

Getting the most out of your Annual and Perennial garden soil test report

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

General Information

Choose a site that is appropriate for the annuals and perennials you want to grow. Many annuals and perennials thrive in full sun while others can tolerate some shade.

When possible, begin improving the soil the year before planting, especially if planning to add additional organic matter (composts, well-aged manures) or needing to adjust soil pH.

Always check drainage which is essential for good growth.

Growing requirements for many different annuals and foliage plants as well as herbaceous perennials have been posted on the Cornell Gardening website. For a listing of links to numerous resources see page 12.

Soil pH in the 6.0 to 7.0 range is optimal for the health of most annuals and perennials.

The soil pH influences nutrient availability and microbial activity. When soil pH is outside this optimal range and very low, lime is used to raise soil pH. Sulfur is used to lower soil pH.

The recommended rate of material should be mixed into the upper 4 to 6 inches of soil, when the soil can be worked without causing compaction. 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 materials into the soil one year before planting, if possible, or in the fall or spring when the soil can be worked.

Adjusting soil pH:

Lowering soil pH: Ideally elemental sulfur should be worked into the upper 6 inches of soil before planting. When possible, allow one year for complete reaction to take place. When adjusting the pH in established plantings apply half the recommended rate in early spring and half in the fall.

If applying sulfur to plantings or grassed areas do not exceed 8 ounces of sulfur per 100 square feet at any one time. Higher rates of sulfur can injure turf and established plants.

Acidifying fertilizers, such as ammonium sulfate, can be used to help lower soil pH *when nitrogen is recommended.*

Raising soil pH: Lime is used to raise soil pH and should be worked into the upper 4-6 inches of soil before planting. If possible, allow one year for complete reaction to take place. There are different kinds of lime, some react very quickly and are easy to handle and some are harder to use. Ground or pulverized limestone is recommended for use in gardens and landscapes. When selecting a liming material read the label and look for the ENV (Effective Neutralizing Value).

The ENV indicates the amount of material that will react with soil acidity in the first year of application. Take the recommended lime rate and divide it by the % ENV to determine exactly how much to apply.

For example, if the soil test report states you will need 8 pounds of lime for every 100 square feet and the product you have has an ENV of 90% you will have to apply 8.8 pounds.

$$\frac{8 \text{ pounds of lime}}{.90} \text{ (recommended rate)} = \text{8.8 pounds needed for each 100 sq. ft.}$$

(percent of ENV)

When 20 pounds or more of lime per 100 square feet is recommended in the report, apply half in the fall and the other half in the spring before planting.

In established plantings apply half the recommended rate in early spring and half in late fall.

What about using wood ashes?

Wood ashes are not used as an amendment to improve soil physical properties such as drainage or organic matter level.

However, they 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.

Do not apply more than 10 pounds of wood ashes per 100 square feet to avoid raising the pH above the optimum range.

Wood ashes are also a source of potassium and contain 3-7% potash (K_2O). When using wood ashes in place of lime just double the recommended lime rate to correct the pH (for example if 3 pounds of lime are required to raise the pH you can use 6 pounds of wood ashes instead).

If applying 5 pounds of wood ashes per 100 square feet supplemental potassium will likely not be needed.

Check the soil pH regularly to determine if additional materials will be needed to maintain the pH in proper range.

Promote plant health and quality with proper fertilizer applications.

Nutrients required by annuals and perennials are nitrogen (N), phosphorus (P) and potassium (K). Other essential nutrients are usually available in adequate quantities in the soil when the pH is in the optimal range.

When only one nutrient is deficient we do not encourage the use of a complete fertilizer, one that contains N, P and K.

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, plant-based compost and plant and animal by-products.

Natural organic sources

Animal manures and plant-based compost (yard waste, grass clippings, food waste) are readily available and are popular fertilizers that are 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. Nitrogen from organic sources is released over a period of time and the

amount available for plant growth depends on the source, time of application, soil condition and temperature.

Knowing the exact 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. Therefore, it will be difficult to calculate their precise nutrient contribution to the soil.

The nutrient analysis of commercially available manure is found on the bag. Keep in mind these products may also have a high salt content and only a portion of the nitrogen would 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 before planting to allow time for the slow release of nutrients in the root zone and to minimize runoff.

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 clay-based soils with 3-5% organic matter will perform fine. **Organic matter levels twice this amount could lead to nutrient imbalances.**

However, if the organic matter level is low, you can apply a 2- inch layer of compost that should be worked into the upper 6" of soil.

Remember 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 annual nitrogen rate by 0.5 ounce per 100 square feet (sq. ft.)

Conventional/Inorganic fertilizers

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 if not mixed accurately and the concentration is too high.

Also, if over applied and watered in excessively they can leach beyond the root zone and end up in the ground water which negatively impacts water quality. So, follow the product label instructions and do not over apply.

