

Review Article

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## Role of Micronutrients (Fe, Zn, B, Cu, Mg, Mn and Mo) in Fruit Crops

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### ABSTRACT

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Micronutrients are essentially as important as macronutrients to have better growth, yield and quality in plants. The requirement of micronutrients (boron, iron, copper, zinc, manganese, magnesium and molybdenum) is only in traces, which is partly met from the soil or through chemical fertilizer or through other sources. Proper plant nutrition is essential for successful production of fruit crops. Integrated supply of micronutrients with macronutrients in adequate amount and suitable proportions is one of the most important factors that control the plant growth in fruit crops. Micronutrients are involved in all metabolic and cellular functions. Plants differ in their need for micronutrients. In this review, we focus on the major functions of mineral micronutrients in fruit production.

### Introduction

The major causes for micronutrient deficiencies are intensified agricultural practices, unbalanced fertilizer application including NPK, depletion of nutrients and no replenishment. Horticultural crops suffer widely by zinc deficiency followed by boron, manganese, copper, iron (mostly induced) and Mo deficiencies. Mo, Cl, Cu, Fe and Mn are involved in various processes related to photosynthesis and Zn, Cu, Fe, and Mn are associated with various enzyme systems; Mo is specific for nitrate reductase only. B is the only micronutrient not specifically associated with either photosynthesis or enzyme function, but it is associated with the

carbohydrate chemistry and reproductive system of the plant. The significance of micronutrients in growth as well as physiological functions of horticultural fruit crops are briefed here nutrient wise. The sufficient amount of micronutrients necessary for better plant growth which resulted in higher yield due to increased growth, better flowering and higher fruit set (Ram and Bose, 2000). The improvement in quality of fruit might be due to the catalytic action of micronutrients particularly at higher concentrations. Hence the foliar application of micronutrients quickly increased the uptake of macronutrients in the tissues and organs and

improves fruit quality (Anees *et al.*, 2011). Nowadays, micronutrients are gradually gaining momentum among the fruit growers because of their beneficial nutritional support and at the same time ensure better harvest and returns. The demand for increasing fruit production will require a thorough knowledge on the relationship between micronutrients and crop growth. Foliar micronutrient is one tool to maintain or enhance plant nutritional status during the growing season. Often quick effects are seen and deficiencies can be corrected before yield or quality losses occur. Foliar fertilization also allows for multiple application timings post planting. In addition, there is reduced concern for nutrient loss, tie up, or fixation when compared to soil applications. The available information regarding the impact of micronutrients on fruit crops is scanty. Based on this background, the present review was compiled to study the role of micronutrients and its effect on different fruit crops.

### **Essentiality and deficiency symptoms of iron**

Plants need iron to produce chlorophyll and to activate several enzymes including those involved in the oxidation /reduction processes of photosynthesis and respiration. Iron increases photosynthesis and carbohydrate synthesis and in reproductive growth of fruit in organs of the plant acts as a strong sink (Sohrab *et al.*, 2013). Iron is also necessary for vital plant metabolic function such as chlorophyll synthesis, various enzymatic reaction, respiration and photosynthesis Given that the main product of photosynthesis is sugar, so increasing the photosynthesis, lead to increase the sugar compounds and cause more soluble solids in fruit juice (Ram and Bose 2000). Iron deficiency is rarely caused through insufficient iron in the soil but usually because it is rendered unavailable for the uptake by alkaline soil conditions or an

excess of manganese or phosphorous. Iron deficiency is a problem of high pH calcareous soils and is often described as lime induced chlorosis. Custard apples are relatively sensitive suffering from iron deficiency while other crops such as bananas are usually not affected much. This sensitivity appears to be related to crop's poor ability to absorb or utilize iron. The common deficiency symptoms include development of light green chlorosis of all the tissues between the veins. A distinctive pattern results from the network formed by the midrib and veins, which remain green for example, custard apples. If the chlorosis is severe and persistent, yellowing increases to the point of bleaching and burns can develop within this chlorotic area. Because iron does not move easily within the plant, older leaves can remain green while flushes of new growth are chlorotic. In pine apples, chlorosis is strongest towards the margins of young inner leaves. The fruits are small, reddish in colour, hard and prone to cracking. The effects of iron deficiency in different fruit crops are discussed below.

