

Getting the most out of your vegetable garden soil test report

- Be certain your soil pH is in the optimal range.
- Add a nitrogen (N) source at the recommended rate.
- Add a phosphorus (P) or potassium (K) source only if soil test levels are low.
- Organic matter will reduce the amount of nitrogen needed.

Soil pH in the 6.0 to 7.0 range is optimal for the health of most vegetable plants.

When soil pH is outside this optimal range, lime can be mixed in to raise soil pH. Sulfur or acidifying fertilizers (like ammonium sulfate or ammonium nitrate) can be mixed in to lower soil pH.

The recommended rate of material should be mixed into the upper 4 to 6 inches of soil. To avoid harming plant roots and to provide the necessary time for the material to adjust the pH throughout the root zone, it is best to mix liming or acidifying material into the soil in the fall after harvest.

When a large amount of material is recommended, such as 20 pounds (lbs.) per 100 square feet (sq. ft.), mix half in the fall and the other half in the spring before planting.

Promote plant health, increase yield, and save money with proper fertilizer applications.

Nutrients required by vegetables in the highest quantity are nitrogen (N), phosphorus (P) and potassium (K). Other essential nutrients are usually available in adequate quantities when the pH is in the optimal range. There is no benefit to applying more fertilizer than plants require. In fact, over application of nutrients may be harmful to plant growth and the environment.

Fertilizer 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 composted manure, peat moss, plant-based compost and plant and animal by-products.

Animal manures and plant-based compost (yard waste, grass clippings, food waste) are readily available and popular fertilizers commonly considered as **natural organic**.

Nutrient content of composted products will vary depending on the source (plant or animal), moisture content, how they were stored and how long they were 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 require testing every time one of the above variables changed so it is not practical.

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

Mix in only manure or other materials that are fully composted. Fully composted manure has aged for at least 6 to 9 months. Incorporate into the upper 4 to 6 inches of soil after harvest and 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 nutrient levels exceed crop needs, limit compost applications to promote healthy soil for plant success.

More about organic matter

Annually replenishing organic matter to improve soil health is a common practice. Sandy soils with an organic matter content of 2-2½% and clayey soils with 3-5% organic matter will perform fine. **Organic matter levels twice this amount could lead to nutrient imbalances.**

Keep in mind some nitrogen will be released as soil microorganisms break down organic matter in the soil. For every 1% organic matter on the soil test report, you can reduce your applied nitrogen 0.5 ounce per 100 square feet (sq. ft.) for the year.

Inorganic fertilizers are compounds that are chemically synthesized from basic raw materials, isolated from naturally occurring sources or mined materials that provide nutrients. They are less expensive and have a higher nutrient content. They are water-soluble and are quickly available to plants, easy to apply and especially useful in cool weather.

Care should be taken however, when using *water-soluble fertilizer* sources because they are made of salts that can burn plants. Also, if over applied and watered in excessively they can leach beyond the root zone and end up in the ground water which impacts water quality negatively.

The nutrient content (fertilizer analysis) is required to be printed 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 50 lb. bag of 5-10-5 contains 2½ lbs. of N, 5 lbs. of P_2O_5 and 2½ lbs. of K_2O .

The rest of the material is made up of other inert material, such as sand or clay granules to help spread the fertilizer.

When nitrogen (N), phosphorus (P) and potassium (K) are all needed, use a *complete fertilizer* that contains all 3 nutrients. For example: 10-10-10, 5-10-5, or 5-10-10. Use **Table E** to determine which complete fertilizer could be used based on your soil test results.

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

Timing of fertilizer applications

Pre-plant fertilizing involves mixing fertilizer into the upper 4 to 6 inches of the soil before plants are in the ground. It can effectively address soil deficiencies or replenish nutrients absorbed by plants root systems in previous seasons.

Starter solutions are liquid fertilizers generally containing a small amount of nitrogen (N) and potassium (K) and a high amount of phosphorus (P) such as 4-12-4 or 10-52-10 and are commonly used when setting out vegetable transplants especially in cold soils.

Sidedressing refers to the addition of fertilizer during the growing season. The timing varies by crop. See details in **Table B**.

Nitrogen (N)

The nitrogen content of a soil sample does not necessarily reflect the future availability of nitrogen because unlike phosphorus and potassium, the nitrogen level will fluctuate depending on biological activity and soil conditions. Nitrogen is one of the most important nutrients for plant growth and is needed in relatively large amounts by all plants, so a standard nitrogen recommendation is routinely provided for vegetable gardens. The annual recommended nitrogen rate is 3.5 ounces per 100 square feet or 2.2 pounds per 1,000 square feet. **Table A** lists some common nitrogen fertilizers and the amount needed to apply based on the fertilizer analysis.

