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The value of lime in turfgrass management

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Spring is fast approaching and the workload for the turf manager is already increasing. By the time winter damage has been fully assessed and corrective measures taken, there is the risk of overlooking a very simple yet basic part of turf culture: determining the need for soil pH adjustment.

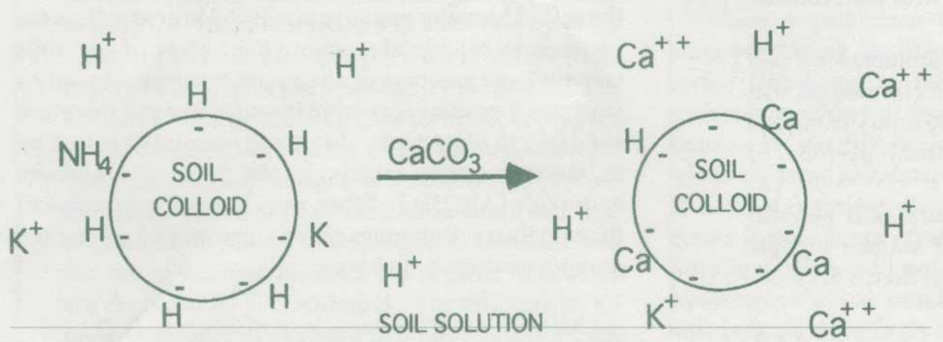
Soil pH and grass growth

For most areas east of the Mississippi, this involves adding lime to raise soil pH to between 6.0 and 6.5. Most turfgrasses grow best within that pH range. While some bentgrasses and fine-leafed fescues will tolerate lower pHs, even they often respond favorably to lime applications.

One problem with pH adjustments is that the grass rarely tells you that the soil is becoming too acid. Any turf decline due, in part, to acid soil conditions is so gradual that even the most attentive manager will rarely see it happening. Lime application is one management practice that is best scheduled by the calendar. Of course an annual soil test will indicate if your soil is becoming too acid and it should raise the red flag that corrective action is needed. Why is soil pH important? You probably know turf managers who rarely use lime and maintain excellent quality turf. During times when budgets are tight, isn't lime application one expense that can safely be delayed?

I would answer this last question in the

Calcium exchange for H^+ on soil colloids



Calcium ions from calcium carbonate exchanging for hydrogen on soil colloids of an acid soil. Hydrogen released from colloids into solution are neutralized by hydroxides which are produced when calcium carbonate dissolves in soil water.

Figure provided by Dr. Richard J. Hull, University of Rhode Island

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negative. While soil pH adjustment can be delayed without causing marked injury to your grass, lime application remains one of the most cost-effective practices in turf management.

Advantages of raising pH

Reducing soil acidity by applying lime is beneficial in ways that are not obviously linked with soil pH.

- Increasing soil pH by adding lime increases the availability of several plant nutrients and makes fertilizer applications more effective.
- Increasing soil pH reduces the plant availability of toxic aluminum and manganese. Aluminum stunts root growth and makes grasses less able to recover nutrients and water.
- Calcium added as lime is a plant nutrient that increases the efficiency with which grass roots can absorb other nutrients.
- Increasing soil pH favors microorganisms which are responsible for turning over organic matter thereby making residual nitrogen more available to grass roots and probably suppressing the growth of disease causing organisms.
- By stimulating microbial activity and favoring vigorous root growth, reduced soil acidity will minimize the opportunities for nitrate leaching into ground water.
- Increased biological activity of the soil promoted by higher pH will contribute to improved soil structure with increased air and water penetration.
- Increased root growth promoted by soil conditions resulting from elevated pH will make grass less subject to injury from root feeding insects and from periods of drought.
- Maintaining a near neutral soil pH will speed decomposition of surface organic residues and help prevent thatch accumulation.

Other advantages attributable to soil pH adjustment through the application of lime could be stated, but this list gives you some idea of the broad range of benefits that have been linked to the use of lime. Given the low cost of ground limestone and its comparative ease of application, is there any surprise that the benefits derived from its use make lime one of the most cost effective materials available to the turf manager? You might be suspicious that these claims for lime use are a bit exaggerated so let us consider the scientific basis for them.

Soil pH and plant growth

To begin, it might be useful to explain what soil acidity and pH are. Acidity simply indicates the relative concentration of hydrogen ions (H^+) in a solution. The more H^+ present in a solution, the more acid it will be. Mildly acid substances have a sour taste due to the presence of H^+. The concentration of H^+ in a solution is indicated by its pH which is the negative logarithm of the H^+ concentration expressed in moles per liter of solution. The H^+ concentration in most solutions is a very small number, e.g. a neutral solution contains 0.000,000,1 moles H^+ per liter of solution. Such small numbers are cumbersome to handle so they are often expressed as an exponential where 0.000,000,1 = 1.0×10^{-7} or as a logarithm = -7.0. To avoid the negative values, it is conventional to express H^+ concentrations as a negative logarithm so -7.0 becomes 7.0. For those not familiar with logarithms, this can become confusing because you might think a pH of 7.0 should be more acid than one of 5.0 when the reverse is true. The table on page 5 shows the relationship between pH units and H^+ concentration of solutions.