### **Effect of iron on fruit crops**

Arora and Singh (1970) reported that the foliar application of 0.2 per cent iron on guava common variety Allahabad safeda, was maximum increase Weight of the fruits (163.5 g), fruit length (4.35 cm) and fruit diameter (4.38 cm), While reducing sugars (4.85%) and TSS (14.30 °Brix). While 0.4 per cent iron was increase the extension of terminal shoots (increase over control 54.61%), number of leaves (increase over control 61.08%), leaf area per shoots (increase over control 143.51%), chlorophyll recovery (increase over control 95.09%), non reducing sugars (2.26%), Vitamin C (264.6mg/100gm), acidity decrease the (0.42). Pant and Lavania (1989) noticed that the foliar application of FeSO<sub>4</sub> (0.15%) was gave maximum TSS (14.3%) while maximum sugars (12.5%),

highest sugar: acid ratio (49.2) and lowest acidity (0.25%) observed in borax 0.15% in papaya fruit. Ahamad *et al.*, (1998a) conducted an experiment to study the effect of foliar application of ferrous sulphate on the yield and quality of guava cv. Allahabad Safeda. They found that maximum yield (37.2kg/plant) with the foliar application of 0.5 per cent ferrous sulfate. Alila *et al.*, (2004) reported that the foliar application of micronutrients i.e., FeSO<sub>4</sub> (0.2%) and boric acid (0.1%) on papaya cv. Ranchi at 2nd and 4th month after transplanting. They observed that the growth parameters (plant height, basal diameter and number of leaves per plant) significantly increased under the micronutrients treatment in comparison to the control. Meena *et al.*, (2008) showed that foliar application of ferrous sulphate and borax at 0.6 per cent produced maximum average fruit weight, fruit length, fruit breadth, pulp weight, stone weight, pulp to stone weight ratio compared than the control and 0.3 per cent spray of ber trees. Pathak *et al.*, (2011) reported that combined application of Fe (0.5%) and Zn (0.5%) showed the best response on plant growth in terms of plant height, basal girth of pseudostem, number of leaves produced per plant and minimum duration between emergences of two successive leaves in banana. Modi *et al.*, (2012) revealed that individual application of ZnSO<sub>4</sub> (0.5 per cent) and borax (0.3 per cent) exerted great influence on plant height, stem girth and number of leaves as well as earlier initiation of flower bud and minimum days taken from fruit setting to first harvest of papaya (*Carica papaya* L.) cv. Madhu Bindu.

### **Essentiality and deficiency symptoms of Zinc**

Zinc deficiency is the most widespread and limiting growth and yield in fruit crops. It commonly affects banana, custard apple and mangoes. Problems often appear in spring

when crops are growing quickly but have difficulty in absorbing nutrients from cold soil. Zinc is required for the synthesis of tryptophan a precursor of auxin thus helps in reducing fruit drop. Application of zinc at higher level increased the foliar zinc content which ultimately encourages the endogenous production of auxin thereby reducing fruit drop (Meena *et al.*, 2014). Involvement of Zn in the synthesis of tryptophan which is a precursor of indole acetic acid synthesis, consequently it increased tissue growth and development. It has important role in starch metabolism, and acts as co-factor for many enzymes, affects photosynthesis reaction, nucleic acid metabolism and protein biosynthesis (Alloway, 2008). The severe stunting of leaves and shoots, which is so typical of zinc deficient crops is a consequence of low auxin levels in tissue. Young leaves are usually the most affected and are small, narrow, chlorotic and often rosetted due to failure of the shoot to elongate. Bloom spikes are small, deformed and drooping. In young pine apple plants, zinc deficiency is indicated by the young heart leaves bunching together and then tilting horizontally. This condition is commonly called crook neck. Older plants may develop yellow spots and dashes near the margins of older leaves that eventually coalesce into brown blister like blemishes giving the leaf surface an uneven feel. The symptoms and corrective measures for zinc deficiency in different tropical fruit crops are mentioned below.

