Plant Health: Determine Nutrition Deficiency by Observation

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Index

1. Terminology

Chlorosis

In botany, chlorosis is a condition in which leaves produce insufficient chlorophyll. Chlorophyll is responsible for the green color of leaves, **chlorotic leaves are pale, yellow, or yellow-white**. The affected plant has little or no ability to manufacture carbohydrates through photosynthesis and may die unless the cause of its chlorophyll insufficiency is treated.

Reference: wikipedia

Die-back

Dieback, common symptom or name of disease, especially of woody plants, characterized by progressive death of twigs, branches, shoots, or roots, starting at the tips.

Reference: Britannica

Witches' Broom

Figure 1: Witches'-broom on azalea (Rhododendron)

Witches'-broom on loosestrife (Lythrum)

Reference: website

2. Nutrition Deficiency & Symptoms

Nitrogen (N) Deficiency

Slow growth and **uniform yellowing of older leaves** are usually the first symptoms of nitrogen (N) deficiency, **yellowing proceeds to younger leaves**. Nitrogen-deficient plants produce smaller than normal fruit, leaves, and shoots and these can develop later than normal. Visual symptoms (e.g., uniform yellowing of older foliage) strongly suggest nitrogen deficiency.

Reference: nitrogen deficiency

Figure 2: Uniformly yellowish older leaves and greener newer foliage due to nitrogen deficiency.

Figure 3: Yellow leaves especially in older foliage due to nitrogen deficiency.

Figure 4: Nitrogen deficiency in stone fruits causes yellowing and reddening of leaves at top of tree with some red spotting.

Figure 5: leaf necrotic lesion

Figure 6: stem necrotic lesion

Figure 7: vascular browning

Phosphorus (P) Deficiency

Purplish coloration of older leaves in some plants.

Symptoms vary greatly when plants are deficient in phosphorus. In broadleaf plants, **young leaves may be dark green and have purplish veins, especially on the underside of leaves**. **Older leaves can develop an overall purplish tint and tip dieback**. Leaves may be curled, distorted, smaller than normal, or drop prematurely.

In phosphorus-deficient conifers, **foliage on older trees is discolored gray-green or dull blue-green**. With severe deficiency, few or no new needles are produced, and needles die prematurely starting with lower needles and progressing upward.

Reference: phosphorus deficiency

Figure 8: Phosphorus deficiency commonly causes older leaves to curl, distort, and remain smaller than normal.

Figure 9: Unusually purple leaf veins and tip dieback from phosphorus deficiency.

Figure 10: Purpling of leaf undersides due to phosphorus deficiency.

Potassium (K) Deficiency

Leaf margins turn chlorotic and then necrotic. Tip and marginal burn starting on mature leaves. Lower leaves turn yellow. Weak stalks and plant lodge easily.

All palm species are susceptible to potassium deficiency. **Symptoms always appear first in older leaves** and eventually progress into younger leaves, but symptoms otherwise vary among palm species. The most common symptom is **yellow or orangish flecks or spots on older leaves, which appear translucent when discoloring is observed from the leaf underside**. In some species, yellowing begins at the leaf margins or tips and leaves gradually become entirely yellow, then brown and withered.

Potassium deficiency in broadleaves causes **leaves to turn yellow and then brown at the tips and margins and between veins**. **Older leaves are affected first and can entirely discolor, crinkle, curl, roll along edges, or die and drop prematurely**. In potassium-deficient conifers, older foliage turns dark blue-green, progressing to yellow then reddish brown. Needles are often undersized with brown, dead tips.

Reference: potassium deficiency

Figure 11: Yellow stippling of older fronds of queen palm due to potassium deficiency.

Figure 12: Yellow citrus leaves bent at tips and margins due to potassium deficiency.

Figure 13: Cupped edges and bronze to gray discoloration along margins of potassium-deficient pear leaves.

Figure 14: Yellowing between veins of avocado leaves due to potassium deficiency.

