

Enriching the Soil for Good Plant Growth



LESSON FIVE

What's Ahead

In Lesson #5, you'll learn about:

- what the nutrients plants need to grow are;
- fertilizers — what kinds there are and how to apply them;
- soil tests;
- soil pH; and
- using lime in your garden.

Nutrient Know-How

Suppose you are a gardener who uses the same garden spot year after year without fertilizing or adding anything to the soil. What would result? Over time, the plants in the garden would become less and less productive. They would be small and stunted. Fruit may never form or be small and immature. Insect and diseases would have a field day on the weak plants. Problems would multiply. Within a few years, the garden would not produce harvestable crops.

Most smart gardeners realize that plants need nutrients for good growth. Did you know that 16 nutrients are essential for plant growth? Some nutrients are needed in large amounts. These nutrients are called macronutrients. They are commonly “used-up” by growing crops and must be replaced or replenished regularly.

Other nutrients are needed in very small amounts. They are called micronutrients. They are just as important as the macronutrients, but there is usually enough of them in the soil to meet plant needs.

Plants get carbon (C), hydrogen (H) and oxygen (O), all essential macronutrients, from air and water. Some macronutrients, specifically,

nitrogen (N), phosphorous (P) and potassium (K), come from soil and need to be replenished.

Chemical Elements Essential to Plants

Boron = B	Magnesium = Mg
Carbon = C	Molybdenum = Mo
Calcium = Ca	Nitrogen = N
Chlorine = Cl	Oxygen = O
Copper = Cu	Phosphorus = P
Hydrogen = H	Potassium = K
Iron = Fe	Sulfur = S
Manganese = Mn	Zinc = Zn

Adding Nutrients to the Soil

When you add nutrients to the soil, you can choose synthetic fertilizers or organic (natural) fertilizers. Fertilizers generally contain nitrogen, phosphorous and potassium. A fertilizer nutrient “ratio” is a set of at least three numbers that reflects the relative amount of N, P and K (in that order). (Usually, a fertilizer ratio of 1:1:1, 1:2:1 or 1:4:2 is best for growing vegetables. For example, a ratio of 1:4:2 means one part nitrogen to four parts phosphorus to two parts potassium.

Fertilizers for sale must have a “guaranteed analysis,” which shows the percentage of each major nutrient in the bag by weight. Here's an example.

Let's say that the bag label reads:

1-2-1 ratio

5-10-5 guaranteed analysis

N-P-K nutrients

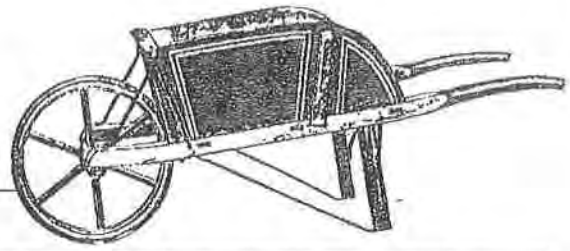
This means the bag contains:

5% nitrogen by weight (N)

10% phosphorus by weight

KEY POINT 1:

The fertilizer analysis shows the percentage of each major nutrient in the bag by weight.



Comparison of Fertilizers

Synthetic

PROS:

- lightweight
- easy to handle
- readily soluble and fast acting
- moderately priced

CONS:

- some are acid-forming
- depletes non-renewable resources
- potential salt damage
- solidifies in bag when wet

Organic

PROS:

- time-released
- conditions the soil
- less likely to burn plants
- doesn't deplete non-renewable resources

CONS:

- bulky and difficult to handle
- expensive in terms of price/pound
- may contain weed seed
- odor
- salts may build up

(P₂O₅ phosphoric acid)
5% potassium by weight
(K₂O potash)

In this example, the N-P-K content totals 20 percent by weight of the bag. The remaining 80 percent of the material in the bag is "filler," which helps spread and distribute nutrients evenly.

Before you buy fertilizer, always read the bag. All bagged fertilizer (organic or synthetic) will list the guaranteed analysis. Different fertilizers are designed for specific purposes or crops. Be sure you choose the one you need.

Synthetic and Organic Fertilizers

A fertilizer can be synthetic or organic. Both types will supply nutrients to plants in an identical form, although the sources differ. The plants do not "know" the difference between synthetic or natural (organic) nutrient sources. Synthetic fertilizer is made from non-renewable resources or by treating rock minerals with acids. Organic

fertilizers are made from plant and animal products or from mined rock minerals.

Organic fertilizers provide a good food source for micro-organisms and earthworms. They may also help the soil by boosting organic matter. Both types of fertilizer have their pros and cons (see chart). They can, however, be used in combination.

If you use farm manures or compost, you won't know the analysis unless you have the material tested or analyzed by a lab. Animal manures differ slightly in analysis from season-to-season, place to place and depending on the species.

