

Fertilizing Home Vegetable Gardens

Managing the fertility of vegetable garden soil is part of an overall soil management program, which should include proper tillage practices, use of cover crops, water management (irrigation and drainage), limestone applications, weed management and crop rotation (especially in large garden plots). Fertilizer whether it be common garden fertilizers such as 5-10-5 or 5-10-10 or those derived from organic sources including manure will not alone overcome shortcomings in the areas mentioned above.

Maintain Soil Structure: Some practices have the ability to damage soil structure. You should prepare the soil only deep enough to provide an adequate seed bed. Never plow, rototill or turn soil under with a shovel when the soil is too wet. Tillage tools (garden hoes, rototillers, etc.) breakdown soil aggregation; and intensive cultivation practices help accelerate loss of organic matter and causes soil to develop a crusty layer on top. In most small gardens heavy equipment use is probably not a factor but you should avoid any practices that could cause soil compaction especially when the soil is wet.

Crop Rotation: In small gardens crop rotation may not be practical unless you have a few different plots. In such cases it is desirable to grow grass or legume sods in the rotation once every 3 years. Such rotation helps maintain soil porosity, improve the water holding capacity of coarse soils and reduce the buildup of insect, disease and weed pests. An added benefit of a legume crop is the available nitrogen through decomposition, *which can reduce the nitrogen fertilizer requirement for your vegetables.*

Cover Crops: Growing a cover crop after harvest in late summer is often more feasible in a small home garden in comparison to crop rotation. Cover crops help add organic matter to the soil and help prevent soil erosion and the leaching of certain nutrients during the off season (fall, winter and early spring). Cover crops may aid in the control of certain weed problems. Some cover crops to consider in a home garden:

- *Oats* – any variety can be seeded at a rate of 1 ½ to 2 ¼ lbs. per 1000 sq. ft. during August or early September. Oats will die down during the winter making it relatively easy to turn them into the soil during the spring
- *Winter Rye or wheat* – any variety can be seeded at the rate of 1 ¾ to 2 ½ lbs. per 1000 sq. ft. after early September
- *Domestic ryegrass* – a mixture of annual and perennial ryegrass seeded at a rate of ½ lb. per 1000 sq. ft. before September or later.

Winter rye, wheat and ryegrass remain alive so they may help reduce loss of nutrients during the winter. But because they will resume growth in the spring it is best to turn them under early before they become too vegetative. If that happens you may find they are more difficult to turn into the soil.

Soil Testing: The supply of essential nutrients in the soil along with the soil pH can not be determined without conducting a soil test. In general the majority of vegetables grown in a home garden will thrive when the soil pH is at 6.0 to 6.8. When the soil pH is adequate, the availability of both major and minor nutrients is maximized. Adequate soil pH also decreases the solubility of metals such as iron, aluminum, manganese and heavy metals (all of which can be toxic to plants at high concentrations). You will not be able to maximize the nitrogen, phosphorus or potassium in your garden soil if the soil pH is not maintained in the proper range. For this reason many people consider soil pH to be the most important part of a soil test. Keep in mind that two soils with different soil textures (i.e. sands vs. loams) and the same low pH reading require markedly different rates of limestone to correct the low soil pH situation. Therefore applying a given amount of limestone not based on a soil pH test could over lime one soil, causing problems that did not exist previously, whereas the same amount of limestone might be insufficient to correct the undesirable acidity in the other soil.

For information on having your soil tested you should visit our web site Cornell Cooperative Extension | Horticulture Diagnostic Labs or contact our office directly.

General Fertilizer Information: Fertilizers whether they be synthetic or those derived from organic sources (i.e. manure) are applied to improve the health of your garden vegetables by providing nutrients, which are not adequately supplied by the soil. When soil contains enough of a certain nutrient to support optimal growth it is not recommended that you supply additional amounts of that nutrient. Nitrogen (N), phosphorus (P) and potassium (K) are the most common major nutrients found in a bag of commercial garden fertilizer. Phosphorus and potassium are shown on a fertilizer label as the oxides P_2O_5 and K_2O respectively. Calcium (Ca) and magnesium (Mg) are usually supplied by limestone and in most cases are usually not deficient when the soil pH is in the proper range.

Your vegetable garden plants are able to utilize soil nutrients when the nutrients are present in moist soil where the roots of the vegetables are present. When irrigation or rainfall is adequate nitrogen applied on the soil surface will leach into the soil where the vegetable plant roots are growing. But since phosphorus and potassium will not move extensively from the soil surface they must be placed deeply enough in the soil where roots will be growing actively and where they will remain in moist soil throughout the growing season.