Acidity and interaction with the soil

Soil acidity is not in itself harmful to plants and does not inhibit root growth. Many plants will grow happily in a nutrient solution when its pH is between 4 and 5. Acidity is a problem primarily due to its interaction with the soil. The major negative condition in acid soils is the increase in soluble aluminum (Al). Most of our soils contain large amounts of aluminum but normally only a very small amount is soluble in soil water and therefore available to plant roots. Most soil aluminum is tied up as mineral matter largely in the form of aluminum hydroxide [$Al(OH)_3$]. When soils become acid, some of these hydroxy aluminum groups lose an OH^- giving the group a positive (+) charge.

$$Al(OH)_3 + H^+ \longrightarrow Al(OH)_2^+ + H_2O$$

Such positively charged groups are much more soluble in water than the uncharged $Al(OH)_3$. When the soil pH drops below 5.0, some mineral aluminum loses all of its hydroxides and goes into solution as a free triple charged aluminum ion (Al^{+3}). Such charged aluminum groups are dissolved in the soil solution and can be absorbed by

-continued on page 4

Soil acidity and fertilizers

Many fertilizer materials can have an effect on soil acidity. Some will make a soil more acid while other materials have a liming effect. The table below lists several fertilizers commonly used on turf along with the amount of pure lime required to neutralize 100 pounds of the material.

You will observe that those fertilizer materials which contain nitrogen in the ammonium form will contribute to soil acidity. If ammonium is oxidized to nitrate by soil bacteria (nitrification), H^+s are released into the soil solution and that contributes to acidity. When ammonium is absorbed by grass roots, it essentially exchanges with H^+ in the roots and that also makes the soil slightly more acid. The amount of acid produced by the fertilizer is roughly proportional to the amount of ammonium-nitrogen in it. Even if the nitrogen in a fertilizer is present as organic molecules not as an ammonium salt, e.g. urea or Milorganite, the nitrogen is released into the soil as ammonium when the organic molecules are degraded by soil microbes. For this reason, all organic sources of nitrogen will have an acidifying effect on the soil.

Fertilizers which contain nitrogen in the nitrate form actually make the soil a little less acid. This is because each nitrate ion enters plant roots or microbial cells along with two H^+s (see TGT September 1994). This absorption of H^+ by living cells removes acidity from the soil solution which is the equivalent to adding a small amount of lime (indicated as 'B' in the table below). Any nitrate containing fertilizer will have an acid neutralizing effect unless it is added along with ammonium, e.g. urea-ammonium solution or ammonium nitrate. Because ammonium releases more H^+s than are absorbed by cells along with nitrate, the net effect of an ammonium nitrate application is to make the soil slightly more acid.

These contributions to soil acidity by ammonium containing fertilizers are not a serious concern. Compared to the total acidity of a soil, ammonium makes a small addition. However, if ammonium fertilizers are used regularly and in relatively large amounts, as would often be the case in turf management, lime applications may be required a little more often than if nitrate fertilizers were used. I would not recommend using nitrate fertilizers to avoid ammonium acidity because nitrate is much more likely to leach out of the root zone and contaminate ground water (see TGT February 1995). It is better to apply ground limestone a little more often and use the often less expensive and environmentally safer ammonium or organic fertilizers.

Acidity or alkalinity of fertilizers and the amount of pure lime needed to neutralize 100 lbs. of each

material	**nutrient supplied**	**nutrient content (%)**	**lime equivalent (lbs.)**
Ammonium sulfate	N	20.5	110
Calcium nitrate	N & Ca	15.0	20B*
Sodium nitrate	N	16.0	29B
Urea	N	46.6	84
Urea-ammonia solution	N	45.5	82
Milorganite	N	7.0	12
Muriate of potash	K	51.0	0
Sulfate of potash	K	43.0	0
Superphosphate	P	8.0	0

* B indicates basic reaction and lime equivalent provided by fertilizer

plant roots. The $Al(OH)_2^+$ form is absorbed most because triple charged ions do not cross root cell membranes easily. When a soil of pH 4.5 was extracted with a KCl solution, 4.33 meq of Al were removed from each 100 grams of soil. The same soil at pH 5.5 lost only 0.37 meq of Al/100 grams of soil. Consequently, making the soil less acid dramatically reduces the amount of aluminum available to turfgrasses.

It is not understood exactly how aluminum inhibits root growth but it clearly does. Plants growing in a nutrient solution containing more than 10 ppm of soluble Al produced stunted brown roots similar to those of plants growing in an acid soil. When soils become acid, other metallic elements including manganese and iron can also be made soluble and will contribute to plant toxicity. Iron and manganese are essential nutrients for plants but at the high concentrations present in acid soils, they too will cause injury to root cells and inhibit growth. In most cases, however, soluble aluminum is responsible for poor plant growth in acid soils.

