Micronutrient Management

Dr. Lay Lay Nwe

5 . 10. 2022

Micronutrients

The word "Micronutrient" represents some essential nutrients which are required in very small quantities for the growth of plants and micro-organisms

What are micronutrients?

- Boron
- Iron (Fe)
- Manganese (Mn)
- Zinc
- Chlorine (Cl)
- Copper (Cu)
- Molybdenum (Mo)
- Nickel (Ni)
- Cobalt (Co)

Functions of Micronutrients

Micronutrients	Functions
Boron	regulates the metabolism of carbohydrates in plants. It's critical for new growth and assists in pollination, fertilization and more.
Iron (Fe)	requires for formation of chlorophyll in plants.
Manganese (Mn)	assists iron in chlorophyll formation. It serves as an activator for enzymes in the growth process.
Zinc	is an important plant regulator. It's essential in root and plant growth.

Contd.

Micronutrients	Functions
Chlorine (Cl)	requires for photosynthesis and root growth.
Copper (Cu)	activates enzymes in plants.
Molybdenum (Mo)	needs for utilization of nitrogen in plants. Without molybdenum, plants can't transform nitrate nitrogen into amino acids.
Nickel (Ni)	requires to complete the life cycle of the plant and viable seed.
Cobalt (Co)	needs for nodulating in bacteria for fixing atmospheric N in legumes.

Deficiency, Toxicity Symptoms and Their Management of Micronutrients in Crops

Boron (B)

- Plants having B concentration in the order of 5 to 30 ppm are suspected to be boron deficient.

- Boron deficiency symptoms are conspicuous on the terminal buds or the youngest leaves; which become discolored and may die under acute deficiency.

- Internodes become shorter and gives appearance of a bush or rosette.

Contd.

- **Factors affecting plant-available B:**
  - **Soil moisture and weather**
  - **Soil pH**
  - **Soil texture**

Boron deficiency in rice

- B deficiency occurs in highly weathered, acid upland, coarse textured sandy soils, acid soils derived from igneous rocks, and in soils of high organic matter and calcareousness
- B availability is reduced under moisture stress and dry conditions
- B deficiency symptoms usually appear first on young leaves.
- Reduced plant height and the tips of emerging leaves are white and rolled
- Rice plants fail to produce panicles if they are affected by B deficiency at the panicle formation stage

Boron deficiency symptoms

Soybean

Sunflower

Cauliflower

Peanut

Management of Boron deficiency

- **Borax, granubor & boric acid are efficient sources .**
- **Basal soil application of B (2.4 - 4.8 kg B / ac) is superior to foliar sprays. Soil application has residual effect for 1-2 seasons.**
- **For hidden deficiency spray 0. 2% boric acid or borax at pre flowering or flower head formation stages .**

Boron toxicity

- Occurs in arid and semi arid regions, high in temperature, in volcanic soils
- Use of B-rich groundwater, sewage and municipal wastes or borax
- Critical toxicity limits of B in soils –

> 4 mg/ kg (0.05N HCl) or

> 5 mg B /kg (hot-water soluble B) or

> 2 mg B /L in irrigation water

Symptoms

- Plants show brownish leaf tips and dark brown elliptical spots on leaves.

Management of B Toxicity

- Deep plowing during off season and leaching, use of surface water with low B content or dilution
- Growing B tolerant varieties

Iron (Fe)

- Solubility of Fe is very low and decreases with increasing soil pH.

- Plants having < 50 ppm of Fe are usually classified as iron deficient.

- Deficiency of Fe results in interveinal chlorosis appearing first on the younger leaves with leaf margins and veins remaining green.

Contd.

❖ **Causes of Fe deficiencies:**

- **An imbalance with other metals such as Mo, Cu, or Mn.**
- **Excessive P in the soil.**
- **A combination of high pH, high lime, wet, cold soils, and high bicarbonate levels.**
- **Plant genetic differences. Plant species can differ significantly in their ability to take up Fe.**
- **Low soil organic matter levels.**

Iron deficiencies in upland rice

- Interveinal chlorosis of emerging leaves, whole leaves becoming chlorotic and turns very pale.
- Plants become stunted with narrow leaves.

- Fe deficiency is serious constraint to rice in uplands in neutral, alkaline and calcareous soils, in coarse textured low organic matter soils, in alkaline and calcareous low lands, and under excessive concentrations of Mn, Cu, Zn, Al and nitrates in root zone.

