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Phosphorous Fertility

the key to turf quality

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TURF LINE NEWS

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Phosphorous (P) is the nutrient consumed in the third largest quantity by turfgrass, after nitrogen and potassium. It is constituent material in all DNA, performs a critical role in plant root formation, germination as well as the energy transfer a within plant cells. P deficient turfgrass will initially exhibit a dark green color, which progresses to various shades of purple as the deficiency increases. P deficiency symptoms are sometimes confused with drought stress.

P fertility and fertiization is one the most misunderstood aspects of turfgrass agronomy, largely because of because of the complex biological cycle this nutrient has within the soil. Some of the misunderstanding stems from different soil test extraction methods used to assess P fertility and their different interpretation guidelines. Consequently, chronic P deficiencies have become Western Canada's single biggest nutritional factor limiting turf quality.

The Soil – Phosphorous Relationship

Soil P is present in three forms. Soluble inorganic P exists freely in the soil solution and is readily available for plant consumption. This happens to be the smallest portion of total soil P. Organic forms of soil P are available over the medium term and are the greatest contributor to the pool of immediately available soluble P. As a result, the potential release of organic P is critical when assessing soil P fertility. Mineral P, the largest component of soil P, is very insoluble and available to the turfgrass plant only over the long-term. The proportion of the different types of soil P is not static; rather they constantly change as part of a broader P cycle in the soil environment.

Soil pH influences P availability by catalyzing chemical reactions that affect the balance between soluble, organic and mineral P. As soil pH rises, P increasingly fixes with soil calcium to become less available – a condition maximized at a pH of approximately 8.0. This explains why turf grown in high pH, calcareous soils experience frequent P deficiencies. As soil pH decreases, P becomes less available when it fixes with aluminum (maximized at a pH of approximately 5.7) and iron (maximized at a pH of approximately 3.4). Maintaining a soil pH between 6.0 and 7.5 maximizes P availability because the chemical reactions that fix soil P are minimized.

Soil temperature also affects the availability of P. When soil temperatures are low, the biological reactions that make P available - the phosphorous cycle - slow down. Quite often, the turfgrass plant simply needs more P than the soil is able to supply. This explains why the P deficiencies are pronounced in the spring, dissipate in the summer and return with a vengeance as soil temperatures drop in the fall. It also explains why high P "starter" fertilizers are traditionally recommended for spring application on established turf.

Phosphorous Soil Testing

The complex factors that affect soil P availability invariably make assessing P fertility somewhat difficult. The science of soil nutrient analysis has developed a number of P extraction methods designed to estimate the total amount of P available to the turfgrass plant over a typical growing season. Soil testing measures both the P that is in solution (immediately

available for plant uptake), as well as the organic P that should become available through the growing season. As with any other nutrient, the results obtained by soil testing for P are not absolute. They are intended to provide the turfgrass manager with a reasonable estimation, or a "probability index", of nutrient availability.

We often hear comments about P soil analysis relating to the apparent irrelevance of test results due to "tie-up" or "unavailability" of this nutrient. Soil testing for P accounts for the various chemical reactions that can affect P availability (such as pH). So the amount of P reported by a soil analysis measures the available P ***after*** accounting for the soil properties that affect P availability. It's worth noting that soil analysis doesn't assess how P availability will be impaired under cold soil temperature conditions.

The Bray and Olsen extraction methods are the two most widely used P extraction techniques in Western Canada. The Bray method is designed for acidic soils and is used when soil pH is below 7.2. The Olsen method is designed for alkaline soils and is used when soil pH is above 7.2. The Mehlich II and Mehlich lll methods are popular, though somewhat less commonly used in Western Canada. There's even a method used by a BC lab called the "Modified Kelowna" extraction. Its critical to keep in mind that the different extraction methods produce different results and therefore use completely different fertility guidelines. This is an important reason why P soil testing is both misunderstood and underutilized.

The following chart provides a guideline to P fertility.

Phosphorous Soil Test Guidelines

(in parts per million)

Extraction Method	Bray (soil pH < 7.2)	Olsen (soil pH > 7.2)
deficient	1-15	1-9
low	15-25	10-15
adequate	26-40	16-24
high	40 +	24 +

The Big Phosphorous Myth

The persistent belief that P fertilization promotes Poa Annua growth at the expense of desirable grass species, such as Kentucky Bluegrass and Creeping Bentgrass, is not supported by scientific research. Yet many turf managers continue to drive their soils into severe P deficiencies in the hopes of preventing Poa annua encroachment. This practice has been compounded by the fertilizer industry, who try to assist in the prevention of Poa annua by promoting the use of fertilizers without P - even on P deficient soils. Ironically, this practice has probably had the opposite effect, with low-vigor P deficient turf ultimately losing the battle to weeds and Poa annua.

In their book Turfgrass Soil Fertility and Chemical Problems, professors Carrow, Waddington and Reike explain the root of this legend. "Initially, P content of turfgrass fertilizers was reduced in the 50s and 60s when tricalcium arsenate was used to selectively control poa annua in other cool season grass stands. Since high P can counteract the phytotoxic effects of Arsenic...turf growers did observe that high P favored Poa annua survival". In other words, P fertilizer nullified the effectiveness of the arsenic based Poa annua herbicide. The end result is that P fertilizer and Poa annua have since been unfairly linked.

Phosphorous Fertilization

Recent research published in Golf Course Management magazine indicates that, in the case of a P deficiency, P fertilization improves turfgrass quality. One study conducted on calcareous sand greens noted that the "quality of the creeping bentgrass turf improved in color, growth and density in response to P applications in all but the lowest application rate". Another long-term study on creeping bentgrass noted that "visual quality is lowest for the plots that received no

phosphorous". In addition, I've seen Kentucky Bluegrass respond dramatically to P fertilization under similar P deficient conditions.

Tradition dictates that turfgrass managers apply most of their P in the spring. In my experience P deficiencies are actually more prevalent in the fall, when we see a gradual decline in soil temperatures before winter sets in. This has led me to advocate a more balanced approach to P fertilization throughout the growing season. I believe this seasonal "build" approach maximizes the utilization of fertilizer applied P, which ultimately leads to better turf quality in the spring and fall.

It's frequently suggested that soil applied P fertilizers are ineffective because they are "tied-up" immediately after application. In fact, the turfgrass plant will consume about 30% of applied P fertilizer in a given growing season. The rest will be captured within the phosphorous cycle, with about 80% of that initial application consumed over a 4-5 year period. This explains why a one-time P application will not offer a quick fix to a chronic P deficiency. When correcting a P deficiency, the only solution is to build soil P over the medium term with high rates of P fertilizer.

Conclusion

When planning your fertilizer program, take a critical look at P. Soil test to determine P availability and apply P fertilizer in accordance with your lab's recommendations. Alleviating a P deficiency will give you a more healthy, vigorous stand of turf. Sustaining adequate soil P levels with a "maintenance" application will prevent the onset of a potentially troublesome P deficiency. Avoid P fertilization only on soils excessively high in P. In short, manage soil nutrition to create an environment that will grow the best turf possible.

Sources: MDS Harris Labs, Golf Course Management magazine, Turfgrass Soil and Chemical Problems (Carrow, Waddington and Rieke)

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