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A REVIEW ON EXPLORING THE SIGNIFICANCE OF MICRONUTRIENTS IN CROP PRODUCTION

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ABSTRACT

The essential plant nutrients for growth and development include Zinc, Iron, Boron, Molybdenum, Manganese, Copper, and Chlorine. For an agricultural product to be successfully developed proper crop nutrition is crucial. One of the most significant variables that promote crop production and development is the linked supply of micronutrients with macronutrients in sufficient levels and optimum proportions. Even though they are frequently needed in very low amounts, micronutrients are necessary for plant development. To produce a maximum number of high-quality products, vegetable production must employ micronutrients effectively. The current study has given a significant of micronutrients in crops. Zinc, Boron, Copper, Chloride, Iron, Manganese, and Molybdenum are significant micronutrients. Although Mo is particularly specific to nitrate reductase, other micronutrients are engaged in a variety of photosynthetic processes. Other micronutrients like Zn, Cu, Fe, and Mn are also connected to a variety of enzymatic activities.

Keywords: micronutrients, importance, agricultural, crop, soil

INTRODUCTION

A micronutrient is an element that is crucial for all agricultural crop production with limited availability and storage in less amount, often measured in milligrams per kilogram of soil or biomass or gram per hectare. Trace elements which elements that are present in trace amounts in soil, water, air, or living beings such as microbial bacteria, plants, animals, or human beings(Alloway, 2013). The significance of micronutrients in agriculture production is well established and their utilization has remarkable contributions to the expanded productivity of such crops(Tripathi et al., 2015). The nutrient components that are needed to be approximately in less amount are called micro or minor nutrients of trace elements. Micronutrients are necessary as dominant to be a superior extension, yield, and standard in a plant(Yadav et al., 2018)(Maurya et al., n.d 2018.).

Micronutrients play a very important role in the particles and simple state of crops and are suggested to do as impulsions in proceeding to various responses in crops(Karthick et al., 2018). Micronutrients are necessary for plant growth, development, and metabolism, so their shortage can result in several physiological disorders/diseases in plants reducing both the quality and quantity of crops(Sharma & Kumar, 2016). Due to intense cropping, soil erosion, nutrient losses by leaching, liming of acid soils, and imbalanced fertilizer application including NPK, there is no replacement due to the percentage of their deficiency in crops has increased substantially in recent years (Aske et al., 2017).

Zinc:

(Pankaj et al., 2018) studied that Zinc is essential for appropriate plant growth and development. It is required for the synthesis of plant hormones which include auxin along with carbohydrate formation. (Kochian, 1991) was discovered that Zinc is transferred in xylem routes in divalent or organic acid bonds. Zinc creates a complex with organic acid with lower molecular weight in phloem sap, enhancing its concentration. (Horst, 1992) identified the quantity of Zn found in natural (unfertilized and uncontaminated) soil relies on the parent rock's chemical components and the degree of weathering processes.

Table 1: The source of Zinc Fertilizer: (Alloway, 2008)

Compound	Formula	Zinc Concentration%
Inorganic compounds		
Zinc sulfate monohydrate	$ZnSO_4.H_2O$	36
Zinc sulfate heptahydrate	$ZnSO_4.7H_2O$	22
Zinc oxysulphate	$xZnSO_4.xZnO$	20-50
Basic zinc sulfate	$ZnSO_4.4Zn(OH)_2$	55
Zinc oxide	ZnO	50-80
Zinc carbonate	$ZnCO_3$	50-56
Zinc nitrate	$Zn(NO_3)_2.3H_2O$	23
Zinc phosphate	$Zn_3(PO_4)_2$	50
Zinc first	Fritted Glass	10-30
Ammoniated zinc sulfate solution	$Zn(NH_3)_4SO_4$	10
Organic Compounds		
Disodium zinc EDTA	$Na_2ZnEDTA$	8-14
Sodium zinc HEDTA	NaZnHEDTA	6-10
Sodium zinc EDTA	NaZnEDTA	9-13
Zinc polyflavonoid	-	5-10
Zinc lignosulfonate	-	5-8

Effect of zinc:

(Noulas et al., 2018) was studied that the zinc effect in soil may be related to geological or human causes, but its insufficiency in agricultural soil is expected to be the most globally common micronutrient shortage limitation affecting crop productivity (yield losses can approach 40%). Zn insufficiency was more common in calcareous (high pH) soils that have been artificially leveled to ensure consistent irrigation flow. This is due to the elimination of topsoil and organic matter rich in micronutrients in field leveling, especially in calcareous soil.

