Fertilizers for Bonsai

By Mark Wallerich

Plants Fertilizer Nutrients and What They Do -

Fertilizers typically contain nutrients that help plants grow, including: Nitrogen (N), phosphorus (P), and potassium (K). These are the main nutrients in fertilizers, and are known as macro-nutrients. They are the building blocks of plants and make up most of what is in fertilizer.

Calcium (Ca), magnesium (Mg), and sulfur (S) are secondary nutrients, meaning that most plants need them in smaller amounts.

The micro nutrients are: Iron (Fe), Boron (B), Copper (Cu), Manganese (Mn), Zinc (Zn), Chlorine (Cl), Cobalt (Co), Molybdenum (Mo), Sodium (Na), and Nickel (Ni) in tiny amounts.

- ## Macro nutrients -

Nitrogen (N) - Nitrogen (Ammonium nitrate, urea, ammonium sulfate) is a major component of proteins, hormones, chlorophyll, vitamins and enzymes essential for plant life. Helps plants grow green leaves, and develop all parts of the plant. Nitrogen forms a part of Chlorophyll and is mainly absorbed through the roots.

Phosphorus (P) – Phosphorus (Calcium phosphate, ammonium phosphate) helps form roots, flowers, and fruit, and is needed for cell division.

Potassium (K) – Potassium (Potassium chloride) helps plants with many chemical processes, builds strong stems, resistance to pests and overall vigor. A major component in developing strong roots and pest resistance.

- ## Secondary Nutrients -

Calcium (Ca) - Calcium is an important structural component of cell walls which gives plants rigidity. It is necessary for cell growth and division, and influences water movement in cells. Calcium is essential for root health, growth of new roots and root hairs, and the development of leaves.

Magnesium (Mn) - Magnesium constitutes the core of the chlorophyll molecule and is therefore essential for photosynthesis. This makes it an indispensable element for plant health and growth. Magnesium is essential for photosynthesis and formation of carbohydrates.

Sulphur (S) – Sulfur is a constituent of amino acids in plant proteins and enzymes, and is involved in energy-producing processes in plants. It is also essential for the synthesis of chlorophyll. Sulfur is also used to acidify the soil and break up micro nutrients in the soil for the plant to use. Sulphur is also a good fungicide for the soil, and in a dilute liquid form, can be used as a foliage fungicide.

- ## Micro Nutrients -

Iron (Fe) – Iron is necessary for the formation and maintenance of chlorophyll in plants. It is also involved in cell division that supports plant growth.

Boron (B) - Boron is necessary for cell wall formation, membrane integrity and calcium uptake. It assists in the translocation of sugars.

Copper (Cu) - Copper is involved in nitrogen and carbohydrates metabolism. It is a component of several enzymes. Copper is essential for proper photosynthesis and to the strengthening of a cell wall. Copper is also used as a fungicide.

Manganese (Mg) - Manganese is essential for photosynthesis, nitrogen metabolism, and respiration. Manganese functions primarily as part of enzyme systems and activates several important metabolic reactions. It improves green color and increases sugar and protein content.

Zinc (Zn) - Zinc is an essential element which helps in photosynthesis, energy production and regulation of growth.

Chlorine (Cl) - Chlorine is important for plant photosynthesis as it is involved in the opening and closing of stomata (pores in leaves) that enable plants to take in and use carbon dioxide.

Cobalt (Co) - Cobalt helps with stem growth, leaf expansion, and healthy bud development. Cobalt helps plants absorb nutrients like nitrogen, phosphorus, and potassium and helps faster recovery from plant stress. It is the center element of vitamin B-12 (Cyanocobalamin, $C_{63}H_{88}CoN_{14}O_{14}P$) a vital antioxidant and growth regulator in plants.

Molybdenum (Mo) - Molybdenum is required for the synthesis and activity of the enzyme nitrate reductase. Molybdenum is used for pollen formation and is also responsible for nitrogen fixation.

Sodium (Na) - In trace quantities, aids plant metabolism and chlorophyll production.

Nickel (Ni) - Nickel is important in plant Nitrogen metabolism because it is a component of the urease enzyme which helps metabolize urea nitrogen into usable ammonia. Important component for enzymes that help synthesize amino acids.

