NUTRIENT DEFICIENCY AND TOXICITY

Causes and Symptoms

Nitrogen

When N supplies are more than sufficient, carbohydrates are converted to proteins. Hence, vegetative portion is less with carbohydrates and more with protein as protoplasm. As protoplasm are highly hydrated more succulence results.

Excessive succulence may have a harmful effect. With cotton, a weakening of the fiber; with grain crops, lodging particularly with a low K supply; more susceptibility to disease and insect attack occurs.

N deficient plants become stunted and yellow in appearance. The loss of protein N from chloroplasts in older leaves produces **yellowing or chlorosis -** indicative of N deficiency. Chlorosis appears first on lower leaves; upper leaves remain green. Under severe N deficiency, lower leaves turn brown and die. This necrosis begins at the leaf tip and progresses along the midrib until the entire leaf is dead. The tendency of the young upper leaves to remain green as the lower leaves yellow or die is an indication of the mobility of N in the plant.

Phosphorus

The marked effect of P deficiency is **retarding** overall **growth**; the striking foliar symptoms that are evident with N or K deficiency are seldom observed for P, In corn and some other grass species, purple discoloration of the leaves or leaf edges appears.

Potassium

When K is limiting, characteristics deficiency symptoms appear in the plant. Typical K deficiency symptoms in alfalfa are white spots on the leaf edges; in corn nd banana **chlorosis** and **necrosis** of the leaf edges.

Since K is mobile in plant, visual deficiency symptoms appear first in the lower old leaves, progressing toward the top with severity. K deficiency also occurs in young leaves of high-yielding, fast maturing crops like cotton and wheat. Another symptom is weakening of straw in grain crops, causing lodging in small grains and stalk breakage in corn and sorghum, reducing crop yields.

In fact, serious yield reductions may occur without deficiency symptoms. This phenomenon is termed *hidden hunger* and is not restricted to K alone.

Calcium

In corn, Ca^{2+} deficiency prevents the emergence and unfolding of new leaves, the tips are almost colorless covered with a sticky gelatinous material that causes them to adhere to one another.

In fruits and vegetables, the most frequent indicator of Ca^{2+} deficiency is disorders in the storage tissues: **I** 22 (1/6) **rot** *in tomato*, **bitter pit** *of apples*. Often Ca^{2+} is an immobile element in the plant; hence, there is very little translocation of Ca^{2+} to fruits and storage organs.

Magnesium

Deficiency symptoms often appear first on the lower leaves. In many species, shortage of Mg^{2+} results in interveinal chlorosis of the leaf, in which **only**

veins remain green. In more advanced stages the leaf tissue becomes uniformly pale yellow, then brown and necrotic. In cotton, the lower leaves may develop a reddish-purple cast, gradually turning brown and finally necrotic.

Sulphur

S deficiency has a pronounced retarding effect on plant growth, characterized by **uniformly chlorotic** plants - stunted, thin-stemmed, and spindly. In many plants, these symptoms resemble those of N deficiency. Unlike N, deficiency symptoms occur first in younger leaves.

S deficient cruciferous crops such as cabbage and rapeseed will initially develop a reddish color on the underside of the leaves. In rapeseed the leaves are also cupped inward. In **cabbage**, there is a reddening and purpling of both upper and lower leaf surfaces; the **cupped leaves** turn back on themselves, presenting flattened-to-concave surfaces on the upper side.

Boron

B deficiency symptoms appear as thickened, wilted, or curled leaves; a thickened, cracked, or water-soaked condition of petioles and stems; and a discoloration, cracking, or rotting of fruit, tubers, or roots.

22 (2/6)

Internal cork of apple is caused. In **citrus** fruits uneven thickness of the peel, lumpy fruit, and gummy deposits result. The breakdown of internal tissues in root crops appear as darkened areas and referred as ***brown heart or black heart***.

Iron

Fe deficiency is most frequently seen in crops growing on calcareous or alkaline soils. Fe chlorosis is exhibited by citrus and deciduous fruit crops, by sorghum, grown in neutral to alkaline soils. Other crops are soybeans, beans, corn, strawberries, avocado, vegetable crops, and many ornamentals.

