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Tools for Sand-Based Rootzone Management

By Michael DePew

A common scenario for sand-based rootzone construction is installation, followed by turf establishment, quickly followed by the commencement of play. Once play begins, you likely concentrate efforts on trying to maintain a satisfactory turf cover that provides good playability and aesthetics. You can be quite successful for the first three to five years if the initial installation was reasonably well designed and constructed. However, it is after this "honeymoon period" that things often really begin to change.

By monitoring and recording rootzone conditions over time, you can begin to note trends in rootzone conditions and subsequent effects on turf growth and performance. When problems do arise, you are armed with information that can be very valuable if the decision is made to contract with an agronomist or soil scientist. To monitor rootzone conditions, there are a few tools that you can have on hand to assist you.

Initial Tools

The first tool in your arsenal is a good soil *core sampler*. The coring device of choice is a simple golf course putting-green cup cutter, because it takes a large core six to eight inches deep. Not only do you have a core if needed, but you also have a hole in the soil that is large enough to make direct observations of the soil profile. The large core is more versatile for evaluating short-order spatial variability across the four-inch diameter of the core.

Next, you'll need a *box* — such as an army ammo box, old briefcase, tool box or a cheap tackle box — that can be used to organize, store and transport other soil test items.

These start with a set of Munsell Soil Color Charts. The *color charts* are organized to provide a fairly comprehensive coverage of colors common to rootzones. Make sure your set includes the gleyed color charts. (One source for the charts is Macbeth Division, Kollmorgen Instruments Corp., 405 Little Britain Rd., New Windsor, NY 12553; phone: 1-800-MACBETH.)

Use the charts to note the color of the rootzone at construction and the changes over time. This includes changes in color with depth or in zones within the rootzone profile and of any nodules or mottles. Color characterizations should be noted at least down to six inches and preferably the entire depth of the constructed rootzone. Color determinations are done by matching the soil to the chart color that most closely matches.

Take care to make observations of color under similar light conditions each time. Generally speaking, avoid artificial light and especially florescent lighting. Mid morning on a bright, clear day works well. Whatever the lighting, the conditions should be as near the same as possible. If not, the light source or intensity differences should be noted and recorded along with the color determinations.

Soil moisture influences soil color, and in many soils, differences between dry and moist colors can be quite dramatic. If possible, report the colors of the soil both in a moist and in a dry state. If only one color is noted, it should be the moist color. Water from a *spray bottle* is often used to bring soil to near-saturation for moist-soil-color determinations.

A good tool kit will also contain a *ruler* and/or tape measure. Use a ruler to note such things as depth of rooting or thickness and depth of any layering effects, or size and location of any distinct features in the rootzone. Notations of these thickness and depth conditions over time can be a valuable diagnostic tool for a turf manager or an agronomist. Use the metric scale for these determinations — not only is it the one familiar to agronomic professionals, but the resolution of scale is much finer within the metric system.

Chemicals

A few simple chemicals can go a long way in providing valuable information for turf management decisions. One of these is *hydrochloric acid* (HCl), commonly known as muriatic acid. When mixed to about 10 percent solution (~1.2 M), it is relatively safe to use. Muriatic acid is available at most hardware and home improvement stores, generally in the section containing concrete cleaners.

One of the most valuable uses of HCl is in determining carbonates. Carbonates may abound in many rootzone systems, and in course-textured soils such as sands, small amounts of carbonates can cause big headaches. It is a common misconception that carbonates are found only in the more arid parts of the world. While it is true that carbonates do occur more commonly in arid regions, they can also be found in rootzones in other regions, even in areas that have predominately acid soils.

If the hydrochloric acid is used at a consistently mixed concentration (10 percent), the rate and duration of reactivity of acid with the soil can be a diagnostic consideration. The test is normally completed by placing a drop or two of acid on the soil where a reading is desired. If testing the entire profile, start at the bottom and work up, gently spraying a small stream onto the profile. This may also be done on an excavated soil core placed in a hori-

This soil core has been treated with a dipyridyl indicator solution. The red staining on the core indicates the presence of reduced iron.

