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Critical Analysis on Effect of Micronutrients on Flowering Plants: A Review

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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Review Article

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ABSTRACT

We have explored the effect of various micronutrients to plant growth and some of the problems due to their deficiencies. The various treatments of micronutrients to plants gives yield at different proportion. This thorough analysis explores how micronutrients affects the flowering of crops, concentrating on how they affect fruit set, flowering, and general plant health. Micronutrients are necessary for many physiological processes, such as hormone regulation, photosynthesis, enzyme activation. Plant growth may be negatively impacted by their excess or deficiency, which could result in lower quality, quantity, and flowering. The impact of micronutrients on flowering plants is the subject of a systematic analysis of the most recent scientific literature in this review. Micronutrients are essential for many physiological processes that are vital to plant growth and

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development. These processes include those involving zinc, copper, chlorine, manganese, molybdenum, and iron. Their unique impact on the complex phases of flowering and reproductive development is examined in this paper. We look at the interactions that occur between micronutrients and environmental variables like soil pH and temperature that affect flowering. The study delves into the molecular mechanisms that underlie flowering responses mediated by micronutrients, encompassing the regulation of hormones and gene expression. In an effort to close knowledge gaps regarding the complex interplay between micronutrients and plant flowering, the review highlights obstacles and suggests future lines of inquiry. To sum up, this analysis adds to a thorough knowledge of how micronutrients influence plant flowering dynamics and offers insights that can improve crop productivity and agricultural practices.

Keywords: Micronutrients; photosynthesis; chlorophyll; auxin; vase life; corm weight.

1. INTRODUCTION

In global agriculture and horticulture, flowering crops [1] are essential because they provide food, aesthetic appeal, and support for ecosystems. Many elements must come together for these crops to be grown successfully, including the availability and balanced intake of vital nutrients. Micronutrients frequently go unnoticed despite playing a crucial role in the growth and development of plants, whereas macronutrients like potassium, phosphorus, and nitrogen are extensively researched and utilised. Micronutrients play an essential role in plant metabolism, including cell wall development, photosynthesis, chlorophyll formation, respiration, various enzyme activities, hormone synthesis, and nitrogen fixation, despite having a relatively low requirement in normal crop production. A micronutrient is an element that is necessary for all higher plants but whose accumulation and requirement are both relatively low. It is typically measured in milligrammes per kilogramme of soil or biomass or in grammes per hectare [2]. Due to their advantageous nutritional support, micronutrients are currently gradually gaining popularity among flower growers and simultaneously make better harvests and returns.

Crop enrichment with micronutrients, particularly iron and zinc, may be useful in controlling flowering in plants, better flower production, as well. In a variety of respiration-related oxidation-reduction reactions, iron is an essential component. During photosynthesis, nitrates and sulphates are created. For the production of high-quality corm and cormlet seeds, the growers are not provided with any recommended doses of chemical fertilisers, particularly micronutrients. Even flower growers can increase their corms' growth without using any chemical fertilisers. As a result, they are unable to obtain corms and cormlets of the best possible size for flower cultivation [3,4].

Gladiolus grandifloras L., a member of the Iridaceae family. Due to the fact that Gladiolus, which refers to the long - pointed leaves, means sword in Latin, it is commonly known as Sword Lilly [5]. Gladiolus represent faithfulness, moral integrity, strength of character and remembrance. Its ancestralchromosome number is 15. The output of flowers can be increased, and vase life can be extended, by using micronutrient sprays in the right amounts. My further research focuses on the flowering of gladiolus as the corm is easy to available as compared to some species and gladiolus is the plant which is used in various decoration purposes and under the category of ornamental plants.

