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Plant Nutrient Deficiency: Influence on Plant Growth and Development

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ABSTRACT

Many chemical elements are becoming recognized as necessary, or in some cases beneficial if not essential to the normal growth and reproduction of higher plants. The quantitative requirements of the respective elements vary from minute traces to comparatively large amounts, and the concentrations tolerated by plants are limited to a narrow range with some elements but extend over wide ranges with others. Tolerating a wide range of concentrations of the major nutrient elements is an important factor enabling plants to adapt to varied soil environments. Despite this adaptability, symptomatic indications of maladjustments in crop plants have become increasingly prevalent in recent years. Biochemical studies of normal and affected plants, considered in connection with growth and yield response to soil treatment, have contributed to an understanding of the relationship between plant metabolism brought about by malnutrition. The results lead to a more accurate diagnosis of plant malnutrition with the aid of symptoms.

INTRODUCTION

A growing plant is a remarkable organism, not only in the great number of highly complex organic substances that make up its living substance and supporting framework but, also in the complexity, and nicety of the balance of interrelated reactions that take place in its growth, also in the fact that as a manufacturing concern, it must rate at full speed throughout the time it is under construction.

Plants for their growth and survival need 12 mineral nutrients. Toxicity or deficiency in any one or more of these nutrients affects the growth of plants and may even destroy plants (Lambers and Oliveira, 2019). Therefore, carefully examining the growing plant can help identify a specific nutrient stress. If a plant is lacking in a particular nutrient, characteristic symptoms may appear. Deficiency of a nutrient does not directly produce symptoms. Rather, the normal plant processes are thrown out of balance, with an accumulation of certain intermediate organic compounds and a shortage of others. This leads to the abnormal conditions recognized as symptoms. Visual evaluation of nutrient stress should be used only as a supplement to other diagnostic techniques (i.e., soil and plant analysis). Nutrient deficiency symptoms may be classified as follows:

- Complete crop failure at the seedling stage.
- Severe stunting of plants.
- Specific leaf symptoms appear at varying times during the season.
- Internal abnormalities such as clogged conductive tissues.
- Delayed or abnormal maturity.
- Obvious yield differences, with or without leaf symptoms.
- Poor quality of crops, including differences in protein, oil, or starch content, and storage quality.
- Yield differences are detected only by careful experimental work.

Causes of Nutrient Deficiency in Plants

In poor soils, inadequate chemical content typically results in nutrient starvation of the vegetation. Even in rich soils, crops might not be able to absorb the necessary chemicals. It specifically occurs because of soil salinization, which is a major factor in plant nutritional deficiencies (Abbas *et al.,* 2021). Furthermore, the state of the vegetation and the surroundings surrounding crop production affect the capacity to absorb nutrients. Nutrient transfer will therefore be hampered due to:

- Poor drainage
- Excessive or insufficient watering
- Undeveloped or damaged roots
- Incorrect pH levels

Identification of Nutrient Deficiency in Plants

Crop growth difficulties are detected first by inspecting the field. Furthermore, abnormal circumstances with comparable indications must be excluded before providing the crop with the appropriate element. The methods for identifying plant nutrient deficiencies are as follows: Visual assessment to exclude pest attacks and crop illnesses caused by biotic stress; Consideration of the potential influence of an unfavorable growing environment (abiotic stress); EOSDA monitors crops for nutrient shortage and conducts soil tests for chemical content, pH, electrical conductivity (EC), salt, and other factors (Pessarakli, 2019).

Symptoms of Nutrient Deficiency in Plants (Aye and Masih, 2023)

Macroelements

Nutrient deprivation in vegetation is visually identified by sluggish development and discoloured or deformed leaves. The most common nutrient shortfall in plants is nitrogen famine, although they can often lack many substances at once. Accordingly, macronutrients and micronutrients are primary and secondary chemical elements. The volumes that crops require are what set them apart. At a certain stage of crop growth, each component has a distinct function. Let us look at what occurs when there are insufficient amounts of this or that element.

Nitrogen (N)

Pale-green younger leaves and yellowish mature leaves are the primary indicators of nutrient deficiencies in plants since N gives green color to vegetation because of the chlorophyll pigment. If the early symptoms are ignored, they can progress to stunting, purple stem striping, crop thinning, or poor secondary shooting. Specifically, glossy kernels or V-shaped yellowing are indicators of a nitrogen shortage in maize. Rice has weak tillering and canopy production.

Phosphorus (P)

Phosphorus is necessary for crops to develop buds, seeds, flowers, and proteins. The lower portions of mature leaves that have a bronze, purple, or reddish color are typically indicative of phosphorus nutritional deficiencies in plants. Severe hunger can occasionally cause necrosis and reddish dots. Poor tillering occurs when grain crops, such as wheat, are deficient in P.

Potassium (K)

Crops use K to withstand disease and produce carbohydrates for protein synthesis, cell division, and root development. When plants lack the nutrient potassium, the result is irreversible leaf-margin yellowing, rotting, burning, crinkling, curling, shrinking, and necrosis of the midribs.

