Update on infield skin playability

By Karl Guillard, Seth A. Goodall, William M. Dest, and Kenneth R. Demars

Maintenance budgets for baseball and softball fields are overwhelmingly focused on the infield, due to the laborious nature of maintaining the skinned area. The demand for high quality infields is attributed to the fact that as much as 75% of the game can be played on this portion of the field (Zwaska, 1999). Therefore, the goal of most groundskeepers is to maintain their infield skins in peak playing conditions. This is accomplished in a variety of ways including grooming, watering, and the application of amendments or soil conditioners.

The intensity and frequency of these practices, however, are dependent upon the top mix materials that make up the infield soil. Commonly, the composition of the skinned infield soil varies greatly from one field to another even though guidelines for construction and maintenance have been developed for these purposes (70 to 85% sand and 15 to 35% silt and clay; ASTM, 2005). Recommendations from experienced field managers call for a soil with 50 to 75% sand, 15 to 35% silt, and 15 to 35% clay (Zwaska, 2002), but this advice may not be followed regularly.

Because of the differences in the materials used for construction, soils of varying textural class, particle size distribution, and shapes are installed into skinned infields and topdressed with amendments depending upon cost, level of play, geography, availability, demand for certain visual attributes, and ability of a sales representative to market a product. These variations in the composition of the surface materials influence soil physical properties, which in turn may affect the playability of the skinned infield surface, including hardness, traction, friction, and the movement of balls entering onto and leaving the skin surface.

The lack of research and understanding of these attributes forces the field manager to rely more on trial and error or advice from experienced peers about practices that produce desirable results, instead of recommendations based on scientific measurements and analyses. There is little scientific information on how calcined clays affect physical properties of skinned infields and subsequent ball reaction to the surface. The lack of information on ball response and physical property changes of skinned infields when amended with calcined clay provided the motivation for our research. A full report of the results can be found in Goodall et al. (2005).

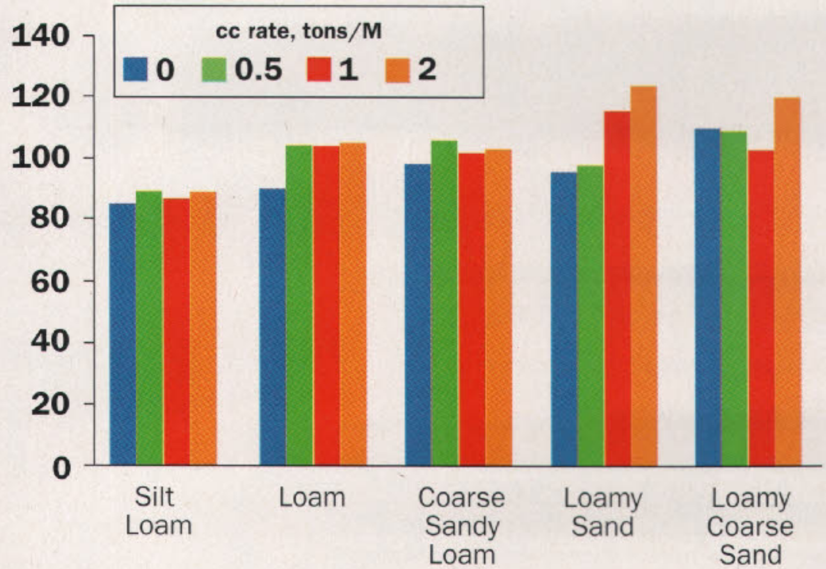

Figure 2: Hardness, Gmax

Skinned infield plots were constructed at the University of Connecticut's Plant Science Research and Teaching Facility in Storrs, Connecticut. The plots consisted of five different soils of varying textural class and sand fraction distribution amended with four rates (0, 0.5, 1, and 2 tons/1,000 sq. ft.) of calcined clay (Turface Pro League from Profile Products). The added calcined clay represented half, full, and twice the recommended rate by the manufacturer for newly constructed infields with high sand content.

The soils were obtained from five Northeast soil distributors, and are used widely in baseball and softball infields in our region on both low- and high-end fields. The soil classified as a loamy coarse sand in Table 1 is actually a crushed rock product manufactured primarily for skinned infields. Even though a clay fraction was determined for this material based on particle size analysis, it does not possess clay mineralogy properties (i.e., cohesive characteristics).

