Cornell CALS
College of Agriculture and Life Sciences

Horticulture Section
School of Integrative Plant Science

# Getting the most out of your landscape tree and shrub soil test report

- Select trees and shrubs suitable for your site conditions.
- Measure your soil pH in order to choose the right plants for your site.
- Apply fertilizer only if soil test or plant growth indicates need.
- Add organic matter to planting site to reduce the need for fertilizer and improve the soil.

## The Key to Successful Plant Establishment

Complete a site assessment to help you identify limitations of your site. For example, consider:

- Above and below ground obstructions such as utility wires.
- Hours of sunlight, wind, USDA hardiness zone and other microclimate factors.
- Soil pH as well as drainage and compaction.
- Potential interference from wildlife.

*Site Assessment for Better Gardens and Landscapes* by Charles P. Mazza provides a step by step guide to site assessment. Download a copy.

Find the right plant for your site with help from this Woody Plant database.

## Do I need to fertilizer my trees & shrubs every year?

Many ornamentals can thrive in fair to good quality soil provided there is enough organic matter and proper drainage to meet their needs. Trees and shrubs grown in lawn areas that are being fertilized are probably getting enough nutrients and will not need supplemental fertilization. Conifers rarely need any fertilizer at all.

If your soil test shows the nutrient levels are very low and if you observe poor growth, smaller leaves, off-colored foliage (chlorosis on leaves), dieback and other leaf or crown abnormalities of trees, fertilization may be warranted.


Chlorosis in Red Maple

However, fertilization will not correct planting the wrong tree or shrub in a site with poor soil drainage or droughty conditions or the wrong pH. Overfertilization can make matters worse by reducing plant health and attracting more pests to the site.

**Many trees and shrubs can do well within a soil pH range of 6.0 to 7.5. Some can tolerate more acidic or alkaline levels**

## Soil pH Recommendations

It is best to identify the specific soil pH needs of trees and shrubs in advance of planting. It can be difficult and impractical to significantly adjust and maintain a proper soil pH after planting. Many trees and shrubs will do well when the soil pH is between 6.0 and 7.5. Others will tolerate more alkaline soils with a higher pH, up to 8.2, while still others require acid soils with a lower pH, 5.5 -7.0.

When the pH is outside the optimum range for a specific tree or shrub find a different tree or shrub that will thrive in your soil pH. For a comprehensive plant list check: Woody Plant database

Acid loving plants, such as rhododendrons, mountain laurels and others, thrive when the soil pH is less than 6.0. It will be extremely difficult to establish acid

loving plants in soils that naturally have a high pH (above 7.0) and high calcium levels. It will not be economically feasible to permanently reduce the pH to the needed level. In these situations, select plants that can tolerate alkaline soils or consider an alternate site for the acid-loving plants.

### Promote plant health and protect the environment with proper fertilizer applications.

Nitrogen (N), phosphorus (P) and potassium (K) are required for optimum growth. The nutrient demands of established trees and shrubs are not high. Those grown in areas near lawns that are fertilized will likely not need supplemental fertilizer after establishment. Only apply fertilizer if the soil test indicates low levels of nutrients. Poor growth, smaller leaves, off-color foliage, dieback or other leaf abnormalities may also indicate nutrient deficiency.

## Organic Nutrient Sources

**Organic matter** is added to the soil to improve soil properties by increasing the water and nutrient holding capacity, improving aeration and drainage, feeding microorganisms and providing some nutrients. Common organic matter sources include plant-based compost, plant and animal by-products and composted manure.

**Animal manures and plant-based composts** (yard waste, grass clippings [free of any herbicides], food waste) are readily available and popular fertilizers, commonly considered as ***natural organics***.

Nutrient content of composted products will vary depending on the source (plant or animal), moisture content, how it was stored and how long it was composted. Weed seeds, a high salt content and pathogens might also be a problem with fresh manure or other organic materials if they are not fully composted. Knowing the nutrient and salt content of your compost or manure pile would add precision to the application rates for a given site. However, this would require testing every time one of the above variables changed making this impractical and cost prohibitive for the average gardener.

The nutrient analysis of commercially available manure is found on the bag. Keep in mind these products may also have a high salt content and only 5 to 20% of organic forms of nitrogen will be available to the plants during the first year of application.

Only mix in manure or other materials that are fully composted. Fully composted manure has aged for at least 6 to 9 months. Incorporate into the upper 6 to 8 inches of soil before planting to allow time for the slow release of nutrients in the root zone and to minimize runoff.

