"Micromanaging" your sports turf

By Dr. Beth Guertal

Recently, I spent the better part of my week engaged in e-mail exchanges with soil scientists from all over the country. The topic that held us in such extended discourse? The micronutrient cobalt and whether or not this micronutrient deserved the ranking of "essential element."

What makes an element essential? In general, to be considered essential for plant growth and development, an element must 1) be required for a plant to complete its life cycle, 2) not be substituted by any other element and, 3) be directly involved in the plant's nutrition. Plant scientists pretty much agree on the essentiality of our macronutrients, which are needed in larger amounts by growing turf. Those macronutrients are nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), and sulfur (S). Nitrogen, P, and K are typically applied via fertilization, while Ca and Mg are supplied through liming (if lime is needed), or application of non-lime materials such as gypsum, epsom salts, or other fertilizers.

When compared to our general agreement about the number of macronutrients, the number of micronutrients that are considered

Auburn University's Jordan-Hare Stadium in the offseason. Photo by Dr. Guertal.

"essential" is still under discussion, as aptly demonstrated by my recent cobalt debate. In general, plant scientists agree that the micronutrients iron (Fe), manganese (Mn), boron (B), zinc (Zn), copper (Cu), molybdenum (Mo), chlorine (Cl) and nickel (Ni) are considered essential. The micronutrients cobalt (Co), silicon (Si) and sodium (Na) are what many call "quasi-essential," which roughly means that some plants, but not all, have shown a need for that element (Epstein and Bloom, 2005).

For example, we have seen some turfgrasses (Saint Augustinegrass) respond to application of Si fertilizer (Datnoff, 2005). However, the positive response is because Si adds resistance to some turf diseases, and not because the turfgrass could not live without the Si.

So, if iron, manganese, boron, zinc, copper, molybdenum, chlorine and nickel are considered our essential micronutrients, should you be running out to apply these nutrients to your sport fields? In a short answer: mostly no. In a longer answer, let's take a look at each micronutrient separately, and figure out how it works in your sports turf fertilization program.

Guaranteed Analysis

Total Nitrogen (N)	8.00%
1.76% Ammoniacal Nitrogen	
0.04% Nitrate Nitrogen	
3.20% Water Soluble Nitrogen	
3.00% Water Insoluble Nitrogen	
Available Phosphate (P205)	4.00%
Soluble Potash (K20)	5.00%
Calcium (Ca)	7.0000%
Total Magnesium as (Mg)	0.7000%
0.70% Water Soluble Magnesium (Mg)	
Sulphur (S)	3.0000%
3.00% Combined Sulphur (S)	
Boron (B)	0.0200%
Chlorine (Cl) Not more than	0.1000%
Cobalt (Co)	0.0005%
Copper as (Cu)	0.0500%
0.05% Chelated Copper (Cu)	
Iron as (Fe)	0.1000%
0.10% Water Soluble Iron (Fe)	
Manganese as (Mn)	0.0500%
0.05% Chelated Manganese (Mn)	
Molybdenum (Mo)	0.0005%
Sodium (Na)	0.1000%
Zinc as (Zn)	0.0500%
0.05% Chelated Zinc (Zn)	

Derived from:
Chicken Manure, Urea, Anhydrous Ammonia, Cobalt Sulfate, Copper Lignosulfonate, Ferrous Sulfate, Manganese Lignosulfonate, Molybdenum Oxide, Sulfate of Potash, Magnesia, Potassium Chloride, Sulfuric Acid, Boric Acid* and Zinc Lignosulfonate.

Iron

The one micronutrient that does not fit the general "no" offered above is iron. Iron is the only micronutrient that is routinely recommended for application to sports turf. This is because iron can provide temporary turf greenup without stimulating additional tissue growth. In fact, some turf managers will use iron application as a part of their striping program, alternating sprays every ten yards to enhance striping on their football fields.

