Cation Ratios and Soil Testing Methods for Sand-based Golf Course Greens

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Objectives:

1. To evaluate and correlate several existing soil extraction methods with tissue analysis.
2. To modify, if necessary, existing extraction methods to better suit turfgrass soil types.
3. To better understand how the Basic Cation Saturation Ratio (BCSR) theory applies to turfgrass sytems.
4. Improve current soil testing recommendations for fertilization of turfgrass.

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While research has been done applying the Basic Cation Saturation Ratio (BCSR) theory to agronomic crops, little research has been done applying the BCSR method to sandy, low-CEC media, and even less research has been done applying this theory to turfgrass growth. With a large majority of commercial soil testing facilities using the BCSR concepts for fertilizer recommendations, more work needs to be done to determine its effectiveness on sand-based systems.

This research project encompasses two main parts, 1) to better understand basic cation saturation ratios and how they apply to creeping bentgrass, and 2) to determine the best soil testing techniques to be used for sand-based greens.

Two greenhouse experiments were performed using pots of creeping bentgrass established on either calcareous or silica sand. A mixtures design was employed to measure different ratios of Ca, Mg, K, and H. Twenty-seven treatments were chosen. Figure 1 has two graphical representations of the treatments we used compared to the 'ideal soil' according to the BCSR theory. The blue area represents an area defined of soils that have cations saturating the exchange sites at 65-85% Ca, 6-12% Mg, and 2-5% K.

There were no differences in quality and clipping weights for either experiment. Tissue and soil analysis has been completed and there are some differences among the treatments. Adding Ca, Mg, or K appears to have increased the leaf concentration of those nutrients, respectively. Leaf tissue concentration of Ca was very high among all the treatments on both silica and calcareous sand, ranging from 7.5 - 17.5 g kg^{-1}.

Soil analysis from the greenhouse samples has also been completed. There were large differences between the two sands. Although there were some deficiencies for soil exchangeable Ca, Mg, and K, there were no deficiencies in leaf Ca concentration, and only a few deficiencies for leaf Mg and K. Creeping bentgrass can tolerate a wide range of cation ratios. But due to the complicated design of the experiment, we are still analyzing the data to determine if we can say what those ranges are.

Evaluation of soil testing techniques for measuring exchangeable basic cations has been completed. The ammonium acetate pH 7 and Mehlich 3 procedures were most affected by the presence of calcium carbonate. These two procedures dissolved large amounts of calcium carbonate, reporting as much as 167% more exchangeable calcium than calcium levels reported from the ammonium acetate pH 8.1 procedures.

Evaluation of soil testing techniques for measuring cation exchange capacity has been completed and we are currently analyzing the data. We hoped to use DOWEX ion-exchange resins to mimic sands and compare different soil testing techniques. However, we have had several problems relating to the exact calculation of CEC of the resin, saturation of the resin with certain nutrients, and processing the DOWEX with different soil testing techniques. At the moment, we can not use ion exchange resins to evaluate cation exchange capacity.

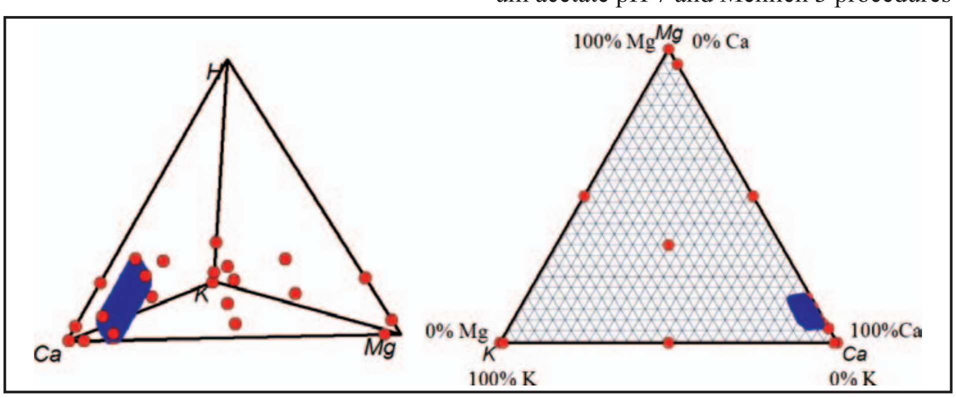

Figure 1: Three and two dimensional representations of the treatments used in this study (red) compared to the space occupied by the 'ideal soil' according to the BCSR theory. The axes represent the percent saturation of the cation exchange sites from 0 - 100%. In the two dimensional plot on the right, H would be the Z-axis coming out of the page and is not shown.

Summary Points

- Current soil test methods may not be appropriate for sand-based systems.
- A mixtures design was employed to measure the effect of different ratios of Ca, Mg, K, and H. There were no differences in quality and clipping weights of creeping bentgrass for either experiment.
- Tissue and soil analysis has been completed and adding Ca, Mg, or K appears to have increased the leaf concentration of those nutrients, respectively. Leaf tissue concentration of Ca was very high on both silica and calcareous sand, ranging from 7.5 - 17.5 g kg^{-1}.
- Soil analysis from the greenhouse samples has been completed. Although, there were some deficiencies for soil exchangeable Ca, Mg, and K, there were no deficiencies in leaf Ca concentration, and only a few deficiencies for leaf Mg and K.
- Creeping bentgrass can tolerate a wide range of cation ratios.