For parks and open spaces requiring cutting versatility, rotary mowers are a solid choice.

as creeping bentgrass or Bermudagrass, tolerate close mowing, while more upright growing grasses such as bluegrasses and ryegrasses need higher mowing heights to thrive. Another consideration is leaf texture. Fine-leaved grasses, such as certain Bermudagrasses and bentgrasses, can be mowed shorter than grasses having coarse leaf texture, like turf-type tall fescues.

The height of cut should be determined by the natural growth pattern of the specific grass variety (physiological characteristics) and the form and structure of the specific grass cultivar (morphological characteristics) in conjunction with the role the grass has to play, such as a park playground area, putting green, football field, or baseball infield.

For example, hybrid bermudagrass may have a suggested height of cut ranging from 1/4-inch to one-inch. Therefore, mowing should take place when the grass reaches a height of 3/8-inch for the 1/4-inch turf; a height of 1-1/2-inches for the one-inch turf. Kentucky bluegrass varieties with a suggested height of cut of two inches should be mowed when the grass reaches a three-inch height.

The grass plant tries to balance its below-ground root growth to its above-ground growth. When a large portion of the top growth is removed in a low cutting height, the root system becomes more shallow in compensation. A shallow root system can impair the turf's ability to withstand stress.

Turf top growth helps insulate the growing points from temperature extremes. Too warm temperatures can drive a cool season grass to dormancy. Too cool temperatures will curtail the growth of warm season grasses.

Turf top growth also serves as a cushion of protection against wear and traffic damage for grass growth points. This is always a factor on high-use athletic fields where extreme wear occurs.

Reel Close-Up

The reel mower has fixed blades, which are part of a turning cylinder (reel) that moves down and back against a stationary bedknife at the base of the mower. The blades are positioned on the reel at an angle so that they move across the stationary bedknife in a scissor-like action to produce a clean cut.

Rollers are positioned at the front and back of the cutting reel. Front rollers pass over the turf prior to mowing — they can be either solid or grooved. Optional roller scrapers can be used for cleaning the rear rollers to maintain a more consistent height of cut.

Reel mowers use individual cutting units that contain one reel per unit, combining multiple cutting units to cover a wider expanse of turf.

Walk-behind reel mowers will have a single cutting unit, whereas ride-on reel mowers may have one or multiple cutting units. Many options are available in reel mowing to meet individual needs while providing consistent quality.

A reel mower, with properly sharpened blades, gives a more precise, manicured cut than a rotary mower. A high-quality cut is delivered when the reel is pow-

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Reel Versus Rotary Mowers
continued from page 11

ered at a consistent rate in the pre-set reel-to-bedknife position with the cutting unit properly positioned for the terrain being mowed.

The cutting units should offer the option of being placed in fixed position for flat, even turf conditions or higher heights of cut, or in the "floating" position to adjust to uneven terrain. The reel power source should be able to deliver consistent power under a variety of mowing conditions.

To attain the desired close-cut precision, reel cutting units should be easy to adjust in small increments of 1/16- to 1/8-inch within a range of mowing heights. On reel mowers, the cutting height is measured from a flat, solid surface to the edge of the bedknife.

Reel mowers offer an option in the number of blades on the reel. Generally, the lower the desired height of cut, the greater the number of blades to the reel. For example, to maintain turf above one inch, use five blades; for 1/2- to one-inch turf, use six blades; and for turf maintained below 1/2-inch, use seven or eight blades.

Reel mower cutting units may be quickly detached from the traction unit so that reels can be checked or ground, or adjustments can be made. Optional backlapping valve attachments allow sharpening in place, on the mower.

Reel mowers are frequently used to give the striping effect for added aesthetic appeal. To accomplish this, a specific mowing pattern must be used on an alternating basis — perhaps following a clock pattern from six to 12, then 10 to four, eight to two, and 12 to six.

Rotary Spin

A rotary mower has one or more horizontally moving, high-speed blades that operate within a mower deck. The sharpened tips of the blades cut grass by impact.

On rotary mowers, the blades' function is not only to slice bits of grass with the two sharpened tips of the blade, but to create a vacuum within the mower deck to pull the grass up for an even, clean cut. Where material discharge is desired, the mower must generate sufficient clockwise blade rotation to move cut material to the right and discharge it out the side (or back) of the mower deck.