Iron fertilizer sources include ferrous sulfate (~19% Fe), iron chelates (~5-10% Fe, varying with chelate type and manufacturer), and organic forms of iron such as iron humates (~10% Fe). A "humate" is a mined organic deposit, typically containing a wide variety of micronutrients and usually a little bit of N as well. Chelated and inorganic sources can be applied at light and frequent rates as foliar sprays (1/2-1 lb. actual Fe per acre) (Carrow, et al., 2001). Typically, such applications are made monthly, as the greening effect is short-lived, and frequent mowing will remove the Fe-treated leaves.

Rates of Fe application can vary widely, with granular organic Fe sources safely applied at rates up to 10, or even 20 pounds of Fe per acre. This high rate, however, is for organic products where the iron is derived from humate or waste sources (such as biosolids). Such materials will have a much slower color response, and may not provide the rapid greening provided by soluble sources of Fe. At Auburn we were able to safely apply humate-based iron sources to hybrid bermudagrass at rates up to 20 lbs. Fe per acre. However, when chelated and inorganic sources (iron sulfate) were applied at higher rates (in excess of 5 lbs./acre) we observed significant phytotoxicity.

A good rule of thumb for the inorganic or chelated sources is between 1/2 and 2 pounds of Fe per acre, per application. The exact rate will vary with grass species, humidity, and air temperature. Be careful, because the chance of injury (a noticeable black-green discoloration) increases as air temperature increases. Research in Georgia on centipedegrass (a turf sensitive to Fe) showed that iron sulfate or iron chelate applied as foliar sprays at rates of 0.8, 1.6, or 2.7 lb. Fe/acre improved turf color, but phytotoxicity increased as it got hotter. When the air temperature was 70-88 degrees, the highest Fe rate could be sprayed with minimal damage, but when air temperature increased to 85-99 degrees, only the lower rates of Fe could be safely applied (Carrow, et al., 1988).

Manganese

Recently you may have read about Mn fertilization for the suppression of some turf diseases. Research has shown that Mn has some potential for reducing the disease take-all patch (caused by Gaeumannomyces graminis), when it was applied to bentgrass putting greens of a rate of 2 lbs. Mn/acre (Heckman et al., 2003). These results, however, are still specific for one turfgrass species, and one disease, and additional research is needed to see the long-term benefits of Mn fertilization for disease suppression.

In general, the majority of our sports field soils supply more than enough Mn for your turf needs, and additional Mn fertilization is not needed. The application of manganese (1 lb. Mn/acre as a foliar $MnSO_4$ spray) might be warranted if you are growing turf on very sandy soils, or if you have a newly constructed sand-based field that is very low in organic matter. You might also see a Mn response if your soils have a high pH, or have a high phosphorus soil-test. Otherwise, your native soil will provide more than sufficient Mn, and additional Mn is not needed.

The rest of the team

If you were a pecan grower or a sweet corn grower, at this point I might discuss your Zn fertilization program. Likewise, I could spend a few sentences talking about B fertilization of your cotton, soybean, broccoli, or alfalfa crops. In other words, there are specialty crops for which we do make micronutrient recommendations, and the crops will respond and grow when these nutrients are applied (usually at low rates as foliar applications).

For turfgrass, however, these remaining micronutrients (boron, zinc, copper, molybdenum, chlorine, and nickel) do not need to be applied as supplemental fertilizers, as sufficient amounts are either: 1) already in the soil, 2) applied via dust, irrigation water or in topdressing sand, or, 3) applied via their presence in fungicides. Many fertilizers contain supplemental micronutrients, in granulated blends, or in organic materials. Check the back of a fertilizer bag for the guaranteed analysis; that's the legally required list that gives the percent fertilizer nutrient contents, and it provides the source from which the nutrient was obtained.

In conclusion, managing your micronutrients is pretty darned easy. Consider Fe applications for color, especially when you want to limit tissue growth. After that, if you are managing turf on new sand-based construction or very sandy soils, consider application of a fertilizer that contains a micronutrient package a few times a year. You'll be good to grow!

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John Mascaro's Photo Quiz

Can you identify this sports turf problem?

