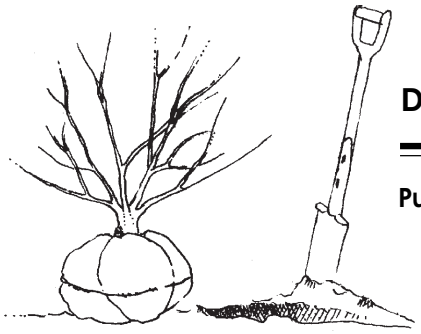

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Fertilizing Woody Plants

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Why Fertilize?

To grow well, trees and shrubs need suitable light, moisture, temperature, air, and nutrients. Nutrients furnish the elements necessary for growth, and soil is the chief source of these elements. Yet around our homes, soils are often deficient in one or more of these vital nutrients. Under forest conditions, decay of fallen leaves and dead plants continually replaces nutrients taken up by living plants. However, fallen leaves and litter are generally removed around homes, and soil fertility declines. Also contributing to poor soil fertility is loss of topsoil and the use of subsoil for filing and grading during building construction. Subsoils often have poor physical properties and lack adequate amounts of essential mineral nutrients. Many homeowners, recognizing this problem, fertilize their lawns regularly but forget that trees and shrubs need similar attention.

Vigorous, hardy growth with more resistance to disease and insect pests is the result of providing proper plant nutrition. Signs of poor nutrition may be small leaves, yellow-green leaves rather than deep green leaves, mottled leaves, early loss of leaves, and little annual twig growth. Proper fertilizing will help overcome weak growth and will aid in recovery from defoliation due to insects, disease, or damage.

Growth rate will vary somewhat among different species and from season to season, but generally, young, healthy trees produce 9 to 12 inches of terminal growth per year. Large, mature trees usually average 6 to 9 inches of annual growth. The amount of growth for the current year can be measured from the tip of the twig to the first ring of bud scale scars; for previous years, the distance between one ring of bud scale scars and the next ring measures growth. Growth rate for an individual tree can be determined by comparing the growth of several seasons.

Fertilizing can quicken growth of young plants and can help stimulate growth of slow-growing species. Under proper nutritional care, even the so-called slow-growing trees may grow as rapidly as many other species. Although mature trees and shrubs that have reached full size need less fertilizing than young specimens, regular light fertilizing will maintain good color and health while limiting excessive growth.

Organic and Inorganic Fertilizers

Organic fertilizers come from plant or animal sources such as manure, bone meal, and cottonseed meal. Inorganic fertilizers are from non-living sources. Some are mined from mineral deposits; other are obtained through complex manufacturing processes.

Most elements are absorbed by plants as inorganic ions (electrically charged atoms). Organic forms must be converted to inorganic ions before root uptake occurs. A plant does not distinguish between ions originating from inorganic or from organic sources. This is not to say that different materials containing the same amount of a particular nutrient will be equally effective. Effectiveness may vary depending on solubility of the materials, how they affect the structure or pH of the soil, or how they persist in the soil. Organic sources are slower in releasing nutrients because they must be decomposed by soil micro-organisms before they are available to plants. Synthetic organic fertilizers have been developed for their slow release character, reducing the possibility of fertilizer injury to plant roots. Urea formaldehyde is an example of a slow-release fertilizer. Simple urea, however, is *not* slow-release.

The principal advantage of natural organic fertilizers is that they improve soil tilth or structure while meeting the nitrogen requirement of plants if supplied in sufficient amounts. For example, manures incorporated in surface soils reduce crusting and enhance seedling emergence. Animal manures, however, may create a problem by introducing weed seeds into the area.

When nutrients are the primary interest, inorganic fertilizers are usually favored. They cost less per unit of nutrient, contain greater percentages of a given nutrient,

and are easier to handle and apply because they are more concentrated and less bulky. The nutrients are more quickly available to the plants and are not dependent on the rate of organic decomposition, which, in turn, is dependent on temperature, moisture, and soil composition.

Use of Inorganic Fertilizers

The term “complete fertilizer” refers to a fertilizer that contains nitrogen (N), phosphorus (P), and potassium (K). The “analysis” on the fertilizer bag label indicates the percentage by weight of these three nutrients, always listed in the same order. Thus, a 10-6-4 analysis fertilizer contains 10 percent nitrogen, 6 percent phosphorus (expressed as P_2O_5), and 4 percent potassium (expressed as K_2O). For example, a 100-lb bag of 10-6-4 fertilizer contains 10 pounds of nitrogen, 6 pounds of phosphate, and 4 pounds of potash. A 50-lb bag of the same fertilizer contains half as much of each nutrient. The remainder of the weight consists of material that makes it possible to spread the fertilizer evenly and easily.

