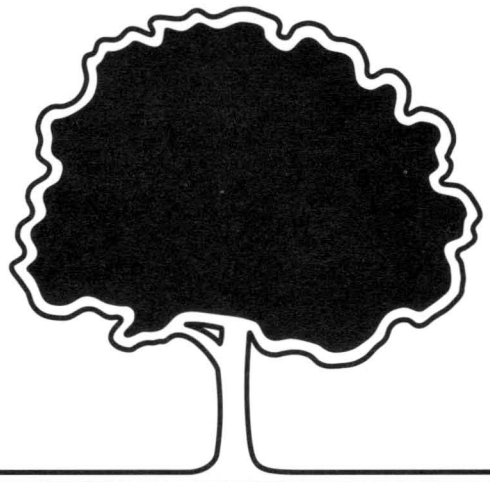
Tree Fertilization:

A Guide for Fertilizing New and Established Trees in the Landscape



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The Need for Nutrients

Trees require nutrients to live and thrive. When one or more of these nutrients are deficient in the soil, the tree will not reach its full landscape potential, will be more susceptible to disease and insect problems, and will have a shorter life than a similar, well-fertilized tree. The nutrients required by all plants, including trees, can be divided into two groups: macronutrients and micronutrients, based upon the quantity necessary for growth. Macronutrients are required by plants in larger quantities than micronutrients. The macronutrients required by plants for growth include nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), and sulfur (S). Addition of macronutrients, especially nitrogen, can result in improved growth while deficiencies can lead to slower growth and visible symptoms. Micronutrients, which are required in very small amounts, include iron (Fe), manganese (Mn), zinc (Zn), copper (Cu), boron (B), chlorine (Cl), and molybdenum (Mo). **Most soils in Minnesota contain adequate micronutrients to meet the needs of landscape trees**. The micronutrient most commonly lacking in Minnesota soils is iron, which results in iron chlorosis—a yellowing of leaves between the veins.

Many fertilizer products are available to provide trees with the appropriate nutrients. All fertilizer labels indicate the amount of nitrogen, phosphorus, and potassium contained in the product by percent. These labels also indicate the weight of these nutrients per 100 pounds of product. For example, 100 pounds of a fertilizer marked 10-8-6 contains 10 pounds of nitrogen in various forms [eg. ammonium (NH_4) or nitrate (NO_3)], 8 pounds of phosphate expressed as P_2O_5, and 6 pounds of potash expressed as K_2O. Fertilizers containing N, P, and K, such as 9-18-9 and 20-20-20, are referred to as "complete fertilizers".

Both organic (naturally occurring) and inorganic (synthetic) fertilizers can be used to supply plant nutrients. Inorganic fertilizers are usually highly soluble and are more rapidly available to the plant than organic fertilizers. Organic fertiliz-

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ers take time to break down and release nutrients more slowly. Organic fertilizers and inorganic fertilizers may be combined so that nutrients are available to a plant rapidly and for an extended period of time. Some inorganic fertilizers are coated with various products to slow down the release of nutrients. These are called slow release fertilizers and are used to extend the length of time nutrients are available to the plant.

Determining the Need for Fertilization

Trees in urban and suburban environments are often under high stress conditions due to low moisture availability, soil compaction, physical damage, nearby construction, and competition from turf and nearby trees and shrubs. Fertilizer applications may reduce, but cannot eliminate, environmental stresses such as these. It is important to keep newly planted trees watered and pruned and to keep weeds away from their bases to avoid excess stress.

The best indicator of whether fertilization is necessary is a soil test. Ideally, a soil sample should be taken before trees are planted. Additional samples can be taken every 3 to 5 years thereafter to determine whether any nutrients are lacking. A soil test kit may be obtained from your county extension service.

In the absence of a soil test, the best indicator of the need for additional fertilization of established trees is shoot growth. If new shoot growth (growth occurring in the present year) is in excess of 6 inches, then fertilization is probably unnecessary. If shoot growth is between 2 and 6 inches then fertilizer may be applied and, if shoot growth is under 2 inches, then fertilizer applications are appropriate as indicated in the **Application Methods and Rates** section of this folder.

