



Golf course maintenance budgets are under closer scrutiny than ever before. Wise turf managers have realized employing the BCSR approach to interpreting soil tests may result in misdirected use of golf course funds while chasing the “ideal” cation.

# Overcome Your Infatuation with Base Saturation

Does it make sense to apply all that calcium?

BY BRIAN WHITLARK

A frequent topic of conversation on USGA Turf Advisory Service visits is soil test interpretation and the resulting recommendations for turfgrass fertility and soil amendments. In my experience, the greatest inconsistencies with regard to soil testing are firmly grounded in the interpretation phase. The purpose of this article is to provide a brief description of two different methods for soil test interpretation and review recent research data that should help turf managers decide what method is best for them.

## TWO BASIC APPROACHES

One approach to interpreting soil data is the *basic cation saturation ratio* method (BCSR), which suggests an ideal ratio “balance” of calcium (Ca), magnesium (Mg), and potassium (K) on the soil exchange complex. On the other hand, the *sufficiency level of available nutrient* (SLAN)

approach interprets the amount of individual plant-available nutrients in the soil and determines levels where fertilizer applications will likely produce a response and levels where additional nutrient applications are unwarranted.

## THE BCSR PERSPECTIVE

The foundation from which the BCSR approach was formed goes back to research conducted in the mid-1940s by Bear and Toth, who proposed the following basic cation percentages: 65% Ca, 10% Mg, 5% K, and 20% H. From these percentages the following cation ratios were formed: Ca:Mg 6.5:1, Ca:K 13:1, and Mg:K 2:1. In 1959, Graham suggested broadening the basic cation percentages to a more realistic range, 65–85% Ca, 6–12% Mg, and 2–5% K. Therefore, the cation ratios change accordingly to Ca:Mg (5.4–14.1), Ca:K (13:1–42.5:1), and Mg:K (1.2:1–6:1).

Proponents of the BCSR theory state that the concept of cation balance is important with regard to plant growth and provides important information relative to the nutrient-supplying power of the soil. In addition, the BCSR theory states that plants accumulate cations in accord with their ratios in the soil solution, which is why certain ratios of the ions need to be maintained on the cation exchange sites.

### FINALLY, SCIENTIFIC DATA!

Those in the SLAN camp claim there is a lack of scientific evidence in support of the BCSR theory. A recent study (St. John and Christians) revealed some interesting data with regard to the validity of the BCSR approach. The soil data listed below show a silica sand soil with several of the basic cations outside their “perfect balance” or “ideal ratios.”

**Silica sand soil containing the following cation percentages and ratios.** The “ideal” percentage and ratios are provided in parentheses (St. John and Christians).

- Ca = 21% (ideal = 65–85%)
- Mg = 7% (ideal = 6–12%)
- K = 73% (ideal = 1–5%)
- Ca:Mg ratio = 3:1 (ideal = 5.4:1 - 14:1)
- Ca:K ratio = 0:1 (ideal = 13:1 - 42.5:1)
- Mg:K ratio = 0.1:1 (ideal = 1.2:1 - 6:1)

Applying the BCSR approach to the scenario presented above reveals that Ca is low at only 21%, Mg is ideal, and K is high. An appropriate fertilizer recommendation based on these data and utilizing the BCSR theory may be to apply some form of calcium and no addition of Mg and K. However, as is frequently the case, employing the BCSR method, following such recommendations would have resulted in an unnecessary Ca addition and a missed K application, resulting in K deficiency in the leaf tissue, as follows:

**Leaf Ca, Mg, and K concentrations of Pencross creeping bentgrass grown on the same silica sand soil as in the first example.** Ideal tissue levels for bentgrass are provided in parentheses (St. John and Christians).

- Ca = 1.3% (ideal = 0.5 - 0.75%)
- Mg = 0.46% (ideal = 0.25 - 0.3%)
- K = 0.47% (ideal = 2.2 - 2.6%)

This example shows the leaf Ca concentration is in fact high, even though the saturation per-

centage in the soil was only 21% and both the Ca:Mg and Ca:K ratios were lower than ideal. Leaf K levels are deficient, although the BCSR percentage was very high at 73%. This example provides data from just one soil, but further investigation of the data from St. John reveals a similar scenario for all 28 treatments where leaf Ca levels in silica sands averaged 1.2% (0.5–0.75% is optimal), yet all but one of the soil samples had Ca percentages less than the “ideal soil” range of 65–85%. In other words, in 27 of the 28 samples, employing the BCSR method would have resulted in needless Ca applications. Moreover, leaf K levels averaged only 0.87% (2.2–2.6% is optimal) in all 28 samples, yet none of these samples called for a K application under the BCSR strategy.



