International Journal of Farm Sciences **7(2):** 15-21, 2017

Review

Role of foliar application of micronutrients (B, Zn and Fe) in vegetables

PRAVIN SINGH, DHARMENDRA KUMAR PATIDAR and OM PRAKASH PRAJAPAT*

Department of Vegetable Science, College of Horticulture and Forestry, (AU, Kota) Jhalawar 326023 Rajasthan, India
***Division of Agronomy, Rajasthan Agricultural Research Institute (SKNAU, Jobner) Jaipur 302018 Rajasthan, India**
Email for correspondence: singhthefarmer999@gmail.com

Received: 27.12.2016/Accepted: 23.2.2017

ABSTRACT

Proper plant nutrition is essential for successful production of vegetable crops in open and also under protected conditions. 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 vegetable crops. Micronutrients are involved in all metabolic and cellular functions. Plants differ in their need for micronutrients. Major functions in vegetable production of mineral micronutrients zinc (Zn), boron (B) and iron (Fe) that are generally accepted as essential for all higher plants are reviewed in the paper.

Keywords: Vegetable crops; functions; growth; micronutrients

INTRODUCTION

Micronutrients are essentially as important as macronutrients to have better growth, yield and quality in plants. In the past there was no need of micronutrients because these trace elements were naturally supplied by soil. But due to intensive cultivation, increase in salinity and soil pH in most of soils these nutrients are present but are not available to plants (Ahmad et al 2010). Micronutrients are to be necessarily taken up by the plants from soil or supplemented through foliar application for good growth and yield of crops and maximizing the efficient use of applied N, P and K. In the absence of these micronutrients the plants suffer from physiological disorders which eventually leads to imbalanced growth and low yield. Nowadays micronutrients are gradually gaining momentum among the vegetable growers because of their beneficial nutritional support and at the same time ensure better harvest and returns. For increasing vegetable production a thorough knowledge on the relationship between micronutrients and crop growth is needed. Applying foliar micronutrients is one tool to maintain or enhance plant nutritional status. Often quick effects are seen and deficiencies can be corrected before yield or quality losses occur. Foliar fertilization also allows for post-planting multiple application timings. In addition there is reduced concern for nutrient loss, tie up or fixation as compared to soil application. The available information regarding the impact of micronutrients on vegetable crops is scanty. Thus present review was made to study the role of micronutrients and their effect on different vegetable crops.

Important points about foliar fertilization

- Routine use of foliar fertilizers without a documented need is not recommended.
- Foliar fertilization is unable to meet the total plant requirements for the major nutrients nitrogen, phosphorus and potassium.
- Foliar fertilizers are most effective when soil problems occur that restrict nutrient availability such as iron availability in high pH soils.
- Foliar fertilization should not be used as a substitute for good soil fertility management.
- The soil needs to be tested and fertilized according to soil test recommendations.

Preparation of solution

Foliar fertilizers are applied as liquid solutions of water and the dissolved fertilizers in ion or small molecule form. Foliar nutrient entrance is mostly through the waxy cuticle, the protective layer that covers the epidermal cells of leaves. The required quantity of boric acid, zinc sulphate and ferrous sulphate are sprayed after dissolving them directly in distilled water followed by neutralizing them using $Ca(OH)_2$. The spray of solution is made after 25 and 45 days after sowing.

Essentiality of zinc

Zinc as one of the essential micronutrients in plants is necessary for plant growth and development and involved in many enzymatic activities and IAA formation to increase flower number and fruit set. However excessive Zn in plants can profoundly affect normal ionic homeostatic systems by interfering with the uptake, transport, osmotic and regulation of essential ions and results in the disruption of metabolic processes such as transpiration, photosynthesis and enzyme activities related to metabolism (Sainju et al 2003). Zinc plays a fundamental role in several critical functions in the cell such as protein metabolism, gene expression, structural and functional integrity of bio-membranes and photosynthetic carbon metabolism (Cakmak 2000). In case of zinc deficiency in plants terminal leaves are small, bud formation is poor and leaves have dead areas. It is seldom a problem except in high pH (>6-7) soils. The sources of Zn are zinc–EDTA chelate (Zn content 12%), zinc sulphate monohydrate (Zn content 33%) and zinc sulphate heptahydrate (Zn content 21%).

