



## **Fertilizing Your Vegetable Garden**

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All green plants require sunlight, water, and certain plant nutrients in order to grow and develop properly. A deficiency of any one of the 16 essential nutrients may result in slow growth and unhealthy plants. Adequate plant nutrition is especially important for the vegetable gardener. Although plants will remain alive without optimum nutrition, nearly all vegetables grow best in full sun, with an abundance of water, and with adequate nutrition.

Plants require sixteen nutrients for optimum growth. The major nutrients include carbon, oxygen, hydrogen, nitrogen, potassium, calcium, magnesium, phosphorus, sulfur, iron, and chlorine. The micronutrients needed by plants include manganese, boron, zinc, copper, and molybdenum. Fortunately, for gardeners, most of these nutrients are plentiful in the soils, water, and air. The three nutrients that comprise 96 percent of the dry weight of a plant (carbon, oxygen, and hydrogen) are provided to plants by air and water. Calcium and magnesium are found in adequate supply in most well-limed garden soils. Sulfur is rarely deficient in Illinois gardens because it is a common atmospheric pollutant. The micronutrients are needed in very small amounts and are usually abundant in all soils except the sandy ones.

Of the sixteen essential nutrients, only nitrogen (N), phosphorus (P), and potassium (K) are likely to be needed in Illinois gardens. If you suspect a deficiency of any of the nutrients, check with your local Extension Service or a local garden center before taking corrective measures.

### **SYMPTOMS OF NUTRIENT DEFICIENCIES**

The table below describes general deficiency symptoms for the nutrients most often found to limit the productivity of Illinois gardens.

## General Deficiency Symptoms

<u>Nutrient</u>	<u>Symptoms</u>
Nitrogen (N)	A general chlorosis (yellowing) of the older leaves, slow growth, and small leaves
Phosphorus (P)	Dark, blue-green leaves, possibly with red or purple veins; slow growth
Potassium (K)	The margins of the lower leaves look yellow and may develop brown regions; slow growth.

Inexperienced gardeners often mistake insect, disease, or simply cold-weather damage for nutrient deficiency symptoms. The diagnosis of a nutrient deficiency, based on visual symptoms, is difficult at best. Symptoms vary according to plant species, soil type, climate, and age of the plant. This is complicated further by the fact that several of the symptoms of nutrient deficiency are similar in appearance. The best practice with a home garden is to make an annual application of a balanced, garden fertilizer.

### SOIL TESTING

Most garden books recommend having your soil tested for adequate fertility. This is especially valuable to a grower who can save money by not applying a particular nutrient to soils that already contain an adequate amount. However, the savings will be minimal in small gardens. In addition, the interpretation of soil tests is difficult because fertilizer recommendations are based on the soil type and the crops being grown. Since most gardeners grow a wide variety of crops, it is difficult to tailor fertilizer recommendations to fit each garden.

Gardeners who have grown satisfactory vegetables in the same location over several years will need only a pH test if they have been making annual applications of fertilizer, manure, or compost. Also, if you have applied fertilizers to sandy soils, they should be tested for soluble salts every 4 to 5 years.

If you are starting a new garden or have experienced nutrient problems previously, have your soil tested for phosphorus, potassium, calcium, and magnesium; also, for pH and soluble salts. The soil test for nitrogen is often a poor indicator of the actual amount of nitrogen available to plants during the growing season.

The soil should be collected from the top 4 to 6 inches of the garden. Take at least 5 samples from random locations. Mix them together for a composite sample. Then, take 1 pint of air-dried composite sample to a soil testing laboratory for analysis. Although the soil-testing

laboratory will usually provide fertilizer recommendations based on the analysis, the following table outlines the general guidelines for gardeners.

### **Preferred Soil-Test Levels for Vegetable Gardens**

<u>Soil Test</u>	<u>Desired Test Level</u>
Phosphorus (P <sub>1</sub> )	75 pounds per acre
Potassium	400 pounds per acre
Calcium	1,000 pounds per acre
Magnesium	250 pounds per acre
pH	6.0 to 6.8

### SOIL pH

All garden soils should be tested for pH (the relative acidity-alkalinity, measured on a scale of 1 to 14, with 7 being neutral). Any pH value above 7 is alkaline. Soil pH has a direct effect on nutrient availability to the plant. If the pH value is below 5.5 or above 7.5, several micronutrients as well as phosphorus are fixed in the soil and cannot be readily taken up by the plant.

