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Physiological Effects of Certain Micronutrients and Their Mixtures on The Growth and Metabolism of Some Plants

Aiad Abdelkareim Akhreim[1*] K. D. Ahire[2]

[1]Omar Al-Mukhtar University, Faculty of Science, Botany Department, Box 919, Al-Bayda, Libya.
[2]Department of Environmental Science, K.R.T. Arts, B.H. Commerce, A.M.. Science (KTHM) College, Nashik, Maharashtra, India

ABSTRACT

The objective of the current study was to examine the effects of micronutrient mixes and their applications as a biofertilizer solution on the growth and metabolism of different plants. There has been a notable progress in our understanding of the critical function "trace metals" play in plant viability and production during the last three decades. The application of nanomaterials has demonstrated potential in enhancing seed germination, nutrient utilization, plant tolerance to environmental challenges, and overall plant growth while minimizing environmental effect when compared to the use of conventional fertilizers and pesticides. It has been discovered that zinc oxide nanoparticles, or ZnO-NPs, are essential for plants to be able to detect and react to abiotic stressors. An attempt has been made to increase the yield per unit of land and increase the farmed area in order to improve the overall productivity and quality of legumes. This has been made possible by the use of high-yielding cultivars and enhanced agronomic techniques, such as fertilization. The application technique (soil, foliar, or the new "seed coat" method at planting) and the source of the micronutrient fertilizer (salts, acids, or chelates) have a major impact on how effective micronutrient fertilization is. Nonetheless, a number of studies have shown that the administration of micronutrients in combination is essential for controlling a number of plant biochemical processes that result in improved yield, growth, and seed quality. The effects of foliar application of liquid metalostates of Fe, Mn, and Zn (amino acids - chelated) on pea and cowpea plants in a pot experiment using loamy soil [21]. Each element's concentration, either alone or in combination, was set at 100 parts per milliliter. When Fe was applied topically alone or in combination with Mn and Zn, the researchers saw a considerable increase in plant development, including plant height, internode length, number of branches, and dry weight. They also found that combining Fe and Mn boosted the number of pods and seed output. The same authors also observed that applying Fe and Mn alone or in combination (with Zn) was the only way to raise the 100-seed weight in pea plants. Although the relationship between ZnO and salt in higher plants has been extensively studied, little is known about the possible benefits of applying ZnO-NP to mitigate the harm that comes with salinity stress. Furthermore, methods such using PGPBs and plant genetic engineering can be used to lessen the stress that salinity causes to plants. The number of branches/plant, pods/plant, and seeds/pod increased in field experiments[23] when Zn was applied as seed coating with Zn0 (at 0.1 and 0.2%) followed by two foliar sprays with ZnSO4 (at 15 and 30 or 15 and 45 days after emergence). Specific seed weight, seed yield/plant, harvest index, and seed yield all increased as well. According to the current study's findings, spraying Zn or Mo, or both together, during the early and late stages of inflorescence after sowing for 96 days (stage II) and 133 days (stage III) significantly improved the fresh and dry weight of bean plant leaves. Comparing treated plants (at stage II) to untreated ones, it was shown that the administration of Zn & Mo at a low level of 50 mg increased the fresh and dry weight of leaves more than the high level of the two mineral ions. Moreover, the fresh and dry weight of the leaves increased significantly when the mixture of both ions was applied.

Keywords: *Bio-fertilizers; Microbial Technology; Biodegradation of environmental hazardous, Micronutrients and their Mixtures.*

Corresponding Author
Aiad Abdelkareim Akhreim
Omar Al-Mukhtar University, Faculty of Science, Botany Department, Box 919, Al-Bayda, Libya.

INTRODUCTION

We are frequently exposed to a range of chemicals and heavy metals, such as lead, cadmium, arsenic, chromium, and mercury, through the consumption of food and water. These substances have been connected to a number of illnesses. The cultivation of plants, animals, and other living forms for the production of food, fiber, biofuels, and other goods necessary for human well-being is known as agriculture, sometimes referred to as farming or husbandry. Biofertilizers (Eco-solution) can be used to promote crop plant nutrient uptake and improve the quality of agricultural soil. These preparations comprise viable or dormant microbe strains that, when given by seed or soil, interact with the rhizosphere.

