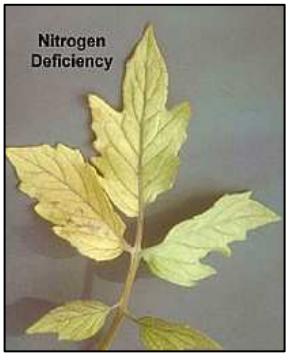
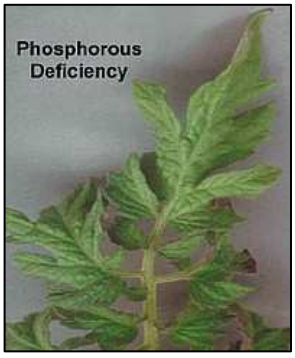
Fertilizer Elements – What they do, Organic Sources, & Deficiency Symptoms

I have been interested in Plant requirements for several years, and have been compiling data on all of the nutrients that the plant needs to be healthy. The following in no way is complete or completely accurate because of the interactions of the chemicals and shouldn't be used as the only guide to diagnosing problems. It is written to help novice gardeners gain a basic understanding of nutritional requirements of plants. There are six macro-nutrients: Nitrogen (N), Phosphorus (P), Potassium (K), Calcium (C), Magnesium (Mg), and Sulfur (S), which are absorbed by plants in large quantities. There are also seven Micro-nutrients: Boron (B), Chloride Cl), Copper (Cu), Iron (Fe), Manganese (Mn), Molybdenum (Mo), and Zinc (Zn), which are absorbed in small or trace amounts. There are three other macro-nutrients required by plants, Carbon, Hydrogen, and Oxygen, which are supplied by water and carbon Dioxide in the air.

Understanding N-P-K values: Nitrogen (N), Phosphorus (P), and Potassium (K) values are the "percentage by weight" in the fertilizer. Actually, the important thing to think about is the relationship of the numbers to each other. A NPK of 7-15-10 is the same as 14-30-20 in relative proportions to each other, just a little more concentrated. Beyond NPK, of upmost importance are the micronutrients. Plants are similar to people in that they need a balanced diet.



Nitrogen (N): Nitrogen is required to make amino acids, which provides proteins to the plant. Proteins are required for plant growth, and repair or healing when the plant is damaged. It is also a major component of chlorophyll, the compound by which plants use sunlight energy to produce sugars from water and carbon dioxide (i.e., photosynthesis).
Nitrogen Deficiency: Causes stunted growth or slow growth, and purple stems, pale green or sometimes purplish leaves, with older leaves yellowing. Sources of Nitrogen: Refined Urea Nitrogen is 46% nitrogen, not to be confused with urine, contains no salt, and is environmentally safe. Nitrate Nitrogen is considered a toxic to water supplies, and is produced by decomposing organic matter (compost), though it is the most desirable form of Nitrogen for plants. Ammoniacal Nitrogen is considered a toxic material. Although it contains high levels of Nitrogen, it also has significant levels of salt.
Organic Sources of Nitrogen: Blood Meal 13.25% (**13.2N**-1.0P-0.6K), Bone Meal 4.00% (**4.0N**-21.0P-0.2K) Rabbit manure 2.4% (**2.4N**-1.4P-0.6K, Coffee Grounds 2.0% (**2.0N**-0.4P-0.7K).

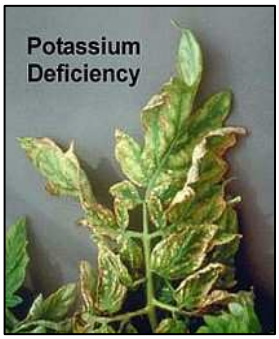


Phosphorus (P): Phosphorus aids in photosynthesis by converting light energy to chemical energy. It is critical for stimulating root development, increased stalk and stem strength, improved flower formation and seed production, more uniform and earlier crop maturity, increased nitrogen N-fixing capacity of legumes, improvements in crop quality, and increased resistance to plant diseases.

