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Review Article

Interaction Relationship of Plant Nutrients and its Significance in Soil Fertility

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Abstract

Interaction relationship of plant nutrients may also affect the supply of nutrient. In case of phosphorus and zinc interaction (negative) was well known, thus we avoid the application of phosphorus and zinc at same time and field. The plant bio available nutrients was taken up by plants by several process, these processes was also directly or indirectly affected by nutrients interaction. Thus the availability of plant nutrients(macro and micro) was depend upon several biotic, biochemical and edaphic factors, these factors are manage by judicious use of chemical fertilizer and organic sources viz: animal salary, crop residues, green manures and bio-fertilizer. The overall keep our mind the use of manure and chemical fertilizer time of application and rate of fertilizers are also affect the plant nutrient interaction.

Keywords: plant nutrients micronutrients deficiency , Mechanism of nutrient uptake, Plant nutrient interactions

Introduction

Indian soils have become deficient not only in major plant nutrients like nitrogen, phosphorus and in some cases, potash but also in secondary nutrients, like sulphur, calcium, and magnesium. The micronutrients deficiency in Indian soils during the last three decades has grown in both, magnitude and extent because of increased use of high analysis fertilizers, use of high yielding crop varieties and increase in cropping intensity. While zinc, iron, boron and manganese deficient areas are vast, copper and molybdenum deficiency has also been observed in many districts of the country. The problem has been compounded by soil acidity affecting large area in eastern and southern states and soil alkalinity commonly observed in north-western states as crops grown on such soils encounter nutritional disorders and toxicities. Thus, there is an urgent need for correction of individual nutrient deficiency and for arresting its further spread. Accordingly, it has been planned to address micronutrient deficiency in major rice, wheat and pulses growing states of India. It is further intended to support and popularize use of gypsum and lime or dolomite as sources of sulphur and calcium, respectively. The deficiency of calcium in acid soils and sulphur in pulse growing areas has been increasing due to continued mining by crops and use of sulphur free fertilizers.

The requirements of plant nutrition are high or low amount and they should not be neglected although they are needed in adequate quantities. This understanding was developed in 1840 by the German chemist, Justus von Liebig, who made a major contribution to the science of agriculture and biological chemistry. He purpose the 'Law of the Minimum', which describes the effect of individual nutrients on crops. Liebig's Law of the Minimum, often called Liebig's Law, is a principle developed in agriculture that states that if one of the nutritive elements is deficient or lacking, plant growth will be restricted and not in its full potential even when all the other elements are abundant. Any deficiency of nutrient, no matter how small the amount needed, it will hold back plant development. If the deficient element is supplied, growth will be increased up to the point where the supply of that element is so longer the limiting factor. Increasing the supply beyond this point will not be helpful, as some other elements would then be in minimum supply and become the limiting factor. Liebig used the image of a barrel to explain his law. The capacity of a barrel with staves of unequal length is limited by the shortest stave, so a plant's growth is limited by the nutrient in shortest supply. The increase in cultivation intensity with the increasing demand for higher yields with better quality has resulted in increasing demand for nutrient. Plant productivity has increased along the years due to genetic improvement and selection of high yielding cultivars. These cultivars with intensive cultivation methods were found to remove higher quantities of macro & micro nutrients from the soil, leading to deficiencies occurring in many soils. Plants require water, air, light, suitable temperature, and 17 nutrients to complete our vegetative and reproductive life cycle. Plants absorb carbon, hydrogen and oxygen from air and water. and other 14 nutrients come from the growing medium such as soil. Soil nutrients are divided into two groups according to their demanded quantity by the plants. The macronutrients are those that are demanded in relatively high levels. In the group of macro-elements we can distinguish between two sub groups, major ones and secondary ones. The nutrients nitrogen (N), phosphorus (P) and potassium (K) are referred as the major macro-elements, and calcium (Ca), magnesium (Mg), and sulfur (S) are the secondary ones. The micronutrients, which are needed only in trace amounts, are iron (Fe), manganese (Mn), boron (B), zinc (Zn), copper (Cu), molybdenum (Mo), chloride (Cl), sodium (Na), nickel (Ni), silicon (Si), cobalt (Co) and selenium (Se). Within this group of nutrients two definitions exist. The 'essential mineral elements' (or mineral nutrients); this term was proposed by *Arnon and Stout* (1939). The 'beneficial elements' are those that can compensate for toxic effects of other elements, or may replace mineral nutrients in some other less specific functions such as the maintenance of osmotic pressure. The omission of beneficial nutrients in commercial production could mean that plants are not being grown to their optimum genetic potential but are merely produced at a subsistence level. Different divisions exist and in certain references some nutrients might be considered essential, although they only serve as such for certain plant species.

Mechanism of nutrient uptake

Plants absorb nutrients only from the liquid solution phase of the soil. The problem with micro-elements is their limited solubility and therefore their limited presence in the solution. The uptake from the soil solution is done in three major ways: root interception, mass flow and diffusion.

Root interception

As roots proliferate through the soil they also move into spaces previously occupied by soil containing available nutrients, for example, absorbed by clay particles. Root surfaces may thus intercept nutrients during this displacement process (Barber, 1984).

Mass flow - is movement of water and dissolved nutrients, which is driven by the transpiration gradient.

Diffusion is movement of nutrients according to the gradient from high concentration to low concentration. In diffusion, the soil moisture content has a major effect as well as the presence of other ions - both factors may increase the diffusion coefficient (De) of the micro-elements and may increase their uptake. Diffusion is considered the major uptake route for micro-elements, especially when their concentration is limited in the soil solution.

