Late fall fertilization of athletic fields

BY **DR. PETER LANDSCHOOT**

Fall is the time of year when cool-season turfgrasses recover from summer stress-related conditions such as drought, heat, and disease. For athletic fields, fall is also the time that turf takes a beating from football and other school sports. This year, many athletic field managers will be making late fall fertilizer applications with the hopes of improving turf vigor and recovery from injury next spring. In this article, we will examine how late fall fertilizer applications influence turf performance, when to make your applications, as well as the types of fertilizers and rates which provide the best turf response.

Why fertilize in late fall?

Late fall fertilization has been promoted as a means of prolonging turf color into early winter without increasing the chance of winter injury and disease. Winter color is more noticeable in regions where winters are warmer (mid-Atlantic states) and during mild winters. Late fall fertilization will also enhance spring green-up without the excessive growth that often accompanies early spring fertilization. This green-up often will last into mid spring, so an early spring fertilizer application is not needed. A fertilizer application in mid to late spring is usually required to sustain turf color and growth.

A small but potentially important increase in the plant's carbohydrate reserves occurs when fertilizer is applied in late fall instead of early spring. Turfgrasses accumulate carbohydrates in stems and rhizomes during fall. These carbohydrates help turf resist winter injury and aid in disease and environmental stress resistance the following spring and summer. Because carbohydrates are tapped for energy by roots and shoots during periods of rapid growth, forcing excess growth with early spring fertilizer applications can deplete carbohydrates quickly, leaving turf vulnerable to spring and summer stresses.

Late fall fertilizer applications do not force as much growth as equal amount of early spring fertilizer, thus carbohydrates are not exhausted as quickly. The result is a slight advantage to the turf in the form of better stress tolerance and disease resistance.

Another reported benefit of late fall fertilization is an increase in rooting, though precisely when and how this increase occurs is a source of some debate. Maximum root growth of cool-season turfgrasses occurs in spring and fall. Some root growth will occur in winter if temperatures are above freezing; whereas, little if any growth occurs in summer.

Most fertilizer applications are made in spring and late summer in attempts to promote root growth. One problem in using this approach is that the shoots use much of the fertilizer, sometimes preferentially over roots. One reported advantage of late fall fertilization is that roots are still growing at a time when shoot growth has ceased, thus allowing the roots to make full use of the fertilizer. However, during this period root growth is very slow, and if the soil is frozen, they do not grow at all. Consequently, the benefit of increased root growth in response to fall fertilization is questionable.

One study in Virginia showed that moderate rates of soluble nitrogen (1 lb. nitrogen/1000 sq. ft) in late fall increased rooting of turfgrass without a noticeable increase in shoot growth. In contrast, a study in Ohio showed no increase in root growth during late fall or winter following late fall fertilizer applications. However, when compared to early spring applications of nitrogen, late fall fertilization allowed more rooting in spring. Presumably, this benefit was due to early spring green-up from late fall applications, which alleviated the need for early spring fertilization. When fertilizer was not applied in late fall, but instead, in early spring, excessive shoot growth occurred, depleting carbohydrate reserves that would have otherwise gone into root production later in spring.

The take-home message from the Ohio study is that while the net effect of late fall fertilization on rooting is slight, application in late fall may be more beneficial with respect to rooting than an early spring application.

Late fall fertilization is occasionally blamed for increased winter injury, snow mold, and annual bluegrass encroachment. A few studies have been designed to examine the influence of late fall fertilization on winter injury. But to my knowledge, none have conclusively demonstrated detrimental effects. Heavy fertilization in mid-fall, when grass shoots are actively growing, can enhance snow mold diseases (presumably due to reduced pre-winter hardening and increased succulence of plant tissue). Increased plant succulence should not occur with late fall fertilization. In fact, some research has shown that late fall fertilization may actually reduce winter diseases.

While some studies have shown increased annual bluegrass populations in fall, there is no good evidence to show that this increase is related to late fall fertilization.

When to apply

Most experts agree that late fall fertilization should take place when foliar growth stops (or slows to the point that turf no longer needs to be mowed), grass is still green, and before the soil freezes. Application timing may vary from year to year depending on weather conditions.