Boron:

(Gupta, 1980) investigated that Boron is one of seven forms of a list of nutritional elements needed for regular plant growth. The significance of boron as an agricultural substance has also increased significantly. Hundreds of research and publications have been generated in the last 50 years about the significance of Boron for a variety of crops in countries on every continent. (Alt, D., & Schwarz, W. ,1973) studied that Boron is assimilated as the molecule and that boron is passively dispersed with the transpiration steam, at least in high supply. (Shen et al., 1993) found about Boron is required for nitrogen (N) metabolism so it increases the nitrate levels and suppresses nitrate reductase activity when boron is low. (Bolaños et al., 2004) studied that Earlier research focused on the function of Boron in the creation of cyanophycean heterocyst in leguminous crops, actinomycete symbiosis, and rhizobial N fixation.

Table 2: Source of Boron Fertilizer (Niharika & Sheeba, 2022)

Effect of Boron:

Source	Formula	Boron Concentration%
Borax	$Na_2B_4O_7.10H_2O$	11
Boric acid	H_3BO_3	17
Colemanite	$Ca_2B_6O_{11}.5H_2O$	10-16
Sodium pentaborate	$Na_2B_{10}O_{16}.10H_20$	18
Sodium tetraborate (Fetibor)	$Na_2B_4O_7.5H_20$	14-15
Sodium octaborate (Solubor)	$Na_2B_8O_{13}.4H_2O$	20-21

(Ali et al., 2015) studied Boron's effect on the nutrient quality of FCV tobacco (Nicotiana tabacum L.) has been studied in two types, TM-2008, and Speight G-28. According to the studies, tobacco crop yield increased at 1kg B ha-1 and then reduced sequentially in both categories. The amount of boron given had a significant impact on the quantities of N and P. Potassium amounts were also raised, and increased, indicating that the tobacco crop would be of greater quality. Boron exposure increased nutritional ratio concentrations such as K/B, Cl/B, and Mn/Fe, whereas K/Cl and Zn/Cu ratios enhanced at lower boron concentrations and reduced at higher boron concentrations. (Kumar et al., 2018); (Niharika & Sheeba, 2022) found out that boron levels are higher up to 1.0 mg B kg-1 of soil-applied boron-enhanced seed cotton crop and its assigning features(plants height, number of leaf and monopodial stems, dry matter accumulation, and number of flowers per plant) and root biomass considerably over the control, but after that became non-significant.

Copper (Cu):

(Quartacci et al., 2000);(Kabata-Pendias, 2010)studied that Copper, as a micronutrient, has been important in several physiological processes, such as oxidation, photosynthesis, carbohydrate, protein, and cell wall metabolism, along with symbiotic N2 fixation. (Wang et al., 2018) studied about Due to the general effects on environmental safety, heavy metal contamination in the soil becoming a worldwide challenge. (Nagajyoti et al., 2010)(Gallego et al., 2012) reported that Human activities, especially the use of agrochemicals, are the basic sources of heavy metal accumulation in the soil.

(Fifield and Haines 2000) was discovered It is created in the form of parental rocks and human activity in the soil. Batteries, pigments & paints, alloys, fuel, catalysts, fertilizers, and insecticides all are significant industrial and agricultural usage for Cu. (Savithri et al., 2003)had study However certain micronutrients are also influenced by Zn, MN, and Fe amounts are reduced when the Cu content in the soil of grape farms is raised with continuous application of copper fungicides in the form of Bordeaux combination.

Table 3: Source of Copper Fertilizer(Havlin et al., 2016)

Source	Formula	Copper Concentration %
Copper sulfate	$CuSO_4.5H_20$	25
Copper sulfate monohydrate	$CuSO_4.H_2O$	35
Copper acetate	$Cu(C_2H_3O_2)2.H_2O$	32
Copper ammonium phosphate	$Cu(NH_4)PO_4.H_2O$	32
Copper chelates	Na_2Cu EDTA	13
Organics	-	<0.5

Effect of Copper:

(Trehan & Grewal, 1995) was discovered that soil and foiler application of copper fertilizer increased potato tuber yield as compared to the control. Additionally, they discovered that foliar spray of Cu was established better than soil application. (Agarwal et al., 2004)submitted a report that the use of copper fertilizer at 5% under drip irrigation expanded the uptake of major and micronutrients as compared to the control.

