Interaction of the Wetting Agent Primer and Poor Quality Water on a USGA Specification Soil and Creeping Bentgrass

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Summary

With ongoing concerns in the golf course industry on the matter of water conservation it appears to be inevitable that low to poor quality water will have to be utilized as an irrigation source on golf courses. The issue of irrigating with such water poses several problems, one of which is the effect it will have in the soil specifically on nutrient level concentrations and plant availability. The objective of this experiment was to measure the effect of the wetting agent, Primer, on sodium (Na) levels in creeping bentgrass USGA specification greens. High sodium levels in irrigation water have been shown to inhibit calcium (Ca) and magnesium (Mg) availability.

No existing research was available on the effects of wetting agent on sodium levels within the soil but it was thought that the product would reduce these levels and therefore allow for calcium and magnesium to be readily available to be taken up by the turf. When there is an excess amount of Na in the soil Ca and Mg are left in soil solution and soon tied up by carbonates forming calcium bicarbonates ($CaCO3$) and magnesium bicarbonates ($MgCO3$) that are not very soluble and therefore not available to the plant for uptake. The experiment consisted of a control plot with no wetting agent and five plots of different wetting agent application rates. The five rates consisted of 0.5 x the regular rate, 1.0 x the regular rate, 2.0 x the regular rate, 2.0 x the regular rate, 4.0 x the regular rate, and 8.0 x the regular rate. Each application was given daily to the plots and results were observed and recorded weekly. Testing included growth rate, pH level, EC level, hardness ($CaCO3$), infiltration rates and sodium at the beginning and end of the experiment.

Expected results were found positively affecting the plots with the greatest effect on the plugs with the highest rate of *Primer* application and the least effects being noticed on the plugs with no wetting agent.

Introduction

The use of good quality water as an irrigation source on golf courses is a luxury that many superintendents do not have or cannot afford. The near future poses the potential that all golf courses will be forced to use effluent or at very best, low quality water as an irrigation source. To categorize water as low or poor in quality, high to toxic levels of bicarbonates ($HCO3$), carbonates ($CO3$), or nutrients would be present that are harmful to the plant.

If the water being irrigated on the turf is high in sodium, it would force the calcium and magnesium off the exchange sites by mass flow. Calcium and mangnesium are important in the soil to help bind the soil particles together and create a stable growing media as well as providing essential roles within the plants themselves. Calcium and magnesium are responsible for functions in plants such as cell wall production, cell elongation, and the production of chlorophyll. If the water is high in bicarbonates and carbonates in combination with high sodium levels, it can lead to very poor soil and turf. The high levels of bicarbonates and carbonates combine with the calcium and magnesium to create calcium bicarbonates, calcium carbonates, magnesium bicarbonates and magnesium carbonates. After being converted to these forms, the nutrients calcium and magnesium become unavailable to be taken up by the plant. As sodium levels increase on the soil exchange sites, calcium and magnesium are left in solution, which leaves them susceptible to uptake by carbonates and bicarbonates creating an insoluble compound leaving the turf with potential magnesium and calcium deficiencies. In addition, the excess sodium will be taken up by the plant causing toxicity in the plant.

Low quality water in combination with high temperatures forces intense stress on the plant both physically and physiologically. When watering with poor quality water to try to help these dry conditions, one might be worsening the situation for the turf. The wetting agent Primer has been used for years to help reduce the effect of the phenomenon known as hydrophobic soils or localized dry spot (LDS). Primer is used to reduce water repellency, improve the quality and uniformity of the turf, while increasing available water.

This experiment was done to observe the addition of the wetting agent Primer and its effect on the levels of sodium, pH, salinity (measured by EC), total hardness, infiltration and growth rates on a USGA specification creeping bentgrass green.

Objective

To determine the effects on soil and turf by using a wetting agent at different rates in combination with a poor quality water source. The tests were intended to compare available sodium to available magnesium and calcium. The expectations for this experiment are that the sodium levels will be high leaving little magnesium and calcium for plant uptake. This will cause high levels of pH and EC, which will in turn negatively affect the growth rate of the plant due to the excess of sodium blocking exchange sites. The effects of the higher levels of wetting agent are unknown and yet to be proven.

