W 362-B

YOUTH GARDENING IN TENNESSEE: SOIL BUILDING & PLANT NUTRITION

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Nutrition is defined as the process of providing or obtaining the food necessary for health and growth. It is also the branch of science that deals with nutrients and nutrition. Another word for nutrition is nourishment. Both plants and humans require nutrition in order to be healthy and grow.

Nourishing foods are ones that contain healthy amounts of **macronutrients** and **micronutrients**. Macronutrients are required in larger quantities while micronutrients are required in small amounts. The same is true for soils and plants, and soils that contain healthy amounts of macro- and micronutrients are most beneficial for plant growth.

This fact sheet focuses on plant nutrition and explores how building proper soils in the garden can help the gardener grow healthy plants that produce a vigorous yield. For more information on how some of our important nutritional needs can be met by plants, please refer to W 362-D "Ten Favorite Plants for Youth Gardeners in Tennessee."

Creating Ideal Soil for Your Garden

Ideal soils for gardening will be loose; easy to work with; and contain enough nutrients, oxygen and moisture to be beneficial to plants. Garden soil should also drain well while retaining some moisture and nutrients for plants to take up. Soils that contain **decomposed organic matter** usually have more **microorganisms**, as well as nutrients and oxygen, making them more suitable for gardening. Decomposed organic matter also helps soil to retain moisture, which is beneficial for plants. Decomposed organic matter consists of anything that once lived, such as leaves or wood chips, but has been broken down by microorganisms.

In Tennessee, our soils sometimes have high **clay** content while organic matter can be lacking. These soils, however, can be improved and made ready for gardening by adding **topsoil** and decomposed organic matter. Topsoil is the upper layer of soil found naturally and can be purchased in smaller quantities at home improvement or gardening stores. Decomposed organic matter, such as **compost** and **sphagnum peat moss**, can also be purchased by the bag and added to soils to improve them for gardening. Compost that is ready to be added to your garden's soil can also be found at facilities that recycle green waste, or you can make it. Bagged garden soil or soil conditioners contain decomposed organic matter as well. Sphagnum peat moss is mostly decomposed and works well to improve soils for raised bed gardening. When adding organic matter to improve the soil, be careful not to add raw materials such as wood chips, saw dust or leaves. As these materials break down, their **decomposing** microorganisms will use up necessary soil **nitrogen**, an important nutrient, in the process. While some people say adding sand to soil will help improve drainage, store-bought sand usually does not have the right texture to improve clay soil and can actually make them harder to work with and for plants to grow in.

Generally, a good mixture for raised bed gardening will contain about 50 percent mineral soil, like our clay soils, and 50 percent organic matter. For example, and ideal mix would be 50 percent mineral soil, 20 percent topsoil or garden soil, 20 percent compost, and 10 percent sphagnum peat moss, mixed evenly. Some organic soil or compost mixes already contain the sphagnum peat moss, so you wouldn't have to add any more.

If you are gardening on a site that receives high foot traffic and/or is surrounded by Bermudagrass, a commonly used grass on school grounds in Tennessee, we recommend you use **raised beds**. Raised beds in a school setting should be made from some sort of structure, like wood or recycled plastic. Although more expensive at the outset, better quality materials will last longer and can be worth the investment.

Build the bed no wider than 4 feet so that children do not have to walk in the bed in order to work the center of it. Bed height should be at least 8 inches to provide enough soil depth for plant roots to grow. This is especially true if the soil beneath the bed was not tilled before constructing the raised bed. Suppressing weeds below and around the beds is critical, so consider using layers of cardboard and mulch, which will eventually decompose and improve the soil.

Testing Your Soil

After improving the soil, it's wise to test it to determine whether it is lacking any important nutrients and also to determine whether the soil has the correct **pH** in order for nutrients to be made available to the plants. Soil pH is a measure of the acidity and alkalinity in soils. A pH range of between 6 and 7 is optimal for most garden plants, as most nutrients are made available to the plants within this range. If you need to adjust the soil pH, you can add elemental sulfur or lime, according to soil test recommendations. For more information on how soil pH affects nutrient availability, refer to UT Extension publication W 346-A "The Tennessee Vegetable Garden: Site Selection and Soil Testing" at extension.tennessee.edu/publications/Documents/W346-A.pdf. For information on how to submit and read a soil test, please refer to the University of Tennessee's Soil, Plant and Pest Center website at ag.tennessee.edu/spp.

