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Role of micro-nutrients in fruit production: A review

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Abstract
Plant nutrition is critical for both statistical crop output as well as long-term sustainability, and crops required 17 key components to grow and develop on a consistent basis. In terms of plant development, yield, and quality, micronutrients are just as important as macronutrients. Micronutrient requirements (such as iron, zinc, copper, molybdenum, and manganese) are only needed in minute quantities and are met in part by soil, chemical fertilizers, or other materials sources. Plant physiology, nutrition stability, reproductive growth, chlorophyll synthesis, carbohydrate generation, fruit and seed formation, and other processes generally require micronutrients. In horticultural crops, iron and zinc insufficiency, as well as other micronutrient deficiencies, are widespread. As a result of these deficiencies, some vigorous orchards are becoming unproductive plantations with low-quality fruit. Micronutrients must be absorbed by plants from the soil or supplied through inorganic fertilizer or other sources via soil application or foliage treatment for optimal crop growth and output.

Keywords: Micronutrient, boron, vegetative growth, quality, fruits

Introduction
Horticulture is India's fastest-growing agricultural sector. Horticulture currently accounts for 28% of agricultural GDP, with horticultural crop production up 8.9%. In 2006-07, vegetables, fruits, plantation crops, and spices accounted for 59.8%, 30.9 percent, 6.5 percent, and 2.1% of total horticultural production. After China, India is the world's second-largest fruit grower, with 97.36 million tonnes of fruit produced and a huge export market (NHB, 2018) [38]. However, India continues to lag in producing high-quality fruits, which are frequently rejected during trade by importing countries. The production of high-quality fruits is dependent on several factors, including the use of high-quality planting materials to avoid inferior seedlings, proper care and management practices, such as water management, weed management, nutrient management, the use of plant growth regulators, training, and pruning, and disease and pest protection.

Horticultural crops make up 10% of all cultivated land. Fertilizer use in horticulture has increased from 2% in the 1990s to 8% in 2012-13 with grapes and bananas being the two most intensively fertilized fruit crops (Malhotra *et al.*, 2015) [30]. The plant's productivity is mostly determined by the nutritional balance and biological activity.

Micronutrient shortage is a severe problem in soil and plants all over the world (Imtiaz, *et al.*, 2010) [25], and correct micronutrient quality is necessary for better development, quality, yield, blooming, fruit set, and post-harvest life of horticulture products (Ram and Bose, 2000) [49], whereas its deficiency decreases the productivity (Zagade, 2017) [64]. Aside from the basic plant nutrient, there are eight vital nutrients that plants require regularly. Fruit Micronutrients such as manganese, copper, boron calcium, zinc, magnesium, iron, and others greatly boost crop yield and quality. Zinc is an important trace element because it takes part in crucial metabolic function in plants' vegetative and reproductive phases, as well as their growth and development. Calcium is essential for fruit quality growth, whereas magnesium is a crucial component (Marschner and Rengel, 2012) [31].

Nutrients required in quantities are applied through the soil, whereas nutrients through a foliar spray can be better absorbed (Fageria *et al.*, 2009) [18]. In a study of soil application vs. foliar application of nutrients, soil application of B and Zn (250 gm/plant each) was compared to foliar treatment of B and Zn (2gm) (3gm). The results demonstrated the efficacy of foliar application of nutrients over soil application of nutrients since all plant vegetative and yield features were superior to the results obtained for soil application of micronutrients (Davinder *et al.*, 2017). Foliar sprays should be given at one or more of the times listed below: after fruit harvesting, at the start of a new flush, parenthesis/2-3 weeks before fruit bud differentiation, and during the period of small fruit production at full bloom. Because boron, zinc, and iron have limited mobility in plant tissues, and since orchard crops aim to acquire as many necessary nutrients as possible before flowering, the authors believe that micronutrient foliar sprays should be applied preferably before flower formation and after fruit harvest, in addition to recommended deficiency doses already applied through the soil.

Foliar sprays can prevent or solve a problem with very little amounts absorbed by the leaf, but it is also known that in order to maximize the benefit of foliar sprays, root uptake must be increased. Readers can consult several reviews for more information on many parts of foliar nutrition (Haynes and Goh, 1977) [22]. Mineral nutrients enter leaves in three stages: penetration of nutrients through the cuticle and epidermal walls, adsorption of mineral nutrients on the plasmalemma surface, and passage through the plasmalemma into the cytoplasm (Frank, 1967). Discontinuities and fissures in the epicuticular waxes, on the other hand, provide a conduit for leaf-applied nutrients to penetrate. Encouraging the previous researcher published reviews on the effects of micronutrient application on the yield, growth, and quality of several fruit crops. Plant growth was found to be affected by micronutrient deficit, which resulted in reduced yield.

The ideal amount of nutrients not only boosts productivity but also enhances harvest quality. As a result, the foliar application is the most efficient method to do a large number of tasks in a short period. Intensified agriculture methods and uneven fertilizer application are the main cause of micronutrient deficits. Most horticulture crops suffer from zinc deficiency followed by manganese, Mo, iron, boron, and copper deficiencies. These micronutrients help in photosynthesis and various enzyme system. Boron is associated with the enzyme or photosynthetic function; however, it is linked to the chemistry of plant polysaccharides and reproductive function. For improved plant development, flowering, and fruit set, an adequate quantity of micronutrients was required. (Ram and Bose, 2000) [49]. For improved plant development, flowering, and fruit set, an adequate quantity of micronutrients was required. (Anees *et al*., 2011) [5]. Micronutrients are becoming increasingly popular among fruit farmers since they give good nutritional support while also ensuring increased harvest and returns. For a better fruit production quality of fruit, attention should be given. A special technique must be followed for enhancing the post-harvest quality of fruit.