Magnesium (Mg) Deficiency

Interveinal chlorosis on older leaves which proceeds to the younger leaves as the deficiency becomes more severe. **The chlorotic interveinal yellow patches usually occur toward the center of the leaf with the margins being the last to turn yellow**. Curling of leaves upward along margins.

Reference: magnesium deficiency

Figure 15: In poinsettia (Euphoria pulcherrima), magnesium (Mg) deficiency symptoms develop in the lower or older leaves as interveinal chlorosis and can work up the plant over time. All photos by W. Garrett Owen, MSU Extension.

Figure 16: In severe instances, magnesium (Mg) deficient poinsettias (Euphoria pulcherrima) will develop interveinal chlorosis and marginal leaf necrosis (death). It is important to correct this disorder when symptoms first appear. Severe leaf symptomology cannot

Calcium (Ca) Deficiency

Light green colour on uneven chlorosis of young leaves. **Brown or black scorching of new leaf tips and die-back of growing points**. Growing points of stems and roots cease to develop. Poor root growth and roots short and thickened.

Reference: calcium deficiency

Figure 17: The older, larger leaves just above the bottommost ones will show the first symptoms. Yellow/brown spots occur, which are often surrounded by a sharp brown outlined edge.

Figure 18: Taken from https://www.ruralsprout.com/calcium-deficiency-plants/

Sulfur (S) Deficiency

Uniform chlorosis first appearing on new leaves.

Sulfur deficiency results in **yellowing of the upper, younger leaves**. Leaf veins may appear lighter in color than the surrounding areas of the leaf. The visual symptoms of a sulfur deficiency are very similar to the chlorosis found in nitrogen deficiency, which can make diagnosis a bit tricky. To decipher between the two, take note of where the discoloration is occurring.

Reference: sulfur deficiency

Figure 19: Sulfur Deficiency: Pale yellow leaves that are often smaller than normal

Reference: sulfur deficiency in potatoes

Iron (Fe) Deficiency

Interveinal chlorosis of new leaves followed by complete chlorosis and or bleaching of new leaves.

Iron deficiency in broadleaves causes young foliage to be **bleached, chlorotic, or pale between distinctly green veins**. Fading appears first around leaf margins, then spreads inward until **only the veins are green on younger foliage**. When severe, young leaves remain undersized, turn almost white, and develop black or brown spots, margins, and tips. Twigs may die-back and leaves may drop prematurely.

In iron-deficient conifers, newer needles are commonly undersized, and the upper canopy becomes chlorotic while older, lower canopy foliage remains green. In iron-deficient palms, new leaves typically are uniformly yellow.

Reference: iron deficiency

Figure 20: Yellowing between veins indicates iron or manganese deficiency.

Figure 21: Severe iron deficiency yellows leaves except for distinctly green veins.

Figure 22: Sweetgum with iron deficiency (left) compared to a healthy leaf.

Figure 23: Iron deficiency in younger leaves of toyon.

Figure 24: Premature leaf drop and twig dieback due to severe iron deficiency from adverse soil conditions.

Zinc (Zn) Deficiency

Interveinal chlorosis of new leaves with some green next to veins. Short internodes and small leaves. **Rosetting or whirling of leaves**.

In broadleaves mildly deficient in zinc, **leaves are uniformly yellowish or pale between the veins and may develop dead spots**. Symptoms are usually most apparent on new foliage in the spring. Severely deficient plants bloom and leaf out late, sometimes several weeks later than normal. When buds open, leaves are atypically pointed, narrow, undersized, and yellowish. Internodes are often shortened, resulting in tufts of leaves (**rosettes, or witches' brooms**). Older leaves may drop prematurely. Symptoms of zinc deficiency commonly resemble those of iron deficiency, manganese deficiency, or herbicide phytotoxicity from exposure to glyphosate or preemergence herbicides.

Zinc-deficient conifers have undersized, yellowish needles that may drop prematurely. When plants are severely affected, branches are undersized and may die-back.

Reference: zinc deficiency

Figure 25: Zinc deficiency in citrus leaves, severe to mild (left to right).

Figure 26: Small, yellowish almond leaves in tufts due to zinc deficiency.