Taking a soil test can save you the trouble of trying to garden in soil that may be lacking in certain important nutrients like **nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg)** and **sulfur (S)**. These nutrients are required by plants in relatively large quantities, especially N, P and K. As a result, they're referred to as macronutrients. Too much or too little of these macronutrients can lead to problems with the plants' growth and development, as described in Table 1 on the next page. Plant macronutrients can be found in man-made or natural, **organic**, sources. **Synthetic fertilizers**, fertilizers made through laboratory chemistry, often contain the first three macronutrients, N, P and K.

Organic fertilizers made through recycled natural materials more often contain N, P and K as well the secondary macronutrients — Ca, Mg and S — which are also important for plant growth. In addition to supplying plant nutrient needs, organic fertilizers feed **soil microbes** because they are made from naturally occurring organic materials like feather meal, bone meal and pasteurized manures. This contributes to the overall long-term health of your soil as well as your plants. The amount of each nutrient is listed on the plant label as a percentage of the contents of each bag of fertilizer. For

instance, a fertilizer that contains 3 percent nitrogen (N), 4 percent phosphate (P_2O_5) and 4 percent potash (K_2O) would read 3:4:4. Labels on organic fertilizers, such as the one pictured above, may list the percentage of macronutrients contained in compounds such as **phosphate** (includes phosphorus-P) and **potash** (includes potassium-K). Your soil test recommendations will be expressed as an amount of N, P_2O_5 and K_2O to add per unit area.

So what do plants do with these nutrients? Macronutrients are important not only because they are used by plants in large quantities, but also because they serve important functions. Nitrogen, for example, is responsible for green leafy growth and plays a key role in producing plant chlorophyll, which is essential for photosynthesis. As a result, soils lacking in nitrogen will produce plants and fruits that are slow to grow and foliage that may be yellowish in appearance. Table 1 describes the role of these macronutrients and the role they play in proper plant health. Micronutrients are also important, but deficiencies in micronutrients are less common as these nutrients are used in smaller quantities by plants. Adding compost and organic matter to your soils can be one way to maintain healthy amounts of micronutrients for your plants.

TABLE 1. MACRONUTRIENTS

Adapted from http://www.ncagr.gov/cyber/kidswrld/plant/nutrient.htm

NITROGEN (N)

- Nitrogen is used in larger quantities by plants than any other mineral nutrient.
- Nitrogen is necessary for plant production of proteins and plant growth.
- Nitrogen is also essential for the production of enzymes and the transfer of energy within the plant.
- Nitrogen is a part of chlorophyll, the green pigment of the plant that is responsible for photosynthesis.
- Nitrogen helps plants with rapid growth, increasing seed and fruit production and improving the quality of leafy crops.
- Too much nitrogen can cause excess leaf growth, lack of flowering and lack of fruiting.
- One sign of nitrogen deficiency in plants is the yellowing of older leaves, those that appear on the bottom of the plant. The rest of the plant may have a light green appearance. (See photo on page 5.)

PHOSPHORUS (P)

- A common source of phosphorus for plant use is called phosphate.
- Like nitrogen, phosphorus is essential for plant photosynthesis.
- Phosphorus is involved in the formation of all oils, sugars, and starches.
- Phosphorus helps plants withstand environmental stress, as it improves the ability of plants to absorb water and other nutrients.
- Phosphorus is especially needed by plants during periods of rapid plant growth and helps them mature properly.
- Phosphorus encourages blooming and root growth.
- One sign of phosphorus deficiency in plants is older leaves turn a dark green or reddish-purple. (See photo on page 5.)

POTASSIUM (K)

- A common source of potassium for plant use is called potash.
- Potassium is absorbed by plants in larger amounts than any other mineral element except nitrogen and, in some cases, calcium.
- Potassium helps in the building of proteins, so it can increase the protein content in plants.
- Potassium also helps with the process of photosynthesis, improving fruit quality and the reduction of plant diseases.
- One symptom of potassium deficiency is leaf margins that become brown and cup downward. (See photo on page 5.)

CALCIUM (Ca)

- Calcium is an essential part of cell wall structure in plants.
- Calcium provides for normal transport and retention of other elements as well as strength in the plant.
- Lack of calcium can cause the blossom end of tomatoes to rot.