Deficiency of Fe shows up first in young leaves, as a result, growth ceases. The young leaves develop an **interveinal chlorosis**, which progresses rapidly over the entire leaf. In severe cases, *the leaves turn entirely white*.

Fe **toxicity** causes nutritional disorders in rice grown on poorly drained, submerged soils. This condition known as **bronzing** is associated with Fe levels > 300 ppm in leaf blade of rice at tillering.

Manganese

In broad-leaved plants, interveinal chlorosis appears. Mn deficiency of several crops is described by terms: **gray speck** of oats, **marsh spot** of peas, **speckled yellows** of sugar beets. Wheat plants low in Mn are often more susceptible to root rot diseases.

Plants are injured by **exces** 22 (3/6) s of Mn. *Crinkle leaf of cotton* is an Mn toxicity observed in highly acid red yellow soils. Mn toxicity in tobacco, soybeans, tree fruits, and rapeseed is noted on extremely acid soils.

Copper

Deficiencies of Cu are reported in numerous plants, *although they are more prevalent among crops growing in* **peat and muck soils**. Crops most

susceptible to Cu deficiency include alfalfa, wheat, onions, carrots, clover, corn, and fruit trees.

Symptoms vary with crops. In corn, the youngest leaves become yellow and stunted, and if more severe, the young leaves turn pale and older leaves die back. In advanced stages, dead tissue appears along the tips and edges of the leaves *in a pattern similar to that of K deficiency*.

Cu-deficient small-grain plants lose color in young leaves, which break, and die. In many vegetable crops, the leaves lack turgor, developing a bluish-green cast, with chlorotic curl; flower production fails.

Zinc

Crops sensitive to Zn deficiency are corn, beans, citrus, flax, grapes, onions, rice, and soybeans. Mildly sensitive crops are alfalfa, clovers, sorghum, sudan grass, and tomatoes.

Deficiency symptoms appear frequently in leaves; sometimes in fruit or branches or affect in overall development of the plant. Symptoms include light green, yellow, or white areas between the veins of leaves particularly the older lower leaves resulting in: Chlorotic leaf areas; Shortening of the stem **rosette** appearance of the leaves; Malformation of the fruit, often with low or no yield.

22 (4/6)

White bud in corn and sorghum, **little leaf** in cotton, **mottle leaf or frenching** in citrus crops, **fern leaf** in potato are described terms of Zn deficiency.

Molybdenum

Mo is a structural component of nitrogenase enzyme that actively involves in N_2 fixation. Mo deficiency arrests biological N_2 fixation. Legumes exploit soil N supplies, turning soil to low N fertility, if the legume residues are not incorporated in soil.

Chloride

As Cl^- is the active osmotic agent, its deficiency results in partial wilting and loss of leaf turgor. Chlorosis in younger leaves and an overall wilting of the plants are the two most common symptoms of Cl^- deficiency. Necrosis in some plant parts, leaf bronzing, and reduction in root growth may be seen. Tissue concentrations below 70 to 700 ppm are usually indicative of deficiency.

Symptoms **high level of Cl^-** in wheat plants are increase total leaf water potential and cell sap osmotic potential. Excess of Cl^- can be harmful, and crops vary widely in their tolerance to this condition. Tobacco, legumes are among the most sensitive crops. Leaves of tobacco and potatoes thicken and tend to roll. The storage quality of potato tubers is adversely affected.

Cobalt

The essentiality of Co is for the growth of symbiotic microorganisms such as symbiotic rhizobium, free-living N_2-fixing bacteria, and blue-green algae and in the formation of vitamin B12. Hence, lack of cobalt affects N_2 fixation in soil.

Silicon

Freckling, a necrotic leaf condition is a symptom of low Si in sugarcane receiving direct sunlight due to Ultraviolet radiation. Adequate Si in sugarcane plant filters out harmful ultraviolet radiation.

The oxidizing power of rice roots and accompanying tolerance to high levels of Fe and Mn were dependent of Si nutrition. Si application is necessary when Si concentration in rice straw falls below 11%. Many of the favorable effects of Si on plant growth, such as disease resistance, stalk strength, and reduction in lodging, have also been attributed to K.

Nickel

High levels of Ni may induce Zn or Fe deficiency because of cation competition. Application of some sewage sludge may result in elevated levels of Ni in crop plants.