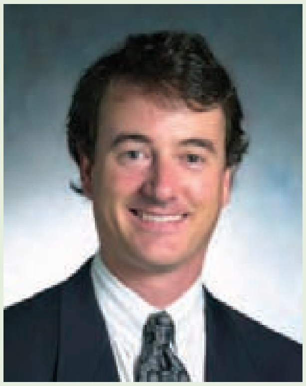
SportsTurf's Point–Counterpoint: SLAN vs. BCSR

Soil fertility interpretation: base saturation or sufficiency level?

SOIL FERTILITY TESTING is a valuable agronomic tool composed of four steps; sampling, analysis, interpretation, and recommendation. Sampling practice is standard boilerplate stuff. Perhaps modified in regard to depth; e.g. by potential rooting depth of species or need for subsoil investigation, sampling accuracy improves with each additional sub-sample pooled from the area of interest.

The next stage is analysis, and "routine" soil fertility analysis affords little artistic liberty. Submitted soils are dried and homogenized before an exact mass is mixed with an extraction solution. Typically chosen on the basis of regional parent material or sample soil pH, extraction solutions include Mehlich-1, Bray P-1, Morgan, and Mehlich-3. Their purpose is to rapidly displace nutrients from soil and preserve them in their soluble forms, facilitating precise measure of solution nutrient concentrations by state-of-the-art analytical equipment. Since a known volume of extractant is added to a known soil mass, each resulting soil nutrient level (in parts per million, ppm) is derived precisely from extractant concentration (mg/L).



>> Max Schlossberg, PhD

Success through the first half of the soil fertility testing process relies on consistency, and this is something I believe we can all agree upon. If only the second half were so easy.

Interpretation is simple characterization of soil pH and nutrient levels by keywords like suboptimal, deficient, adequate, optimal, supra-optimal, and/or excessive. Dependable interpretation relates inversely to the number of presumptions made in the process (fewer presumptions = better interpretation).

The recommendation component communicates the rate and application frequency of the liming agent, amendment, and/or fertilizer(s) required to achieve the turfgrass manager's expectation, and may be divided into pre-plant and annual maintenance sections. The value of the recommendation depends on the provider's interpretation of soil nutrient levels and familiarity with the growing environment and maintenance level imposed. The best consultants base their recommendations on soil nutrient levels, resident turfgrass species/cultivar(s) adaptation, irrigation water quality/quantity, soil pH, seasonal climate patterns, and the client's cultural practice "schedule." Recommendations to engage in very specific fertilizer/amendment "programs" composed of numerous products containing similar nutrients should be considered suspect.

The base saturation tool in turf management

THE CONTROVERSY over the use of the base saturation ratio (BCSR) versus the sufficiency levels of available nutrients method (SLAN) has perpetuated for many years now and with very little change in either side's thinking. The reality is that base saturation is one tool of many that most independent agronomists use to help their clients become more successful. The other important reality is that most of us using the BCSR method also look very closely at the sufficiency levels of nutrients studying both standard colloidal soil test audits and water soluble paste extracts.

>> Joel Simmons

For 25 years I have been a strong advocate of the BCSR model and have heard everything from "it's wrong" to "he's going to ruin golf courses." A university agronomist recently said to me "We don't agree with the BCSR method but we know that most independent consultants use this tool." That spoke volumes, if it was in fact wrong or going to ruin golf courses we wouldn't be using it because our clients wouldn't pay us to come back. There are strengths and weaknesses to all models which is why using a broad spectrum approach to managing soil and building fertility programs is critical.

Base saturation measures the percentage of the cations on the soil colloid. Based on the extensive works of many people, most notably Dr. William Albrecht from the University of Missouri, the ideal cation percentages are 68% calcium, 12% magnesium, 5% potassium, 3% trace nutrients, 2 % sodium and 10% hydrogen. These ideals are never found in practice and are simply a guideline to start from. This model is not a great tool in sand-based low CEC soils or calcareous soils as compared to clay/silt based soils so we compensate in these situations and lean much more on the sufficiency models. However since most soils that we do evaluate are true soil profiles the BCSR model is a good tool to start with and provides us with much information as to the nature of the soil.

