Longevity of Turf Response to Urea, Coated Urea, and Blends – 2012 trial

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Sponsor: Agrium Advanced Technologies

The objective of this research project was to quantify turf response to a one-time application of urea-based fertilizers on Kentucky bluegrass turf on a soil rootzone.

Data collected included the duration and strength of the color response following application of the tested products, turf quality, uniformity, and density, and resistance of the turf to disease and other stresses.

MATERIALS/METHODS

The treatments consisted of the sponsor’s products at specified rate and application program (Table 1). An unfertilized check treatment was also included. Treatments were applied to 1 x 3 m plots of Kentucky bluegrass turf maintained as a home-lawn type turf on the research ranges at the Guelph Turfgrass Institute (mowing at 40 mm, irrigation to prevent stress) (Figure 1). Treatments were replicated four times in a randomized complete block design.

Color response of the turf to treatments was assessed pre-treatment, and then on a weekly basis, both visually and using instrumental color (canopy reflectance – normalized-difference vegetation index using an Ntech Greenseeker). Uniformity of the color response was assessed visually using a scale of 1 to 9 (1=dead, 9=ideal,

Table 1. Treatments

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Application program</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Untreated control</td>
<td></td>
</tr>
<tr>
<td>2. 100% urea</td>
<td>All treatments were applied once</td>
</tr>
<tr>
<td>3. 15% XCU, 85% urea</td>
<td>(May 17, 2012)</td>
</tr>
<tr>
<td>4. 30% XCU, 70% urea</td>
<td>at</td>
</tr>
<tr>
<td>5. 50% XCU, 50% urea</td>
<td>1 lb / 1000 sq ft actual N</td>
</tr>
<tr>
<td>6. 100% XCU</td>
<td>(4.88 g m⁻²)</td>
</tr>
<tr>
<td>7. 15% SCU, 85% urea</td>
<td></td>
</tr>
<tr>
<td>8. 30% SCU, 70% urea</td>
<td></td>
</tr>
<tr>
<td>9. 50% SCU, 50% urea</td>
<td></td>
</tr>
<tr>
<td>10. 100% SCU</td>
<td></td>
</tr>
</tbody>
</table>

Treatments were applied May 17, 2012 according to the recommended programs.

Figure 1. Plot area June 7, 2012 (21 DAT).
5 = acceptable). Plots were rated for turf quality, density and uniformity. Clippings were collected at 2, 4, 6, 8, 10, 12, 14, and 16 weeks after treatment, dried and weighed to determine shoot dry matter accumulation per unit area. Soil temperature at 5 cm depth was monitored with Spectrum WatchDog data loggers, and reported as daily mean. Other stresses were measured as they occurred (disease, weed, drought).

Spring greenup will be assessed in April 2013.

An anecdotal photographic record of the experiment was kept.

All measurements were analyzed by appropriate statistical analyses (general linear models).

RESULTS

Environmental data

Daily air and soil temperatures for May - October 2012 are presented in Figures 2 and 3.

Visual ratings

There were few significant differences in visual ratings of turf color compared to the trial done in 2012. Color differences between treated and control plots appeared by 12 DAT (Table 2), but no differences between fertilizer treatments

Table 2. Visual ratings of treated plots.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Color</th>
<th>Uniformity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12 DAT</td>
<td>28 DAT</td>
</tr>
<tr>
<td>100% SCU</td>
<td>7.5 a(^1)</td>
<td>8.3 a</td>
</tr>
<tr>
<td>100% urea</td>
<td>8.5 a</td>
<td>7.8 a</td>
</tr>
<tr>
<td>100% XCU</td>
<td>7.8 a</td>
<td>8.5 a</td>
</tr>
<tr>
<td>15% SCU, 85% urea</td>
<td>8.3 a</td>
<td>7.8 a</td>
</tr>
<tr>
<td>15% XCU, 85% urea</td>
<td>8.3 a</td>
<td>8.0 a</td>
</tr>
<tr>
<td>30% SCU, 70% urea</td>
<td>8.0 a</td>
<td>8.3 a</td>
</tr>
<tr>
<td>30% XCU, 70% urea</td>
<td>8.0 a</td>
<td>8.3 a</td>
</tr>
<tr>
<td>50% SCU, 50% urea</td>
<td>8.3 a</td>
<td>7.5 ab</td>
</tr>
<tr>
<td>50% XCU, 50% urea</td>
<td>8.3 a</td>
<td>8.0 a</td>
</tr>
<tr>
<td>Untreated control</td>
<td>5.5 b</td>
<td>6.0 b</td>
</tr>
<tr>
<td>msd p=0.05</td>
<td>1.8</td>
<td>1.6</td>
</tr>
</tbody>
</table>