In recent years, foliar nutrition feeding of fruit plants has gained popularity, as it is a cost-effective and obvious strategy to avoid nutrient imbalances. Micronutrients such as molybdenum, zinc, copper, and boron play a specialized function in plant growth and development, quality products, and the uptake of key nutrients, Plant vigor and productivity are aided by macronutrients such as potash, nitrogen, and phosphorus. Because of the importance of applying micronutrients to improve fruit quality, the current study was carried out to assess the influence of micronutrients by foliar application on fruit quality parameters of the L-49 guava crop during the rainy season. (Ambe Bahar).

Foliar application of micronutrient increases the nutrient availability to the plant and supplement the fertilizer to the soil. Spraying with the correct strength has a lot of advantages in terms of simplicity, and it takes around one or two weeks to obtain favorable results. In India, the application of various pesticides through foliar application in the guava plant resulted in a positive result. Mixed fertilizers, such as magnesium sulfate, potassium sulfate, zinc sulfate, ferrous sulfate, calcium nitrate, and boric acid, were found to be beneficial when applied to foliar, and the recommendations made by various workers for various chemicals appear to have a significant impact on fruit quality via their effects on size, soluble solids, color, shape, and amount of sugar. In guava, foliar spraying of several chemicals has improved production and quality factors (Arora and Singh, 1970) [6].

Essentiality and deficiency symptoms of micronutrients

Iron

Iron is also a necessary component for plant growth. It is involved in various physiological operations of plant systems, such as protein synthesis with chloroplasts, chlorophyll formation and degradation, and electron-carrying enzyme systems. (Somasundaram *et al*., 2011) [55]. Plants require iron to make chlorophyll and to activate a number of enzymes, as well as those implicated in the reduction/oxidation cycle. Iron supports respiration and carbohydrate synthesis while also acting as a significant sink in the vegetative phase of fruit in plant organs. (Sohrab *et al*., 2013) [54]. Chlorophyll synthesis, respiration, enzymatic reactions, and photosynthesis are all crucial plant metabolic functions that require iron. Involvement of iron in physiological processes of plants leads to enhancement of fruit parameters besides an increase in fruit yield in the papaya plant (Pant and Lavania, 1989) [40]. Iron deficiency is a major constraint for many calcareous soil-grown fruit crops. Iron deficiency has an impact on fruit productivity and quality. Chlorosis has a significant impact on fruit crops such as pineapple, kiwifruit, raspberry, citrus, vines, tomato, and many deciduous fruits tree species such as plum, peach, avocado, pear, and cherry (Tagliavini and Rombolà, 2001) [60]. For most crops, iron concentrations of 50-100 ppm are commonly cited as satisfactory leaf analysis levels. However, due to low mobility between tissues, leaf analysis is not a good guide. Iron deficiency is most commonly caused by alkaline soil conditions or an excess of phosphorus and manganese rendering iron unavailable for uptake. Iron deficiency, often known as lime-induced chlorosis, is an issue in calcareous soils with a high pH. Custard apples are especially vulnerable to iron deficiency, whereas other crops, such as bananas, are usually unharmed. This sensitivity appears to be associated with the crop's failure to absorb and utilize iron.

Zinc

Several enzymes and proteins in plants, especially carbohydrate metabolism (both in photosynthesis and in the transformation of sugars to starch), auxin (growth regulator) metabolism, and resistance to disease by some bacterial pathogens, contain zinc as a basic element or regulatory cofactor. (Alloway, 2008) [2]. Zinc is an essential microelement involved in the synthesis of tryptophan that is required by plants because it is a precursor to the creation of Indole acetic acid (Ahmad *et al.,* 2012) [1]. Fruit tree foliar feeding has grown increasingly important in recent years as fertilizer application through the soil has become more difficult due to complex chemical processes that allow some fertilizer to leach down and others to remain unavailable to the plant. Except for TSS in the fruit, foliar or soil application of zinc sulfate did not increase mango fruit yield and quality.

In kinnow foliar spray of zinc sulfate in combination with iron, sulfate increases fruit juice, acidity, reducing sugar, ascorbic acid, non-reducing sugar, and total sugar (Patidar *et al*., 2021) [43]. Zn is essential for the functioning of several enzyme-like transphosphorylases, aldolases, RNA and DNA, dehydrogenases, polymerases, and isomerases (Swietlik, 1999) [57]. Zinc is utilized to promote early blooming, which increases fruit size, growth, and quality. Zinc (Zn) is an essential trace element for plants since it is required for normal growth and development as well as a number of enzymatic functions. Zinc application at a higher level enhanced foliar zinc content, which minimizes fruit drop and ultimately increases endogenous auxin synthesis, (Meena *et al*., 2014) [32]. Zn is a precursor of indole acetic acid and its production is involved in the synthesis of tryptophan, resulting in greater tissue growth and development. It plays a key role in protein production, and nucleic acid starch metabolism and works as a cofactor for several enzymes, as well as influencing photosynthesis, protein production, and nucleic acid metabolism. (Alloway, 2008) [2]. Low auxin levels in tissue induce the severe stunting of leaves and shoots that are so prominent in zinc-deficient crops. Young leaves are usually the most impacted, and they are rosette, tiny, chlorotic, and narrow, as a result of the shoot's inability to lengthen. Bloom spikes are tiny, malformed, and drooping. Zinc insufficiency is the most common cause of stunted development and productivity in fruit crops. It is most typically found in bananas, custard apples, and mangoes. Zinc deficiency is a typical condition that appears in the spring when crops are growing rapidly but have problems collecting nutrients from cold soil in the winter environment. Zinc deficiency is detected in young pineapple plants by the immature heart leaves bunching together and then leaning downwards. This illness is also known as crookneck. Existing plants may have yellow spots and dashes at the margins of mature leaves, which eventually combine into brown blister-like defects on the leaf surface, providing an uneven appearance.