Foliage color is another indicator of the need for fertilization. Yellow or "off-color" leaves may indicate the need for fertilization as these symptoms generally occur on trees which are not taking up enough of one or more required nutrient. Always remember, however, that apparently "off-color" leaves are normal for certain plants such as 'Sunburst' Honeylocust and some maple and ash trees in the fall.

A final indicator of the need for fertilization is the history of the yard. Trees in yards that are fertilized for turf on a regular basis rarely need to have supplemental fertilizer applied. Supplemental fertilizer should only be considered if shoot growth is less than 2 inches, or if a soil test reveals a specific nutrient deficiency.

If the only indicator of the need for fertilization is slow shoot growth, then a high nitrogen fertilizer should be applied to the tree following the recommendations in the **"What to Apply"** section of this guide. If, however, the leaves of the tree are yellowing, or there is some other indication of a nutrient deficiency, then it is appropriate to take a soil sample from around the root zone of the tree and have a soil analysis performed.

Yellowing may be due to a variety of nutrient deficiencies. The most common reason for yellowing foliage in Minnesota is a lack of iron and occasionally manganese. Deficiencies of these elements are commonly due to a high pH (7.0 or higher) rather than a lack of these nutrients in the soil. Because different trees do well at different pH levels, it is strongly recommended that soils be checked for pH before planting. If you know that the soil has a pH of 7.0 or higher, be sure to investigate species that can take up iron and manganese under high pH conditions such as the plants listed in **Table 1**. If a sensitive tree has already been planted on a high pH site, pH can be reduced by amending the soil with elemental sulfur and using a fertilizer high in ammonium, such as ammonium sulfate to supply nitrogen needs. Reducing the pH of a soil is a long drawn out process that may take many years to correct.

Some soils in northeastern and central Minnesota have low pH levels (5.5 and below) which may negatively affect trees by reducing the availability of some nutrients and increasing the availability of aluminum, a potentially toxic element. In low pH soils, lime can be applied to raise the pH to a level that is more beneficial to the plant. Liming is best done before a tree is planted. Do not add lime unless a need is indicated by a soil test.

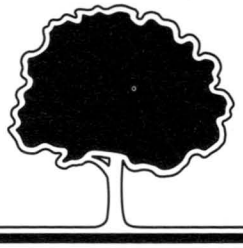


Table 1: Selected plants with the ability to withstand a pH of 7 to 8[1].

Scientific Name	Common Name
Acer saccharinum	Silver Maple
Alnus glutinosa	Common Alder
Betula papyrifera	Paper Birch
Carpinus caroliniana	American Hornbeam
Catalpa speciosa	Northern Catalpa
Celtis occidentalis	Hackberry
Cornus sericea	Red Osier Dogwood
Juglans nigra	Black Walnut
Pinus banksiana	Jack Pine
Pinus nigra	Austrian Pine
Quercus bicolor	Swamp White Oak
Quercus macrocarpa	Bur Oak
Salix alba	White Willow
Tilia americana	American Linden
Tilia cordata	Little Leaf Linden

[1]For a more comprehensive list of plants and their pH response see BU-1731, *Soil test interpretations and fertilizer management for lawns, turf, gardens, and landscape plants.*

When to Fertilize

Most trees experience a single flush of growth during spring followed by slower growth throughout the summer and fall. Because of this single flush of growth, it is desirable to have nutrients available to the tree as this growth is about to occur. The most beneficial time to apply fertilizer is from when the ground is workable in the spring until just before trees start growing in early May. On sandy soils, applications should be split, half in early spring and half in mid- to late May.

If a tree shows yellowing, extremely slow growth, or some other sign which might indicate a nutrient deficiency, then fertilizer can be applied at any time during the growing season. If fertilizer must be applied under the hot, dry conditions of the summer, it is important to provide water for the tree soon after fertilizer is applied so that salts from the fertilizer don't build up and damage the tree's root system. Two to three inches of water (as measured by a rain gauge) applied every two or three weeks around the area where fertilizer was applied will be sufficient to wet the top 1-1 ½ feet of most soils. Sandier soils will require lighter, more frequent watering while clay-based soils will require heavier watering less frequently.