Chlorophyll and Wood Composition -

Chlorophyll A is $C_{55}H_{72}MgN_4O_5$ (basic formula for Chlorophyll). So the Carbon (C) mostly comes from the Carbon Dioxide (CO_2) that the leaves absorb. Hydrogen (H) would mostly come from the water. Magnesium (Mg) would come from the soil or fertilizer and is vital for the formation of Chlorophyll. Nitrogen (N) would come from the soil or fertilizer. The Oxygen (O) would come from the soil through the roots (which is why you need porous soil).

Wood is primarily composed of three main organic polymers: cellulose, hemicellulose, and lignin which together are called lignocellulose. Wood also contains small amounts of other organics, which contribute to its color, smell, and other properties depending on the wood species. Overall, dry wood has an elemental composition of about 50% carbon, 6% hydrogen, 44% oxygen, and trace amounts of inorganics.

Fertilizers Brands and Compositions Investigated -

- Biogold Bonsai Fertilizer - N 5.5%, P 6.5%, K 3.5%, S .5%, Fe .12%, Co 50 mg/kg, Mo 27 mg/kg
- Bonsai Rapeseed Cake (various brands) - N 5%, P 4%, K 1% (unable to find micro nutrients)
- Arizona's Best Palm Tree Food – N 10%, P 5%, K 10%, Mg 1%, S 14%, Fe 3%, Mn 1%, Zn 1%
- Arizona's Best All Purpose - N 10%, P 10%, K 10%, S 10%, Fe 5%
- Arizona's Best Citrus Food - N 13%, P 10%, K 4%, S 16%, Fe 5%, Mn 1%, Zn .5%
- Arizona's Best Rose Food - N 9%, P 11%, K 3%, Ca 1.5%, Mg 1%, S 13%, Fe 5%, Zn 1%
- Arizona's Best Tree & Shrub Food - N 13%, P 7%, K 7%, S 12%, Fe 1%
- Miracle Grow Rose Food - N 18%, P 24%, K 16%, Cu .05%, Fe .10%, Mn .05%, Zn .05%

- Miracle Grow Bloom Buster - N 15%, P 30%, K 15%, B .02%, Cu .07%, Fe .15%, Mn .05%, Mo .0005%, Zn .08%
- Miracle Grow All Purpose - N 24%, P 8%, K 16%, B .02%, Cu .07%, Fe .15%, Mn .05%, Mo .0005%, Zn .06%
- Miracle Grow Azalea/Camellia - N 30%, P 10%, K 10%, B .02%, Cu .07%, Fe .325%, Mn .05%, Mo .0005%, Zn .07%
- Miracle Grow Miracid - N 30%, P 10%, K 10%, B .2%, Cu .5%, Fe 3%, Mn .46%, Mo .05%, Zn .5%
- Osmocote Indoor/Outdoor Plus - N 15%, P 9%, K 12%, Mg 1.3%, S 6%, B .02%, Cu .05%, Fe .46%, Mn .06%, Mo .02%, Zn .05%
- Vigoro Citrus & Avocado Food - N 6%, P 4%, K 6%, Mg 1%, S 6%, B .02%, Cu .05%, Fe 1%, Mn .05%, Mo .0005%, Zn .05%
- Bayer/BioAdvanced 3 in1 Rose food - N 9%, P 14%, K 9%, S 2%, Tebuconazole .80%, Imidacloprid .15% (fungicide and Insecticide)
- Superthrive – N 0.5%, P 0%, K 0%, 0.09% Vitamin B1 from Thiamine Hydrochloride (aka. Thiamine $C_{12}H_{17}N_4OS+$)

Plants Needing Acidic Soil/Fertilizer –

Plants Needing Acidic Soil/Fertilizer would benefit from some added organic material in the soil (about 10% if the roots have been washed at replanting) and/or additional Sulphur.

Basic to Mildly Acidic soil or nutrients –

Trees: Pin oaks, magnolias, dogwoods, and some conifers such as pines, spruce, and yews (investigate what is the native soil and the Ph. to be sure; many junipers grow in a neutral soil). Many different Ficus', Bougainvillea, Lavender Star Flower, Japanese Boxwood, Lantana, Star Jasmine, and many other tropicals.

More Acidic soil or nutrients –

Azaleas, Rhododendrons, Camellia, Water Jasmine, gardenia, hibiscus, and holly.

