ONE MIGHT describe floriculture crops as “totally dependent.” Most are grown in pots and have no means to acquire nutrients other than what the grower provides. Of course, the grower tries to provide optimal levels of nutrients to get healthy crops and maximize profits.

Objective:
Discuss plant nutrition and fertilizers.

Key Terms:
- chlorosis
- complete fertilizer
- fertilizer
- fertilizer analysis
- fertilizer injector systems
- incomplete fertilizer
- limestone
- macronutrients
- micronutrients
- nutrient deficiency
- parts per million
- plant nutrition
- primary macronutrients
- secondary macronutrients
- slow-release fertilizers
- soil pH
- soil test
- sulfur
- water-soluble fertilizers

Plant Nutrition
Plants need nutrients for healthy growth and development. Plant nutrition involves the absorption of nutrients, or chemical elements, for plant growth.
ESSENTIAL ELEMENTS

Plant growth is dependent on 16 essential elements. Three of the 16 elements—oxygen (O), hydrogen (H), and carbon (C)—make up 89 percent of a plant’s tissue by dry weight. These three are considered nonfertilizer nutrients because plants acquire them through natural processes from air and water.

**Macronutrients**

Six essential elements, besides oxygen, hydrogen, and carbon, are required in greater quantity than the others. They are called macronutrients. The macronutrients are nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), and sulfur (S).

Nitrogen, phosphorus, and potassium are considered primary macronutrients because they are used in complete fertilizers. Nitrogen promotes green, leafy growth. Phosphorus encourages flowering and root growth. Potassium provides disease resistance.

Calcium, magnesium, and sulfur are said to be secondary macronutrients because plants need them in moderate amounts. These secondary macronutrients may or may not be used in complete fertilizers.

**Micronutrients**

The other seven essential elements, called micronutrients, are needed in small quantities. These are sometimes called trace elements. They are boron (B), copper (Cu), chlorine (Cl), iron (Fe), manganese (Mn), molybdenum (Mo), and zinc (Zn). Six of these—boron, copper, iron, manganese, molybdenum, and zinc, are supplied to plants as fertilizers. Chlorine is not added to fertilizers because plants obtain sufficient quantities of chlorine from the medium or water.

**Mnemonic Phrase**

A mnemonic (pronounced ne-mon-ik) phrase can be used to help memorize the 16 essential elements for plant growth. It is “C. B. Hopkins Café Mighty Good Closed Monday Morning See You Zen.” It represents the following: carbon (C), boron (B), hydrogen (Hopkins), oxygen (HOpkins), phosphorus (HoPkins), potassium (HopKins), nitrogen (HopkINs), sulfur
Other Elements

Other elements also play important roles in plant growth and development. However, they are not listed as essential. For instance, silicon (Si) improves plant strength and disease resistance, and nickel (Ni) is an important component of an enzyme.

Nutrient Deficiency

Plants receive most of the nutrients that they need from the growing medium. To maintain healthy plants, a grower must provide the right type and amount of nutrients to the medium so that the plants can absorb the nutrients and grow. A soil test can be performed to determine which nutrients are present and which nutrients are deficient or lacking.

When nutrients are deficient in the soil, the plant growth is adversely affected. Plant leaves commonly show symptoms of a nutrient deficiency by turning colors. When nitrogen is deficient in the soil, a plant’s older leaves turn yellow. Abnormal yellowing of plant leaves is a condition called chlorosis. A plant will show purpling in the stem or leaf when phosphorus is deficient.

INFLUENCE OF pH ON NUTRIENTS

Nutrient availability is influenced by the pH of the soil. Soil pH is a measure of the acidity or alkalinity of the soil. It is based on the concentration of hydrogen ions present in the soil.

Soil pH can range from 1 to 14. A pH reading of 7 is neutral. Substances that have pH readings below 7 are acidic. Substances that have pH readings above 7 are alkaline, or basic.

Many times, the nutrients needed for plant growth are present in the soil, but the plants cannot absorb the nutrients because of the soil chemistry. Nutrients in strongly acidic or alkaline soils are locked up and unavailable for the plants to absorb. Plants have specific pH ranges that are ideal for maximum growth. Most plants grow best at a pH of 5.5 to 7.0. Some important horticultural plants, such as azaleas, do better in a medium that has a more acidic pH. Florist hydrangeas have pink flowers when grown in slightly alkaline soil and blue flowers when grown in acidic soil.
A soil test can be done to determine the pH of the soil, and amendments can be added to modify the pH. **Limestone** is commonly added to growing medium to raise the pH. **Sulfur** or sulfur compounds can be added to the medium to lower the pH.

### FERTILIZERS

A **fertilizer** is any material added to growing medium that provides nutrients for plants. Fertilizers vary in the components they contain, the way they are applied, and the function they serve.

When choosing a fertilizer to use, begin by looking for the fertilizer analysis on the bag or box. The **fertilizer analysis** states the percentage of primary macronutrients present in the fertilizer. The analysis is written as three numbers—for example, 15-10-26. The numbers represent the percentage of nitrogen, phosphorus, and potassium present in the fertilizer. The primary macronutrients are always listed in that order. The example given has 15 percent nitrogen, 10 percent phosphate, and 26 percent potassium.

![FIGURE 3. Nutrient availability as influenced by soil pH.](image-url)
If a fertilizer contains all three primary macronutrients, it is called a **complete fertilizer**. If a fertilizer lacks any of the three primary macronutrients, it is called an **incomplete fertilizer**.

