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Calcium: The New Vogue

Calcium has always taken a back seat to the "big boys" of soil fertility. The industry buzz is usually nitrogen, and new forms are frequently being released to the market. Recently, potassium has taken on the role of "favored son." Referred to as a secondary nutrient behind nitrogen, phosphorous and potassium, calcium is finally starting to take its place in the ranks of vogue nutrients.

Calcium is of macro importance to both the plant and the soil in many more ways than simply moving the pH scale. It plays a major role in the physiology of the plant, strengthening its physical structure and helping in protection from disease attack.

It is true that NPK is used in greater percentages than calcium, but calcium is used more by weight and volume than any other nutrient. Practically speaking, calcium is rarely considered as a nutrient at all! Instead, the focus on calcium has been more as a soil buffer to help adjust pH. Calcium is of macro importance to both the plant and the soil in many more ways than simply moving the pH scale. It plays a major role in the physiology of the plant, strengthening its physical structure and helping in protection from disease attack. In the soil, the importance of calcium is manifold, including the reduction of soil compaction and assistance in providing a better environment for the proliferation of beneficial bacteria. Some research even suggests that calcium plays a role in weed populations. The list goes on, and yes, it can have a role in the pH of the soil!

The Plant

Imagine that the room you're sitting in is a plant cell of your favorite turf species. The walls that surround you are made of calcium pectase. The more calcium that is available to that cell, the stronger those walls become. If calcium is limited, the walls are as weak as balsa wood. As more calcium becomes available, those walls take on the strength of cinder blocks. The stronger the cell, the stronger the plant, and the quicker its recovery from the enormous pressures that it faces on the golf course. This works for both leaves and roots. The stronger the root cells are, the more aggressive the roots will be moving through the soil. Proper levels of calcium within the plant strengthen the whole plant and allow for efficient use of sunlight, carbon dioxide, water, nitrogen and mineral nutrients.

Calcium also plays a major role in the construction of numerous hormone and enzyme systems that can help protect the plant from insect and disease attack. It has been reported that as a pathogen probes its way into a cell, it injects an enzyme to help break that cell down. There is research that suggests that as this occurs, proper levels of calcium within the cell can actually slow the attack down or stop it all together. The levels of calcium within the cell are going to be dictated, to a large extent, by the management of calcium within the soil.

The Soil

Calcium plays many roles in the soil, but it is its relationship with other nutrients such as magnesium, potassium and sodium that is most significant. To associate calcium only as a buffer of pH in the soil is an injustice. In fact, pH can be driven by numerous minerals such as magnesium, potassium, sodium or even aluminum. Oftentimes calcium is applied to the soil to *lower* pH. It is important to understand that an imbalance of calcium will lead to tight, hardpan soils that will restrict the flow of air and water through the soil profile. This will not only affect the plant roots, but also—perhaps even more important—will slow down the growth of beneficial microorganisms.

The soil is an extremely dynamic environment consisting of numerous chemical, biological and physical reactions. It is on all three levels that we must manage the soil. We can change the physical structure of a soil by properly managing the chemistry, thus providing a stronger biological environment. It is this biology that is so important to the success of managing any crop, turf being no exception. For the first time in recent memory, soil biology has risen to the forefront of our industry. Pathologists are introducing soil inoculants as biological controls for pests, advocates of IPM are starting to look closer at soil management as an integral part of their success and we are all beginning to understand the need for soil carbohydrates. If we are going to make any improvement in the health of the plant, proper soil management is imperative, and this all starts by managing calcium levels in the soil.

Managing Calcium in the Soil

Dr. William Albrecht, the former head of the soils department at the University of Missouri, established the protocol for balancing the basic cations on the soil colloid over 50 years ago. Today, that research is the backbone of a growing interest in sustainable soil management. Many of the predominant soil-testing laboratories, including Brookside Labs—a company that Dr. Albrecht helped to form—use this methodology today. His research focuses on the soil tests' base saturation readings, where calcium plays the largest role.

Base saturation measures the relationship between the cations

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on the soil colloid. These nutrients are expressed in percentages and will always add up to 100%. The beauty of base saturation methodology is the fact that it deals with the relationship among the cations, not the actual pounds per acre of any one nutrient. On a soil with a high holding capacity, or CEC, the pounds per acre of a nutrient is naturally going to be much higher than on a similar soil with a lower CEC. If we manage soils to specific levels of a nutrient, the relationship between the cations will vary significantly depending on this holding capacity.

When evaluating the base saturation percentages of a soil, the ideal targets are:

- 68% calcium;
- 12% magnesium;
- 5% potassium;
- 2% sodium;
- 3% trace nutrients;
- 10% hydrogen.

With an ideal range of calcium in the high 60th percentile, it becomes very clear why calcium is so important. Using these percentages as a standard, the manipulation of these nutrients becomes manageable. If one nutrient is high, it can be exchanged off the soil colloid by applying one of the other nutrients. For example, if magnesium is excessive in a soil, 20% or higher, another nutrient becomes weaker. The relationship is always 100%, so it becomes a game of "give and take." Very often, the nutrient given up will be calcium. The addition of calcium will drive out the excessive magnesium, allowing calcium to saturate the colloid. This manipulation will work with any nutrient that is out of balance.