Analysis for Bonsai Use -

- Arizona's Best fertilizers have a lot of Sulphur, some Iron, and several micro nutrients and is designed for organically poor soil like the desert area of Arizona (and like the PBS std. soil mix). But with a lot of watering, only lasts about a month or so before needing to refertilize the plant again.
- Miracle Grow fertilizers does not contain any Sulphur, but does carry many micro nutrients and is mostly designed for organic soils like standard potting soil which is more acidic.
- Osmocote has most of the micro nutrients that a plant needs and does last 2 to 3 months or more on bonsai soil, but after the nutrients are gone you are left with a lot of little water filled balls.
- Vigoro Citrus & Avocado Food or many of the Vigoro plant foods has a lot of the micro nutrients that a plant needs and can be used for organically poor soil (like the PBS std. soil mix). But with a lot of watering, only lasts about a month or so before needing to refertilize the plant again.
- Bonsai Rapeseed Cake has a tendency to promote root rot if you water too much. The cakes also attracts wildlife (birds, squirrels, packrats, etc.) that likes it as food. Also, it is low on potassium and can hinder development of many chemical processes, weaken stem development and make the plant prone to pests. It does last for 3 or more months.

- Biogold Bonsai Fertilizer is made of composted fish meal and rapeseed meal, it does last 2 to 3 months or more on bonsai soil and has several micro nutrients that the plant needs. The only down side is that it does not have all the micro nutrients that the plant needs and it is expensive.
- Bayer/BioAdvanced 3 in1 Rose food only carries the basic NPK nutrients but does have systemic fungicide and Insecticide to protect the plant from many insects and diseases. Not very compatible with Elm trees.
- (In Bayer/BioAdvanced 3 in1 Rose food) Tebuconazole ($C_{16}H_{22}ClN_3O$) is a broad-spectrum fungicide that's effective against many types of fungi. It works by stopping fungi from spreading spores, which slows their growth. Tebuconazole helps plants deal with abiotic stresses like drought, salt, heat, and chilling stress.
- (In Bayer/BioAdvanced 3 in1 Rose food) Imidacloprid ($C_9H_{10}ClN_5O_2$) is a synthetic, systemic insecticide that is used to control a variety of insects and pests. Imidacloprid is a neonicotinoid, which is a class of insecticides that mimic nicotine and is toxic to insects. It works by activating nicotinic receptors in the nervous system, causing nerves to fire continuously until they fail. Imidacloprid can affect insects on contact or through ingestion.
- Superthrive is excellent for preventing stress in plants due to repotting or excessive heat. It is a non-toxic vitamin solution that encourages the natural building blocks a plant needs while under the best conditions, fortifying growth from the inside out.
- Also note that none of the fertilizers have Nickel in them so the plant will have to obtain nickel by other means to metabolize urea nitrogen.

Conclusion and Recommendations –

- It is recommended to alternate between several different fertilizers to insure the bonsai gets the nutrients that it needs for proper growth and health.
- For any soil mix used, the soil must be sifted (dry) to remove any particles smaller than 1/16 inch.
- If you are repotting a plant and not washing the roots after combing them out and trimming them, then this should be enough organic material for the bonsai.
- Several of the non-traditional fertilizers (for bonsai) that can be used for bonsai will work very well and is recommended. There are a lot of other fertilizers out there that could be used, but pay attention to the ingredients and the micro nutrients to insure you bonsai gets all the nutrients that it needs for growth and plant health.
- If you wish to use a traditional bonsai fertilizer, then using Biogold Bonsai Fertilizer is recommended, but it does need to be augmented occasionally with a light sprinkling of Arizona's Best, Vigoro or Osmocote to provide the bonsai with all the micro nutrients it needs.
- If you are using Miracle Grow fertilizers, it is recommended to fertilizing ½ to ¼ strength every week or every other week, but if you are using a full inorganic soil mix (like the PBS std. soil mix), augment fertilizing by adding a light sprinkling of Sulphur and Iron, or possibly Arizona's Best, Vigoro or Osmocote.
- For plants needing acidic soil/fertilizer and if the roots have been washed at replanting and if you are using an inorganic soil mix like the PBS mix, it is recommended to use primarily Arizona's Best fertilizer alternated with Vigoro or Osmocote.
- Sulphur, because of its acidic tendencies, is also beneficial in releasing micro nutrients from both organic and inorganic soils.
- If you are concerned with protecting the plant from many insects and diseases, you can use the Bayer/BioAdvanced 3 in1 Rose food along with other fungicides and Insecticides. Note that it is not very compatible with Elm trees and you must investigate what fungicides/Insecticides is compatible with your specific plant. It does work fairly well with Bougainvillea.