Perhaps the greatest value that those of us that lean on the base saturation tool gain is the one that tends to generate the most passionate debate. Base saturation helps us primarily with the physical properties of the soil, as we move a soil into

The question of how soil nutrient levels are used to recommend fertilizer/amendment applications to a turfgrass-environment-culture system is typically answered by one, or both, of the predominant methodologies; the *base cation saturation ratio*(BCSR) or *sufficiency level of available nutrients* (SLAN). Brief and objective summaries of each method follow (in no particular order).

The BCSR concept, developed by F.E. Bear and colleagues in 1945, supports maintenance of an "ideal" soil having: 65% of cation exchange sites occupied by calcium (Ca) charge, 10% by magnesium (Mg) charge, 5% by potassium (K) charge, and 20% by hydrogen (H) charge. Thirty years later, "The Albrecht Papers" defined the ideal BCSR as 10% H, 10–20% Mg, 2–5% K, 60–75% Ca, 0.5–5% Na, and 5% other cations. In support of plant productivity and health, BCSR embraces balanced availability of base-cation nutrients in soil. The SLAN concept, introduced by Mitscherlich in 1909 and further-developed by Bray in 1945, supports comprehensive maintenance of nutrient levels (i.e., thresholds) on a soil mass basis. The SLAN method seeks to rectify nutrient deficiencies that would otherwise limit productivity and health (yield). Discussions relating each concept to justifiable attributes follow.

SIMPLICITY

Remember: the less presumed, the better the result. Interpretation by BCSR requires conversion of soil nutrient mass to nutrient charge concentration, and presumes divalent cations of interest

a range of "balance" we have repeatedly seen the soil open up physically allowing more water and air movement through the soil profile. We are not changing clay into sand, we are not making silt into clay, but are flocculating the soil just enough to relax the soil colloids to create the tiniest of pore spaces to allow air to flow through the soil a little more freely. The range that we are looking for from on a true base saturation test puts calcium into the 60-70 percentile, magnesium down to the 12-18 percentile, keeping potassium close to 5% and holding hydrogen levels to around 10%. On a true base saturation soil test when hydrogen is at 10%, the soil pH is always at 6.3 which is generally recognized as the point at which we have maximum potential nutrient mobility.

Unfortunately, many laboratories do not run what we call true base saturation soil tests; they may show only the percentage of calcium, magnesium and potassium. Some very popular labs run reports that have pH readings in the low 6 range, which clearly suggests that there is close to 10% hydrogen on the soil colloid. Since pH measures the acidity of the soil, or in layman's terms the percentage of hydrogen, when the soil pH is below 7.0 we know that hydrogen is on the soil colloid. Too often the soil report does not show a hydrogen percentage or for that matter show the percentage of either the trace elements or sodium which in combination could add up to over 15% of the colloidal makeup when the soil pH is in the low 6 range.

(Ca+2 and Mg+2) each occupy two soil exchange sites. However, modern solution chemistry models show this dependability diminishes with increasing alkalinity of soil. The SLAN approach interprets the soil nutrient mass as is (ppm soil), and simply recommends nutrient delivery equal to the difference between the current nutrient level and the field-calibrated deficiency threshold.

SCALABILITY

The SLAN concept offers interpretational flexibility both practically and agronomically, specifically in regards to yield expectation, sampling depth, and extractant. Examples of SLAN sensitivity to yield expectation are the widely—adopted Mehlich-3 soil K deficiency thresholds of: 232 lbs/acre in intensively—maintained recreational turf systems, and 167 lbs K/acre for general use turf under limited culture. A logical approach considering support of turf vigor and recuperative potential requires more growth-stimulating inputs (e.g., culture, N, irrigation) than general use turf systems. Consequently, increased K-sufficient tissue off take results in greater seasonal K uptake/requirement. The likelihood of clipping removal from the former system, and return of clippings to the latter further validates the intuitive scalability of SLAN.

Similarly, a sampling depth example involves a recreational turfgrass target of 250 lbs soil K per acre (from above SLAN-based Mehlich-3 recommendation). Since a 6-inch deep acre of soil typically weighs 2 million pounds dry, this target equates to 125 ppm

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The other truth of base saturation is that it is a percentage so it always has to add up to 100%, not more and not less as many labs report, so it is easy to see the concern about using this tool when it is not a true percentage. I have heard an industry leader say to a group of turf managers that he can tell the base saturation by looking at the pH which was truly baffling. A soil pH can be driven by many different cations on the soil colloid and understanding their relationships to each other and reducing the excesses by supplying the deficiencies we have repeatedly and with great consistency brought the soil into balance. This in turn opens the soil up physically and provides a better environment for the proliferation of beneficial micro-organisms.