Boron

Boron is an important micronutrient that is necessary for optimum crop quality and productivity (Dale and Krystyna, 1998) [14]. It is involved in the cell wall integrity RNA, phenol metabolism respiration, synthesis, and lignification of the cell wall, glucose. B is the only micronutrient that is not especially related to enzyme function or photosynthesis, but it is associated with the plant reproductive system and carbohydrate chemistry (Suman *et al*., 2017) [28]. Boron is an essential nutrient for plant development and growth. Low B has a greater impact on plant sexual reproduction than on vegetative development. Boron's primary roles include cell division, seed development, and cell wall growth, strength, hormone development, sugar transport. The roles of boron in plants are associated with those of nitrogen, phosphorus, potassium, and calcium. Boron's structural involvement in cell wall formation, as well as the activation or inhibition of specific metabolic pathways, are thought to be the most important roles of boron in plants. Boron is considered to be necessary for the active growth of plants, root tips, new leaf formation, and bud development. Boron deficiency also causes distorted development and cracking in the fruit. Boron is an immobile nutrient that does not easily move around the plant; therefore, deficiency symptoms usually appear first and are most severe at growth points, immature tissues, root tips, young leaves, and developing fruit. The fruits of boron-deficient papaya are distorted and rough due to unequal fertilization and seed development within the fruit. Growing fruit secretes pinkish white to brown latex as it ripens unevenly. Male flower shedding prematurely results in poor fruit set and impaired pollen tube development.

Copper

Copper deficiency in tropical fruit crops appears to be uncommon. It is required for the activity of many enzymes, photosynthesis, and the creation of lignin, which gives shoots and stems their physical strength, and seed development. It increases chlorophyll synthesis by activating various enzymes in plants (Ram and Bose, 2000) [49]. Copper is an essential component of many enzyme proteins, including polyphenol oxidase, oxidase, diamine oxidase, cytochrome, and ascorbic acid. It can also act as a catalyst or as a component of various enzyme systems. It was also revealed that plant cells require calcium and copper in order for iron to function properly. The indications of a deficiency include terminal growth restriction, twig dieback, death of developing points, as well as numerous buds forming at the end of twigs and sometimes rosetting. In bananas, the foliage might be chlorotic, darker than normal, or dull and brownish. Pineapple leaves are downward at their tips, narrow u-shaped in section, and growth is severely limited. Some immature leaves develop tip necrosis. Excess Cu also has a deleterious impact on plant pigment levels and, eventually, the photosynthetic process. According to several research, one of the main impacts of Cu toxicity is reduced pigment content and hindered photosynthesis (Jaime-Pérez *et al*., 2019). Cu inhibits the formation of photosynthetic equipment via influencing the composition of pigments and proteins in the photosynthetic membrane (Nazir *et al*., 2019).

Manganese

Manganese is an essential element for plant growth and development, and also the regulation of metabolic activities in many plants cell compartments. Manganese stimulates the plant enzymes oxidase, dehydrogenase, and decarboxylase, which are involved in nitrogen assimilation, photosynthesis, and nitrogen metabolism. It is required for respiration and is involved in the breakdown or oxidation of indole-3-acetic acid (IAA). The metal is a required cofactor for the oxygen-evolving complex (OEC) of the photosynthetic machinery, which catalyzes the water-splitting action in photosystem II (PSII). Manganese is essential for the synthesis of chlorophyll, which is important for nitrate assimilation, respiration, and photosynthesis, as well as the activity of numerous enzymes. Because manganese is only moderately mobile in plant tissues, symptoms appear initially on younger leaves, particularly those just reaching full size. Manganese availability is limited in calcareous soils with high pH, but it is frequently relatively high in acid soils utilized for tropical fruit production. Manganese insufficiency results in a pale green mottle between the major veins. The major veins retain a darker green band, but the interveinal chlorotic patches fade to a pale green or dull yellowish color. Manganese treatment in the soil could be inefficient due to adsorption, particularly in heavier soils or soils that have been over-limed. Two to three sprays of 0.1 percent manganese sulfate are sufficient.

Manganese transfer from the leaves to the developing fruit is possible, as is manganese translocation from older leaves to young growing leaves on the same stalk. This yellow patch grows until only the tip and base of the leaf remain green, showing an inverted V-shaped area on the midrib.