A field soil tool kit includes a cup cutter and a box large enough to hold a camera, color charts, thermometer, spray bottle, chemicals and other items. Photos courtesy: Michael DePew.

zontal position.

Acid (HCl) reactivity (aka "effervescence") descriptions for soils generally include four classes:

- Very slightly effervescent — few bubbles seen.
- Slightly effervescent — bubbles readily seen.
- Strongly effervescent — bubbles form low foam.
- Violently effervescent — thick foam forms quickly.

Sand rootzones "slightly effervescent" or stronger have a higher potential for rootzone problems.

Some soil scientists also use the term "moderate effervescent" to denote an intermediate phase between slightly and strongly effervescent. Which class you place your soil in is not nearly as important as consistency of evaluation when taking readings over time. If you adjust how you place a soil into one of the classes, the date of that change should be noted so that old readings and their interpretations can be distinguished from the new.

Hydrochloric acid is also useful as an indicator of amorphous iron sulfide. Amorphous iron sulfide, when present in sufficient quantities, is the mineral form of soil black layer. However, its formation does not always indicate a strong black color until it is extensive and well formed in the rootzone. The formation of black layer occurs in soils under anaerobic conditions of reduced chemical potential. This is known as "low redox potential."

While redox potential can be measured with an instrument similar to a pH meter, HCl can be used as a simple qualitative tool for determining reduced conditions in which amorphous iron sulfides are forming. Detecting the production of amorphous iron sulfides may help you make management decisions that will prevent the formation of black layer.

The HCl test for amorphous iron sulfides is simple. First, smell the sample before treating to get a background smell. It may already smell somewhat or strongly like hydrogen sulphide gas (rotten egg smell). Next, as in testing for carbonates, place a few drops of acid on the soil or rootzone portion in question.

The acid will chemically oxidize the

iron sulfides that may be present and in the process will release hydrogen sulphide gas. After placing the acid, draw your hand gently over the sample pulling air from the sample toward your nose. If iron sulfides are present, the rotten-egg odor should be very strong and distinct (like the geysers and hot springs in Yellowstone Park). As the acid reacts, also note any change in color of the soil. As the acid oxidizes the iron sulfides, the soil should lighten.

Another qualitative chemical test for anaerobic reduced soil conditions involves a *dipyridyl indicator solution*. When applied to the soil, it will indicate the presence of reduced iron. This test is more sensitive than the acid test for indication of reduced iron because iron sulfides do not have to be formed in order for reduced conditions to be indicated.

An awareness of high reduced iron forms in the soil before significant amounts of iron sulphide production occurs can be a much earlier warning signal for reduced conditions than HCl alone. (However, note that the lack of reduced iron in a rootzone is not always an indicator of reduced conditions. The reason is that reduced iron is soluble in the soil solution and may have moved out of the rootzone or portions of the rootzone with drainage water.)

As useful as the dipyridyl indicator solution is, it cannot be readily obtained over the counter at a store. It is a specialty chemical and must be purchased through a chemical supplier along with a few other chemicals. That is not, however, difficult to do, and by using a little simple chemistry, it can be easily mixed up in the shop. (One source for chemicals is Aldrich Chemical Co., P.O. Box 355, Milwaukee, WI 53201; phone: 414-273-3850.)

The recipe is as follows as taken from C.W. Childs' 1981 article "Field Test for Ferrous Iron and Ferric-Organic Complexes" (*Australian Journal of Soil Resources*, 19:175-180):

This core is wrapped, labeled and ready for transport.

(1) Add 5 mL acetic acid to 400 mL of deionized or distilled water.

(2) To the above (2.5 percent acetic acid) solution, add 1 g of alpha,alpha — dipyridyl.

(3) Add 77 g of ammonium acetate and mix to clear (using hot deionized or distilled water for the mixing solu-

tion to start with will aid in ensuring that the ammonium acetate dissolves completely and goes into solution).