Effect of zinc on vegetable crops

Singh and Singh (2004) observed the benefits of zinc (0, 10, 20 and 30 ppm) at 30 and 60 DAT in increasing the yield and quality of cauliflower. Narayanamma et al (2009) reported that foliar application of zinc sulphate (0.01%) influenced the nutrient content of bitter gourd particularly with respect to nitrogen and potassium contents in fruits. But phosphorus content in fruits was high with the application of ferrous sulphate (0.01%). Sweet potato plants responded positively to foliar application of Zn (0, 10, 20 and 30 ppm) and the highest production of roots was obtained with the highest zinc doses as indicated by Abd El-Baky et al (2010).

Kalroo et al (2014) conducted an experiment to examine the effect of different levels of chelated zinc (zinc sulphate) on the growth and fruit yield of chilli. Foliar zinc was applied at concentration of 1, 2, 3, 4 and 5 ml per litre water. The results revealed that all the growth and green chillies production traits were significantly (P <0.01) influenced under foliar zinc application at different concentrations. The highest zinc concentration of 5 ml per litre water resulted in 85.66 cm plant height, took 56.33 days to flower emergence, 77 cm plant spread, 13.00 branches per plant, 481.33 fruits per plant, 5.50 cm fruit length, fresh fruit yield of 705 g per plant and 16.350 tonnes fruit yield per ha. However the fruit yield per ha did not increase significantly under 5 ml per litre water Zn concentration as compared to 4 ml per litre water which indicates that Zn @ 4 ml was an optimum level for obtaining economical fruit yield in chillies variety Talhari. Harris and Mathuma (2015) reported that the foliar application of zinc at 250 ppm resulted in the maximum plant height, total dry weight, number and fresh weight of fruits/ plant. The results also revealed that the yield could be increased by the application of Zn at the rate of 250 ppm at flowering stage.

Singh et al (2017) conducted a field experiment to study the effect of different levels of potassium and zinc on growth, yield and economics of sweet potato. The individual foliar application of zinc (30 ppm) significantly increased the number of tubers per plant (4.18), average weight of tuber (234.73 g), length of tuber (18.12 cm), diameter of tuber (5.16 cm), tuber yield per plot (8.33 kg) and tuber yield per hectare (42.05 tonnes) as compared to control.

Essentiality of boron

Boron is considered to be necessary for hormone metabolism, photosynthetic activities, cellular differentiation and water absorption in plant parts. Boron plays an essential role in the development and growth of new cells in the plant meristem, improves the fruit quality and fruit set. It is needed by the crop plants for cell division, nucleic acid synthesis, uptake of calcium and transport of carbohydrates. It also plays an important role in flowering and fruit formation. Due to the lack of boron there is hypertrophy, degeneration and disintegration of cambium cells in the meristematic tissues. Its deficiency may cause sterility, small fruit size and poor yield (Davis et al 2003) and affects translocation of sugar, starches, nitrogen and phosphorus, synthesis of amino acids and proteins. B deficiency affects the growing points of roots and youngest leaves. The leaves become wrinkled and curled with light green colour. Its deficiency affects translocation of sugar, starches, nitrogen and phosphorus, synthesis of amino acids and proteins.

In case of B deficiency tip of growing plant dies, bud becomes light green, roots are brown in center, fruit is corky brown in center and flowers do not form. Some Virginia soils are low in boron. B deficiency is managed best by organic matter additions. The sources of B are borax (sodium tetraborate, 10.5% boron, boric acid (17.0% boron) and disodium octaborate tetrahydrate (20% boron).