Molybdenum
Molybdenum is a vital component for plant growth that is only needed in minimal amounts. It is required for nitrate absorption in soil and is an important component of nitrate reductase and nitrogenase. Molybdenum is a component of the nitrate reductase enzyme, which converts nitrate to nitrite during plant N absorption. Mo's role in nitrogen metabolism is intrinsically linked, and its lack leads to an N deficit in plants (Pollock, 2002) [45]. Despite the fact that molybdenum deficiency can be detected in many vegetables, pasture legumes, soil, and cereals, it is extremely rare in fruit crops. Citrus with a molybdenum deficiency known as the yellow spot has been reported in a few cases. The common method of satisfying the need for 2-5 years is to apply molybdenite single super phosphate to the soil at a rate of 250-500 kg/ha.

Role of micronutrients on fruit plant:
Iron
In peach, application of $FeSO_4$ (0.5%) increases the vitamin C, fruit firmness, reduced acid percentage, yield per tree, and fruit diameter (Baksh *et al.*, 2020). An application of iron on guava (0.2%) foliar application improved fruit weight, fruit length, and fruit diameter however, there was a decrease in TSS and sugar content of the harvested fruits (Arora and Singh, 1970) [6]. In bananas, a combination of iron and zinc (0.5%) provides the best response to the number of leaves generated per plant, plant growth, the basal girth of the pseudostem, and the shortest time between the emergences of two successive leaves. (Pathak *et al.*, 2011) [41]. Boron (0.3%) + Iron (0.2%) + Zinc (0.5%) foliar treatment improved sweet orange vegetative development (Nandita *et al.*, 2020) [36]. In peach, application of $FeSO_4$ (o.5%) increases the fruit firmness, fruit diameter, TSS vitamin C, yield per tree, and reduced acid percentage (Baksh *et al.*,2020).

Zinc
When compared to the control, a zinc treatment on kinnow mandarin (0.3 percent) had the maximum acidity, total soluble solids, and juice content (Monga and Josan, 2000) [34]. When zinc sulfate was given foliar rather than in the soil, the uptake rate of zinc was higher in mango plants (Bahadur *et al.*, 1998) [9]. Zinc is involved in the formation of tryptophan, which is a precursor of auxin, as revealed by (Singh *et al.*, 2010) in papaya, which may be attributed to zinc sulfate in increasing vegetative development. The involvement of zinc sulfate borax and copper sulfate (1%) will increase fruit weight, specific gravity, fruit yield, fruit length, and fruit volume (Sachin and Arvind Kumar, 2019). Boron and zinc combinations enhanced metabolite activity, which increased plant metabolites involved in plant growth, cell elongation, and cell division (Bhalerao and Patel, 2015) [12]. Foliar zinc application (100ppm) on litchi results in maximum diameter, fruit weight, diameter ratio, and fruit length (Sharma *et al.*, 2005) [50]. When zinc is applied 0.25% and 0.5% to the leaves of papaya after two months of transplanting significantly boosted plant growth, leaves per plant, and petiole length (5th leaf) (Singh *et al.*, 2005). Zinc was sprayed thrice, at 0, 0.3, and 0.6% each time. TSS, TSS/acid ratio, aril juice quantity, and leaf area all showed substantial zinc impacts. Zinc foliar spray of 0.3% was found to be the best combination of Zinc on analyzed pomegranate properties under current conditions. An application of zinc sulfate 0.75% on sweet orange has a good effect in terms of plant growth and fruit growth (Yadav *et al.*, 2007) [62]. ZnSO4 showed the highest total soluble solid (20.40°B) and non-reducing sugars (2.98 percent) in litchi plants treated with 0.75 percent (Priyadarshi *et al.*, 2018) [46].

Boron
In lemon application of (0.2%) boron significantly increases the fruit weight, juice percentage, yield per plant, vitamin c, fruit per plant, and reduces the acidity of the fruit (Kumari *et al.*, 2022). Boron influences sugar transport and appears to be involved in a number of calcium-related activities. Boron influences pollination and the generation of viable seeds, which in turn influences fruit growth. The borax reaction was more positive because boron enhanced pollen viability plays an important function in carbohydrate translocation, auxin production to the sink, and fertilization. (Yadav *et al.*, 2013). Application of boron on mango (0.5%) shows maximum fruit weight, ascorbic acid content, reducing sugar, non-reducing sugar, fruit yield, fruit volume, and TSS, (Bhatt *et, al*, 2012) [13]. Foliar spray of boric acid (0.3%) results in the highest sugar in the guava plant and in greater TSS (Priyaawasthi and Shantlal, 2009). Boron deficiency causes buds and flowers to drop, resulting in decreased seed and fruit set and lower quality of developing fruit, nuts, and seed. Fruit cracks and grows distortedly when there is a deficiency of boron. With the treatment of (1.0%) H3BO3, (Bhatia *et al*., 2001) reported maximum yield and fruit weight in guava. Boron is applied at 1kg per hectare to the papaya plant resulting in maximum yield (Mollah *et al.*, 2006). Compared to the no-boron control, it is found that boron spraying significantly increased the growth of Navel orange trees through boron nutrition (Cang *et al.*, 2009). (Priyadarshi *et al.*, 2018) [46] evaluated that the plants treated with 0.75% ZnSO4 had non-reducing sugars (2.98%) and the highest total soluble solid (20.40°B). Boric acid (0.75%) application resulted in the highest reducing sugars (11.14%). Foliar spray of ZnSO4 (0.5%) + boric acid (0.5%) considerably decreases titratable acidity (0.32%) and improves total sugar content (13.79%) of fruits.