While some metals (Al, Mn, Fe, Zn) become more available to plants in acid soils, others become less available. As indicated above, nitrogen availability depends on organic matter decomposition which is depressed in acid soils. Therefore, nitrogen is more likely to be inadequate when soil pH is low. Nutrients like phosphorus, molybdenum and to a lesser extent sulfur become bound into mineral structures when soils are acid and are most available to plants when soil pH is between 6 and 7. For reasons which will be explained later, potassium, calcium, magnesium and copper are readily leached from very acid soils and are best retained in a plant available form in soils of pH 6 to 7. Clearly, soil pH has a dramatic influence on the soil's ability to deliver nutrients to plant roots in a form that can be used.

Acid soil conditions not only inhibit root growth, they also depress the growth and activity of many microorganisms. Thus an acid soil may have a somewhat unique microflora, often dominated by fungi, which normally will not decompose organic residues as rapidly as the bacteria and fungi present in less acid soils. Many soil microorganisms have a distinct pH optimum for their growth which is not related to toxic metals in soil solution. Many nitrogen transforming reactions which are carried out by soil bacteria, e.g. nitrification and nitrogen fixation, are severely restricted in acid soils. This reduced biological activity caused by acid conditions creates a soil environment which does not permit rapid turnover of plant nutrients either from plant residues or organic fertilizers and makes the soil generally less fertile and suitable for plant growth.

How does lime raise soil pH?

While there are several liming materials, the least expensive and most widely used on turf is ground limestone. Limestone is composed mostly of calcium carbonate ($CaCO_3$) which is a natural mineral mined throughout the world. It is ground to a fine powder so that all will pass a 10 mesh screen and about 20% will pass a 60-100 mesh screen. The finer the grind, the more rapidly limestone will raise soil pH. When added to an acid soil, ground limestone reacts with soil water and releases into solution free calcium ions (Ca^{++}), bicarbonate ions (HCO_3^-) and hydroxide ions (OH^-).

$$CaCO_3 + H_2O \longrightarrow Ca^{++} + HCO_3^- + OH^-$$

The OH^- then reacts with H^+ in the soil solution to form water.

$$OH^- + H^+ \longrightarrow H_2O$$

If the soil is sufficiently acid, the HCO_3^- will form another OH^- which will react with another H^+ to produce H_2O and CO_2. The CO_2 is a gas and is lost to the atmosphere.

$$HCO_3^- + H^+ \longrightarrow CO_2 + H_2O$$

Thus, for every $CaCO_3$ that reacts completely with the soil solution, two H^+s are neutralized to water.

That is how limestone removes H^+ from the soil solution but it also does another important job. The Ca^{++} released into the soil solution from limestone displaces H^+s that are attracted to fixed negative (-) charges on the solid particles of the soil. The Ca^{++} replaces H^+s on the fixed negative charges and the H^+s (now in solution) are neutralized by other $CaCO_3$ molecules from limestone. Thus, not only are H^+s in solution neutralized by limestone but also those H^+s bound to negative exchange sites on the fine solid particles of the soil. Most of the acidity in a soil is the result of H^+s bound to exchange sites and because limestone neutralizes them as well as those in solution, it is very effective in raising soil pH (lowering the H^+ concentration).

The Ca^{++} now attracted to negative charges on fine soil particles (clay and organic matter) can exchange places with other positively charged nutrient ions, e.g. K^+, Mg^{++}, NH_4^+ (Figure 1). When these negative exchange sites attract basic nutrient ions instead of H^+s, those ions remain available to plant roots and the fertility of the soil is increased. In this way, limestone not only raises soil pH but it also increases the percent base saturation of exchange sites which increases the nutrient delivery power (fertility) of the soil.

Other lime materials also are used. Calcium hydroxide (slaked lime) and calcium oxide (burned lime or quicklime) contain more neutralizing power per pound of material and react in the soil more rapidly than ground limestone. Thus, while limestone will take two years or more to raise soil pH to the level desired, these other more reactive materials will do it within a few months. However, these liming materials are more expensive than limestone, are more dangerous to handle and have the potential to injure turf if applied directly to growing grass. Consequently, ground limestone is normally recommended as the material of choice for use on turfgrasses.

Using lime on turf

Because ground limestone requires about two years to achieve its full benefits, it is wise to think ahead when making lime applications. Lime works best when it is incorporated into the top six to ten inches of soil. For turf, this can only be done prior to seeding or laying sod. If the soil is acid, incorporating ground limestone thoroughly within the top soil is the most effective way to prevent acidity based problems. This is also a time when the more reactive liming materials can be used with no concern over injuring turf. These materials will raise soil pH more rapidly than ground limestone. Phosphate fertilizer can be incorporated into the soil prior to seeding because it also is difficult to distribute throughout the root zone once the turf is in place. Distributing lime and phosphate fertilizer throughout the root zone will help insure rapid establishment of a strong and deep root system. Other major nutrients are more mobile in the soil and can be applied effectively after the turf is in place. The amount of limestone to apply should be based on a soil test and, prior to establishment, there is little concern over applying too much at one time.