Problem: Brown areas on football field sideline

Turfgrass Area: The Orange Bowl

Location: Miami, FL

Grass Variety: 419 Bermudagrass

Answer to John Mascaro's Photo Quiz on Page 45

John Mascaro is President of Turf-Tec International

Update on FLUROXYPYR

By Greg Breeden and Dr. Scott McElroy

When discussing troublesome weeds with turfgrass managers there will be different opinions on which weeds are the worst. However, most turfgrass managers will acknowledge that many of the troublesome weeds are broadleaf species. Controlling broadleaf weeds help turfgrasses develop a dense, uniform cover that resists further weed invasion, reduces mowing requirements, and improves the aesthetic appearance. On sports fields weed control also improves the safety and uniformity of playing surfaces.

White clover (Trifolium repens), ground ivy (Glechoma hederacea), and Virginia buttonweed (Diodia virginiana) are three of the most problematic broadleaf weeds in turf. White clover has leaves that are arranged in groups of three. The flower is a round white cluster. Most turf managers are familiar with white clover because of its widespread appearance under many turf conditions. White clover is a member of the legume family (Fabaceae). Members of this family can fix nitrogen, so it can survive in low nitrogen conditions.

Ground ivy is a member of the mint family (Lamiaceae) and has a

Above: White clover is one of the most problematic broadleaf weeds in turf.

similar toothed edged leaf and a square stem as henbit (Lamium amplexicaule) and purple deadnettle (Lamium purpureum). Ground ivy has leaves that are nearly round and are arranged in an opposite pattern. It has creeping stems that root at the nodes. Flowers are small and often are a blue-violet color.

Virginia buttonweed has opposite leaves that often have a mottled yellow appearance that is caused by a virus that infects Diodia species. Stems are occasionally hairy and flowers are white in a star shape with four petals. Virginia buttonweed is probably the most difficult to control because it can produce rhizomes several feet in the ground and it produces viable under ground flowers that self pollinate to produce seed. If you manage turf for very long you will have to deal with one or a combination of these three weeds.

When selecting a herbicide accurate identification is the first step in control. Once the weed or weeds are identified then the next step will be selecting a herbicide for controlling the problem weeds. This can also be somewhat confusing. There are several new herbicides labelled for broadleaf weed control in turf. Not to mention that many herbicides are premixes of several active ingredients. While most herbicides work good by themselves often the activity and spectrum of weeds can be increased when tank mixed.

Fluroxypyr is a new broadleaf herbicide labelled for most turf situations. Fluroxypyr is the only active ingredient contained in Spotlight. This active ingredient acts in a similar manner to triclopyr and clopyralid, the active ingredients in Confront. Fluroxypyr is a systemic herbicide that is rapidly absorbed by the foliage of growing plants. Uncontrolled cell elongation and leaf and stem twisting are the symptoms of fluroxypyr, like those of other auxin-type herbicides. Fluroxypyr is also contained in the herbicide Escalade, along with 2,4-D, and dicamba.

Research was conducted in 2005 at the University of Tennessee to compare fluroxypyr products to standard products on tough to control broadleaf perennial weeds. The herbicides

Virginia buttonweed produces rhizomes several feet in the ground making it difficult to control.

evaluated were Spotlight, Escalade, Confront, and Trimec Plus. Single applications were evaluated for control of white clover and ground ivy and sequential applications were evaluated for control of Virginia buttonweed. Sequential applications were used with Virginia buttonweed because of prior research indicating that for season long control they are needed. All trial locations had infestations of weeds that were well established. Herbicide application volume was 30 gallons per acre.

All treatments provided similar control of white clover except the lower rate of Spotlight. Escalade, Confront, and Spotlight at the higher rate (2 pt/a) provided excellent control (> 99%) of white clover at 6 weeks after application. When the rate of Spotlight was decreased (1 pt/a) white clover control decreased by 10%.