**Too much of a good thing?** *If a regular soil test indicates that nutrient levels exceed plant needs, limit compost applications to promote healthy soil for plant success.* High organic matter levels can lead to nutrient imbalances.

## Using compost on large sites

The safest addition of compost would be to use those made with yard trimmings, leaves and food waste. Animal manures may be very high in phosphorus , nitrogen and soluble salts. If animal manures will be used on a regular basis, the manure should be tested for nutrients, salts and pH. Caution should be used when adding them to the landscape planting site.

Work with testing facilities that use the TMECC compost testing protocols. Thompson, W.; Leege, P.; Millner, P.; Watson, M.E. *Test Methods for the Examination of Compost and Composting (TMECC)*; US Composting Council: Reston, VA, USA, 2002.

More information about composts and their use in the landscape can be found on the Cornell Waste Management Institute website.

## Fertilizer Terms

**The nutrient content (fertilizer analysis) is required on every bag of commercially available fertilizer.** The first number indicates the *percent* of nitrogen (N), the second number is the *percent* of phosphate ($P_2O_5$) a source of phosphorus, and the third number is the *percent* of potash ($K_2O$) a source of potassium. They are simply referred to as N-P-K. A 100 lb. bag of 10-6-4 contains 10 lbs. of N, 6 lbs. of $P_2O_5$ and 4 lbs. of $K_2O$. The rest of the material is made up of inert material, such as sand or clay granules to help spread the fertilizer.

When nitrogen (N), phosphorus (P) and potassium (K) are all needed, a *complete fertilizer* that contains all 3 nutrients and has the correct proportion can be used. Trees tend to benefit from fertilizers with a ratio of nutrients close to a 3:1:2. Fertilizers like 15-5-10, 20-5-10 could be used.

# Fertilizer Sources and Forms

***Inorganic fertilizers*** are chemically synthesized from basic raw materials, isolated from naturally occurring sources or mined materials that provide nutrients. Some examples include calcium nitrate, ammonium sulfate, ammoniated phosphates and calcium and potassium nitrate (Chilean nitrate).

Inorganic fertilizers are less expensive and have a higher nutrient content than organic fertilizers. They are water-soluble and are quickly available to plants, easy to apply and especially useful in cool weather.

Care should be taken when using *water-soluble fertilizer* sources because they are made of salts that can damage plants if misapplied. If over applied and watered in excessively they can negatively impact water quality if leached beyond the root zone and into the ground water.

***Organic fertilizers*** contain carbon and are derived from living organisms. Corn gluten meal, feather meal, composted manure and bio-solids are examples of **natural organic fertilizers** derived from plant and animal residue. Using nitrogen from organic sources is almost always more expensive because generally organic fertilizer sources have lower amounts of nutrients. Warm (higher than 55°F) moist soil for microbial activity is needed to release nutrients from organic fertilizers.

***Water soluble sources*** of nitrogen are quickly available to plants. Care should be taken when using *water soluble* sources because they are made of salts which can burn plants at high concentrations. If over applied, watered in excessively or applied before a heavy rain, they can leach beyond the root zone and end up in the ground water and negatively impact water quality especially on coarse-textured sandy soils.

***Slow release fertilizers*** are ideal for trees and shrubs providing nutrients over an extended period of time and are less likely to leach and pollute water.

When fertilizing trees and nitrogen is needed, select a fertilizer that has 50% of the nitrogen in the *slow release* form. A portion of nutrients will be available quickly while the other portion will become available over an extended period of time.

See next section to see how to determine the slow release fertilizer in a bag of fertilizer.

**How much slow release nitrogen is in that bag of fertilizer?**
(Water insoluble nitrogen (WIN)

To calculate how much slow release nitrogen and how much water-soluble nitrogen is in the bag of fertilizer first read the fertilizer label to determine the total amount of nitrogen. In this example the fertilizer analysis is **30-0-0**, which means it contains 30% nitrogen**.** It is easy to figure out how much of the nitrogen is slow release and how much is water soluble (quickly available).

First, look on the label for the language "slowly available nitrogen" or "**W**ater **I**nsoluble **N**itrogen" (**WIN**), or something similar.

In this example,
the water insoluble nitrogen is 15%.