Organic matter such as aged animal manures and plant-based compost can supply some nitrogen throughout the growing season, however, nitrogen may not be released from these sources early in the season. When the soil temperature is below 50 degrees Fahrenheit, the microorganism activity that breaks down organic matter to release nitrogen is minimal.

The percent of organic matter in your soil is listed on your soil test report. For every 1% of organic matter in your soil, you can reduce the recommended nitrogen rate by 0.5 ounce per 100 square feet for the year. Most gardens have at least 2% organic matter so you will only need to apply 2.5 ounces of nitrogen for each 100 square feet. If you soil has more than 5% organic matter you will only need to apply 1 ounce of nitrogen per 100 square feet at the beginning of the season.

Table A: Some common nitrogen (N) fertilizer sources				
Nitrogen fertilizers	Fertilizer analysis	Amount of this fertilizer needed to supply 3.5 ounces of nitrogen per 100 square feet	Rate of nutrient release	Other considerations
Urea (synthetic)	46-0-0	7.5 oz.	Rapid	Inexpensive, concentrated, may be difficult to apply
Calcium nitrate (inorganic)	15-0-0	23 oz.	Rapid	Can help raise pH
Ammonium sulfate (inorganic)	21-0-0	16.5 oz	Medium	Can help lower pH, can use for acid loving crops
Blood Meal (natural organic)	12-0-0	29 oz.	Medium-rapid	Commonly available
Corn Gluten (natural organic)	10-0-0	35 oz.	Medium	Expensive
Cotton Seed Meal (natural organic)	6-2-1	58 oz.	Slow-medium	Can help lower pH, also contains phosphorus and potassium
Sodium Nitrate (natural organic)	16-0-0	22 oz.	Rapid	Avoid high rates

When possible, apply about 1/3 of the nitrogen pre-plant, another 1/3 at transplanting possibly in the form of a starter solution and the rest a few weeks after planting as a side-dress.

For established vegetable gardens, if nitrogen was not applied before planting, apply half the recommended rate as a side dress immediately and then the other half after a couple weeks.

Apply the side dress fertilizer 2 to 4" from the growing plant to avoid contact with green plant tissue, lightly rake into the soil and then water it in to move fertilizer through soil to where roots are growing. **Table B** lists recommended side-dress rates and timing.

Table B: Recommended time to side-dress with nitrogen (N)					
Crop	Timing of side-dressing	Amount of nitrogen (N) fertilizer to apply per 100 sq. ft.			
		Urea 46-0-0	Calcium nitrate 16-0-0	Ammonium nitrate 33-0-0	Ammonium sulfate 20-0-0
Asparagus	End of harvest	¼ cup	½ cup	¼ cup	½ cup
Beets, Carrots, Celery, Endive, Turnips	When 4" tall	¼ cup	½ cup	¼ cup	½ cup
Cabbage, Cauliflower	When leaves 4-6" tall	¼ cup	½ cup	¼ cup	½ cup
Cucumbers, Melons, Pumpkins, Squash	When vines spread	¼ cup	½ cup	¼ cup	½ cup
Eggplant, Peppers, Tomatoes	Fruit set	¼ cup	½ cup	¼ cup	½ cup
Potatoes	When 8" tall	¼ cup	½ cup	¼ cup	½ cup
Spinach	When 3" tall	¼ cup	½ cup	¼ cup	½ cup
Sweet corn	When 8" tall	¼ cup	½ cup	¼ cup	½ cup

Phosphorus (P)

Phosphorus is important in early root development and improves the quality of vegetables and fruits.

Phosphorus does not move in the soil much. It is best to incorporate P into the soil before planting so the roots can access more of this nutrient. A starter phosphorus solution is often applied when transplanting small plants in early spring when soils are cold even when phosphorus levels are adequate.

If only phosphorus is needed, use **Table C** to help determine the amount of fertilizer to apply.

Animal manures, fresh and composted, often contain high levels of P. Regularly adding manure to gardens can raise soil P to excessive levels.