Similar results were seen for ground ivy control however, the decrease in control when the rate decreased was more drastic. The higher rate of Spotlight (2 pt/a) provided excellent control (95%) of ground ivy at 6 weeks after application, but the lower rate of Spotlight (1 pt/a) provided unacceptable controlled (66%) of ground ivy at the same rating date. All other treatments provided control of ground ivy equal to the higher rate of Spotlight.

A different approach was taken when evaluating Virginia buttonweed. Sequential applications were evaluated for Virginia buttonweed

Ground ivy leaves are nearly round.

Herbicide Rating Chart

Herbicide	Active Ingredient	Product Rate/Acre	Ground Ivy	Virginia Buttonweed	White Clover
Confront	triclopyr + clopyralid	1-2 pt.	Good	Excellent	Excellent
Escalade	fluroxypyr + 2,4-D + dicamba	0.67-3.0 pt.	Good	Good	Excellent
Spotlight	fluroxypyr	0.67-2.5 pt.	Good	Fair	Good
Trimec Plus	MSMA + 2,4-D + MCPP + Dicamba	1-1.7 gal.	Good	Fair	Good

KEY TO WEED CONTROL CODES: Excellent (90 to 100%); Good (80 to 90%); Fair (70 to 80%); Poor (less than 70%)

control, due to the fact that it is one of if not the most difficult to control broadleaf weeds. Sequential applications of herbicides with fluroxypyr and clopyralid provided good to excellent control (> 90%) of Virginia buttonweed at 6 weeks after the sequential application. Herbicides with one of these two active ingredients (fluroxypyr and clopyralid) are important components for control of Virginia buttonweed. Fluroxypyr is contained in Spotlight and Escalade and clopyralid is contained in Confront. These were the top three treatments for Virginia buttonweed in this research. Sequential applications of Trimec Plus provided fair control (80%) of Virginia buttonweed at the same rating date.

These products compared equally to or better than industry standards and both were safe on the turf species evaluated. With any hard to control perennial regrowth is likely to occur overtime. But with persistent monitoring and timely applications control of these can be achieved.

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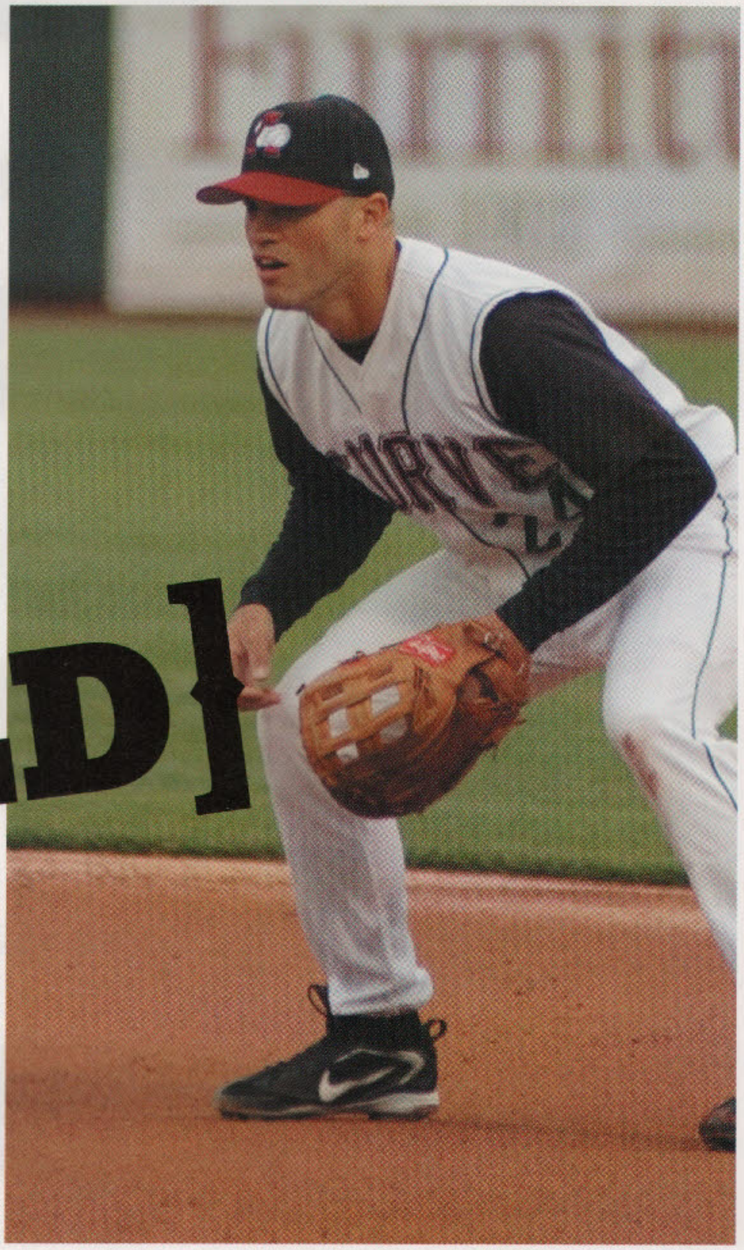
Take better care of your {INFIELD} skin



