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01. Plant Nutrient Basics

Key Points

- 17 Essential Nutrients
- Soil Tests
- Fertilizer Components
- Fertilizer Calculations
- Global Staple Crops

Introduction

Humans need four basic things to live: food, water, air, and shelter. But what does food production require? Food that supports life is dependent upon plants. What do plants need to live? Plants require sunlight, proper temperature, water, air, and nutrients. Understanding what certain vegetation requires is essential in producing the best possible crop with the highest quality and quantity. Success in farming comes only when the correct crop is planted. Crops are selected based on availability of plant growth requirements, seed availability, and the nutritional needs of the community. To some, understanding these basics may seem like a daunting task, but every farmer is more than capable of mastering these concepts.

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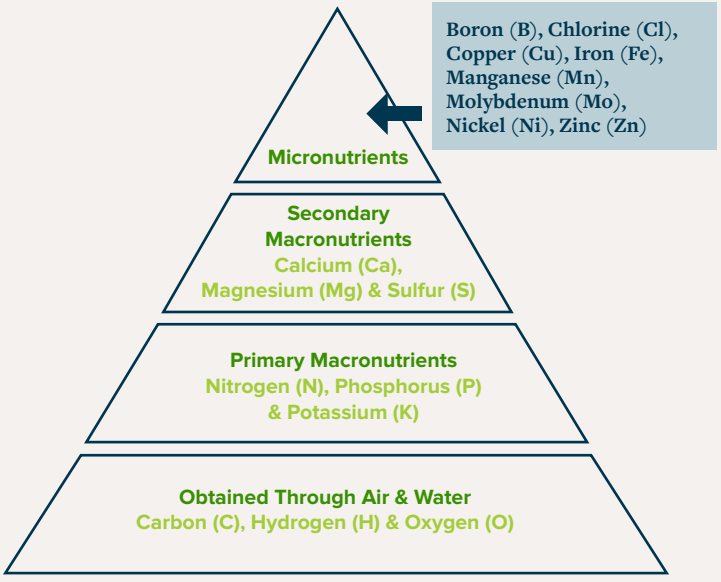
What Is a Nutrient?

A nutrient is a substance that plants need to grow. If a plant doesn't get its essential nutrients, it may have problems producing products or developing leaves and roots. The plant may also suffer major consequences or could die.

There are 17 essential nutrients that every plant generally needs. Carbon, hydrogen, and oxygen are taken in through air and water, and the other 14 nutrients come from the soil. There is a balance of nutrients needed for optimum plant growth. Scientists use the terms "macro" (more) and "micro" (less) to separate the two groups of nutrients. Within the macro group, there are primary and secondary macronutrients. Take a look at the chart below to see which nutrients fit into their respective categories.



Sometimes, you can tell if a plant is lacking certain nutrients from its appearance. Experts call this a "deficiency," when something is receiving less than what it requires. Knowing which nutrients a plant has or needs more of will improve its quality of life. Next is a list of common deficiencies and how they appear visually (Provin, 2014).

- **Nitrogen (N)** – There is yellowing in the lower leaves with excessive leafy growth and late fruiting.
- **Phosphorus (P)** – There is undersized growth and a reddish-purple shade in leaf tissues.
- **Potassium (K)** – The edges of the leaves turn brown.
- **Calcium (Ca)** – The tips of leaves burn or blossom bulbs rot, which is caused by poor watering, too much soil moisture, or damaged roots.
- **Sulfur (S)** – There is undersized scraggly growth and leaves gain a yellow tint, which is often seen in sandy soils.

Each plant species and variety is different. Some are tougher than others. Certain plants may be more sensitive to a lack of nutrients and show very obvious signs. It might be harder to identify a deficiency in less-sensitive plants.

Soil Nutrient Content

After you have identified what your plant needs to grow, it's time to find out what nutrients your soil has. The best way to analyze this is to do a soil test. The process is simple and easy to complete.

Organizations that offer these tests may have varying specifications, so it's important to check with the company. (Often, this can be done through a website, phone call, or email.) To find a local company to test your soil, click here.

For some, conducting a soil test may be a daunting task. Contact your local extension agent for additional resources, if needed. Please remember that different types of soil often act in various ways. Below are important things to note (Cogger, 2019).

- Soils with clay and organic components will be chemically reactive, meaning they hold nutrients and slowly release them to the plant.
- Sandy soils will not carry nutrients as effectively as more moist soils.
- The pH (degree of acidity in soil) should generally be 5.5 to 7.0 logarithmic units (with some exceptions). Fluctuations can alter nutrient availability and biological factors.

Fertilizers

After discovering your soil's nutrient availability, select a fertilizer to make up for the gaps in nutrients. Often, the soil test results will include a recommended fertilizer. There are many different options, including organic or synthetic fertilizers. *Organic fertilizers* are carbon-based and made from living organisms' byproducts, including compost or manure. *Synthetic fertilizers* are manufactured products that often use water to dissolve into the soil.