The fertilizer analysis does not equal 100 percent. The rest of the fertilizer composition consists of filler materials necessary for the fertilizer to be applied. Some fertilizers also have some micronutrients.

**MEETING NUTRITIONAL NEEDS OF PLANTS**

Different plants have different nutrient requirements. Some are said to be heavy feeders, and others light feeders.

**Stages of Growth**

Plants have different nutrient requirements based on their stage of growth. There are five main stages of growth for potted flowering plants. The first is the young seedling or cutting stage. The second is the vegetative or leafy growth stage. This is followed by the flower-bud initiation stage, the flower-bud development stage, and the flowering stage. Each stage calls for different rates of fertilizers. When in the vegetative stage, plants use more nitrogen, and when in the flowering stage, they require less nitrogen and more phosphorus.

**Types of Fertilizers**

Fertilizers are typically applied as slow-release fertilizers or water-soluble fertilizers. **Slow-release fertilizers** continually discharge small amounts of nutrients into the growing media over time. They are available in two forms. One form consists of a water-soluble fertilizer held within a plastic resin or sulfur coating. The coating is designed to allow a small amount of fertilizer to be slowly released. The coated fertilizer has the appearance of little round beads that are sometimes mistaken for insect eggs by the uninformed. The other type of slow-release fertilizer comes in a granular form. This type releases no more than 1 percent of the fertilizer in a 24-hour period.

**Water-soluble fertilizers** dissolve completely in water and stay in solution. The concentration of a water-soluble fertilizer is easily adjusted. The fertilizer concentrate is then mixed with the water in exact proportions before irrigating plants. With **fertilizer injector systems**, growers can provide specific levels of

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**FIGURE 4. Fertilizer injector systems deliver exact amounts of nutrients to plants.**
water-soluble fertilizers to crops. Fertilizer injector systems are standard equipment in today’s greenhouses.

There are a number of advantages to using water-soluble fertilizers with injector systems. The greenhouse plants are provided with constant liquid feeding. This is especially important with soilless media that have low cation exchange capacity. The plants are fertilized when they are watered, thus reducing labor. All the plants of a particular crop receive the same levels of nutrients. This helps in producing a uniform crop. In addition, adjustments to the level of nutrients in solution can be made easily.

**CALCULATING FERTILIZER RATES**

Nutrients in solution are measured in **parts per million** (ppm). Fertilizer rates can be found in tables in reference books or in instructions for injector systems, or growers can calculate the amount of fertilizer needed to reach a desired ppm. In either case, it is beneficial for a grower to understand how to calculate parts per million of fertilizer nutrients.

An example problem calls for 200 ppm nitrogen. The chosen fertilizer is calcium nitrate with an analysis of 15-0-0. A rule of thumb in calculating ppm is that 1 ounce of anything in 100 gallons of water equals 75 ppm.

**Problem:** Wanted, 200 ppm N

**Chosen fertilizer:** 15-0-0 Calcium Nitrate

Multiply the percentage of the nutrient in the given fertilizer by 75.

\[
0.15 \times 75 = 11.25 \text{ ppm N (if 1 ounce is added to 100 gallons)}
\]

\[
200 \div 11.25 = 17.8 \text{ ounces of fertilizer needed in 100 gallons to get 200 ppm}
\]

If the injector system delivers 1:100 (1 gallon of concentrate mixed with 99 gallons of water, for a total of 100 gallons), 17.8 ounces of fertilizer are needed for each gallon of concentrate. If the tank holds 30 gallons of concentrate, 534 ounces (33.38 pounds) of fertilizer are needed to deliver 200 ppm.

**Summary:**

Plant nutrition involves the absorption of nutrients, or chemical elements, for plant growth. Plant growth is dependent on 16 essential elements. Three of the 16 elements—oxygen (O), hydrogen (H), and carbon (C)—make up 89 percent of a plant’s tissue by dry weight. Six essential elements, besides oxygen, hydrogen, and carbon, are required in greater quantity than the others. They are called macronutrients. The other seven essential elements, called micronutrients, are needed in small quantities. Plants sometimes suffer from nutrient deficiencies
when certain nutrients are lacking. Nutrient availability is influenced by the pH of the soil. Most plants grow best at a pH of 5.5 to 7.0.

A fertilizer is any material added to growing medium that provides nutrients for plants. The fertilizer analysis states the percentage of primary macronutrients present in the fertilizer. Fertilizers are typically applied as slow-release fertilizers or water-soluble fertilizers. Slow-release fertilizers continually discharge small amounts of nutrients into the growing media over time. Water-soluble fertilizers dissolve completely in water and stay in solution. Water-soluble fertilizers are applied with fertilizer injector systems.

**Checking Your Knowledge:**

1. What are the 16 essential elements for plant growth?
2. How do macronutrients and micronutrients differ?
3. How does pH influence nutrient uptake by a plant?
4. What are fertilizers?
5. How do slow-release and water-soluble fertilizers compare?

**Expanding Your Knowledge:**

Grow a number of plants of the same type under the same conditions with the exception of nutrition. From one plant to another, vary the rates of nutrients given and observe how the growth of the plants is affected.

**Web Links:**

- **Essential Plant Nutrients**

- **Mineral Nutrition**
  [http://www.esf.edu/efb/course/efb530/lectures/nutritio.htm](http://www.esf.edu/efb/course/efb530/lectures/nutritio.htm)

- **Plant Nutrition Facts**
  [http://www.greenair.com/plantlnk.htm](http://www.greenair.com/plantlnk.htm)

- **Agricultural Career Profiles**
  [http://www.mycaert.com/career-profiles](http://www.mycaert.com/career-profiles)