Iron deficiency symptoms

otton

anana

oybean

orn

Management of Fe deficiency

- Ferrous sulphate (19 - 20.5% Fe), organic manures (FYM 0.15% Fe), poultry and piggery manure (0.16% Fe), sewage sludge are used as sources for correcting Fe chlorosis.
- Seed treatment with 2% $FeSO_4.7H_2O$ solution/slurry.
- Foliar sprays (2-3) of 1-2% $FeSO_4.7H_2O$/ $FeNH_4SO_4$ (pH 5.2) solution at weekly interval at early stage of deficiency are successful.
- Combination of green manure (GM) or organic manures with foliar spray

Manganese (Mn)

- Mn deficient plants contain less than 25 ppm Mn.
- Deficiency symptoms of Mn are more severe on middle leaves than on the younger ones because Mn is preferentially translocated to the younger tissues.
- Interveinal chlorosis in dicotyledons is characterized by the appearance of chlorotic and necrotic spots in the interveinal areas.
- In monocotyledonous plants like cereals, Mn deficiency symptoms appear as greenish grey spots, and stripes more on the basal leaves.
- Chlorotic leaf areas soon become necrotic and turn red, reddish brown or brown.

Manganese deficiency symptoms

oybean

oybean field

otton

il palm

Management of Manganese deficiency

- **Soil application - $MnSO_4.4H_2O$ @ 16-20 kg/ac (less economical)**
- **Foliar spray 3-4 times @ 0.5-1.0% $MnSO_4$ solution (12 - 36 kg Mn /ac) at tillering stage in about 200 L water/ha.**
- **Apply farmyard manure or straw incorporation**
- **Chelates are less effective because Fe and Cu displace Mn.**

Mn Toxicity Symptoms

- Visual symptoms of manganese toxicity in rice appear as brown spots on older leaves.
- About eight weeks after planting the tips of leaves dry out.
- Vegetative growth is not appreciably affected, but grain yield is markedly depressed because of high sterility.

Management of Mn Toxicity

- Liming is a common remedy for manganese toxicity.
- The application of ferrous sulfate ($FeSO_4$), gypsum and farmyard manure can also be helpful.
- Silica slag at a rate of 0.6 to 1.25 mt/ac.
- NPK fertilizer is often needed, but acidifying nitrogen sources should not be used.

Zinc (Zn)

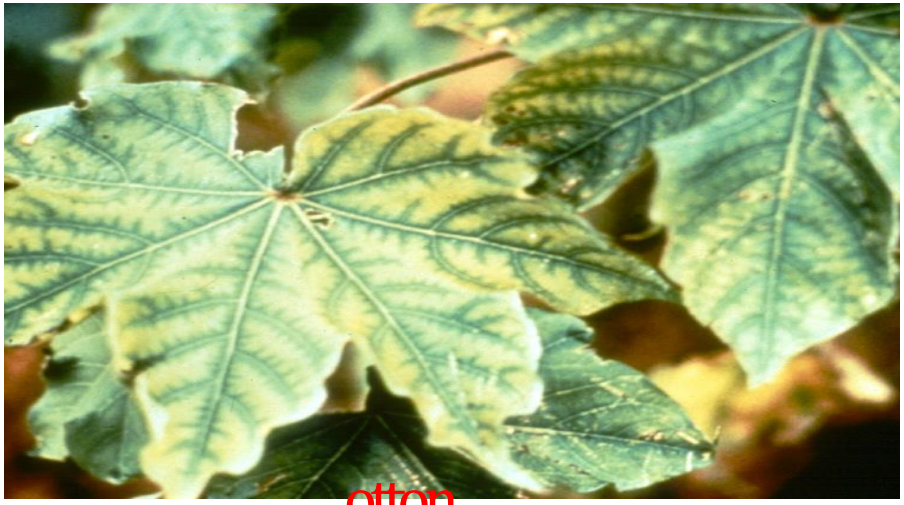
- Zn deficiency symptoms show wide variation in different plant species.
- The common symptoms are chlorosis between the veins.
- Reduction in the size of the young leaves, which are often clustered, bronzing, purple, violet, reddish brown or brown coloration of the foliage.