\(^1\) Visual ratings 0-10, 10 = best, 6 = acceptable. Means of 4 replicates; means within columns followed by the same letter are not significantly different (Tukey’s HSD test, p=0.05).
Figure 4. Relationship between visual color ratings and change in canopy reflectance in treated plots. The association is not tight, but the pattern is consistent across observation dates. Points graphed are plot means for ΔNDVI values, and plot values for visual color.

were seen for color, uniformity, or density. The NDVI values are a reasonable proxy for visual color (Figure 4), with observed range of differences in NDVI (~0.2 units) corresponding to about 3 ranks of visual color differences (6 to 9).

Canopy reflectance

The canopy reflectance (normalized-difference vegetation index) data collected with the Greenseeker gave a very precise picture of the response to the treatments. Index values were calculated both as the raw NDVI values and as values corrected by subtracting the value of the untreated control to remove background variation, since the NDVI value is affected by mowing, moisture status, and other factors in addition to nitrogen status. Figure 5 shows the pattern of change of the raw NDVI values (averaged across all plots) and the ΔNDVI values (averaged across all non-control plots) during the experiment. The maximum fertilizer response in 2012 (~0.13 units) was about double the maximum response in the 2011 trials, but the background (raw NDVI values) showed a sharp reduction during the hot dry summer in 2012, which was not seen in 2011.

Figure 5. Changes in overall mean NDVI (black •) and ΔNDVI (corrected to remove control value; blue •) during the experiment.

There were significant differences in canopy reflectance among the treatments beginning 5 DAT and lasting consistently until 74 DAT (Table 3), and sporadically until 90 DAT. By 17 DAT all treatments had significantly larger canopy reflectance values than the untreated control. Generally there were no strong patterns among the fertilizer treatments in NDVI values per se.

The ΔNDVI values, when plotted over time, allowed some differentiation among the fertilizer treatments in terms of release characteristics as detected by canopy reflectance. Replicate mean values of ΔNDVI were tested against various curves to determine which functions had potential to adequately describe the responses. The online curve fitting and surface fitting web site at www.zunzun.com was used to investigate families of curves. One of the best functions to fit the data was a compound exponential function

\[ \Delta \text{NDVI} = 4A \cdot e^{-0.7 \times \text{DAT}/C} \cdot (1 - e^{-0.7 \times \text{DAT}/C}) \]

in which there are two fitted parameters: A, which varies with maximum ΔNDVI, and C, which varies with days to maximum ΔNDVI (Figure 6 and 7). The suitability was judged based on the combination of goodness of fit, minimum number of parameters, and interpretability of the parameters.