In sustainable agriculture, biofertilizers are used to increase plant yield by minimizing or doing away with the usage of chemicals like chemical soil fertilizers and pesticides. By providing organic nutrients made by microorganisms, these biofertilizers—also referred to as "plant-growth promoting rhizobacteria" or PGPR—play a critical part in enhancing soil fertility and satisfying plant nutrient requirements. Biofertilizers don't contain dangerous chemicals that could disrupt the soil environment, unlike chemical fertilizers. In comparison to conventional fertilizers, they are thought to be safe and eco-friendly, providing advantages like better soil quality, higher crop yields, and the creation of compounds that encourage plant growth. Furthermore, biofertilizers are inexpensive and easily manufactured in large amounts on the farm as needed. The parental inoculums eventually become adequate for plant growth and multiplication, reducing the requirement for ongoing application.

The potential application of safe, natural compounds to promote plant development and increase resistance to various illnesses has received a lot of attention lately. Zn treatment has no interactions with P and little effect on lentil plant growth [50]. [32] the effects of zinc on lentil plants and found that varying zinc administration rates and techniques had a significant impact on plant height, number of branches per plant, pods per plant, and weight of 100 seeds. Spraying faba beans with 0.3% Zn produced the largest root dry weight, whereas 5 mg Zn/kg soil produced the maximum root weight and nodulation [3].

In his research, [55] chickpea plants and found that a zinc shortage stunted the plants' growth. Interestingly, he also found that too much zinc—up to 100 parts per million—caused toxicity in plants and inhibited their ability to grow. On the other hand, after 30 and 45 days of sowing foliar seeds, [24] discovered that the application of 0.1% and 0.2% ZnO or two flairs of 0.5% ZnSO4 mixed with 0.25% lime considerably improved the yield of seeds in plants. Applying 50 mg of zinc increased the production of fenugreek (Trigonella foenum–graecum) and onions (Allium cepa) by a small amount. Additionally, they observed that at 400 mg/kg of zinc in the soil, the production of fenugreek dropped. The researchers came to the conclusion that the crop being grown affected how harmful a given heavy metal was[13]. Moreover, they discovered that the concentration of zinc in fenugreek leaves and onion bulbs rose linearly as the amount of administered micronutrients increased. Applying 20 kg of zinc chloride/ha greatly increased the output of groundnut plant pods, according to [7].[3] studied *Vicia faba*, they discovered that the best dry weight values were obtained by foliar spraying the plant with 0.3% Zn-EDTA and applying 90 or 180 kg of P2O5/fed. Additionally, they showed that applying 0.5 kg of Zn-EDTA/fed or spraying 0.3% Zn-EDTA to the soil in conjunction with 90 kg of P2O2/fed greatly boosted the dry weights of different plant organs, including the roots, leaves, and stems. When faba bean (*Vicia faba*) plants were treated with Boy flan as a nutrient.

1.2. Combined effects of certain micronutrients on the growth characteristic of some plants:

Nitramin-6 is a trace element compound that contains Mn, Zn, Cu, B, Mo, and other elements. [56] found that applying Nitramin-6 topically to soybean plants resulted in a considerable increase in dry matter. S. Applying Cu, Zn, B, and ammonium molybelate to faba bean plants also boosted dry matter production and branch counts, according to [2] Zn-treated plants had the greatest number of seeds/pot and seed index, while Cu-treated plants had the most pods, seeds, seed/plant, and harvest index. Application of zinc and magnesium boosted nodulation and nodule dry weight in chickpea plants, according to [33] reported that Mn & Zn spray greatly enhanced the number of pods produced by a single soybean plant. This observation may have been made because zinc and manganese activated certain enzymes in the soybean during cell division and elongation. Studies conducted by [8], [38],[49] and [33] showed that chickpea plants treated with zinc and manganese had higher branch counts and dry weights. When other conditions are favorable, [22] emphasized the significance of balancing the amounts of zinc and B concurrently for maximum yields.

