Popular Article

SECONDARY AND MICRONUTRIENTS: DEFICIENCY SYMPTOMS AND MANAGEMENT IN ORGANIC FARMING

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ABSTRACT

The plant requires seventeen essential nutrients for their optimum growth and development. When a plant needs a certain nutrient element, it shows deficiency symptoms or hunger signs. These symptoms are nutrient specific and show different patterns in different crops for different essential nutrients. Secondary nutrients (sulfur, calcium, and magnesium) are necessary as well. Micronutrients are required in small amounts for the proper functioning of plant metabolism. The absolute or relative absence of any of these nutrients can hamper plant growth; alternatively, too high a concentration can be toxic to the plant or to humans. Visual clues of plant nutrient deficient symptoms can alert farmers and other service providers on the type of nutrient deficiencies in soil. If identified early enough, corrective measures can be taken during the growing season to correct the negative impact of such deficiencies.

INTRODUCTION

Plant nutrients are the chemical elements that are essential to the nourishment of plant health. Plant nutrients fall into three categories, all of which are based on the amount a plant needs, not the importance of the individual elements (primary, secondary and micronutrients). Each plant nutrient performs a crucial role in plant growth and development. 17 nutrients are essential for plant health (Dobermann and Fairhurst, 2000). Optimal yields can only be produced when all these nutrients are in proper supply. According to the Law of Minimum, if one or more nutrients are lacking in the soil, crop yields will be reduced, even though an adequate amount of other elements is available. The secondary nutrients are calcium, magnesium, and sulphur. For most crops, these three are needed in lesser amounts that the primary nutrients. They are growing in importance in crop fertilization programs due to more stringent clean air standards and efforts to improve the environment. The micronutrients are boron, chlorine, cooper, iron, manganese, molybdenum, and zinc (Das *et al.,* 2014). These plant food elements are used in very small amounts, but they are just as important to plant development and profitable crop production as the major nutrients. Especially, they work "behind the scene" as activators of many plant functions. In addition to the listed above nutrients, plants require carbon, hydrogen, and oxygen, which are extracted from air and water to make up the bulk of plant weight (Das, 2014).

Calcium (Ca)

Deficiency symptom

The tips of youngest leaves become (white) rolled and curled necrotic tissue may develop along the lateral margins of leaves, and old leaves turn brown and die. Acute deficiency result is stunting and death of the growing point. Possible occurrence of Ca deficiency in soils are coarse textured sandy soils, acid, acid sulphate soils with high leaching and low CEC, soils derived from respective rocks.

Management practices

Ca deficiency can be corrected by proper crop management practices. Application of farmyard manure or straw (incorporated or burned) to balance Ca removal in soils containing small concentrations of Ca is a better option. Besides dolomite (Ca 21%) and lime (Ca 40%) application is also a good option in acid soil not only to manage Ca deficiency but also to raise soil pH.

Magnesium (Mg)

Deficiency symptoms

The symptoms of Mg deficiency are pale-colored plants with orange-yellow *interveinal chlorosis* on older leaves and later on younger leaves, chlorosis progresses to yellowing and finally necrosis in older leaves in severe cases, greater leaf number and length, wavy and droopy leaves and reduced grain quality (Rao KV http://www.rkmp.co.in. Green coloring appears as a *"string of beads"* in which green and yellow stripes run parallel to the leaf. Magnesium deficiency may be confused with Zn or Cl deficiencies, viruses, or natural aging since all have similar symptoms. Fe toxicity is more pronounced in Mg deficient plants.

Management practices

Application of sufficient amounts of FYM or other materials to balance removal in crop plants and straw. Minimizing percolation rates to reduce leaching losses by compacting subsoil during land preparation in coarse textured soils. Foliar application of liquid fertilizers containing Mg and dolomite or other slow acting sources on acid upland soils (Das *et al.*, 2014).. Rapid correction of Mg deficiency symptoms is achieved by applying a soluble Mg source such as kieserite (Mg 17%, S 23%) or Mg chloride (Mg 9%).

Sulphur (S)

Deficiency symptoms

Unlike N, S-deficiency symptoms appear first on the younger leaves, and persist even after N application due to immobile in plant system. Oilseeds, pulses and other crops having high requirement of S suffer most from its deficiency. S-deficient rice plants have less resistance to adverse conditions (e.g., cold).

Management practices

Incorporate straw instead of completely removing or burning it. About 40-60% of the S contained in straw is lost during burning. Carry out dry tillage after harvesting, to increase the rate of sulfide oxidation during the follow period (Das *et al.*, 2014). Usually, S is added as a constituent of fertilizers applied to correct other nutrient deficiencies. Water-soluble S forms such as kieserite and langbeinite are the most efficient fertilizers for treating S deficiency in growing crops. Use slow-acting S forms (gypsum, elemental S) if leaching is likely to be a problem.

Zinc (Zn)

Deficiency Symptoms

Zinc deficiencies mainly occur when soil pH is high, high organic matter in soil, calcareous soils with high bicarbonate content, intensively cropped soils. Symptoms are common on younger or middle aged leaves. Brown to dusty brown spots on younger leaves in red soils, yellowing of leaves/midrib bleaching. Zinc deficiency has also been associated with high bicarbonate content, a Mg:Ca ratio in soils>1, intensive cropping, use of high yielding cultivars, and irrigation with alkaline water.