Effect of boron on vegetables crops

In chilli Dongre et al (2000) recorded the maximum fruit yield per plant (395.33 g) and per hectare (109.8 q) when boron was sprayed in the form of H_3BO_3 (0.25%) as against control (324.33 g/plant and 90.08 q/ha respectively). Furthermore highest average fruit length (11.12 cm) and fruit diameter (1.175 cm) were recorded when H_3BO_3 (0.1%) was sprayed. Foliar spray of boron (0.5%) at 50 per cent flowering period was found beneficial in increasing fruit weight (55.78 g), number of fruits per plant (44.99) and fruit yield (31.82 tonnes/ha) in tomato (Hamsaveni et al 2003). Tariq and Mott (2006) studied the effect of boron supply on the uptake of micronutrients by radish (*Raphanus sativus* L). The results revealed that the maximum growth and yield was recorded with 0.5 mg/ l boron application as compared to other treatments.

Basavarajeswari et al (2008) reported that out of nine different foliar treatments the application of boric acid at 100 ppm resulted in maximum plant height, maximum number of primary branches (18.30), plant length and fruit yield (30.50 tonnes/ha) than control. Saha et al (2010) while studying the effect of foliar application of boron and molybdenum in sprouting broccoli (*Brassica oleracea* var *italic* Plenck) revealed that application of borax (0.3%) produced maximum stem length (45.57 cm), stem diameter (2.56 cm), leaf width (15.62 cm), total head yield, whole plant weight and protein content. Foliar spray of borax (0.5%) recorded significantly higher number of seeds (221.20) and seed yield per fruit (1.06 g), per plant (8.63 g) and per hectare (342.45 kg), seed germination (83.82%), seedling vigour index (1000.4) and seedling dry weight (51.10 mg) with lower electrical conductivity (0.36 dS/ m) in bell pepper (Kumar and Malabasari 2011). In pea higher number of nodules, size and weight of nodules was recorded by the application of 2.86 mg/l boron. Foliar spray of borax (0.5%) resulted in significantly highest number of fruits (8.3) and fruit yield per plant (377.8 g) in bell pepper (Kumar and Malabasari 2011).

Naz et al (2012) reported that application of B increases the percentage of fruit set in tomato. Ali et al (2013) documented that boron increases the number of fruits in tomato. Shnain et al. (2013) reported higher number of fruits/plant at 1250 ppm of boron in tomato. However in this finding higher number of fruits was recorded at the foliar application of 150 ppm which was 8.3 times lesser than the concentration used by Shnain et al (2014). Ali et al (2013) reported 60 per cent of fruit setting percentage with 5 x 106 ppm of boron in plants of Solanaceae family. Arvindkumar et al (2012) sprayed different concentrations of boron (3.0 and 4.0 ppm) and reported that boron at 4 ppm recorded highest seedling length, seedling dry weight and dehydrogenase enzyme activity. The storage study further revealed that boron at 4 ppm maintained highest seed quality parameters like seed germination, seedling length, seedling dry weight and speed of germination. In brinjal the highest plant height (62.93 cm), number of branches (6.36) and number of leaves (55.67) per plant was recorded with foliar spray of boron (0.25%) + APSA-80 (Gogoi et al 2014). Suganiya et al (2015) studied that foliar application of boron at 150 ppm increased the percentage of flowering, fruit set and fruit yield per plant of ratoon crop of brinjal. Harris and Mathuma (2015) reported that foliar application of B at 250 ppm increased dry weight of leaves, stem and roots/plant which were high in both B at 250 ppm and Zn at 150 ppm.