Materials

The materials that were utilized for the experiment were:

- 30 turf plugs of Agrostis palustris (From Gleneagles Golf Club, AB)
- 30 pots (6inches in depth)
- PH and EC measuring kit
- Beakers, graduated cylinders
- Distilled water
- Pie plates
- 30 plastic labels to mark pots
- Stir sticks
- USGA specification sand
- Greenhouse space
- Fertilizer
- Poor quality water (Olds G.C)
- Stopwatch
- Ruler
- Filter fabric (bottom of pots)
- Filters
- Infiltrometer (cylinder 5in by 2in)

Methods
In order to conduct this experiment, 30 plugs of creeping bentgrass (cultivar Penncross) were obtained from the Gleneagles Golf Course in Cochrane, Alberta. Once moved to Olds, these plugs were set in 6-inch pots with USGA spec sand as a growing media. The pots were labeled from 1 to 30 and then set up in a complete randomized block design. The design was set up with six treatments with five replications. The concentrations of Primer that was added to the treatments were:

1. No wetting agent (control)
2. Half the normal rate (0.5X)
3. The normal rate (1X)
4. Twice the normal rate (2X)
5. Four times the normal rate (4X)
6. Eight time the normal rate (8X)

The recommended rate of primer is 2oz per 1000ft^2 every 14 days. We then calculated out the amount to conform to the size of our plugs. It was determined to make mixtures of 2 liters for every concentration mixture. Since one plug is such a small amount of turf, the amount of wetting agent in each mixture was very small. One turf plug is equal to 0.087 ft^2 (square feet). The amount of wetting agent for the recommended rate in 2 liters is 0.05 ml (milliliters). Therefore the mixtures were:

1. No wetting agent
2. 0.5X the rate = 0.025 ml
3. 1X rate of 0.05 ml
4. 2X rate = 0.1 ml
5. 4X rate = 0.2 ml
6. 8X rate = 0.4 ml

It was also determined that when applying the wetting agent, only 0.6 ml of the mixtures should be applied. This equaled out to one spray from the spray bottles for each application. Once the turf was established in the pots we started to apply the treatments of wetting agents. The plugs received an application of wetting agent and a watering of poor quality water every day with a light fertilization every two weeks. A sample of the poor quality water was sent away to the Enviro-Test Laboratory for an initial analytical test. The testing was done over a period of four weeks with four testing dates. For every testing period we tested:

1. pH
2. EC
3. Total hardness
4. Infiltration rate
5. Growth rate
6. Sodium levels

PH and EC Testing
To test the pH and the EC, a pH/EC meter was used. Pie plates were placed under every pot and poor quality water was run through to obtain leachate. This leachate was collected and placed into a beaker and tested with the pH/EC meter. PH and EC were then recorded in a logbook under the proper heading. (Week #1, #2...etc...)

Total Hardness Testing
Testing the total hardness was more time consuming and more tedious work. To test the total hardness, a 'total hardness and iron' kit was used. This kit was obtained from one of the Olds College laboratories. Using the leachate from the plugs, we filled the small cylinder to a pre-determined level and dispensed the liquid into the Erlenmeyer flask. To the flask three drops of the Strong Buffer solution was added and stirred. Next one drop of the Manver Indicator solution (which is dark pink in color) was added and stirred. This turned the entire mixture a light pink color. Next, drops of the Standard Versenate solution was added at a rate of one drop per second while stirring the flask. The number of drops it took until the mixture turned a blue color was recorded. Each drop of the solution represents the amount in grains per gallon. The next step was to multiply the amount of drops by 17.1, which gives you the amount of calcium carbonate (CaC03) in mg/l (PPM). The total hardness of each individual pot was measured each week and results were recorded in the logbook under the proper heading.