Management practices

Most preventing measures for zinc deficiency is selection of Zn efficient variety that is tolerant to high level of bicarbonate as well as low zinc in soil. Application of $ZnSo_4$ in nursery beds, drain the field, seedling root dipping in 2-4% ZnO suspension, mid season correction by spraying 0.5% $ZnSO_4$ thrice at weekly intervals between 3-6 WAT *etc* (Das *et al.*, 2014). Curative measure for correcting are application of 20-25 kg/ha ZnSo4 in acid soil, 22 kg Zn/ha initially followed by 5-10 kg Zn in the later years or 50% gypsum + 10 t GM + 22 kg Zn once in 2-3 years in sodic soils, 1.0-1.5 kg/ha Zn as foliar spray at tillering stage and 2 times latter is very helpful for correct this deficiency.

Iron (Fe)

Deficiency symptoms

Deficiency of iron causes chlorosis between the veins of leaves and the deficiency symptom show first in the young leaves of plants. It does not appear to be translocated from older tissues to the tip meristem and as a result growth ceases. The main important deficiency symptoms are interveinal yellowing and chlorosis of emerging leaves, less dry matter production, reduced sugar metabolism enzymes, plants become stunted with narrow leaves.

Management practices

Though it is the most difficult and costly micronutrient deficiency to correct it can be controlled by application of $FeSO_4$ 25 kg/ha in between rows or foliar spary of $FeSO_4$ 1-3% solution (Das, 2013). Iron toxicity can be controlled by seed treatment with Ca peroxide @ 50–100% seed wt., intermittent irrigation at tillering stage and by balanced application of organic fertilizers.

Boron (B)

Deficiency symptoms

Deficiency occurs under moister stress and dry condition which cause reduced plant height. Plants fail to produce panicles if they are affected by B deficiency at the panicle formation stage. The tips of emerging leaves are white and rolled.

Management practices

Boric acid (16.5% B), borax (11.3% B) or Solubor (20.5% B) can be applied to soils to correct boron deficiency. Borax, Boric Acid or Solubor can be dissolved in water and sprayed or applied to soil as a dust. Soil application of B (1-2 Kg/ha) is superior to foliar sprays. For hidden deficiency spray 0.2% boric acid or borax at pre flowering or flower head formation stages.

Manganese (Mn)

Deficiency symptoms

Manganese deficiency is very common in upland, degraded soil high in Fe content, accumulation of H_2S, acid sandy or acid sulphate soil, excessive liming in acid soil etc. Symptoms include yellowing of leaves with smallest leaf veins remaining green to produce a *chequered' effect*. The plant may seem to grow away from the problem so that younger leaves may appear to be unaffected (Das, 2014). Brown spots may appear on leaf surfaces, and severely affected leaves turn brown and wither.

Management practices

Application of FYM, $MnSO_4$ or MnO @ 2-5 kg/ha as multiple application. Chelates should be avoided as Fe and Cu displaces Mn. Prevention can be achieved by improving soil structure. Do not over-lime.

Silicon (Si)

Deficiency symptoms

The major deficiency symptoms of Si are soft droopy leaves and culms, lodging of plant, severe pest-disease attack (Das and Avasthe, 2015). Deficiency generally occurs due to small mineral reserves in organic soil, old soils of subtropical and temperate climates.

Management practices

Silicon deficiency can be correct by irrigation of water rich in Si, avoid excessive application of N fertilizers, recycling rice hulls or hull ash, apply granular silicate like Ca-silicate: 120–200 kg/ha; K-silicate: 40–60 kg/ha for rapid correction. Foliar spray of Si @ 0.1-0.2% with sodium silicate improve Si nutrition.

Copper (Cu)

Deficiency symptoms

Main important deficiency symptoms of copper are chlorotic leaves, bluish green leaves, new leaves don't unroll and leaf tips give needle like appearance, reduced tillering, less pollen viability. Dieback of stems and twigs, yellowing of leaves, stunted growth and pale green leaves that wither easily.

Management practices

Excessive liming in acid soil sometimes cause Cu deficiency in soil. Foliar application can be done during tillering to panicle initiation stage. Soil application can also be done with $CuSO_4$ as broadcasting or band placement. Increased phosphorus and iron availability in soils decreases copper uptake by plants.

Molybdenum (Mo)

Deficiency symptoms

Deficiency symptoms of Mo resembles to nitrogen deficiency (older leaves become chlorotic). Necrotic spots are seen at leaf margins because of NO_3 accumulation. Other symptoms of Mo deficiency include pale leaves that may be scorched, cupped, or rolled (Das and Avasthe, 2015). Leaves may also appear thick or brittle, and will eventually wither, leaving only the midrib.

Management practices

Where large amounts of farmyard manure have been used, molybdenum deficiency is less likely. Dusting with Na/NH_4 @ 100-500 g/ha is very much beneficial. Foliar spay of Na/NH_4-molybdate @ 0.1% is also beneficial.

Conclusion

More information on the transformation and availability of macro and micro nutrients for different soils and the effect of manipulating the soil physical environment and its moisture regimes on plant available nutrients need to be generated. Continuous use of farmyard manure or of other organic sources arrests the depletion of available micronutrient pools from soils. Development of integrated nutrient technology using available organic materials is needed not only to increase nutrient use efficiency but also to decrease the pressure on the use of costly inorganic nutrient carriers. The residual availability of various sources of nutrients for a cropping system needs to be worked out.

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