### **Effect of zinc on fruit crops**

Monga and Josan (2000) observed that foliar application of ZnSO<sub>4</sub> (0.3%) gave maximum juice content, total soluble solids and acidity decreased with all micronutrients as compared to control in Kinnow mandarin. Sharma *et al.*, (2005) reported that the highest Fruit weight (18.17g), length (3.60 cm), diameter (3.06

cm) and length : diameter ratio (1.18) with foliar application of 100 ppm zinc on litchi cv. Dehradun. Singh *et al.*, (2005) observed that the foliar application of zinc (0.25% and 0.5% ZnSO<sub>4</sub>) at two month from transplanting significantly increased the plant growth, number of leaves per plant and length of petiole (5th leaf) in papaya. El-Khagawa (2007) studied the effect of foliar application of zinc sulphate at three levels (2000,3000 and 4000 ppm) on quality of fifteen years old pomegranate trees in El-Balyna, Egypt during 2002 and 2003. They observed that the highest TSS (16.9 and 16.6 °Brix), maximum acidity (1.25 and 1.27 %), maximum total sugar (12.2 and 12.0 %) and maximum reducing sugar (11.2 and 11.0 %) in the trees treated with foliar sprays of 4000 ppm zinc sulphate. Yadav *et al.*, (2007) studied the effect of three sprays (2nd week of May, last week of June and second week of August) of zinc sulphate 0.75 per cent on sweet orange fruit trees in term of plant growth and fruit drop. Application of 0.75 per cent zinc sulphate (three sprays) resulted in better growth and less fruit drop. Priyaawasthi and Shantlal (2009) reported that, maximum values of weight (147.6 g), diameter (7.15 cm), length (8.11cm) and volume (164.5 ml) were found in guava fruits produced with the foliar application of 1.5% zinc sulphate. Rawat *et al.*, (2010) concluded that spray of zinc sulphate at 0.4 per cent enhances the TSS, total sugars, sugar /acid ratio and reduced the acidity of the guava fruits. Goswami *et al.*, (2012) studied the effect of pre-harvest application of micro-nutrients on quality of guava (*Psidium guajava* L.) Cv. Sardar and reported that maximum weight of fruit (120.87 g) was obtained by foliar the application of (0.4%) boric acid. However, maximum length (6.18 cm), diameter (5.46 cm) and volume (120.28 cc) of fruit was obtained with the foliar application of zinc sulphate (0.4%). Hasani *et al.*, (2012) conducted an experiment on effects of foliar

sprays of zinc on the fruit yield and quality in pomegranate. Zinc was applied twice at the rate of 0, 0.3 and 0.6 percent. Zn effects were significant in TSS, TSS/TA ratio, juice content of arils and leaf area. The suitable combination of the Zinc on studied characters of pomegranate under prevailing conditions was foliar spray of 0.3% ZnSO<sub>4</sub>. Eiada *et al.*, (2013) investigated the influence of spraying manganese and zinc solutions on Salemy pomegranate. Zinc was applied at 0 (Zn0), 1.5 (Zn1.5), 3% (Zn3) levels. The obtained results showed that 60 mg/l manganese with 3% zinc recorded the highest fruit weight (188.88 and 187.97 g) in the first and second seasons, respectively. Bakshi *et al.*, (2013) reported that the plants treated with 0.6 per cent ZnSO<sub>4</sub> showed highest TSS (8.310B), ascorbic acid (60.88 mg/100 g pulp), TSS/acid ratio (11.70) and lowest acidity (0.716%). of strawberry cv. Chandler. Waskela *et al.*, (2013) reported that, the maximum weight (187.18 g), length (7.06 cm) and width (7.09 cm), high pulp (96.91%), pulp: seed ratio (32.09), of fruit was obtained with the foliar application of 0.75% zinc sulphate in guava cv. Dharidar.

