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Role of Chelates in Nutrient Availability for Plant Growth

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Introduction

The availability of nutrients might change depending on how heterogeneous the soil is. Chelated fertilisers are created when the chelates are mixed with a nutrient. These safeguard the micronutrients from oxidation, precipitation, and immobilisation as well as shield them from unfavourable soil interactions. The chelated fertilisers increase the micronutrient availability of Fe, Zn, Cu, and Mn, which boosts crop productivity and profitability for commercial agriculture. Chelated fertilisers are created to improve the efficiency of micronutrient uptake.

Chelates

The word "chelate" comes from the Greek word "chele," which alludes to the binding effect of the compound. It is an organic molecule in which a ring-shaped bond between two or more atoms and one metal atom exists. It creates coordinate bonds with a single central metal atom and an organic ligand. The ligands are organic substances that can either be created synthetically or by the roots and excreted into the soil. These ligands may also be referred to as chelators, sequestering agents, chelants, or chelating agents. Chelated micronutrients are a class of products that increase a micronutrient's availability to plants by tying it to an organic ligand.

Chelating agents

Chelating agents are organic or inorganic substances that react with metal ions to produce compounds that are water soluble. Those are composed of a ring-shaped core that creates two or more bonds with metal ions. Inhibiting metal collapse, removing target ions from the environment, preventing metal collapse, and allowing ions to pass across biological membranes are just a few of the ways that chelating chemicals work. The breakdown of organic materials, such as amino acids, organic acids, sugar acids and derivatives, phenols, etc., produces a variety of naturally occurring chelates. The organic chelating agents citric acid ($C_6H_8O_7$), gluconic acid ($C_6H_{12}O_7$), homo citric acid, 2,3-Di hydroxy benzoic acid, etc. are some of the naturally occurring ones.

Additionally, many synthetic chelating agents have been created. These include ethylene diamine-tetraacetic acid (EDTA), N-(hydroxyethyl)ethylene-diamine-triacetic acid (HEEDTA), diethylene-triamine pentaacetic acid (DTPA), ethylene diamine-di-(o-hydroxyphenylacetic acid) (EDDHA), ethylene diamine-di-(o-hydroxy-p-methylphenylacetic acid) (EDDHMA), and ethylene diamine-d (EDDCHA). The most popular synthetic chelating agent among them, EDTA, is utilised for both soil-applied fertilisers and nutrients applied to leaves. DTPA is more efficient and frequently used for alkaline soils.

Chelation Is Required

Because Fe, Mn, Zn, and Cu are present in soil solution as positively charged ions and easily react with negatively charged ions, applying them straight to the soil is ineffective. New chemicals that are not bioavailable to plants resulted from this. Applying zinc to soil causes it to precipitate as zinc phosphate, rendering it inaccessible to plants. The chelate joins with the exposed zinc to make it accessible while shielding it from phosphate fixation. To protect the inorganic nutrient, the organic ligand's bond with it needs to be strong, but it also needs to be able to release the nutrient once it has reached the plant.

Chelation mechanism

Crop leaves are naturally covered in wax, which keeps them from drying out. It also makes it difficult for inorganic nutrients to enter the leaves since it repels water and other inorganic compounds. In order for the plants to use the nutrient, the chelate releases it from the leaves.

Plant roots exude exudates into the soil, and these exudates contain natural chelates. With the aid of this chelate, plants are better able to absorb nutrients in the root-solution-soil system. When the chelated micronutrient gets close to the root hair, it releases the nutrient after the plant's excreted chelate forms a metal complex with the micronutrient ion. The secreted chelate is free and joins forces with a different micronutrient ion in the nearby soil solution to create a complex.

Chelates' function in nutrient availability

Because they are positively charged, many trace elements are unavailable to plants in their basic forms. Plants have negatively charged pores on their leaves and roots. As a result of the disparity in charges, the elements cannot enter the plant. However, when a chelate is added to an element, the metal ion is effectively encapsulated and the charge is changed, allowing the element to pass through the pore and enter the plant.