Table C: Soil test levels and approximate pre-plant phosphorus (P) recommendations

Soil test report levels	Ounces of phosphate (P ₂ O ₅) to apply per 100 sq. ft. prior to planting	Some fertilizer sources that contain (P) phosphorus			
		Inorganic fertilizers		Organic fertilizers	
		Super-phosphate	Triple super-phosphate	Bone meal	Rock phosphate
		0-20-0	0-46-0	1-15-0	0-3-0
		20% P ₂ O ₅	46% P ₂ O ₅	15% P ₂ O ₅	3% P ₂ O ₅
		Quickly available	Quickly available	Slowly available	Slowly available
Amount of product to apply per 100 square feet					
Very low	6 oz.	30 oz.	13 oz.	2½ lbs.	12½ lbs.
Low	4.5 oz.	22 oz.	10 oz.	30 oz.	9¼ lbs.
Medium	3 oz.	15 oz.	6½ oz.	20 oz.	6¼ lbs.
Relatively high	1.5 oz.	7½ oz.	3¼ oz.	10 oz.	3 lbs.
High	0.75	3¾ oz.	1½ oz.	5 oz.	1½ lbs.

If the garden is already established, select a water-soluble fertilizer with a high percentage of P and apply according to label directions.

Potassium (K)

Potassium increases water efficiency, improves stress tolerance and the quality of seeds and fruit.

Some of the potash (a source of potassium) should be applied before planting, mixed into the soil and the rest applied at the time of planting. **Table D** lists the **total amount** of potassium needed for your soil. The soil test report indicates the amount to apply *before planting* and the amount to apply *at the time of planting*.

Wood ashes are not used as an amendment to improve soil physical properties. However, they do contain potassium (3-7% K₂O) and can be used to raise soil pH in place of lime.

Avoid applying both lime and wood ashes which can raise the soil pH beyond the optimum range of 6.0-7.0.

When using wood ashes as a lime substitute, be sure to incorporate them into the upper 4 to 6 inches of soil in advance of seeding or transplanting.

Do not apply more than 10 lbs. of wood ashes per 100 square feet (sq. ft.) to avoid raising the pH above the optimum range.

Table D: Soil test levels and <u>approximate</u> pre-plant potassium (K) recommendations					
Soil test report levels	Ounces of potash (K₂O) to apply per 100 sq. ft. prior to planting	Some fertilizer sources that contain potassium (K)			
		Inorganic fertilizers	Organic fertilizers		
		Potash 0-0-60	Kelp 1-0-2	Greensand	Wood ashes
		60% K₂O	2% K₂O	7% K₂O	3 - 7% K₂O
		Quickly available	Quickly available	Very slowly available	Quickly available
Amount of product to apply per 100 square feet					
Very low	6 oz.	10 oz.	18¾ lbs.	5⅓ lbs.	12½ - 5⅓ lbs.
Low	4.5 oz.	7½ oz.	14 lbs.	4 lbs.	9⅓ - 4 lbs.
Medium	3 oz.	5 oz.	9⅓ lbs.	2½ lbs.	6¼ - 2½ lbs.
High	1.5 oz.	2½ oz.	4½ lbs.	1⅓ lb.	3 - 1⅓ lbs.

Matching Your Soil Test Levels with a Fertilizer Ratio

Notice the proportion of nutrients recommended on the soil test report. **If all nutrients** are at a low or medium level, a fertilizer with a 1:1:1 ratio, for example: 10-10-10, 18-18-18, 20-20-20, could be ideal. The exact amount to apply would be different based on the concentration of the fertilizer.

When the exact fertilizer ratio desired is not readily available select a fertilizer close to the needed ratio of nutrients, remembering a little less may be better than too much. **Table E** provides some possible fertilizer ratios based on soil test levels.

Table E: Matching your soil test levels with a fertilizer ratio				
Soil Test Levels		Fertilizer ratio	Examples N-P-K	Approximate amount of fertilizer needed for a 100 square foot area
Phosphorus (P)	Potassium (K)			
Very low	Very low	1:2:2	5-10-10	4 lbs.
Very low	Medium	1:2:1	5-10-5	4 lbs.
Low	Low	1:2:2	5-10-10	4 lbs.
Low	Medium	1:2:1	8-16-8	2.5 lbs.
Medium	Low	1:1:2		2.5 lbs.
Medium	Medium	1:1:1	10-10-10	2 lbs.
High*	Low	1:0:2		Use Table D to find K source
High*	Medium	1:0:1	19-0-19	Use Table D to find K source
Low	High*	1:2:0		Use Table C to find P source
Medium	High*	1:1:0		Use Table C to find P source

* A recommendation will only be made if nutrients are low or very low.

Re-test your soil every 2-3 years!

For more gardening information visit Cornell Garden-Based Learning

website: gardening.cals.cornell.edu/garden-guidance

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