The addition of second and third blades within the mower deck allow the rotary mower to cut a wider swath. With a two-blade deck, the two blades must overlap. The left blade is set in further from the drive wheel while the right blade placement remains about the same to facilitate discharge at the right side of the deck. With the discharge chute at the right side, the left side becomes the trimming side, the one closest to the landscape feature when a turn is made. Because of the slightly altered relationship of the blade to the wheel, the operator must make a little "star shape" pattern to achieve a smooth cut.

In large-deck mowers with the three-blade configuration, the middle blade is set out in front of the deck with the other two blades close to the right and left drive wheels. The closer the blades are to the drive wheels, the smoother the circle cut around a tree or other landscape feature will be.

Each blade takes its series of bites. Horsepower requirements increase as the bite size increases. Foliage removed by multiple-blade decks must move a greater distance to be discharged from the mower deck, which also requires additional horsepower.

On rotary mowers, engine speed controls the blade speed. At full throttle the blades rotate 50 times per second, which translates to 175 miles per hour. The faster the mower moves forward, the larger the size of the bite taken.

Another variable in rotary mower performance is that lift can vary with the type of blade. Some blades have very little lift, while others provide a large amount that can create a tremendous vacuum or pulling action. Some mower decks have the option of changing blades to fine-tune the cutting and vacuum.

With mulching mowers, or mowers with the mulching option, the lift action of the blades combined with other mower features allow the blades to cut and recut the grass several times. The cut material is small enough to filter into the stand of grass and be hidden from view, where it slowly decomposes.

Rotary mowers can be walk-behind or ride-on units. With some ride-on units, multiple mower decks can be used. As with reel mowers, many options are available in rotary mowing machines to meet individual needs while providing consistent quality.

The rotary mower deck must follow the contour of the ground in order to put the blades in proper contact with the grass to be cut. With large-deck mowers, the wheel placement and the flexibility of motion should allow the deck to move or "float," both vertically and side-to-side, in response to the contour of the terrain to cut the turf without scalping grass or leaving uncut grass on one side of the mowing swath.

Correct set up and leveling of the rotary mower deck are extremely important for proper performance and good cut quality. With improper conditions, lift is reduced and too much of the blade comes in contact with the grass.

Cutting height adjustment allows crews to tailor the mowing to the needs of the turf. Height options should range from the lowest to the highest recommended heights for the grasses the mower will cut. The easier it is to adjust mower deck height, the more frequently the adjustments will be made. On rotary mowers, the cutting height is measured from a flat, solid surface to the cutting edge of the blades.

In general, rotary mowers are better for higher cutting heights and where control of grass is more important than aesthetic appeal. They are more versatile, better able to adapt to rough conditions, and can handle tough grasses and chop clippings well.

Rotary mowers usually are less complex mechanically and require less skill to operate and maintain than reel mowers.

Just as there's no one grass to fit all turf needs, there's no one mower right for all mowing situations. Each mower must ultimately deliver the desired cut quality at the desired turf height.

Beyond Mower Choice

Maintaining quality turf doesn't end with mower selection. Whether working with a reel or rotary mower, proper setup and service of the mower and proper choice of the machine attachment options directly influence the quality of cut, and thus the perception of the quality of the mowing unit.

The mowing unit will face challenges introduced by the cutting environment, the place where the cut actually happens. Along with the type and height of the grass and the desired finished cut height, these challenges include the lushness or thickness of the grass, the moisture content, and general characteristics of the terrain like hills, bumps, and landscaping. The operator controls travel speed and direction and engine throttle setting. Mower choice, mower condition, machine operation, and the cutting environment combine to affect grass cutting quality. ❑

Editor's Note: Steve and Suz Trusty are the principals of Trusty Associates, horticultural consultants to the green industry in Council Bluff, IA. They are frequent contributors to this magazine.

Building A Successful Fertilizer Program

By John Wildmon

Building a fertilizer program involves answering two basic questions: How much fertilizer do I apply and at what intervals? Although the questions are simple enough, the answers are somewhat more complex and must take into account a number of factors that influence the plant's nutritional needs.

A yearly fertilizer program is a necessary planning tool and can be created by utilizing information about the climate in a particular area. However, any scheduled fertilization should remain flexible enough to change when weather and other variables affect the needs of the turfgrass. In other words, the best fertilizer program also includes an ongoing process of monitoring and adjusting for changing plant needs.