Essentiality of iron

Iron is an essential micronutrient required for normal growth and plant function. Iron helps in the synthesis of enzymes and chlorophyll. It is a component of various flavoproteins and participates in oxidation-reduction process such as nitrate, sulphate and nitrogen fixation (Al-Bamarny et al 2010). It is an important enzyme cofactor in many plant processes. Lack of iron causes the classical symptoms of inter-venal yellowing which in turn leads to loss in yield and produce quality. The availability of iron and the ability for it to be absorbed by plants are largely determined by the pH of the nutrient solution. Iron acts as a catalyst in formation of chlorophyll through formation of chlorophyll precursor and acts as oxygen carrier. Iron being a structural part and an activator of enzyme affects enzyme activity. It is bound to the protein in ionic form like metalloflavin and metalloporphyrin. Iron helps in electron transport coupled with oxidative phosphorylation during respiration. Its deficiency symptoms are observed first on the youngest leaves which become small but not deformed. If its deficiency continues the entire leaf including veins exhibit chlorotic symptoms and the crop may exhibit bleached appearance, may dry and finally die. In iron deficiency young leaves are yellow between veins from top to bottom and veins, margins and tips stay green. It is more problematic usually due to pH problems for which iron sulfate or chelated iron may be used. The sources of iron are ferrous sulphate ($FeSO_4.7H_2O$, 20%) and Fe-EDTA chelate (12% iron).

Effect of Iron on vegetable crops

Tamilselvi et al (2002) reported that foliar application of iron combined with other micronutrients (Zn, Cu, Mn, B and Mo) significantly increased the number of fruits per plant, fruit setting percentage, single fruit weight, yield per plant of tomato and seed yield of tomato. Malawadi et al (2004) observed that application of iron increased ascorbic acid content, TSS and TA in Chilli. Vala and Savaliya (2014) observed that application of iron ($FeSO_4$ 0.5%) recorded maximum fruit yield (15.37 tonnes/ha) of bitter gourd.

Effect of combination of micronutrients in vegetable crops

Raj et al (2001) found significant increase in yield, zinc and iron content of brinjal fruits with the application of zinc and iron either through soil or foliar spray. Among the treatments soil application of $ZnSO_4$ (12.5 kg/ha) along with three sprays of $ZnSO_4$ (0.2%) and $FeSO_4$ (0.5%) at weekly interval at later stages recorded significantly highest fruit yield of 37.7 tonnes/ha with 23.6 per cent increase over control in brinjal cv Bhagyamathi. Foliar application of zinc (3 ppm), copper (1 ppm) and boron (0.5 ppm) produced the highest number of fruits per plant but the increasing polyfeed spray frequency 3-4 times did not increase the number of fruits per plant in chilli (Jiskani 2005). Hatwar et al (2003) reported application of micronutrients viz zinc (0.1%) and boron (0.1%) separately and/or in combination resulted in improvement of growth, yield parameters and yield of chilli.

Karuppaiah (2005) found the foliar application of borax (0.5%) at 35, 50 and 65 days after transplanting to be the best in terms of number of flowers per plant, number of productive flowers per plant, number of fruits per plant, individual fruit weight and yield (32.15 tonnes/ha) followed by copper sulphate (0.5%) and zinc sulphate (0.5%) sprayed at 35, 50 and 65 days after transplanting in brinjal. Baloch et al (2008) observed that foliar application of zinc (3 ppm), copper (1 ppm) and boron (0.5 ppm) increased height of plant (68.00 cm) and number of branches per plant (6.93) in fresh chilli.

Kumari (2012) suggested that foliar application of boron, iron and manganese each at 100 ppm at 30 days after transplanting at an interval of 10 days resulted in maximum seed yield and seed germination (95, 92 and 88% respectively) in tomato. The maximum plant height and number of photosynthetic leaves per plant were registered with the application of boric acid, zinc sulphate and copper sulphate each at 250 ppm in tomato (Singh and Tiwari 2013).

Kazemi (2013a) reported that in cucumber the effect of Zn and Fe was promoting as 50 mg/l and at 100 mg/l of Zn and Fe led to significant increments of vegetative factors, chlorophyll and leaf NK content and fruit quality. However the best results were found when Zn was applied accompanied with Fe. It was also reported that combined spray of zinc 100 mg/l and iron 200 mg/l on foliage resulted in maximum plant height (124.14 cm) and number of branches per plant (8.36) in tomato as reported by Kazemi (2013b). The maximum plant height (2.93 m) and number of leaves per plant (39.33) were obtained with combined application of boron 1.25 g/l and zinc 1.25 g/l in tomato under agro-climatic conditions of Allahabad (Shnain et al 2014).

