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Principles of Home Landscape Fertilization

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Plants growing in a home landscape co-exist with one another in a nonnative environment. The urban landscape includes combinations of trees, shrubs, and turf, all of which have most of their absorptive roots intermingled in the top 3 to 4 inches of soil. During home construction, many urban soils are compacted, or topsoil is removed. The remaining soil, which often is higher in clay, is spread over the surface to make an almost impenetrable material. This situation often reduces oxygen and nitrogen within the root zone, lowers available water, and reduces root penetration into the soil.

It is easy to visualize competition for light, nutrients, and water when one observes grass attempting to grow under a shade tree. However, root competition may be just as intense over the entire lawn. Roots from large trees compete with turf in unshaded as well as shaded lawn areas, since the roots may extend horizontally at least two times a tree's height. Even trees in a neighboring lawn may be competing with the turf.

The question is, "Can one fertility program promote growth and/or quality for all landscape plants in a managed lawn?" The answer is "No." Each situation is unique, and several choices exist for home landscape fertility programs. Consider the following aspects when deciding on the best program for a specific landscape.

Soil Testing

What Is Measured?

Soil testing is the basis for many fertility recommendations. A soil test can be obtained for a nominal fee through your county Extension office. An agricultural soil test reports the pH and levels of phosphorus, potassium, calcium, magnesium, and zinc. Although nitrogen is the most important component of many fertilizers, the soil test does not provide information about nitrogen because nitrogen is rapidly lost through leaching (it is carried away by soil water), or it is removed by plants. Specialized soil tests can be obtained for an extra fee. However, such tests are not normally used unless a specific plant nutrient problem is suspected and needs verification. Perhaps the most valuable information revealed through the soil test is soil pH. See *Soil Testing* (AGR-57) and *Taking Soil Test Samples* (AGR-16), available at your county Extension office.

When Do You Test?

Soil testing should be done before trees and shrubs are planted and the lawn is seeded. In an established landscape, a soil sample can be taken any time. Take subsamples from eight to 10 locations in the area you have identified—front yard, backyard, garden area, etc.—within 3 to 4 inches of the surface. Put the subsamples into a clean plastic container. After all subsamples are in the container, crush and mix them and remove any thatch and live plant material. Remove 1 pint of the mixed soil and place it in a special bag or box available from the county Extension office.

Taking subsamples deeper than 3 to 4 inches dilutes the important soil close to the surface. In a landscape situation, the fertilizer or lime is applied to the surface with little or no tillage, so most of the crucial soil fertility reactions and nutrient uptake occur in the top 2 to 3 inches of soil.

This publication first discusses each aspect of fertility and then assesses different type of fertilizers.

Acidity (pH)

Soil acidity is measured as "pH." Soil pH is an index of the amount of acidity present. The pH scale ranges from 0 to 14. At pH 7, soil is neutral. At pH levels below 7, soil is acid ("sour"), and at pH levels above 7, it is alkaline ("sweet").

Acid Soil

Most turfgrass species will perform best at a pH between 6 and 7. A pH as low as 5 does not present severe problems to turf except that it may encourage development of Kentucky bluegrass thatch. Since tall fescue accumulates no thatch, it does well at low pH levels. A soil pH between 5 and 7 is within the range of adaptation for most tree and shrub species (although azaleas and rhododendrons may prefer a pH of 4.5 and should certainly be maintained at pH levels below 6.0).

For acid-loving plants, you may need to increase the soil's acidity. If the soil is above a pH of 6.5, the most practical thing to do is to bring in additional soil to form a berm—a shelf around the plant. For shrubs like rhododendrons and azaleas, berms should be at least 20 inches tall at the edge and a minimum of 3 feet across—large enough to provide an adequate rooting area for the plant at maturity. Berms are not recommended for trees because of trees' extensive root system. The soil for the berm should consist of a 50:50 mixture of topsoil and peat moss. For soils with pH below 6.5, sulfur can be added according to the amount shown in Table 1.

Table 1. Suggested application of ordinary powdered sulfur to reduce the pH of an 8-inch layer of soil.

