The Effects of Calcium Carbonate On a USGA Specification Rootzone

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Abstract

This study was conducted in order to determine the effects of calcium carbonate enhanced irrigation water on soil pH, carbonate levels, infiltration rates, sodium levels, and macronutrient levels within a United States Golf Association (USGA) specification putting green rootzone. Each experimental plot consisted of 12" sections of 4" PVC pipe that was cut into 3" sections and taped together. Each piece of pipe was then filled with a USGA putting green rootzone mixture of 90:10 sand to peat ratio. A plug of Creeping Bentgrass "Penncross" (*Agrostis stolonifera*) was placed on top of the rootzone mix. Each tube was placed on 2" of ¾"washed rock within a 6" pot. Treatments included: untreated tap water and calcium carbonate enhanced water from Cordova Bay Golf Course in Victoria, British Columbia. Infiltration rates were timed with each 75mL watering. Soil samples were collected and sent to Enviro-Test Laboratories for analysis of pH, EC, macronutrient levels, and carbonate levels. The results showed that there was a decrease in infiltration rates between the two types of water.

Introduction

The purpose of this experiment was to determine if an impermeable layer at the soil surface could be created with the use of irrigation water containing high amounts of calcium carbonate. The creation of an impermeable layer at the soil surface would cause numerous problems for the turf due to the effects upon the soil (St. John et al., 2001). This includes reduced moisture levels due to poor infiltration, reduced nutrient availability, and the possibility of nutrient toxicity of certain elements. If it was determined that impermeability could be induced, the experiment would be continued to test the effects of products available on the market that are said to amend the impermeability problem.

Several golf courses on the Canadian Prairies and in British Columbia are faced with the problem of having irrigation water that is of poor quality. The water generally has a high pH and E.C. (Electrical Conductivity) as well as high calcium and carbonate levels. Each year more products become available on the market to compensate for the poor quality water. No research has been done to test if there is actually a correlation between the calcium carbonate levels and impermeability (Carrow, 2003). It is thought that water high in calcium carbonate content will plug macro-pores within the soil structure, therefore causing infiltration and percolation problems within the soil. These types of soils are often referred to as caliche soils. A caliche soil is a calcareous soil containing a zone near or at the soil surface of weakly to strongly cemented calcium carbonate ($CaCO_3$) and/or magnesium carbonate ($MgCO_3$) precipitated from soil solution, usually as a result of irrigation water high in these carbonates (Carrow, 2001).

Our objective was to determine if impermeability could be created through the use of irrigation water high in calcium carbonate levels. If impermeability could be created,

then testing of various products available on the market for their performance on alleviating the problem could be done.

Materials and Methods

This experiment was conducted in the greenhouses situated at Olds College in Olds, Alberta. Greenhouse temperatures ranged from 20-25°C throughout the experiment. Water from Cordova Bay Golf Course was amended with calcium carbonate at the rate of 0.5 g/1000ml to increase the levels of calcium carbonate to 974 parts per million (ppm), a pH of 12.1, and an EC of 2.8 mS/m. Prior to being amended with calcium carbonate, the water from Cordova Bay had a pH of 7.9 and calcium carbonate levels of 310 ppm. The control plots were watered with the tap water from the Olds College greenhouses and had a pH of 8.2 and an EC of 0.434 mS/m. The calcium carbonate level of the tap water was 393 ppm.

Each experimental plot was set up in 12" sections of 4" PVC pipe, in order to replicate a USGA rootzone. Each length of pipe was cut into 3" increments and then taped back together using duct tape. This was to allow for the ease of division so accurate testing could be done on the different levels of the profile. Each piece of pipe was placed on 2" of ¾" washed rock inside 6" plastic pots. The sand used was USGA specification sand from Torrington Sand and Gravel in Torrington, Alberta. Sphagnum peat moss (Professional Fibrous Blond Sphagnum Peat Moss) was incorporated into the rootzone media at a 90:10 mixture. Creeping bentgrass "Penncross" (*Agrostis stolonifera*) plugs were taken from the research plots at the Prairie Turfgrass Research Center (PTRC) situated at Olds College. The plugs were cut to a thickness of 1" before being placed on top of the sand/peat blend within the PVC pipe.

The water from Cordova Bay Golf Course was amended with calcium carbonate to reach pH levels of 12.1 and calcium carbonate levels of 974 ppm. This was accomplished by adding 0.5 grams of calcium carbonate to 1000 ml of water. The pH was tested using an Oakton pH/Conductivity/°C Meter (Model #35630-00, Singapore). The hardness of the amended water was tested using a Hach Test Kit (Hardness and Iron, Model # HA-77, Cat. No. 2023-00).