Figure 27: Lateral buds developing slower than terminal buds and narrow, stiff leaves indicate zinc deficiency.

Manganese (Mn) Deficiency

Interveinal chlorosis of new leaves with some green next to veins and later with grey or tan necrotic spots in chlorotic areas.

In manganese-deficient palms new leaves are uniformly chlorotic with necrotic streaks. Younger leaves remain smaller than older fronds. As manganese deficiency worsens, emerging new leaves and older leaves become distorted, necrotic, and withered, giving palm canopies a scorched, shriveled, undersized appearance.

Manganese deficiency in broadleaves causes new leaves to be yellow to whitish with relatively wide, green areas along the veins. On severely affected leaves, brown dead spots develop between veins. Leaf margins may become crinkled, curled, or wavy, and shoot growth can be reduced.

In conifers, manganese deficiency symptoms closely resemble iron deficiency. New needles are stunted and chlorotic, while older, lower-canopy foliage remains green.

Reference: manganese deficiency

Figure 28: Wide yellowish areas between green veins in manganese-deficient maple leaves.

Figure 29: Yellowing between veins of manganese-deficient avocado leaves.

Copper (Cu) Deficiency

Interveinal chlorosis of new leaves with tips and edges green, followed by veinal chlorosis. Leaves at the top of the plant wilt easily followed by **chlorotic and necrotic areas in the leaves**. Dieback of terminal shoots in trees.

Reference: copper deficiency

Figure 30: Necrotic spots and chlorotic patches on mature leaves.

Boron (B) Deficiency

Death of terminal buds, causing lateral buds to develop and producing a 'witches broom' effect.

Twisted growth of the leaf tips. Curled or wrinkled new leaves. Death of the growing tips.

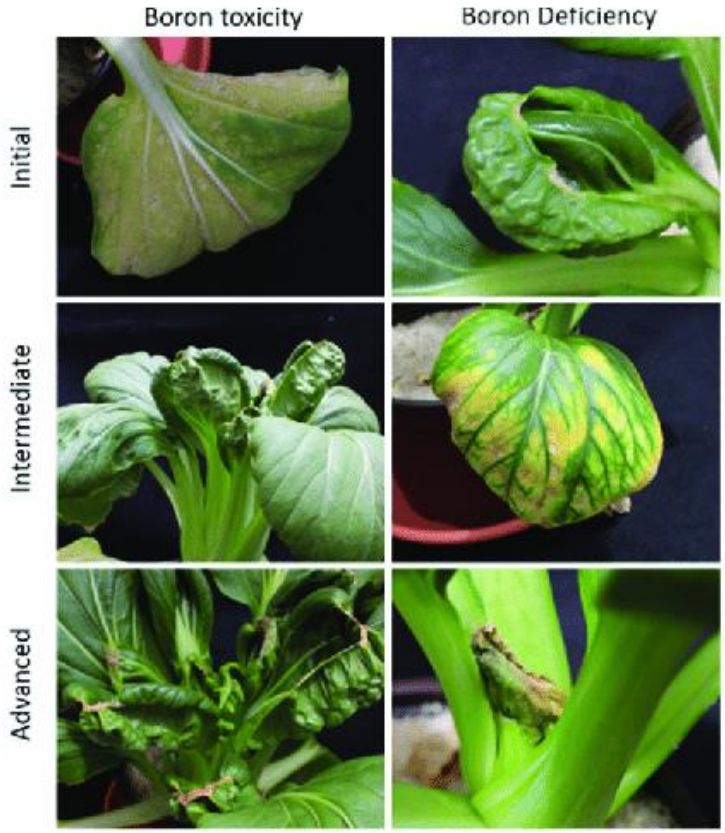


Figure 31: 'Black Summer' boron toxicity and deficiency symptoms for initial, intermediate, and advanced stages. Symptoms of Boron toxicity were initially expressed 35 days after transplant, and boron-deficiency symptoms were observed 21 days after transplant.