**30-0-0 Sunshine Fertilizer**

**Total Nitrogen 30%**

**WIN 15%**

Divide WIN (%) by the Total Nitrogen to determine the % slow release Nitrogen. In this example, **half of the total nitrogen is slow release.**

**WIN on label = Water Insoluble Nitrogen**
**% total Nitrogen**

**15% (WIN) = 50% slow release nitrogen**
**30% total N**

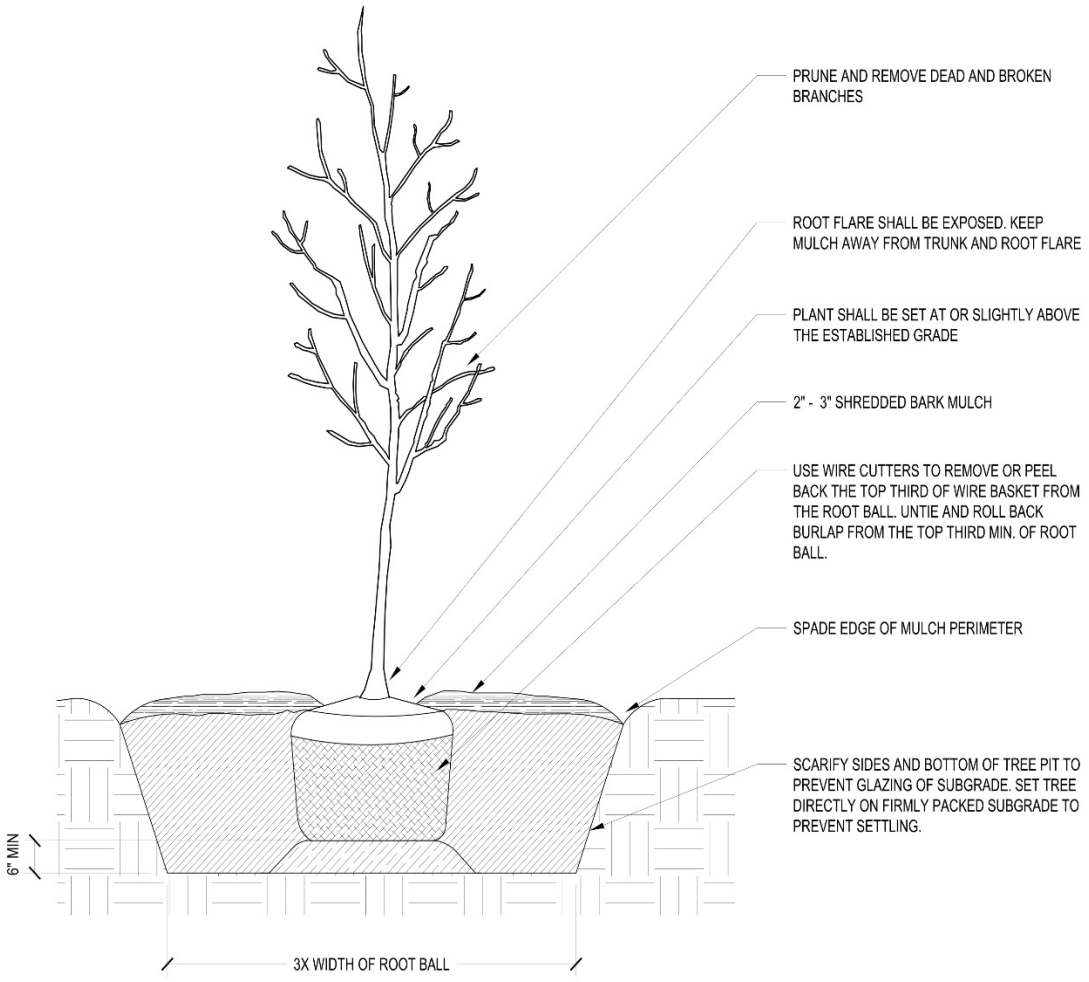
## Pre-plant practices for establishing Trees and Shrubs

Ideally, the soil should be prepared a year before planting to adjust soil pH if necessary and to add phosphorus and potassium if recommended. If this is not possible prepare the planting site as soon as the soil can be worked.

Remember to choose plants that are adapted to the pH on site. To check preferred pH levels for trees and shrubs visit: http://woodyplants.cals.cornell.edu/

The planting hole should be 3 times the diameter of the root ball, container or root spread. If the organic matter level is less than 5% apply a 2" level of good quality compost and mix it into the upper 6" of soil along with pH adjusting materials (lime

or sulfur if needed) or any nutrients like phosphorus and potassium (if recommended).