Singh et al (2014) obtained higher yield (23.10 and 18.33 tonnes/ha) of tomato with the application of different micronutrients (boron and zinc) in combination and at different concentrations (0.2 and 0.4%) as compared to control (14.52 tonnes/ha) where micronutrients were not applied. The highest number of flower clusters per plant (12.33), number of fruits per cluster (7.17), number of fruits per plant (88.33), yield per plant (6.33 kg) and total yield (113.628 tonnes/ha) were registered with combined application of boron 1.25 g/l + zinc 1.25 g/l in tomato under agro-climatic conditions of Allahabad (Shnain et al 2014).

Vala and Savaliya (2014) reported that among different levels of zinc (0.0, 0.5 and 1.0%) 0.5 per cent treatment significantly increased fruit yield (15.65 tonnes/ha). Among different levels of iron (0.0, 0.5 and 1.0%) 0.5 per cent treatment significantly increased fruit yield (15.37 tonnes/ha). Among different levels of boron (0.0 and 0.1%) 0.1 per cent treatment significantly increased fruit yield (14.96 tonnes/ha).

Among all the interactions of zinc, iron and boron Fe_1Zn_1 ($FeSO_4$ 0.5% + $ZnSO_4$ 0.5%) significantly obtained highest fruit yield (16.33 tonnes/ha). It can be summarized that foliar application of micronutrients $ZnSO_4$ 0.5 per cent + $FeSO_4$ 0.5 per cent at 30, 45 and 60 days after sowing along with a recommended dose of NPK (60 + 60 + 60 kg/ha) and FYM 20 tonnes/ha to the bitter gourd cv Pusa Vishesh was the most beneficial treatment for obtaining higher vegetative growth and yield.

Ali et al (2015) reported that to increase the yield of BARI Hybrid Tomato 4 cultivated in summer season of Bangladesh, foliar application of zinc and boron was done. They recorded maximum plant height (106.9 cm), number of leaves (68.9/plant), leaf area (48.2 cm^2), number of branches (11.9/plant), number of clusters (21.6/plant), number of fruits (1.8/cluster, 33.6/plant), fruit length (5.3 cm), fruit diameter (5.1 cm), single fruit weight (60.4 g) and yield (1.9 kg/plant, 25.7 kg/plot, 58.3 tonnes/ha) in tomato due to foliar application of 12.5 ppm $ZnSO_4$ + 12.5 ppm H_3BO_3. Early flowering (49.3 days) and minimum disease infested plants (9.4%) were also found in the same treatment. Combined foliar application of zinc and boron was more effective than the individual application of zinc or boron on growth and yield.

The combination of RDF + $ZnSO_4$ (10 kg/ha + borax (0.1%) spray at bud initiation stage was effective in causing maximum plant height (33.80 cm), number of leaves/plant (34.30) at bud initiation stage, length of inflorescence (93.80 cm), number of siliqua/ plant (363), siliqua weight/plant (26.30 g), siliqua length (5.34 cm), number of seeds/siliqua (5.67), seed recovery (92.87%), seed yield (199.93 kg/ha), germination percentage (92.20), seedling vigour index I and II (2100 and 467 respectively) (Deepika and Pitagi 2015).

Patidar et al (2016) reported that foliar application of (boron 40 ppm + zinc 40 ppm + iron 80 ppm) resulted in the production of first female flower at minimum node number (3.47), maximum number of branches per plant at 90 DAS (24.40), vine length at final harvest 120 DAS (568.33 cm), minimum number of aborted flowers (68.24%), maximum fruit length (14.10 cm), fruit diameter (3.40 cm), number of fruits per plant (43.13) and days to maturity (38.83) in cucumber.

CONCLUSION

Micronutrients are indispensable for growth and development of crops in general and vegetables in particular. The nutritional value of crops is becoming a major issue. Therefore the application of micronutrients to sustain soil health and crop productivity besides maintaining the quality of vegetables is of profound importance. However foliar application of micronutrients shows better efficacy than soil application as the uptake and assimilation of micronutrients by latter method takes more time.