### EXCESS Ca FERTILIZATION MAY DO MORE HARM THAN JUST WASTE DOLLARS

Excessive Ca fertilization in a scenario where K or Mg soil levels are low could potentially exacerbate the problem by removing these ions from exchange sites, causing plant deficiencies. Excess Ca applications may also result in reduced phosphorus (P) availability when calcium carbonate (lime) is present, as insoluble Ca-P precipitates are formed. This same principle is also appropriate under problematic sodium (Na) conditions, where Ca fertilization in the presence of calcium carbonate may actually reduce Ca levels and aggravate Na problems.

The debate between those who subscribe to the BCSR approach versus those who employ the SLAN method to interpreting soils tests is ongoing.

## FEED THE SOIL FOR IMPROVED FLOCCULATION

Base saturation purists theorize this methodology is an integrated soil/plant approach that promotes soil flocculation, allowing for better air and water movement. In the absence of elevated Na levels, the addition of Ca and/or Mg to achieve levels several-fold greater than those generally needed to fulfill turfgrass fertility requirements will not benefit the grass, improve soil physical properties, or stimulate soil microbial activity.

## UTILIZING THE BCSR APPROACH FOR MANAGING SALTS

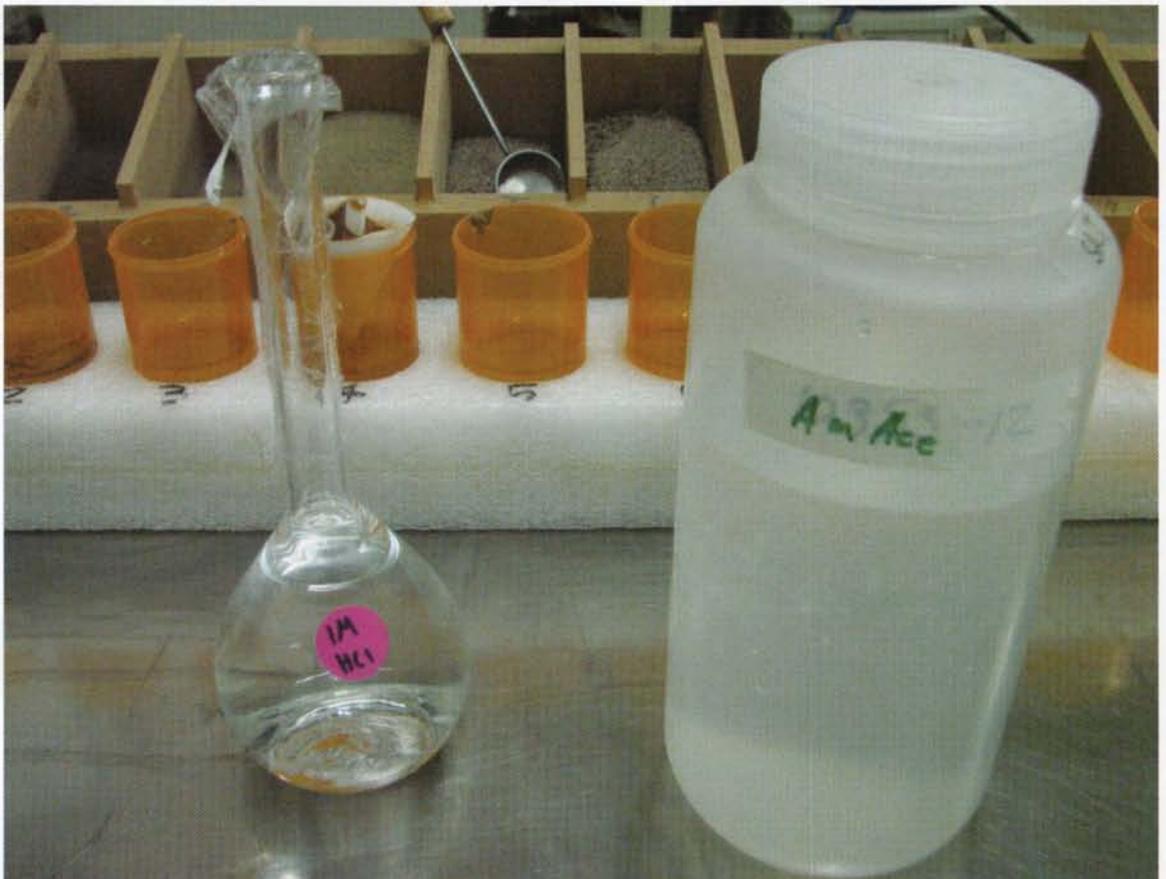
The BCSR methodology is functional in a scenario where Na-laden water is used for turfgrass irrigation. The percent Na on the soil exchange complex, better known as the Exchangeable Sodium Percentage (ESP), can be used in conjunction with the total soluble salts to indicate the potential to cause structural breakdown of soils. In such situations, Na and soluble salt accumulation may occur and must be properly dealt with.