### **Essentiality and deficiency symptoms of Boron**

Boron is much required for cell division and development in the growth regions of the plant near the tips of shoots and roots. It also affects sugar transport and appears to be associated with some of the functions of calcium. Boron affects pollination and the development of viable seeds which in turn affect the normal development of fruit. Borex response was more positive due to boron which plays an important role in translocation of carbohydrates, auxin synthesis to the sink and increased in pollen viability and fertilization Yadav *et al.*, (2013). A shortage of boron also causes cracking and distorted growth in fruit. Boron does not easily move around the plant and therefore the effects of

deficiency appears first, and are usually most acute in young tissues, growing points, root tips, young leaves and developing fruit. The fruits of boron deficient papaya are deformed and bumpy due to the irregular fertilization and development of seeds within the fruit. Ripening is uneven and the developing fruit secrete pinkish white to brown latex. Premature shedding of male flowers and impaired pollen tube development can lead to poor fruit set. Growth is ceased at the growing point.

### **Effect of boron on fruit crops**

Bhatia *et al.*, (2001) reported maximum fruit weight and consequently the yield of guava with the application of 1.0 per cent  $H_3BO_3$ . Mollah *et al.*, (2006) studied on the performance of papaya cv. Shahi and Local in response to boron application. They observed that Shahi gave highest yield using 1 kg boron per hectare as foliar application. Khayyat *et al.*, (2007) reported that foliar spray of  $H_3BO_3$  (1500 ppm) resulted in highest yield as well as greater part of pulp weight, pulp/seed ratio, fruit length and diameter of date palm cv. Shahanv as compared to control. Cang *et al.*, (2009) reported that boron application obviously improved the growth of the Navel orange trees through boron nourishment compared with the no-boron control. Priyaawasthi and Shantlal (2009) reported that foliar application of boric acid at 3.0% resulted in higher contents of TSS (14.47 °Brix) and total sugars (6.99%) in guava fruits. Yadav *et al.*, (2011) reported that, the foliar application of 0.4% borax recorded the maximum TSS (11.70%), total sugar (7.51%), ascorbic acid (172.00 mg/100 g fruit pulp) and minimum acidity (0.30%) in guava fruits. Alila and Achumi (2012) reported that pre-harvest application of 4 per cent boric acid resulted in higher TSS and lower acidity content in litchi fruits during storage. Total sugars (15.92%) and reducing sugars

(11.94%) were also enhanced with 4 per cent boric acid pre-harvest application. Ullah *et al.*, (2012) reported that the foliar application of B significantly affected the vegetative growth parameters of kinnow mandarin tree. Tree height, spread, stem diameter, flush length and leaf width was significantly increased by the foliar application of B. Trees sprayed with 0.3 per cent boric acid revealed the highest increase in the tree height and flush length of kinnow mandarin as compared to control. Bhatt *et al.*, (2012) reported that the trees sprayed with 0.5% borax showed maximum fruit yield, fruit weight, fruit volume, TSS, reducing sugar, non reducing sugar and ascorbic acid content in mango. Gaur *et al.*, (2014) reported that the maximum TSS (11.7 °Brix), total sugar (7.51%), ascorbic acid (172 mg/100g) and minimum acidity (0.3%), maximum fruit length (6.07 cm), fruit width (5.92 cm), and fruit weight (98.48 g) with foliar application of 0.4% borax on winter season guava cv. L-49.

