

PRINCIPAL MINERAL NUTRIENTS OF GRAPEVINES

Mineral nutrition is the base for proper metabolic and physiological processes through the grapevines growth and fruit production. There are two major groups of nutrients; macro-nutrients and micro-nutrients.

The macro-nutrients are all the minerals utilized in large amounts and they have higher quantities in the tissue, which are expressed as a percentage (%) of fresh or dry weight. The macro-nutrients are: nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg) and sulphur (S). In the case of micro-nutrients, these are used in lower quantities in compared to macro-nutrients, therefore, their content is expressed in parts per million (ppm). The most relevant micro-nutrients are: zinc (Zn), manganese (Mn), iron (Fe), copper (Cu) and boron (B). The interaction of all these minerals has an impact on the vineyard's development through the season and consequently an impact on wine quality.

To have healthy vines with good nutrient balance, it is essential to have knowledge of the nutritional status of the vineyard, and then to detect and correct any potential nutritional imbalance. The information about nutritional status of vines allows us to improve nutrient absorption, to avoid a deficit or excess of nutrients in the grapevines, and to plan the correct fertilization calendar with a focus on quality, and with respect to the environment.

This document summarizes the main nutrients, with an explanation of their role, symptoms of their deficiencies, the effect of excess and how these interactions can affect the growth and productivity of grapevines.

Macro-nutrients

Nitrogen (N)

Why is Nitrogen important?

- It is the most relevant nutrient for the development and metabolism of the plant, which impacts photosynthesis, fruit-set and cluster initiation.
- N is very important in the development of new vineyards, for promoting rapid growth of the vines.
- Adequate N increases fruit set, yield and quality, and improves berry color and consequently wine quality.
- N is highly mobile in the plant and has medium-high mobility in the soil.

N Deficiency Symptoms:

- Overall reduction in growth; berries are small.
- Reduced vigor and growth; distance between nodes is short.
- Leaves become uniformly light green or yellow and their size is smaller.
- From véraison onwards the leaves become red in the veins and petioles. In some cases even the stem of bunches will turn red, regardless of the cultivar.
- Leaf senescence starts earlier in the season.
- Low levels of nitrogen in grape vines cause lower levels of yeast assimilable nitrogen (YAN) for winemaking.
- Deficiency has to be quite severe to cause observational changes in the grapevines.

N Excess Symptoms:

- High growth and vigor, the canopy becomes dense with many layers of leaves.
- Shoot growth can finish very late, which can cause problems for controlling the vineyard development.
- Leaves with bigger size, with a very intense green color.
- It may be necessary to spend more hours on leaf thinning and more applications of fungicide may be needed.
- Very compact grape bunches; berries will be very big and some bunches will have missing berries.
- Berries will have an unnecessary excess of YAN and high amounts of N, which can cause a higher incidence of botrytis.



Phosphorus (P)

Why is Phosphorus important?

- It is important for flower and fruit formation.
- P plays a structural role in cell membranes and a part in photosynthesis.
- It is very important for vine establishment and root growth.
- Adequate levels of P lead to healthy green foliage and improved plant quality.
- Phosphorus has low mobility in the soil, and high mobility in the plant.

P Deficiency Symptoms:

- Vines have stunted shoots, lower fruitfulness and fruit set is poor.
- It can produce poor bud initiation at the beginning of the season.
- Reduced number of leaves produced.
- The most notable deficiency in leaves is the yellowing of the interveinal area of basal leaves.
- In extreme cases red dots can appear on basal leaves. The dots then become more linear and line up at right angles to the secondary veins and form dark red bars, which form into large blotches between green veins.
- Some of these symptoms can be confused with leafroll virus, but phosphorous symptoms occur earlier in the growing season (at bloom).
- It can produce a change in root growth pattern, increasing the root-shoot ratio.



The photo on the left shows the deficiency with yellow interveinal color and the one on the right shows an extreme case of the deficiency.

