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Plant Nutrient Deficiency and Toxicity Symptoms: A Guide

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Just like humans, plants need nutrients in a sufficient balanced amount to grow, develop and bear fruits. Nutrients play an important role in physiological processes from roots growing to fruiting. If nutrient concentrations are not within the sufficiency range for plants, then the overall growth of the crops will be impaired due to deficiency or toxicity of nutrients. Nutrient deficiency is defined as the state in which there are insufficient levels of a nutrient needed by the growing plant, while toxicity means that the plant has an excess amount of a nutrient. Plant growth and productivity demand the presence of all the necessary nutrients. The importance of these nutrients is that they play different roles in plants physiology, starting from roots growing and ending with flowering and fruiting, so knowledge about these nutrients is the main thing that should be taken into account in order to have successful plant cultivation.

Criteria of Essentiality of Nutrients

As stated by D.I. Arnon and P.R. Stout in 1939, Criteria of essentiality of nutrients is defined as three core criteria for determining whether a mineral element is essential for plant growth:

1. **Life Cycle:** The plant must be unable to complete its vegetative or reproductive life cycle in the absence of the element.
2. **Specificity/Non-replaceability:** The function of the element must not be replaceable by another mineral element.
3. **Direct Metabolism:** The element must be directly involved in plant metabolism (e.g., as a constituent of an essential metabolite or required for an enzyme function).

A total of 17 essential nutrients has been categorised by the scientific community of which there are 9 elements of Macronutrients (Required in amounts greater than 10 mmol kg^{-1} of dry matter) and 8 elements of Micronutrients (Required in amounts less than 10 mmol kg^{-1} of dry matter).

Science of Plant Nutrition

In order for a plant to remain healthy, the plant must maintain itself within its sufficiency range, which is defined as the ideal nutrient concentrations necessary for optimal growth. Deficiency will occur if nutrient levels fall below their optimum; toxicity occurs when nutrient levels exceed their optimum.

Nutrient disorders can be determined by utilizing three key methods:

1. Soil Tests: These determine the nutrient content in the soil.
2. Plant Analysis: These tests determine the actual level of nutrient content in plant tissue.
3. Observation: Recognizing visible symptoms such as yellowing and stunting.

Locating the Problem: Mobile vs. Immobile Nutrients

In order to find out the problem, one needs to consider the site at which the symptoms occur. It depends on the mobility of the nutrient in the plant. Mobile nutrients (N, P, K, Cl, Mg, and Mo) are the type of nutrients that are capable of migrating out of the older leaves into the younger ones where their availability is limited. Since the nutrients are mobile, any signs of

deficiency will be noticed at first in the older or lower leaves and may be either local or widespread. On the other hand, immobile nutrients (Ca, S, B, Fe, Mn, Cu, Zn and Ni) cannot move around from one plant tissue to the other and thus deficiency symptoms will be first noticed at the younger or upper leaves and will be local in nature. This is an exception for zinc (Zn) since it is only partially immobile and thus Zn deficiency symptoms will first show up on middle leaves and then on older and younger ones.

Common Deficiency Symptoms

1. The Macronutrients (The Big Players)

- ✓ Nitrogen (N): Needed in protein and chlorophyll synthesis. Yellowing occurs, first seen on the tips of old leaves. In cereals, it produces characteristic "V" marking from tip towards the midrib.
- ✓ Phosphorus (P): Required for ATP. Plants appear stunted and dark green, with purple to red coloration on old leaves and stems as result of sugar accumulation.
- ✓ Potassium (K): Helps in regulation of water and enzyme activity. It shows as burning of leaf margins on old leaves, with midrib remaining green.
- ✓ Magnesium (Mg): The core of chlorophyll structure. It causes interveinal chlorosis (yellowing between green veins) on old leaves.
- ✓ Calcium (Ca): Cell wall formation. Because of its immobility, deficiencies occur in growing points, producing blossom end rot on tomatoes or black heart on celery.

2. The Micronutrients (Specialists):

- ✓ Iron (Fe): Needed for chlorophyll synthesis. Iron deficiency results in an acute interveinal chlorosis on the younger leaves; the whole leaf will become whitish in case of a severe deficiency.
- ✓ Zinc (Zn): Essential for growth hormones. It is responsible for little leaf (small, tufted leaves) and rosetting (shortened stems).
- ✓ Boron (B): Essential for cell wall formation and reproductive tissue. Shortage causes death of the growing point, hooks in young leaves, and hollow stems in plants such as cauliflower.
- ✓ Manganese (Mn): Involved in photosynthesis. Manganese deficiency results in frizzle top in coconut palms and grey speck in oats.
- ✓ Nickel (Ni): A newly-discovered essential nutrient, needed for urea synthesis. Nickel deficiency is responsible for mouse-ear symptoms in pecan trees; leaflets become small and rounded.

From Deficiencies to Excess: Nutrient Toxicity

Rarely observed but just as dangerous as deficiencies, toxicities are caused by over fertilization and low-quality irrigation water.

•Nitrogen Toxicity: Causes unusually tall and fragile plants that are prone to falling (lodging), thus attracting pests.

•Boron Toxicity: Found in areas of low humidity, it causes burning of leaf tips and edges, causing the trees to have burned looks due to boron toxicity.

•Iron/Manganese Toxicity: Found in flooded rice paddies, this problem causes bronzing, the appearance of small brown spots that eventually cover the entire leaf.

Hidden Dangers: Pseudo-Deficiencies

Be sure to check yourself twice! There are pseudo-deficiencies when plant problems look like a lack of nutrients but may be caused by drought, disease, weed killer and insect damage. For example, phosphorous deficiency is also caused by low temperature or root rot.

Conclusion

The process of a healthy harvest starts by observing. This can be done by knowing what the functions of mobile and immobile nutrients are and which symptoms to look for to tell whether there is a problem. If unsure about some things, it is recommended to combine visual observation and laboratory testing to keep within sufficiency range of nutrition.