Selecting specific fertilization dates and amounts must take into account factors such as climate, species of turfgrass, soil type, level of use of the turfgrass, expected quality, and release characteristics of the fertilizer. Successful monitoring requires that the turf manager be familiar with the release characteristics of the fertilizer, know where to look for the response, and be familiar with nutrient deficiency symptoms. Soil testing and tissue analysis are also useful tools.

Fertilizer needs increase as growth rate increases. Climate and species interact to determine turfgrass growth rates. Cool season grasses grow fastest in the spring and fall and need heavy fertilization in these seasons. Summer brings partial dormancy and heavy fertilization should be avoided. Warm season grasses, however, grow fastest in the summer and may require two or more fertilizer applications during that period. Most managers also fertilize in early spring after the last frost, both on cool and warm season grasses to help break winter dormancy and aid in recovery from winter damage. Additionally, late fall fertilization is gaining popularity as a means of improving winter hardiness and aiding in spring recovery.

Turfgrass species vary considerably in the quantity of fertilizer they require. High-fertility species such as bermudagrass and creeping bentgrass might require as much as one pound of nitrogen per 1,000 square feet per growing month, in high-maintenance conditions. Low-fertility species such as tall fescue or bahiagrass may require as little as 0.2 pound of nitrogen per 1,000 square feet. Keep in mind any fertilization guideline may need adjusting for specific conditions.

Guidelines for N Rates

lbs N/1000 ft sq per growing month	Species	
0.5 to 1.2	bermudagrass St. Augustinegrass	creeping bentgrass colonial bentgrass
0.3 to 0.6	zoysiagrass centipedegrass	Ky. bluegrass perennial ryegrass
0.2 to 0.4	bahiagrass carpetgrass	tall fescuegrass fine fescuegrass

Turfgrass requirements for other nutrients will be related to nitrogen rate and soil conditions. In general, rates for potassium should be approximately equal to nitrogen, while phosphorus, magnesium, and sulfur should be applied at one-quarter to one-half the nitrogen rate. Annual or semi-annual applications of micronutrients, especially in iron and manganese, will typically avoid micronutrient problems. However, some situations such as high pH soils, cold soils, or overseeding may require frequent foliar applications and/or the use of chelates. Care should be taken to avoid over-application of micronutrients, since many of them are toxic at higher concentrations.

Soil type has a dramatic effect on fertilizer rate and frequency of application. Finer-textured soils such as clays and loams have higher cation exchange capacities (CEC), consequently, they require less frequent fertilization. Conversely, coarse textured soils such as sands have low CECs and require more frequent fertilization.

Soil type may interact with other factors to affect fertilizer programs. For example, sands are much more susceptible to leaching during periods of heavy rainfall than loams or clays. Sands are frequently used for sports turf applications, such as USGA sand-spec greens and Prescription Athletic Turf (PAT) systems because of their drainage characteristics and compaction resistance. Fertility requirements for such areas will be considerably higher than adjacent turfgrasses growing on finer textured soils.

Sports turf also tends to be unique because of the high use and exceptional quality which are typically required. Excessive wear and the need for speedy recovery may necessitate additional fertilizer applications. Sports turf managers often face situations that involve high-fertility grass species, which are grown on low CEC soils, receive heavy or excessive use, and are expected to be high-quality and dense. This often involves the use of slow-release fertilizers. Fertilizer scheduling must account for the release characteristics of these products.

Time Frame

Fertilizer materials can be divided into two groups: quick-release materials (i.e. water soluble), and slow-release materials. Quick-release materials will provide an immediate response, but generally last only four to eight weeks. Slow-release materials typically will not give an acceptable initial response; however, they will begin releasing in three to six weeks and last 12 to 16 weeks. The time frame for fertilizer responses will be shortened by conditions of heavy growth, high temperature, heavy rainfall, and leachable soils. Knowledge of the release characteristics for various fertilizer materials is essential for evaluating plant responses to fertilizer.

Release Catagory for Selected Fertilizers

Quick Release Sources	Slow Release Sources
ammonium nitrate	urea formaldehyde
ammonium sulfate	IBDU
DAP, MAP	sulfur coated materials
potassium nitrate	PVC & resin coated materials
urea	sewage sludge