According to [39] B must be present for maize seedlings cultivated in black earth soil to utilize zinc as efficiently as possible. It was proposed that Zn interaction could begin prior to B insufficiency even in cases when boron levels are only slightly low. Applying boron fertilizer stopped the Zn from interacting with the plant, allowing for more growth until the accumulation of dry weight reduced the Zn levels to an extreme deficit. In the absence of zinc fertilizer, high amounts of boron from fertilization tended to restrict root development and lower zinc uptake and translocation. The function of B in the physiological mechanisms controlling the uptake and transport of Fe, Mn, and Zn was also emphasized by [14], in a study, the absorption of Fe and Mn was significantly reduced, whereas the uptake of Zn was increased in bean plants that were three weeks old and cultivated in a nutrient media lacking in B. [6] found that B and Mn hastened cotton maturity and increased fiber output. Furthermore, [25] found a considerable positive association between the concentration of B in the solution and the concentration of Mn in the leaves, but not between the B levels and the Zn levels in the leaves. Low B levels were associated with lower Mn and Zn concentration in cotton leaves [45]. Moreover, [4] found that increased foliar B, Zn, and Mn treatment significantly increased peanut fruit and foliage yield. According to [9], foliar spraying of 60 ppm Mn + 60 ppm Fe + 90 ppm Zn + 2 ppm Mo on groundnut plants produced a considerable increase in the weight of the pods, seeds, straw, 100-seed weight, pod yield per fed, and seed yield per fed.

However, phosphatic fertilizer and trace elements (Zn, Mn, Cu, and Mo) were applied to lentil plants in a study by [1]. Remarkably, the findings demonstrated that the number of branches per plant and plant height were not significantly

impacted by the trace elements. On the other hand, spraying Zn and Cu alone or in combination greatly increased the production of faba bean plants and their constituent parts, according to [48]. The same scientists also noted that when B (10 gm/L) was applied to faba bean plants, it significantly improved the number of pods, seed weight per plant, and 100-seed weight when compared to untreated plants. [19] Conducted a study on faba bean plants and discovered that spraying the plants with B, Zn, and Cu increased the amount of dry matter per plant, plant height, protein percentage, and the amounts of Cu, Zn, and Fe in the seeds. In a similar vein, [20] found that spraying Zn and Cu onto faba bean plants greatly increased yield and its constituent parts, as well as the percentage of protein and the Zn, Fe, and Cu content of the seeds. According to [17], spraying cowpea plants with varying amounts of Mn and Mo, either separately or together, often enhanced plant development traits like the quantity of pods produced per plant and seed yield. Moreover, the same investigators discovered that cowpea seeds with 20 parts per million of Mn had higher levels of protein, N, and total carbs. Nevertheless, it was found that Mn and Mo, either separately or in combination, had no appreciable impact on the quantity and weight of seeds in each pod, the weight of 100 seeds, or the amount of P and K present in the seeds.

1.5. Physiological effects of some micronutrients on certain mineralion contents of some plants:

The transition element molybdenum is mostly found in aqueous solutions as the highly oxidized molybdate oxyanion. This form is essential to the functioning of enzymes. Oxidized molybdate is similar to other divalent inorganic ions like phosphate and sulfate because of its electron configuration. These parallels have important ramifications for soil molybdenum availability and plant absorption. Molybdenum is readily mobile in both the xylem and phloem of plants when it comes to long-distance transport [34]. With the exception of nickel, plants require less molybdenum than other mineral nutrients. Because it can modify its valency when it is a part of metal enzymes, molybdenum has a variety of uses in plants. Only a small number of enzymes in higher plants have been shown to have molybdenum as a co-factor. These enzymes are intimately involved in redox processes and perform both structural and catalytic roles. Xanthine oxidase/dehydrogenase, nitrogenase, nitrate reductase, and perhaps sulphate reductase are a few notable examples. The requirements for molybdenum are contingent upon the method of nitrogen supply, and the activities of molybdenum are intimately associated with nitrogen metabolism. However, not only do plant species range greatly in their molybdenum distribution among various organs, but genotypes within the same species, like Phaseolus vulgaris, also differ dramatically [12]. As would be predicted, adding molybdenum to deficient soils specifically promotes the growth of plants that depend on N2 fixation. The increased ability for N2 fixation is reflected in the rise in nodule dry weight in response to molybdenum. On the other hand, the type of nitrogen supply determines how applying molybdenum to legumes in soils lacking in the mineral would affect the plants.

According to a study by [46] applying molybdenum (Mo) to both nodulating and non-nodulating soybean plants improved the nitrogen content and seed yield exclusively in the nodulated plants, particularly in situations where there was not enough nitrogen fertilizer available. This emphasizes that molecular oxygen has a more significant role in nitrogen fixation than nitrate reduction. Furthermore, it implies that Mo fertilizer in conjunction with appropriate rhizobial infection can substitute nitrogen fertilizer treatment to legumes in soils with low Mo availability. During the initial phases of growth, foliar spraying legumes with Mo is especially beneficial since it is mostly delivered to the nodules. This has been seen in soybean and groundnut, where foliar spray, as opposed to soil application, not only boosts production but also improves the amount of Mo and nitrogen absorbed by shoots, seeds, and nodules. Ascorbic acid concentration in plants decreases when Mo is deficient, according to several research. Additionally, [29] emphasized the connection between chloroplast disorganization—a common illness induced by Mo deficiency—and whiptail symptoms. While Mo is clearly involved in plant phosphorus metabolism, the precise mechanism is yet unknown. According to [15] lower leaf chlorotic interveinal mottling is one of the outward signs of Mo deficiency, which is followed by marginal necrosis and leaf infolding. Severe weather can cause the mottled patches to become necrotic, which would wilt the leaves. Additionally, mo shortage prevents the development of flowers, and when they do, they frequently abscise before bearing fruit.