What to Apply

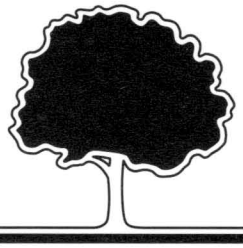
Unless a tree is deficient in some other element, increased nitrogen provides the most pronounced effects on the growth of all plant nutrients. Just because an increase in nitrogen produces a more visible increase in growth, however, does not mean that other elements are not required. A soil test provides the best indicator of elements that may need to be added to the soil to prevent nutrient problems. **High rates of P fertilizer should not be used unless a need is indicated by a soil test**. If soil test P is high then it is best to use fertilizers such as 24-0-15, 30-0-10, 32-3-10, 18-5-9, 27-3-3, or 16-4-8 with a high rate of N and a low or zero rate of P. High rates of P can negatively affect the environment by causing excessive algae to grow in nearby lakes and streams which will, in time, kill fish and other aquatic life. Never use a fertilizer which includes any kind of herbicide around a tree. These fertilizers may be beneficial to turf, but can damage trees.

Application Methods and Rates

Landscape plants typically go through 3 stages of nitrogen need: a) newly planted stage, 1-2 years after planting; b) young rapid growth stage; 3-5 years after planting; and c) mature, maintenance stage, 5 or more years after planting. Nitrogen needs should be adjusted to account for the stage of growth.

Growth Stage 1—Planting to Newly Planted

During the newly planted phase, quick release nitrogen levels should not exceed 0.1 lb N/100 sq. ft. per year. For examples of how much of some common fertilizers to use for an application rate of 0.1 lb N/100 sq. ft., see **Table 2** on page 4. As an alternative, a higher rate of a slow release fertilizer, up to 0.2 lb N/100 sq. ft. per year, can be used. Slow release and natural organic fertilizers can be incorporated into the backfill soil.



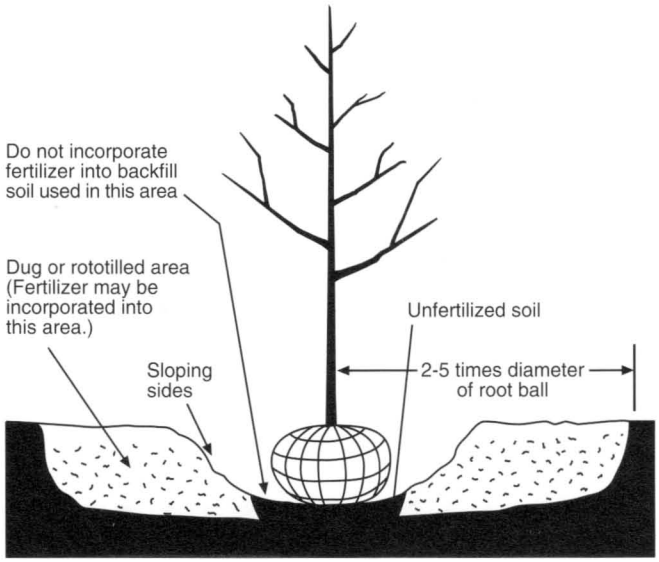


Figure 1. *Fertilizing new plantings. From BU-1731, Soil test interpretations and fertilizer management for lawns, turf, gardens, and landscape plants.*

Quick release fertilizers should be broadcast after planting and then watered in. Do not mix quick release forms with the soil used to backfill the planting hole, because direct contact with fertilizer will burn the roots. If a soil test shows low P or K, then the best time to add these elements is when the tree is planted. Base the rate to apply on your soil test. See **Figure 1** for the best way to incorporate these nutrients at planting. See FO-3825, *Planting trees and shrubs* for more information on planting.

Table 2. *Amount of some common fertilizers to apply for an application rate of 0.1 lb N / 100 sq. ft.*

Product Analysis[1]	Chemical Name	lbs/100 sq ft.
45-0-0	Urea	0.2
38-0-0	Urea form	0.3
33-0-0	Ammonium Nitrate	0.3
21-0-0	Ammonium Sulfate	0.5
18-6-12	Osmocote	0.5
14-14-14	Osmocote	0.7
12-12-12	——	0.8
10-10-10	——	1.0

[1]Other fertilizers are available. To calculate the amount to use for an application rate of 0.1 lb N / 100 sq. ft. use the formula [0.1÷ (Percent of N in the fertilizer ÷ 100)].