2. ESSENTIALITY OF ZINC

Zinc is required for the creation of auxin [5]. Zinc application to plants aids in raising yields. The best rate at which to apply zinc foliar spray in order to achieve a notable grain yield[15]. the possible harm that plants, people, and animals could sustain from low zinc bioavailability in soil. Moreover, zinc can be included in proteins and other macromolecules. Zinc is an element found in proteins that functions as a structural, functional, or regulatory cofactor for numerous enzymes [6,7]. Based on research, it is evident that foliar spraying plants with zinc micronutrients [8] yields good results. As such, zinc should be considered an essential micronutrient in agriculture.

Effect of zinc in flowering plants: Zinc is a micronutrient that is vital to plants and is involved in many physiological functions. Zinc plays a number of important roles in roses' growth, development, and general health, just like it does in other plants. Zinc is involved in the synthesis of chlorophyll, the green pigment responsible for photosynthesis. Adequate zinc levels support optimal photosynthetic activity, which is crucial for the production of energy and biomass in rose. Flowers form in part because of zinc. A. C. Bhaskarwar and the co-workers proved that zinc plays a vital role in flowering. As per their study [9], it is recorded that: the 0.5% zinc foliar spray treatment took significantly fewer days for the first flower bud initiation (35.33 days) and 50% flowering (52.00 days), which was found to be comparable to the 0.75% zinc treatment (37.67 and 55.33 days, respectively). In contrast, the water spray control treatment and the 2.0% zinc treatment recorded the maximum number of days for the first flower bud initiation (42.33 and 42.67 days, respectively) and 50% flowering (59.33 days each). It affects how reproductive structures develop, which in turn affects the quantity and caliber of rose blooms. Reduced flowering and irregular flower development can result from zinc deficiency.

Many of the enzymes involved in metabolic processes require zinc as a cofactor. These enzymes are essential for many different biochemical processes, such as energy metabolism, absorption of nutrients, and the synthesis of significant molecules. Cell division and DNA synthesis depend on zinc. It is essential for the development of new tissues and structures, such as stems, leaves, and flowers. Gladiolus, which are grown for their beautiful flowers, should pay special attention to this. Flowers develop in part because of zinc. It influences gladiolus bloom quality, size, and colour as well as the development of reproductive structures. Zn foliar spray significantly increased the number of corms in gladiolus. According to research by J. P. Singh and peers [10], the number of corms per plant was 1.74 compared (1.46 for the control group). Reduced flowering and irregular flower development can result from zinc deficiency.

Chlorophyll, the green pigment involved in photosynthesis, contains zinc. The production of chlorophyll, which is essential for the plant's capacity to absorb sunlight and transform it into energy, is supported by adequate zinc levels. The size, quality, and colour of flowers are all influenced by zinc during their growth. Growers cultivate chrysanthemums for their eye-catching blooms; a zinc deficit can cause aberrant flower development and decreased flowering. The activation of enzymes that support plant defence mechanisms is mediated by zinc. soil application of Zn is more effective than other applications when applied to chrysanthemum , according to research done by Z. Derakhshani et al. Zinc-rich chrysanthemum plants are more resilient to a number of illnesses and environmental stresses [11].

3. ESSENTIALITY OF MANGANESE

Manganese may play a role in the bio-assimilate synthesis that produces more leaves and, ultimately, the partitioning of floral growth. Manganese contributes to photosynthesis, which increases the absorption of carbohydrates and produces lush vegetative and floral growth [12]. Manganese is a necessary cofactor for the photosynthetic machinery's oxygen- evolving complex (OEC), which catalyses the water-splitting reaction in photosystem II (PSII). Foliar sprays have been proven to be more cost-effective than soil application for a variety of ornamental flower crops, and combination sprays containing micronutrients havebeen effectively sorted [12,13]. However, applying manganese topically can reduce crop losses caused by drought as it has multiple physiological and biochemical functions, including the synthesis of proteins, the activation of enzymes, the formation of chlorophyll, and the metabolism of carbohydrates [14].