By Jim Brosnan and Dr. Andy McNitt

Baseball field maintenance is unique, and many of the maintenance practices used to prepare baseball fields for play are rooted more in tradition than science.

Maintenance programs often evolve out of simply having a feel for what techniques have worked in the past. Field managers agree that maintaining the skinned area is really an art form.

We conducted a research study at Penn State in 2006 to take a closer look at some of the most common skinned infield maintenance procedures. We had three main reasons:

First, injuries are common in sports. The National Youth Sports Safety Foundation reports that over 3.5 million children under the age of 14 are injured annually competing in athletics. Not all of these injuries are surface related, but such staggering numbers warrant taking a closer look at how we prepare fields for play, and how these practices affect athletes.

Second, not all baseball field managers are lucky enough to have been trained by one of the great "artists." Those managers that have not been exposed to the tricks of the trade may benefit from documentation of proven maintenance techniques.

Above: Simon Pond readies himself on the award-winning infield of the Class AA Altoona Curve (see p. 42).

Cleat used during traction testing.

Pennbounce apparatus used to measure the speed of skinned infields.

Thirdly, field managers do admit that a large portion of their skinned maintenance is done by "feel." Through experience, the veteran field manager knows how to prepare the skinned area for play during various weather conditions. It would be useful to know the actual affect of the various maintenance procedures they employ.

Research plots were constructed at the Joseph Valentine Turfgrass Research Center using an infield mix comprised of approximately 75% coarse particles (gravel + sand) and 25% fine particles (silt + clay). After construction, plots were differentially rolled to create areas of high, medium, and low compaction. Within each area of compaction, calcined clay was applied at four rates: 0, 0.5, 1.0, and 1.5 tons per 10,000 sq. ft. These treatments are similar to the amount of calcined clay applied to professional skinned infields as topdressing before play. Plots were then groomed to four depths with a nail drag: 0, 0.25, 0.50, and 0.75 inches.

We investigated how these factors affected 1) the safety of the infield, 2) the speed of the infield, and 3) moisture management.

To measure skinned infield safety we evaluated two properties, surface hardness and traction. The hardness of a playing surface determines the amount of energy that the surface can absorb when a player falls on it during competition. A survey, conducted by the Penn State Center for Turfgrass Science, found many skinned infields to be above the surface hardness threshold (200 Gmax) set by the U.S. Consumer Product Safety Commission. Traction is a measure of how players' cleats interact with the surface. Surfaces high in traction are said to "grip" the cleat, resisting either linear or rotational motion. Both surface hardness and traction have been linked to anterior cruciate ligament (ACL) injury, one of the most debilitating injuries an athlete can suffer.

Skinned areas are heavily compacted at construction to ensure proper grade and surface drainage. Player traffic on the skinned area will compact the surface even more. Our research found this compaction to be directly linked to unsafe playing conditions (hardness + traction). What can be done? Periodically try grooming the skinned area deeper than usual. This will prevent a heavily compacted layer from forming near the soil surface, reducing both the surface hardness and traction of the skinned area.