Infiltration Rate
The infiltration rate was measured every week by measuring out 100 ml of poor quality water and pouring it into a cylinder placed over the individual plugs in the pots. As soon as the water was poured in the cylinder, recording of the seconds began with a stopwatch. As soon as 100% of the water infiltrated the surface the time was stopped. Results were recorded in the logbook under the proper heading.

Growth Rate
The growth rate measurements were taken at the end of each week. A ruler was used to measure the growth of the turf. When measuring the growth of the turf, an average height of the leaf blades was taken and recorded. The results were recorded in the logbook under the proper heading. After each growth rate measurement testing period, the turf was cut back down to level height with the sides of the pot.

Sodium Levels Testing
To test the levels of sodium in the soil, we acquired a Cardi meter from the Olds College Laboratory. To do this test, we first set the Cardi meter to read 10 with pure distilled water on the sensor. Next, we mixed the soil and distilled water together using 11ml of soil and 100ml of water. We carefully dug under the layer of thatch to get a sample of sand. The next step was to mix the soil and water together thoroughly in a beaker. A filter was then placed in the beaker and the solution was allowed to filter through. After enough solution was filtered through a sample was placed on the sensor pad. The reading was multiplied by 10 to achieve the adjusted reading. Record results in logbook under proper heading.

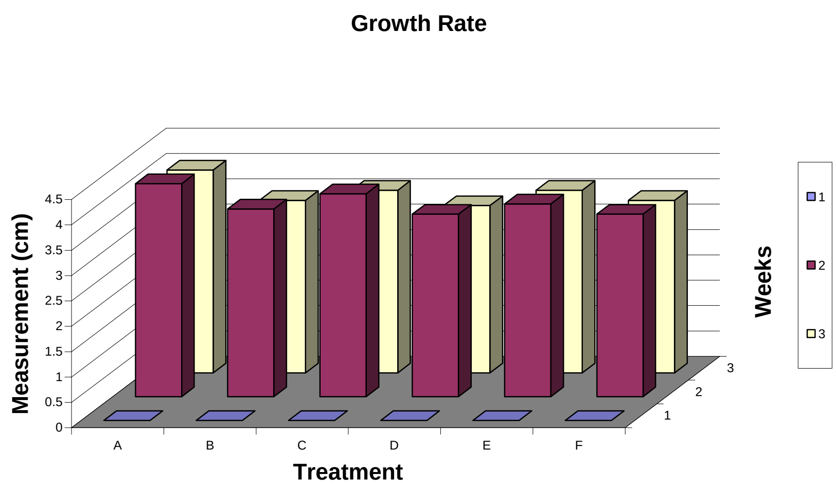
Results and Discussion

On 25 November 03 we completed our final testing period and were then able to compile and evaluate our data. The results of our experiment showed significant differences in the ranges of pH and infiltration rates. The test pots with the higher rates of the wetting agent Primer, showed the most increases in infiltration rates. There was a slight increase in pH in all the test pots throughout the experiment, which was due to the application of the poor quality water daily. The salinity as measured by EC, showed a decrease as the different treatment concentrations increased. The total hardness ($CaCO_3$) was showing definite signs of reduction with the highest decrease with the highest rate. Growth rates within all the treatments remained consistent throughout the experiment, as did the apparent health of the plant.

When sodium testing began several problems confronted us and eventually resulted in a brief and inaccurate tabulation of results. The first problem was that the only sodium-testing device the College had to use was a measuring device known as a Cardi meter. The second was that the cost of sending away samples to a lab every week would be too expensive and too destructive to our experimental pots. The Cardi meter as a source of sodium testing proved to be unreliable and inconsistent. For the final testing of the plugs we destructively sampled and sent away a blended mixture of each replicate within the treatments. We took one inch of sand from directly under the thatch layer from each pot, blended all the replicates from each treatment section and dried over night. The samples were then bagged and sent to the lab for a saturated paste test, unfortunately the results did not come in on time and therefore we are left with no sodium analysis of the treatment plots with the exception of some very inconsistent and unreliable information obtained via the Cardi meter.