Copper
An application of copper sulfate (0.4%) in combination with hydrated lime on guava will give maximum fruit yield (Arora and Singh, 1971) [7]. Involvement of copper in combination with spray Cu + B + Zn, Cu+B, Cu+Zn, resulted in early blooming, greater fruit set, and accelerated fruit maturity, fruit yield (Kundu and Mitra,1999). Foliar application of boron + copper + zinc enhanced plant height, the number of fruits per plant, fruit set %, yield, biochemical, and improved the physical characteristics. It also provided maximum canopy spread (Zoremtluangi *et al.*, 2019) [66]. Copper is required for photosynthesis, the activity of seed development, numerous enzymes, and lignin production. It provides the shoot and stems physical strength. Copper activates several enzymes in the plant body. The best result was recorded with the combined spray of CuSO4 + CuSO4+borax (0.4%) reported the maximum weight, fruit length, and diameter, maximum TSS, reducing sugar, highest ascorbic acid and pectin content, maximum yield in guava fruits (Singh and Singh,2002).

Manganese
In kinnow foliar application of $MnSO_4$ (1%) + $FeSO_4$ (1%) showed the positive result in terms of increment in shoot length, plant canopy, and tree height (Pawar *et al.*, 2019) [44]. Manganese sulfate (0.75g. L) in combination with zinc sulfate

(0.75g/L) significantly increased total soluble solids, TSS/TA ratio, increased fruit weight, juice percentage, and flavedo thickness of fruit (Hussain *et al.*, 2022) [24]. (Saraswathi *et al.*, 1998) investigated the effect of micronutrients (Zn, Mg, and Mn each at 0.5% alone or in different combinations) with 1% urea on mandarin orange quality. They found that trees treated with Mn @ 0.5%+ urea@ 1% + Zn @0.5% had average maximum fruit weights of 116.36 and 140.2 g. (Babu *et al.*, 2007) investigated the influence of micronutrients (MgSO4, ZnSO4, and MnSO4 at 0.5% each, alone or in combination) on the quality of ten-year-old Kinnow mandarin trees. The trees treated with 0.5% ZnSO4 + 0.5% $MnSO_4$ had the largest fruit diameter (69.24 mm). A combination of $MnSO_4$ (1%) + $FeSO_4$ (0.5%) applied in kinnow mandarin gave high yield, best quality fruits as well as provided the highest net returns (Gurjar *et al.*, 2018) [20].

Effect of combination of micronutrients on fruit crop:
In strawberry foliar application of borax + $ZnSO_4$+ $FeSO_4$ (0.2%) reported the maximum runner per plant, number of leaves, a greater number of pickings, fruit width, fruit length, fruit yield per plant, fresh weight of fruit, fruit per plant, plant spread, (Kumar *et al.*, 2021). Foliar application of $ZnSO_4$(0.5%) + K_2SO_4(1.00%) on Nagpur mandarin was conducted and found that it increases the quality parameter like TSS/ acidity ratio ascorbic acid, non-reducing sugar, pH of juice, total sugars, reducing sugar (Meena *et al.*, 2021) [33]. The use of urea in combination with Zn and boron has also produced some positive prospects in kinnow mandarin. It has been discovered that combining all of these micronutrients with urea is more advantageous for improved fruit chemical properties than using any of them alone (Al-Obeed *et al.*, 2017).

Table: Effect of micronutrients on fruit crop

S No.	Crop	Micronutrients	Effect	Reference
1	Mango	Fe+ zinc	Highest fruit set, Retention percentage, highest TSS and ascorbic acid	(Mahida *et al.*, 2018) [29]
2	Bitter apple	Zinc	Increase soluble solid, vitamin C, and dry matter but reduce total phenol and flesh firmness.	(Nikbakhat *et al.*, 2021)
3	Litchi	Boron	Maximum reducing sugar	(Priyadarshi *et al.* 2018) [46]
4	Banana *cv.* Grand naine	$FeSO_4$(0.2%), ZnSO4(0.5%), H3BO3 (0.1%) and CuSO4 (0.2%).	Increases the growth and yield of fruit	(Hazarika *et al.*, 2018) [23]
5	Strawberry	Zn+Fe+Mn+Cu (3.5ml/L)	Increase plant height	(Farid *et al.*, 2020)
6	Banana	$ZnSO_4$(0.5) + $FeSO_4$ (0.5)	Improve the number of hand bunch, bunch length, girth, and yield.	(Mahato *et al.* 2016)
7	Sweet Orange *cv.* mosambi	$ZnSO_4$ (0.6%)	Improved fruit quality, total soluble solids, juice content, fruit set, fruit size, and fruit retention.	(Saha *et al.*, 2020)
8	Pomegranate *cv.* sindhuri	Zn (0.4%) +B (0.4%) +Fe (0.4%)	Maximum Ascorbic acid, Maximum juice percentage, TSS, lowest total acidity, TSS/acid ratio.	(Yadav *et al.*, 2018) [63]
9	Acid lime *cv.* Sai sarbati	GA3 (50ppm) + ZnSO4 (1%) + $FeSO_4$(1%)	Increase yield, fruit set, number of fruits per shoot, the maximum number of fruits, minimum fruit drop fruit, weight, and fruit volume.	(Tagad *et al.*, 2018) [59]
10	Mango	Iron (250ppm) + Zinc (200) + Boron (100ppm)	Improve leaf zinc content, fruit set, fruit weight, fruit peel weight, fruit yield, total soluble solids, and fruit number per tree.	(Zahedi *et al.*, 2020) [65]
11	Pomegranate	Boric acid (0.05%) + potassium nitrate (1%) + Magnesium sulphate (1%)	Maximum number of fruits, number of arils per fruit, juice content, fruit yield	(Bashira *et al.*, 2019) [11]
12	Litchi *cv.* calcuttia	Zinc 0.50% and Zinc (0.75%)	Decrease fruit drop and increase yield	(Priyadarshi *et al.*, 2018) [46]