Most vegetables grow best in slightly acid soils (pH 6 to 7). Potatoes are an exception to this rule; they are often grown at pH values below 5.5 to avoid scab disease. However, this practice should be restricted to relatively large gardens where there is a history of the disease. Gardeners should also grow scab-resistant cultivars as a way to prevent this disease. Reduction of soil pH is accomplished through the addition of elemental sulfur (S) to the soil. See the table below for recommended amounts.

### **Pounds of Sulfur Required per 100 Square Feet to Lower the pH**

<u>To Lower the pH</u>		<u>Soil Type</u>		
<u>From</u>	<u>To</u>	<u>Sandy</u>	<u>Loamy</u>	<u>Clay</u>
8.5	6.5	4	5	6
7.5	6.5	1	1.5	2
8.5	5.5	5	6.5	8
7.5	5.5	2	3	4
6.5	5.5	1	1.5	2

Several types of liming materials can be used to raise the soil pH (decrease soil acidity). These include ground limestone, hydrated (slaked) lime, and burned lime. The ground limestones are by far the most commonly used liming materials. They are labeled as either calcitic or dolomitic, according to their magnesium (Mg) content. Calcite consists of calcium carbonate and is usually referred to as "limestone." Dolomite is somewhat similar but contains higher amounts of magnesium. For this reason, dolomite is often preferred, especially on low magnesium soils. Hydrated and burned limes are faster reacting and can burn plant roots if used in excess. These materials are also more expensive than the ground limestones and should be used with care. Home gardeners are encouraged to use a finely ground limestone, at the rates given in the table below, if they need to decrease soil acidity.

**Pounds of Limestone Required per 100 Square Feet to Bring Soil pH to 6.5 from the Initial pH Shown**

<u>Initial Soil pH</u>	<u>Sands and Sandy loams</u>	<u>Loams and Silty Loams</u>	<u>Clays</u>
4.5	28	46	46
4.8	24	37	42
5.2	17	25	34
5.6	8	16	25
6.0	5	10	15

Note: These rates are based on a 9-inch plow depth and limestone with a 100 percent calcium carbonate equivalent.

**MICRONUTRIENTS AND SULFUR**

Deficiencies of sulfur and micronutrients are extremely rare in Illinois soils. Gardeners who make annual applications of manure and compost will not have to worry about micronutrient deficiencies. Soil-testing is not a reliable means of determining the need for micronutrients in gardens. Apply generous amounts of organic matter and maintain the soil pH between 6 and 7.

**ANNUAL ADDITIONS OF N, P, AND K**

Nitrogen (N), phosphorus (P), and potassium (K) are the nutrients most often lacking in garden soils. A simple method of supplying N, P, and K is with a complete, balanced fertilizer, such as 10-10-10 (10 percent each of nitrogen, phosphorus, and potassium). Although commercial vegetable growers adjust their fertilizer applications for each vegetable grown, this is neither practical nor very important for home gardeners. They can ensure adequate fertility by making annual applications of a standard garden fertilizer such as 10-10-10 or something comparable.

Established vegetable gardens will require 2 pounds of garden fertilizer per 100 square feet each year. Do not use lawn fertilizers on vegetable plants. They may contain weed killers, which will damage the plants; furthermore, too much nitrogen can result in excessive leaf growth at the expense of fruits and roots. If the entire 2 pounds of fertilizer are applied before planting, spring rains can leach the nitrogen out of the rooting zone of vegetable plants. A better method would be to apply half of the fertilizer before planting to stimulate early growth.

The first application should be broadcast (scattered) evenly on the top of the soil and worked down about 6 inches with a rototiller. A second application of fertilizer should be made about 4 weeks after seeding. In Illinois, this is usually about the same time the corn is 10 inches tall and early tomatoes about the size of a golf ball. At that time, sidedress the plants with 1 pound of garden fertilizer per 100 square feet. The sidedress application is scattered on top of the soil, about 6 to 12 inches from the base of the plants. It can be raked in to a shallow depth or washed in with water. Do not apply the fertilizer too close to the stems, which could burn the roots.

Gardeners who have only a few plants can use a soluble fertilizer, such as houseplant food. Apply the soluble fertilizer strictly according to label directions in order not to burn the roots with excessive amounts.