The relationship between pH and the H^+ concentration of solutions

pH	H^+ concentration moles/liter	Acidity level
0	1.0	Strong acid
1	0.1	Strong acid
2	0.01	Highly acid
3	0.001	Highly acid
4	0.000,1	Very acid
5	0.000,01	Acid
6	0.000,001	Mildly acid
7	0.000,000,1	Neutral
8	0.000,000,01	Mildly alkaline
9	0.000,000,001	Alkaline
10+	0,000,000,000,1-	Highly alkaline

Established turf presents more of a problem for pH adjustment. Surface applications of liming materials will reduce acidity of the surface soil but deeper layers will take much longer to respond. The best approach is to apply lime regularly, no more than 25 to 50 pounds per 1000 sq-ft at a time. If calcium hydroxide or oxide forms are used, use less than 25 pounds per 1000 sq-ft per application. Larger rates will cause turf burning especially when temperature and humidity are high. For surface application, these more reactive liming materials offer no real advantage. Monitor soil pH via soil test and if a declining trend is evident, increase annual lime use preferably by making more frequent applications. Lime can be applied at any time of the year. Early spring and late fall are good because less disruption of turf use will occur then and natural incorporation through rainfall is more likely. Applying lime to frozen ground is fine so long as run-off is not likely. Run-off has rarely been observed on turf but it can occur when the soil is frozen and water infiltration is prevented. Applying lime to snow is risky especially if the snow might be blown into drifts. It is also more difficult to observe a uniform application pattern when the ground is white.

With spring hard upon us and soil test in hand, now is a good time to consider your liming program. If your soil pH is between 5.0 and 6.0, a lime application is warranted. Even if the soil is between 6.0 and 6.5, light maintenance applications are probably justified. Remember, response to lime will be slow so it is best not to wait until a serious acidity problem is before you. Use a fine grind of limestone even if it is a little more costly. It will provide more rapid results even when used as a surface application. Dolomitic limestone ($CaCO_3 + MgCO_3$) is recommended unless your soil analysis reports a high magnesium level. Magnesium is a macronutrient which is not likely to be supplied in fertilizer and may not be provided in significant amounts in top dressing materials. Dolomitic limestone is the least expensive way to provide this element which is essential for healthy grass growth.

Both calcium and magnesium are essential for grass growth. Ground limestone provides these nutrients while it maintains soil pH within an optimal range. For the expense and effort involved, regular lime applications may be among the most cost effective management tools available to the turf manager. ■

Which Kentucky Bluegrass cultivars are best for you?

Dr. Bridget Ruemmele, University of Rhode Island

Most grasses grown in the northern and transition zones are classified as cool-season turfgrasses. These plants prefer temperatures between 60 and 70 degrees Fahrenheit, which is why they thrive in these regions from spring through fall. Cool-season turfgrasses also have good cold tolerance as well, enabling them to survive sub-freezing northern winters.

Kentucky bluegrass, (*Poa pratensis* L.) is a widely grown cool-season turfgrass. Although you might surmise that this grass comes from Kentucky, it is actually native to Europe. You may find Kentucky bluegrass on home lawns, around industrial sites, in parks, and on athletic fields. This grass is usually mixed with two other cool-season turfgrasses: fine fescues and perennial ryegrasses. Each grass contributes specific attributes to the mixture, enabling establishment over a wider range of environments.

Kentucky bluegrass leaves are medium to fine textured with a medium to dark green color. A distinguishing character of this grass is the boat-shaped tip found on unmown leaf blades.

The good sod-forming ability of this grass is one reason it is so popular. Underground stems, known as rhizomes, become interwoven, forming a strong, dense sod. These rhizomes also enable Kentucky bluegrass to recuperate more rapidly from injury or wear compared to other cool-season turfgrasses. A good, dense stand of Kentucky bluegrass will prevent most weeds from becoming established.

Kentucky bluegrass exhibits moderate tolerance for heat and drought. If summers become excessively dry and hot, this grass turns brown, becoming dormant until cooler temperatures and adequate moisture return.

Well-drained, fertile soils on open, sunny sites favor Kentucky bluegrasses. Although not known for shade tolerance, some cultivars of Kentucky bluegrass tolerate moderate shade. Examples include A-34, Bristol, Eclipse, Glade, Nugget, and Touchdown.

The most limiting nutrient for turfgrasses is usually nitrogen. Kentucky bluegrasses grow best with 2 to 4 pounds of actual nitrogen per 1000 square feet per year. Excessive nitrogen on Kentucky bluegrass may result in undesirable thatch development. Too much thatch inhibits water infiltration into the ground for favorable turf root growth, while increasing the potential for disease and insect damage. Preferred pH ranges from 6 to 6.5 or 7. In some areas, naturally low pH levels may necessitate the use of lime to bring the pH up to the desired range.

Kentucky bluegrasses should be mown at heights between 1.5 to 2.5 inches. Mowing height should be raised 1/2" higher than normal during high heat and humidity, which often occur in summer.

Occasionally, disease and insect pests may attack Kentucky bluegrasses. Leaf spots, dollar spot, stripe smut, necrotic ring spot, and summer patch are some of the more damaging diseases. The severity of some diseases may be reduced by adjusting management practices. Optimal pH and nitrogen levels, as well as avoiding drought stress, reduce occurrences of disease outbreaks. Several improved cultivars selected for genetic disease resistance or tolerance have been released over the past 30 years. Severe disease eruptions may require fungicidal controls.