Conclusion
The current micronutrient strategy is only focused on improving horticulture crop yields. Farmers' interests will be protected if micronutrients are employed to improve biological production and marketable yield by enhancing the quality and post-harvest life, resulting in increased profitability. According to the studies, The role of micronutrients has a significant impact on fruit trees, significantly improving plants growth, quality, and shelf life of fruit harvests, fruit output, because of the economic benefits, the use of micronutrients will continue to expand in the future.

References

1. Ahmad AMH, Khalil MK, Abd-El-Rahman AM, Nadia AMH. Effect of zinc, tryptophan, and indole acetic acid on growth, yield, and chemical composition of Valencia orange trees. Journal of Applied Sciences Research. 2012;8:901-914.
2. Alloway BJ. Zinc in soils and crop nutrition. Second edition, published by IZA and IFA, Brussels, Belgium, and Paris, France, 2008.
3. Alloway BJ. Zinc in soils and crop nutrition. International Zinc Association Brussel, Belgium, 2008.
4. Ram RA, Bose TK. Effect of foliar application of magnesium and micronutrients on growth, yield, and fruit quality of mandarin orange (*Citrus reticulata* Blanco). Indian Journal of Horticulture. 2000;57(3):215-220.
5. Anees M, Hameed F, Mumtaz A, Ibrahim M, Saeed KM. Dialysis-related factors affecting the quality of life in patients on hemodialysis, 2011.
6. Arora JS, Singh JR. Some effects of iron spray on growth, yield, and quality of guava fruits (*Psidium guajava* L.). J Japan Soc. Hort. Sci. 1970;39(2):139-142.
7. Arora JS, Singh JR. Some responses on guava (*Psidium guajava* L.) to copper spray. Indian J Hort. 1971;28:108-113.
8. Arora JS, Singh JR. Effect of nitrogen, phosphorus, and