If trees and shrubs are growing in a lawn where a complete fertilizer program is followed to promote healthy turf, the woody plants probably will not need additional fertilizer. If grown in beds, however, where the shrub roots are not under the lawn, the woody plants should be fertilized as detailed below. Note that *fertilizer-herbicide mixes designed for turf should never be used in plant beds.* In general, turf herbicides such as 2,4-D and dicamba should not be used over the roots of trees or shrubs, because they may enter the plants though the root system and cause damage. Damage can include disfiguring of new growth, dieback of twigs and branches, and, in severe cases, death of the plants.

A soil test should be used to determine the soil pH and whether or not adequate levels of phosphorus and potassium are present in the soil. Usually for woody ornamental plants, nitrogen is the nutrient in short supply. All three, plus other elements in less amounts, are necessary for healthy plants, but nitrogen leaches out of the root zone and must be replaced annually. Rarely are all three elements deficient in the same soil.

Generally, an application of phosphorus and potassium every three to five years is adequate for satisfactory growth of woody plants. Phosphorus forms relatively insoluble compounds in the soil and becomes available slowly through several growing seasons. Potassium is available in the soil as an exchangeable ion.

Nitrogen should be applied as required to maintain green leaves and vigorous growth. For rapidly growing plants, an annual application in the early fall is preferred to ensure adequate amounts, while in poor, sandy soils, which do not hold fertilizers well, it may be necessary to make more frequent applications.

If a soil test shows that phosphorus and potassium are at low or medium levels, use a fertilizer mix such as 10-10-10, 16-8-8, or 20-10-5. If the soil is high in phosphorus and potassium, use a nitrogen-only fertilizer such as 21-0-0, 33-0-0, or 45-0-0.

Rates and Timing of Application

A fertilizer program for trees and shrubs needs to maintain a fertility level that will provide nutrients as required during the growth of the plant. Calculate the size of the planting bed or lawn area containing the woody plants. Fertilizer should be applied to the feeder root zone of shrubs and trees. For shrubs, consider either the entire bed area, or an area twice the diameter of the shrub, as the feeder root zone. Tree feeder roots occur in an area below and on either side of the dripline of the tree canopy (end of branch spread). To calculate an appropriate area to fertilize, include the area from one-half the canopy radius from the trunk extending to one-half the canopy radius beyond the dripline. For several trees in a yard, calculate the entire yard as the tree root zone. A rate of 2 to 4 pounds of nitrogen per 1000 square feet of soil per year is considered optimal. To reduce the risk of fertilizer injury, this total amount should be divided into two or more portions and used in two or more applications during the growing season. Even if applied all at one time, a nitrogen treatment of 4 pounds/1000 square feet is not considered excessive for well-established plantings in beds. For plants growing in turf, however, split applications should be used to avoid damage to the turf.

A complete program would be an application of 1 or 2 pounds of nitrogen per 1000 square feet in the early fall (September to early October) and 1 or 2 pounds again in the spring just as buds are swelling (late March to April). As long as soil temperatures are above 40°F, roots can absorb nutrients (see Table 1). An added advantage is that in spring and midfall, soil moisture conditions favor plant nutrient uptake.

Table 1. Spring and fall soil temperatures (°F) at 4" depth, Tippecanoe Co., IN, average over 18-year period.

		Under Bare Soil	Under Turf
Spring			
March	15	38.1	38.2
	22	41.1	41.1
	29	43.9	43.7
April	5	46.7	46.1
	12	49.4	48.7
	19	52.2	51.1
	26	55.0	53.7
Fall			
Oct.	20	55.1	55.6
	27	52.5	53.4
Nov.	3	49.9	51.2
	10	47.2	49.1
	17	44.5	46.9
	24	41.9	44.7
Dec.	1	39.3	42.5
	8	36.5	40.3

If desired, quick-release nitrogen may be applied in late spring. Knowledgeable people avoid fertilizing during mid-summer. The late season growth stimulated by such treatments may be injured by fall and winter cold snaps in some areas.

To calculate the amount of fertilizer needed to supply 2 pounds of nitrogen per 1000 square feet, use the percent nitrogen figure in the fertilizer analysis. N is the first number of the three numbers in a fertilizer analysis. If the fertilizer has a 10-6-4 analysis, a 50-pound bag contains 5 pounds of nitrogen (10% of 50 lb. = 5 lb.). Applied at a rate of 20 pounds of fertilizer (2 lb. actual N) per 1000 square feet, the 50-pound bag will cover 2500 square feet. Stated another way, for 1000 square feet, use 20 pounds of 10-6-4 fertilizer, or, for smaller beds, apply 2 pounds for every 100 square feet. Table 2 gives rates for applying some common fertilizers.

Table 2. Amount of nitrogen fertilizers needed to supply 4, 2, and 1 lb. of actual nitrogen per 1000 square feet.