Chinch bugs and Japanese beetles have been particularly severe insect problems on many turfgrasses. Hot, dry conditions favor chinch bugs. Milky spore disease is a biological control which has had limited success in the battle against Japanese beetles. Its availability has also been quite limited. Chemical controls are available for severe infestations of both chinch bugs and Japanese beetles. Other potentially damaging insects to Kentucky bluegrasses include bluegrass billbugs and sod webworms.

When selecting Kentucky bluegrasses, they may be grouped into improved and common types. Improved types, such as Midnight, Lofts 1757, 1757, and SR2000 generally have been developed for better growth characteristics or enhanced pest tolerance or resistance. Common types, like Park and South Dakota Certified tend to do better under lower maintenance conditions where higher mowing heights are used. Common types also tend to be more susceptible to leaf spot diseases than improved Kentucky bluegrasses.

The University of Rhode Island, along with universities across the country, conducts cultivar evaluations of several turfgrasses, including Kentucky bluegrass, as part of the National Turfgrass Evaluation Program (NTEP). Usually, every four or five years a new cultivar test is initiated for each species. The last complete Kentucky bluegrass trial ran from 1985 through 1990 with 72 entries grown under one kind of management scheme at each location.

Our current tests in Rhode Island, started in 1990, contain both low and high maintenance trials. Changing demands and environmental concerns necessitated inclusion of a low maintenance evaluation to determine which, if any, Kentucky bluegrasses would thrive under reduced fertility and irrigation management. The low maintenance group involves 64 cultivars mown at 2 inches, fertilized with 2 pounds nitrogen per 1000 square feet per year with no supplemental irrigation. The high maintenance test has 144 cultivars mown at 1 1/2 inches, fertilized yearly with 3 to 4 pounds nitrogen per 1000 square feet per year, and irrigated as needed to maintain active growth. Both trials have silt loam soils with potassium levels between 241 and 375 pounds per acre, phosphorus levels between 271 and 450 pounds per acre and pH ranging from 6.1 to 6.5.

Cultivar tests are evaluated regularly for turf quality and any pest infestations. Diseases evaluated in the 1985 and/or 1990 Kentucky bluegrass NTEP tests included snow mold, fusarium patch, spring and fall melting out, leaf spot, stem rust, dollar spot, red thread, summer patch, necrotic ring spot, stripe smut, crown rust, powdery mildew, leaf rust, and stripe rust. Insect damage ratings included sod webworms and billbugs. If your location is prone to damage from any of these pests, you may want to select cultivars which suffered the least damage

Additional information such as genetic summer and winter colors, spring greenup, leaf texture, wear toler-

Bluegrass

ance, seasonal density, percent cover, dormancy and recovery potential, growth rates, sod strength, seedhead production, and nitrogen deficiency response were also recorded. Except for percent cover, which is listed as a percentage, all information is scored from 1 to 9 with 9 being the best or most desirable value.

Each evaluator may score cultivars slightly differently, so it is important to compare one cultivar's scores with other cultivars within that rating rather than comparing scores between two evaluators. Local adaptations or different management practices may also affect cultivar performance. Some cultivars perform well over a wide range of environmental conditions, while others are better suited to specific situations.

This information is compiled locally for publication in annual reports from some universities and nationally through the NTEP. NTEP results are available for a $30 subscription fee by writing to: Kevin Morris, National Director; National turfgrass Evaluation Program; Beltsville Agricultural Research Center - West; Building 002, Room 013; Beltsville, Maryland 20705. Since most turfgrasses are perennial, it is important to determine performance

Table 1

Mean quality performance of 1990 NTEP[*] Low and High Maintenance Kentucky bluegrasses at Rhode Island compared to averages across all locations during 1992[1]

	Low Maintenance		*High Maintenance*	
Cultivar	**Rhode Island**	**All Locations**	**Rhode Island**	**All Locations**
Midnight	3.4	5.6	6.3	6.4
Bartitia	4.0	5.2	5.4	6.1
Cobalt	3.9	5.2	4.7	5.8
Opal	3.8	5.2	6.0	5.7
Unique	3.6	5.2	5.4	6.1
Ram-1	4.6	5.1	6.0	5.1
SR2000	4.0	5.1	6.6	6.0
Barsweet	3.6	5.1	6.5	5.9
Sophia	4.1	5.1	NA[2]	NA
NuStar	4.7	5.1	5.9	5.9
Livingston	4.6	5.1	6.0	5.8
LSD[2]	0.7	0.3	1.0	0.2

[1]Quality ratings: 1 = poor, 9 = best.

[2]Cultivar was not included in this test.

[3]To determine statistical differences among cultivars within each column, subtract one cultivar's mean from another cultivar's mean. Statistical differences occur when this value is larger than the corresponding LSD (Least Significant Difference) value.

[*]National Turf Grass Evaluation Program

over a number of years. A five-year summary from the 1985 trial and up to fourth year data from the 1990 tests are available. Specific information from 1985 and 1990 trials are discussed below.