# Nutrients for plant growth

## Nitrogen (N)

Nitrogen is one of the most important nutrients for plant growth. In most situations when the soil has been prepared properly before planting and the organic matter level is 3-5%, adequate levels of nitrogen may already exist. So, depending on the purpose of the planting supplemental fertilization may or may not be necessary.

## Phosphorus (P)

Phosphorus is important in early root development and establishment. It is possible that your soil has an adequate level of P and additional P will not be needed.

Phosphorus does not move in the soil much so when needed it is best to incorporate P into the soil before planting so the roots can access more of this nutrient.

When only phosphorus is needed use **Table A** to determine the amount of phosphorus fertilizer to apply.

**Table A: Soil test levels and <u>approximate</u> pre-plant phosphorus (P) recommendations for landscape trees and shrubs**

| **Soil test report levels** | **Ounces of phosphate ($P_2O_5$) to apply per 100 sq. ft. before planting** | **Some fertilizer sources that contain phosphorus** (notice the concentration differs for each so the amount to apply differs) | | | |
|---|---|---|---|---|---|
| | | **Inorganic fertilizers** | | **Organic fertilizers** | |
| | | Super-phosphate 0-20-0<br>20% $P_2O_5$ | Triple Super-phosphate 0-46-0<br>46% $P_2O_5$ | Bone Meal* 1-15-0<br>15% $P_2O_5$ | Rock Phosphate 0-3-0<br>3% $P_2O_5$ |
| | | Quickly available | Quickly available | Slowly available | Slowly available |
| | | **Amount of product to apply per 100 square feet** | | | |
| Very low | 4½ oz. | 1⅓ lbs. | 9¾ oz. | 2 lbs. | 9⅓ lbs. |
| Low | 3½ oz. | 1 lbs. | 7½ oz. | 1½ lbs. | 7⅓ lbs. |
| Medium | 2¼ oz. | 11¼ oz. | 5 oz. | 1 lb. | 4½ lbs. |
| Relatively high | 1½ oz. | 7½ oz. | 3¼ oz. | 10 oz. | 3 lbs. |

* Bone meal also supplies nitrogen.

## Potassium (K)

Potassium increases drought resistance and root growth. If potash, a source of potassium, is needed mix into the upper 6 inches of soil before planting.

If only K is needed use **Table B** to determine the amount of potassium fertilizer to apply. Remember to use the <u>higher bolded amount</u> if your soils are sandy.

| **Table B: Soil test levels and <u>approximate</u> pre-plant potassium (K) recommendations for landscape trees and shrubs** | | | | | |
|---|---|---|---|---|---|
| **Soil test report levels** | **Ounces of potash ($K_2O$) to apply per 100 sq. ft. before planting** | **Fertilizer sources that contain potassium (K)** (notice the concentration differs for each so the amount to apply differs) | | | |
| | | **Inorganic fertilizers** | | **Organic fertilizers** | |
| | | Potassium sulfate 0-0-50 50% $K_2O$ | Potassium chloride 0-0-60 60% $K_2O$ | Kelp* 1-0-2 2% $K_2O$ | Greensand 7% $K_2O$ |
| | | Quickly available | Quickly available | Quickly available | Very slowly available |
| | | **Amount of product to apply per 100 square feet** | | | |
| Very low | 4½ -**5½ oz**. | 9 - **11 oz.** | 7½ -**9 oz.** | 14 - **17 lbs.** | 4 - **5 lbs.** |
| Low | 3⅓ - **3½ oz.** | 6½ - **7 oz.** | 5½ - **5¾ oz.** | 10⅓ - **11 lbs.** | 3 - **3 lbs.** |
| Medium | 1¾ oz. | 3½ oz. | 3 oz. | 5½ lbs. | 1½ lb. |
| High | - | - | - | - | - |

Note: *Kelp also supplies nitrogen.
Use the <u>higher bolded amount</u> if your soils are sandy.

## Fertilizing Established Trees and Shrubs

**Recommendations for phosphorus (P) or potassium (K) nutrients will only be made if these nutrients are low.** Additional P or K should not be added unless soil test levels are low.

For established trees and shrubs **apply half** the recommended amount listed in **Table A** for phosphorus and **half** the recommended amount listed in **Table B** for potassium rate.