Original pH of Soil (based on water pH value)	Sulfur Needed to Reach pH of									
	4.5		5.0		5.5		6.0		6.5	
	Sand	Loam	Sand	Loam	Sand	Loam	Sand	Loam	Sand	Loam
5.0	2/3	2	—	—	—	—	—	—	—	—
5.5	1 1/3	4	2/3	2	—	—	—	—	—	—
6.0	2	5 1/2	1 1/3	4	2/3	2	—	—	—	—
6.5	2 1/2	8	2	5 1/2	1 1/3	4	2/3	2	—	—
7.0	3	10	2 1/2	8	2	5 1/2	1 1/3	4	2/3	2

Note: Since pH reduction is often needed for a single plant or small group of plants, sulfur use per 100 sq ft is indicated. Although aluminum sulfate is often recommended to gardeners for increasing the acidity of the soil, it has a toxic salt effect on plants if it is used in large amounts, and small amounts are not effective. About 7 lb of aluminum sulfate is required to accomplish the same effects as 1 lb of sulfur.

Alkaline Soil

A soil pH just above 8, which is the maximum found in Kentucky, will not detrimentally affect turf, although it will be a serious problem for woody plant species such as azaleas, rhododendrons, dogwoods, hollies, oaks, and blueberries. Other species, such as butterfly bush, beech, and the viburnums, may grow well at a pH of 7 or above.

Plants should be matched to a soil's natural pH as much as possible, since permanently adjusting soil pH to a radically different level is difficult. However, even if the pH is not optimum for a particular species, plants rarely die because of a pH problem alone. Improper soil pH will, however, reduce plant growth rate and cause yellowing (chlorosis), especially between veins of new leaves. This stress, if severe, will allow otherwise harmless microorganisms to attack the affected plant and cause the death of roots, branch tips, or even whole plants.

Adjusting Soil Acidity Levels

What to Use

If soil pH correction is needed, agricultural limestone can be applied to raise pH (make the soil less acid), and finely ground, elemental sulfur or aluminum sulfate can be applied to lower pH (make the soil more acid). Since these materials are normally surface-applied in landscape situations, they adjust the pH in only a few inches of soil at the top. Changing soil pH may take several months or years, and repeat applications are often needed. Lime or sulfur can be applied at any time of year. Tables 1, 2, and 3 provide recommended amounts of these materials to adjust soil pH. If most of your woody plants need a soil pH below 5.5, select either tall fescue or one of the fine fescues for the lawn instead of Kentucky bluegrass.

For most urban landscapes, maintaining a soil pH between 5.5 and 6.0 is the best compromise. Reducing the pH beyond this range would not be necessary except for azaleas and rhododendrons. Since these woody plants are normally grown in beds or on a berm, pH could be adjusted by applying sulfur around the plants' roots.

How Much to Use

The amount of lime or sulfur needed to adjust pH depends on the

- amount of change needed.
- soil texture.
- fertilizer used.

Tables 1, 2, and 3 give general guidelines, but soil tests should be taken periodically to evaluate pH. Soil test results often give two figures for soil pH: a value for water pH and one for buffer pH. The buffer pH provides a better estimate of how much lime or sulfur is needed to change soil pH because it takes into account the soil's buffering capacity. A soil with high buffering capacity is more resistant to changes in the pH. Clay loam soils usually have more buffering capacity than sandy loam soils, for example.

Before planting, lime or sulfur should be broadcast evenly on the soil and worked into the top several inches. If woody plants and turf are already established, a surface broadcast application is the only alternative. Immediate irrigation after applying sulfur will help prevent foliage burn.

Table 2. Amount of agricultural limestone needed (silt-loam soil) in terms of water pH to raise pH to 6.4.

Water pH Value	Agricultural Limestone (lb/1,000 sq ft)
Above 6.4	0
6.4 - 5.8	0 - 100
5.8 - 5.2	100 - 200
Below 5.2	200

Table 3. Amount of agricultural limestone needed to raise pH to 6.4 in terms of buffer pH.