- ❖ It is recommended to use Superthrive at repotting and occasionally during the hot days of summer to help prevent stress in the plants.
- ❖ All of the conclusions and recommendations are based upon the data herein and many years of observation.
- ❖ Also see **James McEown's** presentation – **Fertilizer, Soil, and Pest Control – 10/12/2014**, on the PBS website at Resources => Lecture/Workshops

Element Abbreviations –

N = Nitrogen	P = Phosphorous	K = Potassium	Fe = Iron
Mn = Manganese	Zn - Zinc	Cu = Copper	Mo = Molybdenum
B = Boron	Mg = Magnesium	Ca = Calcium	S = Sulphur
H = Hydrogen	O = Oxygen	Cl = Chlorine	Co = Cobalt
Ni = Nickel	Na = Sodium		

General Plant Nutrients needed –

TABLE 1: Form, source, mode of uptake and major functions of the 16 plant essential nutrients.

Nutrient family	Nutrient	Percentage of plant	Form taken up by plants (ion)	Mode of uptake	Major functions in plants
Primary	Carbon	45	Carbon dioxide (CO_2), bicarbonate (HCO_3^-)	Open somates	Plant structures
	Oxygen	45	Water (H_2O)	Mass flow	Respiration, energy production, plant structures
	Hydrogen	6.0	Water (H_2O)	Mass flow	pH regulation, water retention, synthesis of carbohydrates
	Nitrogen	1.75	Nitrate (NO_3^-), ammonium (NH_4^+)	Mass flow	Protein/amino acids, chlorophyll, cell formation
	Phosphorus	0.25	Dihydrogen phosphate ($H_2PO_4^-$, HPO_4^{2-}), phosphate (PO_4^{3-})	Root interception	Cell formation, protein syntheses, fat and carbohydrate metabolism
	Potassium	1.5	Potassium ion (K+)	Mass flow	Water regulation, enzyme activity
Secondary	Calcium	0.50	Calcium ion (Ca^{2+})	Mass flow	Root permeability, enzyme acitivity
	Magnesium	0.20	Magnesium ion (Mg^{2+})	Mass flow	Chlorophyll, fat formation and metabolism
	Sulfur	0.03	Sulfate (SO_4^{2-})	Mass flow	Protein, amino acid, vitamin and oil formation
Micro	Chlorine	0.01	Chloride (Cl^-)	Root interception	Chlorophyll formation, enzyme activity, cellular development
	Iron	0.01	Iron ion (Fe^{2+}, Fe^{3+})	Root interception	Enzyme development and activity
	Zinc	0.002	Zinc ion (Zn^{2+})	Root interception	Enzyme activity
	Manganese	0.005	Manganese ion (Mn^{2+})	Root interception	Enzyme activity and pigmentation
	Boron	0.0001	Boric acid (H_3BO_3), borate (BO_3^{3-}), tetraborate (B_4O_7)	Root interception	Enzyme activity
	Copper	0.0001	Copper ion (Cu^{2+})	Mass flow	Enzyme activity
	Molybdenum	0.00001	Molybdenum ions ($HMoO^{4-}$, MoO_4^{2-})	Mass flow	Enzyme activity and nitrogen fixation in legumes

References –

The fertilizer Institute - https://www.tfi.org/why-fertilizer/intro-to-fertilizer/nutrient-science/

Wikipedia - https://en.wikipedia.org/wiki/Plant_nutrition

PDF Essential Nutrients for Plants by TL Provin - https://texaslocalproduce.tamu.edu/files/2018/07/Essential-Nutrients-for-Plants.pdf

American Chemical Society – Chlorophyll, January 21, 2019

Phoenix Bonsai Society Website information.

MSDS (Material Safety Data Sheet) for several of the fertilizers and Superthrive.

Bonsai Outlet website – Contents of Biogold Bonsai Fertilizer and the bag information.

Fertilizers Brands and Compositions compiled from the bag contents and looking up the bag contents.

Individual plant requirements searches, including but not limited to tropical plants and native area soil conditions for the specific plants.

Google AI Overview generation with “fertilizer”, “Wood Composition”, “Plants Needing Acidic Soil/Fertilizer”, “what is Tebuconazole”, and “what is Imidacloprid” searches.

Many years of trial and error in growing bonsai (mostly learning from error) and discussions with long time members.