Slow release fertilizers are materials that have been formulated to release nutrients over an extended period of time. They are labor saving, easy to use and very popular. Check their analysis (the percent of N-P-K and the length of nutrient release, some provide nutrients for 3-4 month period vs. others can provide up to a 6 month nutrient release.

Fertilizer Terms

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 D** 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 materials or fertilizers 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 the plant's root system in previous seasons.

When setting out transplants especially in cold soils **starter solutions** are often used. These are generally liquid fertilizers containing smaller amounts of nitrogen (N) and potassium (K) and a higher amount of phosphorus (P) such as 4-12-4 10-52-10. Be sure to mix according to directions and don't exceed recommended rates.

In-season fertilizing strategies include periodic applications of fertilizer to sustain growth. Gardeners can use dry granular conventional fertilizers that are spread and worked into the soil carefully or use *water soluble* liquid or powder fertilizers that are mixed into water, form a solution that can be applied when watering. Caution should be used to only apply recommended amounts.

Amending and preparing soils before planting

The ideal time to incorporate pH adjustment materials (if needed) and organic matter (if less than 3-5%) is before planting.

This is also an important time to incorporate any recommended phosphorus (see **Table A**) or potassium (see **Table B**) into the upper 6" of soil. If this is not possible applications can be made as soon as possible after planting. Make sure to avoid fertilizer contact with plants and water the fertilizer off the plants.

The soil test report recommendations are for the entire growing season. Once the planting is established the demand for P and K is not as high. Nitrogen applications become the focus unless soil tests indicate a deficiency of P or K.

Phosphorus (P)

Phosphorus is important in early root development and establishment.

Note that animal manures, fresh and composted, often contain high levels of P. Regularly adding manure to gardens can raise soil P to excessive levels. Phosphorus does not move in the soil much so it is best to incorporate P into the soil before planting so the roots can access more of this nutrient.

If only P is needed, use **Table A** to help determine the amount of phosphorus fertilizer to apply before planting.

| Table A: Soil test levels and <u>approximate</u> 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 | 3.0 oz. | 15 oz. | 6.5 oz. | 1¼ lbs. | 6¼ lbs. |
| Low | 2.0 oz. | 10 oz. | 4½ oz. | 13½ oz. | 4¼ lbs. |

| | | | | | |
|---------------|---------|---------|--------|--------|--------|
| Medium | 1.5 oz. | 7.5 oz. | 3¼ oz. | 10 oz. | 3 lbs. |
| High | 0.5 oz. | 2.5 oz. | 1 oz. | 3½ oz. | 1 lbs. |

If the planting bed or garden is already established and phosphorus is recommended and the above fertilizer cannot easily be applied, a water-soluble fertilizer with a high percentage of phosphorus can be used instead. Apply according to label directions.

Potassium (K)

Potassium increases water efficiency and improves stress tolerance in plants. If only K is needed use **Table B** to help determine the amount of potassium fertilizer or wood ashes to apply before planting.

| Table B: 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 | 3.0 oz. | 5 oz. | 9 lbs. | 2½ lbs. | 6 - 2½ lbs. |
| Low | 2.0 oz. | 3½ oz. | 6¼ lbs. | 1¾ lbs. | 4¼ - 1¾ lbs. |
| Medium | 1.5 oz. | 2½ oz. | 4½ lbs. | 1¼ lbs. | 3 - 1¼ lbs. |
| Slightly High | 0.5 oz. | 1 oz. | 1½ lbs. | ½ lb. | 1 - ½ lb. |

*Wood ashes are a source of potassium (3-7% K₂O). 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. See pH adjustment section on page 2 – 3 to learn how wood ashes affect soil pH.

If the planting bed or garden is already established and potassium is recommended and the above fertilizer cannot easily be applied, select a *water soluble* fertilizer with a high percentage of potassium can be used instead.

Apply according to **label** directions.

Nitrogen

Nitrogen is one of the most important nutrients for plant growth and is needed in relatively large amounts by all plants however, over application can be harmful to plants and the environment.

Nitrogen is supplied to the soil by existing organic matter, the addition of organic materials and by fertilizer applications. Aged animal manures and plant-based compost will 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. This is one reason why supplemental fertilizer is applied either at the time of planting or during the growing season.

Why is the nitrogen level not provided on soil test report?

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.

A standard nitrogen recommendation is routinely provided for garden and landscape plantings where production is not the goal but where plant quality and growth are the goals– not excessive growth.

The annual recommended nitrogen rate we use is approximately 2.0 – 3.0 ounces of nitrogen per 100 square feet. This represents the amount of nitrogen needed for the entire growing season.

Pre-plant fertilizer applications

If your soil needs N, P and K and you plan to use a complete conventional fertilizer, for example 5-10-5, note only a portion of the total recommended nitrogen will be provided at this time.