Reference: boron deficiency

Reference: boron toxicity

Molybdenum (Mo) Deficiency

Older leaves show interveinal chlorotic blotches, become cupped and thickened. **Chlorosis continues upward to younger leaves as deficiency progresses**.

Figure 32: Early signs of molybdenum deficiency in sunflower are seen as paleness of the leaves of the affected plant

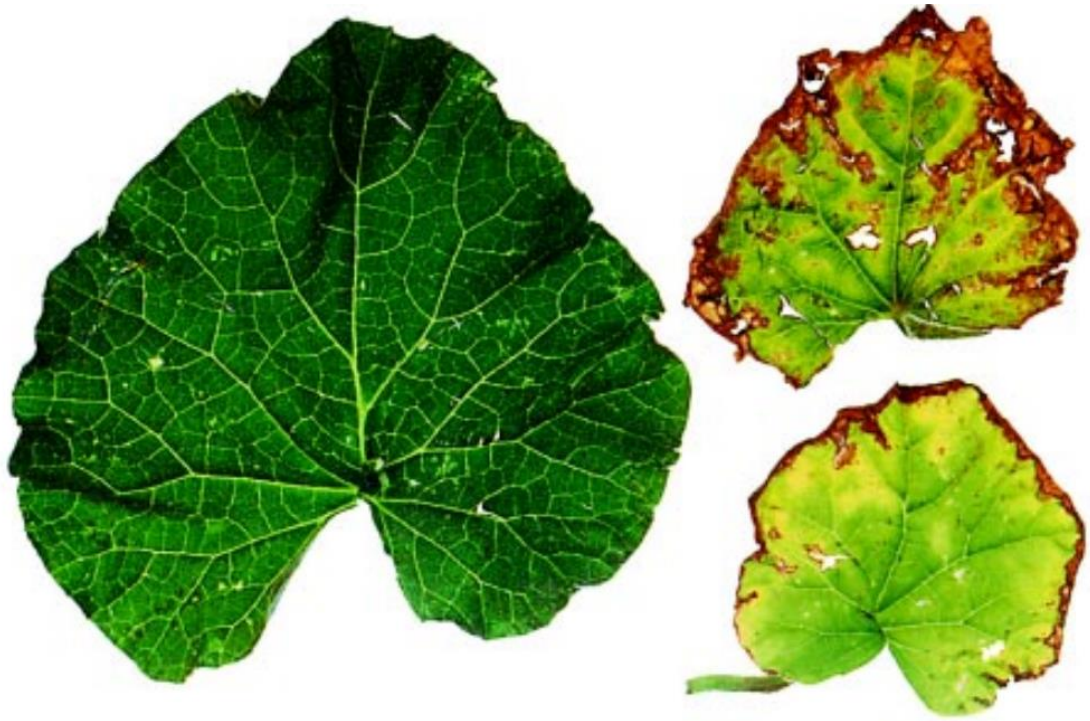


Figure 33: Molybdenum deficiency of rockmelons. Below left: a healthy leaf from a plant treated with sodium molybdate.

Figure 34: A molybdenum deficient rockmelon plant showing pale leaves which have become burnt around the edges and between the veins. This burning develops because a molybdenum deficient plant cannot use the nitrates it takes up from the soil to build proteins. Photo: R. Weir.