- Promotes root development
- Increases stalk and stem strength
- Improves flower formation and seed production
- Promotes more uniform and earlier crop maturity
- Increases nitrogen N-fixing capacity of legumes
- Improves crop quality
- Increases resistance to plant diseases

When starting seedlings, a low-phosphorus fertilizer will result in compact sturdy plants. When you visit a greenhouse and see compact yet beefy plants in six packs, then a high nitrogen, calcium, magnesium, and low phosphorus fertilizer is much of the reason. Feeding with higher Phosphorus helps reduce transplant shock when repotting seedlings. Timing is everything when it comes to phosphorus, and more is not always better. Applying such high rates of phosphorus will also cause plants to stretch, which will make your plants look thin instead of filled out as they should. Use high phosphorus formulations during periods of bud set to increase the number and size of blossoms. Resume use of traditional or lower phosphorus fertilizers for the remainder of the growing cycle to avoid "leggy" or "stretched" plants.
Phosphorus Deficiency: Extremely difficult to detect, and include thin and dwarfed growth, with leaflets drooping, curling backward and develop strong, dull purple tints. New leaves develop intense green coloration.
Organic Sources of Phosphorus: Bone meal 21% (4N-**21P**-0.2K), Fish Emulsion 4.4% (2.2N-**4.4P**-0.3K), Rock Phosphate 34% (0N-**34P**-0K).

Potassium (K): Potassium controls the opening and closing of pores in the leaves reducing water loss and increasing drought tolerance. Potassium is used to build cellulose and cell walls. Potassium affects quality factors such as size, shape, color and vigor of the seed or grain.



- Increases root growth
- Improves drought tolerance
- Builds cellulose strengthening cell walls
- Activates growth enzymes
- Aids in photosynthesis and food formation
- Increases starch production in fruit/food
- Increases protein in plants
- Reduces water loss and wilting
- Retards the spread of crop diseases and nematodes.

Potassium Deficiency: symptoms include susceptibility to pathogens, wilting, brown spotting, and susceptibility to frost and heat damage. Leaf Tips die first, starting at the ends of each branch, gradually working toward the main stem.
Sources of Potassium: Soluble Potash (K2O) is found both in nature and chemically processed. Sulfate of Potassium is made by reacting Potassium Chloride with sulfuric acid which results in a very soluble form of Potash. Sea Kelp is a good natural source of Potash (50%K), however, in an unrefined form it has significant levels of heavy metals and arsenic. Wood Ashes contain Potash, but also contain high levels of Sodium (salt), so spreading significant amounts of wood ashes on your garden will cause more harm than good.
Organic Sources of Potassium (K): Kelp 2% (1.5N-0.3P-**2.0K**), Horse Manure 6% (5N-2.5P-**6.0K**), Grapefruit Skins (ash) 30% (0N-3.6P-**30K**)

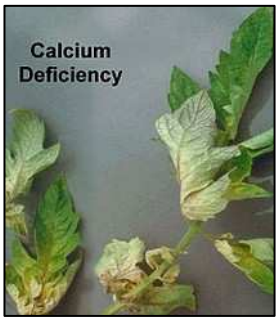
Sulfur (Su): Sulfur is a structural component of some amino acids and vitamins, and is essential in photosynthesis. Sulfur is important in maintaining proper Ph, making the soil more acidic (lowering Ph).

- Essential for production of protein.
- Promotes development of enzymes and chlorophyll formation.
- Improves root growth and seed production.
- Promotes vigorous plant growth and resistance to cold.

Sulfur Deficiency: Symptoms are pale yellow new leaves, and older growth staying green. Ph has significant effects on plants. If sulfur content in soil is low, (Ph above 6.0),

strawberries and blueberries fruit production will drop significantly. If the soil Ph is too high (alkaline), the plant is unable to absorb sufficient iron, and regardless of how much iron you add to the soil, the plant will continue to have an iron deficiency.
Organic Sources of Sulfur (Su): Kelp 3.5%, Espoma Organic Soil Acidifier 90% (Fast-Acting), Tiger 90CR® Organic Sulphur 90% (slow-release)

Calcium (Ca): Calcium regulates how the plants absorb nutrients. It is essential for cell wall structure, & strength in the plant. Calcium contributes most to thick stems & beefy structure. Proper development of fruits and storage roots are dependent on a constant soil supply of calcium. It plays a role in the functioning of enzymes, is part of the structure of cell walls, helps control the water content of cells, and is necessary for cell growth and division. Some plants must have calcium to take up nitrogen and other minerals.