The ΔNDVI values for each treatment were
Table 3. Change in canopy reflectance (ΔNDVI) in treated plots.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>DAT</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>100% SCU</td>
<td>-0.028</td>
<td>-0.019</td>
<td>-0.010</td>
<td>-0.026</td>
<td>-0.025</td>
<td>0.035</td>
<td>0.049</td>
<td>0.048</td>
<td>0.066</td>
<td>0.066</td>
<td>0.070</td>
<td></td>
<td></td>
</tr>
<tr>
<td>70% urea</td>
<td>-0.045</td>
<td>-0.034</td>
<td>-0.023</td>
<td>-0.015</td>
<td>-0.004</td>
<td>0.069</td>
<td>0.087</td>
<td>0.086</td>
<td>0.099</td>
<td>0.106</td>
<td>0.105</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30% XCU</td>
<td>-0.006</td>
<td>-0.032</td>
<td>-0.025</td>
<td>-0.018</td>
<td>-0.006</td>
<td>0.047</td>
<td>0.059</td>
<td>0.057</td>
<td>0.079</td>
<td>0.089</td>
<td>0.082</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15% SCU, 85% urea</td>
<td>-0.011</td>
<td>0.016</td>
<td>0.020</td>
<td>0.022</td>
<td>0.020</td>
<td>0.029</td>
<td>0.042</td>
<td>0.104</td>
<td>0.100</td>
<td>0.123</td>
<td>0.125</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15% XCU, 85% urea</td>
<td>-0.014</td>
<td>-0.004</td>
<td>-0.004</td>
<td>-0.006</td>
<td>0.012</td>
<td>0.078</td>
<td>0.096</td>
<td>0.094</td>
<td>0.113</td>
<td>0.109</td>
<td>0.105</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30% SCU, 70% urea</td>
<td>-0.005</td>
<td>0.001</td>
<td>0.002</td>
<td>0.002</td>
<td>0.012</td>
<td>0.058</td>
<td>0.074</td>
<td>0.063</td>
<td>0.076</td>
<td>0.086</td>
<td>0.087</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15% SCU, 85% urea</td>
<td>-0.006</td>
<td>-0.002</td>
<td>0.010</td>
<td>0.002</td>
<td>0.018</td>
<td>0.064</td>
<td>0.078</td>
<td>0.072</td>
<td>0.093</td>
<td>0.099</td>
<td>0.099</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100% SCU</td>
<td>0.019</td>
<td>0.010</td>
<td>0.005</td>
<td>0.004</td>
<td>0.003</td>
<td>0.037</td>
<td>0.075</td>
<td>0.080</td>
<td>0.079</td>
<td>0.088</td>
<td>0.090</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50% SCU, 50% urea</td>
<td>-0.023</td>
<td>-0.009</td>
<td>-0.006</td>
<td>0.005</td>
<td>0.016</td>
<td>0.078</td>
<td>0.100</td>
<td>0.097</td>
<td>0.112</td>
<td>0.117</td>
<td>0.111</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50% SCU, 50% urea</td>
<td>-0.023</td>
<td>-0.009</td>
<td>-0.006</td>
<td>0.005</td>
<td>0.016</td>
<td>0.078</td>
<td>0.100</td>
<td>0.097</td>
<td>0.112</td>
<td>0.117</td>
<td>0.111</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Untreated control</td>
<td>-0.002</td>
<td>0.001</td>
<td>0.002</td>
<td>0.002</td>
<td>0.000</td>
<td>0.000</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
<td>0.002</td>
<td>0.002</td>
<td></td>
</tr>
<tr>
<td>msd p=0.05</td>
<td>NS NS NS NS NS NS NS NS NS NS NS NS NS</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1Normalized-difference vegetation index corrected to zero the untreated control means: mean of 4 replicates; means within columns followed by the same letter are not significantly different (Tukey’s HSD test, p = 0.05). Readings in bold are from dates with significant treatment effects.
fitted to these curves using GraphPad Prism, and the estimates of A and C for each treatment were compared using ANOVAs. The parameter estimates of the fitted curves are shown in Table 4 and Figure 8, and the fitted curves are shown in Figures 9 – 11.