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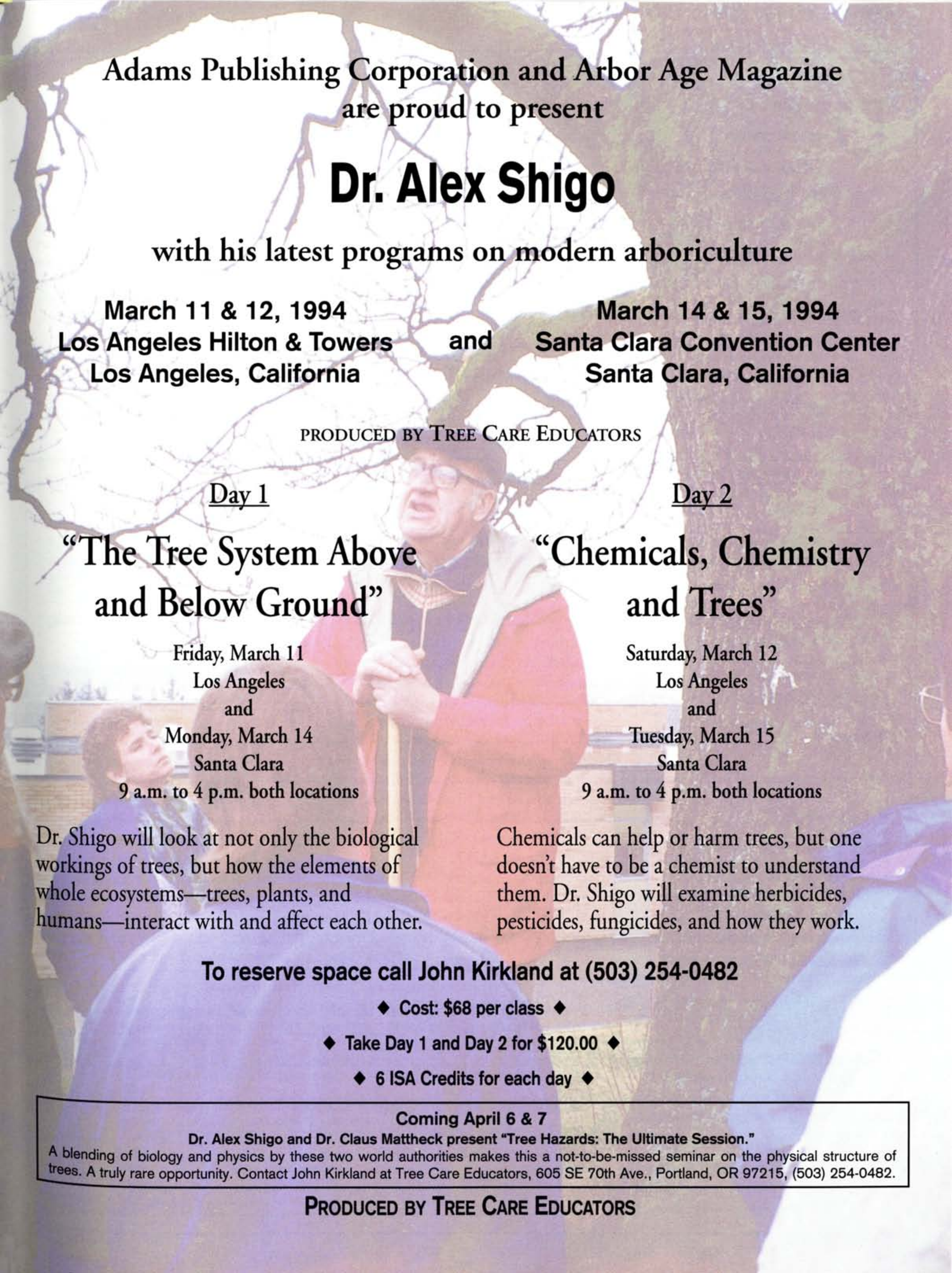
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Dr. Shigo spent 26 years as a plant pathologist for the U.S. Forest Service, where he was a chief scientist and leader of a pioneering project on tree decay. He is currently in private practice as a researcher, lecturer, author and consultant with his company, Shigo & Trees, Associates, based in Durham, NH.

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Fertilizer Program

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It is also necessary to know where to look for the response if you are going to accurately evaluate a fertility program. For example, if you applied phosphorus and waited for a color response, you would probably be disappointed. Several parameters such as color, shoot growth, root growth, tolerance to various environmental stresses, recuperative capacity, and disease resistance are affected by plant nutrition. Generally, turfgrasses will respond to increasing quantities of nutrient up to a point of sufficiency. Increasing applications of a nutrient beyond the sufficiency point will not give any additional positive plant response and may actually be detrimental.