The mixed solution should be marked, dated and stored in dark bottles at about 35-40 degrees F. As with any chemicals, exercise caution when handling and follow any label precautions or warning on the MSDS, material safety data sheet.

When using the dipyridyl solution, you can obtain false readings on soil that has been in contact with ferrous iron. So, it's imperative the exposed soil face has not been in contact with iron of any kind. If you use an iron coring device, shovel or knife to remove a soil sample, a clean exposed surface must be prepared using a wood or plastic implement before applying the dipyridyl solution.

More Tools

The soil kit should also include a *means of measuring soil pH.* This can be done either colorimetrically with indicators and a correlated color chart or with an inexpensive pH meter.

A *thermometer* is also a good diagnostic tool as many soil processes are temperature dependent. Many types of thermometers are adequate if they include the appropriate temperature range for soils in your area.

A few other items to include in your kit include simple tools such as a cheap hunting-type *knife*, a small hand *shovel*, an assortment of zip-lock *bags*, permanent *marker* and a *notebook.* And, of course, one of the most valuable tools is a *camera*, which should be considered indispensable. A strong record keeping system backed up by photographic documentation is a very useful, powerful tool in diagnostic evaluations.

Often it is desirable to collect and preserve an entire soil core for further examination or shipping for laboratory analysis. In these instances, cheese *cloth* or an old bed sheet works well. Simply roll enough material out (double or triple layered if using cheese cloth) to wrap the core with. Next, as gently as possible, push the core out of the cup cutter onto the cloth. Then gently wrap the cloth around the core and tape it in strategic locations (two-inch-wide masking tape works well). Once secured in this fashion, the cores are fairly stable and can be handled or shipped without excessive packing or padding. Just make sure you mark the cores with a permanent marker on the tape after sampling.

Spatial Variability

As a final note, I should mention something about spatial variability across the playing surface — that is, changes in soil characteristics with distance and depth (space). Spatial variability is quite high in natural soil systems for a large variety of soil characteristics. Likewise, spatial variability is also high in human-made soil systems.

To measure this requires a knowledge of differences across the playing field. These differences include differential data output from such areas as soccer goal mouths, center field, sidelines or other areas that receive concentrated traffic. Variability can also include areas of microtopography differences, differential sprinkler distribution and so forth. Spatial variability may also occur without any readily apparent reasons.

This variability, however, is not necessarily undesirable as it may be telling you something that you are not aware of. Variability then can be your friend, especially when you learn how to interpret its significance and the story it is telling you.

It will be up to the individual turf manager to determine how many different areas he or she will have to evaluate separately and how many replications within each area. The important thing is that you monitor soil conditions, keep accurate records, make frequent observations and ask lots of questions. ❑

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By James S. Alderson

Basics of Fertigation

The controlled application of fertilizers through an irrigation system, *fertigation*, has been used for the past three decades in such areas as nurseries and agriculture. More recently, turfgrass managers have discovered the distinct advantages and benefits that fertigation holds over the conventional application of slow-release fertilizers.

Applying soluble fertilizer through an irrigation system is easy. Since there is no need for agitation or mixing when using liquid fertilizers, there is no need to purchase any special mixing or spraying equipment. And, with the low parts-per-million usage rate, the fertilizer does not cause damage to the irrigation system.

Advantages

Fertigation saves money. Everyone likes to hear that. Over the years, prices for such staples as fertilizers, water, labor, chemicals and pesticides have kept rising. Fortunately, the cost of soluble, liquid fertilizers tends to be less than for slow-release fertilizers. The application of soluble fertilizer through fertigation also requires less equipment, and there are virtually no labor costs.

Another advantage is that nutrients can be more carefully monitored and regulated. Exact amounts of fertilizer can be applied to turfgrass, so managers are able to set an exact mixture to control growth and color. This lessens the chance of burnout or streaking by overapplying fertilizer.

Light feeding with each irrigation cycle keeps turf in a flat growth rate. This eliminates excessive top growth — which in turn cuts down on mowing time, excessive thatch and disease potential.