- Therefore **all** of the phosphorus and potassium and **a portion** of the nitrogen that would be recommended for a growing season should be applied shortly before or at planting.
- Most home garden vegetables will benefit from nitrogen applied during the growing season. This is done by making a “sidedressing” with a source of nitrogen. Sidedressing simply means that fertilizer is applied to the soil adjacent to the plant at a certain stage of development during the season.
- Therefore any nitrogen which is recommended in addition to the portion applied shortly before or at planting would be applied as a sidedressing(s) during the growing season.

Seasonal Nitrogen Fertilizer Recommendation
(lbs. of actual nitrogen / 1000 sq. ft.)

Add 2 ¼ lbs. (100)

Table 1. Seasonal fertilizer nitrogen recommendations for Long Island vegetable gardens. Although Nitrate-Nitrogen (NO_3-N) is reported on the CNAL soil test result form, the interpretation of this value is not reliable unless soil samples are taken and handled in specific manners. Therefore this seasonal nitrogen fertilizer recommendation is based on the requirements of gardens with commonly grown “mixed vegetable”. (*Vegetable Production Handbook*, Cornell University, 1994)

CNAL Soil Test Results for Phosphorus
in Pounds per Acre (lb./acre)

<3 lbs./acre Very Low	3 – 5 lbs./acre Low	6 -12 lbs./acre Medium	13 -39 lbs./acre High	40+ lbs./acre Very High
Add 3 ¾ lbs. (160)	Add 2 ¾ lbs. (120)	Add 1 ¾ lbs. (80)	Add 1 lb. (40)	Add 0 – ½ lb. (0-20)

Table 2. Seasonal fertilizer phosphorus (P_2O_5) recommendations for Long Island vegetable gardens based on CNAL results. Recommendations are pounds of actual phosphorus per 1000 sq. ft. (*Vegetable Production Handbook*, Cornell University, 1994)

- Fertilizer used for sidedressing should be applied no closer than 2 inches to the plant and should be lightly raked into the upper 2 inches of soil. Adding too much fertilizer has the potential to damage plants therefore apply fertilizer accurately. It is important to account for accumulated slow-release nitrogen if you have been adding manure to your garden for several years. *The accumulated nitrogen can reduce the nitrogen fertilizer requirement for your vegetables.* **How much fertilizer should I use?** Since different vegetables have different soil nutrient requirements and the nutrient status of each garden soil is different it is difficult to make a “rule of thumb” fertilizer recommendation that would take all vegetable gardens into consideration. Therefore the following charts can be used as a guide for determining how much N, P and K fertilizer is needed for a growing season for most “mixed vegetable” gardens. The suggested rates of individual nutrients are based on soil test results (except in the case of nitrogen) and soils having the soil pH in the proper range. The Cornell Nutrient Analysis Lab (CNAL) at Cornell University, Ithaca, NY reports soil test results in “pounds per acre” and uses the terms “very low, low, medium, high & very high.” The following charts are based on soil test results from CNAL. To use the following charts first locate the column indicating the soil test result. In the box below each soil test result you will find how many pounds per 1000 sq. ft. of the particular nutrient are recommended for the entire growing season.

CNAL Soil Test Results for Potassium
in Pounds per Acre (lb./acre)

<50 lbs./acre Very Low	50 – 99 lbs./acre Low	100 -199 lbs./acre Medium	200 -299 lbs./acre High	300+ lbs./acre Very High
Add 3 ¾ lbs. (160)	Add 2 ¾ lbs. (120)	Add 1 ¾ lbs. (80)	Add 1 lb. (40)	Add 0 lb. (0)

Table 3. Seasonal fertilizer potassium (K₂O) recommendations for Long Island vegetable gardens based on CNAL results. Recommendations are pounds of actual potassium per 1000 sq. ft. (*Vegetable Production Handbook*, Cornell University. 1994)

It is then your choice to decide what source of nutrients you will use to provide the recommendation. You may purchase common commercial fertilizer blends that are derived from synthetic or natural organic sources. If using synthetic fertilizer it is recommended that slow-release types be used. In the case of manure it is important to understand how nutrients become available to the plant after a manure application. This is explained in the section below on manure use.

