

Plant nutrients

All plants require nutrients to survive and grow. Plants take nutrients from the air, the soil, and the water. Because you cannot see nutrients — they are colourless gases or are like dust dissolved in water or stuck onto each piece of soil — it is sometimes hard to understand how they work.

The quantity of nutrients available to the plants is affected by:

- substrate quality
- water quality
- plant type.

Nutrients are taken up by the fine root hairs, not by the big roots. Even the very largest of trees have many small, fine root hairs to absorb the nutrients and water they need. The larger roots are used for supporting the tree and for storage of water and other plant food. The root hairs can also excrete liquids that affect the acidity of the soil (pH). When the pH changes, the amount of nutrients available may also change.

There are two sorts of nutrients: macronutrients, required in large quantities, and micronutrients, required in small quantities. The big three, nitrogen, phosphorus and potassium, together comprise over 75% of the mineral nutrients found in the plant. All nutrients are abbreviated by one or two letters, their chemical symbols that are based on their Latin names. The symbols are the same in all languages.

macronutrients	micronutrients
Nitrogen (N)	Iron (Fe)
Phosphorus (P)	Manganese (Mn)
Potassium (K)	Zinc (Zn)
Calcium (Ca)	Copper (Cu)
Magnesium (Mg)	Boron (B)
Sulphur (S)	Chlorine (Cl)
	Molybdenum (Mo)

The only way to know if one nutrient is missing is to analyse the leaves, stems and roots in the laboratory and compare this to published values for that species. If values are not known, fertilizer trials might show what is lacking. This would involve adding different types of nutrients and at different levels during the growing season. Soil analyses can show what is in the soil, but might not indicate what is available for the plants to use, and you might need a soil scientist to help interpret these results.

Nutrient balance and nutrient deficiencies

Plants (like people) need a ‘balanced diet’. They need all 13 nutrients to remain healthy. If one is missing, the plant will not grow well. Poor plant nutrition causes plants to grow slowly in the nursery and in the field, and to be more susceptible to diseases.

Many people confuse the symptoms of nutrient deficiencies with those of too much or not enough shade or water. In fact, all three factors, shade, water and nutrients affect plant growth, and interact to produce healthy plants. A plant that grows in full light with abundant moisture and receives all the 13 nutrients will grow fast and have a dark green colour in its leaves. A plant that grows slowly in the shade may also have dark green leaves, but when exposed gradually to the sun, the leaves may turn yellow. This does not mean that plants do not like full sun — it might indicate a nutrient deficiency which did not show up in the shade because the plant did not have enough light to stimulate fast growth.

Carefully monitor the leaves of your plants for signs of nutrient deficiency.

Together, water, shade and nutrients must be monitored and adjusted to produce quality seedlings.

It takes practice to learn the signs identifying a missing nutrient or nutrients, but you can learn to do so, and some of the signs are common to many plants. A *good nursery practice* is to carefully monitor the leaves of your plants for signs of nutrient deficiency, and correct them with a better substrate or with fertilizer. The symptoms can vary for each species — the lists on the next pages are only a general guide.

Inorganic fertilizers

Inorganic fertilizers are mined from the soil, or produced during complicated chemical reactions. A *good nursery practice* is to read the fertilizer labels. This allows you to apply what the plants need without wasting nursery resources. Fertilizers contain only plant nutrients; they are not used to combat plant diseases or insects. Inorganic fertilizers do not improve the

Common nutrient deficiency symptoms

Macronutrients

Nitrogen: This is a mobile nutrient, which means that when nitrogen is deficient, plants move it from the older foliage to the younger, actively growing leaves. The older leaves (the ones lower on the stem of the tree) become yellow first, while the new leaves remain green.

Phosphorus: The entire seedling is stunted, especially during early growth. Depending on the species, the leaves may become dull green, yellow or purple-tinged. The purpling of leaves is a classic symptom, but sometimes there are no colour differences in leaves, so visual diagnosis is not always reliable. The purple colour should not be confused with new leaves that often appear purple or red when they first flush out.

Potassium: Symptoms appear in older leaves first. These start to yellow at the edges, and have some green at the base. Later, leaf edges turn brown and may crinkle or curl and small necrotic (dead) spots may appear. Plants may wilt, even though sufficient water is available in the substrate. When deficiencies are severe, leaves will die.

Calcium: This is difficult to detect because signs include slow growth, and die-back of bud or root tips. Seedlings will have stubby little roots with brownish discoloration. The problem is most common in very acidic soils. A well-developed root system with many fine root hairs is important for calcium uptake.