Because fertilizer is supplied at a low parts-per-million usage rate, fertigation does not cause damage to an irrigation system. Photo courtesy: Hunter Industries.

The uniform distribution of soluble nutrients through both foliar absorption and rootzone uptake is another plus of fertigation. The foliage absorbs about 15 to 25 percent. The rest of the nutrients penetrate to the rootzone and, if applied in low concentrations, will be taken up by roots at about the same rate as the nutrients are applied, thereby decreasing the chance of being washed away or leached out of the soil.

The application at very low concentrations allows the fertilizer to be placed deeper in the soil and more evenly than ever before, even on soils that vary greatly in clay content. When nitrogen is placed deeper, the ammonium ion is converted to nitrate at a controlled rate. This occurs because, deeper in the soil, temperatures are lower, so conversion is slower.

According to Ed Nash, an agronomist and president of PlantStar Inc. in Watkinsville, Calif., when fertigation users allow nitrogen to build up to 1/10 pound or less at the rootzone level, they have "a tremendous rate of success in maintaining healthy turf."

Finally, fertigation offers the opportunity for more frequent applications of nutrients — such as nitrogen, potassium and sulfur — that tend to be used up quickly by the turfgrass. These nutrients can be added through the fertigation system anytime they are required to keep the turfgrass looking its best.

Rates and Timing

The time of day for fertigation and the amount needed, according to Nash, depend on turfgrass usage, geographic location, type of turfgrass and time of year.

Turfgrass Usage. Since irrigation systems can be used day or night, any time is a good time for fertigating as far as the grass is concerned. However, unless you like to hear people complain, you wouldn't use fertigation on your turfgrass when participant usage is high. So, a good time to use fertigation would be *after* a field is closed, especially at night when there is less evaporation. Just set the irrigation system's automatic timer and it'll do the rest. That's about all the labor that is involved.

Geographic Location. Rate of fertigation partly depends on geographic location and soil type. The nutrient requirements of turfgrass in the sandy, acidic soils of the desert Southwest are vastly different from those in the Midwest or Northeast, where many nutrients are already found in the soil.

Types of Turfgrass. Different types of turfgrass have different nutrient requirements. To determine the quantity of nitrogen needed to provide proper growth and color desired for a particular facility, make a light application, say 0.25 pound of nitrogen, and observe the response. The ideal application rate should be approached from the low side.

Time of Year. Since water evaporates at a higher rate during the summer heat, managers may have to use fertigation more often to keep turfgrass looking its best, as opposed to spring or fall, when temperatures are lower and evaporation is less.

Types of Injectors

Key to fertigation is the nutrient injector pump.

The nutrient injector is key to the application control of liquid fertilizer. There are two major types of injection systems: proportional and fixed-rate.

Both are generally available in tank sizes from 7 to 200 gallons. For long-lasting performance, the injection pump should be equipped with stainless steel heads, valves and fittings, along with stainless steel injection lances that are equipped with check valves, antisiphon valves, union disconnects and isolation valves.

Generally, the rate of fertilizer injection should be possible at 0.1% of the irrigation flow rate. In other words, if the irrigation pump is able to deliver 1,000 GPM, a fertilizer injector should deliver at least 1 GPM.

Proportional Injection System. The proportional injection system is generally used on larger sites. The system is controlled by the irrigation flow rate and will apply a constant nutrient-to-water ratio, roughly 50 to 300 parts per million (ppm). Thus, a larger area with a high-gallons-per-minute (GPM) ratio will receive more fertilizer nutrient than a smaller area, where the GPM is less.

How does the injector know how much fertilizer is enough? The unit that reads the amount of flow is the in-line water flow sensor. A batch control unit receives pulses. If the unit is properly calibrated, the injector pump senses that X amount of fertilizer needs to be injected into the system. Any change in the rate of flow is detected by the flow sensor, and it automatically adjusts to the new amount of fertilizer needed.

The proportional injection system can be very accurate. Generally, if a problem does occur, it will be with the improper measurement of the irrigation water flow rate. This can happen for two reasons: the flow meters are inexpensive and inaccurate, or the flow meter is placed near turbulence-causing fittings.