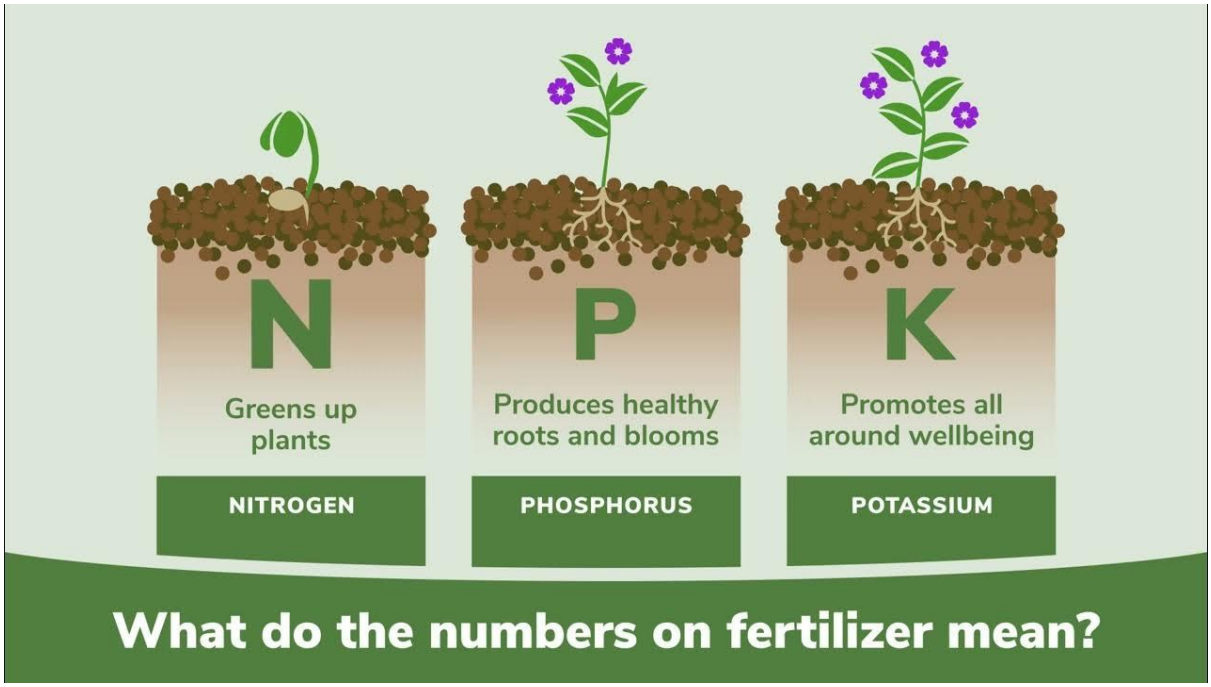
Reference: molybdenum deficiency

3. NPK Fertilizers

NPK fertilizers are three-component fertilizers providing **nitrogen, phosphorus, and potassium**. There exist two types of NPK fertilizers: compound and blends. Compound NPK fertilizers contain chemically bound ingredients, while blended NPK fertilizers are physical mixtures of single nutrient components.

NPK rating is a rating system describing the amount of nitrogen, phosphorus, and potassium in a fertilizer. NPK ratings consist of three numbers separated by dashes (e.g., 10-10-10 or 16-4-8) describing the chemical content of fertilizers. The first number represents the percentage of nitrogen in the product; the second number, P_2O_5; the third, K_2O. Fertilizers do not actually contain P_2O_5 or K_2O, but the system is a conventional shorthand for the amount of the phosphorus (P) or potassium (K) in a fertilizer. A 50-pound (23 kg) bag of fertilizer labeled 16-4-8 contains 8 lb (3.6 kg) of nitrogen (16% of the 50 pounds), an amount of phosphorus equivalent to that in 2 pounds of P_2O_5 (4% of 50 pounds), and 4 pounds of K_2O (8% of 50 pounds). Most fertilizers are labeled according to this N-P-K convention, although Australian convention, following an N-P-K-S system, adds a fourth number for sulfur, and uses elemental values for all values including P and K.

Reference: wikipedia



Youtube: https://www.youtube.com/watch?app=desktop&v=trYLhTCP9jM

4. Parameters to Observe

Chlorosis								
Young Leaves (average %)	Old Leaves (average %)	Entire Plant	Edges of Leaves (average %)	Spots	Tip	Interveinal (Complete)	Interveinal (with some green around veins)	Vein

Leaf Colour		Leaf Condition		Growth		
Deep Green Leaves	Pale Green Leaves	Roll, Curling, Whirling	Flaccid Leaves	Witches' Broom	Stunted Growth	Die-back

Brown/Ash Colour			Red/Purple Colour			
Edges	Spots	Tip	Edges	Spots	Tip	Vein

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