It is important to note that we evaluated traction using a baseball cleat that contained metal spikes. The cleat used during testing contained 8 flat, metal studs approximately 0.5 x 0.5 in. Research has found that the shape of the studs on a cleat and their location on the sole of the shoe can change the traction characteristics of a playing surface. Future research needs to evaluate the traction of skinned infield surfaces using different types of baseball cleats, especially cleats with molded rubber studs.

Speed of the infield

We can determine how fast an infield plays using an instrument termed Pennbounce, which calculates the velocity of baseballs propelled at the playing surface before and after impact. Our findings indicate that speed of a skinned infield is determined by the characteristics of the sub-surface soil, which is the soil below the material loosened during the grooming (scarifying) process. Sub-surface soils on skinned areas are often highly compacted at construction. We have found that as this soil becomes more compacted, the speed of the infield will increase.

Surface treatments, such as applying calcined clay at rates as high as 1.5 tons per 10,000 sq. ft. and grooming up to 0.75 inches, did not change the speed of the infield in this study. Thus, if the goal is to change how fast the infield plays, one must do something to change this sub-surface soil. Relieving this compaction will slow down an infield that plays too fast.

Baseball field managers agree that the most important task in maintaining skinned areas is managing soil moisture content. The moisture content of the skinned area affects how both the ball and players react with the surface. On the game-day, field managers often apply water up to five times. This process takes a lot of time. Part of this research project was to investigate skinned infield irrigation practices in order to find the most efficient method of irrigation.

We have found that the time required to re-wet skinned infield soils is related to compaction as well. Infiltration into compacted skinned areas is very slow for two reasons; these soils lack permeability and are often crowned.

Most skinned infield soils contain at least 25% silt and clay particles. Some non-commercial skinned infield mixes are much higher in silt and clay. Therefore under compaction, there is very little internal porosity (permeability) through these soils, and pores that are present are smaller in size (micropores). There is very little internal drainage through skinned infield soils.

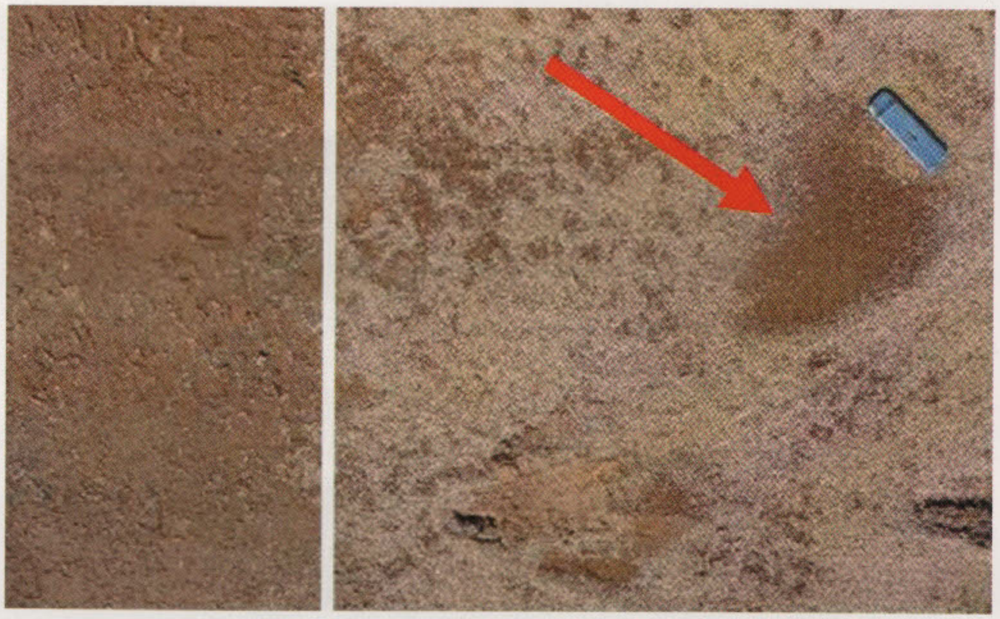
The fact that skinned infield soils lack internal drainage is not news to most of us. Skinned areas are often constructed with a crown of at least 1/2%. This crown is designed to move rainwater off the field of play. We know that if we have a prolonged rain on the skinned area the moisture will be retained in that soil for a long time, often rendering the surface unplayable. Thus, we rely on that crown to move water off the field via surface drainage.