Plots were arranged in a Randomized Complete Block Design (Appendix 1). There were 2 different treatments in each block. Two plots received tap water and four plots received amended water. The blocks were repeated four times to make a total of 24 experimental units. Each plot was set up inside 4" PVC pipe. Application of the water was done three times a week (Monday, Wednesday, and Friday) at a rate of 75 milliliters per plot. This quantity of water is equivalent to approximately ¼" per watering. Infiltration rates were timed with each watering. Time intervals were recorded from the time the water was poured until the last drop was no longer visible. A solvent weld slip coupler was placed over each plot during watering so all the water could be poured at once with no overflow (Borsheim, 2002). The grass was cut to a height of approximately 1/4" every Monday and Friday.

Applying a water-soluble product with an analysis of 20-10-20 every other Monday attained nutritional requirements required by the turf. It was applied at a rate of 5 grams of product per 100 milliliters of water and sprayed evenly over the plots as a foliar application. This equated into a rate of 2.5 kg per 100 m^2.

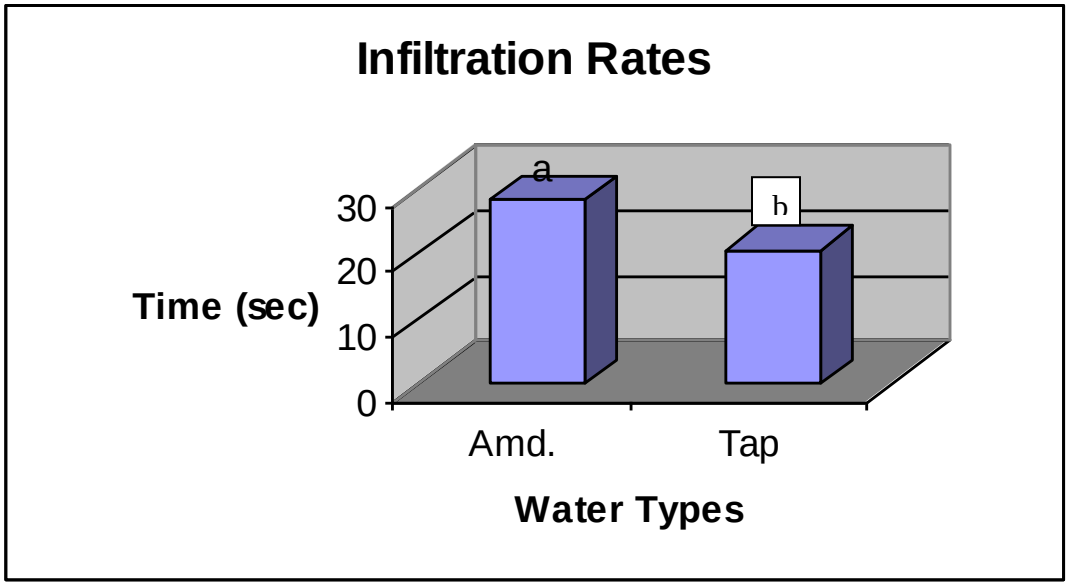
During the research, the plots became diseased with pythium foliar blight. The plots were treated with Truban (etridiazole) at a rate of 190 grams of WP to 100m^2 in 20L of water.

After four weeks of treatments with the two types of water, eight of the plots were destructively sampled (4 treated with tap water and 4 treated with amended water). The tape was removed from the top section of the profiles and the samples placed on aluminum pie plates. The turf and top 1" of root-mass was separated from the remainder of the profile and replanted for further testing. The remainder of the profile was left to dry for 24 hours at room temperature and then packaged for submission to Enviro-Test Laboratories in Calgary, Alberta. This resulted in eight samples to be tested (4 watered with tap water and 4 watered with amended water). Testing was done for pH, EC, macronutrient levels, and carbonate levels.