Effect of Manganese in flowering plant: A number of photosynthesis-related enzymes, including the water-splitting complex in photosystem II, require manganese as a cofactor. Sufficient levels of manganese improve the plant's capacity to absorb and utilise sunlight for energy production. Manganese helps other nutrients, like iron, enter and move through plants more easily. For the general health of the plant, it aids in maintaining the balance of nutrients. The synthesis of lignin, a substance found in plant cell walls, requires manganese. Sufficient amounts of manganese help maintain the structural integrity of plant tissues in rose**.**

During the photosynthetic process, manganese functions as an activator for enzymes, which is necessary for the synthesis of chlorophyll. It is necessary for the metabolism of nitrogen and contributes to the reduction of nitrates. Additionally, the growth of root systems as a whole and the production of root hairs in gladiolus are both aided by manganese. Manganese deficiency in gladiolus can cause chlorosis, or yellowing of the leaves, as a result of reduced chlorophyll synthesis. Plants may experience stunted development and reduced growth. A manganese deficiency may also have an impact on gladiolus flowering and total yield.

Maintaining ideal manganese levels in the soil is crucial for gladiolus growth. The manganese content of the soil can be ascertained with the use of soil testing, and excess or deficiencies can be corrected with the use of suitable fertilisation techniques.

Many enzymes involved in photosynthesis, respiration, and nitrogen metabolism require manganese as a cofactor. Superoxide dismutase is one of the enzymes it activates, helping plants to cope with oxidative stress. Manganese plays a role in the photosynthetic process, specifically in photosystem II's water-splitting complex in chrysanthemum. It facilitates the transformation of light energy into chemical energy, supporting normal development and growth. Through stimulating the activity of enzymes involved in nitrogen metabolism, manganese contributes to the assimilation of nitrogen. This is necessary for the production of proteins and amino acids in chrysanthemum.

4. ESSENTIALITY OF IRON

The role of iron as a micronutrient to plant is vital for their growth. Plant growth and development are significantly impacted by iron deficiencies, and too much iron within cells is harmful [15,16]. High soil pH, free calcium carbonate, low organic matter, cool, damp springs, low soil oxygen, high temperatures, and high levels of soil phosphorus, copper, manganese, and zinc can all lead to iron deficiencies.

Effect of Iron in flowering plants: A necessary ingredient for the production of chlorophyll, the green pigment that drives photosynthesis, is iron. Sufficient levels of iron guarantee that roses can effectively absorb and utilise solar radiation for energy generation, fostering robust and healthy growth. Several of the enzymes involved in photosynthesis depend on iron to function. It facilitates the transformation of water and carbon dioxide into carbohydrates, which gives the plant the energy it needs for metabolic activities. Enzymes involved in cellular respiration, the process by which plants turn carbohydrates into energy, require iron as a cofactor. This energy is essential for many physiological processes, such as the uptake of nutrients, the development of flowers, and the general vigor of plants. The synthesis of the pigments that give flowers their colour depends on iron. It adds to the level of intensity.

Enzymes involved in cellular respiration, the process by which plants turn carbohydrates into energy, require iron as a cofactor. This energy is required for many metabolic processes, such as the uptake of nutrients, the development of roots, and the formation of flowers. The synthesis of proteins and enzymes involved in nitrogen metabolism depends on iron. This is critical for the effective use of nitrogen in the synthesis of amino acids and other necessary molecules. The number of corms in gladiolus increased significantly when foliar sprayed withiron. According to research by J. P. Singh and coworkers, the number of corms per plant was 1.66 (1.55 for the control group).

In gladiolus, iron is necessary for healthy flower development. It aids in the synthesis of pigments and other substances that affect the size, colour, and general quality of flowers. During photosynthesis, iron is a component of the electron transport chain, which helps to convert light energy into chemical energy. The synthesis of carbohydrates and other organic compounds necessary for plant development depends on proper photosynthesis. The plant uses iron as a cofactor to activate the enzymes responsible for cellular respiration, which releases stored sugars as energy. This energy is necessary for many metabolic functions, such as the uptake of nutrients, the growth of roots, and the production of flowers in chrysanthemum.