The better injectors come as a complete system and include:

- an electronic controller;
- an in-line water flow sensor that controls pump motor speed;
- mainline injection lances made of stainless steel;
- a pump motor powerful enough to handle your fertigation needs;
- at least a two-year warranty.

Since all components must be designed to work together, beware of hybrid units pieced together from different manufacturers and avoid foreign imports that use different voltages from the U.S. Finally, choose a supplier that has expertise in this subject.

Fixed-Rate Injection System. A fixed-rate injector generally works better on small areas. Whenever flow is detected in the main irrigation line, a flow switch is turned on, allowing fertilizer to be injected at a *preset* rate.

A drawback to this injector is that, if the mainline water flow decreases unexpectedly, the same amount of fertilizer is released, concentrating a greater amount of fertilizer in a lesser amount of water. This could result in overfertilization and the possibility of burning the turfgrass.

Retrofitting

Is it possible to retrofit an existing irrigation system? Yes, it is. After selecting the proper system for your needs, the installation process consists mainly of mounting the fertilizer holding tank and pump assembly above-ground or below-ground. The injector is then tied into the irrigation mainline.

Effective fertigation keeps turfgrass at both its greenest and highest level of nutrient content. "Water," states Nash, "is the limiting factor" in obtaining healthy turf. Decreasing the volume of nutrient-rich water decreases the nutrients available to the turfgrass. Take away the water completely and you can't use fertigation.

Fertigation is increasing in use on a daily basis. That is not at all surprising. Its ease of use, its low cost, its exact coverage and its consistently good results help to make fertigation a popular, low-cost, practical way to add nutrients to turfgrass.

With all the wonders that fertigation can do for you and your turfgrass, does it mean that you should trash your dry fertilizer? No. The dry fertilizer will come in handy either for places the fertigation system can't reach or for a problem area that requires more attention than the system can give it. ❑

Winterizing Sprayers

By Stu Cavender

Like other turf machinery, sprayers need proper winterization. Here are some steps to follow. When doing so, remember to inspect the entire machine for any signs of wear. Replace any worn or damaged parts.

Traction Unit

1. Thoroughly clean the traction unit and engine.
2. Check the tire pressure.
3. Check all fasteners for looseness; tighten as necessary.
4. Grease or oil all grease fittings and pivot points. Wipe up any excess lubricant.
5. Lightly sand and use touch-up paint on painted areas that are scratched, chipped or rusted.
6. Service the battery and cables as follows: (A) remove the battery terminals from the battery posts; (B) clean the battery, terminals and posts with a wire brush and baking soda solution; (C) coat the cable terminals and battery posts with petroleum jelly to prevent corrosion; (D) slowly recharge the battery every 60 days for 24 hours to prevent lead sulfurizing of the battery.

Engine

1. Drain the crankcase completely, and refill with recommended engine oil.
2. Run engine until completely out of gasoline, then restart and run on unleaded gasoline mixed with stabilizer for at least 10 minutes.
3. Check coolant protection.
4. Disconnect and remove battery.
5. Clean exterior surface of engine.
6. Leave spark plugs in holes, or seal spark plug holes with suitable threaded metal plugs.
7. Seal all openings in engine and accessories with weatherproof tape. Mask off all areas used for electrical contact.
8. Make sure all surfaces are dry, including ignition wiring, and all exterior surfaces of engine.
9. Thoroughly clean and service the air cleaner assembly.
10. Check the oil filler cap, gas cap and radiator cap to ensure they are all securely in place.

Spraying System

1. Flush pump and entire spraying system with water and tank cleaning agent. Drain pump and spray system completely. If using granule agents, you may need to remove and disassemble components in order to clean them satisfactorily.
2. Add a rust inhibiting antifreeze solution to the pump and recirculate through the system, coating the pump interior. Drain solution completely.
3. Remove coil assemblies from solenoid valves. Apply a light film of petroleum jelly or equivalent to the armatures. Reinstall coil assemblies on solenoid valves.

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