Expected Response to Selected Nutrients

	Parameter			
	Color	Shoot growth	Rooting	Stress Tolerance
nitrogen	+	+/-	+/-	-
phosphorus			+	+
potassium	+		+	+/-
magnesium	+	+		
iron	+		+	+

\+ parameter increases with increasing quantities up to the sufficiency point

\- parameter decreases with increasing quantities beyond the sufficiency point

+/- parameter increases with increasing quantities up to the sufficiency point then decreases beyond the sufficiency point

Plants that are well below the sufficiency level in terms of nutrition for one or more elements will typically exhibit deficiency symptoms. These visible symptoms can be useful in diagnosing fertility problems. However, care must be taken to correctly identify what caused the deficiency. Even with adequate nutrient levels in the soil other root problems, such as diseases, compacted or saturated conditions, nematodes, and more, can reduce nutrient uptake and cause deficiency symptoms to occur.

A large part of managing turf nutrition is obtaining the equipment that is accurate and efficient.

Selecting specific fertilization dates and amounts must take into account factors such as climate, species of turfgrass, soil type, level of use of the turfgrass, expected quality, and release characteristics of the fertilizer.

Soil testing has been around for approximately 50 years, yet little correlation data is available concerning turfgrass fertility. This makes predicting specific fertilizer quantities from soil test results a dubious practice at best. However, soil test results can be valuable for monitoring fertility trends such as gradual build-up or loss of a particular element. Be sure to stick with same lab. Changing labs may result in a different extractant being used in the test leading to results that have no relative value when compared to previous test results. Soil test results are probably most useful when used in conjunction with tissue analysis.

Nutrient Deficiency Symptoms

nitrogen	Turfgrass initially exhibits light green color and reduced growth, left untreated progresses to a general chlorosis of the older leaves first, followed by severe stunting, thinning and general chlorosis of all leaves
potassium	Turfgrass initially exhibits less wilt resistance and some chlorosis may occur, left untreated progresses to reddish scorch of leaf margins and tip, leaf necrosis, turfgrass may take on a stemy appearance
phosphorus	Turfgrass initially appears darker green and slightly stunted, left untreated older leaves take on purple color gradually progressing to newer leaves
Magnesium	Turfgrass initially exhibits lighter green color and some growth reductions, left untreated warm season grasses develop general chlorosis of the older leaves first and some stunting. Cool season grasses will develop cherry red color in older leaves, color may be general and/or blotchy
iron & manganese	Turfgrass develops interveinal chlorosis of the new leaves first, progressing to older leaves and general chlorosis, some stunting occurs

Tissue analysis is a relatively recent tool available to the turfgrass manager. Interpretation of tissue analysis data is becoming more refined every year. Tissue analysis can be an excellent management tool and may also be a very useful diagnostic tool. Nutrient levels need to be within a fairly narrow range in the new leaves or deficiencies or toxicities can occur. Using tissue analysis to monitor fertility is similar to the use of deficiency symptoms in one respect — it only reveals tissue levels of elements. It does not tell you how the plant got that way. Various problems in the root zone will affect nutrient uptake. Consequently, deficiencies in the tissue may only be a symptom of some other problem in the root zone, not low fertility.

General Sufficiency Ranges in Turfgrass Tissue**

% dry weight new leaves	
nitrogen	3.5-5.0
phosphorus	0.3-0.6
potassium	2.0-4.0
ppm new leaves	
iron	50-300
manganese	25-250

** more precise values for your area and conditions may be available through local extension agent or university

A successful fertilizer program will make other aspects of turfgrass management easier. Remember to keep your fertilization schedule flexible to account for changing conditions. Monitor turfgrass on a regular basis and make appropriate adjustments in your program. Lack of response to applied fertilizer or deficiency in the tissue may only be symptoms of other problems in the root zone. ❑

Editor's Note: John Wildmon is an instructor at Lake City Community College in Lake City, FL. This is his second article for sportsTURF.

Speed Seed Outpaces Pregermination and Limited Priming

By Todd Detzel

Speed Seed techniques are used to prepare this Laytonville School District football field for play. Photos courtesy: Todd Detzel.

Limited priming and pregermination have been used for several years on the 6.5 acres of sports fields for which I am responsible. The fields are located in the coastal mountains of Northern California where hard frosts begin in October and occur until late May. Heavy snows usually fall in March. To further complicate matters, the athletic fields are *de facto* public parks. Therefore, rapid turf establishment, following the football and soccer seasons in the fall, and summer renovation are necessities.