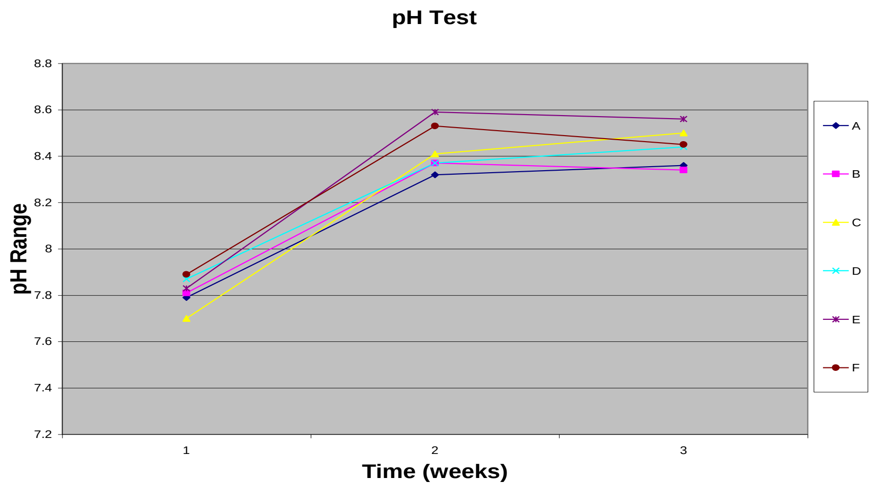
Growth Rate

The growth rate within the treatments did not show any significant difference. The range of growth remained relatively consistent throughout the experiment ranging at levels of approximately 3.5 – 5 cm in average length per week.



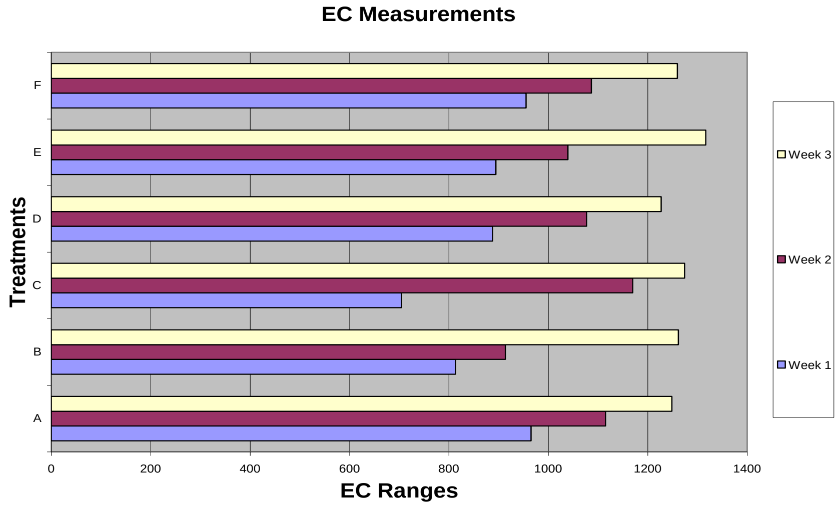
pH Testing

The results from the pH testing produced significant differences within the treatments, specifically treatment E (4.0 x the regular rate) and treatment A (control). Treatments B, C, D and F were not significantly different from one another. The treatments with the highest application rates showed the greatest increase in pH level while the control did show the lowest pH level in weeks 2 and 3. One of the assumed reasons for the increased pH levels may have been due to the fact that leachate was composed of the poor quality water that was exceptionally high in sodium and bicarbonates. Therefore when the testing occurred and the leachate was measured for pH level the sodium was actively within the leachate.



