Genesis and prevention of iron-cemented layers in sand putting green soil profiles
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Glen R. Obear and William C. Kreuser

- A column study was initiated in October 2015 to determine how root zone chemistry affects iron accumulation. The study will be completed in 2016 and will be replicated in a rhizotron facility in the field.
- Preliminary data show that putting greens with high pH gravel layers may be more prone to formation of cemented layers when high rates of iron are applied. Root zones with high pH sand may be less likely to form layers at the sand/gravel interface due to immobilization of Fe near the surface.
- In 2016, soil samples will be collected from at least 50 golf courses to determine the distribution of Fe-cemented layers, and to create and validate a model to explain their formation.

Iron-cemented layers form in putting greens, leading to decreased water infiltration and anaerobic conditions in the soil. These layers have been documented, but the factors that lead to their formation have not been studied. The objectives of this study are to determine 1) how root zone chemistry affects iron accumulation at different application rates, and 2) the distribution of these layers across the US, which will provide a dataset against which a model can be created and validated (beginning late 2016).

A column study (Fig. 1) was established in October 2015 as a 2x2x3 factorial design with three replications. The root zone was comprised of a silica sand from Florida (pH 5.5) or a calcareous sand from Wisconsin (pH 8.2); both met USGA particle size recommendations. The gravel layer was comprised of either limestone (pH 8.8) or granite (pH 5.4). After establishment of creeping bentgrass, columns will receive weekly applications of ferrous sulfate at a rate of 50 or 200 kg ha^{-2}, and these will be compared to untreated columns. All columns will be irrigated to replace 150% of water lost through evapotranspiration. After each iron application, x-ray fluorescence (XRF) will be used to measure the concentration of Fe inside columns in 2.5 cm depth increments. Air permeability will be measured weekly to track changes in pore space resulting from iron accumulation. This study will be replicated in a rhizotron facility in the field in 2016.

Data from a preliminary trial show that XRF can accurately track accumulation of iron (Fig. 2). After eight applications at a rate of 200 kg $FeSO_4$ ha^{-2}, a marked accumulation was observable at the interface of sand and gravel in a column with low-pH sand and high-pH gravel (Fig. 3). Iron oxidized above the gravel layer in columns with low pH sand and high pH gravel. In columns with high pH sand, the Fe became immobilized near the surface and never reached the gravel layer. These findings suggest that iron-cemented layers are more likely to form in root zones with high pH gravel. However, these layers may be less likely to form in putting greens with high pH sand, since the iron is immobilized before it reaches the gravel. The full-scale study will provide a wealth of information about how root zone chemistry affects iron accumulation.

Figure 1. Columns were constructed to meet the recommendations of the USGA for putting green construction.

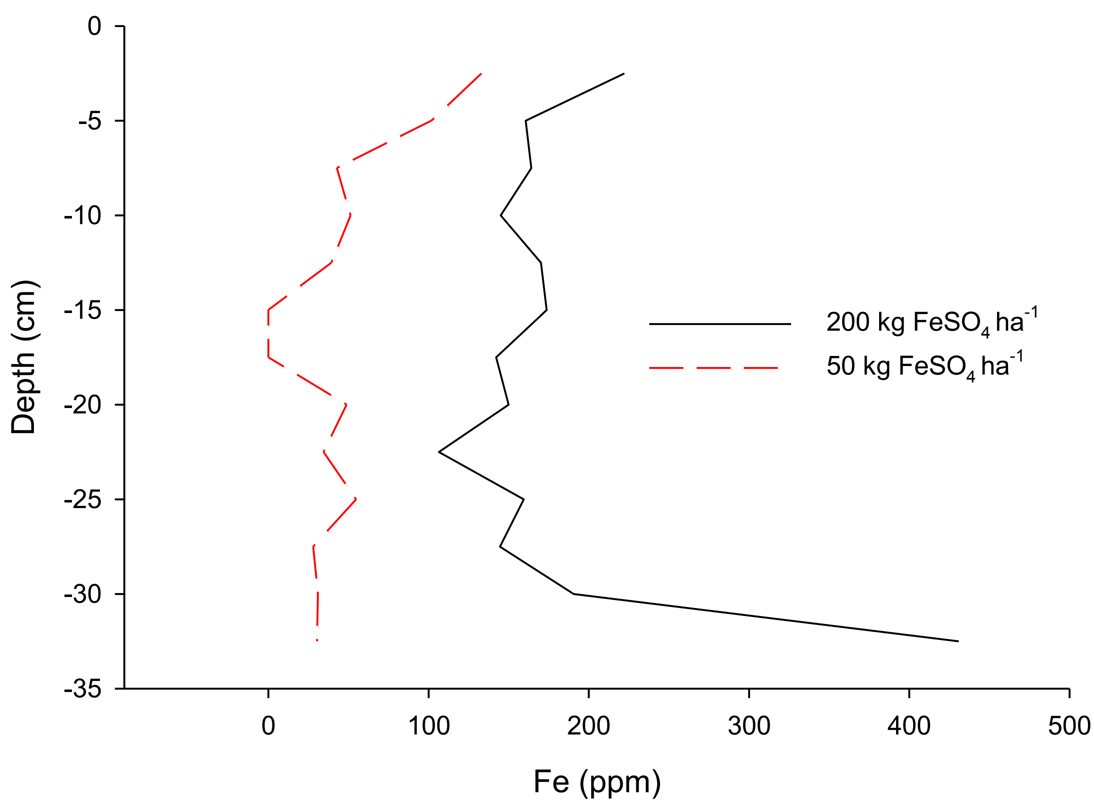

Figure 2. X-ray fluorescence measurements of iron in 2.5 cm depth increments in columns treated with 50 or 200 kg $FeSO_4$ ha^{-1}.

Figure 3. Iron-cemented layer at the sand/gravel interface of a root zone with a low-pH sand and a high-pH gravel. The column received eight total applications of Fe at a rate of 200 kg $FeSO_4$ ha^{-1}.