A GUIDE TO TURFGRASS FERTILIZATION

Many factors are involved in establishing and managing healthy turf. Overlook one, and you may be wasting your time with the rest.

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Maintaining a quality turfgrass stand depends of a variety of management practices. The most critical are proper species and variety selection for the site, soil preparation, mowing, irrigation and fertility practices. Failure to seriously consider and properly implement any of these factors invariably leads to a decline in turfgrass performance and a rise in potential pest problems.

Some landscape managers, like lawn care operators, often have control only over the site's fertility. Thus, it becomes even more critical for these businesses to implement sound fertilizer programs that maximize the performance potential of an existing turfgrass stand.

Sod damaged two weeks after installation due to high soluble salts. When soil testing for new sites, obtaining a soulble salts test in addition to the regular test can prove very valuable.

Nitrogen fertility

Nitrogen fertility has received far more attention than any other nutrient and more than most other management practices. This is not suprising. Nitrogen can have a dramatic impact on turfgrass growth, color, density, recuperative capacity, tolerances to environmental stresses, competitiveness against weeds, and incidence of diseases. Using a sound nitrogen fertility program can have a major beneficial impact on producing quality turf. But an unsound program can just as easily create major problems and result in the rapid deterioration of a stand.

Several factors must be considered when implementing a nitrogen program: turfgrass species, rate and time of application, geographic location, source of nitrogen, soil type, other management practices and special problems. All of these factors are interrelated and impact on the final nitrogen program devised. Consideration of only one or two of these factors in a program's development will generally result in less than satisfactory results.

Phosphorus deficiency on creeping bentgrass. The turf has thinned to a wilted, purplish appearance that could be mistaken for drought stress. This turf will green up slowly in the spring.

Turfgrass species

Large differences exist among the turfgrass species in nitrogen rate requirements and optimum timing of application. The inability to correctly identify turfgrass species can lead to misapplications of nitrogen. What follows are numerous pest and environmental stress problems. The most common example would be differences in optimum timing of application for warm- versus cool-season grass species. Late spring through early fall is generally optimum for the former; late summer and fall generally being ideal for the latter.

Ideal rates of application vary tremendously among the species, even within the cool- and warm-season grass species. Thus, the first factor that must be considered in developing any program is the predominant (or desired) turfgrass species.

In a mixture of species, you can shift populations over a period of years towards a desired species simply by manipulating the nitrogen program.

Application rates

Over the years, standardized nitrogen application rates have become widespread for the different turfgrass species. They are commonly used without much thought. These standardized rates are an averaging of rates found to produce acceptable turf over a wide range of conditions.

For the good turfgrass manager however, these rates only provide a rough guideline. They must be adjusted, sometimes dramatically, for local conditions.

For example, turf grown on excessively sandy soils, particularly those that recieve heavy irrigation, may need more nitrogen than the standardized rates. Turf stands which are heavily used and need greater than normal recuperative rates, such as athletic fields, may also need more nitrogen. However, where limited budgets may restrict mowing to infrequent intervals, reduced nitrogen rates would be advisable to prevent too much tissue removal and potential turf scalping.

Application timing

Perhaps no greater mistake is made by homeowners than nitrogen applications during the wrong time of year. Unfortunately, this type of mistake is not limited to homeowners. It is commonly made by turfgrass professionals as well, often due to the economics and demands of business rather than to a lack of agronomic knowledge. The results in either case can be devastating.

A common example of the economics versus agronomics problem occurs in the spring fertilization of cool-season grasses in the transition zone. Spring applications in excess of 1 pound of nitrogen per 1,000 square feet can cause disease and summer stress problems in many situations. But the demand for increased dark green color (particularly in comparison to their neighbors) often leads to excessively high nitrogen rates for this time of the year. Turf loss or failures later in the year are often the result of this problem (although the reduced quality is usually blamed on other factors).

As the above example suggests, the problems of timing of application are usually related to the rate. Whereas small applications of nitrogen (1/8 to 1/4 pound per 1,000 square feet) usually cause no problem and are generally

Other factors to consider when selecting a nitrogen source

When choosing a nitrogen source, it is important to contact local turfgrass researchers and extension specialists. They can help determine which nitrogen sources have performed best in your geographic location. However, you must not only consider cost and general performance.

Although several different nitrogen sources may produce excellent results, the application program (timing of application, number of applications, etc.) to produce favorable results can vary dramatically for these nitrogen sources both within a region and among regions throughout the country. Consider the following:

Soil Type. The soil upon which turf is growing can substanially alter the nitrogen program needed to produce acceptable turf. Soil influences the breakdown rate of fertilizers, the leaching rate of nitrogen, and the growth rate of turfgrass and thus its annual nitrogen requirement.