Growth Stage 2 — Rapid Growth on Young Trees and Shrubs

On young landscape trees and shrubs where rapid growth is desirable, use the high maintenance rate given in **Table 3**. During the rapid growth phase, the N rate should be 0.2 to 0.4 lb N/100 sq. ft. per year. A low maintenance level should be used in situations that restrict growth (eg. slow growing and dwarf species, dry or compacted soils, and where the plant has a restricted root zone). For trees in lawn areas, do not exceed 0.1 lb N/100 sq. ft. per application unless a slow release or natural fertilizer is used. Higher rates will burn the grass.

Growth Stage 3 — Maintaining Maturing Trees and Shrubs

As trees and shrubs mature and growth rate naturally slows down, the need for N drops. The low maintenance level in Table 3 should be used for established trees and shrubs. The purpose of this low maintenance level is to maintain landscape plants in a healthy condition without excessive vegetative growth.

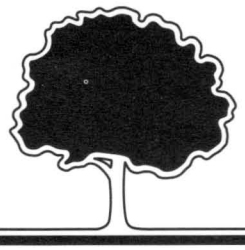
Table 3. *Nitrogen recommendations for landscape trees and shrubs.*

Soil organic matter level[3]	Maintenance level	
	Low[1]	High[2]
	Amount of nitrogen (N) to apply -- lb. N/100 sq. ft. --	
Low	0.10	0.20
Medium to high	0.07	0.15
Organic soils	0.05	0.10

[1]Use the low maintenance level:
a) for newly planted landscape plants
b) to maintain health of mature trees and shrubs where rapid growth is not desirable
c) for young trees and shrubs under restricted growing conditions

[2]Use the high maintenance level on young trees and young landscape plants when rapid growth is desired.

[3]Low organic matter = less than 3.1%, medium to high = 3.1 to 19%, organic soil = greater than 19% organic matter. Organic matter may be determined by a soil test.



Plants respond best to surface applications of nitrogen fertilizer which are broadcast over the area where the roots of the tree lie, a radius of about 12.5 feet from the center of an established tree (encompassing about 500 square feet). Dry or granular fertilizers can be applied by hand or with the use of a mechanical spreader. If turfgrass is present in the area where fertilizer is to be applied, then one application of fertilizer containing 0.1 pound of actual nitrogen per 100 square feet should be applied during the spring and one application of fertilizer containing 0.1 pound of actual nitrogen per 100 square feet should be applied during the late fall. Levels of fertilizer above this rate can cause excessive growth of or even damage to many turf grasses. Trees should always be watered around the area of fertilizer application soon after fertilizer has been applied. This helps to ensure that the fertilizer will move down to the trees' root system before it can be taken up by weeds or grass. A good rain (1-2") will also be sufficient to move fertilizer to the trees root zone.

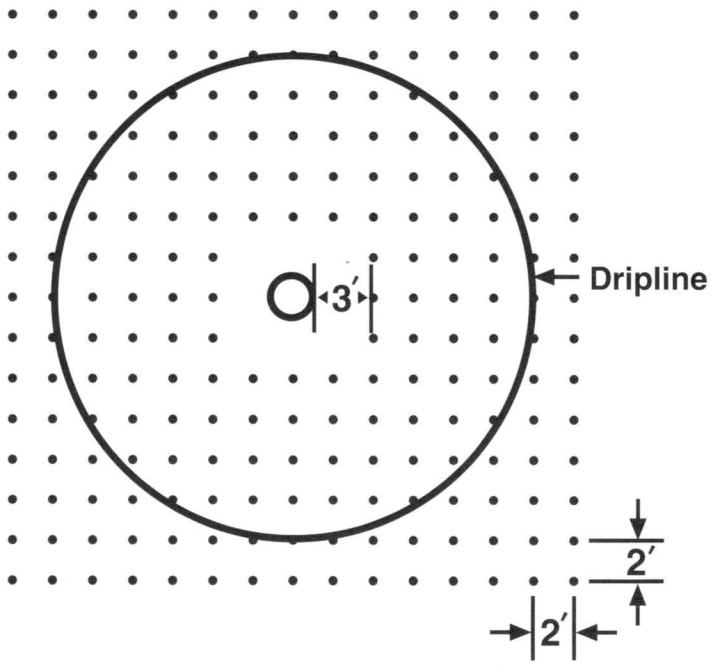


Figure 2. *Placement of holes for the drill hole method of fertilizer application.*