potassium spray-on guava (*Psidium guava* L.). J Jap. Soc. Hort. Sci. 1970a;39(1):55-62.
9. Bahadur L, Malhi CS, Singh Z. Effect of foliar and soil applications of zinc sulfate on zinc uptake, tree size, yield, and fruit quality of mango. J Plant Nutr. 1998;21(3):589-600.
10. Bakhsh A, Hussain F, Raza MK, Akhtar A, Javaad HW. Response of pre-harvest foliar application of micronutrients on yield and quality attributes of peach cv. Early Grand. Journal of Pure and Applied Agriculture. 2020;5(4):18-26.
11. Bashira M, Noreen A, Ikhlaq M, Shabir K, Altaf F, Akhtar N. Effect of boric acid, potassium nitrate and magnesium sulphate on managing fruit cracking and improving fruit yield and quality of Pomegranate. J. Hortic. Sci. Technol. 2019;2:49-53.
12. Bhalerao PP, Patel BN. Effect of foliar application of Ca, Zn, Fe and B on growth, yield and quality of papaya var. Taiwan Red Lady. Indian J Hort. 2015;72(3):325-328.
13. Bhatt A, Mishra NK, Mishra DS, Singh CP. Foliar application of potassium, calcium, zinc, and boron enhanced the yield, quality, and shelf life of mango. Hort Flora Res. Spectrum. 2012;1(4):300-305.
14. Dale GB, Krystyna ML. Boron in plant structure and function. Annu. Rev. Plant Physiol. Plant Mol. Biol. 1998;49:481-500.
15. Daswani PG, Gholkar MS, Birdi TJ. *Psidium guajava*: A single plant for multiple health problems of the rural Indian population. Pharmacognosy Reviews. 2017;11(22):167.
16. Davarpanah S, Tehranifar A, Abadía J, Val J, Davarynejad G, Aran M. Foliar calcium fertilization reduces fruit cracking in pomegranate (*Punica granatum* cv. Ardestani). Scientia Horticulturae. 2018;230:86-91.
17. El-Khawga AS. Reduction in fruit cracking in mentality pomegranate following a foliar application with paclobutrazol and Zinc sulfate. J Applied Sci. Res. 2007;3(9):837-840.
18. Fageria NK, Filho MPB, Moreira A, Guimaraes CM. Foliar fertilization of crop. plants. J Plant Nutr. 2009;32:1044-1064.
19. Gao Q, Tian Q, Song Z, Chen W, Li X, Zhu X. Calcium chloride postharvest treatment delays the ripening and softening of papaya fruit. Journal of Food Processing and Preservation. 2020;44(8):e14604.
20. Gurjar SC, Rathore RS, Singh V, Singh S, Singh Y, Bhati BS. Effect of Mn and Fe on Yield, Fruit Quality and Economic Feasibility of Mandarin (*Citrus reticulata* Blanco) cv. Kinnow. Int. J Curr. Microbiol. App. Sci. 2018;7(7):2815-2820.
21. Hasani M, Zamani Z, Savaghebi G, Fatahi R. Effects of zinc and manganese as a foliar spray on pomegranate yield, fruit quality, and leaf minerals. Journal Soil Sci. and Plant Nutrition. 2012;12(3):471-480.
22. Haynes RJ, Goh KM. Review on physiological pathways of foliar absorption. Scientia Horticulturia. 1977;7:291-02.
23. Hazarika BN, Raghavan M. Effect of micronutrients on growth and yield of banana cv. Grand Naine (AAA) under foothills of Arunachal Pradesh. Crop Research. 2018;53(5and6):242-246.
24. Hussain Z, Iftikhar Y, Mubeen M, Saleem MZ, Naseer MU, Luqman M. Application of micronutrients enhances the quality of kinnow mandarin infected by citrus greening disease (Huanglongbing). Sarhad Journal of Agriculture. 2022;38(1):360-371.
25. Imtiaz M, Rashid A, Khan P, Memon MY, Aslam M. The Role of Micronutrients in Crop Production and Human Health. Pak. J Bot. 2010;42(4):2565-2578.
26. Kumar L, Bairwa HL, Mahawer LN, Meena SC, Kaushik RA, Choudhary RC. Response of foliar spray of iron, zinc, and boron in strawberry (*Fragaria× ananassa* Duch.) cv. winter dawn. The Pharma Innovation Journal 2021;10(12):2057-2061
27. Kumari B, Kumar L, Soni AK. Effect of micronutrients on growth, yield, and quality of lemon (*Citrus limon* L.) in the rainy season. 2022.
28. Mahaveer Suman, Pency Sangma D, Deshraj Singh. Role of Micronutrients (Fe, Zn, B, Cu, Mg, Mn, and Mo) in Fruit Crops. Int. J Curr. Microbiol. App. Sci. 2017;6(6):3240-3250.
29. Mahida A, Tandel YN, Mantri A, Patel N, Parmar VK. Effect of Fe and Zn fertilization on fruit setting and yield attributes of mango cv. Kesar. ICJ'S. 2018;6(5):532-534.
30. Malhotra SK, Srivastava AK. Fertilizer requirement of Indian horticulture: An analysis. Indian Journal of Fertilizer. 2015;11(7):16-25.
31. Marschner P, Rengel Z. Nutrient availability in soils. In Marschner's mineral nutrition of higher plants. Academic Press. 2012, 315-330.
32. Meena D, Tiwari R, Singh OP. Effect of nutrient spray on growth, fruit yield, and quality of aonla. Annals Plant and Soil Res. 2014;16(3):242-245.
33. Meena D, Bhatnagar P, Kumar N, Meena L. Effect of foliar spray of nutrients on yield and quality of Nagpur mandarin (*Citrus reticulata* Blanco.). Pharma Innov. J. 2021;10:1122-1127.
34. Monga PK, Josan JS. Effect of micronutrients of leaf composition, fruit yield, and quality of kinnow mandarin. J Applied Hort. 2000;2(2):132-133.
35. Morton JF. Guava. Fruits of Warm Climates. Purdue University. 1987, 356-363.
36. Nandita K, Kundu M, Rani R, Khatoon F, Kumar D. Foliar feeding of micronutrients: An essential tool to improve growth, yield and fruit quality of sweet orange (*Citrus sinensis* (L.) Osbeck) cv. Mosambi under non-traditional citrus growing track. International Journal of Current Microbiology and Applied Sciences. 2020;9(3):473.
37. Nandita K, Kundu M, Rani R, Khatoon F, Kumar D. Foliar feeding of micronutrients: An essential tool to improve growth, yield and fruit quality of sweet orange (*Citrus sinensis* (L.) Osbeck) cv. Mosambi under non-traditional citrus growing track. International Journal of Current Microbiology and Applied Sciences. 2020;9(3):473-
38. NHB. Indian Horticulture Database-2018. National Horticulture Board, Gurgaon, Haryana, 2018.
39. Nikbakht M, Solouki M, Aran M. Effects of foliar application of zinc nano-chelate and zinc sulfate fertilizers on some quantitative and qualitative properties of bitter apple (*Citrullus colocynthis* L.). Iranian Journal of Medicinal and Aromatic Plants Research. 2021;36(6):898-911.
40. Pant V, Lavania ML. Effect of foliar application of iron, zinc, and boron on quality of papaya fruits (*Carica papaya* L.), Prog. Hort. 1989;21(1-2):165-167.
41. Pathak M, Bauri FK, Misra DK, Bandyopadhyay B,