Conversely, concerning the important function of the mineral ion zinc, it is most likely related to the production of the auxin plant hormone, or indole-3acetic acid (IAA). According to [51], tomato plants without zinc had a subtle drop in auxin concentration, but when zinc was given, the plants' IAA content significantly increased. These alterations in auxin content, both positive and negative, happened before any growth reaction to the presence or lack of zinc, indicating that symptoms of deficiency may have something to do with the decline in plant concentrations. In this context, zinc serves as an activator for a number of enzymes related to the metabolism of plants. Carbonic anhydrase, an enzyme that is mostly found in mammals but can also be found in some marine plants, was the first enzyme known to contain zinc [35].This enzyme helps carbonic acid break down into water and carbon dioxide. [30], other enzymes that depend on zinc include alcohol dehydrogenase and pyridine nucleotide dehydrogenase. Zinc deficient tomato plants accumulate inorganic phosphorus, indicating that zinc may also operae as an activator for several phosphate-transferring enzymes, including triosephosphate dehydrogenase and hexose kinase. The accumulation of soluble nitrogen molecules, such as amides and amino acids, is another noteworthy feature of zinc deficiency [47]. This observation suggests that zinc is essential for the production of proteins.

Effects of zinc on several mineral ions in plants, namely Ammi visnaga plants[10]. They found that treated plants had significantly higher levels of P & Zn than untreated plants. Similarly, [43] found that while Ca & P levels were not significantly impacted, there was an increase in Fe & Zn levels in the leaves of Tagetes erecta plants treated with 0.5% zinc. According to [41], adding micronutrients like zinc (Zn) greatly increased the amount of phosphorus present in the sweet peas' above-ground sections. Zn treatment at 100 ppm boosted Zn% in Catharanthus roseus plants, as shown by [28], spraying Zn on Tagetes patula plants raised P throughout the entire plant and Zn & Fe in the leaves and stems, according to [16] research. In their 1989 study, *Mentha arvensis* was treated with 5 ppm Zn by [52] which led to an increase in Zn, P, and Fe absorption. They also came to the conclusion that applying zinc improved the availability of zinc and P in the soil. [42] found that spraying 50 parts per million of zinc to mustard plants greatly raised the amounts of zinc, P, and Fe in the seeds. In comparison to the control treatment, [53] found that spraying 500 ppm Zn as EDTA boosted P, Fe, and Zn absorption on Rosmarinus officinalis (L.) plants. According to [5], *Nigella sativa* plants' leaf Fe and Zn contents increased when ZnSO4 at 60 ppm was sprayed on them. Zinc at the maximum amount (75 ppm) was observed by Moustafa et al. (1997) to significantly lower Zn or Fe levels in Chrysanthemum plant leaves.

In contrast, [11] investigation on *Lolium pernne* L. Cv Apollo revealed that when the Zn supply rose from 0.0 to 0.5 mM, the Ca content of the leaves reduced.

In a different study, [37] found that, in comparison to the control treatment, applying zinc to *African marigold* plants increased the amounts of P, Zn, and Fe in the herb and flowers. In a similar vein, Moreover, [36] showed that applying a zinc spray to peanut plants raised the amounts of Ca, Zn, and P in the plant's leaves.

To sum up, a number of studies have emphasized how mineral ions affect plant development and nutrient content. Environmental elements like temperature and soil moisture content may have an impact on these impacts, which may result in increases or decreases in nutrient concentrations. These elements may have an impact on the rate of shoot growth as well as the availability and uptake of nutrients by the roots. Compared to deep-rooted perennial species, which have a greater ability to buffer nutrients within the shoot, shallow-rooted annual species are more vulnerable to these environmental impacts. When interpreting the current study's findings, it is critical to take these considerations into account.