P Excess Symptoms:

- An excess of phosphorous can limit the uptake of other elements, for example Zinc.

Potassium (K)

Why is Potassium important?

- Vines remove a large amount of potassium from the soil.
- Most of the potassium is removed through the fruit.
- Potassium is crucial between blooming and véraison.
- It is an important and relevant component of grape juice (must) and wine.
- Potassium acts as an antifreeze when applied at the proper rates and leads to successful overwintering of grape vines.
- Potassium has low-medium mobility in the soil and high mobility in the plant.

K Deficiency Symptoms:

- Begins as yellowing (white grape varieties) or reddening (red grape varieties) of the margins of older leaves.
- As the deficiency worsens, leaf margins become necrotic, curl upwards and inter-vein chlorosis develops.
- Other symptoms are: reduced bunch weight, uneven berry ripening and even blackening of leaves.



Both photos show deficiencies of potassium; the left one is in a white variety and the right one in a red variety.

K Excess Symptoms:

- Excessive K in the soil can cause high levels of potassium in the berry juice, resulting in an increase of the must pH, which may cause troubles with color and stability of the wine.
- Increasing the K concentration can cause a reduction in the concentration of nitrogen and magnesium levels.
- An excess of K can cause a reduction of uptake of calcium and magnesium.

Magnesium (Mg)

Why is Magnesium important?

- Combats chlorosis giving healthier green foliage.
- Increases sugar level in berries.
- Prevents and controls grape stem necrosis.
- Excessively high levels of magnesium may limit the uptake of potassium.
- Magnesium has low mobility in the soil and high mobility in the plant.

Mg Deficiency Symptoms:

- The symptoms are similar to potassium deficiencies, but in this case the symptoms appear at véraison in the basal leaves.
- Plants with deficiencies are particularly light sensitive, which may be more obvious in leaves with sun exposure.
- White varieties – bright yellow wedge shaped areas extend inward between the veins on older leaves.
- Red varieties – red wedge shaped areas extend inward between the veins on older leaves.
- It can interrupt root growth.
- Can lead to fruit cluster stem necrosis and berry withering.



Calcium (Ca)

Why is Calcium important?

- Improved berry quality.
- Reduction of grape stalk necrosis.
- Improved berry firmness and storage potential.
- Calcium has low mobility in the soil and the plant.

Ca Deficiency Symptoms:

- Grapes turn brown and dry out.
- Diminishes elasticity of the grape berry skin and potentially produces issues when the fruit begins to expand, increasing the incidence of botrytis damage.
- Reduction in root size and consistency.
- Calcium deficiency is worse in acidic soils, sandy soils (leaching), soils rich in Na and Al, during drought conditions, and when the crop is too large.



Sulfur (S)

Why is Sulfur important?

- Sulfur is present in proteins and chlorophyll.
- Plays a role in energy metabolism.
- Sulfur plays a significant role in the control of plant pathogens and mites; it is usually sprayed on a regular basis in vineyards.
- Sulfur has moderate mobility in the soil and low-medium mobility in plants.

S Deficiency Symptoms:

- Typically they are fairly rare, but they are similar to the symptoms of nitrogen deficiency.

Micro-nutrients

Boron (B)

Why is Boron important?

- Improves flowering.
- Improves fruit set.
- Gives more even ripening.
- Boron has high mobility in the soil and low-medium mobility in the plants.

B Deficiency Symptoms:

- It can produce shortened internodes which create very crooked zig-zag cane shoots. Shoot tips may die and there may be interveinal chlorosis of older leaves.
- Only a few seeded berries set, most berries remain small and seedless. This is commonly referred to as 'hen and chicken' disease.
- Deficiency first appears as chlorosis on leaf margins and extends between the veins. Later, leaf margins show red brown color and die off.
- Boron deficiency is one of the most serious nonparasitic grapevine disorders. It is most common on highly acidic soils.



Copper (Cu)

Why is Copper important?