Magnesium: This nutrient is commonly deficient in coarse-structured soils and in acidic soils. Uptake may be blocked if there is too much potassium in the soil. Like nitrogen, magnesium is a mobile nutrient, so deficiency symptoms show up in the older leaves first. These leaves show a very characteristic yellowing between the veins or ribs, and they appear streaked.

Sulphur: Plants will be slightly stunted. This is not a mobile nutrient, so the symptoms show up on younger leaves which are initially light green, but eventually develop scorched and curled margins. Dry areas can form along the margins and then spread inward to the leaf midrib.

Common nutrient deficiency symptoms

Micronutrients

Micronutrient deficiencies are difficult to diagnose because often more than one nutrient is missing. Only the most common symptoms are listed below.

Iron: Deficiency is common on alkaline or calcareous soil (pH above 7). Younger leaves become yellow to white and dry up.

Manganese: The tissue between the veins mottles, while the veins remain green and are surrounded by a band of green tissue.

Copper: New leaves are yellow at the tips and often become twisted.

Boron: The deficiency affects the terminal bud which yellows, dries out and dies. Plants grow slowly.

substrate physical properties, whereas organic material such as compost does. Inorganic fertilizers are also expensive and not always available in the stores. Nursery managers should carefully consider the cost and benefit of buying these products.

Granular fertilizers are commonly given names like “17-17-17”, or “10-30-10”. What do the numbers mean? They represent the percentages of nitrogen (N), phosphorus (P), and potassium (K) in the fertilizer — 17% N, 17% P, 17% K. In this case, 51% of the mixture is made up of N-P-K, and the rest is inactive material used to help spread the fertilizer evenly. Urea contains only N, and is labelled as 46-0-0. Urea is very strong and can easily burn the plants if too much is applied.

Granular fertilizers can be mixed into the substrate or into the irrigation water, or be applied to older plants on the soil surface. It is better to mix the fertilizer directly into the substrate before planting the seed because the roots can avoid or seek the fertilizer as they need it. Use only small quantities such as 2 or 4 grams ($\frac{1}{2}$ teaspoon) per 1 kg of soil. It is better to add too little than too much. You need to experiment with different levels. Plants should respond within two weeks.

When dissolving fertilizer in warm water, carefully note whether it is thoroughly dissolved. If not, it is probably the phosphorus that remains. It may be better to apply fertilizer in granular form if it does not dissolve thoroughly. Apply liquid fertilizer to the soil, not to the leaves which are easily burnt if fertilizer remains on them. Be extremely cautious when applying fertilizer to young plants.

Foliar fertilizers are used in order to get the nutrients to the plants quickly. They are specially formulated to apply directly on the leaves. Foliar fertilizers are absorbed by the leaves, not by the roots. When plants are acutely deficient in nutrients, foliar fertilizers often help 'green them up'. Frequently, foliar fertilizers only contain the micronutrients, since it is assumed that the macronutrients are available in the substrate. However, some such as 'GroGreen'® contain both micronutrients and 20-30-10 of N-P-K. Often an adhering agent such as 'Da-Plus' is used to help the fertilizer stay on the leaves so that it is not washed off in the rain. Because foliar fertilizers are expensive, and they may not encourage strong root growth, they should not be used as a long-term solution for plant nutrients.

Calculating fertilizer quantities

The following technique can be used for calculating the amount of fertilizer or any pesticide that is mixed with water. A typical foliar fertilizer recommends using one bag of fertilizer (1 kilo) per 200 litres of water. How much is needed then in one 15 litre back pack sprayer? You can simply approximate by dividing in half both amounts:

1 kilo (1000 grams) is for 200 litres

500 grams is for 100 litres

250 grams is for 50 litres

125 grams is for 25 litres

62.5 grams is for 12.5 litres

You would need a little more than 62 grams, because the sprayer contains a bit more than 12 litres, or 75 grams, to fill the sprayer. If you divided the fertilizer in the bag into 10 equal parts each would weigh 100 grams. So in this case you would need a bit less than one-tenth of the bag.

Summary of plant nutrients

Plants require 13 nutrients in different quantities to grow well. Common deficiency symptoms help identify which nutrients are missing. Nutrient deficiencies should not be confused with the effects of too much or too little shade and water.

Good nursery practices

- carefully monitor the leaves for signs of nutrient deficiencies, and correct them with compost or fertilizer
- understand fertilizer labels so that the right nutrients are applied
- thoroughly dissolve and dilute the granular fertilizer in warm water and apply it only to the soil, not the leaves