5. ESSENTIALITY OF MOLYBDENUM

A trace element that can be found in soil, molybdenum is necessary for the growth of most biological organisms, including plants and animals. As a transition element, molybdenum can be found in a variety of oxidation states [17], from zero to VI, the most prevalent of which is present in the majority of agricultural soils. Petiolar Mo concentration [15]changes between flowering and veraison were influenced by availability.

Effect of molybdenum: Enzymes involved in nitrogen metabolism, specifically those that convert nitrate to ammonia in plant tissues, require molybdenum as a cofactor. The synthesis of proteins, amino acids, and other molecules containing nitrogen depends on this process. Sufficient molybdenum facilitates roses' effective uptake of nitrogen**.** Plants need molybdenum in order to produce seeds and flowers. In roses, this can help with both the development of strong, viable seeds and the creation of beautiful flowers. Although plants require molybdenum for growth, high concentrations can be hazardous.

Although it is uncommon, molybdenum toxicity can happen in soils that are highly molybdenum-containing or acidic. A surplus of molybdenum can cause nutrient imbalances by interfering with the absorption of other vital nutrients in roses.

Enzymes involved in nitrogen metabolism, specifically in plant tissues' conversion of nitrate to ammonia, contain molybdenum. The synthesis of proteins, amino acids, and other molecules containing nitrogen depends on this process. Sufficient molybdenum facilitates gladiolus's effective use of nitrogen. Nitrate reductase is one of the enzymes that molybdenum cofactors with in a variety of metabolic pathways. These enzymes are involved in the metabolism of sulphur and the assimilation of nitrogen. Plants use molybdenum in the process of making seeds. In chrysanthemums, adequate molybdenum levels support the growth of healthy seeds. Molybdenum influences nitrogen metabolism, which has an indirect effect on plant photosynthesis even though it is not directly involved in the synthesis of chlorophyll. Chlorophyll production is aided by molybdenum-supported efficient nitrogen utilisation. Although molybdenum is necessary for plant growth, high concentrations can be hazardous. Although rare, molybdenum toxicity can result in nutrient imbalances and occur in acidic or high molybdenum soils.

6. ESSENTIALITY OF CHLORINE

It is evident that the organisms responsible for nearly 50% of the world's annual net primary production in saline environments are tolerant of high external Cl^-, which is considerably above the beneficial range. younger leaves developing chlorosis and the plant withering. Because Cl is present in both the atmosphere and rainwater, deficiencies are [18,19].

Effect of chlorine in flowering plants: Necrosis or leaf burn can result from elevated chlorine concentrations. This usually happens at the leaf margins and may cause the affected tissue to turn yellow. A plant's capacity to make energy and synthesise carbohydrates may be adversely affected by chlorine toxicity, which can obstruct photosynthesis. Unbalanced nutrient levels can result from excessive chlorine levels interfering with the plant's ability to absorb other vital nutrients. The entire health of the rose may be impacted by this disruption of nutrient uptake. The process of photosynthesis may be hampered by chlorine toxicity, which would impair the plant's capacity to make energy and carbs. Stunted growth and subpar overall plant development may result from this. Overspray of chlorine can interfere with plant roots' ability to absorb vital nutrients. This disruption could result in nutritional deficiencies and imbalances, which would affect a number of physiological functions. Gladiolus plants may experience damage to their roots from chlorine, which could limit their ability to take up water and nutrients from the soil.

Most people don't think of chlorine as a necessary nutrient for plants, including chrysanthemums. On the other hand, plants may suffer detrimental effects if exposed to elevated levels of chlorine, which are frequently found in chlorinated irrigation water. The following are possible consequences of too much chlorine in chrysanthemum plants. Elevated levels of chlorine may cause leaf burn, which results in browning or necrosis on the leaf margins. This obvious damage, which can affect the plant's overall aesthetic appeal, is a sign of stress. The process of photosynthesis may be hampered by chlorine toxicity, which would impair the plant's capacity to make energy and carbs. Growth and development can be stunted and compromised by reduced photosynthesis.