Zn deficiency in rice

- It is widely spread in calcareous, clayey-neutral, saline-sodic, coarse-textured, highly weathered and leached soils
- Uneven plant growth in patches and stunted, earliness, low spikelet no. and yield.
- Brown to dusty brown spots on younger leaves in red soils, yellowing of leaves /midrib bleaching in black soils appearing at 2–4 WAT.

Zinc deficiency symptoms

oybean



otton

vocado

om

Management of Zn deficiency

- **Regular application of OM (FYM, PM, BG slurry, Compost) @ 0.83 – 1.6 t/ac helps mitigate deficiencies of all micronutrients**
- **Drain the fields frequently with good quality irrigation water**
- **Normal soils, Apply 2 - 4 kg Zn/ac for every 3 seasons**
- **Sodic soils, 22 kg Zn/ha initially followed by 5-10 kg Zn in the later years**

Contd.

❖ **Seed treatment or root dipping in 2.0% ZnO suspension in moderate Zn deficient soils.**

❖**Mid season correction - Spraying 0.5% ZnSO4 thrice at weekly interval between 3-6 WAT.**

❖ **Grow Zn efficient and tolerant varieties.**

Chlorine (Cl)

Deficiency symptoms

- Common symptoms are wilted appearance of the foliage and stuffy roots with laterals showing branching.

- Tomato leaves show chlorotic mottling, bronzing and tissue necrosis.

Chlorine deficiency symptoms in wheat

Management of Chlorine Deficiency

- **Chloride fertilization:**
  - **Most practical source is potassium chloride (KCl), or muriate of potash, which contains about 47% Cl.**

Copper (Cu)

- Plants having a copper content of less than **5** ppm are regarded as Cu deficient.

- Male flowers' sterility, delayed flowering and senescence are the most important effects of Cu deficiency.

- Chlorosis of the younger shoot tissue, white tips, reclamation disease, necrosis, leaf distortion and die back are characteristics of Cu deficiency.

- Necrosis of apical meristem results in elongation of shoot in cereals and auxiliary shoots in dicots.

Contd.

- In cereals, bleaching and withering of young leaves
- Yellowish brown blotches on the leaf particularly in legumes
- Tip drying and bluish green leaf tips are the symptoms in rice
- Empty glumes in wheat
- Total amino nitrogen accumulates in plants

Copper deficiency symptoms

il palm

ugarcane

om

Management of Copper Deficiency

- Soil and foliar application are both effective. Soil application @ 2.4 – 12 kg /ac of $CuSO_4$. 5 H_2O (24 % Cu).
- Foliar application of $CuSO_4$ @ 0.2 % concentration.
- Cu-EDTA contains 9-13 % Cu.

Molybdenum (Mo)

- In most plants, the first effect of Mo deficiency appears as chlorotic mottling between the veins.
- Brassica crops are very susceptible to Mo deficiency, the symptoms developing in 3-4 week old plants.
- Tomato, lettuce, spinach, beet root and Brassica speces especially cauliflower, broccoli and rape seed are very sensitive to restricted Mo supply.
- Legumes develop symptoms which resemble N deficiency.
- Grasses seem to have low Mo requirement

Contd.

- Cauliflower exhibits whiptail (leaves get twisted elongated).

- Cabbage shows cupping, veins become purple, leaves become necrotic and malformed along the margins.

- Tomato– chlorotic mottling – old leaves roll inwards along leaf margin.

- In rice, slight chlorosis between the vein in the middle of the upper and middle leaves and extending across the width.

Deficiency symptoms of Molybdenum

Management of Molybdenum

- Application of 400 -500 gm of sodium molybdate (Na_2MoO_4) along with super phosphate to the soil.
- Mo deficiency can be corrected by spraying 0.1 % sodium molybdate.
- Liming of acid soils helps in correcting Mo deficiency.
- Seed treatment with Mo as sodium molybdate is very effective method of correcting the deficiency.

Deficiency Symptoms of Si

- Rice absorbs ~100 kg Si per ton of grain
- Si-deficient plants are susceptible to lodging with soft, droopy leaves and culms
- Lower leaves with yellow / brown necrotic
- Critical concentration for Si - 40 mg Si/kg soil
- Si deficiency occurs in old and strongly weathered, leached acid soils, and due to removal of rice straw , excessive use of N.
- Si deficiency is not yet common in intensive irrigated rice systems of tropical Asia.