Buffer pH Value	Agricultural Limestone (lb/1,000 sq ft)
6.7	70
6.6	100
6.5	115
6.4	140
6.3	160
6.2	190
6.1	210
6.0	230
5.9	245
5.8	255
5.7	280
5.6	315
5.5	325

Besides sulfur, the use of acid mulches (such as pine needles, composted sawdust, and acid peat) and continued use of ammonium sulfate as a nitrogen fertilizer tend to increase soil acidity. Almost all nitrogen sources increase soil acidity, but to a lesser degree than ammonium sulfate.

Nitrogen

Nitrogen is the nutrient most responsible for plant growth and vigor, and yet it is the nutrient most often deficient or misused in urban landscapes. Before deciding whether or not to use nitrogen, decide on your objectives for landscape appearance.

Why Do You Want to Fertilize?

Fertilization objectives for *shade trees* could include

- promoting rapid growth so young trees quickly become large and functional.
- maintaining health and appearance of mature trees.
- attempting to rescue declining trees. (However, in some circumstances, providing nitrogen to a declining tree only worsens the tree's condition.)

Fertilization objectives for *turfgrass* could include

- promoting thick, lush, green growth even if it needs a lot of maintenance.
- maintaining a healthy, persistent turf that needs less mowing and maintenance.
- having a grassy area for erosion control or utility that requires minimum upkeep.

Furthermore, by examining the landscape periodically, you may be able to tell by the way the plants look whether nitrogen is needed. For example, if mature trees are consistently adding 6 inches of new twig growth annually, no additional nitrogen is needed. On the other hand, if turfgrass or plants are growing slowly and appear off-color (pale green) or weak, nitrogen may be needed. Finally, a landscape is a complex system, and a single program, while adapted for some plants in the yard, may be disastrous for others. You may need either to compromise or use nitrogen at different times in different areas of the landscape.

Factors Influencing Nitrogen Use

The following factors will influence how nitrogen might be used in the landscape.

- In many urban environments, the low organic matter content of disturbed soils makes it necessary to apply nitrogen annually to maintain growth and quality for turf and ornamentals.
- In many mature and natural landscapes, trees and turf live harmoniously without added nitrogen because nutrients are recycled from decaying plant residue or from original soil organic matter. Shredding grass clippings and fallen leaves with a mulching mower and recycling them into the landscape will reduce the need for fertilization.
- In most home lawns, if a tree is big enough to be aesthetically pleasing, adding nitrogen fertilizer to force rapid growth would be senseless.
- Rapid turfgrass growth due to heavy nitrogen fertilization increases stress on the grass, which then requires more mowing, irrigation, and pest control and often requires thatch control.
- Turf that grows in heavy shade will survive only when it has low nitrogen fertility during the late spring and summer months. High levels of nitrogen applied to such areas are harmful because the grass is forced to metabolize nitrogen, requiring more energy (light). As light becomes the limiting growth factor, shaded turf is soon depleted of energy and will deteriorate. As this happens, moss, algae, and vining weeds become established. However, you can still fertilize the tree under these circumstances. Since most active tree roots are growing beyond the tree canopy, tree fertilization can be accomplished by reducing the nitrogen rate in the most shaded turf area and increasing the rate on unshaded turf nearby.
- Many shade trees can tolerate and respond to high rates of nitrogen (up to 6 lb of N per 1,000 sq ft) in infertile soils; conifers and broadleaf evergreens should not be overfertilized (fertilize to a maximum of 3 lb of N per 1,000 sq ft).
- Lush, succulent, nitrogen-stimulated growth may make landscape plants more susceptible to insect infestations. Under these circumstances, plants in the rose family will be more susceptible to fire blight, other trees and shrubs may succumb to powdery mildew or rust, and turfgrass may be more susceptible to patch diseases.
- Weak, nitrogen-deficient growth may make landscape plants more susceptible to canker and decay diseases and turfgrass more susceptible to the diseases of red thread and dollar spot and to weed infestations.