The most obvious example is a soil containing substanial amounts of sand. The soil's retentive capacity for nitrogen is reduced and the leaching rate of nitrogen is increased. Thus, the annual nitrogen requirement is usually higher on these sites. More frequent applications at lower rates per application must be used to meet the needs and conditions on these soils.

Management practices. General management practices should be considered as affecting the optimum nitrogen program for the site.

Heavy irrigation will usually require that somewhat higher annual nitrogen rates be used due to leaching losses and higher turfgrass growth rates. When turfgrass clippings are removed, you are in effect also removing nitrogen from the site. Thus, annual nitrogen rates in the long term will need to be somewhat higher. Also, if pesticide applications are not available for a site or you are trying to minimize their use, it is important to adjust your nitrogen program, particularly timing of application. This will minimize potential disease and weed problems that regularly occur or can be expected to occur.

Special Problems. A good turfgrass manager will anticipate problems and will record problems that tend to reappear on a site on a regular basis. He then should adjust the nitrogen program accordingly to minimize these problems.

Diseases are typical of these recurring type problems. For example, if serious snow mold problems regularly occur on a turfgrass stand being maintained, late fall applications of nitrogen should probably be avoided, even though these applications are generally considered beneficial in most situations.

Another example is brown patch problems that recur every year on tall fescue or perennial ryegrass. Late spring applications of more than 1/2 lb. of nitrogen per 1,000 ft. should be avoided to help reduce the severity of disease incidence.

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Phosphorus deficiency in seedling Kentucky bluegrass seven weeks after planting. Only the plot on left received phosphorus.

beneficial. Despite the timing of application, higher rates may be very beneficial at certain times of the year and detrimental at others.

Geographic location

As has been alluded to previously, geographic location greatly influences the nitrogen fertility program that is most desirable. For example:

1.) The predominant species and cultivars grown are basically determined by geographic location.

2.) The length of the growing season—which directly influences the annual nitrogen requirement of a particular grass—is determined by geographic location. Bermudagrass grown in Texas will likely have higher annual nitrogen requirements than Bermudagrass grown in Maryland due to the shorter growing season in Maryland.

3.) Soil types and rainfall rates, both of which influence leaching rates of nitrogen and turfgrass growth rates, vary with geographic location.

4.) The performance of different types of nitrogen sources depends on prevailing environmental conditions. Thus, nitrogen sources that are relatively inefficient in one part of the country may produce excellent results in another.

New nitrogen sources with varying response characteristics are continually being marketed. In fact, this development of a wide variety of nitrogen fertilizers has been the most exiciting change in the area of turfgrass fertility over the last 20 years.

Essential considerations

Often the first considerations given in selecting a nitrogen source are cost and whether to select a granular or sprayable material. The most important point to remember, however, is that whichever nitrogen source you choose, most can produce good turfgrass quality if you understand their individual characteristics and adjust your application programs accordingly. Following are brief descriptions of the characteristics of some of the more important materials used in the industry today:

Urea: one of—if not the most-commonly—used nitrogen sources in the industry today, primarily due to its low cost compared to other nitrogen sources and its solubility, which allows for liquid as well as granular applications. It is 100 percent water soluble, resulting in rapid turfgrass uptake and response. However, residual response (five to eight weeks) is generally shorter than most other turfgrass fertilizers.

Urea is converted to the ammonium ion (NH_4+) in the presence of the enzyme *urease*, which is rarely limlting in turfgrasss situations. The ammonium ion then undergoes *nitrification* by micro-organisms to form the nitrate ion (NO_3-), the primary form of plant uptake. Under high pH conditions, the NH_4+ may, however, combine with an hydroxyl ion to form ammonia gas, which will volatilize. Thus, urea should be avoided on high pH soils, near the time of lime applications, or in a tank solution of high pH.

The burn potential of urea is higher than most other nitrogen sources commonly used on turf, having a salt index of 1.62 (based on equal amount of plant nutrient applied). Ureaformaldehyde and isobutylidene diurea (IBDU) have salt indices around 0.20, while methylene urea, sulfur coated urea, and natural organics are about 0.86, 0.70, and 0.70, respectively. It would be advisable that when conditions are present which are conducive to fertilizer burn, i.e. dry soil and high temperatures, that nitrogen sources with a lower burn potential than urea be selected.

Urea does have a lower burn potential than some other soluble nitrogen sources, which is one of its advantages over these materials. Ammonium nitrate and ammonium sulfate, for example, have salt indices of about 3.18 and 3.25, respectively.