Soil Test First

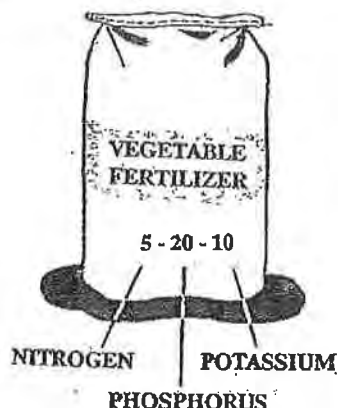
Test your soil before you apply fertilizer. A soil test will tell you nutrient levels and the needs of the crops to be grown. After testing, you can decide just how much and what fertilizer to apply.

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Enriching the Soil for Good Plant Growth

Commercial Fertilizers: What Do the Numbers Mean?

The principle plant food elements that are supplied in a fertilizer are nitrogen, phosphorus and potassium. A fertilizer marked "5-20-10," for example, contains five percent nitrogen (N), 20 percent phosphoric oxide (P_2O_5) and 10 percent potash (K_2O).



Nitrogen is not directly measured with a routine soil test. The soil's seasonal nitrogen supply changes with soil temperature, moisture level and organic matter content. The nitrogen needs of vegetable crops have been set through years of trials and research. Too much nitrogen will cause plants to grow too big. There will be lots of green growth but limited fruit development. Too little nitrogen may not allow for good plant growth. Plants will look yellow and stunted.

Applying Fertilizers

Apply fertilizer when the plants need the nutrients. There are two ways to do this: broadcasting and banding. With either method, the fertilizer should be worked into the soil.

Broadcasting fertilizer means spreading it over the entire garden surface. The fertilizer is spread before crops are planted in the garden.

One advantage of this method is that nutrients are distributed evenly. However, a disadvantage is that some nutrients will not be near the plant so it can use them, even though they may add to your soil's fertility in future years.

Broadcasting fertilizer will encourage weed growth in between rows. For best results, work broadcasted fertilizer into the soil with a tiller, rake or hoe.

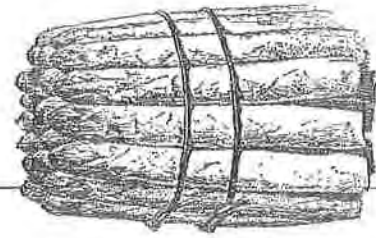
Banding fertilizer is a good way to get the needed nutrients near the plants. To band fertilizer, apply it only to the rooting area around the plants, such as along the planted row or around the hill. Take care to not apply fertilizer too close to tender, young plants. Apply two or three inches beside and below the row so that roots can grow into it.

Whether you broadcast or band fertilizers, split the applications. Plants need certain nutrients for the entire season. Phosphorus and potassium fertilizer can be split and applied with nitrogen or applied all at once at planting. The soil will hold and release phosphorus and potassium gradually, whereas much or all nitrogen applied at planting may be lost to leaching. Ideally, you should add nitrogen fertilizer in two or three applications since daily nutrient needs vary with plant size and development. In this way, very little fertilizer is wasted. The first application may be broadcast and tilled in or banded beside the row. The second and third application must be topdressed.

Over-fertilization is a waste of money and resources and tends to pollute the environment. Nutrients that plants don't use can be lost. Nitrogen is easily leached through the soil by rain. Phosphorous and potassium can wash

KEY POINT 2:

A **fertilizer ratio** is a set of at least three numbers that reflects the relative amounts of nitrogen (N), phosphorous (P) and potassium (K).



away on the soil surface. Smart gardeners are careful with fertilizer. Using split applications and following soil test recommendations are two smart practices.

Liming Acid Soils

The acidity of a soil affects the productivity of the plants growing in the soil. Acid soils:

- reduce availability of plant nutrients;
- restrict root growth;
- restrict top growth;
- decrease desirable soil biological activity; and
- increase the availability of elements toxic to plants.

If you manage your soil acidity, you'll reap more benefits from your garden. Acid soil conditions develop gradually. As rain water moves down through the soil, some nutrients are dissolved and carried out of the root zone. As plants grow, calcium, potassium and magnesium are used up in the soil. The loss of these alkaline nutrients allows other acid-forming elements to take their place. The result is more acid soil. Using acid-forming fertilizers also contributes to soil acidity.

A typical way to neutralize acid soil is to add calcium and magnesium with alkaline materials. Most people use finely ground limestone for this purpose.

Maintaining the proper soil pH is as important for high crop yields as fertilizing, watering, weeding and pest control. Your decision to use lime and how much to use must be based on soil tests and the crop species to be grown. The type of liming material you choose is generally determined by the need for magne-

sium; availability of the materials; cost; rate of reaction in the soil; and ease of handling the material.

How well a liming material corrects soil acidity is determined by its "effective neutralizing value" (ENV). Pure calcium carbonate has an ENV of 100. Other liming materials are compared on a percentage basis with pure calcium carbonate. Most common agricultural or garden-grade lime has an ENV of 75 or 95 percent. When a material has lots of magnesium carbonate, calcium hydroxide, calcium oxide or magnesium oxide, the neutralizing power will be greater than 100 percent.