It would be beneficial to make another application or two during the growing season to apply the total recommended nitrogen. Table C lists nitrogen sources and an example of a fertilizer strategy is listed on page 10.

| Table C: <u>Approximate</u> amount to apply using some commonly available nitrogen (N) fertilizer sources | | | | |
|--|----------------------------|--|---------------------------------|---|
| Nitrogen fertilizers | Fertilizer analysis | Amount of this fertilizer needed to supply 1.0 ounces of nitrogen per 100 square feet | Rate of nutrient release | Other considerations |
| Urea (synthetic) | 46-0-0 | 2¼ oz. | Rapid | Inexpensive, concentrated, may be difficult to apply |
| Calcium nitrate (inorganic) | 15-0-0 | 6½ oz. | Rapid | Can help raise pH |
| Ammonium sulfate (inorganic) | 21-0-0 | 4¾ oz. | Medium | Can help lower pH, can use for acid loving crops |
| Blood Meal (natural organic) | 12-0-0 | 8¼ oz. | Medium-rapid | Commonly available |
| Corn Gluten (natural organic) | 10-0-0 | 10 oz. | Medium | Expensive |
| Cotton Seed Meal (natural organic) | 6-2-1 | 16¾ oz. | Slow-medium | Can help lower pH, also contains phosphorus and potassium |
| Sodium Nitrate (natural organic) | 16-0-0 | 6¼ oz. | Rapid | Avoid high rates |

Fertilizing Established Plantings

Spread the fertilizer evenly around the plants and lightly scratch it into the soil. Water immediately to remove fertilizer from plant surface and for the fertilizer to reach the soil. If the planting is mulched, pull back the mulch to expose the soil and apply the fertilizer.

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 D** provides some possible fertilizer ratios based on soil test levels.

The fertilizers listed in **Table D** contain nitrogen, phosphorus and potassium and are suggested when the soil test results indicate a complete fertilizer is needed.

When using these rates, the nitrogen applied only provides a portion of the total annual nitrogen recommendation of 2.0 - 3.0 ounces per 100 sq. ft. for the growing season. So additional applications of nitrogen are warranted if more growth is desired.

A reasonable fertilizing schedule:

For example: Let's assume your soil test indicates P is *very low* and K is *medium* low, and you select a fertilizer with a 1:2:1 ratio, such as 5-10-5. According to **Table D** 1½ lbs. of 5-10-5 will be needed for each 100 sq. ft area.

At this application rate, the amount of nitrogen provided is actually providing only 1.5 ounces of nitrogen so a follow up application of nitrogen would be beneficial.

So about 4 weeks after the initial application you can select a nitrogen source from **Table C** to apply another ounce of nitrogen.

If your soil pH happens to be a bit high you could select ammonium sulfate, which provides nitrogen and also helps to lower the soil pH. You would need to apply 4¾ ounces ammonium sulfate for each 100 sq. ft. area.

| Table D: 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 | 1:1:1 | 10-10-10 | 1¾ lbs. |
| Very low | Medium | 1:2:1 | 5-10-5 | 1½ lbs.* |
| Low | Low | 1:1:1 | 10-10-10 | 1¼ lbs.* |
| Low | Medium | 1:2:1 | 5-10-5 | 1¼ lbs.* |
| Medium | Low | 1:2:2 | 5-10-10 | 1¼ lbs.* |
| Medium | Medium | 1:1:1 | 10-10-10 | 1 lb.* |

| | | | | |
|--------|--------|-------|---------|------------------------------|
| High** | Low | 1:0:2 | | Use Table B to find K source |
| High** | Medium | 1:0:1 | 19-0-19 | Use Table B to find K source |
| Low | High** | 1:2:0 | | Use Table A to find P source |
| Medium | High** | 1:1:0 | | Use Table A to find P source |

* At this application rate, additional nitrogen will be needed to achieve the annual recommended nitrogen rate. See page 8.

** When only phosphorus or only potassium levels are low or medium use **Table A** for phosphorus or **Table B** for potassium to determine the amount to apply.
Remember nitrogen will be needed too.

Re-test your soil every 2-3 years!

Visit Cornell University's gardening site at

<http://gardening.cals.cornell.edu/garden-guidance>

Flower growing guides can be found at

<http://www.gardening.cornell.edu/homegardening/scenec139.html>

Herbaceous perennial growing guides can be found at

https://aggie-horticulture.tamu.edu/ornamentals/cornell_herbaceous/

Additional resources for the avid gardener include Cornell Classics like Sequence of Bloom, Ornamental Grasses for the Garden and the Rock Garden. Be sure to check out:

<http://gardening.cals.cornell.edu/garden-guidance/lawns-landscapes/#Annual%20and%20Perennial%20Flowers>