Plant nutrient interactions

Some of the interactions interfere and damage the availability of micro-elements. Some of the interactions are soil interactions, and some are happening in plant tissue due to excessive concentrations in the tissue.

a). Zinc-Nitrogen-high levels of nitrogen induce zinc deficiency (Camp & Fudge1945; Ozanne 1955). Explanations exist: increased growth rate with marginal supply of Zn change in soil solution pH due to different nitrogen source; Zn retention in the roots as *Zinc-Nitrogen* protein complex.

b). Zinc-Phosphorus-high levels of available *Phosphorus* induce zinc deficiency (Thorne, 1957; Stuckenholtz *et al.,* 1966). Several explanations exist: soil interaction with the creation of $Zn_3(PO_4)_2$ *Zinc-Phosphorus* antagonism in the roots affecting the zinc translocation; 'dilution' effect in the plant tissue due to high growth rate that exceeds the uptake rate; physiological effect due to interference of *Phosphorus* in the plant zinc metabolic function.

c). Iron-Phosphorus-excessive supply of *Phosphorus* and an increase of the *Phosphorus* /Fe ratio (Watanabe *et al.,* 1965) inactivates iron (Biddulph & Woodbridge *et al.,* 1952). Explanations are not fully clear and relate to possible competition of *Phosphorus* for Fe with the roots; plant capacity to absorb and hold Fe in a soluble, mobile form decrease as the *Phosphorus* tissue concentration increase; Fe-phosphate precipitate on or in the roots.

d). Copper-Phosphorus - Heavy or prolonged applications of phosphorus result in phosphorus and copper interactions (Bingham, 1963; Spencer, 1966). A significant decrease in Cu leaf concentration was observed at increasing P applications (Bingham & Garber, 1960).

e). Molybdenum-sulphur - plants Molybdenum uptake is reduced by sulphur (Stout *et al.* 1951). It is explained as direct competition between two equivalent anions (negative ion) of the same size; another explanation suggests inhibition of Molybdenum utilization within the plant occurring at low levels of Molybdenum (Reisenauer, 1963).

f). Zinc-Magnesium - An increase of soil pH, followed the use of $MgCO_3$, causes interaction between Zinc and Magnesium within the plant and in the soil (Seatz, 1960).

g). Boron-Calcium- Boron toxicity can be alleviated by increasing concentrations of Calcium. Plants grow normally only when a certain balance exists in the uptake of Calcium and Boron, expressed in equivalent weights of the two elements (Jones and Scarseth 1944). Deficiency due to the formation of *Iron* -Molybdate precipitate in the roots (Gerloff, Stout and Jones, 1959).

h). Molybdenum-*Iron* It was suggested that Molybdenum could interfere with the reduction of *Iron* in solid phase compounds. In another situation, at marginally adequate level, Molybdenum enhanced *Iron* uptake, and at higher levels depressed *Iron* uptake (Berry and Reisenauer, 1967).

i). Copper-Iron - In several crops and mainly citrus, *Iron* chlorosis was produced due to high concentration of *Copper* in the nutrient solution (Chapman, Liebig and Vanselow, 1940).

j). Copper-Molybdenum - antagonism of *Copper* and Molybdenum in plants was suggested (Giordano, Koontz and Rubins, 1966). Some evidence was found to show that Cu interfered with the role of Molybdenum in the enzymatic reduction of NO_3^- Deficiency of one was developed because of the high application rate of the other, and increasing the rate of the antagonist reduced toxicity.

k). Copper-Zinc - zinc was found to induce copper deficiency in several crops. The mechanism is not clear, yet the relation was found to a greater extent in coarse-textured soils (Gilbery, Greathead and Cartell, 1970).

l). Zinc-Iron - the metabolic functioning of Fe in plants is connected in a way with the supply of Zinc (Rosell and Ulrich, 1964). Mechanisms remain unclear, yet one of the suggestions insinuates that the addition of Zinc increases growth and leads to a marked reduction in Iron concentration in the plants.

m). Iron - Manganese - Iron and Manganese are interrelated in their metabolic functions, with the effectiveness of one determined by the proportionate presence of the other. Iron chlorotic plants were observed in different crops when soils contained large amounts of available Manganese. Epstein and Stout (1951) suggested that Manganese interfered with the transport of Fe from the roots to the shoots.

n). Iron – Molybdenum: Two effects of molybdenum and iron are suggested - one beneficial and one detrimental. The mechanisms are not clear. Iron-Molybdenum interactions were observed and it was suggested that Molybdenum accentuated iron deficiency due to the formation of Iron - Molybdate precipitate in the roots (Gerloff, Stout and Jones, 1959). It was suggested that Molybdenum could interfere with the reduction of iron in solid phase compounds. In another situation, at marginally adequate level, Molybdenum enhanced Iron uptake, and at higher levels depressed iron uptake (Berry and Reisenauer, 1967).

Conclusion

The importance of nutrients in overall plant nutrition cannot be neglected. Plant performance is crucially dependent on adequate supply of all elements including those that are demanded in relatively adequate quantities. Although in nature plants have succeeded in developing different techniques to assure sufficient supply of nutrients, in intensive growing methods where plants are pushed to their productivity limits, relying on the plant to feed by itself is not a good option. The interaction of macro and micro-nutrient may also affect the supply of nutrient. In case of phosphorus and zinc interaction (negative) was well known, thus we avoid the application of phosphorus and zinc at same time and field. Thus the availability of nutrient was depend upon several biotic and edaphic factors, these factors are manage by judicious use of chemical fertilizer and organic sources viz: animal salary, crop residues, green manures and bio-fertilizer. The another problem has been compounded by soil acidity & alkalinity affecting large area was found in different part of country. Thus, there is an urgent need for correction of the problematic soils by respective amendments and managed individual nutrient deficiency and for arresting its further spread.

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