Example on how to use the charts:

1. Calculate the area (square feet) of your garden. (area = length x width)
2. Perform the following simple calculation to determine how much of a fertilizer is needed to provide the recommended seasonal amount of pounds of a nutrient. For this example we will calculate the seasonal nitrogen requirement which is 2 ¼ (2.25) lbs. for a 500 square foot garden using a fertilizer with 5% (.05) nitrogen content.

$$\frac{2.25 \text{ lbs. of nitrogen}}{0.05 \text{ (5\% N in fertilizer)}} \times \frac{500 \text{ sq. ft. (garden size)}}{1000 \text{ sq. ft.}} = 22.5 \text{ lbs. of fertilizer}$$

$$2.25 \div 0.05 = 45$$

$$500 \div 1000 = 0.5$$

$$45 \times 0.5 = 22.5 \text{ lbs.}$$

Although it is highly recommended that the rate of fertilizer used be based on soil nutrient test results some individuals may not have such results. In such cases where “mixed vegetables” are being grown in a garden the following seasonal rates of N, P and K may be used as guides: 2 ¼ lbs. of N, 2 ¼ lbs. of P and 2 ¼ lbs. of K per 1000 sq. ft. This takes into consideration that the soil pH is in the proper range and that proper fertilizer/manure applications have occurred in past seasons.

Manure: If manure is available it should be considered for use in a home vegetable garden. In addition to being a good source of organic matter manure will also supply soil with both major and minor nutrients. When used regularly it adds organic matter which helps alleviate soil structure problems. Generally when the CNAL soil tests indicate organic matter levels greater than 3% the soil is considered to have good structure and has a high potential for yield. But a mineral soil with more than 5% organic matter may drain poorly. Fresh manure can be a source of weeds since seeds are capable of passing through animals. Utilizing aged composted manure will help reduce the potential for weed problems.

The nutrient content of farm manures will vary widely because of the varied diets of the animals, the bedding used, water loss and the storage and handling procedures. Although “guidelines” are available describing the nutrient content of various manure types the only true way to determine nutrient content is to have the manure tested for nutrients.

The CNAL soil tests reflect how much potassium and phosphorus have been applied in the past from manure and fertilizer applications. Therefore the recommendations are appropriate to use for garden soils that have had previous manure applications. Using the nutrient recommendation charts the following guidelines apply when using manure:

- If the recommendation exceeds 1 lb. P₂O₅ / 1000 sq. ft. (40), apply the first 1 lb. as fertilizer and the remaining pounds as manure.
- If the recommendation is for 1 lb. P₂O₅ / 1000 sq. ft. (40) or less, apply the entire amount as fertilizer
- If the recommendation exceeds ½ lb. K₂O / 1000 sq. ft. (20), apply ½ lb. as fertilizer and the remaining pounds as manure.
- If the recommendation is for ½ lb. K₂O / 1000 sq. ft. (20) or less, apply the entire amount as fertilizer.

Most potassium in manure is available for plant growth during the year of the application. Some of the phosphorus in manure is in organic form and must first decompose before it will be available for plant growth. Phosphorus is not very mobile in soil (regardless of its source) and therefore it must be incorporated into the soil (do not broadcast on top) for it to be efficiently available for plant growth.

Manure contains two forms of nitrogen, the unstable form in the urine and the stable form in the feces. The unstable form is primarily urea and can account for 50% or more of the total nitrogen in manure. This form will decompose rapidly to ammonium and this converts to volatile ammonia which can be lost. For this reason much of this unstable form of nitrogen is unlikely to be available to and taken up by your vegetable garden plants. Home gardeners are more likely to be utilizing the more stable organic nitrogen, which is present in the feces if they are utilizing aged composted manure instead of fresh manure. The less-resistant organic nitrogen decomposes during the year of application, whereas the more-resistant organic nitrogen decomposes slowly during future years. In general about 35% of the stable nitrogen decomposes during the year of application, about 12% the second year, about 5% the third year and about 25 the fourth year. As you add manure to the garden each year this will result in an accumulation of a slow-release source of nitrogen. The addition of manure to your garden each year will result in an accumulation of slow-release nitrogen *which will reduce the nitrogen fertilizer requirement for your vegetables*.

Since manure contains small quantities of micronutrients in addition to major and minor nutrients it is unlikely that micronutrient deficiencies would occur where manure applications have occurred in the past.

For information on the nutrient value of organic materials including manure you should visit our web site https://s3.amazonaws.com/assets.cce.cornell.edu/attachments/69995/A_Guide_To_The_Nutrient_Value_Of_Organic_Materials.pdf?1731604409 or contact our office directly.

References: *Vegetable Production Handbook*. Cornell University. 1994; *Soils and Fertilizer Resource Notebook*, Department of Floriculture and Ornamental Horticulture, Cornell University. March 1989; *Improve Your Soil With Cover Crops*, Eco Gardening Fact Sheet #9, Marcia Eames-Sheavly, Dept. of Fruit and Vegetable Sciences, Cornell University.

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