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Calcium for Kentucky Turfgrasses

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Calcium (Ca) is the dominant cation in all soils of agronomic importance, and Kentucky soils are no different. Kentucky soils are naturally high in Ca. Consequently, Ca deficiency in Kentucky turfgrasses is extremely rare, and the probability of observing a Ca response on golf courses, home lawns, sod production, or sports fields is very low. Applying Ca fertilizers to artificially increase soil Ca above the level necessary for proper plant growth normally does not result in an increase in plant uptake because Ca uptake is genetically controlled. Regardless, Ca is commonly applied in both granular and liquid forms, often resulting in wasted time and money.

Function of Calcium in Turfgrasses

Calcium is taken up by the turfgrass as Ca^{2+} (a positively charged divalent cation) and, under normal conditions, turfgrass receives sufficient quantities of Ca^{2+} from the soil without the need to apply Ca fertilizers. Calcium is required for cell membranes to function properly and likely serves to bind phospholipids or membrane proteins. Most Ca in turfgrasses is found in cell vacuoles or serves as a structural component of cell walls. Calcium activates some enzymes but inhibits others. Translocation of Ca into phloem tissues is limited, which is why deficiency symptoms, although exceedingly rare, will appear on newer leaves/tissues first. Deficiency may appear as twisted or deformed tissue in roots, stems, or leaves where cell division occurs. Leaf blades may appear rose to brown and the leaf tips and/or margins may wither.

Tissue Testing for Calcium

In general, tissue testing for Ca is unproven. First, Ca-deficient turfgrass is almost never observed. Even on sand-based rootzones, Ca levels are normally high enough to provide the turfgrass with all the Ca the turfgrass needs. Second, we do not have sufficient information to determine what "normal" Ca levels should be in healthy turfgrass. Without knowing what exists in healthy turfgrass, we cannot determine if the Ca levels in your turfgrass are high, low, or normal.

Soil Calcium

Calcium may be present in soils at 3% or greater. However, much of this Ca is bound in primary and secondary minerals. Calcium on soil exchange sites and in soil solution is appreciably lower. Turfgrass will uptake Ca from the soil solution, and Ca on the soil's CEC will then replenish the soil solution.

Soil Testing for Calcium

The decision to apply Ca should not be based upon soil test Ca levels. Soil testing for Ca is of little value because the extractant dissolves Ca compounds, which would not otherwise be plant available. In addition, correlations between Ca soil test values and turfgrass response to applied Ca has not been demonstrated in Kentucky soils. Furthermore, applying Ca to balance soil cations (base cation saturation ratio) is not supported by evidence and has been widely rejected by land grant institutions. In fact, the application of Ca has been shown to provide no beneficial effect on turfgrass grown on calcareous putting greens.

Soil pH and Bicarbonates

Management of soil acidity (pH) and bicarbonate (also called alkalinity, HCO_3^-) affects the decision on whether to apply a fertilizer containing Ca to Kentucky turfgrasses. Gypsum and limestone are both sources of Ca. The application of gypsum does not increase pH, whereas limestone increases pH. The counterion in limestone (carbonate, CO_3^{2-}) increases pH and can be applied if pH is below the target level for turfgrass.

In contrast to limestone, gypsum contains sulfate (SO_4^{2-}) rather than carbonate. Gypsum does not increase pH and can actually lower pH and neutralize bicarbonate in situations where the soil pH is initially high due to the presence of sodium (Na). Elevated Na levels may result in sodic soils, which are defined as soils that have an exchangeable Na percentage ≥15% and have a pH ≥ 8.5. Sodic soils are very rare in Kentucky and therefore the application of gypsum to remediate sodic soils should be equally rare. How rare? Well, the UK soil testing laboratory has analyzed more than 65,000 soil samples from turfgrass locations since 1990 and found exactly 22 soil samples with a pH ≥ 8.5. Thus, sodic soils may exist in Kentucky but the likelihood of managing turfgrass on sodic soils is less than 0.01%. Nevertheless, when gypsum is applied to sodic soils, the turfgrass response, if any, would likely be due to the increased biological activity that typically accompanies a reduction in pH (i.e. increased microbial activity and increased micronutrient availability).

