Agri Articles
(e-Magazine for Agricultural Articles)
Volume: 02, Issue: 04 (JULY-AUGUST, 2022)
Available online at http://www.agriarticles.com

Symptoms of Nutrient Deficiency and Toxicity in Plants

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Abstract
Nutrient deficiencies and toxicities reduce crop health and productivity, which can lead to crop failure. Unusual visual symptoms manifest. The plant's role and movement can be beneficial. Find out which nutrient is to blame for a toxicity or insufficiency symptom. Symptoms of a general deficit include Interveinal chlorosis, stunted growth purple or crimson discoloration, and chlorosis necrosis. Mobile nutritional deficiencies Older, lower leaves show up first, whereas immobile nutritional deficits will occur are seen in the younger, higher leaves.

Keywords: Micro-Nutrient, Macro-Nutrient, Deficient, Toxic, Elements, Symptoms.

Introduction
This assignment discusses the numerous visual indications used to diagnose nutrient deficiency and toxicity, as well as the general link between nutrient content and plant growth/yield. It goes over the different nutrient concentrations that are considered insufficient, adequate, and hazardous. Environmental factors such as temperature and soil water content can have a significant impact on the nutrient concentration of leaves, which can negatively impact the availability and uptake of nutrients by the roots, as well as the rate of shoot growth. Plant age, plant part, and other nutrient concentrations all contribute to higher critical deficiency concentrations. The results of soil testing for nutrients, soil water status (dry/waterlogged), weather conditions (low temperature or frost), and the application of fertilizers, fungicides, or pesticides are acquired for this additional information related to soil pH, soil testing for nutrients, soil water status (dry/waterlogged), and the application of fertilizers, fungicides, or pesticides. Cu and P deficiency can be diagnosed using a combination of histology and histochemical approaches, while enzymatic procedures utilizing marker enzymes provide another way to examine plant nutritional status. If the total concentration or soluble fraction of a nutrient is poorly linked with its physiological availability, enzymatic, biochemical, and biophysical approaches can be highly useful.

Essential nutrients
Three Criteria for Essentiality of Nutrients:

- In the absence of the element, a plant unable to complete its life cycle.
- Every necessary element's action must be unique, with no other element being able to completely replace it.
- The element must be shown to be directly involved in plant nutrition. It must be a constituent of a metabolic pathway or at least be required for the activity of an essential enzyme.

Essential elements may be classified into three groups:

1. Primary nutrients: Major Elements, also known as Primary Nutrients, are the key elements that plants require in greater quantities. C, H, O, N, P, and K.
2. Nutrients or secondary elements: In addition to fundamental nutrients, the plant requires these components in greater quantities. Ca, Mg, and S are examples.
3. Trace elements, micronutrients, and minor elements: Minor or Trace Elements are the important elements that plants require in lower levels or traces. Fe, Mn, Cu, Zn, Mo, B, and Cl are the elements involved.

Occurrence of Deficiency Symptoms

Depending on the mobility of the nutrient, symptoms of lack of certain nutrients will occur on old or young leaves.

"Mobile element deficiency symptoms will occur on older leaves because these elements will migrate quickly from older to younger leaves. N, P, K, Mg, and Zn, for example. Non-mobile element deficiency symptoms, on the other hand, will show up on young leaves due to their build-up on older leaves due to their immobile nature. Ca, B, Cu, Mn, Fe, and S, for example"

Corrective Measures for Deficiency

NUTRIENTS	CORRECTIVE MEASURES
N	For correcting N deficiency, fertilizers like ammonium sulphate, calcium nitrate, urea etc. are supplied. Foliar spray of 1-2% urea is a quick method of ameliorating N deficiency.
P	Spraying 2% DAP or application of Phosphatic fertilizers will correct the deficiency.
K	Supply of muriate of potash or foliar spray of 1% potassium chloride is commonly used to overcome K deficiency.
Mg	Magnesium sulphate is usually applied for redressing the deficiency. The malady can be readily corrected as foliar spray @ 2% of $MgSO_4$.
Ca	Calcium ammonium nitrate (CAN) or super phosphate or gypsum is supplied in
S	Common fertilizers used for supplying nitrogen and phosphorus contain appreciable amount of sulphur sufficient to meet the crop requirement. In case of severe deficiency, gypsum is added to the soil @ 500Kg/ha.
Fe	Foliar spray of 0.5% ferrous sulphate along with lime (50% requirement) will remove the deficiency in the plant and soil.
	Chelated iron compounds such as Fe-EDTA, give a very good response in ameliorating Fe deficiency
Mn	Foliar spray of 0.5% manganous sulphate plus 50% lime requirement is quite effective and it should be applied in the early stage of the crop.
	Soil application of 15-30 kg $MnSO_4$ per ha (mixed with sand) is sufficient.
Cu	Foliar spray of 0.5% of $CuSO_4$ is recommended.
Zn	Foliar spray of 0.5% $ZnSO_4$ twice at 7-10 days interval during early stages of growth will alleviate the problem. Also, soil application of 25 kg $ZnSO_4$ per ha is also found beneficial.
Mo	The Molybdate deficiency is commonly found in cauliflower, legumes, oats and other brassicas which can be corrected by soil application of 0.5 to1.0 Kg/ha sodium or ammonium molybdate or by its foliar spray@ 0.01-0.02% conc.
B	Foliar spray of 0.2% borax acid will be effective for quick recovery.
	Liming of soil should be strictly avoided when boron-containing fertilizers are applied.