### **Essentiality and deficiency symptoms of Copper**

Generally copper deficiency appears to be minimal in tropical fruit crops. Copper is essential for photosynthesis, for the functioning of several enzymes, in seed development and for the production of lignin which gives physical strength to shoots and stems. Copper activates several enzymes in plant, helps in chlorophyll synthesis (Ram and Bose, 2000). The deficiency symptoms include restriction of terminal growth, die back of twigs, death of growing points and sometimes rosetting, and multiple buds form at the end of twigs. Foliage can be chlorotic in bananas or darker than normal or dull and brownish in colour. In pineapple, growth is severely stunted and leaves are narrow, U shaped in section, and curved downward at their tips. Tip necrosis occurs in some young leaves. Since foliar application of copper can



result in burning of foliage, soil application of copper sulphate @ 30 kg/ha is recommended to correct the deficiency.

### **Effect of copper on fruit crops**

Arora and Singh (1971) conducted an experiment to study the responses of copper spray on five years old guava cv. Allahabad Safeda and reported that the maximum increase (100%) yield with foliar application of Copper Sulphate @ 0.4% with half quantity of hydrated lime. Kundu and Mitra (1999) advocated that the combined spray of Cu + B + Zn, Cu+B, Cu+Zn and Cu alone brought about earlier flowering and increased the fruit set and hastened fruit maturity. Combined spraying of Cu + B + Zn was most effective in increasing the yield, fruit weight and size in guava cv. L-49. Singh *et al.*, (2001) conducted an experiment to determine the effect of ZnSO<sub>4</sub> (0.5%), borax (0.2%), CuSO<sub>4</sub> (0.4%) and their combinations on the fruit quality of aonla cv. Francis. The best result was recorded with the combined spray of ZnSO<sub>4</sub> + borax + CuSO<sub>4</sub>. Singh and Singh (2002) reported the maximum weight (168.7 g), length (5.19 cm) and diameter (5.03 cm), maximum TSS (11.06%), reducing sugar (4.27%) and pectin (0.87%) content, maximum yield (62.63 kg/tree) in guava fruits with the foliar application of copper at 0.4%, of fruit was obtained with foliar application of copper @ 0.4%, while highest ascorbic acid (298.4 mg/100 g pulp) was obtained with application of copper at 0.2% and minimum acidity (0.58%) was obtained in control treatment.

### **Essentiality and deficiency symptoms of Manganese**

Manganese is necessary for chlorophyll formation for photosynthesis, respiration, nitrate assimilation and for the activity of several enzymes. Manganese is only

moderately mobile in plant tissues so symptoms appear on younger leaves first, most often in those leaves just reaching their full size. Manganese availability is reduced in high pH calcareous soils but is often very high in the acid soils commonly chosen for tropical fruit production. Over liming of the soils particularly well drained, poor, coastal sandy soils can induce deficiency. Manganese deficiency causes a light green mottle between the main veins. A band of darker green is left bordering the main veins while the interveinal chlorotic areas become pale green or dull yellowish colour. Soil application of manganese can be ineffective due to immobilization especially in heavier soils or soils which have been over limed. Two to three sprays of 0.1 % manganese sulphate can be recommended.

### **Effect of manganese on fruit crops**

Eiada *et al.*, (2013) investigated the influence of spraying manganese and zinc solutions on Salemy pomegranate. Zinc was applied at 0 (Zn0), 1.5 (Zn1.5), 3% (Zn3) levels. The obtained results showed that 60 mg/l manganese with 3% zinc recorded the highest leaf area (5.43 and 5.69 cm<sup>2</sup>), chlorophyll content (56.12 and 56.26, SPAD unit). Saraswathi *et al.*, (1998) studied the effect of micronutrients (Mg, Mn and Zn each at 0.5% alone or in different combinations) with 1% urea in each treatment on quality of mandarin orange. They observed average maximum fruit weight (116.36 and 140.2 g) in trees treated with Zn @ 0.5% + Mn @ 0.5% + urea @ 1%. Babu *et al.*, (2007) studied the effect of micronutrients (MgSO<sub>4</sub>, ZnSO<sub>4</sub> and MnSO<sub>4</sub> each at 0.5% alone or in combinations) on quality of ten years old Kinnow mandarin trees. They observed maximum fruit diameter (69.24 mm) in the trees treated with 0.5% ZnSO<sub>4</sub> + 0.5% MnSO<sub>4</sub>. Babu and Yadav (2005) conducted an experiment to evaluate the effects of foliar