7. ESSENTIALITY OF COPPER

In a peat-sand substrate, the effects of deficiencies in copper and boron on spray chrysanthemums (cv. Hurricane) have been investigated. A severe lack of copper inhibited the initiation and growth of buds; if any lateral shoots were present, they grew longer and produced more leaves and bracts. Plants that have the majority of their roots in the top soil are directly impacted by high soil Cu concentrations because Cu is mostly concentrated in these upper soil layers (0–15 cm) [20,21,22].

Effect of copper in flowering plants: A number of enzymes necessary for vital processes like photosynthesis and respiration require copper as a cofactor. These enzymes are essential for the synthesis of energy and other metabolic processes. Chlorophyll, the green pigment that is essential for photosynthesis, is made with copper. Sufficient amounts of copper are necessary for both effective photosynthetic activity and a healthy leaf colour of rose. The process of photosynthesis may be hampered by chlorine toxicity, which would impair the plant's capacity to make energy and carbs. Growth and development can be stunted and compromised by reduced photosynthesis [23].

The production of lignin, a structural element of plant cell walls, requires copper. Gladiolus poisoning symptoms can include yellowing, deformed, and stunted growth of the leaves. Elevated copper levels may cause nutritional imbalances by interfering with the absorption of other vital nutrients. Plant development and general health may be impacted by this.Soil Testing: Regularly test the soil to determine the concentrations of micronutrients, such as copper. Gladiolus foliar sprayed with copper significantly increased corm number. According to research by J. P. Singh and colleagues, 1.68 corms are produced for every plant, compared to 1.53 for the control group. This aids in figuring out whether the soil contains an excess or deficit of copper. Fertilisation: If a deficiency is found, apply fertilisers containing micronutrients, such as copper. On the other hand, overfertilization must be avoided because too much copper can be toxic.

Chlorophyll, the green pigment that is essential for photosynthesis, is made with copper. Sufficient amounts of copper are necessary for both effective photosynthetic activity and a healthy leaf colour. The pH of the soil affects copper availability. To guarantee adequate copper uptake, keep the pH of the soil in the ideal range for chrysanthemums, which is slightly acidic to neutral. Pay attention to the amount of copper in irrigation water because too much copper in water sources can lead to soil buildup. If necessary, think about using different sources of water. For chrysanthemum plants to grow and develop healthily, copper levels must be balanced. Proper fertilisation techniques combined with routine soil and plant health monitoring will help guarantee that chrysanthemum plants get just the right amount of copper without becoming toxic.

8. SUMMARY

Blooming plants depend heavily on micronutrients for their growth and development. Compared to macronutrients, these necessary elements are needed in smaller amounts, but their lack or insufficiency can have a major impact on the productivity and health of plants. Iron (Fe), manganese (Mn), zinc (Zn), copper (Cu), and molybdenum (Mo) are the main micronutrients.

9. CONCLUSION

The analysis of micronutrients' effects on flowering plants concludes by highlighting the vital role these nutrients play in the growth and development of plants. Micronutrients are necessary for many physiological processes, such as photosynthesis, enzyme activation, and nutrient uptake. Examples of these processes include iron, manganese, zinc, copper, boron, and molybdenum. Micronutrient availability must be balanced for flowering plants to function at their best. To address micronutrient excesses and deficiencies, appropriate soil testing and nutrient management techniques are essential. Additionally, the effects of micronutrients can differ based on the type of plant and the surrounding environment, highlighting the significance of customised strategies for various plant species.

In summary, understanding the effects of micronutrients on flowering plants is fundamental for optimizing agricultural and horticultural practices. Proper management of micronutrient levels can lead to healthier, more vibrant plants with improved flower production, ultimately benefiting both growers and the environment. Further research in this field is essential for advancing our knowledge and improving the cultivation of flowering plant

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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