IBDU: has a low solubility in water as well as having relatively small amounts of free urea. Thus, it acts as a slow release fertilizer. Nitrogen becomes available as the product is hydrolyzed. Thus, the two most important factors that influence the release rate of nitrogen from IBDU are soil moisture levels and fertilizer particle size.

As soil moisture increases, so does nitrogen release from IBDU. This is an advantage under dry conditions when little nitrogen is needed by the turfgrass plant but can be a slight disadvantage under very wet conditions, where excessive growth may be stimulated at a time when mowing is already difficult. The release rate of nitrogen from IBDU also increases as its particle size decreases, since there is a greater surface area per unit of nitrogen for water to react with.

Past research has shown finer-sized IBDU to be more efficient in regards to turfgrass use, although it is generally more expensive. Temperature has less influence on nitrogen release from IBDU than most other nitrogen fertilizers. Thus, it has proven to be a superior cool weather performer and will give excellent winter color and early spring greenup.

Most IBDU fertilizer products sold now are mixed with varying amounts of urea or soluble nitrogen fertilizer. These products will give quicker initial response than 100 percent IBDU (which can be very slow due to its low soluble fraction) and will give a more uniform response throughout the season. The drawback is a shorter residual response.

Sulfur-coated urea: urea which has been coated with sulfur. As a result, the urea is protected from immediate solubilization and the product acts as a slow-release fertilizer. Several types of sulfur-coated ureas are available on the market but research has shown that they perform very similarly.

The advantage of the sulfur-coated ureas is that the nitrogen release rate is influenced less by soil conditions than most other slow-release fertilizers. Thus, turfgrass response to sulfur-coated urea in past research has shown it to be a superior performer and has tended to be more uniform throughout the year than other slow release fertilizers.

Research at the University of Maryland has also shown performance to be excellent under a wider range of timing of applications than most other nitrogen sources, making it more flexibile. Cost has also generally been lower than other slow release fertilizers that have not been mixed with urea.

The primary disadvantage of sulfur-coated urea is that it must be applied dry whereas finer grades of other slow-release materials can usually be adapted to spray programs.

Ureaformaldehyde-type: which are produced from the chemical combination of urea and formaldehyde. The charactersitics of the fertilizer produced are primarily determined by the ratio of urea to formaldehyde used during production. As the ratio of urea to formaldehyde decreases, longer-chained UF polymers are produced. As the polymer lengths and number of longer polymers increase, the slower the release of nitrogen.

The urea/formaldehyde ratio for some typical products are approximately 1.3:1, 1.8:1 and 1.8:1 for Nitroform, methylene urea, and flowable UF, respectively. As a result, only about 1/3 of the nitrogen in Nitroform is water soluble, compared to 2/3 and 4/5 for methylene urea and flowable UF, respectively. In addition, Nitroform contains a greater percentage of longer-chained polymers in the slow-release fraction than these other products, further increasing its residual activity.

The nitrogen in the slow-release fraction of UF fertilizers is released primarily through soil microbial activity. Thus, any factor affecting microbial activity, such as soil temperature, moisture, pH and aeration, also affects the rate of nitrogen release from UF. As conditions become less favorable for microbial activity, nitrogen will be released from UF at a slower rate. Since environmental conditions that favor microbial activity are similar to those favoring turfgrass growth, nitrogen release from the slow release fraction of UF should occur at rates similar to turfgrass requirements.

There are two exceptions to this principle, however. In early spring, when cooler soil temperatures exist, a lag time exists between initial turfgrass growth. Thus, nitrogen is released from UF due to reduced microbial activity. Early spring greening (and cool weather response in general) is poorer when UF with high percentages of slow-release nitrogen are used compared to most other fertilizers. Also, during very warm weather, nitrogen release could at times be greater than is needed for growth of cool-season turfgrass species in the transiton zone.

Another potential problem exists when UF with high percentages of slow-release nitrogen is used on all sand putting greens or athletic fields (particularly if the mix was sterilized or fumigated). Microbial activity could be very low under these conditions and nitrogen release from UF would thus be minimal. This potential problem would be greatest in the first year or two after construction.

Response to the UF products in general improve with continued use over a period of years, regardless of soil conditons.

Organics: particularly activated sewage sludges, have been used as turfgrass fertilizers for more than 50 years. The primary means of nitrogen release is through microbial activity. Thus, response patterns would generally be expected to be similar to UF products, although residual activity is shorter.

As with UF products, any soil condition adversely affecting soil microbial populations may reduce nitrogen availability to the turfgrass plant. In Maryland research, response to activated sewage sludge has been acceptable but generally not as good as most other nitrogen sources. Their low percentages of nitrogen (typically six percent or less) and high relative cost are also drawbacks. If you are interested in a purely "organic" nitrogen source for use on turfgrass site, however, they can be used successfully.