## FINAL THOUGHTS ON BCSR

The base saturation concept is a Ca-dominated approach to interpreting soil nutrient levels and therefore often requires Ca applications in the absence of real need. The definitive plant nutrition reference by Marschner (*Mineral Nutrition of Higher Plants*) indicates the Ca requirement for grasses is met at pH 6.3. Clearly, the evidence is overwhelming that the BCSR theory is just that — a theory that lacks scientific and substantive evidence. The percentages and ratios of Ca, Mg, and K are simply not important for turfgrass growth, rather the amount of these exchangeable cations in the soil is important. This may seem a rather abrupt opinion, but researchers exploring the validity of the BCSR approach have concluded similar findings:

- “The results strongly suggest that for maximum crop yield, emphasis should be placed on providing sufficient, but non-excessive levels of each basic cation rather than attempting to attain a favorable BCSR which evidently does not exist” (McLean, Hartwig, and Eckert).
- “The crops were much more responsive to the amounts of exchangeable Ca and Mg than to their % saturations” (Kussow).

Collecting representative soil samples and choosing a laboratory that uses extraction methods appropriate to your soils ensure the data on your soil reports will be useful, but it is the interpretation phase where costly errors are typically made.



- “No relationship was observed between the clipping yield and visual quality of either turfgrass (bermudagrass and perennial ryegrass) and the Ca to Mg ratio of the soil” (Sartain).
- “Bermudagrass and perennial ryegrass will tolerate a wide range in soil Ca to Mg ratios without exhibiting detrimental effects” (Sartain).
- “It is recommended that the results of BCSR soil testing not be used as the final determining factor in developing fertility systems for sand-based golf course greens” (St. John and Christians).

### WHY THE SLAN APPROACH IS SIMPLY THE BEST

The Sufficiency Level of Available Nutrients (SLAN) approach to soil test interpretation is the most tried and true method that has been validated from many decades of research on a variety of soil types and crops, including turfgrass. The SLAN approach essentially states that the probability of a response to fertilization increases with decreasing soil test level — simply right! Soil testing laboratories typically categorize exchangeable nutrient levels as very low or critical, low, medium, high, and very high or toxic, based on research for a particular soil type and plant. As an example, it is estimated that a fertilizer application made in response to a soil test level registering very low will have an 85% probability of response. A fertilizer application with a low reading may provide a response 60–85% of the time, whereas reaction from an application with a very high soil test rating will likely occur only 15% of the time. Therefore, it is recommended to focus on very low or critical soil extractable levels when interpreting soil test results.

### GET YOUR SLAN SUFFICIENCY LEVELS HERE!

If your soil testing lab does not provide you with sufficiency levels for your turf, you can find this information by reading one of the following references:

- Carrow et al., 2004 — <http://www.gcsaa.org/gcm/2004/jan04/PDFs/01Clarify3.pdf>
- Textbook: *Turfgrass Soil Fertility and Chemical Problems — Assessment and Management* by Carrow, Waddington, and Rieke, 2001.
- PACE Turf — <http://www.paceturf.org/index.php/public/C29/>



### FINAL THOUGHTS ON SOIL TEST INTERPRETATION

What information on the soil test report is most important and accurate for assessing soil nutrient status? The quantity of plant-available nutrients ranks at the top. These readings are accurate, repeatable, and have the best scientific basis for making fertilizer recommendations. The SLAN is a pragmatic method based on research conducted on a wide variety of soil and turfgrass types and should be used as the basis of any fertilization plan.

### REFERENCES

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- McLean, E. O., et al. “Basic Cation Saturation Ratios as a Basis for Fertilizing and Liming Agronomic Crops.” *Agronomy Journal*. 75(1983):635-639.
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Laboratories typically provide both exchangeable cation nutrient levels and the percent those cations occupy in the soil exchange complex. It is up to the end-user to determine how to interpret the data and make the appropriate applications in the field.