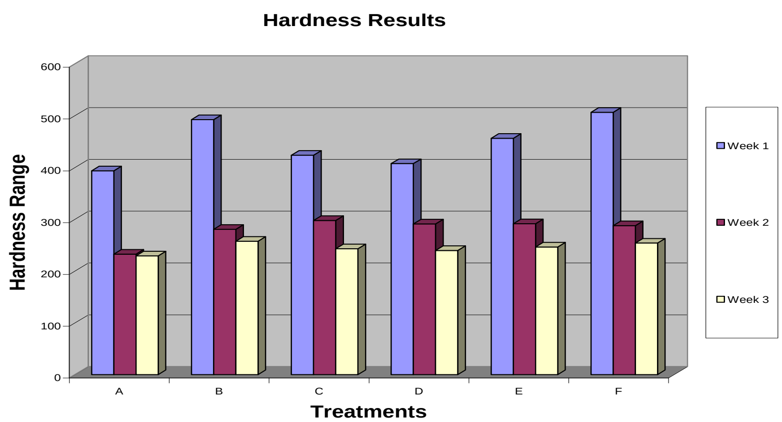
EC

The electrical conductivity or EC levels showed no significant difference in the ANOVA tables; however the treatments did increase throughout the experiment, which is most likely due to watering the plugs with the poor quality water.



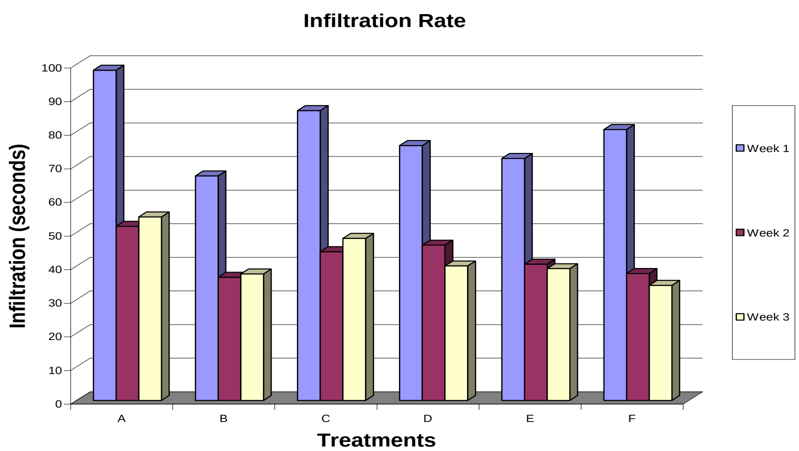
Total Hardness

Total hardness was measured as CaCO3 levels and showed no significant differences within the treatments. However the total hardness did decrease throughout the experiment including the control. With more time allotted for this experiment we feel that CaCO3 levels would continue to decrease but more specifically in the treated plots. The possible reasoning for the decrease in CaCO3 levels could be due to the altered weekend watering schedule or simply an error in testing procedures.



Infiltration Rate

The infiltration rates, as expected, increased as the rate of Primer application increased. The control showed considerably longer infiltration rates while as application rate increased the infiltration time lessened in the time it took for the water to infiltrate the surface layer of the turf and into the soil.



Critical Analysis

This experiment proved to be a very informative project but definitely had its limitations. If we were to do this project again we would change several aspects, first of which would be a longer time period. This experiment needs at least six months in order to be determined successful and accurate. Four weeks is just not enough time to establish the wetting agent and produce significant results. The second major factor we would change is the sodium information gathering methods. We would require a more accurate measuring tool or weekly sample periods through a lab. The third factor that would benefit this experiment would be the testing of calcium and magnesium to truly determine the effects of the sodium levels within the differing treatments on calcium and magnesium availability.

Conclusion

The experiment was beneficial to us and provided us with an increased knowledge of the effects of poor quality water on turfgrass, as well as an insight on how wetting agents work within the soil and the turf. While the result showed what our objective projected, the experiment needs more time to develop which would provide a better outlook on the actual effects of the interaction of the product Primer and poor quality water on a USGA spec soil and creeping bentgrass. The pH levels and infiltration rates were the only data that showed significant differences but we believe given more time the remaining data would prove to be significantly different as well. The complications that we were confronted with on our sodium testing also considerably affected the results and overall interpretation of the experiment and the effect of the treatments.

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