Chlorine (Cl):

(Heckman, 2016) had found that Chlorine is considered a micronutrient however, it is usually taken up by plants in macronutrient amounts. Natural chlorine supplies are usually sufficient, and an evident indication of insufficiency is seldom. (Engvild, 1986) studied about In many crops, it is essential to remove chlorine from the air, chemicals, and water to create symptoms of chlorine shortage. Anion chloride constitutes most of the chlorine in plants. More than 130 native chlorine-containing chemicals were identified in plants. (Xu et al., 1999) is discovered that Chlorine reaches soil through a variety of sources, such as chloride in rainwater, irrigation water, animal manures, plant residues, nutrients, and some crop protection compounds. The amount of chloride discharged by the atmosphere annually ranges from 18-36 kg/ha/year in continental areas to more than 100 kg/ha/year in coastal locations.

Table 4: Source of Chlorine Fertilizer(Heckman, 2016)

Source	Formula	Chlorine Concentration%
Potassium chloride	KCL	47

Sodium chloride	NaCL	60
Ammonium chloride	NH_4CL	66
Calcium chloride	$CaCL_2$	64
Magnesium chloride	$MgCL_2$	74

Effect of Chlorine:

(PARK & LEE, 1995) was discovered the effect of chlorine treatment on microbial population and sustaining the quality of cut vegetables were examined. The procedure with < 100 ppm chlorine probably reduced the microbial load in vegetables without causing serious quality losses.(Komosa & Górniak, 2012) evaluated that the effect of raising the chloride concentration in the nutrient solution resulted in higher chlorine content and reduced nitrogen, and ascorbic acid, decreasing sugar, and dry matter content in specific fruit products. There wasn't any other effect on the amount of nitrate and nitrite besides the acidity and carotene amount in fruits.

Iron (Fe):

(Adnan et al., 2020) was found out that Iron is an essential micronutrient for all living things because it has a significant impact role in metabolic activity such as DNA composition, respiration, and photosynthesis. Iron also promotes several metabolic pathways. It is an element of many enzymes' prosthetic groups. Iron is required for several physiological and biochemical plant processes. (Borlotti et al., 2012) is discovered in porphyrin molecules including cytochrome, hemes, hematin, ferrochrome, and leg hemoglobin. These chemicals engage in an oxidation-reduction reaction process that takes place during respiration and photosynthesis.

Table 5: Source of Iron fertilizer(Havlin et al., 2016)

Source	Formula	Fe concentration%
Ferrous sulfate	$FeSO_4.7H_20$	19
Ferric sulfate	$Fe_2(SO_4)_3.4H_2O$	23
Ferrous oxide	FeO	77
Ferric oxide	Fe_2O_3	69
Ferrous ammonium phosphate	$Fe(NH_4)PO_4.H_2O$	29
Ferrous ammnonim sulfate	$(NH_4)_2SO_4.FeSO_4.6H_2O$	14
Ironammnonium polyphosphate	$Fe(NH_4)HP_2O_7$	22
Iron chelates	NaFeEDTA NaFeEDDHA NaFeDTPA	5-14 6 10
Natural organic materials	-	5-10

Effect of Iron:

(Husain et al., 1989),(Silspour, 2007) proved that the foliar applications of Fe in the form of ferrous ammonium citrate at 0.1 percent in combination with Zn and B micronutrients at 0.1% at 30,60, and 75 days after transplanting resulted in a caused significant elevation in chili plant height. (Wisal et al., 1990) proposed that applying 5kg/ha raised wheat grain production by 14% when compared to the control. (El-Magid et al., 2000)found that foiler applications of Cu, Mn, Zn, and Fe enhanced wheat grain and straw yields. A field study was carried out to explore the effect of Zn and Fe on quantitative and quality indicators of winter wheat. A foliar experiment of Fe and Zn enhanced grain production and protein content, according to their discovery.