One of the great fallacies of conventional soil management is that we too often manage exclusively to soil pH. The acidity of a soil is dictated by the percentage of hydrogen on the soil colloid. On the above example, base saturation of hydrogen is 10%. On this test, with 10% hydrogen, the pH will always be 6.3. As the percentage of hydrogen increases, the pH drops, and as it increases, it rises. If we effectively manipulate the relationship of the base saturation, we can always manage the soil to 10% hydrogen and end up with a pH in the range where we have the greatest potential nutrient mobility (6.0 - 6.5).

When imbalances among the cations exist, the soil becomes very tight and air and water can not penetrate. When this occurs, roots are not the only thing that suffers, but beneficial bacteria suffer as well. Since the relationship between calcium to magnesium makes up 80% of the soil colloid, it is this relationship that is most important. As calcium drops below 60% and magnesium creeps above 20%, the soil becomes very tight. These are looked at as heavy, unmanageable soils, and excessive mechanical aeration appears to be the only help. Unfortunately, this does not address the real problem and until the Ca:Mg ratio is addressed, that soil will remain tight.

We have seen soils all over the country "open up" through the use of appropriate liming materials and the balance of base saturation. Soils that once went to battle with a GA60 aerator now see that machine walk across the fairways with great ease! Because air and water movement improves, so does biological activity. This helps to suppress disease problems, reduces isolated dry spots and allows for the reduction of nitrogen usage. Earthworms that were once absent are now actually becoming a management problem, one that agronomically is the best "problem" to have.

Types of Calcium

There are a number of good ways to supply calcium to a soil, but when calcium levels are below 60% base saturation, limestone is the most appropriate. Not all limestone is created equal, though! There are two basic forms of lime: high-calcium lime, or calcitic lime, and high-magnesium lime, or dolomitic lime. Depending on the source, calcium levels can vary from around 30% to 45%, but the real difference is that percentage of magnesium. High-calcium lime will have a magnesium oxide reading of about 5%, while dolomitic lime will read closer to 20%. This difference in magnesium is significant since it will drive pH up faster than calcium and will quickly create a tight soil. In soils with excessive magnesium levels, dolomitic lime would not be appropriate, and in fact can create even worse imbalances in the soil. In this situation, high-calcium lime will actually allow for the exchange of magnesium for calcium and can often actually lower soil pH by better balancing the base saturation and allowing for better hydrogen saturation. In many situations, both high-calcium and dolomitic lime would be called for to best balance this critical Ca:Mg ratio. The specifics of these recommendations are often best left to a qualified consultant, but in general terms, if the soil shows a high percentage of magnesium and calcium levels are below 60%, high-calcium lime is the lime of choice.

Gypsum is calcium sulphate and is typically around 23% calcium and 18% sulfur. It has this magical reputation of reducing soil compaction, which it will do in many situations, but is often misused. Gypsum is not very effective in a soil that shows less than 60% base saturation calcium.

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A soil with a significant calcium deficiency often needs large quantities of calcium to saturate the soil colloid. If this is applied as gypsum, too much sulfur is being applied and problems can occur. It is important to use the appropriate type of lime on calcium-poor soils. Once the calcium base saturation is above 60%, gypsum becomes the calcium of choice. Here it will help to knock excessive magnesium (or any other excess) off the soil colloid through a reaction with sulfur and the exchange with calcium. Since it is sulfur-rich, it will typically not raise the pH.

Calcium is an extremely immobile nutrient. This is supported by the water-soluble LaMotte soil tests and tissue testing. Even in the calcium-rich soil with strong biological activity, calcium does not mobilize well. In heavily managed soils with high compaction, such as a golf course green, calcium mobility is very weak. If it is appropriate to use gypsum, mobility can be improved slightly but in order to get the calcium to the plant, foliar applications are best. Foliar calcium is perhaps the greatest vogue in the industry today, and it's about time! It is imperative we balance the calcium in the soil so we can provide the environment that microbial populations need to proliferate, but it is also very important that we provide the plant cell with calcium. Since the large majority of golf course soils do not provide enough mobile calcium, foliar feeds are important. This is very true on all the greens and tees but often can be justified in the fairways as well.

There are no great secrets with calcium. The two most popular forms of foliar calcium are calcium nitrate (8% Ca) and calcium chloride (12% Ca). There are many forms of chelated calcium products available and they do provide an added value by stabilizing the calcium and making it more available to the plant. The chelates are more expensive but can be worth the cost. Another way to make calcium available is to use ammonium sulphate. This will actually knock calcium off the soil colloid, putting it into solution and making it more available. This is how it can lower the soil pH, which is getting a lot of attention for disease suppression. Is it possible that this available calcium may play a role in this disease suppression?

Conclusion

Calcium perhaps plays more roles in the overall health of both the plant and the soil than any other nutrient. If well-balanced on the soil colloid, it will help to physically open up the soil for better air and water movement. This, in turn, provides the needed environment for beneficial bacteria creating checks and balances for pathogens. Within the cell, it provides turgidity and is needed for numerous physiological reactions. It helps in root and leaf development and makes phosphorous and micronutrients more available. If well-balanced, the proper levels of calcium are going to help reduce the need for nitrogen by making nitrification more efficient. As Dr. Albrecht explains it in his volumes of research, if we get the calcium right in the soil, most of our work is done.

This article was first published in TurfNet Monthly, *December 1997, and appears here thanks to Dave Holler of Arthur Clesen, Inc., who obtained reprint permission. The author is the owner of Earth Works Natural Organic Products. He is currently teaching soil fertility at the Rutgers Turf Management Program.*