- Essential part of plant cell wall structure
- Assists in uptake and retention of other nutrients
- Builds strength in the plant
- Counteracts the effect of alkali salts and organic acids within a plant.

Calcium Deficiency: Without a sufficient supply of calcium, plants may display stunted or stopped growth. Other possible symptoms include distorted new growth, black spots on leaves, or yellow leaf margins. Deficiency results in stunting and symptoms include distorted of hook shaped new leaves and leaf tips dying and purplish brown tint. It also contributes to blossom end rot in tomatoes, tip burn of cabbage, and brown hearts in celery.
Organic Sources of Calcium: Bone Meal 32% (Slow-Acting), Kelp 3.5% (Slow-Acting), Rabbit Manure 1% (Slow-Acting), Egg Shells 94% (Slow-Acting), Calcium Carbonate Tablets 1200mg (Drug Store).

Boron (B): Promotes stem and root growth. Boron aids production of sugar and carbohydrates, and is essential for seed and fruit development. It is used in cell wall formation, for membrane integrity within cells, for calcium uptake and may aid in the transfer of sugars between plant parts. Boron affects a variety of plant functions, including flowering, pollen germination, seed development, cell division, water balance, and the movement of hormones. Boron must be available throughout the life of the plant as, like calcium, it is fixed in the plant once absorbed.

- Helps in the use of nutrients and regulates other nutrients.
- Aids production of sugar and carbohydrates.
- Essential for seed and fruit development.

Boron Deficiency: It can lead to stunted or irregular growth, with leaves that are thick, curled and brittle. Roots can become discolored, cracked and covered with brown spots, and/or buds dying at the ends of branches.
Organic Sources of Boron: Kelp = 194 ppm, Rabbit Manure = 78 ppm, Decaying leaves & grass = 68 ppm

Copper (Cu): Copper is primarily used by the plant to fight off fungal diseases, as well as promoting healthy leaves and flowering. Copper is concentrated in roots of plants and plays a part in nitrogen metabolism. It is a component of several enzymes and may be part of the enzyme systems that use carbohydrates and proteins.

- Aids in reproductive growth
- Aids in root metabolism and helps in the utilization of proteins
- Important to fighting Fungal attacks

Copper Deficiency: Symptoms include stunted growth. Leaves can become limp, curl, or drop. It can also cause poor growth, delayed flowering, and plant sterility. It can result in the die back of the tips of new growths which may appear as wilting with leaf tips turning a bluish-green color. In grain-type plants, the tips may become brown and appear as frost damage.
Organic Sources of Copper: Chicken Manure = 332 ppm, Rabbit Manure = 322 ppm,

Chloride (Cl): Plants require relatively high chlorine concentration in their tissues. Chloride is very abundant in soils, and reaches high concentrations in saline areas, but it can be deficient in highly leached inland areas. It is also involved in osmosis, the balance necessary for plants to take up mineral elements and in photosynthesis.

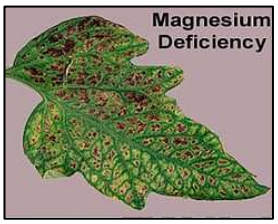
Chloride Deficiency: The most common symptoms are chlorosis and wilting of the young leaves. The chlorosis occurs on smooth flat depressions between the veins of the leaf blade. In more advanced cases there often appears bronzing on the upper side of the mature leaves. Plants are generally tolerant of chloride, but some species such as avocados, stone fruits, and grapevines are sensitive to chloride and can show toxicity even at low chlorine concentrations in the soil.

Iron (Fe): An adequate supply of soluble iron in the plant nutrient also inhibits the formation of phenol compounds, which can kill roots. It is necessary for enzyme functionality and is important for the synthesis of chlorophyll. It is essential for young, actively growing tissues.