spraying of micronutrients on the yield and quality of Khasi mandarin. The plants were sprayed with manganese, zinc and magnesium (each at 0.5%) and observations were recorded for number of fruits per tree, fruit weight, fruit yield per tree, juice content, total soluble solids, titratable acidity, ascorbic acid and total sugars. Zinc and manganese sprays recorded significantly higher values for all parameters, except for titratable acidity.

### **Essentiality and deficiency symptoms of Magnesium**

Magnesium is the metallic constituent of chlorophyll and regulates the uptake of other nutrients (Ram and Bose, 2000). It is also essential for the metabolism of carbohydrates (sugars). It is an enzyme activator in the synthesis of nucleic acids (DNA and RNA). It regulates uptake of the other essential elements, serves as a carrier of phosphate compounds throughout the plant, facilitates the translocation of carbohydrates (sugars and starches), and enhances the production of oils and fats. Magnesium deficiency is most prevalent on sandy coastal plain soils where the native magnesium content is low. The predominant symptom is interveinal chlorosis (dark green veins with yellow areas between the veins). The bottom leaves are always affected first. Magnesium deficiency has been a major worldwide problem in citrus production.

Magnesium deficiency symptoms appear as a result of translocation of Mg from the leaves to the developing fruit, although there may also be a translocation from older leaves to young developing leaves on the same shoot. This yellow area enlarges until only the tip and the base of the leaf is green, showing an inverted V-shaped area pointed on the midrib. In acute deficiency, the yellow area may gradually enlarge until the entire leaf becomes yellow or bronze in color.

### **Effect of magnesium on fruit crops**

Singh *et al.*, (1982) conducted an experiment at H.A.U., Hissar, to study the effect of magnesium and season on growth, flowering, fruiting and yield of guava cv. Allahabad Safeda and observed that maximum fruit set (79.44%), fruit retention (46.27%) and highest yield (93.43 kg/tree) was obtained during rainy season with foliar application of 0.4% magnesium. Ghosh (1986) revealed that, maximum fruit length (6.4 cm), diameter (7.7 cm) and weight (173.0 g) was obtained with foliar application of Mg + Zn + B +Mn (0.3% each).

Waskela *et al.*, (2013) reported that the effect of micronutrients on growth of guava. foliar application of Magnesium sulphate at 0.75% shows significantly increased the number of shoot length (13.44 cm), leaves per shoot (11.65), shoot diameter (0.52 cm), leaf area (71.60 cm<sup>2</sup>), TSS (11.04 °Brix), ascorbic acid (158.24 mg/100 g), TSS: acid ratio (16.73), pectin content (0.84%), reducing sugar (3.45%) and non reducing sugar (3.45%) content in guava fruits.

### **Other micronutrient**

#### **Essentiality and deficiency symptoms of Molybdenum**

Molybdenum functions in enzyme nitrate reductase which is responsible for reduction of nitrate to nitrite during N assimilation in plants. Although molybdenum deficiency is observed in many soils and pasture legumes, vegetables and occasionally cereals, it is very rare in fruit crops. There are few reports that molybdenum deficiency called as yellow spot is observed in citrus. Soil application of molybdenised single super phosphate @ 250-500 kg/ha is the usual means of satisfying the need for 2-5 years.