The Benefits of Organic Matter

Organic matter helps plants use soil nutrients. Rototill or spade organic matter in before planting. Farm manures should be well-rotted or aged several weeks before you use them. Fresh manure can cause problems. Composting manure before you use it will kill most weed seeds.

Poultry manure is very high in nitrogen and phosphorous in comparison to other farm manures. It also contains lime material, which will raise the pH of the soil. Use poultry manure sparingly or mix it with another type of manure

Application Rates of Well-rotted/Aged Manures

sheep, goat, rabbit, poultry 1 bushel/100 square feet
pig, horse, cow 2 bushels*/100 square feet

*1 bushel = 9.3 gallons or 1.25 cubic feet and weighs about 30 pounds (on average)

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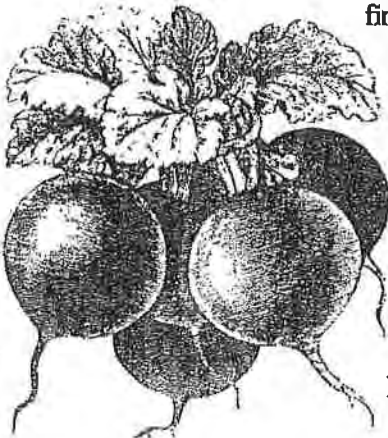
Some Common Forms of Lime			
Common Names	Other Names	Characteristics	Neutralizing Power
Limestone (calcic)	_____	Almost entirely calcium carbonate	75 to 90%
Limestone (dolomitic)	_____	Contains up to 50% magnesium carbonate	95 to 100%
Limestone (dolomite)	_____	Almost entirely magnesium carbonate	100 to 120%
Hydrated Lime	slaked lime, caustic lime, agricultural hydrate	Fast acting; disagreeable to handle (caustic); more expensive than limestone; not recommended in home gardens/lawns	125 to 145%
Wood Ash	_____	Hardwoods contain about one-third more calcium than softwoods	30 to 70%
Ground or Burned Mollusk Shells	_____	Good liming material; localized use	up to 95%

Information obtained from: "Liming Acid Soils," Agriculture Fact Sheet 4-5-4, by J.W. Schwartz and R.F. Follet, Soil Scientists, U.S.D.A., Science and Education Administration, 2/79.

or organic matter so that crops will not get an over-dose and burn.

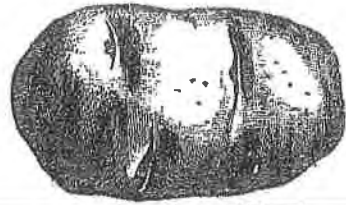
If you can't get manure, you can substitute peat moss, leaf mold, compost or another type of organic matter. Use two to four bushels per 100 square feet, depending on the material.

Organic matter improves the soil by keeping in moisture and nutrients (in sandy soil) and improving drainage and reducing compaction (in clay soils).



Many gardeners use wood ashes on their garden. Wood ash is similar to lime in that it raises the pH of the soil. However, too much wood ash can cause problems. Take a soil test to find out if pH is too high. If it is too high, stop using wood ash. You can store wood ashes in a rain-tight metal container until they can be evenly spread onto the soil.

Sulfur is recommended only to increase soil acidity in situations where certain crops need a lower pH or when the pH is too high for good plant growth.



Summary

In this lesson, you learned about soil nutrients, fertilizers, soil pH, soil tests and lime. Now try to answer the **Study Questions**. The **Study Activity** will help you expand your knowledge in this area. In the next lesson, you'll learn all about mulches.

Study Questions

1. Describe the difference between fertilizer analysis and nutrient ratio.
2. List the things to consider when choosing a fertilizer.
3. Your soil test recommendation is for 25 pounds of 10-20-20 per 1,000 square feet. How much of each nutrient will be applied to a 2,000 square-foot garden?

(See answers on the bottom of page.)

Study Activity

Garden Store Field Trip

Go to visit a garden store, a feed/seed store or garden center. Make a list of at least eight different types of fertilizers. Specify whether the fertilizer is organic or synthetic, what crops the fertilizer is designed for and the analysis of each. Use the Garden Store Visit Chart on page 30.

(Lessons #6 and #7 also have garden store activities. You may want to combine these in one trip.)

Other Resources

For a soil test kit, contact your county Cooperative Extension office.

Study Question Answers

1. A fertilizer analysis gives the percentage, by weight, of nitrogen, phosphorous and potassium in the product. A ratio tells you the relative amount of these three nutrients.
2. Weight, cost, ease of handling, odor, time release, weed seeds, salts, availability.
3. 5 pounds N, 10 pounds P_2O_5 , 10 pounds K_2O .

GARDEN STORE VISIT



Learning More
About Fertilizers

Fertilizer Name	Type	Crops	Analysis	Package Size	Cost