When Should Fertilizer Be Applied?

Fall and winter are the best times to fertilize most landscape plants and grasses that grow in Kentucky. The annual amount of nitrogen should be split into two or three applications approximately six weeks apart to benefit both turf and woody plants. (Nitrogen applied to turf between April and September can promote excessive top growth and thus decrease resistance to drought, disease, and heat.)

Do not apply nitrogen to woody plants between July 1 and November 1, since some of the less winter-hardy plants may not harden in time for winter weather.

Fall and winter fertilization benefits turfgrass because it promotes root and tiller growth needed for improved health and density. Woody plants and turf can absorb nitrogen any time in late fall and early winter that soil temperatures are above 32°F.

How Much Nitrogen Should Be Applied?

Refer to landscape maintenance objectives to determine needs that may exist. Nitrogen is normally applied at rates expressed as pounds of actual nitrogen (N) per 1,000 sq ft. If a fertilizer contains 10 percent N and 2 lb N is needed, then 20 lb of fertilizer would be spread over 1,000 sq ft. The percentage of nitrogen contained in a package of fertilizer is stated on the

Table 4. Sample programs for nitrogen fertilizer in the landscape.

Annual Nitrogen Application (lb/1,000 sq ft)	Effect on Turfgrass	Effect on Woody Plants
0	Quality and growth minimum. Tall fescue more tolerant of low fertility. Weeds may become dominant in sparse bluegrass lawns.	Mature healthy plantings will continue moderate growth. Immature woody plants will not achieve adequate growth.
2	Good quality and growth. Optimum for most turfgrass sites that cannot be irrigated and are not heavily used.	Mature, healthy plantings will achieve good growth. May stimulate some growth of young plants
4	Lush, high-maintenance turfgrass. May be detrimental if irrigation and pest control are mismanaged or if heavy shade exists.	May push unneeded growth for mature plants. Young plants can attain size more rapidly at this rate.
6	Problematic for bluegrass and fescue lawns. Thatch accumulates in bluegrass. Excessive growth is succulent and susceptible to disease. Root system tends to be shallow, thereby increasing drought susceptibility. Excessive top growth is at the expense of good root development. Without irrigation during dry periods, bluegrass lawns will die. Unless applied in three equal doses at three separate intervals (minimum of six weeks apart) or unless applied during cold weather, lawn will be burned with excess fertilizer.	Will cause shoots to lengthen considerably, and the succulent growth may be more susceptible to disease. Difficult to know how woody plants actually use the available nitrogen in root growth vs. shoot growth. When extension growth is important (that is, small landscape tree needing maximum extension growth to provide shade for house), this amount of fertilizer may be warranted, but only in the rarest of cases. It is excessive in 99% of cases. Regular irrigation is a must when following this program.

Note: "Landscape" means an established landscape having turfgrass, shrubs, and small, medium, and large shade trees; disturbed, low organic matter soil; tree leaves (but not grass clippings) removed; and fertilizer applied to the soil surface. When tree leaves and grass clippings are finely shredded with a mulching mower and recycled in the landscape, fertilizer needs are reduced.

package and is expressed by the first number in a series; that is, 10-10-10 has 10 percent N, 33-0-0 has 33 percent N, etc. The consequences of applying nitrogen at different rates in the landscape are presented in Table 4.

Phosphorus and Potassium

All plants need a favorable phosphorous (P) and potassium (K) level. Kentucky soils usually have adequate phosphorous and potassium for tree and grass survival except for the P level in many western Kentucky soils. However, Kentucky soils may not have the optimum rates of phosphorous and potassium needed for maximum growth, color, tolerance to heat and cold, and resistance to drought. (Note that if grass clippings are removed regularly during mowing, soil K may decrease more rapidly than if the clippings are not removed.)

To be sure of the fertility level, have soil tested every three to four years. Table 5 gives the amounts of phosphorous and potassium that should be applied according to soil test levels.