2.2. Analysis of data:

According to [26] the findings were statistically analyzed using the "t" test with 0.05 and 0.01 thresholds for the significantly and extremely significantly significant results, respectively.

2.3. Morphological demonstrations:

Plant samples containing Zn (50 mg/L & 100 mg/L), Mo (50 mg/L & 100 mg/L), and a high level combination of both (100 mg/L) were taken both before and after the mineral ions were applied topically. Numerous morphological characteristics were examined, such as the quantity of leaves on a plant, the length of the stem and roots in centimeters, the number of blooms on a plant, and the number of pods on a plant. In addition, measurements were made of the fresh and dried weights of the stems, roots, leaves, and pods. The seeds generated from each treatment and the untreated control were gathered at the conclusion of the growing season (yield stage) in order to examine certain traits like the weight of 100 seeds and the percentage of germination.

2.4. Chemical investigations:

Freshly harvested leaves at various stages of the plant's growth, both before and after treatments, were weighed in order to determine the amounts of photosynthetic pigments such as total chlorophylls a + b carotenoids and chlorophylls a and b. Additionally, using phosphate buffer pH 7.6, a known fresh weight of plants was taken both before and after application to measure the activity of hydrolytic enzymes (lipases, proteases, amylases, and invertases) in the terminal bud at various phases of plant growth. To find plant growth hormones such auxins, gibberellins, and cytokinins, more fresh plant samples from the terminal buds were taken both before and after treatments. The plant sections that were observed morphologically were oven dried at 80°C until a consistent dry weight was reached, both before and after treatments. Following the drying process, these samples were ground into a fine plant powder in order to analyze several metabolites, such as sucrose, total soluble sugars (TSS), and total sugars (soluble and insoluble).

2.5. Determination of chlorophylls:

[54] approach was applied to determine the chlorophylls in a quantitative manner. Using this technique, a single gram aliquot of fresh leaves was finely chopped. Using 100 ml of 80% aqueous acetone (v/v), the sliced tissue was ground with an appropriate amount of glass powder in a mortar to extract the pigments. Using Whatman No. 1 filter paper, the homogenate was quantitatively transferred to a Buchner filter. The filtrate was then put into a 100 ml volumetric flask and filled with 80% acetone to make the entire volume to 100 ml. Using a spectrophotometer, the optical density of the plant extract was determined at two different wave lengths (649 and 665 nm). These are the wavelengths in the spectrum where chlorophyll a and b absorb lightest. The following formulas were used to determine

the amounts of chlorophyll a, b, total chlorophylls, and carotenoids in plant tissue:
- 11.63 (A665) - 2.39 (A649) mg chlorophyll a/gm tissue. where the reading of the optical density is indicated by "A".
- 20.11 (A665) - 5.18 (A649) mg chlorophyll b/gm tissue.
- 6.45 (A665) + 17.72 (A649) mg chlorophyll a+b/gm tissue. [40] description, the contents of carotenoids were ascertained as follows:

Metric of carotenoids mg/g tissue = 1000 times optical density (A470) – 1.82 (content of chlorophyll a) – 85.02 (content of chlorophyll b) / 198.

2.6. Estimation of carbohydrates:

Using an electric shaker incubator, 200 mg of finely powdered plant material that had been oven-dried was soaked in 10 ml of 80% (v/v) ethanol at 25 Co for the duration of the experiment. The filtered extract was then dried in an oven set to 60 degrees Celsius and dissolved, according to the protocol outlined by [31], in a known volume of distilled water to determine the amount of total soluble sugar. Modifications of the methods described by [57] and [27] were used to quantify total soluble sugars and sucrose, respectively.

2.7. Estimation of Total-soluble sugars (TSS):

In a boiling water bath for ten minutes, 0.1 mg of ethanolic extract and 3.0 ml of freshly made anthrone reagent (150 mg anthrone + 100 ml 72% H2SO4) were reacted. Following chilling, the plant extract samples' color was assessed at a wavelength of 625 nm using a spectrophotometer.

2.8 .Estimation of Sucrose:

Reactive sugars in 0.1 ml of the extract were first broken down in 0.1 ml of 5.4 N KOH (30.24 gm/100 ml) at 97 Co for 10 minutes in order to determine the sucrose levels. After cooling the reaction product, 3 ml of freshly made anthrone reagent was added. It was then heated at 97 Co for 5 minutes, cooled, and the color was assessed using a spectrophotometer at 620 nm.