"SELLING" POINT?

My favorite criticism of the base saturation model is that it is used exclusively to sell more fertilizers when in fact the exact op-

K in soil sampled from 0-6 inches. I understand managers of sand-based football fields are investigating lower mowing heights to promote "shallow" root density and enhance divot resistance and stability of the playing surface. A clever tactic given lower mowing heights (within recommended ranges for a turfgrass species) correlate to lesser mean rooting depths (all other things equal), but not less total roots! Like many superintendents managing annual bluegrass putting greens, these athletic field managers may constrain fertility assessment to the upper 4" of soil. But how can SLAN cope? Easily, the recreational turfgrass target of 250 lbs K/acre translates to 188 ppm K in 0-4" of soil. Thus, if analysis shows exchangeable K of 150 ppm soil, then optimal K fertility will require a 38 ppm soil K increase. The 0-4" deep acre root zone weighs 1.33 million pounds, thus a rectifying application of 51 lbs K (61 lbs K_2O) per acre is recommended.

To these scenarios application of BCSR theory generates an identical recommendation, hardly as intuitive or meaningful as those shown.

SUITABILITY

BCSR-derived recommendations typically fail to optimize K availability in soils having limited cation exchange capacity (CEC). Considering SLAN effectively interprets fertility over a wide range of soils, suitability serves as yet another harbinger of doom for the BCSR–turfgrass relationship. For example, a 6" sand rootzone sam-

posite is true. When the soil opens up physically and more air and water is moving through the soil biology is more active and the nitrification processes work better. We consistently see athletic field managers using less fertilizer and getting better vigor, color and recovery. The one input that we may shift for a year or two is the use of calcium products, if the soil test calls for that, as we bring the base saturation of calcium up to the 60 percentile mark. This may be the least expensive input in any program but the impact is significant. The calcium products are not exclusively designed to feed the plant but instead are used to flocculate the soil, opening it physically, and helping to stimulate soil biology which will in turn puts the plant into a position where nutrient mobility is improved.

Once the soil is balanced chemically to allow for a better physical and biological profile the entire focus is sufficiency levels of nutrients so that we can assure that the plant is getting all that it needs especially at high stress times on the athletic fields. This approach makes sense, it addresses both the soil needs and the plant needs not just the latter. It has been proven in the field for years, over and over again, helping turf managers become more successful with less, reducing plant stress. This reduces the need for many inputs including fertilizers and pest control products.

The bottom line is if using base saturation models as a tool truly did not work, sports turf managers would not use it a ple extracted by Mehlich-3 to show both the 'ideal' base cation saturation (5% K) and a CEC of 2 cmol/kg contains approximately 78 lbs exchangeable K/acre. While BCSR is considered a "relatively suitable" calibration technique in fields comprised of high-CEC soil, our greatest challenges currently relate to effective and efficient nutrition of sand-based (low-CEC) turfgrass systems.

In summary, the SLAN (sufficiency level of available nutrients) approach is your boy for effective interpretation of turfgrass sand/soil fertility and responsible fertilizer recommendation. There is no debate regarding claims of soil physical property enhancement via BCSR recommendations. Of all the techniques available for maintaining porosity in highly-trafficked mineral soils, none invokes more laughter among turfgrass scientists than the "fertilizing to obtain a balanced base saturation" approach.

Why not both SLAN and BCSR together? Because there are already too many unimaginative fence-sitters proclaiming hybrid harmony. Furthermore, the hybrid model deviates from the concepts originally proposed! The above-mentioned scientists, who spent significant portions of (if not all) their careers developing these mutually exclusive methods, just wouldn't approve. Besides, do you know how labs using BCSR for Ca, Mg, and K make P recommendations? SLAN . . . because it works. ■

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second time because they are responsible and understand their needs to produce a quality product every single day. As we have been focusing on in our "Soil Profile" series in *SportsTurf*, like the Wellesley article featuring the successes of turf manager John Ponti, base saturation a good tool to start with to help create the environment for a stronger chemical, physical and ultimately biological profile to help better mobilize nutrients that do become available to the plant. So with this level of success and a thorough program that does focus on both BCSR and SLAN, where is the controversy? ■

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