Once the infield plots were established, packed, and groomed to simulate a skinned infield on game day, we took the following measurements on each soil-calcined clay rate combination: surface hardness with a Clegg Soil Impact Tester; surface traction using a friction/traction apparatus modified with steel baseball cleats; static ball-to-surface friction using a disc apparatus with two plates that held four baseballs; and dynamic ball-to-surface friction using a pendulum apparatus. Samples of the soils with and without the calcined clay were analyzed in the laboratory for bulk density, saturated hydraulic conductivity, and shear strength.

Bulk density decreased and saturated hydraulic conductivity (permeability) increased across all soils as the rate of calcined clay increased. In situations where skinned infields would benefit from a decrease in bulk density and an increase in permeability (e.g., compacted conditions), the incorporation of calcined clay would achieve this goal. Improvements to infield materials that have a low permeability by incorporating calcined clay or by selecting materials with a high permeability are important in regions where wet weather prevails or where the infield cannot be covered before rainfall (which is often the case with municipal fields). On the other hand, materials with low permeability having a high moisture holding capacity could be advantageous in drier climates.

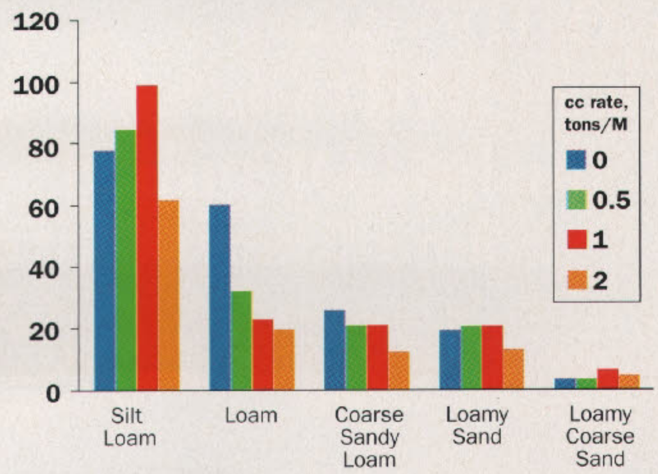

Figure 1: Dry Shear Strength, lbs in^{-2}

Dry vs. wet & strength

Shear strength of a soil gives an indication of the binding capacity of that soil. Soils with greater cohesiveness will require more force to reach shearing; when the binding between soil particles is broken. From a practical standpoint, shear strength is important with skinned infields since it is positively correlated to traction and friction. Players require adequate traction for movement between the bases (running, and stability for fielding and making throws); frictional resistance influences sliding properties and ball reaction to the surface.

If a soil relatively high in silt and clay content (as shown in our study) is wetted, packed, then allowed to dry, shear strength is far greater in

Student researcher Seth Goodall in the test plots at UConn.

the dry condition than in the wetted state. This can happen with infield skins resulting in a soil that is harder to break up and groom once it dries following wetting. Calcined clays are commonly applied to the skins when this occurs. Our results showed that the soils in the study, except for the loamy coarse sand, generally decreased in shear strength when comparing the lower versus highest rates (see Figure 1). As expected, coarser-textured soils exhibited less shear strength than the finer-textured soils. Overall, the silt loam, at dry and moist conditions, exhibited the greatest strength and least amount of weakening with the addition of calcined clay, which is attributed to the silt loam's greater particle cohesiveness. Accordingly, coarse-sandy soils may exhibit greater shear strengths when their clay fraction is significantly greater in proportion to the silt fraction. Because shear strength of an infield soil will affect traction and friction, the field manager should keep this in mind as the long-term application of calcined clays to infield soils may reduce their shear strength over time, particularly with finer-textured soils.