Certain micronutrients are more soluble and accessible to plants thanks to chelates in the soil. For instance, the chelating compounds bind to the insoluble iron in soils with high pH levels, converting it to a water soluble form that is accessible to plants.

Chelating drugs also stop chemical processes from converting certain nutrients into insoluble molecules that are inaccessible to plants. The nutrient's surface property is altered by the pincer-like bonding process to the ligand, which improves the absorption efficiency of nutrients administered topically.

By bringing the concentration of some metal ions back to healthy levels, chelates can lessen the toxicity of those ions to plants. Chelates stop the leaching or washing out of nutrients. Chelation makes nutrients in soil more mobile. The plant's ability to absorb nutrients is improved by this greater mobility. Chelating chemicals decrease the amount of iron available, which inhibits the growth of plant pathogens.

Need of chelated fertilizers

1) For commercial crop production, micronutrient fertilisers are required since high pH soil ($pH > 6.5$) frequently has low bioavailability in micronutrients as Fe, Mn, Zn, and Cu.
2) The sensitivity of a crop to the aforementioned micronutrient deficits relies on the cultivar and species of the plant. Three susceptibility categories for commercial crops exist: high, medium, and low. Chelated fertilisers are frequently necessary for the first two types.
3) Application of inorganic water-soluble micronutrients to the soil is frequently unsuccessful for resolving micronutrient imbalances.
4) Chelated fertilisers can greatly improve nitrogen uptake and utilisation efficiency and are less reactive to soil conditions.
5) Foliar application of chelated fertilisers is typically more effective thanNumerous edaphic factors, including high pH, bicarbonate content, plant species, and abiotic stresses, can decrease the bioavailability of iron.
6) In plants, iron is mostly used as the ion Fe^{2+}. When the soil pH is higher than 5.3, this can easily be converted by the plant to the inaccessible ferric form (Fe^{3+}). Application of chelated iron can stop the conversion of Fe^{2+} to Fe^{3+}, which is a common occurrence in soil with a pH higher than 7.4.

Chelate Benefits

1) Rapid assimilation: Chelated micronutrients are more quickly absorbed by plant leaves than when supplied as crystalline salts, making them readily available to plants.
2) Tolerance: Chelates are often well tolerated by plant leaves. Mineral salts, on the other hand, frequently result in leaf burning after foliar treatment.

3) Decent solubility: Mineral chelates typically dissolve in water extremely quickly. They provide crystal-clear solutions devoid of precipitates or sediments. This ensures high levels of efficiency and prevents nozzle blockage.
4) Excellent miscibility: Many crop protection agents, as well as other foliar fertilisers, mix well with chelated fertilisers. They can thus be included in different tank mixtures, reducing the need for field manoeuvres. Before making tank mixtures, the grower should carefully read the manufacturer's label.
5) Extreme stability: Even in unfavourable soil conditions, chelated fertilisers maintain their stability. For instance, even in calcareous soils with a pH as high as 12, HBED-chelated Fe(III) maintains its stability.
6) Extremely cost-effective: A lower rate of chelated fertiliser is required since they are typically more efficient than crystalline salts made of the same nutrients at the same molar concentration. This significantly lowers the overall cost necessary to achieve top performance.

Conclusion

A novel technique to improve the soil's nutrient availability is to utilise chelated fertiliser. Chelated Fertilizers can greatly increase nutrient absorption and usage efficiency despite not responding adequately to soil conditions.

References

Sekhon, B. S. (2003). Chelates for micronutrient nutrition among crops. *Resonance*, *8*(7), 46-53.

Kaushik, P. (2015). Use of natural organic and synthetic chelating agents for efficient phytoremediation. *Int J Enhanced Res Sci Technol Eng*, *4*(6), 99-101.