REFERENCES

Abd El-Baky MMH, Ahmed AA, El-Nemr MA and Zaki MF 2010. Effect of potassium fertilizer and foliar zinc application on yield and quality of sweet potato. Research Journal of Agriculture and Biological Sciences **6(4):** 386-394.

Ahmad I, Aslam Khan M, Qasim M, Ahmad R and Randhawa MA 2010. Growth, yield and quality of *Rosa hybrida* L as influenced by various micronutrients. Pakistan Journal of Agricultural Sciences **47(1):** 5-12.

Al-Bamarny SFA, Salman MA and Ibrahim ZR 2010. Effect of NAA, KNO_3 and Fe on some characteristics of leaf and fruit of peach (*Prunus persica* L) cv Early Coronet. World Food System– A Contribution from Europe, Tropentag, 14-16 September 2010, Zurich.

Ali MR, Mehraj H and Jamal Uddin AFM 2015. Effects of foliar application of zinc and boron on growth and yield of summer tomato. Journal of Bioscience and Agriculture Research **6(1):** 512-517.

Ali S, Javed HU, Rehman RNU, Sabir IA, Naeem MS, Siddiqui MZ, Saeed DA and Nawaz MA 2013. Foliar application of some macro and micronutrients improves tomato growth, flowering and yield. International Journal of Biosciences **3(10):** 280-287.

Arvindkumar PR, Vasudevan SN and Rajarajeshwari MC 2012. Effect of NAA, triacontanol and boron on initial seed quality and storability of bitter gourd (*Momordica charantia*) cv Pusa Visesh. International Journal of Plant Sciences **7(2):** 360-365.

Baloch QB, Chachar QI and Tareen MN 2008. Effect of foliar application of macro and micronutrients on production of green chilies (*Capsicum annuum* L). Journal of Agricultural Technology **4(2):** 174-184.

Basavarajeswari CP, Hosamni RM, Ajjappalavara PS, Naik BH, Smitha RP and Ukkund 2008. Effect of foliar application of micronutrients on growth, yield components of tomato (*Lycopersicon esculentum* Mill).

Karnataka Journal of Agricultural Sciences **21(3):** 428-430.

Cakmak I 2000. Possible roles of zinc in protecting plant cells from damage by reactive oxygen species. New Phytologist **146(2):** 185-205.

Davis TM, Sanders DC, Nelson PV, Lengnick L and Sperry WJ 2003. Boron improves growth, yield, quality and nutrient content of tomato. Journal of the American Society for Horticultural Science **128(3):** 441-446.

Deepika C and Pitagi A 2015. Effect of zinc and boron on growth, seed yield and quality of radish (*Raphanus sativus* L) cv Arka Nishanth. Current Agriculture Research Journal **3(1):** 85-89.

Dongre SM, Mahorkar VK, Joshi PS and Deo DD 2000. Effect of micronutrients spray on yield and quality of chilli (*Capsicum annuum* L) cv Jayanti. Agricultural Science Digest **20(2):** 106-107.

Gogoi S, Das MR, Bora P and Mazumder N 2014. Effect of foliar application of nutrients on fruit and seed production of brinjal. International Journal of Advances in Applied Sciences **2(1-2):** 23-27.

Hamsaveni MR, Kurdikeri MB, Shekhargouda M, Shashidhara SD and Dharmatti PR 2003. Effect of gypsum and boron on seed yield and quality of tomato cv Megha. Karnataka Journal of Agricultural Sciences **16(3):** 457-459.

Harris KD and Mathuma V 2015. Effect of foliar application of boron and zinc on growth and yield of tomato (*Lycopersicon esculentum* Mill). Asian Journal of Pharmaceutical Science and Technology **5(2):** 74-78.

Hatwar GP, Gondane SU, Urkude SM and Gahukar OV 2003. Effect of micronutrients on growth and yield of chilli. Journal of Soils and Crops **13(1):** 123-125.