Bicarbonate dissolved in irrigation water is a concern because of its ability to raise soil pH (above pH 8), and its ability to bind Ca and Mg which can leave behind soluble Na. If water high in bicarbonates increases pH to unaccept-

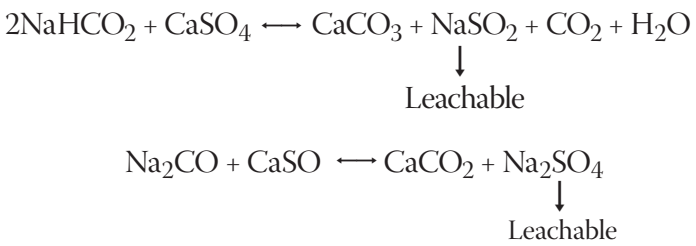

Figure 1. Bicarbonate and carbonate reductions following gypsum application

able levels (>8.0), gypsum may be one of several ways to acidify the soil and reduce bicarbonates through the process shown in Figure 1.

Salt Remediation

Gypsum should not be used for salt remediation. Gypsum is a salt and, therefore, the application of gypsum does not remediate salt-affected turfgrass and, in fact, may exacerbate salt-related problems.

Calcium Sources

Irrigation Water

One of the most common Ca sources for irrigated turfgrass is the irrigation water itself. Because much of our water is sourced from the aquifer, ponds, and lakes, Ca concentration of irrigation water can exceed 40 parts per million (ppm). If so, every 100,000 gallons of water applied also applies 4 gallons of Ca. Having your irrigation water tested annually is recommended and can save you money by reducing or eliminating the need to purchase and apply unnecessary Ca.

Lime

When most turf managers think of lime, they probably think of limestone. Limestone is comprised of calcium carbonate and it is one of the least expensive Ca sources available for turfgrass use. Lime may also be purchased as burned lime, hydrated lime, or dolomitic lime; each lime source has a different capacity to neutralize acidity and increase pH. Lime should be used as a Ca source when soil pH approaches 5.5. If soil pH is greater than 6.5, gypsum is the preferred Ca source in place of lime.

Gypsum

Theoretically, gypsum may enhance soil permeability in clay-textured saline soils, although proof of this dynamic has never been documented in turfgrass systems. High Na levels cause dispersion of clays and often results in poor drainage. Gypsum may alleviate sodic soils by replacing Na with Ca on the soils exchange sites, which may enhance soil structure and increase soil permeability. Na must then be leached through the rootzone to have any beneficial turfgrass response. However, the benefit of applying gypsum to enhance soil structure has not been confirmed on Kentucky turfgrasses. This may be due to the continual destruction of soil structure by mechanical processes such as aerification and verticutting. In addition, gypsum applications to sand-based putting greens to enhance soil structure is unnecessary because sand-based putting greens have no structure.

Calcium Chelates

Some lime and gypsum sources may contain a chelating or complexing agents such as lignosulfates, citrates, gluconates, or plant extracts. These additives are designed to increase the solubility and availability of Ca for plant uptake. When the soil pH is low (< 5.5), the use of Ca chelates may increase pH more effectively than non-chelated Ca sources. However, very few Ca chelates have been tested and confirmed to increase pH more efficiently than non-chelated Ca. Under normal Kentucky conditions, Ca is naturally solubilized from the soil and remains soluble in the soil for extended periods. Therefore, fertilizer additives intended to increase Ca solubility are normally unnecessary.

Calcium Nitrate

Calcium nitrate has a guaranteed N and Ca analysis of 15% and 19%, respectively. Calcium nitrate is normally applied based upon the N component and consequently, any turfgrass response is likely due to N. However, if the soil pH is below 5.5, calcium nitrate will increase pH and supply N in a single application.

Summary

Under normal Kentucky conditions, Ca sources should be used when pH increases are necessary, when soil bicarbonate levels result in unacceptable turfgrass, or when soil Na levels are resulting in unacceptable turfgrass. Applications of Ca for other purposes will not harm the turf or the environment but will increase maintenance costs and is of little to no value for Kentucky turfgrasses.

References

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