Manganese (Mn):

(Graham & Webb, 1991);(Huber & Graham, 1999); Heckman et al., 2003) studied that Manganese is probably the most studied micronutrient in terms of effects, and vital in the development of plant resistance to both roots and foliar disease. (Marschner, 1995a) found that Mn content in soil differs and is dependent on a variety of environmental and soil biotic factors. Mn is essential at significantly higher concentrations by higher plants than by fungi and bacteria, and the pathogen may take the benefits of this variation in requirement. (Brennan, 1992);(Huber & Graham, 1999);(Heckman et al., 2003);(Simoglou & Dordas, 2006) discovered that Manganese supplements can help to control a variety of pathogenic diseases, like powdery mildew, downy mildew, take all, tan spot, and as well as others.

Table 6: Source of Magnesium Fertilizer(Mousavi, Sayed Roholla et al.,2011)

Source	Formula	Magnesium Concentration%
Manganese sulfate	$MnSO_4.3H_2O$	26-28
Manganese Chloride	$MnCL_2$	17
Manganese Carbonate	$MnCO_3$	31
Manganese dioxide	MnO_2	63
Manganese Oxide	MnO	41-68
Manganese Kalat	Mn-EDTA	12

Effect of Manganese:
(Serasinghe, 2013) was identified that using tomato cells in suspension culture, the effects of different Mn concentration ranges in the culture medium on biomass production, nutrient content, cell division, and viability. The biomass and dry weight has the highest at Mn different levels when contrasted to cell grown with different levels like 0 or 0.2 mm (Rahman et al., 2011) were determined that in plant species their height, number of leaves, number of tubers, and weight of tubers were all greatest at some level of micronutrient, while the control already had lower value.

Molybdenum (Mo):
(Bortels, 1930) found that Molybdenum was discovered by the Swedish chemist, Carl Wilhelm Scheele in 1777. Its impact on the biological system wasn't established until 1930 when Bortels found that molybdenum was necessary for the development of Azotobacter bacteria in a nutrient medium. (Arnon, 1937) was identified in these studies conducted in 1937 and 1938, respectively for copper, boron, iron, manganese, and zinc which were considered to be micronutrients. With the help of these observations identifying that plant growth was improved by elements other than these led Arnon to concede that the list of necessary elements was incomplete, and prompted him to test whether or not molybdenum was necessary for the higher plant growth. (Hamlin, 2016) had studied that the allotment of molybdenum for the various plant organs diversified considerably among the plant species, but gradually the concentration of molybdenum is higher in seeds(Marschner, 1995b) and nodules of N2 fixing plants

Table 7: Source of Molybdenum Fertilizer(Havlin et al., 2016)

Source	Formula	Mo Concentration%
Ammonium molybdate	$(NH_4)_6Mo_7O_{24}2H_2O$	54
Sodium molybdate	$Na_2MoO_4.2H_2O$	39
Molybdenum trioxide	MoO_3	66
Molybdenum frits	Mo silicates	2-3

Effect of Molybdenum:
According to some previous studies, Mo supplementation raised the amount of N and P in plants by regulating the amount and activity of N-assimilating enzymes and altering the dynamics of P portions in rhizosphere soil(Qin et al., 2017);(Sabatino et al., 2019); (Imran et al., 2021).In parallel, the researcher identified that Mo fertilization did not affect the proportion of N and P in any species or their elements. These inequalities may be affected by the different plant sections being analyzed; like the stem and leaves have different purposes and react differently to Mo fertilization (H. Liu et al., 2010);(L. Liu et al., 2017). The research is based on the plants' shoots, in contrast to different studies (Rana, Hu, et al., 2020);(Rana, Sun, et al., 2020). were primarily focused on the leaves, which are sensitive to nutritional changes. Another possible explanation for the little effect of Mo intake is stoichiometric homeostasis(Persson et al., 2010). Plants may be capable of preserving homeostasis in changing situations (like ad those containing soil nutrients)(Yu et al., 2015);(Zhou et al., 2023).

CONCLUSION

It is concluded from this review that agricultural products require micronutrients during their growth and development. The nutritional quality of agricultural products is a growing concern, so it's critically important to apply micronutrients to maintain soil health and the production of crops in addition to preserving the quality of agricultural products.

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