2.9 . Estimation of total carbohydrate contents:

Using colorimetric techniques, the total carbohydrate content was determined, first, a sugar tube was filled with a weighted quantity (200 mg) of the dry fine powder made from plant tissue. Then, 20 milliliters of 1 NH2SO4 were quickly added. After that, the tube was brought to a boil in a boiling water bath using a reflux condenser and a Soxhlet apparatus for six hours. After allowing the tube to cool, barium carbonate was added in little amounts. The resultant mixture was then filtered and transferred into a 100 ml measuring flask. Several times, the residue was cleaned using tiny volumes of pure water. Then, using distilled water, the combined filtrate was adjusted to the known volume. A precise volume (1 ml) of the sugar solution was quantitatively transferred into a test tube in order to ascertain the total amount of sugars contained. Then, 5 ml of concentrated analar sulphuric acid was added, and 1 ml of a 5% aqueous phenol solution was added. By measuring the intensity of the resultant yellow-orange color at 490 nm, a spectrophotometer was used. One milliliter of distilled water was used in place of the sugar solution in a control experiment.

A standard curve was made using different sucrose or glucose concentrations, as seen in Figs. 3 and 4. The levels of sucrose (expressed in glucose or sucrose equivalents) and total soluble carbs were then determined using this curve.

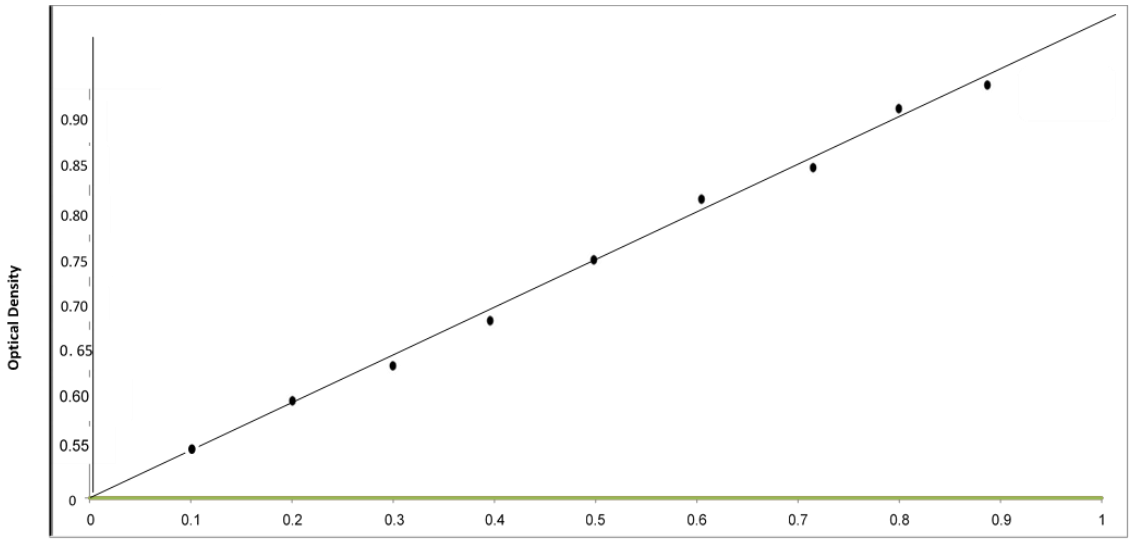

Fig. 1. Standard curve of glucose (m g/ml)