### **Effect of combination of micronutrients on fruit crop**

Bambal *et al.*, (1991) studied the effect of foliar application of three sprays of Fe, Mn, B and Zn as FeSO<sub>4</sub> (0.4%), MnSO<sub>4</sub> (0.3%), boric acid (0.2%) and ZnSO<sub>4</sub> (0.4%) at monthly interval starting from flowering on eleven years old pomegranate cv. Ganesh. They recorded maximum fruit weight (400.77 g) and maximum fruit volume (376.88 ml) in the trees treated with FeSO<sub>4</sub> (0.4%) + boric acid (0.2%). Balakrishnan *et al.*, (1996) reported that foliar application of 0.25% each of zinc sulfate, iron sulfate and manganese sulfate along with 0.15% boric acid increased pomegranate juice content from 65.6% to 74.8% in pomegranate. Ram and Bose (2000) Reported that the maximum plant height (43.76 cm) and stem girth (3.22 cm) with foliar application of magnesium sulphate (2%), copper sulphate (0.4%) and zinc sulphate (0.5%) while, maximum plant spread was recorded with foliar application of Mg (2%) + Cu (0.4%) + Zn (0.5%) + Borax (0.1%) + Fe (0.25%). Balakrishnan (2001) studied the effect of foliar application of micronutrients on guava Cv. Lucknow and reported that maximum TSS (14.15 °Brix), ascorbic acid (160.08 mg/100 g), total sugar (10.28%) and minimum acidity (0.56%) was obtained in guava fruits with combined foliar application of ZnSO<sub>4</sub> (0.25%) + FeSO<sub>4</sub> (0.25%) + MgSO<sub>4</sub> (0.25%) + Borax (0.1%). Singh *et al.*, (2001) determine the effect of ZnSO<sub>4</sub> (0.5%), borax (0.2%), CuSO<sub>4</sub> (0.4%) and their combinations on the growth of aonla Cv. Francis. They observed highest plant height (19.67 m), trunk girth (26.10 m), plant spread (23.39 m), fruit length (3.98 cm) and fruit width (4.43 cm). Singh and Maurya (2004) studied effect of foliar spray of micronutrients, i.e. ZnSO<sub>4</sub> (0.4%), FeSO<sub>4</sub> (0.4%), MnSO<sub>4</sub> (0.2%) and H<sub>3</sub>BO<sub>3</sub> (0.2%), alone and in combinations, on flowering, fruiting and yield of mango cv. Mallika. The

spray of micronutrients was found responsive in increasing the flowering, fruiting and yield of mango. Panwar and Singh (2007) carried out an experiment to study the effect of preharvest foliar spray of micronutrients on chemical attributes of mango cv. Langra. It was found that combined application of boron, zinc, iron and copper increased the total soluble solids, total sugar, beta -carotene and vitamin A content while decreased the total titrable acidity of fruits. Moazzam *et al.*, (2011) observed that the foliar application of 0.4% FeSO<sub>4</sub> + 0.8% H<sub>3</sub>BO<sub>3</sub> + 0.8% ZnSO<sub>4</sub> gave maximum pulp weight (169.2g), minimum stone weight (24.03g), minimum peel weight (28.13g), highest TSS (27.90 °brix), ascorbic acid (150.3mg/100ml) reducing sugar (19.92%), non-reducing sugar (8.83%), total sugar (49.92%) and minimum acidity (0.178%) as compared to control in mango fruit cv. Dusehri. Yadav *et al.*, (2013) reported that the highest fruit weight (74.14g), length (5.59 cm), diameter (5.08 cm), volume (44.57 ml) and fruit firmness (12.37 lb inch<sup>-2</sup>) with foliar application of 0.1 % H<sub>3</sub>BO<sub>3</sub> + 0.5 % ZnSO<sub>4</sub>, 7H<sub>2</sub>O + 0.5 % FeSO<sub>4</sub>, 7H<sub>2</sub>O on low-chill peach cv. Sharbati.

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