Applied irrigation water works the same as rainwater. When we irrigate these skinned areas water wants to move with that crown to the foul line. Thus, it is going to take longer to introduce water into the underlying soil. To combat this problem, many field managers flood their infields during the day. They irrigate to the point that there is standing water on the skinned area, and then simply allow that water to slowly infiltrate into the soil below.

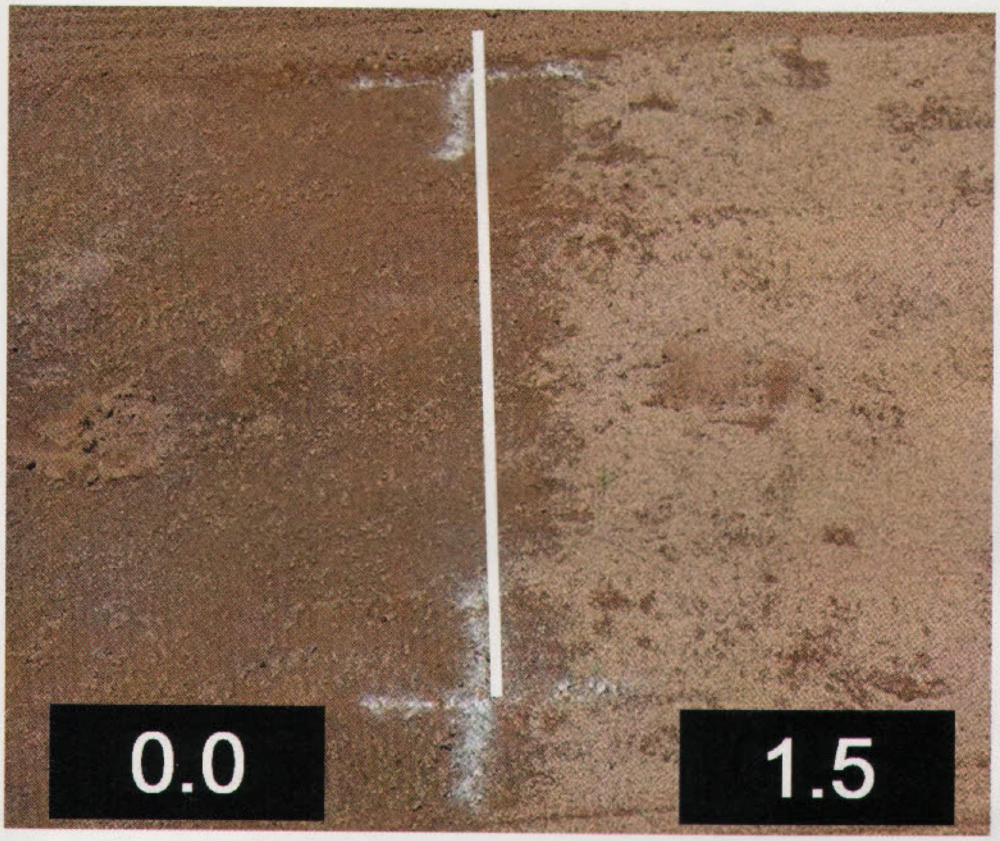
We flooded our infield plots by applying 2 inches of irrigation 14 hours before data collection. We then measured volumetric soil moisture content twice in a 3-hour period. This would be synonymous to flooding the infield the night before a game and taking a pre- and post-game moisture content reading. Following this irrigation schedule, we found no differences in pre- and post-game volumetric soil moisture content. This phenomenon was observed in cooler weather during April and hot and humid weather during June and July. Water introduced into this skinned infield soil was retained throughout the day. Even though at times a color change was noticeable, there was no appreciable soil moisture content change.