## Nitrogen (N)

Nitrogen application rates are based on the age of planting, plant health and desired level of growth. **Table C** lists suggested nitrogen rates based on tree and shrub age. **Table D** lists a few commonly available organic and inorganic nitrogen sources and the amount needed to supply 0.1 (one tenth) pound of nitrogen per 100 square feet area.

| Table C: Approximate amount of nitrogen to apply per 100 square feet | | |
|---|---|---|
| **Age of planting** | **Nitrogen* per 100 sq. ft.** | **Considerations** |
| **Newly planted** (1-2 years) | 0.1 - .2 lb. | If a water-soluble source is used apply at the **lower rate**.<br>If a slow release source is used the **higher rate** can be used. |
| **Young trees and shrubs** <5 years | 0.2 - .4 lb. | If rapid growth is desired use the **higher rate**.<br>If trees and shrubs are grown in fertilized lawn area use the **lower rate**. |
| **Established and mature trees and shrubs** > 5 years | 0.2 - .3 lb. | The need for nitrogen is less for mature plants. Growth naturally slows down.<br>If grown in a fertilized lawn area.<br>N will not be needed. In other areas N may be needed.<br>Application should last 3-4 years. |

* Use the lower rate for shrubs.

| Table D: Amount of fertilizer to apply to provide 0.1 lb. of nitrogen per 100 square feet | | | | |
|---|---|---|---|---|
| **Common Nitrogen Sources** | **% Nitrogen Content** | **To supply 0.1 lb. N apply** | **Availability** | **Other Facts** |
| **Organic Sources** | | | | |
| Natural organics | 3-10 | 3-1 lbs. | slow | By-products from plant and animal processing |
| Corn Gluten | 10 | 1 lb. | slow | Expensive |
| Urea (synthetic organic) | 46 | 3½ oz. | quickly | Inexpensive, concentrated, difficult to apply |
| **Inorganic Sources** | | | | |
| Ammonium sulfate | 21 | 7½ oz. | medium | Can help lower soil pH |
| Sulfur Coated Urea | 32-38 | 5-4 oz. | slowly | Also provides sulfur |

**Example:** if you plan to fertilizer young trees growing in a lawn (check Table C) and need to lower the soil pH, (check Table D), ammonium sulfate could be used.

If the **area is 100 square feet**, and you want to provide **nitrogen at the 0.2 lb. rate**, and plan to use **ammonium sulfate**, 15 oz. would be needed.

0. 2 lb. recommended nitrogen rate = **~15 oz. for a 100 sq. ft. area**
.21 nitrogen analysis of ammonium sulfate

**Fine-tuning your fertilizer application based on plant health**

When both phosphorus and potassium are needed a complete fertilizer, which contains N, P and K can be used.

The rate will be influenced by plant health **Use Table E**.

Different factors can cause poor health including inadequate drainage, compacted soils, over or under watering, and pest pressure.

So, what's "good health"? Some indicators of a healthy tree include adequate growth (≥ 6" of shoot growth per year), green leaf color, and full tree canopy.

A few indicators of poor health could be poor growth (less than 2" of shoot growth per year), leaves small, uniformly light green or yellowish, and open thin canopy. In these situations, the planting may benefit from a fertilizer application.

| **Table E: Selecting a fertilizer based on soil test levels and plant health** | | | | | | |
|---|---|---|---|---|---|---|
| **Approximate amount of fertilizer needed for a 100 square foot area** | | | | | | |
| **Soil test levels for P and K** | **Plant health** | **Fertilizer Ratio** | **Examples N-P-K** | **Rate for trees*** | **Rate for shrubs** | **Comments** |
| **Very low** | Good | 1:1:1 | 10-10-10 | 2 lbs. | 1 lb. | Fertilizer won't fix poor growth due to soils that are compacted, have poor drainage, are not at the optimum pH level, etc. |
| | Fair | 2:1:1 | 20-10-10 | 1½ lbs. | ¾ lb. | |
| **Low** | Good | 2:1:1 | 20-10-10 | 2 lbs. | 1 lb. | |
| | Fair | 3:1:1 | 30-10-10 | 1 lb. | ½ lb. | *Apply fertilizer starting 2 feet away from the trunk of the tree. |
| **Medium** | Good | 4:1:2 | 20-5-10 | 2 lbs. | 1 lb. | |
| | Fair | 3:1:2 | 15-5-10 | 2 lbs. | 1 lb. | Spread fertilizer to the drip line. |
| **High** | | | | - 0 - | - 0 - | |

# Timing of fertilizer applications for trees and shrubs

**General:**

*Pre-plant* fertilizing involves mixing fertilizer into the upper 6 to 8 inches of the soil before plants are in the ground. Nutrient deficiencies of phosphorus and potassium can be addressed at this time.