Table 5. Phosphate and potash levels for established lawn and woody ornamentals.

	lb/1,000 sq ft	
Soil Test Level	**Phosphate**	**Potash**
High (above 60 P, 300 K)	0-1	0-1
Medium (60-30 P, 300-200 K)	1-2	1-2
Low (below 30 P, 200 K)	3-5	3-5

Calcium and Magnesium

Calcium (Ca) and magnesium (Mg) are important components needed for plant structure, metabolism, and photosynthesis. They are seldom so deficient in Kentucky soils that they inhibit growth. As grass clippings and leaves decompose in a landscape situation, much calcium is recycled. A soil test is the best method of determining calcium status.

When soil becomes too acid, agricultural lime can be applied to add calcium. Dolomitic lime adds both magnesium and calcium. If soil needs to be maintained at acid pH levels, calcium and magnesium can be applied as soluble fertilizer. Soluble calcium is available in gypsum or calcium nitrate. Soluble magnesium is available in epsom salts (magnesium sulfate) or sulfate of potash (magnesia).

In other states, magnesium has been found to be deficient for some landscape plants, but this situation has not been confirmed in Kentucky. Magnesium deficiency is usually described as "interveinal chlorosis," or yellowing of tissue between the veins of leaves. Other limitations within the root zone, such as soil compaction, soil oxygen, heat, cold, drought, root damage, air pollution, diseases, insects, and certain chemicals, may also cause leaf chlorosis. Although careful observation and plant/soil testing can greatly narrow the possible causes, most people will still have difficulty determining the exact cause of chlorosis.

Minor Nutrients

Deficiencies in minor nutrients are uncommon in Kentucky soils. Kentucky's soils are high in iron, although most of the iron is only slightly available to plants. Treatment of some chlorotic trees with iron (for example, iron sequestrene foliar sprays or iron chloride injections) do help leaves become greener, at least temporarily. In addition, when soil pH decreases, chlorosis symptoms abate. Iron applied to the surface of soils that have a pH of 6.5 or higher is chemically tied up and not available for immediate plant root uptake. Therefore, soil and foliar iron treatments may have to be done every year to correct an iron deficiency in certain species growing in near-neutral or high pH soils. Certainly, reducing soil pH will provide better long-term control of chlorosis where high iron-requiring species like pin oaks are desired.

Types of Fertilizer

Nutrient deficiencies can be corrected by applying single-ingredient fertilizers, such as ammonium nitrate (N), urea (N), triple super phosphate (P), and muriate of potash (K). They can also be corrected by making appropriate applications of a combination fertilizer such as 10-10-10, 5-10-10, or 20-20-20. Specialty fertilizers marketed for certain ornamentals and grasses can also be used effectively but may not be more beneficial than more economical, farm-type fertilizers. However, specialty fertilizers are convenient to use because the package often gives specific rate and calibration information, and the fertilizer often contains some slow-release (organic) nitrogen that reduces the potential for foliar burn.

Dry vs. Liquid Fertilizers

There is essentially no difference between the nutrient availability of fertilizers applied in dry form and those applied in liquid form. Liquid fertilizers do not move deeper into the soil than dry fertilizers. Both require water from rainfall or irrigation to make nutrients available for root uptake.

Foliar vs. Soil-Applied Fertilizers

On Foliage

Foliar applications of fertilizers give only a temporary response and do not give a long-term solution to a fertility problem. To prevent serious foliage burn, foliar fertilizers must be diluted.

On or in the Soil

Broadcast applications of fertilizer on the soil are effective, since most roots of woody plants and turf grow near the soil surface. Liquid fertilizers can also be applied below the soil surface with a lance or a water needle. Similarly, dry fertilizers may be applied through holes drilled into the soil or made by a punch bar. However, injecting liquid fertilizer or putting dry fertilizer into holes is not the most efficient way to apply fertilizer. Since the absorptive (feeder) roots of most tree and shrubs are in the top few inches of soil and fertilizers move downward with water, much of the fertilizer is placed below the root zone and thus cannot be absorbed if either of these methods is used. Fertilizer that is not taken up by plants will ultimately enter the groundwater, causing potentially serious pollution problems.

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