All fertilizers have a guaranteed analysis, where it will list the N-P-K percentage of each nutrient based on a specific weight. Organic fertilizer nutrients are more difficult to calculate because you have to know and understand what compounds are in your compost or manure. Synthetic fertilizers will list them for easy calculation and application.

Next, you must find out how much fertilizer content you need to adequately fertilize your crops. There are basic math equations to help determine the amount that is needed.

Fertilizers and soil tests are great resources to use if you are looking to improve crop production. Your garden can grow without these, but it may produce higher yields and better crops if they are thoroughly taken care of through the processes suggested in this module. Remember to use caution when working with fertilizers and chemicals.

Calculating Fertilizer

Step 1

Figure Square Footage of Area

- Length × Width = # square feet
- Example: 300 feet x 10 feet = 3,000 square feet

Step 2

Convert Into Acreage

(1 acre = 43,560 square feet)

- # square feet ÷ 43,560 square feet = # acres
- Example: 3,000 ÷ 43,560 = 0.0689 acres

Step 3

Figure Out Material

- Rate per acre ÷ % nutrient of material = material per acre
- N-P-K = Nitrogen, Phosphorus, and Potassium
- Rate per acre (how much of a nutrient you need per acre) ÷ % of nutrient material (how much of that nutrient your fertilizer contains) = material per acre (how much of a nutrient you need per acre)
- Material per acre × plot size = material needed
  - Urea 46-0-0, a nitrogen-based synthetic fertilizer, has an application rate of 150 pounds per acre.
- 150 pounds nitrogen ÷ 0.46 = 326 pounds Urea
  - To calculate the nutrient percentage of a material, multiply by 0.01.
- 326 pounds Urea × 0.0689 acres = 22 pounds Urea for your area of 3,000 square feet or 0.0689 acres in this example

Organic Fertilizers

- Slower release of nutrients through microorganisms in soil (days to weeks)
- More expensive
- Hard to know exact application
- Lower burn rate and doesn't harm the environment
- May have extra weeds or human diseases if not processed properly

Synthetic Fertilizers

- Quick delivery of nutrients
- Generally cheaper
- Increases burn rate and can cause harm to environment
- Easy to calculate exact application
- Does not contain any carbon in the fertilizer mixture

Global Staple Crops

In the end, plants give nutrients back to humans when consumed for food purposes. Around the world there are various staple crops, or crops that are the main source of food in someone's diet. These are common because they are some of the most widely produced and consumed crops. World staple crops, based on how much of each crop is produced, include maize (shelled corn), wheat, rice, potatoes, cassava, soybeans, sugar cane, barley, and sweet potatoes (Conte Jr.). These crops represent agricultural production worldwide, thus crops represented here may not be suitable to grow or be common in your part of the world.

Each of these crops provides varying amounts of macronutrients — proteins, fats, carbohydrates, and calories — if properly cared for. This can be key in deciding what type of crop you should produce or consume based on which macronutrients you desire to have more or less of. The table below shows the main staple crops and the macronutrient ratios associated with each. For example, soybeans have the highest percentage of protein while cassava has little protein. What other comparisons can you make between these staple crops?

Staple Crop	Production Total Standard Tons	Protein	Fat Essential Fatty Acids	Carbs
Maize	906,885,324	8%	46%	77%
Wheat	760,534,962	14%	0%	73%
Rice	755,097,990	7%	0%	80%
Potatoes	346,280,193	2%	0%	17%
Cassava	256,783,618	1%	0%	38%
Soybeans	254,581,702	36%	57%	30%
Sugar Cane	192,143,111	0%	0%	99%
Barley	173,773,559	12%	0%	73%
Sweet Potatoes	121,395,668	2%	0%	20%

Crops outside of these staples are considered "specialty crops." They consist of fruits, vegetables, and tree nuts, and are not as commonly grown by farmers. Each farmer must pick what crop is right for them and their individual situation. These are all attributed to proper growing processes like soil tests, fertilization, and education on choosing the crops that will be staples for your family and the habitat your garden will grow in. For more information, use "Lesson 2: Family Sustainability" to learn more about enhancing food security for your household.

Conclusion

All farmers are capable of managing and producing a harvest, whether they are first-generation farmers or following their family's tradition. Understanding which nutrients plants need is critical to the plant's life and health. It takes time to learn this information, and commitment to devote to the plant's overall success. All of this work is worth the effort when the nutrients in the soil produce food to put on the table.

Convoy of Hope and the Center for Agriculture & Food Security team are passionate about educating people in agriculture — people around us and across the world.

If you need more information, visit **convoy.org/cafs** or contact **info@convoyofhope.org**. May your crops be plentiful!

CAFS Peer-Reviewed

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