Calcined clay

When studying skinned infield management it is necessary to discuss the effects of conditioners like calcined clay. In this study calcined clay, applied as topdressing, had no effect on playing quality. The conditioner had no effect on the safety (hardness and traction), speed, or soil moisture retention of the skinned area.



Soil below calcined clay topdressing is similar in color to soil found on a plot receiving no calcined clay.



Plots receiving lowest and highest rates of calcined clay 17 hours after irrigation.

It is important to note that calcined clay products are used for reasons other than what was evaluated in this study. Calcined clay is often used to improve the aesthetics of the surface and to make the area easier to groom (scarify). Neither effect was measured in this study. Calcined clay products are also often used as drying agents to remove standing water from the infield and to keep the surface playable during an in-game rainstorm. Neither of these effects was measured in this study.

Our research also found calcined clay, applied as topdressing, to have no effect on the amount of moisture the skinned infield could hold at a 3-inch depth. When used as topdressing, there was only a thin layer of material on top of the soil surface. We know that the underlying soil maintains consistent moisture content over time, regardless of the surface application of calcined clay. A 0.25-inch of calcined clay on the surface will not change the amount of water that can be retained in a 3-inch deep soil profile. Moisture retention is a function of the amount of silt and clay in the soil, not the amount of conditioner on the soil surface.

This calcined clay material did change color during the data collection process. After irrigation, the material exhibited a dark brown color (Munsell notation, 7.5YR 4/4). Over a 3-hour time period, the material lightened to very light brown color (Munsell notation, 10 YR 7/4). This color change presents an illusion that the area is drying out and needs additional irrigation, but the soil moisture content did not change during this period.

For example, the photo on this page was taken 17 hours after irrigation. One plot had no calcined clay applied to it while the other had calcined clay applied at a rate 1.5 tons per 10,000 sq. ft. The plot with calcined clay topdressing appears much drier than the plot without topdressing. Many field managers would apply additional irrigation to their skinned areas if they had this appearance. If we remove the calcined clay topdressing, it is apparent that the soils of these plots are very similar in color, and moisture content data shows that they do not differ in soil moisture content.

Thus, there is not a need to irrigate multiple times a day in response to this calcined clay color change. A single heavy application of water to the skinned area will allow for slow infiltration into the underlying soil. Once this water is in the soil, it will be retained for an extended period of time because these soils exhibit very little internal drainage.

The soil below the material loosened during the grooming process (sub-soil) affects the safety of the skinned area. As this soil becomes more compacted, both surface hardness and traction increase. Grooming excessively compacted skinned infields to greater depths will reduce both surface hardness and traction.

The sub-soil affects not only the hardness and traction of the infield, but the speed of the infield as well. As this sub-surface soil becomes increasingly compact, the speed of the infield will increase. Management efforts to change the speed of the infield should be directed towards the sub-soil, as grooming and calcined clay applications do not alter the speed of the infield.

Calcined clay topdressing did not change the playing characteristics of skinned areas in this study. Increasing the amount of calcined clay on the surface did not alter the safety or speed of the infield, nor did it affect the amount of moisture the skinned area could retain. Volumetric soil moisture content on skinned areas appears to be a function of the amount of silt and clay in the soil, not the amount of conditioner on the surface.

A deep, infrequent irrigation program (similar to what is often practiced on turfgrass surfaces) appears to be the most efficient method of managing moisture on skinned areas. Water slowly infiltrates into skinned infield soils, and once it enters the soil profile it is retained for a considerable amount of time in varying weather conditions. Often calcined clay on the soil surface may present an illusion that the skinned area is drying out, but this is not the case.

We have learned a great deal about skinned infield maintenance from this research, but there is more work to be done. Future research needs to evaluate different skinned infield mixes varying not only in sand content, but sand shape and size as well. Additionally, the effect of blending conditioners into skinned infield soils during construction needs to be evaluated.

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