MAGNESIUM (Mg)

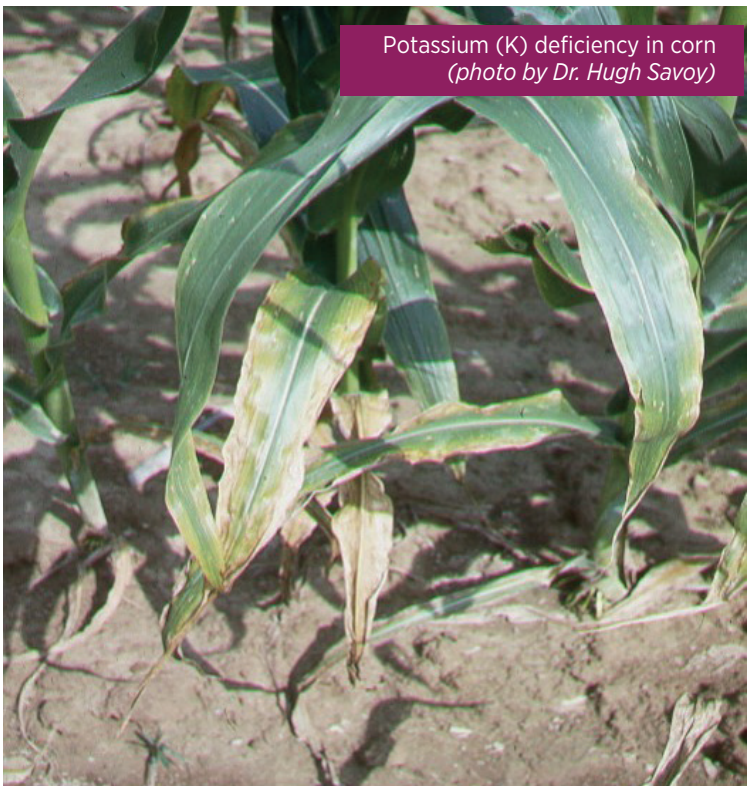
- Magnesium is part of the chlorophyll in all green plants and is essential for photosynthesis.
- Magnesium also helps activate many plant enzymes needed for growth.
- Symptoms of magnesium deficiency appear on older leaves first and can include a yellowing between the veins, known as interveinal chlorosis.

SULFUR (S)

- Sulfur is essential for plant production of proteins and enzymes.
- Sulfur helps in chlorophyll formation, so a sulfur deficiency would result in leaves that appear light green followed by yellowing and poor growth.
- Sulfur improves root growth and seed production.
- Sulfur helps with vigorous plant growth and resistance to cold.

Nitrogen (N) deficiency in corn
(photo by Dr. Hugh Savoy)

Phosphorous (P) deficiency in corn
(photo by Dr. Hugh Savoy)



Potassium (K) deficiency in corn
(photo by Dr. Hugh Savoy)

Conclusion

So now that you're ready build your soil and feed your plants, let's review.

1. Build your soil.
2. Test your soil for nutrients.
3. Add the necessary amount of agricultural lime and/or fertilizer according to soil test recommendations or according to instructions on the label if using an organic fertilizer.
4. Grow your garden!
5. Protect your soil. Retest your garden soil every three to five years after harvest, and adjust the soil for any missing nutrients before the next gardening season. Follow your initial soil test report recommendations annually until you retest.

At the end of the gardening season, you will want to protect the garden bed from soil erosion and encroaching weeds by either covering it with black plastic or sowing seasonal cover crops like buckwheat, crimson clover or hairy vetch.

References and Further Reading:

Soil Preparation of the Vegetable Garden:
extension.org/pages/13419/soil-preparation-of-the-vegetable-garden#.VZ_aqEbN4pM

Gardening With Microbes:
gardeningwithmicrobes.com

Improving Lawn and Landscape Soils by University of Missouri Extension
extension.missouri.edu/explorepdf/agguides/hort/g06955.pdf

North Carolina Department of Agriculture and Consumer Services:
ncagr.gov/cyber/kidswrld/plant/nutrient.htm

Improving Garden Soils with Organic Matter:
extension.oregonstate.edu/polk/sites/default/files/MG_Handouts/ec_1561_improving_garden_soil_with_organic_matter.pdf

W 346-A The Tennessee Vegetable Garden: Site Selection and Soil Testing
extension.tennessee.edu/publications/Documents/W346-A.pdf

W 346-B The Tennessee Vegetable Garden: Garden Planning, Plant Preparation and Planting
extension.tennessee.edu/publications/Documents/W346-B.pdf

W 346-C The Tennessee Vegetable Garden: Managing Plant Nutrition
extension.tennessee.edu/publications/Documents/W346-C.pdf

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