*Maintenance fertilizing* refers to the addition of fertilizer to established plantings during the growing season. If plant growth and quality are adequate a fertilizer application will likely not be needed.

Most trees have a single flush of growth followed by slower growth. It is desirable to have nutrients in the rootzone before growth occurs.

Nitrogen applications can be made in the spring to initiate new growth just before bud break, as buds are swelling. Another possible time is early fall when the soil is still warm, moisture is usually available, and the weather is cooling. Nutrients can still be absorbed and stored and available for next spring's growth.

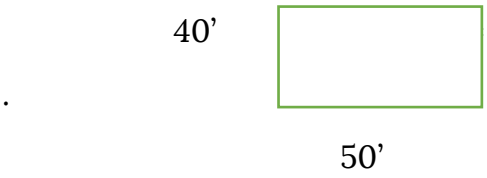
| **Spring** | **Summer** | **Fall** |
|---|---|---|
| ▪Do not apply fertilizer to frozen ground and before April 1st.<br><br>▪Apply before the first signs of growth in the spring, before bud break (late March – April).<br><br>▪On sandy soils apply half the amount in early spring and half in later spring or early summer, mid-May or by early-June. | ▪During drought periods roots will not readily absorb fertilizer.<br><br>▪Summer fertilizer applications are not recommended if irrigation is not possible.<br><br>▪If the soil is moist or irrigation is applied, fertilization should stop by the end of July.<br><br>▪Avoid late summer applications which may promote new growth that could be susceptible to early frost damage. | ▪An application can be made in September to early October. |

# How to apply fertilizer

**Fertilizing shrubs:**
Keep in mind that shrubs grown in fertilized lawn areas will probably not need supplemental fertilizer. If growth and quality are good do not fertilize.

**Fertilizing established trees:**
The soil test report provides fertilizer recommendations per 100 square foot areas. Do you best to estimate the area of treatment to avoid applying too much fertilizer. The below methods can be used to determine the square footage of an application area.

**To determine the application area** that is in the shape of a rectangle or a square just multiply the width by the length to get the square feet.
Example: 40ft. width x 50ft. length = 2,000 sq. ft.




= 2,000 sq. ft.

Ex. Using the above area of 2, 000 sq. ft., if soil test indicates levels are very low and your plant health appears good, **see Table E**, the recommendation is

2 lbs. of 10-10-10 for every 100 sq. ft.

2,000 sq. ft. = 20 x 2 lbs. = **40 lbs. of 10-10-10** needed for the 2,000 sq. ft. area
100 sq. ft. (application rate)

**To measure the area of root coverage** for a tree or shrub growing in an open area, calculate the area of a circle, which is $\pi$ (3.14) x $r^2$ or $\pi$ x r x r.

In this example: we measured in feet the radius (distance/length from the tree trunk to the drip line) which is 15 feet.

Ex: use 3.14 ($\pi$), multiply it by the radius (r) 15', multiply it again by 15' (r) = 706 sq. ft.