	Approx. lb. of fertilizer needed		
	4 lb N	2 lb N	1 lb N
Urea (45-0-0)	8	4	2
Ammonium nitrate (33-0-0)	12	6	3
Ammonium sulfate (21-0-0)	20	10	5
10-10-10	40	20	10
12-12-12	32	16	8

To re-emphasize a point made earlier, once woody plants have reached their desired size, less fertilizing is needed.

Caution: Too heavy a rate of application can lead to weak, excessive growth or to damaged plant tissue, including the roots. A root system that is damaged by excess fertilizer can result in deficiency of nutrients within the plant, even when soil nutrient levels are adequate.

If injury from fertilizer salts occurs, two or more heavy waterings may leach excess fertilizer salts from the soil.

Keeping plants well watered during the growing season after fertilizer application will help prevent injury. If rainfall is sparse or infrequent, supplementary thorough watering will be beneficial. Use of slow-release nitrogen fertilizer (urea formaldehyde) is another safeguard against the possibility of injury. This source of nitrogen breaks down gradually over a period of several months and supplies plants with an even amount during this period. Its disadvantage is its higher cost, which may not be justified due to the fact that many trees and shrubs only grow in one flush per year, so a continuous nutrient supply is not needed. Use of urea formaldehyde at less than recommended rates gives poor results because insufficient nitrogen is available at any given time for the plants needs.

Calculating fertilizer amounts on the basis of size of the bed or spread of the tree (see next section) is considered a better practice than basing amounts on the trunk diameter of the plant.

Methods of Application

Fertilizers are available in granular or pelleted forms for dry application and in water-soluble or liquid forms that can be applied with a hose or sprayer.

Dry fertilizers may be broadcast by hand or spread by drop-type or rotary distributors. Figure 1 illustrates both rotary- and drop-type spreaders. Avoid uneven distribution by dividing the fertilizer to be applied in half, then applying one-half lengthwise over the area, the remainder crosswise over the area. If isolated trees within a lawn are being fertilized, the turf will be stimulated by the treatment and will be greener and faster growing than untreated areas. This so-called "oasis effect" can be avoided by extending the fertilizer treatment beyond the area the trees cover. Water the area thoroughly after application to remove the fertilizer from grass or ground cover and move it down into the soil.

Figure 1. Rotary and push-type spreaders are useful for dry fertilizer distribution.

Since nitrogen moves through the soil readily, surface application as described above is suitable if only nitrogen is being applied. If soil tests indicate a need for either phosphorus or potassium, placing the nutrients in holes in the root zone of the trees is preferred (see Table 3 for rates). Fertilizer in holes 1 or 2 inches in diameter and 12 to 18 inches deep will reach many of the feeder roots of trees. Feeder roots of most trees are abundant in the top foot or two of soil.

Holes may be punched in the soil with a steel bar or drilled with an auger attached to an electric drill. The latter method is preferred in heavy soils since it does not compact the sides of the holes and permits dissolved fertilizer to move more freely from the hole. Such drilling has the added bonus of improving aeration in heavy soils. When the added fertilizer is combined with organic-matter backfill, the hole drilling and filling process is known as “vertical mulching.”

Table 3. Amounts of phosphorus and potassium fertilizer materials needed to supply 3.6 pounds P_2O_5 per 1000 square feet and 6 pounds of K_2O per 1000 square feet.

	Quantity needed per 1000 sq. ft.	Amount per hole based on 250 holes per 1000 sq. ft. (holes on 2 ft. grid)
Phosphorus (P) superphosphate (0-20-0)	18 lb	2 tsp
Treble super phosphate (0-46-0)	8 lb	1 tbsp
Potassium muriate of potash (0-0-60)	10 lb.	1 tbsp.
Nitrogen, phosphorus, potassium 10-20-10	18 lb.	1/4 cup
12-12-12	30 lb.	1/2 cup

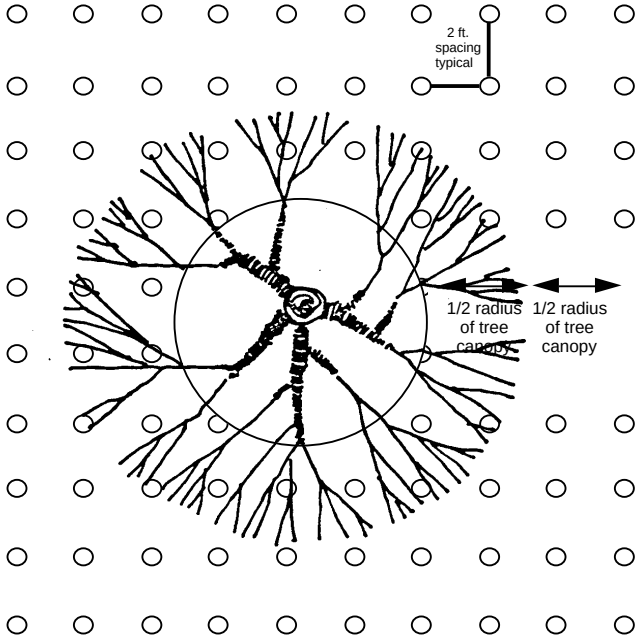

Figure 2. Placing fertilizer in holes, evenly spaced in the root zone of the tree, is recommended for potassium and phosphorus.