Fertilizer sources and rates

Most late fall fertilization programs include moderate amounts of nitrogen, phosphorus, and potassium. Rates of 1 to 1.5 lb. of mostly soluble nitrogen/1000 sq. ft are suggested over higher rates (assuming a late summer application was made) to avoid excessive growth in spring and nitrogen leaching or runoff. One study at the University of Illinois showed that when nitrogen was applied at moderate rates in late fall (1 lb. of nitrogen/1000 sq. ft) both urea and sulfur-coated urea provided a better early spring color response than Milorganite. However, when Milorganite or sulfur-coated urea was applied in late fall at a higher rate of nitrogen (2 lb. of nitrogen/1000 sq. ft), spring green-up was similar to that obtained from applying urea at a lower rate (1 lb. of nitrogen/1000 sq. ft in late fall).

Slow or controlled-release nitrogen sources may be a better choice than soluble sources on sandy soils because of reduced potential for leaching. Nitrogen fertilizer should never be applied to frozen soil due to the increased chance of nutrient runoff.

Although application timing is not as critical with phosphorus and potassium as it is with nitrogen, these elements can benefit turf when applied in late fall. Phosphorus is important for root growth and maturation of turfgrasses and application rates should be determined according to soil test recommendations. If your soil test report indicates a need for phosphorus, late fall is a good time to fertilize. However, there is no need to apply additional phosphorus if it is present at sufficient levels. Turfgrasses require potassium in relatively large amounts, so annual applications are usually required. This element enhances cold-hardiness, disease-resistance, and wear-tolerance of turfgrasses. For these reasons, late summer and late fall are ideal times to fertilize with potassium.

ONE REPORTED ADVANTAGE IS THAT ROOTS ARE STILL GROWING IN LATE FALL WHEN SHOOT GROWTH HAS CEASED, THUS ALLOWING THE ROOTS TO MAKE FULL USE OF THE FERTILIZER

Late fall fertilization should take place when shoot growth ceases, the grass is still green, and before the soil freezes. Benefits of fertilizing in late fall include better winter color, enhanced spring green-up, and possibly increased rooting.

Typically, moderate amounts of soluble nitrogen provide good turf color without excessive shoot growth in early spring. However, slow-release nitrogen sources can also provide a good color response in early spring when used at higher rates. To avoid potential leaching and runoff problems, use slow-release nitrogen sources on sandy soils. Do not apply fertilizer to frozen soils. ST

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Silicon in the life and performance of turfgrass

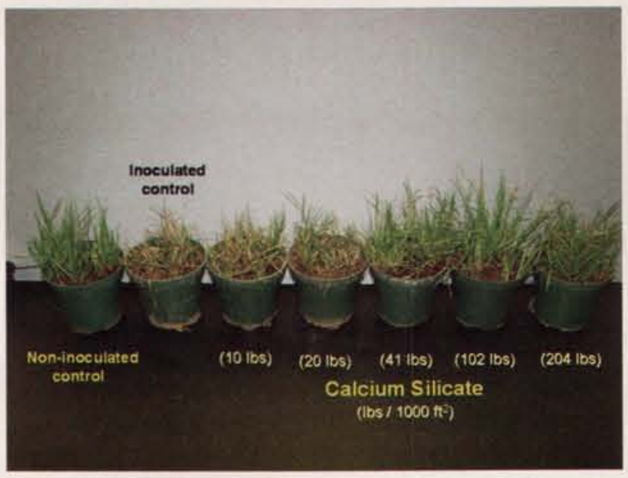
BY **DR. LAWRENCE E. DATNOFF**

There has been a growing interest in the element silicon and its effects on the life and performance of plants over the past few years. Silicon (Si) is the second most abundant mineral element in soil after oxygen and comprises approximately 28% of the earth's crust. Despite the abundance of Si in most mineral soils worldwide, Si deficiency can still occur due to Si depletion from continuous planting of crops that demand high amounts of this element, such as rice. Silicon deficiency occurs more often in highly weathered, low base saturation and low pH soils such as Oxisols and Ultisols in Asia, Africa, and Latin America.