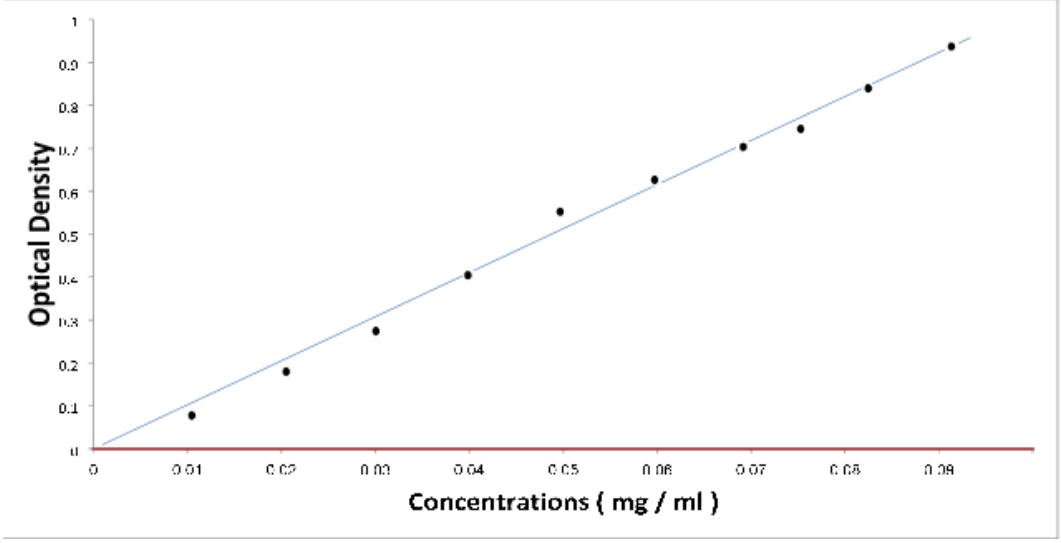

Fig 2. Standard curve of sucrose (mg/ml).

3. Experimental Results and Discussion

3.1. Morphological Investigations:

The capacity of plants to absorb microelements that are essential to their growth and productivity in a selective manner is limited. As such, the essentiality of a mineral element cannot be ascertained from the mineral composition of plants growing in soils. However, a more accurate knowledge of the essentiality of mineral elements and their function in plant growth and metabolism has been attained through the use of water and sand culture techniques. Additionally, by purifying compounds and creating estimation methods—which have proven essential in the study of microelements like zinc and other elements in plant growth and metabolic investigations—these techniques have advanced analytical chemistry. Consistent with these developments, the current work aims to examine the impact of applying zinc and molybdenum on the growth and metabolism of leguminous crops, namely broad bean plants. Before the broad bean plants were given any treatments, a number of morphological traits were examined during the vegetative stage (I) of plant growth. The average length of the stem and root per plant at 68 days of seeding was 31.67 cm and 7.47 cm, respectively, according to the data, which are displayed in Table (1).

Table 1. Some morphological characters of Vicia faba plant after 68 days of sowing before the 1st treatment at vegetative (Stage I). Each value is mean of 20 reading. (±)= standard error of the mean.

Morphological characters		
Stem length (cm)	Number of Leaves/plant	Length of root (cm)
31.67±0.80	6.40±0.15	7.47±0.36
Fresh wt. of stem (gm)	Fresh wt. of leaves (gm)	Fresh wt. of roots (gm)
..0.7± .0.0	7..0..±.000	17017±70.1
Dry wt. of stem (gm)	Dry wt. of leaves (gm)	Dry wt. of roots (gm)
.007±.01.	7.01.±.000	001.±.0..38

According to the study, on the other hand, the stem, leaves, and roots each plant had respective average fresh weights of 80.83 gm, 100.00 gm, and 71.43 gm. Nonetheless, these plant portions had dry weights of 6.53 gm, 10.70 gm, and 9.40 gm per plant, in that order. After 96 days of sowing and the first foliar application of mineral elements, the data shown in Table (1) and Fig. (1&2) clearly showed that spraying zinc element (50mg or 100mg) on broad bean plants reduced the number of leaves per plant during the early stage of flowering (II). Comparing these declines to the corresponding controls revealed that they were statistically not significant. Furthermore, it was discovered that the percentages of these declines were 8.20% and 14.8%, respectively. The number of blooms per plant, however, increased

non-significantly under the same circumstances, increasing by 13.95% at 50 mg and 18.6% at 100 mg. Furthermore, compared to untreated plants, Table (2) and Fig. (1&2) showed that molybdenum application—at either a low or high level—produced little increases in the number of leaves on broad bean plants. Conversely, the application of molybdenum at both low and high concentrations markedly enhanced the quantity of blooms per plant. These gains were 22.09% and 9.30%, respectively, in percentage terms. Regardless of whether the elements were administered singly or in combination, it is significant to note that the treatment of zinc or molybdenum, at low or high levels, encouraged an increase in the number of flowers per plant as compared to non-treated plants.

CONCLUSION:

It is possible to draw the conclusion that applying zinc or molybdenum topically to broad bean plants is crucial for the accumulation of the studied mineral ions in the roots, which in turn promotes plant development and productivity. Applying a low dose of molybdenum reduced the Zn concentration in the plant leaves by 2.08%, while increasing the amounts of Mo, Mg, and P by 432.39%, 79.27%, and 41.62%, respectively. When broad bean leaves were treated with a high dose of Mo (100 mg) at the early fruiting stage, the P content was reduced by 3.43%. However, under the same conditions, the Zn, Mo, and Mg levels increased to 7.29%, 1004.92%, and 71.79%, respectively. After treating the leaves of the faba plant with a mixture of two ions (Zn + Mo by 100 mg), it was discovered that the same trends of reducing or rising with regard to the indicated elements arose.