Of the 72 grasses in the 1985 Kentucky bluegrass test, 55 were commercially available in the United States in 1991. Most varieties mentioned in this article were commercially available in 1994. Varieties included in the following discussion are meant to be representative rather than exclusive for their respective classifications -- there may be additional unlisted varieties which could be included in each group.

With some turfgrasses, e.g. perennial ryegrass, data showed decline in performance for some cultivars as the evaluation progressed over succeeding years. Most Kentucky bluegrasses, with a stronger recuperative ability, maintained or even increased quality rating over the years of assessment in the 1985 test as indicated by the examples in Table 2.

Newer varieties like Blacksburg, Midnight, and Lofts 1757 have improved quality compared to older varieties like Park. The highest rated grasses for quality in the 1985 test include: Blacksburg, Midnight, P-104 (Princeton 104), Asset, Chateau, Lofts 1757, Coventry, Freedom, America, Eclipse, Aspen, Estate, Glade, Classic, Able I, Wabash, A-34, Cheri, and Bristol. Several other grasses were well-ranked and may be better suited to specific sites if they have a resistance or tolerance to a frequent problem at your location.

Quality ratings in 1992 for the 1990 low and high maintenance Kentucky bluegrass tests revealed different results when comparing Rhode Island to an average of all

Table 2

Mean quality performance of 1985 National Turfgrass Evaluation Program (NTEP) Kentucky bluegrasses between 1986 and 1990 averaged across all test sites.[1]

Cultivar	*1986*	*1987*	*1988*	*1989*	*1990*	**89-90** *Mean*[3]
Blacksburg	6.1	6.4	6.4	6.5	6.5	6.3
Midnight	6.1	6.3	6.4	6.3	6.3	6.2
Lofts 1757	5.8	6.0	6.1	6.1	6.1	6.0
Baron	5.8	5.6	5.9	5.8	5.5	5.7
Mystic	5.4	5.4	5.8	6.0	6.0	5.7
Ram-1	5.7	5.6	5.9	5.8	5.9	5.7
Georgetown	5.8	5.6	5.8	5.8	5.7	5.7
Merion	5.4	5.4	5.7	5.6	5.6	5.5
SD Certified	4.7	4.6	5.0	5.1	5.0	4.9
LSD[2]	0.2	0.2	0.2	0.2	0.3	0.3

[1]Quality ratings: 1 = poor, 9 = best.

[2]To determine statistical differences among cultivars within each column, subtract one cultivar's mean from another cultivar's mean. Statistical differences occur when this value is larger than the corresponding LSD (Least Significant Difference) value.

[3]Mean may be slightly different due to rounding.

reporting locations in the United States (Table 2). Many cultivars in the low maintenance test did well overall, but performed poorly at Rhode Island, including Midnight, Bartitia, Cobalt, Opal, Unique, and Barsweet. The first summer after establishment in Rhode Island was hot and dry. That season may have more severely stressed varieties than at other locations.

All other varieties listed were in the highest rated group in Rhode Island. Additional varieties performing best under low maintenance conditions at Rhode Island included: Washington, Cynthia, Baron, Liberty, Monopoly, Freedom, Voyager, Bronco, Crest, Gnome, Barzan, Alene, Banjo, Kenblue, Park, and South Dakota Certified.

Grasses in high maintenance tests typically scored better for quality compared to the low maintenance tests (Table 1). Except for Bartitia and Cobalt all varieties were in the highest rated group in Rhode Island. Other highly rated varieties in the Rhode Island test included: Blacksburg, Eclipse, Able 1, Alpine, Shamrock, Allure, Challenger, Glade, Washington, Minstrel, Classic, Indigo, 4 Aces, Nassau, Broadway, Baron, Silvia, Noblesse, Miracle, Buckingham, Crest, Abbey, Marquis, Viva, Gnome, Barzan, and Chelsea. Best grass varieties averaged over all locations were: Midnight, Blacksburg, Limousine, Eclipse, and Princeton 104.

You may have seen NTEP information displayed in advertising by companies with cultivars in those trials. A word of caution: some advertisements do not include all varieties tested. Their cultivar may have the highest

Table 3

Varieties rated superior in the 1990 NTEP Low Maintenance Kentucky bluegrass test for selected characteristics.

Characteristic	Cultivars
Dark green color	Midnight
Good green color	Barsweet, Amazon, Destiny, SR2000, Fortuna, Gnome, Crest, Unique, Baron
Finer texture	Cynthia, Kenblue, Amazon, Ram-1
Drought tolerance[1]	Fortuna, Voyager, Merion, Unique
Dormancy recovery	Monopoly, Banjo, Alene, South Dakota Certified, Barzan (note: all, except Monopoly, are rated low for quality)
Wear tolerance	Suffolk, Monopoly, Unique, Freedom, Haga, Cynthia
Leaf spot resistance	SR2000, Midnight

[1]Based on least dormancy.

Table 3 lists varieties rated highly in one or more test locations for particular characteristics in the 1990 low maintenance test, while Table 4 includes results from the 1990 high maintenance test. Due to differences in management and/or cultivars included, some may be in one list, but not the other list for a particular characteristic.

score of varieties listed in the advertisement, but there may be other cultivars ranked higher in the complete NTEP list which are not included in the advertisement.