Adequate nitrogen, phosphorus, and potassium can also be supplied without using concentrated fertilizers. If you prefer to use an organic fertilizer, 4 bushels of fresh cow manure or 1 bushel of chicken manure per 100 square feet will provide adequate nitrogen. The fresh manure should be worked into the soil and allowed to decompose for 2 to 3 weeks before planting. Although no waiting time is required if you apply decomposed manure, fresh manure contains more nitrogen and potassium. Annual applications of manure, compost, and plant residues will not only increase soil fertility, but will also improve the tilth of the garden soil.

## SEWAGE SLUDGE

The University of Illinois does NOT recommend the use of municipal sewage sludge on any vegetable garden. Sludge obtained from the wastes of industrial municipalities is likely to contain excessive levels of heavy metals such as cadmium and lead, which may be hazardous to your health. Gardeners who have applied sludge in the past should have the cadmium levels in the soil tested. Soils containing excessive levels should not be used to grow leafy, green vegetables such as spinach, Swiss chard, beet tops, collards, lettuce, or kale. Applied cadmium can be tied up in the soil with applications of lime and phosphorus. Check the pH and adjust it so that it is above 7.0, since cadmium is more available in acid soils. Also, apply phosphorus in the superphosphate form until the soil test level is above 100 pounds per acre.

## STARTER FERTILIZERS

Transplanted vegetables often make little growth aboveground during the first 2 weeks after transplanting. This is due to the shock of transplanting, the small root systems, and, quite often, to cold soil. An application of a starter fertilizer solution will provide the young plants with much-needed phosphorus, as well as some nitrogen and potassium. This will stimulate growth and will often increase the early yields of tomatoes, peppers, and melons. A standard starter solution is 8-32-16 or 10-52-8, but any water-soluble fertilizer that is high in phosphorus will be satisfactory. Mix the starter fertilizer with water according to label directions and apply about 1/2 cupful directly to the soil around each plant. Do not apply more than the amount recommended. Too much soluble fertilizer can injure roots.

## FERTILIZING PERENNIAL VEGETABLES

Most vegetables grown in the home garden are annuals and complete their life cycles in 1 growing season. Numerous other vegetables are classified as biennials, completing their life cycles over 2 growing seasons. For those vegetables, the first season gives only vegetative growth; the second season is predominately reproductive growth. The winter following the first season provides the low temperatures necessary to induce flower formation. However, since most biennial vegetable crops are grown for their leaf, stem and root tissues, flowering is not required and in many cases may be detrimental to yield and crop quality. For this reason, biennial vegetables are cultivated and treated with the same fertilizer schedule as annuals. The vegetables in this category include beet, Brussels sprouts, cabbage, carrot, celery, collard, kale, leek, onion, parsley, parsnip, Swiss chard, and turnip.

There is a select group of vegetables with perennial growth habits, including asparagus and rhubarb. Unlike annuals and biennials, perennial vegetables normally take several years to mature and do not die after flowering. The aboveground portions are killed each winter in Illinois, but the roots remain alive to send up new shoots in the spring. In the home garden, they should be planted on one side or at the end of the garden, so that the remainder can be treated as a separate unit for plowing, cultivating, and fertilizing.

Four to six inches of organic matter should be incorporated into the soil before planting perennial vegetable crops. The soil must be well prepared since these crops occupy the land for many years and there is no opportunity for further preparation after planting. Perennial vegetable crops overwinter and initiate growth on the nutrients stored in their roots. Most of the food material from which the shoots are formed in early spring is produced during the previous summer and fall. Therefore, it is of the utmost importance to keep the roots well supplied with nutrients and to provide an optimum environment for growth.

The specific fertilizer recommendations vary with the particular crop being grown. Asparagus should be fertilized in the spring with 10-10-10, 12-12-12, or 15-15-15 at the rate of 20 to 25 pounds per 1,000 square feet of garden. Starting in the fourth year and thereafter, apply the same amount of fertilizer but delay the application until June or July, immediately after final harvest.

Rhubarb and Jerusalem artichoke are fertilized in a similar manner. Apply a complete fertilizer in the early spring or sidedress fertilizer in late June. In general, a 5-10-10 fertilizer at 30 pounds per 1,000 square feet is recommended. This recommendation may be reduced in established gardens that have been heavily fertilized in the past and that have produced well. In addition, manure should be applied at 500 pounds per 1,000 square feet to the soil surface in the fall and winter, and then worked into the soil early the following spring.