Heavy rainfall in regions where these two types of soils occur can cause high degrees of weathering, leaching, and desilification. Organic soils (Histosols) are also deficient in plant-available Si because of the greater content of organic matter and low content of minerals. Those Entisols having a high content of quartz sand (SiO_2) are also low in plant-available Si. Such Si-deficient condition may be prevalent on USGA-based quartz sand greens and tees.

Soil solutions generally have a Si concentration of 3-17 ppm. This is considered low, but nevertheless it is 100 times greater than phosphorus in most soil solutions.

Many plants are able to uptake Si. Plants absorb Si from the soil solution in the form of monosilicic acid, $Si(OH)_4$, which is carried by the transpiration stream and deposited in plant tissues as amorphous silica gel, SiO_2nH_2O, also known as opal. Depending upon the species, the content of Si accumulated in the biomass can range from 1 to greater than 10% by dry weight.



Influence of silicon on gray leaf spot development in perennial ryegrass. Calcium silicate was the silicon source applied at 10 to 204 lbs. / 1000 ft2.

Si in turfgrass

Fertilization with Si has shown positive effects in alleviating abiotic stress as well as improving plant growth and development in several turfgrass species. Since Si improves leaf and stem strength through deposition in the cuticle and by maintaining cell wall polysaccharide and lignin polymers, the possibility exists that Si could improve wear tolerance. Saiguisa and his colleagues demonstrated significant improved wear resistance in the Zoysiagrass cultivar 'Miyako'. Foliar spraying potassium silicate, 0.02 or 0.04 lbs. Si/1000 ft2, or applying as a soil drench, 0.45 lbs. Si/1000 ft2, also significantly reduced the injury caused by wear around 20% to seashore paspalum. However, K alone or together with Si provided the same effect.

In another study, several cultivars of creeping bentgrass and Zoysiagrass had improved turf quality, growth, and resistance to traffic and heat stress. Under severe drought stress, Si fertilized St. Augustinegrass plants had a better response than those non-fertilized. Leaf firing and density were significantly greater by 13% and 23.5%, respectively, in Si-fertilized plants. Quality, color, and density also were significantly enhanced when fertilized with Si over the controls by 19%, 13.6% and 8.5%, respectively. However, under these test conditions, visual scores were all below what would be considered acceptable for turfgrass use. Nevertheless, this demonstrates that Si may improve these turfgrass qualitative factors under extreme drought stress. Schmidt and his associates also showed that foliar applications of Si significantly enhanced photosynthetic capacity increasing chlorophyll content especially during the summer when plants were influenced by environmental stress.

Gussak et al. demonstrated increased growth and establishment of creeping bentgrass (Agrostis palustris Huds.) fertilized with Si. Brecht et al. and Datnoff et al. also demonstrated similar results in St. Augustinegrass. A percent bare ground coverage (vertical prostrate growth) rating was recorded 11-12 weeks after sprigging a field with St. Augustinegrass by estimating a visual percent area of bare ground covered by grass in a 21.5 ft2 area. They demonstrated that the final percent bare ground coverage was significantly increased by using Si by 17 to 24% over the control. Ten months after sprigging, one pallet, containing about 500 ft2 of St.Augustinegrass, was harvested from each treatment-silicon and a control. Sod pieces (mat), 12x24 inches, were washed to remove soil, dried for 48 hours and weighted.

In addition, fresh, intact sod pieces (mats) from each treatment were transplanted to a sand site and monitored for turf quality and root length development for 21 days. At harvest, the treatment that had been fertilized with Si had a dry sod mat weight that was 13% significantly higher than the control. Sod pieces amended with Si also had improved turf quality ratings, 7.1 to 7.6 vs. 6.6 to 7.1 in comparison to the non-fertilized control, 14 and 21 days after being transplanted to the field. In addition, Si treatments had a significantly greater increase in newly generated roots, 2.0-2.5 inches in root length, in comparison to the non-fertilized control.

