

NUTRIOPHYSIOLOGY

20.1 DEFICIENCY SYMPTOMS OF PLANT NUTRIENTS

A) NITROGEN

Nitrogen being a mobile element within a plant, its deficiency results in movement of N from older to younger (upper) leaves. As a result the older leaves turn yellow in colour.

1. In young plants, growth is stunted with yellowish green leaves. Yellowing of leaves is due to the collapse of chloroplasts resulting in decrease of chlorophyll content.
2. Yellowing always starts from the older leaves and spreads to young ones.
3. Severe N deficiency affects the leaf tissue to become dry and necrotic.
4. Older leaves are shed prematurely.
5. Root growth is affected and branching is restricted.
6. Shoot become short, thin with up right growth and spindly appearance.
7. Flowering is reduced.
8. In cereals, tillering is poor, number of ears per unit area and number of grains per ear head is reduced.

B) PHOSPHORUS

Generally the symptoms of P deficiency appear in the older leaves.

1. Young plants are stunted with **dark blue green leaves**.
2. Stems become slender
3. Root system is limited. Primary and secondary roots elongate in length with short tertiary roots.
4. In many plant species P deficiency induces the **formation of anthocyanin pigment** and the leaves acquire **purple color** primarily along margins and on the lower stalk (eg. Maize)
5. The formation of fruits and seeds is depressed and ripen slowly.
6. Plant often dwarfed at maturity.
7. In potato, tubers may develop rusty lesions in the flesh.

C) POTASSIUM

1. The most characteristic symptom of K deficiency is **tip and marginal scorching** of most **recently matured leaves**.
2. In **barley** which is the most susceptible of the cereals, numerous small brown areas develop in the areas between the veins.
3. Roots are slender and poorly developed in sugar beet.
4. In certain temperate fruit trees, K deficiency may result in severe “die-back”
5. Resistance of plants to infection by bacterial and fungal pathogens is reduced.

6. Putrescine, (a Diamine) accumulates under K^+ deficiency.

D) CALCIUM

1. Symptoms of Ca deficiency appear earliest and severely in **meristametic regions and young leaves** because it is **immobile** one.
2. Breakdown of meristemetic tissues in stems and roots occur.
3. Roots poorly developed, lack fiber and may appear gelatinous.
4. The apical bud “**dies off**” and thus small branches arise from lower leaf axils giving the plant bushy appearance.
5. Little or no fruiting.
6. Calcium deficiency causes “**bitter pit**” disease in apple and “**blossom end rot**” in tomato and watermelon.

E) MAGNESIUM

1. **Interveinal yellowing or chlorosis** occurs in **older leaves** and under severe deficiency the areas become necrotic.
2. In **cotton**, **Mg deficiency** induces formation of **anthocyanin pigments** and a **reddish coloration** of leaves during winter.
3. In **citrus**, the chlorosis commences at the tips and margins of the leaf and spread in ward towards midrib by leaving **inverted V shape** at the bottom of the leaf.
4. In general fruit trees are susceptible to Mg deficiency and show varied patterns of chlorosis, necrosis and pigmentation of old leaves which shed prematurely.

F) SULPHUR

1. Chlorotic symptoms first appear in younger most recently formed leaves.
2. Shoot growth is more affected than root growth.
3. Leaves become narrow and chlorotic in cruciferae.
4. Stems often become slender.

G) IRON

1. Being relatively immobile, Fe deficiency appears first on the younger leaves of the plant.
2. In most species chlorosis is interveinal and a fine reticulate pattern can be observed in the newly formed leaves, the darker green veins contrasting markedly against a lighter green or yellow background. The youngest leaves may often be completely white and totally devoid of chlorophyll.
3. In the leaves of cereals the deficiency is shown by alternate yellow and green strips along the length of the leaf.

4. In fruit trees, iron deficiency is associated with high leaves of CaCO_3 in the soil, where it is called "**lime induced iron chlorosis**"

H) **MANGANESE**

1. Mottled chlorosis with veins green which appears first on younger leaves.
2. Stem becomes yellowish green, often hard and woody.
3. In **groundnut** leaves, the **veins are surrounded by a definite zone of non chlorotic interveinal tissue.**
4. Characteristic symptoms of Manganese deficiency in certain crops have been given specific names. They are **grey speck of oats, speckled yellow of sugar beet, marshy spot of peas, pahala blight of sugarcane etc.**

I) **BORON**

1. B is **immobile** in most plant species and symptoms appear first at tops and roots.
2. The youngest leaves are misshaped, wrinkled and are thicker and of a **dark bluish green color.** Shed prematurely.
3. Plants dwarfed, stunted, flower development and seed production usually impaired.
4. In fruit trees, the bark of the stem may become rough and show splitting. Fruits often develop corky areas internally.
5. Roots exhibits swollen root tips.
6. Characteristic symptom of B deficiency in certain crops are
Heart rot in sugar beet **Hollow stem in cauliflower**
Brown heart of turnip **Corky pith of apples**
Hard fruit of citrus

J) **COPPER**

1. Young leaves show chlorosis
2. Terminal leaves, shoots are wilted and distorted, frequently followed by death resulting in development of several auxillary buds.
3. Cereals show bushy growth with white twisted tips and reduced panicle formation.
4. Poor or no heading in cabbage and lettuce.
5. In citrus, Cu deficiency leads to **exanthema or die-back.**