Management of Si deficiency

- Recycling rice straw (5–6% Si), and rice husks (10%), applying rice hull ash and balanced nutrient use of NPK.
- Apply granular silicate fertilizers for rapid correction- Ca silicate: 50 – 83 kg/ac; K silicate: 17–25 kg/ac.
- Apply basic slag @0.83 – 1.25 t/ac once in two years, or fly ash (23% Si) use is beneficial.
- Foliar spray Si @0.1-0.2% with sodium silicate improve Si nutrition.

Aluminium toxicity

Symptoms

- Orange-yellow interveinal chlorosis of younger leaves
- Poor growth stunted plants
- Yellow to white mottling of interveins, followed by leaf tip death and leaf margin scorch
- Necrosis of chlorotic areas occurs if Al toxicity is severe

Occurrence

- Al toxicity is major constraint in acid upland soils of pH < 5.2
- Acid sulfate soils when grown as upland crop few weeks before flooding

Al toxicity Management

- Planting tolerant cultivars which accumulate less Al and absorb Ca and P efficiently.
- Liming of soil with $CaCO_3$ preferably dolomite lime to supply Mg @ 0.83 – 1.67 t/ac to neutralize soil acidity and replace exchangeable Al.
- Correct sub soil acidity by leaching soluble source of Ca like gypsum / phosphogypsum / SSP / lime Incorporate 0.83 t/ ac of reactive rock phosphate to supply P.
- Planting Al-tolerant cultivars which complex soluble Al by root exhudates and accumulate P, Mg and Ca.
- Soil mulching and / or green manuring / organic manuring prevents water loss and phytotoxicity.

Micronutrient Fertilizers

- **There are many different fertilizers that are marketed as micronutrients. Micronutrient are usually mixed with fertilizers containing N, P, and/or K.**

- **It is important to read the label to determine the source of the micronutrient in the fertilizer. The three primary classes of micronutrient sources are:**
  - **inorganic**
  - **synthetic chelates**
  - **natural organic complexes**

Contd.

- **Because micronutrients are needed in such small amounts, the best method to correct a micronutrient deficiency is usually by application of the micronutrient through foliar fertilization.**

- **There is a strong relationship between micronutrient availability and soil pH; therefore, micronutrient availability can be maximized by keeping the soil pH in the correct range.**

Applying Fertilizer : Solubility

- **Micronutrient fertilizers can vary greatly in solubility, so it is important to know the solubility before using.**

- **If a fertilizer with low water solubility is applied to a soil, it may take several months, or even years, for the nutrient to dissolve and become available to plants.**

Methods of Application: Foliar

- **Foliar application of fertilizers is an efficient method of micronutrient application.**

- **If a visual micronutrient deficiency is observed, micronutrient fertilizers should be foliar applied as soon as possible.**

- **Typically, the greater the degree of the deficiency, the less likely it is that the deficiency can be completely corrected with foliar fertilization.**

  - **If a micronutrient deficiency occurs nearly every year in the same location, it may be more cost-effective to either apply a band application of micronutrient at planting or apply a preventative foliar application of fertilizer before deficiency symptoms appear.**

Antagonistic effects among different nutrients

- Excess P adversely affects utilisation of Zn, Fe and Cu.
- Excess Fe adversely affects utilisation of Zn and Mn.
- Excess Zn, Mn and Cu induce Fe deficiency in crops.
- Excess of S and Cu induces Mo deficiency in crops
- Excess of lime induces deficiency of all micronutrients.

Synergistic relationship among different micronutrients

- Beneficial effect of Mo and P in legumes.
- Beneficial effect of Mn and Mo in field crops.
- Beneficial effect of Zn and P at normal level of application in all field and orchard crops
- Proper level of Ca in soil is essential for higher uptake of B.
- Between K and Cu; K and Fe - a proper balance is essential for their normal uptake.
- Adequate level of Zn is essential for proper utilization of Cu and Mn.

Predisposing factors for occurrence of micronutrient deficiencies in soil and plants

- Parent material
- Soil pH
- Land leveling and shaping
- High yielding varieties
- Imbalanced nutrient application

Contd.

- Soil conditions
- Organic matter
- Soil texture
- Clay content
- Interactions with macronutrients,etc.


Thank You