Other advertisements may show results taken from data provided by a location that is dissimilar from your site. For example, one cultivar may do well under full irrigation, but poorly under reduced or no irrigation.

Due to changing availability of turfgrass cultivars, you should check with your county or university extension personnel for the most current information on common and improved Kentucky bluegrass cultivars. ■

Table 4

Varieties rated superior in the 1990 NTEP High Maintenance Kentucky bluegrass test for selected characteristics

Characteristic	**Cultivars**
Dark green color	Midnight, Buckingham, SR2000, Noblesse
Good green color	Able I, Opal, Minstrel, Summit, Eclipse, Nassau, Bartitia, Blacksburg, Princeton 104, Aspen
Winter color retention	Dawn, Suffolk, Freedom, Nassau, Barzan, Georgetown, Haga, Banff, Classic, Cobalt, Trenton
Finer texture	Summit, Limousine, Alpine, Barblue, Cynthia, Unique, Able I, Silvia
Drought tolerance (least wilt)	Eagleton, Barmax, Monopoly, Silvia, A-34, Indigo, Blacksburg, Challenger, Classic, Freedom, Nustar, Preakness, Suffolk, Georgetown, Trenton, Banff, Dawn, Eclipse, Haga, Merion
Drought tolerance (least dormant)	Barzan, Glade, Ronde, Indigo, Marquis, Merit, Viva, 4 Aces, Abbey, Belmont, Chelsea, crest, Eclipse, Estate, Minstrel, Ram-1, SR2100
Spring greenup	Ginger, Barblue, Nassau
Dollar spot resistance	Eagleton, Midnight, 1757, Buckingham, Livingston, SR2000, Indigo, Barblue, Princeton 104, Blacksburg, Eclipse, SR2100, Unique, Classic, Preakness, 4 Aces, Nassau
Leaf spot resistance	SR2000, Blacksburg, Summit, Cardiff, Destiny, Eclipse, Limousine, Merion, Alpine, Barblue, Able I, Cobalt, Minstrel, Noblesse

The training level requirements for responding to a Hazardous Materials (HAZMAT) spill

This article is general in nature. All information herein should be used for informational purposes only. Contact your local and state HAZMAT representatives for detailed instructions.

OSHA regulations require that all employees, whose day-to-day activities puts them in contact with or expose them to hazardous substances, be trained by their employers how to not only handle the materials during normal operations but that individuals with each organization should be trained how to respond to spills of those hazardous materials.

Within an organization or company that handles hazardous materials on a regular basis, it is important that persons should be designated to deal with emergency hazardous materials spills. How company personnel respond to a hazardous materials spill and what levels of actions that those employees can initiate in response to a spill is regulated and is a function of the differing levels of emergency response training that they receive.

If the company or organizational personnel on the scene of a hazardous materials spill are not qualified to respond to or are unable to deal with that spill, then responding emergency HAZMAT personnel from local police departments and fire companies will assume the worst case scenario and may respond at levels far in excess of what a spill requires. This worst case scenario response, although designed to provide the greatest potential to deal with a very dangerous situation rapidly, can, if inappropriate to the actual on-site situation, be a waste of valuable emergency response resources, as well as cost the company or organization involved in the spill several thousands of dollars that need not have been spent.

Listed below are the OSHA HAZMAT emergency responder's designations, the areas of responsibility for each designation, and the training level required for each.

Responsibility and training levels

Designation	Areas of responsibility	Training required
First responder - awareness level	can initiate emergency response sequence notifying authorities	minimal basic training
First responder - operations level	should work to contain spill at a safe distance, to protect people, property and the environment	minimum of 8 hours training
Hazardous materials technician	should work at spill site to stop any further releases	minimum of 24 hours of specific training
Hazardous materials specialist	should assist HAZMAT technicians and have specific knowledge of materials involved in spill	minimum of 24 hours of specific training with additional emphasis on those hazardous materials used by employer

Turfgrass and landscape managers should realize that they are often in a better position than emergency response authorities to know how to handle the hazardous materials that they work with on a regular basis. So, aside from meeting just the minimal regulatory requirements involved in dealing with any hazardous materials, it is incumbent on managers to be sure that properly trained personnel are available to respond to a spill, not just because it makes good business and legal sense, but because it is their responsibility. —CS

Actions to be taken at a HAZMAT spill

Some basic concepts should be used to guide the actions of spill response personnel at accident sites. The specific actions required to mitigate the effects of a hazardous materials spill will vary depending on the nature of the material spilled, the area affected, and the extent of the spill. The following recommendations are general in nature and for information purposes only. Turfgrass managers should contact their local and state HAZMAT representatives for detailed instructions.

The list below is generic in nature and may or may not be appropriate for the materials and the circumstances involved, but it highlights most of the action areas that managers should be concerned with when formulation a specific plan for a given spill or when designing a company wide emergency hazardous material spill response plan.