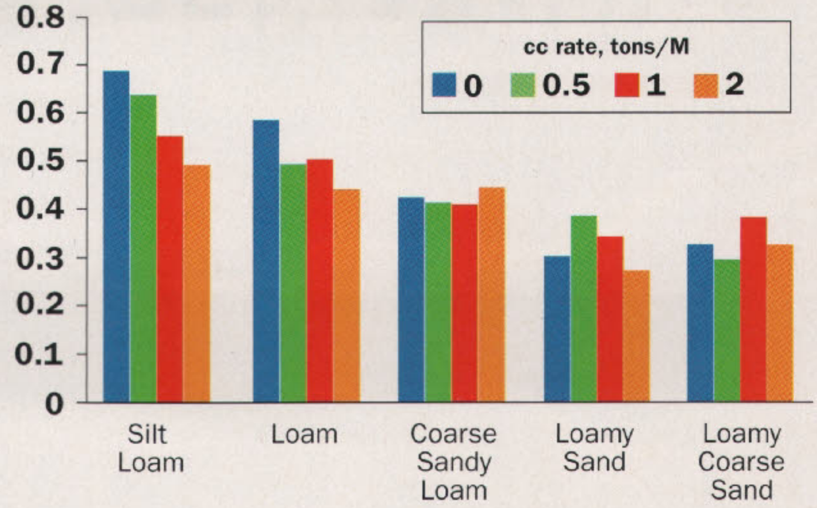

Figure 3: Dynamic Friction, index

Surface hardness of the soils responded differently across calcined clay rates; the addition of calcined clay significantly increased more so with the coarser-textured soils than with the finer-textured soils (Figure 2). It may seem a bit counter-intuitive that hardness would increase with the addition of a coarse particle sized amendment, but we think this may be a result of the interlocking of the sand-size calcined clay particles when packed. Traction was positively related to shear strength, but we could not find any direct rate effects of the calcined clay additions on traction. Grooming and loosening the infield surfaces before making traction readings with the disc apparatus may have masked any direct calcined clay effects.

Dynamic ball-to-surface friction increased as soils became finer in texture and decreased with increasing calcined clay rates (Figure 3). However, the sandier soils were less affected by the calcined clay additions than the finer-textured soils. The higher frictional resistance of the silt loam and loam soils can be attributed to their greater shear strength compared with the other soils in our study. Static ball-to-surface friction results duplicated the same patterns as the dynamic ball-to-surface friction, and so were not shown.

Dynamic ball-to-surface friction has application for skinned infields in situations where ball rebound velocity off the surface is perceived to be a function of an unacceptably hard surface, when, in fact, it may be due to a low frictional coefficient of that surface. We have used the pendulum device to distinguish differences on baseball skinned infields where hardness values were actually lower for surfaces with a higher ball rebound velocity off the surface compared with skinned infields that had a lower ball rebound velocity. This suggested that surface hardness per se, was not resulting in the higher ball velocity off the surface.

The pendulum device, however, was able to show that the dynamic ball-to-surface friction was significantly lower on the skinned infield with the higher ball rebound velocity. Therefore, the reduced friction resulted in less slowing of the ball velocity as it rebounded off the

Devices used for measuring traction, static ball-to-surface friction, and dynamic ball-to-surface friction of skinned infield plots at the University of Connecticut.

surface. This suggests that the frictional properties of certain surfaces should be taken into account along with hardness when determining reasons for unacceptably fast rebound off the surface.

The decision to add calcined clay to fine-textured soils should be made with consideration of the potential changes in surface friction. If the objective were to slow the velocity of the ball off the surface, then calcined clay application rates should be limited on fine-textured soils. Addition of calcined clay would only serve to reduce surface friction and may not achieve the goal. On the other hand, if ball velocity off the surface of fine-textured soils is deemed unacceptably slow, then additions of calcined clay may help to reduce the surface friction, leading to faster ball rebound from the surface.

The results of this study suggest that the playability of skinned infields can be affected by soil composition and the calcined clay rate. In general, the fine-textured soils responded differently than the coarse-textured soils for most measurements. The effects of calcined clay are probably attributable to the potential modification of the textural class of a finer-textured infield skinned soil to one of a coarser-textural class. Therefore, addition of calcined clay to fine-textured soils may cause them to react similarly to coarser-textured soils.

Although our study was not long-term, the results suggest that repeated surface incorporation of a calcined clay into a skinned infield with a finer-textured soil could lead to changes in playability by changing the physical properties. On the other hand, coarser-textured infield soils would be more resilient to changes in physical properties under repeated calcined clay additions because of more similar particle sizes between the soil and the amendment.

We know from experience and from player and coach comments that different infields play differently. Determining those differences and relating them to playability will be an important advancement in successful skinned infield management. Objective measurements similar to the ones used in our study will allow for a more scientific approach to skinned infield management and less reliance on trial and error. This raises the possibility that playing surface standards might be developed for skinned infields using the techniques employed in our study.

The next step in this line of research is to ascertain the relationship between objective measurements and playability. Our preliminary results do not allow us to make specific recommendations at this point because we are not sure what the numbers mean with respect to actual playability of the infield. More research is needed before reaching that endpoint. This would include quantifying infield skins for their hardness, traction, frictional coefficients, shear strength, etc., then matching those values to player preferences and acceptability. Moreover, developing meaningful values from objective scientific measurements will take the guesswork out of how much of a particular amendment should be applied to a specific soil to reach a desired goal for playability. ■

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