Results

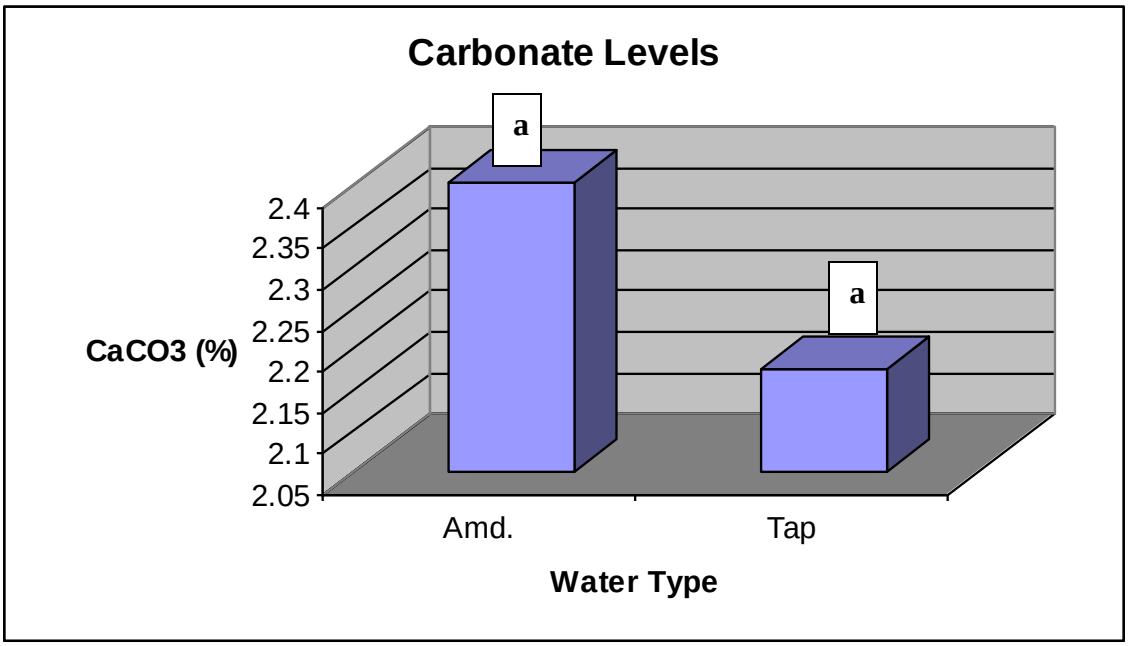
The timings obtained during the watering of the plots were analyzed in an ANOVA table using COSTAT. As COSTAT has limited capabilities, we were only able to analyze the two controls against two replicates of the treated plots from each block. An analysis of the ANOVA table showed that there was a significant difference in the infiltration rates between the two types of water (figure 2). A further analysis using a ranking system showed that the infiltration rate for the amended water was 28.37 seconds while the infiltration rate of the tap water was 20.44 seconds.

Figure 2 – Time to infiltrate amended and unamended water.



The test results received from Enviro-Test Laboratories were analyzed using the ANOVA table format also on COSTAT. The results showed that there was not a significant difference in the amount of calcium carbonate ($CaCO_3$) present in the top 3" of the soil profile (figure 3).

Figure 3 – Carbonate levels for amended and unamended tap water.



Discussion

It was shown that the presence of calcium carbonate in high levels in golf course irrigation water will create an infiltration rate decrease in a USGA specification rootzone. This is shown by the data collected throughout the research project. It was initially thought that with the use of irrigation water high in calcium carbonate, that there would also be a dramatic increase in the calcium carbonate levels within the top 3" of the soil profile, which was not found to be true in this research.

Conclusion

The results of this experiment have shown that there is a definite reduction in the infiltration rates when using water that is high in calcium carbonates. What we found surprising was that the levels of calcium carbonate in the top of the soil profile were not significantly higher. This may have been due to the possibility of the calcium carbonate being leached through the soil profile. More testing should be done on this issue, as it is a very common problem within the golf course industry. If more accurate results could be achieved, then the testing of the products available to the industry could be tested for their effectiveness. "There is not sufficient enough calcium in these commercially available products to correct the problems caused by calcium carbonate levels in the soil" (Carrow, 2003).

The time frame for this experiment was also probably not sufficient for the results we were expecting. The types of problems experienced on golf courses often take years to

develop and become a major issue. Four weeks of applying poor quality water did give us some idea that it definitely is an issue, but to what degree still remains unknown.

Critical Analysis

As this experiment was conducted in a greenhouse environment, the data may be somewhat skewed. Growing conditions inside a greenhouse greatly differ from those on an actual golf course. The humidity levels are much higher, temperatures don't fluctuate very much, and the direct exposure to sunlight may be somewhat limited due to the framework of the greenhouse (i.e. shade). An ideal experiment would take place on out-door trial plots that are maintained at the same standards as most golf courses.

The use of water that had to be amended to reach sufficient pH and calcium carbonate levels may also have skewed the data that was collected. The pH and calcium carbonate levels that were obtained with the calcium carbonate amendment were significantly higher than those that you would expect to find in normal conditions. While the use of this water may have been acceptable for this experiment, more effort should be taken to find water that has excessive levels without being amended.

Further testing using a third type of water with much lower pH and calcium carbonate levels should be done. The tap water used in this experiment was quite high in pH and hardness levels, and this may have been a reason that there was not a significant difference in the calcium carbonate levels in the soil profile. This may also be attributed to our thoughts that the plots were being watered on the weekend with the normal tap water. These thoughts stem from the basis that when we destructively sampled our plots, they were thoroughly saturated when they had not been watered by us for approximately six days.

The timeframe for this experiment due to the course structure was somewhat limited. Surface sealing is something that takes years to develop out in industry, while we tried to induce it in just four weeks. Further testing should be conducted over a much longer timeframe to achieve clearer results.

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