Nutrient Mobility

Nutrient	Macro/micro	Uptake form	Mobility in Plant	Mobility in Soil
Carbon	Macro	CO_2, H_2CO_3		
Hydrogen	Macro	H^+, OH^-, H_2O		
Oxygen	Macro	O_2		
Nitrogen	Macro	NO_3^-, NH_4^+	Mobile	Mobile as NO_3^-, immobile as NH_4^+
Phosphorus	Macro	HPO_4^{2-}, $H_2PO_4^-$	Somewhat mobile	Immobile
Potassium	Macro	K^+	Very mobile	Somewhat mobile
Calcium	Macro	Ca^{2+}	Immobile	Somewhat mobile
Magnesium	Macro	Mg^{2+}	Somewhat mobile	Immobile
Sulphur	Macro	SO_4^-	Mobile	Mobile
Boron	Micro	H_3BO_3, BO_3^-	Immobile	Very mobile
Copper	Micro	Cu^{2+}	Immobile	Immobile
Iron	Micro	Fe^{2+}, Fe^{3+}	Immobile	Immobile
Manganese	Micro	Mn^{2+}	Immobile	Mobile
Zinc	Micro	Zn^{2+}	Immobile	Immobile
Molybdenum	Micro	MoO_4^-	Immobile	Somewhat mobile
Chlorine	Micro	Cl^-	Mobile	Mobile
Cobalt	Micro	Co^{2+}	Immobile	Somewhat mobile
Nickel	Micro	Ni^{2+}	Mobile	Somewhat mobile

Indicator Crops

- Some crops are known to be specialized for the emergence of symptoms associated with a specific nutritional deficiency.
- Indicator Crops are crops that indicate a shortage of a specific element (s).
- This is owing to the element's higher demand in the relevant Indicator Crops.

The elements and some of the indicator crops are listed in the table below.

S.N.	Nutrient Element	Indicator Crop
1	Nitrogen	Cereals like, maize, sorghum and pulses
2	Phosphorus	Tomato, maize, cereals, Lucerne
3	Potassium	Potato, banana, cotton, Lucerne
4	Magnesium	Cotton (leaf reddening)
5	Zinc	Maize, paddy (Khiara disease), citrus, beans
6	Sulphur	Cereals, Lucerne, tea (yellowing)
7	Copper	Citrus, cereals
8	Iron	Sugarcane, sorghum, citrus, ornamental plants
9	Manganese	Citrus, sunflower, sugarbeet
10	Calcium	Cauliflower, tomato (blossom end rot of fruits), sugarbeet
11	Molybdenum	Cauliflower (whiptail)

Hidden Hunger

Hidden hunger occurs when a crop requires more of a specific nutrient but shows no signs of insufficiency. Although the nutrient concentration is above the deficiency symptom zone, it is still significantly needed for optimal crop performance. Significant responses can be produced with most nutrients on most crops even when no observable symptoms have occurred.

Luxury Consumption

• When nutrients are present in appropriate quantities in the soil, some crops have a tendency to absorb and accumulate significantly more than they require.

• The absorption pattern of various nutrients by plants varies substantially among plant species, as well as their age and growth phases.