Chakraborty K. Application of micronutrients on growth, yield, and quality of banana. J of Crop and Weed. 2011;7(1):52-54.
42. Pathak RK, Pandey SD, Dikshit SN, Singh A. 23rd International Congress, Firenze, Italy. 1990.
43. Patidar MK, Kaushik RA, Choudhary RC, Singh M, Jat ML. Foliar sprays of zinc and iron improve the quality attributes of kinnow The Pharma Innovation Journal. 2021;10(11):1617-1620.
44. Pawar PA, Kohale VS, Gawil KA, Khadse A, Sarda A, Nagmote A. Effect of foliar application of manganese and ferrous on vegetative growth, fruit yield and quality of mandarin (*Citrus reticulata* Blanco.) cv. Kinnow. Journal of Pharmacognosy and Phytochemistry. 2019;8(3):434-437.
45. Pollock VV, Conover RC, Johnson MK, Barber MJ. Bacterial expression of the molybdenum domain of assimilatory nitrate reductase: Production of both the functional molybdenum-containing domain and the nonfunctional tungsten analog. Arch. Biochem. Biophys. 2002;403:237-248.
46. Priyadarshi V, Hota D, Karna AK. Effect of growth regulators and micronutrients spray on chemical parameters of litchi (*Litchi chinensis* Sonn.) cv. calcuttia. International journal of economic plants. 2018;5(3):99-103.
47. Priyadarshi V, Hota D, Karna AK. Effect of growth regulators and micronutrient spray-on chemical parameters of litchi (*Litchi chinensis* Sonn.) cv. Calcutta. International journal of economic plants. 2018;5(3):99-103.
48. Priyadarshi V, Hota D, Solanki SPS, Singh N. Effect of growth regulators and micronutrients spray on yield attributing character of litchi (*Litchi chinensis* Sonn.) cv. Calcuttia. Advances in Horticultural Crops. Singh J, Nigam R, Hasan W, Kumar A and Singh H. (Eds), 2018, 269-77.
49. Ram RA, Bose TK. Effect of foliar application of magnesium and micro-nutrients on growth, yield, and fruit quality of mandarin orange (Citrus reticulata Blanco). Indian Journal of Horticulture. 2000;57(3):215-220.
50. Sharma P, Singh AK, Sharma RM. Effect of plant bio-regulators (PBRs) and micronutrients on fruit set and quality of litchi cv. Dehradun, Indian J Hort. 2005;62(1):24-26.
51. Singh DK, Ghosh SK, Paul PK, Suresh CP. Effect of different micronutrients on growth, yield and quality of papaya (*Carica papaya* L.) cv. Ranchi. Acta Hort. 2010;8(2):37-41.
52. Singh DK, Paul PK, Ghosh SK. Response of papaya to foliar application of boron, zinc and their combinations. Res. Crops. 2005;6(2):277-280.
53. Singh SP, Singh BP, Moti R. Effect of magnesium and season on growth, flowering, fruiting, and yield of guava (*Psidium guajava* L.) cv. Allahabad Safeda, Haryana J Hort. Sci. 1982;11(3-4):188-191.
54. Sohrab Davarpanah, Mohammad Akbari, Mohammad Ali Askari, Mesbah Babalar, Mohammad Esmaeil Naddaf. Effect of iron foliar application (FeEDDHA) on quantitative and qualitative characteristics of pomegranate cv. Malas –e-Save. World Sci. J, 2013, (04) ISSN 2307-3071.
55. Somasundaram J, Meena HR, Singh RK, Prasad SN, Parandiyal AK. Diagnosis of micronutrient imbalance in the lime crop in the semi-arid region of Rajasthan, India. Communications Soil Science Plant Analysis, 2011;42:858-869.
56. Srivastava AK, Malhotra SK. Nutrient Management in Fruit Crops. Indian Journal of Fertilisers, 2014, 72.
57. Swietlik D. Zinc nutrition in Horticultural crops. In J. Janick (Ed.). Horticultural Reviews. John Wiley and Sons, Inc, 1999, 109-118.
58. Swietlik D. Zinc nutrition in horticultural crops. Horticultural Reviews. John Wiley & Sons, Inc. New York. 1999;23:109-180
59. Tagad SS, Patil MB, Patil SG, Deshpande DP. Effect of foliar application of plant growth regulators and micronutrients on growth and yield parameters of acid lime (*Citrus aurantifolia* L.) cv. Sai Sarbati. Journal of Pharmacognosy and Phytochemistry. 2018;7(5):741-744.
60. Tagliavini M, Rombola AD. Iron deficiency and chlorosis in orchard and vineyard ecosystems. European Journal of Agronomy. 2001;15(2):71-92.
61. Waskela RS, Kanpure RN, Kumawat BR, Kachouli BK. Effect of foliar spray of micronutrients on growth, yield, and quality of guava (*Psidium guajava* L.) cv. Churidar. International J Agri. Sci. 2013;9(2):551-556.
62. Yadav RK, Rana GS, Ahlawat VP, Dahiya DS, Kumar S. Effect of zinc application on growth and fruit drop of sweet orange (*Citrus sinensis* Osbeck) cv. Jaffa. Haryana J. Hort. Sci. 2007;36(3/4): 205-206.
63. Yadav VK, Jain MC, Sharma MK, Suman M. Effect of micronutrients spray on physical and chemical characteristics of pomegranate (*Punica granatum* L.) cv. Sindhuri. International Journal of Current Microbiology and Applied Science. 2018;7:998-1005.
64. Zagade PM, Munde GR, Shirsath AH. Effect of foliar application of micronutrients on yield and quality of guava (*Psidium guajava* L.) Cv. Sardar. Journal of Pharmacy and Biological Sciences. 2017;12(5):56- 58.
65. Zahedi SM, Karimi M, Teixeira da Silva JA. The use of nanotechnology to increase quality and yield of fruit crops. Journal of the Science of Food and Agriculture. 2020;100(1):25-31.
66. Zoremtluangi JENNY, Saipari ELI.ZABETH, Mandal, DEBASHIS. Influence of foliar micronutrients on growth, yield and quality of Khasi mandarin (*Citrus reticulata* Blanco) in Mizoram. Res. Crops. 2019;20:322-27.