Space holes 2 feet apart in a rectangular pattern beneath and somewhat beyond the spread of the branches (see Figure 2). Do not drill holes within 2 feet of the trunk of trees with a 12-inch trunk diameter or within 3 feet of trees with an 18-inch diameter. The required amount of fertilizer, based on the area to be covered and rate of application, should be divided equally to fill the number of holes, and can be applied with a funnel or a can with the top edge bent to form a pouring spout. After the fertilizer has been added, water thoroughly. The holes then may be filled with sand, topsoil, or organic matter.

So-called “food spikes” that are driven into the ground at intervals beneath and around trees and shrubs may be used as an alternative to drilling and filling holes, but they are more expensive than the method described above.

Other methods of application are a) injection of liquid fertilizer below the ground, using a special injector wand and water pressure to force the solution into the soil; b) application of liquid fertilizer to the foliage of the plant; and c) injection of nutrients into the tree trunk, using special equipment. The latter two methods are usually reserved for treating deficiencies of specific nutrients such as iron or manganese. Foliage treatment and trunk injection give quick results, but are more costly and less long-lasting than nutrients applied to the root zone of the plants. Foliar feeding of small and medium-sized shrubs may be done by the homeowner; proper coverage of trees and large shrubs will require the services of a professional arborist. Injection methods will also call for

employment of a professional; often equipment available to home owners will not supply an adequate amount of fertilizer.

Special Cases

Deciduous Trees

Mature trees need little fertilization as long as they have good leaf color and grow reasonably well. Stimulating increased growth may increase foliage density to the point that interior foliage and plants growing beneath the trees may be weakened by heavy shade.

For trees growing in confined areas where roots are restricted by pavement, buildings, or other construction, fertilizer rates should be based on the area in which the roots are confined and *not* upon the branch spread when using the steel bar or auger method. Applying too heavy a rate will result in root damage.

Trees with very narrow crowns will have a broader root spread than crown spread. Fertilizer should be applied well beyond the canopy spread, up to three times the distance of the dripline.

Deciduous Shrubs

Surface application is preferred to the steel bar method for small or shallow-rooted shrubs. Fertilizer should be scattered evenly beneath the shrub and beyond, to double the shrub diameter, or applied to the entire bed if plants are close together. Care should be taken to avoid contact between the stems or trunks of plants and the fertilizer, and application should be followed with a thorough watering. If the shrubs are known to be deep rooted, the fertilizer may be worked into the soil.

While plants are small and rapid growth is desired, higher rates of nutrients can be applied. As plants reached desired size, reduce or eliminate fertilizer to limit growth.

Newly Planted Trees and Shrubs

Damage to roots can occur when too much inorganic fertilizer is incorporated into soil used in transplanting. Surface application of fertilizer, watered in well, is preferred, and many people avoid using any fertilizer the first year. Slow-release fertilizers may be worked into soil deep in the planting hole if several inches of backfill are added before the plant is placed in position.

Evergreens

Evergreen trees and shrubs appear to require lower rates of nutrients than their deciduous counterparts. Overfertilizing conifer trees leads to open growth with widely spaced branches. Narrow-leaved evergreen shrubs generally need only enough fertilizer to maintain good foliage color, especially if used in small scale plantings.

Many *broadleaved* evergreens have shallow root systems which are easily burned by highly concentrated chemical fertilizers. These plants need an acid soil pH for efficient nutrient uptake. Most garden centers carry special acid-based fertilizers formulated for broadleaved evergreens. These fertilizers contain both an inorganic source of acid-type nitrogen, which is quickly available to a plant, and an organic source, which will supply nitrogen over a period of time. Lime, wood ashes, or bone meal will raise the soil pH and should be avoided. The punchbar method of fertilizer application should not be used with broadleaved evergreens, nor should surface applications be worked into the soil.

An acid-type organic mulch, such as peat moss or rotted oak-leaf mold, will help conserve moisture, keep weeds down, and protect the roots from excessive summer heat. Organic fertilizers such as cottonseed or soybean meal, available from some nurseries and farm supply stores, may be mixed with the mulch.

**The previous edition of this bulletin was co-authored by Philip L. Carpenter, Professor Emeritus, and R.V. Kvaalen.*

For more information on the subject discussed in this publication, consult your local office of the Purdue University Cooperative Extension Service.