- Copper is used as a fungicide treatment on grapevines.
- Levels must be monitored so as to not cause contamination in the must.
- Copper has low mobility in the soil and plants.

Cu Deficiency Symptoms

- Deficiencies are very rare; it is more possible to have toxicity for accumulation of Cu in the top soil as consequence of fungicide use.
- Poor vine growth and yield.
- Small pale colored leaves with small indentations.
- Deficiencies are more common in young vineyards which haven't been exposed to fungicide sprays.



Iron (Fe)

Why is Iron important?

- Combats chlorosis, creating green foliage.
- Iron is important in the synthesis of chlorophyll
- Iron has low mobility in the soil and the plant.

Fe Deficiency Symptoms:

- Symptoms always begin on the youngest leaves with yellow green, and later, pale yellow interveinal chlorosis; the main veins remain green.

- Severe deficiency produces symptoms on older leaves and entire shoots too.
- Iron deficiency is usually uncommon because most soils contain enough iron to meet the growing requirement.



Fe Excess Symptoms:

- To date, excess iron is not known to occur in vineyards.

Manganese (Mn)

Why is Manganese important?

- Combats chlorosis giving healthier green foliage.
- Increases potential alcohol content in berries.
- Increases sugar level in berries.
- Manganese has low mobility in soil and plants.

Mn Deficiency Symptoms:

- Symptoms start on young and fully developed leaves.
- The leaves eventually look like a mosaic; the fine veins will stay green.
- Spots and blotches appear; leaves are smaller than healthy leaves.
- The early stage of deficiency shows symptoms on whole leaf blades.



Zinc (Zn)

Why is Zinc important?

- Promotes healthy green foliage.
- Improved fruit set and development of berries
- Zinc has low mobility in the soil and plants.

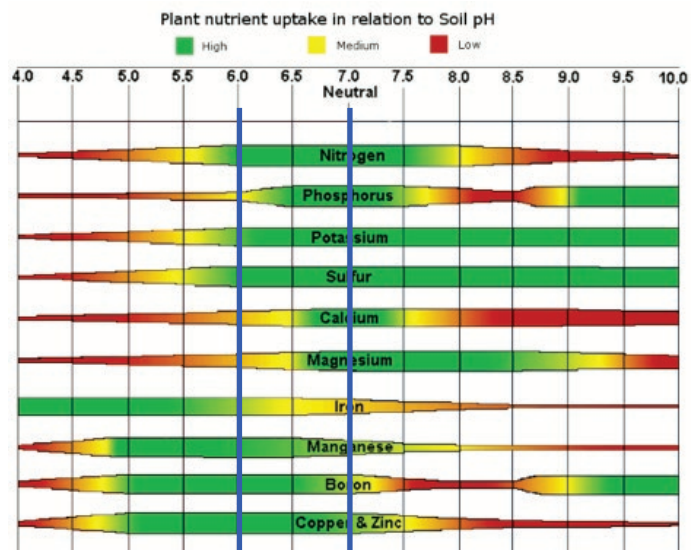
Zn Deficiency Symptoms:

- Appear on young leaves first. A light green mosaic-like chlorosis appears in the interveinal areas and continues to pale over time.
- Along the veins, a dark green border remains.
- The leaf blades are small and asymmetrical; one half of the leaf is always larger than the other.
- The main vein runs in a slight curve with the tip leading towards the small half.



Effect of Soil pH on Nutrients

Soil pH is strongly correlated to nutrient availability for the plant. Having low pH (acidic) can dramatically decrease the effectiveness of nutrient application, causing the applied nutrients to not be available for plant uptake. Alternatively, having a soil pH that is too high (alkaline) can also decrease nutrient availability and cause the soil-plant interaction to be out of balance. The following chart illustrates the plant nutrient uptake in relation to soil pH. The optimum soil pH for grapes is between 6.0 - 7.0.



<https://nutrienttechnologies.com/2017/04/17/manganese-iron-availability/>