NUTRIENT INTERACTION AND ANTAGONISM

S.N.	EXCESSIVE NUTRIENTS	CAUSES DEFICIENCY
1	N, P & K	Cu
2	P	Fe, Zn & Cu
3	N, K & Ca	B
4	K, NH4	Mg
5	Ca	P
6	Ca, Mg	K
7	Fe, So4	Mo
8	Zn & Al	Cu
9	Zn, Mo, Cu & No3	Fe, Zn & Cu
10	B	Mo

One of the most important factors in increasing crop yields is a balanced supply of essential nutrients. Nutrient interactions in crop plants are typically measured in terms of growth response and nutrient concentration change. When two nutrients are added, crop yield increases more than when only one is added; the interaction is positive (synergistic). Similarly, if combining the two nutrients produced less yield than either nutrient alone, the interaction is negative (antagonistic). There is no interaction when there is no change. All three interactions between essential plant nutrients have been documented. However, the majority of interactions are complex nutrient that interacts with multiple nutrients at the same time.

Toxicity Symptoms of Plant Nutrients

Element/status	Visual symptoms
Nitrogen (N)	
Excess	• Plant will be bright green, with succulent new growth; they will be vulnerable to disease and pest infestation, and they can quickly lodge if subjected to drought stress. There will be blossom abortion and a lack of fruit set.
Ammonium toxicity	•Plants fertilised with ammonium-nitrogen (NH4- N) may show indications of ammonium toxicity, including carbohydrate depletion and impaired development. Plant stem lesions, downward cupping of the leaves, and deterioration of the conductive tissue at the base of the stem with wilting of the plants under moisture stress are all possibilities. Blossom-end rot of the fruit will occur, as well as Mg shortage symptoms
Phosphorus (P)	
Excess	Phosphorus excess will not show a direct effect on the plant but have visual deficiencies of Fe, Zn and Mn. High Phosphorus also interfere with the normal Ca nutrition, with deficiency symptoms of Ca occurs.

Potassium (K)	
Excess	Plants shows typical Mg, and Ca deficiency symptoms due to a imbalance in cation.
Calcium (Ca)	
Excess	Plants shows typical Mg deficiency symptoms, and acute situation K deficiency may also occur.
Magnesium (Mg)	
Excess	Cation imbalance, Result showing signs of either a Ca or K deficiency.
Sulphur (S)	
Excess	Occurring premature senescence of leaves.
Boron (B)	
Excess	Tips of Leaf and margins shows brown and die symptoms.
Chlorine (Cl)	
Excess	the lower leaves show premature yellowing with burning effect of the margins and tips of leaves. Leaf abscission will occur and plants wilt easily.
Copper (Cu)	
Excess	Occurs Fe deficiency, Stunted Roots.
Iron (Fe)	
Excess	A bronzing of leaves with tiny brown spots on the leaves, Rice shows a typical frequently symptoms.
Manganese (Mn)	
Excess	Older leaves turn brown spots surrounded by a circle, chlorotic zone.
Molybdenum (Mo)	
Excess	No common occurrence.
Zinc (Zn)	
Excess	Fe deficiency symptoms develops.

References

1. McCauley, A., Jones, C. and Jacobsen, J. (2009). Plant nutrient functions and deficiency and toxicity symptoms. *Nutrient management module*, *9*, 1-16.
2. Kalaji, H. M., Oukarroum, A., Alexandrov, V., Kouzmanova, M., Brestic, M., Zivcak, M. and Goltsev, V. (2014). Identification of nutrient deficiency in maize and tomato plants by in vivo chlorophyll a fluorescence measurements. *Plant physiology and biochemistry*, *81*, 16-25.
3. Havlin, J.L., Beaton, J.D., Tisdale, S.L. and Nelson ,W.L. (1999). Soil Fertility and Fertilizers, 6th Edition. Upper Saddle River, N.J. Prentice-Hall, Inc. 499 p.
4. Sirohi, G., Pandey, B. K., Deveshwar, P. and Giri, J. (2016). Emerging trends in epigenetic regulation of nutrient deficiency response in plants. *Molecular biotechnology*, **58**(3): 159-171.
5. Chishaki, N. and Horiguchi, T. (1997). Responses of secondary metabolism in plants to nutrient deficiency. In *Plant nutrition for sustainable food production and environment* (pp. 341-345). Springer, Dordrecht.
6. Mills, H. A., and Jones Jr, J. B. (1979). Nutrient deficiencies and toxicities in plants: Nitrogen. *Journal of Plant Nutrition*, **1**(2): 101-122.
7. Bradley, L., and Hosier, S. (1999). Guide to symptoms of plant nutrient deficiencies.
8. Sharma, C. P., and Sharma, P. N. (1987). Physiology: Mineral nutrient deficiencies affect plant water relations. *Journal of plant nutrition*, **10**(9-16):1637-1643.