Sulphur (S)

Protein synthesis, chlorophyll production, and nitrogen utilization are all aided by a diet high in sulphur. Due to S undersupply, pale-green to dark-yellow new foliage is a common sign of plant nutrient deficiencies. Certain crops (mostly canola) may have rolling and purple foliage.

Calcium (Ca)

The formation of new cells is aided by this substance. Because of this, a plant's weak growth spots can be used to identify a calcium nutritional deficit: flower drops, undersized fruits, rotted blossom ends, tip burns, and malformations of recently grown sections.

Magnesium (Mg)

Crops need magnesium in addition to other nutrients for chlorophyll. Crop colouration is thus similarly impacted by magnesium undersupply. Small, drooping lower leaves, deep-green veining, and yellowish patches (later necrotic) are common indicators of magnesium nutritional insufficiency.

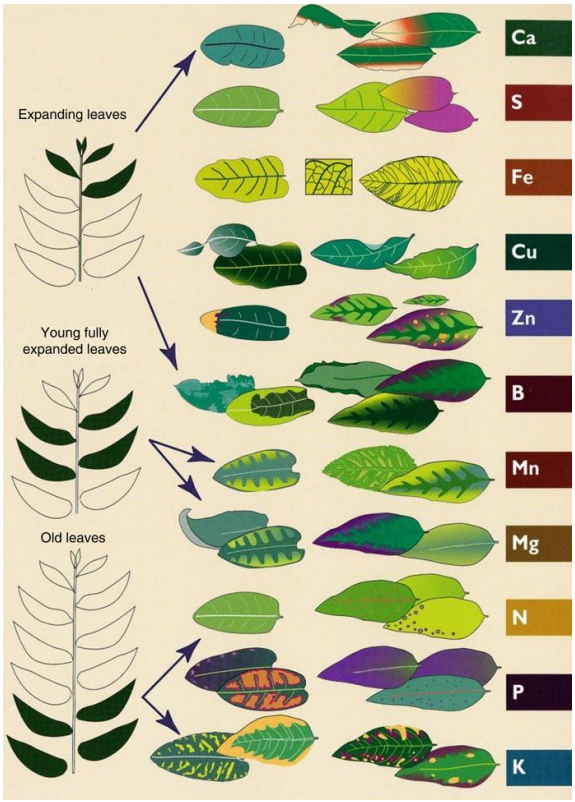

Figure: Deficiency Symptoms in Plants (Alvarado-Hernandez, 2016).

Microelements

Even in small concentrations, microelements are used by vegetation, but they are still necessary for good growth. The absence of them can be explained by visible signs that appear on immature or newly formed leaves. Undersupplies of Fe, Zn, B, Mn, Mo or Cu usually result in new foliage. Mature leaves are the first to show symptoms of inadequate Mo levels.

Copper (Cu)

This component enhances a variety of vegetative processes, including respiration and photosynthesis. Cu deficiency manifests itself as yellowing and necrosis, drooping of the leaves, poor flowering, stunted growth, etc. A recognizable indicator is the blue-greenish leaf of several crops, such as maize and vegetables. Cu is necessary for the production of seeds, hence a deficiency will result in undersized grains, which will reduce yield.

Iron (Fe)

Fe is needed by vegetation to build proteins and enzymes; hence a deficiency will hinder growth. Necrotic spots on pale-green, yellowish, or whitish leaves indicate a shortage in the mineral iron in plants. Cotton often exhibits upper leaf whitening due to Fe undersupply.

Molybdenum (Mo)

Mo is essential in fields because it helps with nitrogen fixation by turning nitrogen into ammonia. Mature leaves with pale green centers and yellowish borders are indicative of a nutritional shortage

in crops. Soybeans low in molybdenum are pale green. Necrosis results from damage that is not repaired.

Zinc (Zn)

Zinc, in combination with other elements, promotes vegetation growth. Crops indicate a zinc deficit by: youthful foliage that is tiny, chlorotic, bronze, or spotted; poor shooting; fading. Unusual indicators of zinc shortage in maize include white buds.

Manganese (Mn)

Mn is needed by vegetation for a variety of processes, including breathing, producing chlorophyll, and replicating cells. Plants lacking in Mn may exhibit symptoms such as small size, inadequate roots and shoot development, yellowish vein fragments, and dark or necrotic spots.

Boron (B)

Boron is used for cell duplication, appropriate water utilization, and sugar transport. It is supplied as borate. Because of aberrant side firing, a telltale indication of boron shortage is the so-called "witches' broom." For lucerne or carinata, this type of bushy or 'rosette' look is typical. Additional indicators include twisted, small, brittle, and occasionally rusty recent leaves. Mature foliage takes on a deep green, glossy color.

CONCLUSION

When a plant is deficient in vital nutrients, it manifests as apparent symptoms that impede its growth and development. These symptoms can vary based on whatever specific nutrient is lacking, but they usually include diminished fruit output, yellowing or discolouration of the leaves, poor flowering, and stunted development. For instance, a shortfall in nitrogen frequently causes leaves to turn yellow, whereas a phosphorus deficiency might result in reddish foliage. The ability to identify these symptoms is essential for prompt intervention because, if proper fertilization or soil amendments are not applied, nutritional deficits can have a detrimental effect on a plant's health and productivity.

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