- Essential for formation of chlorophyll
- Absorption is blocked at a pH between 5.0 and 6.5

Iron Deficiency: Shows leaves with some green netting. The most common symptom for iron deficiency starts out with yellowing of the youngest leaves, evolves into an overall chlorosis, and ends as a totally bleached leaf. The bleached areas often develop spots. Up until the time the leaves become almost completely white they will recover upon application of iron. In the recovery phase the veins are the first to recover as indicated by their bright green color. This distinct venial re-greening observed during iron recovery is probably the most recognizable symptom in all of classical plant nutrition. Because iron has a low mobility, iron deficiency symptoms appear first on the youngest leaves. Iron deficiency is strongly associated with calcareous soils and anaerobic conditions, and it is often induced by an excess of heavy metals.
Organic Sources of Iron: Rabbit Manure = 2240 ppm, Chicken Manure = 1950 ppm, Kelp = 896 ppm.

Magnesium (Mg): Magnesium is a critical structural component of the chlorophyll molecule and is necessary for functioning of plant enzymes to produce carbohydrates, sugars and fats.



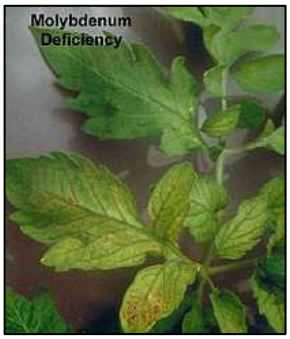
Magnesium Deficiency: It may superficially resemble potassium deficiency. In the case of magnesium deficiency the symptoms generally start with mottled areas developing between the veins of the leaves, expanding eventually producing a raised puckered surface. In some plants such as the Brassica, tints of orange, yellow, and purple may also develop.
Organic Sources of Magnesium: Epsom Salt is great for plants because it is primarily comprised of 99% Magnesium. Rabbit Manure = 0.4 % (4000 ppm)

Manganese (Mn): Manganese is essential for photosynthesis, & activates enzymes needed for growth. It is also critical to blossoming.

- Necessary for breakdown of carbohydrates
- Required for metabolism of Nitrogen
- Absorption is blocked at a pH between 5.0 and 6.5

Manganese Deficiency: Symptoms include slow growth, with younger leaves turning pale yellow between the veins. Older leaves are mottled over the entire surface. Leaves eventually develop dark or dead spots. It also may cause failure to bloom, and reduced fruiting and fruit size.
Organic Sources of Manganese: Rabbit Manure = 290 ppm, Chicken Manure = 277 ppm, Kelp = 35 ppm.

Molybdenum (Mo): Molybdenum is used by the plant to convert nitrates to a form that the plant can absorb and convert to energy. It is a structural component of the enzyme that reduces nitrates to ammonia. Without it, the synthesis of proteins is blocked and plant growth ceases. Seeds may not form completely, and nitrogen deficiency may occur if plants are lacking molybdenum. Legumes need more molybdenum than other crops because the symbiotic bacteria living in the root nodules of legumes require molybdenum for the fixation of atmospheric nitrogen.



Molybdenum Deficiency: Symptoms include older leaves turning yellow or light green. Leaves can become narrow and distorted. Sometimes it is confused with nitrogen deficiency.
Organic Sources of Molybdenum: Kelp = 16 ppm

Zinc (Zn): Zinc is a component of enzymes or as an important aid in the functioning of them, especially auxins, the plant growth hormones. It is essential to carbohydrate metabolism and protein synthesis.
Zinc Deficiency: A symptom is the stunted growth of leaves, commonly known as "little leaf" and leaf ends may form a rosette.

Other Micro-Nutrients include Nickel (Ni), Sodium (Na), Cobalt (Co), and Silicon (Si),

Ph of Soil: Ph is not a nutrient, but it has significant effect on the plants ability to absorb nutrients. Each vegetable has an optimum Ph. For Tomatoes and Peppers, the optimum Ph is 6.5. For Tomatoes, Nitrogen absorption is blocked at ph levels of 4.0- 5.5. Potassium is absorbed best in soil at a ph level of 6.0 to 7.5, while anything out of this range will contribute to a Potassium or Phosphorus deficiencies. Iron and Manganese are blocked at pH below 5.0 and above 6.5.

Diagnosing Nutritional problems: There is no clear-cut checklist of symptoms that can diagnose deficiencies. The nutrients and micro-nutrients are so interrelated that the task becomes next to impossible. The best way to diagnose nutrient deficiencies is with a soil test performed by your local Cooperative Extension. In most cases, the test costs about $10. The results will be provided in parts per million (ppm) and listed as low-acceptable-high.