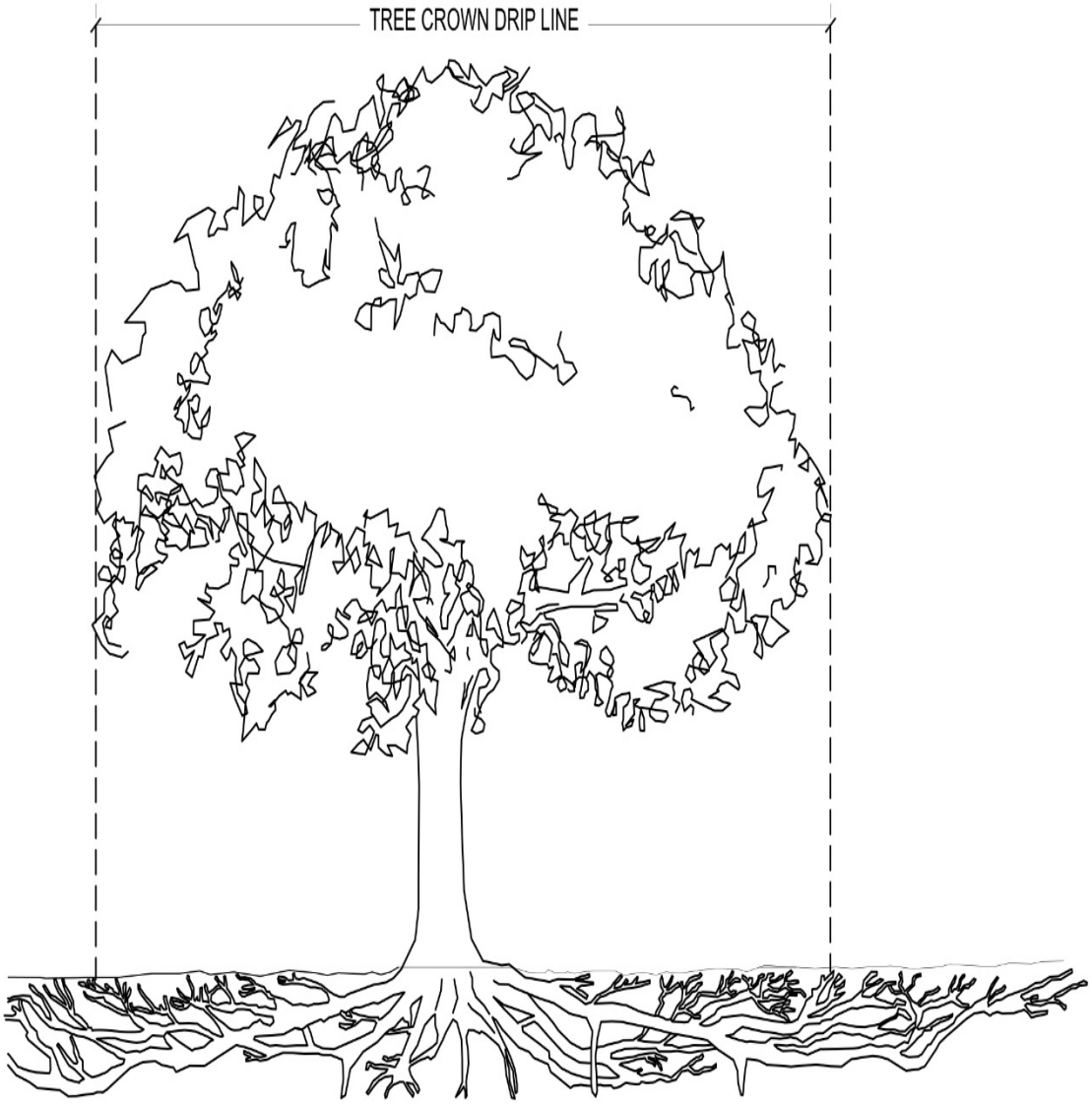
So, if soil test indicates levels are very low and your plant health appears good, **see Table E**, for find the recommended fertilizer rate for each 100 sq. ft. area.

2 lbs. of 10-10-10 for every 100 sq. ft.

706 sq. ft. = ~7 x 2 lbs. = **14 lbs. of 10-10-10** is needed for the 706 sq. ft. area
100 sq. ft. (application rate)

Always avoid fertilizer contact with the tree trunk. Applications should begin 2 feet away from the trunk.

Most of the tree roots are in the upper 12 inches of soil and exist in the drip line and may expand beyond. So, a good practice is to the use the dripline as a guide when spreading the fertilizer.



**Fertilizer application methods:**

*Broadcasting* – applying fertilizer to the surface is the easiest, cheapest and most common application method used. Be sure to determine the area to be fertilized to avoid over fertilization.

If the site is grassed do not use high nitrogen rates and water the treated area with 1-2" of water to move fertilizer off grass blades and into the soil if a light rain is not expected.

*Spikes* – Although very convenient, these concentrated fertilizer spikes **are not recommended** because they only provide very limited distribution and reach only a small portion of the total root volume.

*Foliar applications* – are made when micro-nutrient deficiencies have been determined. The application is a temporary fix and usually does not address the underlying cause of the problem.

*Fertilizer injection* – This hydraulic injection technique allows nutrients to be more quickly available to tree roots. This method is used by arborists and professional landscapers and may be an economically feasible approach when fertilizing a large number of trees.

**Resources:**
The Cornell University Woody Plant database

Diagrams provided by Brian Denig