K) **ZINC**

1. **Little leaf and rosette** are the common symptoms of Zn deficiency.
2. In maize, Zn deficiency results in white or yellow emerging leaves, a condition called **white bud.**

3. Leaves chlorotic and necrotic, young growth first affected, resulting, premature shedding.
4. In Rice Zn deficiency causes 'khaira disease'
5. In monocots and particularly in maize, **chlorotic bands form on either side of the midrib of the leaf.**

L) **MOLYBDENUM**

1. Symptoms of Mo deficiency are similar to those of N deficiency because in the absence of Mo, nitrate is not metabolized.
2. Leaves show marginal scorching and rolling or cupping.
3. In extreme deficiency, the leaf lamina is not formed and only the rib is present in **cauliflower** which is called **whiptail disorder.**

M) **CHLORINE**

1. Chlorosis of younger leaves and an overall wilting of the plant.
2. In some plant species, like tomato, leaves show chlorotic mottling, bronzing and tissue necrosis.

N) **SILICON**

1. Withering of leaves and wilting of plants, which are called **weeping willow habit of growth.**
2. In cereals and grasses, necrotic spots develop on leaves.

20.2 NUTRIENT DEFICIENCIES AND SOME SPECIFIC NAMES

Specific names have been given to symptoms of certain nutrient deficiencies. They are:

Calcium	Bitter pit in apple, Blossom end rot in tomato
Manganese	Grey speck of oats, speckled yellow of sugar beat, Marsh spot of pea pahala blight of sugarcane, Frenching of tung tree.
Boron	Heat rot in sugar beat, Browning or hollow stem in cauliflower, Top sickness of tobacco, Brown heart of turnip, Cracked stem of celery, Corky pith of apple, hard fruit of citrus.
Copper	Exanthema or dieback in citrus
Zinc	White bud in maize, khaira disease in Rice.
Molybdenum	Whiptail in cauliflower

20.3 TOXICITY SYMPTOMS OF PLANT NUTRIENTS

As excess supply of one or more of the essential elements, particularly the heavy metals brings about a reduction in growth and often leads to the production of visual symptoms which at times are characteristic of the elements supplied in excess. The visual effects of excess supply of elements may be due to a direct effect of toxicity of elements or by inducing deficiency of another element. The excess supply of particular elements reduces the uptake and utilization of other essential elements. Eg. Excess phosphorus supply may retard the uptake and translocation of Cu and Zn, thus shows Cu and Zn deficiency symptoms.

Under field conditions N, S and Al toxicities are common. Mn toxicity is observed in acid soils.

A) NITROGEN

1. As a Nutrient – excessive nitrogen commonly produces plants that vegetative so that yield is reduced. In sugarcane both juice quality and sugar recovery is reduced. Fruit quality is impaired in oranges and peach. Cereals receiving excess N have been shown to exhibit lodging as a result of the decreased thickness of the cell walls or due to the poor development of the mechanical tissues of the stem or due to both. In tomato, plants are highly vegetative and fruit production is reduced.
2. As a salt a high level of N application increases the salinity of the soil. Also the form of nitrogen (NH_4^+ or NO_3^-) and associated ions (SO_4^- , Na^+ Ca^{++}) may markedly affect soil structure and plant response.

B) SULFUR

Excess sulfur causes interveinal yellowing in sorghum and lemon leaves. No symptoms of S toxicity is observed in leaves of sugar beet, tomato, cotton and alfalfa, but growth and leaf size was considerably reduced in all the crops

Excessive concentrations of sulfur dioxide in the atmosphere also cause toxicity in the plants. The symptoms produced by excessive SO_2 was divided into (a) acute injury (b) Chlorotic injury.

The acute injury consists of collapsed marginal or interveinal areas which at first have a dull, water soaked appearance, later drying and bleaching to an ivory color in most species. These lesions are caused by rather sudden absorption of enough gas to kill the tissue.

Chlorotic injury is a yellowing of the leaf which may progress slowly and bleaches completely. bleaching most of the chlorophyll and carotenoids. This is due to absorption of an amount of gas somewhat insufficient to cause acute injury or it may be caused by absorption over a long period of time of sublethal amounts of gas.

Another type of S toxicity is Hydrogen sulfide toxicity (sulfide injury). In **poorly drained rice soils, the H_2S toxicity** is common. This disorder is commonly called as “**akagare**” or “**akiochi**”. This anaerobic disorder is characterized by inhibited root development and browning (or blackened) and death of roots which

precede the stunting of shoots. Field observation shows that the roots of affected plants are blackened from the accumulation of iron sulfides (and possibly manganese sulfides) formed under reducing conditions. This black coloring disappears upon exposure to the atmosphere after several hours due to oxidation, a confirmation of sulfide formation. The H₂S toxicity also depresses the uptake and translocation of P and other nutrients.

C) ALUMINUM

Aluminum toxicity is wide spread in most of the acidic soils. In general, roots are affected first, more severely than the tops under aluminum excess. In most species, roots appear thick and brown and the tips of the root lets often appear enlarged. In barely, the general growth of the plants and tillering are severely restricted. Leaf tips often turn brown and wither. The stem becomes dark brown, no ears are formed and plants often die prematurely. The root growth is severely restricted and the root tips appear dark brown and enlarged.