Pregerminated seed was tried several years ago. It was difficult to spread and incorporate when used for overseeding. In addition, there was too fine a line between seed that was spreadable and a mass of interlocking roots that was impossible to use.

We then switched to limited priming. Although limited seed priming usually increased the speed of germination, we found the results to be inconsistent. Some batches germinated in five to seven days, while others showed no overall increase in germination compared to seed "out of the bag." In addition, we needed to have at least 70 percent of the applied seed germinate at the same time so the fields could be reopened as soon as possible. With limited seed priming, we often had to wait a week for "stragglers" to germinate before we reached this goal.

"Speed Seed" was the result of a testing program to find an alternative to limited priming and pregermination. Speed Seed techniques used on ryegrass and tall fescue have shown consistent germination in three days at 50 to 55 degrees F. and two days at a soil temperature of 78 to 80 degrees F. with appropriate seed coverage and irrigation. Bluegrass was not tested as a "binder" for these clump grasses.

The techniques tested were:

- Freezing.
- Freezing and the addition of either a wetting agent, sea weed, or fertilizer during soaking.
- Use of a wetting agent (non-ionic) during soaking.
- Inclusion of gibberellins (sea weed) during soaking.
- Inclusion of a soluble fertilizer during soaking.
- Scarification using dilute sulfuric acid.
- Pre-soaking the seed in water and then re-soaking in either water plus wetting agent, water plus sea weed, water plus fertilizer, or water plus wetting agent, fertilizer and sea weed.

It is important to understand that the soaking referred to in these tests means exactly that: the seed remained in constant contact with excess water during the soaking period(s). Therefore, it should not be confused with limited

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PRODUCT SHOWCASE

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To develop the Speed Sod process, Detzel experimented with a number of limited priming and pregermination techniques, as well as wetting agents and fertilizers, and monitored the results in test pots.

Speed Seed

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priming where seed is merely wetted for short periods of time during "aging."

An excess of water assured that available water remained constant and could therefore be repeated. This is not true for limited priming where the seed is not able to reach a stable osmotic condition. In addition, the temperature during soaking remains more or less constant because of the large volume of water. This helps ensure consistent germination from batch to batch.

Promising Results

All seed was dried at room temperature before testing. The results showed distinct advantages and disadvantages.

1. Pre-frozen seed that was soaked only in water for 12 to 16 hours germinated three days after planting at 55 to 60 degrees, and two days at 70 to 80 degrees. This was faster than any other technique, including the previously used limited priming method, and the seed germinated consistently.

2. A wetting agent increased the germination time and reduced the percentage of germination, regardless of how it was used.

3. A soluble fertilizer incorporated with the wetting agent reduced the germination time when compared to the use of a wetting agent alone and increased the percentage of germination, but took days longer compared to pre-freezing.

4. Sulfuric acid scarification substantially reduced the rate and percentage of germination.

5. The rate of seed growth, as received, soaked in soluble fertilizer solution, showed little difference in growth rate compared to prefrozen seed seven days after germination. However, it took five days to fully germinate.

6. Pre-freezing without soaking did not reduce the germination period.

7. Gibberellins from sea weed did not speed germination or increase the growth rate following germination.

8. Soaking beyond 12 to 16 hours removed needed nutrients as shown by tests, which incorporated a fertilizer in the soaking water.

9. There was no difference in the germination rate between unsoaked, prefrozen seed and seed from the bag.

Tips For Success

Although space does not permit a thorough review of each test, we found three obvious keys to optimizing the rate of germination. The first key is freezing the seed for two to four weeks before soaking it in water. We could find no reference suggesting freezing turfgrass seed to increase its speed of germination.

Freezing should not be confused with pre-chilling, which is noted in Dr. James Beard's book, *Turfgrass Science and Culture*, where there is a reference to pre-chilling seed at 38 to 50 degrees. The test seed had been stored for several months at these temperatures, yet the pre-frozen seed exhibited far faster germination compared to unfrozen seed after soaking.

If a walk-in freezer is not available at your facility, the best alternative would be to soak the seed directly from the bag in water containing about one-half-ounce per gallon of 20-20-20 soluble fertilizer for 16 hours, followed by rinsing and drying. Seed treated in this way began to germinate in about five days at 55 to 60 degrees. However, it must be remembered that the test seed had been stored at cool temperatures.

We did not determine whether there is an optimum freezing time or temperature, but rather used a time period and freezing temperature that was practical for the grounds program.