For established trees requiring phosphorus or potassium, or to apply a higher rate of fertilizer than 0.1 pound of actual nitrogen per 100 square feet, fertilizer can be applied using the drill-hole method. This method is advantageous for supplying phosphorus and potassium to trees because these nutrients are relatively immobile in soils; drilling holes will reduce soil compaction and increase aeration. Unfortunately, the drill hole method is extremely time consuming. Generally, the drill-hole method is only used by professional landscapers for high value trees and trees under extreme nutrient stress.

The drill-hole application method involves digging holes 2 feet apart with a soil auger in a grid pattern with the tree at the center of this pattern (see **Figure 2**). Holes should begin 3 feet from the trunk of the tree and should be 1 ½ to 2 inches in diameter and 1 - 1 ½ feet deep. The holes should be drilled in a series of parallel lines under the spread of the tree and extending 2 feet beyond the dripline. For columnar trees, holes should be drilled 4 to 6 feet beyond the dripline. Avoid major roots whenever possible. To calculate the amount of fertilizer to place into each hole, use the following formula: (100/analysis of N in fertilizer) × 0.12 = amount of fertilizer to add to each hole in teaspoons. For example, if you are using a fertilizer with an analysis of 18-8-8, then use (100 /18) × 0.12 = 0.66 or 2/3 teaspoons of fertilizer per hole. After the holes are dug, place the recommended quantity of fertilizer in each hole, water the fertilizer in, and refill the holes.

Slow release pellets and sticks are available for tree fertilization. These pellets are an acceptable source of nutrients. However, compared to surface application, they do not provide good lateral movement of nutrients and are somewhat expensive. Read and follow all label directions.

Hydraulic injection of liquid fertilizers into the root zone of the tree is an acceptable way to provide nutrients and may be offered by some specialty tree care companies. The use of specialized equipment and fertilizers increases cost, however, when a large number of trees need to be fertilized this system may be economical. Injections are applied in a grid pattern similar to the drill-hole method except that injection sites should be 3 feet from each other and should extend 15 feet from the base of the tree as with the drill-hole method. Hydraulic injection

allows nutrients, including immobile elements, to be available to the tree more rapidly than any other root based system.

To rapidly correct micronutrient problems such as iron, two options are available. Foliar fertilization supplies needed nutrients directly to the leaf, where they are needed. Foliar applications, usually applied to landscape trees with a hand held sprayer, are effective in correcting specific nutrient deficiencies for a short period of time. Soil pH adjustment and additional soil application of these nutrients are required to help correct the problem for a longer period of time. Another rapid way to correct micronutrient problems is by injecting these nutrients directly into the trunk of the tree. This method is very effective, but may lead to some damage of the tree trunk.

In cases where the soil pH is above the optimum range for the growth of a particular plant species, interveinal chlorosis, or yellowing between veins, may occur on their foliage. This chlorosis is an indication of poor iron availability in the soil. The soil contains enough iron, but the plant is not able to take up and use the iron efficiently.

The long term solution for this problem is to decrease the pH of the soil, a short term solution is to apply iron chelate to the leaves or the soil. A chelate is a chemical compound that keeps the iron available to the plant over a broad pH range. Various chelate products are available at garden stores. Foliar applications of chelates need to be made several times during the growing season. Soil applications need to be made on a yearly basis, however, higher rates are needed compared to foliar applications, leading to increased cost. Follow label directions for appropriate rates to apply.

Remember that plant nutrition is a balancing act and that too much fertilizer, as well as too little, can negatively affect the growth and well being of your trees and lawn. The correct amount will keep trees healthy and enhance landscape beauty.

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