Aspects of or all of this generic hazardous materials response plan are appropriate for use by turfgrass and landscape managers for all but the most serious of hazardous materials spills. It can be effective for a broken bag of granular pesticide spilled on a concrete surface or a vehicular accident involving a 2500 gallon spray truck. The nature of the material spilled, the extent of the spill, and the level of the danger that the spill poses to surrounding people, buildings or the environment are the determining factors as to how much of this plan should be instituted on site.

Turfgrass and landscape managers should contact their suppliers or the manufacturers of the products that they use to formulate a company or organiza-

-continued on page 14

Action areas for managers

Initial response -	control access to spill site and personnel movement on site tend to the medical needs of anyone injured determine the substance and form involved determine area involved notify authorities if spill meets minimum reporting standards
Setup command-	senior trained responder on site should take control establish an incident command system (ICS) or command structure establish both, on site, and outside lines of communication senior responder is sole decision maker in control of site and personnel analyze situation and determine course of action determine additional equipment or personnel required to contain spill
Confine spill-	senior responder designates trained responders to initiate containment initiate containment activities senior responder must continually evaluate success of activities document each stage of planned activities, their initiation and success cease activites if planned activities are not working reformulate action plan and initiate new plan withdraw from site if there is any question about personnel safety re-evaluate total site plans if withdrawal is necessary successfully finish action plan
Cleanup-	once contained, inspect site determine best course of action to clean up site clean up plan should not be more hazardous than spill site remediation should not pose any off-site safety problems monitor clean up activities reevaluate and reformulate clean up plans as needed complete clean up decontaminate all personnel and equipment withdraw

E.P.A. acts on worker protection standards

The Environmental Protection Agency (E.P.A.) has taken civil actions against two of the nation's largest pesticide manufacturers for alleged violations of the labeling requirements of the new Worker Protection Standards.

Dupont and Rhone-Poulenc were notified that the E.P.A. determined that they were in violation of the worker protection standards of the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) and that the E.P.A. was seeking fines that would total $2.125 million. Dupont was cited for 379 counts of the prohibited sale of four of its triazine-based agriculture herbicides and Rhone-Poulenc was cited for 46 counts of the prohibited sale of Chico Ronstar 50 WP. The alleged violations occurred when the products were sold, after the E.P.A. had notified the two manufacturers that their proposed new labels for these products contained serious flaws posing significant danger to application workers, and did not meet the new WPS labeling requirements.

Normally, when a manufacturer is issued a "Notice of Serious Error" the notified manufacturer works with the E.P.A. to correct the violations. In both of these cases, the companies did not choose to cooperate with the E.P.A. and ignored the notice by continuing to sell the products with the flawed labels. The proposed fines were $1.895 million for Dupont and $230,000 for Rhone-Poulenc.

Clemson University study

Dollar value put on landscaping

A study conducted at Clemson University found that researchers were able to isolate and verify the increase in dollar value that is added to the sale price of a house as a result of improving the quality of landscaping at the house from fair to good or from good to excellent.

The study, confirming previously held best industry estimates, found that, in addition to shortening the amount of time a property takes to sell, improving the quality of landscaping of a house for sale from fair to good raised selling prices from 8% to 10%, and raising landscape quality from good to excellent raised prices an additional 4% to 8%. Improving the landscaping from fair to good on the nationwide average $117,000 house could add almost $12,000 to its sale value, while upgrading a $200,000 home from good to excellent could add an additional $10,000.

TGT's view: This analysis, published in the "Journal of Environmental Horticulture" *in the June, 1994 issue on the dollar value effect of quality landscaping on the sale prices of houses has finally given landscape and lawn care professionals specific numbers that can be given to their customers when they ask. Additionally, green industry companies should use the results of the study to promote their services, just as the various members of the household remodelling industry have effectively done.* —CS

Mistake found in EPA WPS publication

Page 33 of the EPA publication on the Worker Protection Standards contains an error that could be of considerable consequence. In the pamphlet entitled "Protect Yourself From Pesticides - A Guide for Agricultural Workers" a passage improperly identifies mouth-to-mouth resuscitation as CPR (cardiopulmonary resuscitation). The passage states "If someone gets sick from breathing a pesticide... 1. Get them to fresh air right away. 2. Loosen their clothing. 3. If not breathing, give mouth-to-mouth (CPR)."

Mouth-to-mouth resuscitation is performed when someone has stopped breathing for a period of time. This procedure is done to either restart the individual breathing, or, lacking sustained breathing provide oxygen during the period. CPR is a complex resuscitation technique of both mouth-to-mouth and heart compressions done when an individual's heart stops beating.

The EPA is rewriting the passage and suggests that holders of the uncorrected pamphlet strike the term CPR from their current copies.

TGT View - Although the newly implemented Worker Protection Standards do not specifically apply to turf or landscape management, some managers use WPS. Check to see if you are using the publication, and if so make the appropriate changes. —CS

***Actions** continued from page 13*

tional response action plan before a spill occurs. The manufacturer should supply managers with all of the appropriate response information concerning each product and this information should play a prominent part in establishing response policy. Also manufacturers may be a valuable source of on site information or other resources. —CS

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