P and K

Phosphorus and potassium are essential nutrients provided by the soil. They play a variety of roles in the life and health of the turfgrass plant. The response of turfgrass plants to applications of phosphorus and potassium to soils deficient in these nutrients is not as dramatic as for nitrogen fertilization. But many weed, disease, and stress-related problems may be less critical if deficiencies are avoided.

Phosphorus is especially critical in turf establishment. Its deficiency can lead to a very thin, weak turfgrass stand that is easily overtaken by weeds. Several research studies have addressed the effects of phosphorus on turfgrass establishment. In one such study on a phosphorus-deficient soil seeded with Kentucky bluegrass/perennial ryegrass and Kentucky bluegrass/fine fescue mixtures, seedling growth and density was increased by seedbed phosphorus applications up to about seven pounds per 1,000 ft.

P and K are essential turf nutrients.

Typically, a new seeding on a phosphorus-deficient soil may look good for five or six weeks and then begins to thin and decline. This is due to the exhaustion at this point of seed phosphorus and the development of a plant deficiency due to a lack of soil phosphorus.

Importantly for those interested in reducing pesticide use, crabgrass encroachment into this area decreased dramatically with increasing phosphorus. This undoubtedly was due to a denser turf which minimized crabgrass germination and seedling survival.

Dandelion encroachment in a similar study on Kentucky bluegrass was greatly reduced where phosphorus was added to the seedbed 10 years before the actually measuring this weed's encroachment into the site. This response shows the long-term effect that proper seedbed fertility may have on a future pest problem.

Greening it up

Another quality factor that phosphorus influences is spring green-up. Turf failure to adequately grow and turn green in late winter and early spring has often been shown to be related to deficient soil phosphorus. It can easily be corrected with phosphorus applications. This delayed growth and greenup may be by as much as four to five weeks compared to similar areas nearby which have enough soil phosphorus.

As with limestone and potassium, the amount of phosphorus that should be applied to a site should be determined by a soil test. A particular soil may already be high in phosphorus and potassium and require no additional applications of these nutrients to grow quality turf. Or it may be extremely deficient and require abnormally large applications. Only after a thorough soil test can you know for certain.

However, in situations where you may not have had time to obtain a soil test, a general guideline for phosphorus application rates would be 4.0 pounds per 1,000 ft. tilled in to a four- to six-inch depth for establishment, and 1.0 pounds per 1,000 ft. for annual maintenance applications.

Potassium, although not especially critical during the establishment of turfgrass in most situations, is very important for the maintenance of an existing stand. Its most important role may be in the improvement of a turfgrass stands' tolerance to environmental stresses such as heat, drought, or cold.

Improved tolerance

Cool-season grass tolerance to heat and drought stresses is generally improved with adequate levels of soil potassium. Warm-season grass tolerance to cold stress is usually improved with adequate potassium. Applications of one to two pounds of potassium per 1,000 ft. in spring or late summer to cool- or warm-season grasses, respectively, can help improve tolerance to these environmental stresses. Sites which are very sandy, which are heavily irrigated, and/or have clippings removed (such as putting greens) may need more potassium.

The ability of turf to withstand wear such as might be encountered on athletic fields or golf courses has also been related to increased soil potassium levels. Thus, on sites where abnormal human or equipment traffic is common, maintaining medium-to-high soil potassium levels becomes more critical.

More potassium means better wear.

These improvements in both environmental and wear stress tolerances due to sufficient potassium result in a healthier, more vigorous turfgrass stand. These stands will thus usually have fewer pest problems and, when they are attacked by pests, will often exhibit less damage and will recover more rapidly from any damage that might occur.

For those interested in an integrated pest management program, it is certainly important to not only initiate a sound nitrogen fertilizer program, but also to make sure that soil levels of both potassium and phosphorus are maintained.

Soluble salts

Although not a typical soil fertility issue, an important test for soluble salts can be run by soil testing laboratories. This test can be particularly valuable in coastal areas where soil soluble salt levels may be high, but can also be valuable in diagnosing over-application or spill problems.

These high salt levels may be in dredge soils being used as "topsoil," may be due to salt spills or movement of salt from roads or driveways, or due to excessive fertilizer applications.

No matter what the reason, much effort and money could have been saved by turf managers trying to reestablish these areas if a soluble salts test had been run first. It is prudent that on any major site that is being established, particularly if topsoil has been brought from another location that soluble salts and regular soil tests be taken.

You may save yourself a substanial amount of money, as well as protecting your professional reputation, by doing so. **LM**