**Shoot growth**

Clippings were collected periodically to
Figure 13. Clipping collection: border strips were mowed short (<40 mm) and clippings were then collected from a 0.94 m strip lengthwise in each plot using a Gardena electric reel mower set at 42 mm height of cut.
Table 5. Dry matter accumulation.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>19</th>
<th>34</th>
<th>48</th>
<th>62</th>
<th>76</th>
<th>93</th>
<th>105</th>
</tr>
</thead>
<tbody>
<tr>
<td>100% SCU</td>
<td>7.74&lt;sup&gt;1&lt;/sup&gt;</td>
<td>6.02</td>
<td>2.53</td>
<td>1.48</td>
<td>2.45</td>
<td>4.98</td>
<td>2.60</td>
</tr>
<tr>
<td>100% urea</td>
<td>11.48</td>
<td>7.83</td>
<td>3.28</td>
<td>1.98</td>
<td>3.53</td>
<td>6.28</td>
<td>3.73</td>
</tr>
<tr>
<td>100% XCU</td>
<td>10.80</td>
<td>7.26</td>
<td>3.03</td>
<td>1.70</td>
<td>2.79</td>
<td>5.68</td>
<td>3.35</td>
</tr>
<tr>
<td>15% SCU, 85% urea</td>
<td>9.78</td>
<td>7.16</td>
<td>3.18</td>
<td>1.64</td>
<td>3.11</td>
<td>5.78</td>
<td>3.38</td>
</tr>
<tr>
<td>15% XCU, 85% urea</td>
<td>8.96</td>
<td>6.05</td>
<td>2.75</td>
<td>1.80</td>
<td>3.46</td>
<td>6.18</td>
<td>3.68</td>
</tr>
<tr>
<td>30% SCU, 70% urea</td>
<td>12.44</td>
<td>7.84</td>
<td>3.15</td>
<td>1.68</td>
<td>3.08</td>
<td>6.25</td>
<td>3.38</td>
</tr>
<tr>
<td>30% XCU, 70% urea</td>
<td>10.53</td>
<td>6.99</td>
<td>2.85</td>
<td>1.31</td>
<td>2.70</td>
<td>5.43</td>
<td>2.83</td>
</tr>
<tr>
<td>50% SCU, 50% urea</td>
<td>11.80</td>
<td>7.22</td>
<td>2.33</td>
<td>1.33</td>
<td>2.55</td>
<td>4.83</td>
<td>3.33</td>
</tr>
<tr>
<td>50% XCU, 50% urea</td>
<td>8.50</td>
<td>7.04</td>
<td>2.85</td>
<td>1.80</td>
<td>3.04</td>
<td>5.58</td>
<td>3.53</td>
</tr>
<tr>
<td>Untreated control</td>
<td>7.75</td>
<td>4.72</td>
<td>2.03</td>
<td>1.23</td>
<td>2.41</td>
<td>4.15</td>
<td>2.38</td>
</tr>
</tbody>
</table>

<sup>1</sup> Clippings collected from 0.38 x 0.94 m strip of each plot, mowed at 42 mm after 5-7 days of growth.

### DISCUSSION AND CONCLUSIONS

All treatments gave a significant improvement in colour and growth compared to the untreated control. The fertilizer effects were observable within a week after treatment by the canopy reflectance data, and persisted in significant amounts until more than 10 weeks after treatment. The average gain of fertilized treatments over control was at least 2 ranks on the visual colour rating scale (6 to 8), or about 0.07 units on the canopy reflectance index. The untreated control plots were at an acceptable colour and quality level (>5) through most of the trial. There was no strong or consistent pattern date by date distinguishing the fertilizer treatments from one another, either in visual ratings, or canopy reflectance, or growth.

Using the release curves fitted to the seasonal pattern of ΔNDVI suggests that the ranking of the fertilizer treatments for strength of response (A) was 15% SCU > 50% XCU > 100% XCU > 30% SCU > 100% urea > 15% XCU > 100% SCU > 30% SCU > 50% SCU, though there was much overlap among the treatments statistically.
and the pattern observed in 2012 had little in common with that observed in 2011.

Similarly, the ranking of the treatments for days to maximum release (C) was 100% SCU > 50% XCU > 30% XCU > 15% XCU > 30% SCU > 50% SCU > 100% XCU > 15% SCU > 100% urea, with significant overlap among the treatments, and a different pattern of ordering in 2012 than was observed in 2011.

The release across all treatments was stronger and slower in 2012 than in 2011, with nearly double the increase in NDVI compared to the control, and about 10 days longer to the maximum increase.