Silicon also has been effective in suppressing diseases in a number of warm and cool season turfgrass species. Silicon has increased the resistance of zoysiagrass to Rhizoctonia solani creeping bentgrass to Pythium aphanidermatum, Sclerotinia homoeocarpa and R. solani and in Kentucky bluegrass to powdery mildew (Sphaerotheca fuliginea). Si reduced Gray leaf spot development over a range of 19-78% on several cultivars of St. Augustinegrass under greenhouse conditions. In field experiments, Si alone was compared to foliar sprays of chlorothalonil, and Si plus chlorothalonil for managing gray leaf spot development. Gray leaf spot was reduced by 17-27, 31-63 and 56-64% for Si alone, chlorothalonil alone, and Si plus chlorothalonil, respectively, compared to a non-treated control. Recently, Nanayakkara et al. demonstrated similar results in perennial ryegrass turf. They showed that gray leaf spot severity was reduced from 11-24%.

Datnoff and Rutherford recently evaluated the ability of Si to enhance disease resistance in Tifway bermudagrass to Bipolaris cynodontis, the cause of leaf spot and melting out. They found that plants fertilized with Si had 39% fewer lesions than plants non-fertilized. Silicon increased in leaf tissues 38-105% over the control.

Resistance to plant diseases

The effect of Si on plant resistance to disease is considered to be due either to an accumulation of absorbed Si in the epidermal tissue, or expression of pathogensis-induced host defense responses. Accumulated monosilicic acid polymerizes into polysilicic acid and then transforms to amorphous silica, which forms a thickened Si-cellulose membrane. By this means, a double cuticular layer protects and mechanically strengthens plants. Silicon also might form complexes with organic compounds

IN ANOTHER STUDY, SEVERAL CULTIVARS OF CREEPING BENTGRASS AND ZOYSIAGRASS HAD IMPROVED TURF QUALITY, GROWTH, AND RESISTANCE TO TRAFFIC

in the cell walls of epidermal cells, therefore increasing their resistance to degradation by enzymes released by fungi.

Research also points to the role of Si in planta as being active and this suggests that the element might be a signal for inducing defense reactions to plant diseases. Silicon has been demonstrated to stimulate chitinase activity and rapid activation of peroxidases and polyphenoxidases after fungal infection. Glycosidically bound phenolics extracted from Si amended plants when subjected to acid or B-glucosidase hydrolysis displayed strong fungistatic activity. More recently, flavonoids and momilactone phytoalexins, low molecular weight compounds that have antifungal properties, were found to be produced in both dicots and monocots, respectively, fertilized with Si and challenged inoculated by the pathogen in comparison to non-fertilized plants also challenged inoculated by the pathogen. These antifungal compounds appear to be playing an active role in plant disease suppression.

That Si plays an important role in the mineral nutrition of plant species such as rice and sugarcane is not in doubt nor is its ability to enhance plant development and efficiently control plant diseases. Now evidence is accumulating that similar effects occur in certain turfgrasses. Effective, practical means of application, affordable sources of Si, and methods for identifying conditions under which Si fertilization will be beneficial are needed for use in turfgrass management. However, research on the use of Si for turfgrass is in its infancy. For example, no soil tests for gauging amounts of plant-available Si have been calibrated for turfgrass. Furthermore, most analytical laboratories do not routinely assay plant tissue for Si.

In fact, the current standard tissue digestion procedures used in most laboratories would render Si insoluble, making an analysis of the digested tissue meaningless. Thus, the two analytical tools (soil and plant tissue) most often used for determining the need for fertilization with plant nutrients are not widely available for Si. While a number of beneficial responses of turfgrass to Si applications have been documented in controlled experiments, particularly in the laboratory, few large-scale field effects have been observed to date. Conditions under which beneficial responses to Si fertilization will occur are not well known for turfgrass.

Nevertheless, as the need for environmentally friendly strategies for management of abiotic and biotic stress increases, Si could provide a valuable tool for use in plants capable of its accumulation. The use of Si for improving plant performance while controlling plant diseases in turf would be well-suited for inclusion in integrated pest management strategies and would permit reductions in fungicide use. As researchers and turfgrass managers become aware of Si and its turf potential, it is likely that this often overlooked element will be recognized as a viable means of enhancing turfgrass health and performance. ST

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