

*Irrigation resumed on day 28 after temperature readings were taken.

Table 4. Chlorophyll index in treated rootzone gradient plots (0 – 1000, higher index = more chlorophyll/photosynthetic activity).

	Days without water											
	0	**1**	**4**	**6**	**7**	**8**	**11**	**14**	**15**	**18**	**21**	**28**
Bolster rate												
0	744.7 a	719.9 a	530.2	365.9 ab	420.0 a	372.6 a	394.8 a	346.4 a	343.4 ab	380.2 a	276.2 a	239.9 b
48	710.2 a	655.7 b	504.2	354.4 b	380.1 b	354.8 b	367.9 b	325.5 b	356.2 a	321.5 c	248.8 b	221.9 c
96	748.5 a	710.1 a	578.8	389.5 a	371.2 bc	379.5 a	393.8 a	341.9 a	339.9 b	336.0 b	272.8 a	250.3 a
192	668.2 b	626.0 b	529.7	355.4 b	361.9 c	344.6 b	339.3 c	300.4 c	297.1 c	261.9 d	217.6 c	199.5 d
lsd p=0.05	38.8	33.4	NS	24.4	16.2	10.8	12.4	13.9	15.9	11.8	8.2	9.7
Depth												
2”	669.1 b	564.4 c	479.6 b	356.6 b	344.1 c	332.4 c	343.5 b	284.8 c	314.9 b	237.4 e	184.8 e	184.7 c
3”									307.4 b	283.1 d	229.6 d	
4”	736.8 a	713.5 b	562.0 a	338.7 b	394.2 b	392.0 a	390.7 a	344.2 b	349.7 a	344.6 c	267.5 c	239.9 b
5”									347.9 a	361.8 b	281.8 b	
6”	747.7 a	755.8 a	565.5 a	403.6 a	411.6 a	364.2 b	387.6 a	356.6 a	351.0 a	397.7 a	305.3 a	259.0 a
lsd p=0.05	33.6	28.9	64.4	21.1	14.1	9.3	10.7	12.0	17.8	13.2	9.2	8.4
Block												
1	672.5 c	620.2 c	492.4 b	413.1 a	384.3 b	357.4 bc	378.4 a	323.4	320.0 b	296.1 b	268.8 a	262.0 a
2	769.8 a	706.0 a	592.6 a	430.4 a	384.6 b	365.2 b	382.6 a	330.0	360.7 a	301.0 b	256.5 b	235.9 b
3	724.5 b	717.1 a	450.8 b	316.8 b	329.0 c	378.4 a	382.4 a	337.8	353.4 a	347.9 a	244.1 c	204.3 c
4	704.8 bc	668.3 b	607.1 a	304.9 b	435.3 a	350.6 c	352.4 b	323.0	302.6 c	354.5 a	245.9 c	209.3 c
lsd p=0.05	38.8	33.4	74.3	24.4	16.2	10.8	12.4	NS	15.9	11.8	8.2	9.7