Researchers may make some future recommendations based on current research; like, Multi-element Interactions: Examine how different micronutrients interact to affect the development and metabolism of plants. Even though the effects of individual micronutrients have been thoroughly researched, knowledge of their combined effects and potential synergy or antagonists can be very helpful in improving nutrition for plants.

Investigate the distinct metabolic pathways that are impacted by various micronutrients. To understand their functions in plant growth and development, identify the important enzymes, metabolites, and regulatory elements involved in micronutrient metabolism.

Examine the processes that underlie the uptake and transportation of micronutrients in plants. Examine the properties of ion channels, transporter proteins, and other molecules that are involved in the distribution of micronutrients within plant tissues and their acquisition from the soil.

Micronutrient Efficiency: Create plans to increase plants' ability to use micronutrients more effectively. This could entail genetic engineering techniques to create nutrient-efficient crop varieties or breeding programs targeted at selecting for genotypes with improved nutrient absorption and utilization features.

Stress Tolerance: Investigate how micronutrients can help plants withstand stress. Examine the effects of micronutrient supplementation on plant responses to biotic stressors like diseases and pests as well as abiotic stresses like salt, drought, and nutrient shortage.

Nutrient Remobilization: Examine how plants remobilize micronutrients at various phases of growth. Recognize how micronutrient allocation helps plants sustain vital physiological functions and reproductive development, as well as how nutrient remobilization boosts plant productivity in general.

Innovative biofortification techniques should be developed in order to improve the micronutrient content of food crops. This could entail using genetic engineering techniques to improve nutrient accumulation and bioavailability or traditional breeding methods to select for crop types with higher levels of micronutrients.

Omics Integration: To acquire a thorough grasp of plant micronutrient metabolism, apply omics technologies (e.g., transcriptomics, proteomics, metabolomics, and genomes). To find important genes, proteins, and metabolites connected to pathways for micronutrient absorption, transport, and utilization, integrate multi-omics data.

Environmental Impacts: Evaluate how agriculture's use of micronutrient supplements is affecting the environment. To create ecologically acceptable methods for micronutrient management in agricultural systems, research elements including nutrient leaching, soil pollution, and ecosystem sustainability.

Table 2. Effect of zinc and molybdenum on morphological criteria of *Vicia faba* plants at the Early stage of flowering (Stage II) (after 96 days of Sowing) after first treatments. Each value is mean of 5 readings (±)= Standard error of mean. N.S= Non–significant, S= significant, H.S= Highly significant.

Morphological Criteria	Control	Zinc levels				Molybdenum levels				Mixture of Zn+Mo	
		50 mg/L	%	100 mg/L	%	50 mg /L	%	100 mg/L	%	100 mg/L	%
Number of leaves /plant	12.20±0.66	11.20±0.58 N.S	8.20	10.4±0.66 N.S	14.8	12.60±0.51 N.S	3.28	11.80±0.58 N.S	3.28	12.00±0.55 N.S	1.64
Number of flowers /plant	17.20±0.97	19.60±1.21 +H.S	13.95	20.4±0.97 +H.S	18.6	21.00±1.30 +H.S	22.09	18.80±1.96 +H.S	9.30	19.60±2.01 +H.S	13.95
Shoot length (cm)	47.60±0.75	51.40±0.87 +H.S	7.98	49.4±0.75 +S	3.78	48.40±0.75 N.S	1.68	49.00±0.45 N.S	2.94	48.80±0.37 N.S	2.52
Root length(cm)	7.40±0.51	8.40±0.75 N.S	13.51	7.60±0.51 N.S	2.7	6.20±0.37 N.S	16.21	6.80±0.37 N.S	8.10	5.40±0.24 N.S	27.02

Table 3. Mineral ion contents (ppm) in *Vicia faba* plant parts at the vegetative (stage I) before treatments after 68 days of sowing.

Growth stage	Plant parts	Zn (ppm)	Mo (ppm)	Mg (ppm)	P (ppm)
Vegetative stage (I)	Leaves	0.072	0.785	0.984	4.053
	Stems	0.037	0.825	0.851	6.066
	Roots	0.125	0.915	0.814	2.688

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