form of subsurface drainage. On the skinned area, ½% slope is very difficult for the average maintenance crew to manage effectively and typically requires laser grading a few times a year to remain effective.

Some designers recommend a heavy textured clayey infield mix like XYZ stadium, not understanding that unless the moisture in that mix is impeccably managed, it's going to get hard as a rock.

I witnessed a regulation little league infield constructed with a conical grading plan similar to the professional field I described. In this case the designer was sharp. He understood that ½% slope isn't sufficient. He therefore recommended a 1% slope radiating out in all directions from a point centered on the infield turf. What he failed to realize is that you cannot construct a regulation pitcher's mound using this grading plan and adhere to the requirement that the pitching rubber be 6" above home plate. In fact, there would be no mound at all. A 1% rise from home plate to a pitching rubber at a distance of 46' would be about 5.5". This would however be a very effective grading plan for a softball infield with no mound.

This same consideration afforded to a little league infield is necessary for a 90' baseball infield where the height of the pitching rubber is required to be 10" above home plate. In this situation you cannot construct a regulation mound using any more than a ½ % slope from the pitcher's mound to home plate. Even at ½% slope, the mound would only be about 6" high allowing only enough elevation for a 6' landing zone in front of the rubber. In this situation the desires of the coaches and athletic director need to be understood and the requirements prioritized to allow for a successful project.

ST. ROSE HS GETS A NEW FIELD

I had the opportunity to be involved in a construction project at Saint Rose High School in Belmar New Jersey. The loss of a facility they had used for years required the school construct a new varsity baseball field at another site comprised primarily of soccer fields.

The project started with the inspection of the new site and selection of the location for the new field. The proposed location was in the corner of one of the existing soccer fields. The site was rectangular in shape with a diagonal slope of 1% across the entire tract. We had the option of selecting from two potential locations for the construction project. We could use the upper corner which would entail dealing with a diagonal cross slope away from the proposed home plate or we could use the bottom corner which would mean dealing with a 1% slope right down the center line of the proposed infield. Personally, I believe a cross slope is the most difficult slope to deal with on an infield. The excavation necessary to eliminate the cross slope was cost prohibitive so right or wrong we opted to deal with the 1% slope down the centerline.

After the site selection, all those involved

>> NO COWS on this infield.

>> A WALL was constructed to elevate home plate 24" and create an acceptable grading plan.

>> **Above left: CLAY BRICKS** were installed in the pitcher's mound and home plate.
>> **Above Right**: **6"** of topsoil was applied to all turf areas.

in the construction process were assembled to provide their particular expertise in the project. Those involved were: the coach/field maintenance supervisor; the athletic director; the landscape architect; and me, the consulting construction contractor.

For a few different reasons including budget, it was decided that an engineer was not required for the project and the coach/field maintenance supervisor, Mark Fletcher would be serving as general contractor on the job.

Based on the combined input from Mark and the athletic director, the architect developed the footprint for the field, including dugouts, warning track, backstop, fencing etc. Mark and I took soil tests, evaluated the existing topsoil and chose an infield mix that was compatible with the level of maintenance he would provide. The mix was about 75% sand with about 1:1 silt to clay ratio. Tuckahoe Turf Farms in Hammonton, NJ was chosen as supplier for the bluegrass sod we would be installing. Mark also lined up an irrigation contractor to install the irrigation and quick connect behind the pitcher's mound. A mason was chosen for the dugouts and the retaining wall. A fencing contractor would be installing the backstop and perimeter fencing.

THE INFIELD GETS A PASSING GRADE

Literally every infield I have seen that is constructed in the corner of a multipurpose facility has a problem with home plate washing out due to the prevailing slope. For this reason we decided to elevate home plate 24" by means of a wall directly behind the back stop. Along with this a diversion was designed around the outfield radius of the proposed infield to divert the prevailing flow of surface water around the infield. By elevating home plate 24" we were able to create a grading plan with a level center line and approximately a 1% slope to 1st and 3rd base that continued beyond the infield. I believe 1% to be the optimum slope for a baseball infield at this level of maintenance and play. It's enough slope to get the water off the infield turf when internal permeability of the root zone isn't sufficient. 1% slope on the infield skin provides good surface drainage, doesn't require quite the precision in maintenance a ½% slope requires and 1% slope minimizes the potential for erosion associated with a steeper slope of 1¼ to 1½%.

The elevation of home plate created a need for about 500 cubic yards of fill material to raise the entire infield. Luckily the original construction of the complex had left a mountain of material that would work as an excellent fill material. The material was similar in texture to a sandy unscreened infield mix. I would compare it to select fill which has a specified range of hydraulic conductivity between 2" and 20" per hour. Select fill is a material sometimes used to help regulate percolation in a septic system. Because the topsoil we would be using to cover the fill material was a heavy textured soil that was not very permeable and we all know that infield mix is not very permeable, we decided subsurface drainage would not be necessary. The only drainage pipe we installed was at the base of the wall and we installed a sand slit drain around the outfield radius of the infield to help with any water that might lay in the diversion. We did allow for channel drains to be installed in front of the dugouts at a later date if necessary. As with most any infield, we were relying on surface drainage to evacuate surface water from the infield.

>> SINCE THE TOPSOIL would be reused, we stripped and removed the sod.

Once the grading plan and the architect's footprint for the facility were finalized and documented, we were ready to begin the project. Consideration on the part of all involved in the construction project allowed for a successful project and the construction of a safe, durable and playable field that is currently the pride of Saint Rose High School. ■

Jim Hermann, CSFM is President of Total Control Inc. Athletic Field Management www.totalcontrolinfields.com.

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.


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(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

> 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.

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