Jiskani MM 2005. Foliar fertilizers- fast acting agents. Daily Dawn, The Internet Edition, 5 December 2005.

Kalroo MW, Laghari AM, Depar MS, Chandio AS, Pathan AK, Samoon HA and Meghwar BL 2014. Impact of micronutrient (zinc) foliar spray on fruit yield of chillies (*Capsicum annuum* L). Life Sciences International Journal **8(1-4):** 2944-2949.

Karuppaiah P 2005. Foliar application of micronutrients on growth, flowering and yield characters of brinjal cv Annamalai. Plant Archives **5(2):** 605-608.

Kazemi M 2013a. Effect of foliar application of iron and zinc on growth and productivity of cucumber. Bulletin of Environment, Pharmacology and Life Sciences **2(11):** 11-14.

Kazemi M 2013b. Effects of Zn, Fe and their combination treatments on the growth and yield of tomato. Bulletin of Environment, Pharmacology and Life Sciences **3(1):** 109-114.

Kumar DMR and Malabasari TA 2011. Effect of planting geometry and foliar spray of micronutrients on plant growth, seed yield and quality of bell pepper (*Capsicum annuum* L). MSc (Agric) thesis, University of Agricultural Sciences, Dharwad, Karnataka, India, 52p.

Kumari S 2012. Effect of micronutrients on quality of fruit and seed in tomato (*Solanum lycopersicum* L). International Journal of Farm Sciences **2(1):** 43-46.

Malawadi MN, Shashidhara GB and Palled YB 2004. Effect of secondary and micronutrients on yield, nutrient uptake and quality of chilli. Karnataka Journal of Agricultural Sciences **17(3):** 553-556.

Narayanamma, M Radha Rani M, Lalitha Kameswari K and Reddy RVSK 2009. Effect of foliar application of micronutrients on the yield components, yield and nutrient content of bitter gourd. The Orissa Journal of Horticulture **37(2):** 1-5.

Naz RMM, Muhammad S, Hamid A and Bibi F 2012. Effect of boron on the flowering and fruiting of tomato. Sarhad Journal of Agriculture **28(1):** 32-45.

Patidar DK, Maurya IB, Arvindakshan K, Singh P and Meena B 2016. Influence of boron, zinc and iron on growth and yield of cucumber under polyhouse condition. The Ecoscan **9 (Special Issue):** 895-899.

Raj GB, Patnaik MC, Reddy IP and Rao AP 2001. Response of brinjal (*Solanum melongena* L) to zinc and iron. Vegetable Science **28(1):** 80-81.

Saha P, Chatterjee R, Das NR and Mukhopadhyay D 2010. Response of sprouting broccoli to foliar application of boron and molybdenum under Terai region of West Bengal. Indian Journal of Horticulture **67(Special Issue):** 214-217.

Sainju UM, Dris R and Singh B 2003. Mineral nutrition of tomato. Food, Agriculture and Environment **1(2):**176-183.

Shnain RS, Prasad VM and Saravanan S 2014. Effect of zinc and boron on growth, yield and quality of tomato (*Lycopersicon esculentum* Mill) cv Heem Sohna under protected cultivation. European Academic Research **2(3):** 4572-4597.

Singh DK, Rudra BC and Gangopadhyaya PK 2014. Role of micronutrients in the productivity enhancement of tomato. Journal of Agricultural Technology **1(1):** 68-69.

Singh HM and Tiwari JK 2013. Impact of micronutrient spray on growth, yield and quality of tomato (*Lycopersicon esculentum* Mill). Horticultural Flora Research Spectrum **2(1):** 87-89.

Singh P, Aravindakshan K, Maurya IB, Singh J, Singh B and Sharma MK 2017. Effect of potassium and zinc on growth, yield and economics of sweet potato (*Ipomoea batatas* L) cv CO-34. Journal of Applied and Natural Science **9(1):** 291-297.

Singh S and Singh P 2004. Effect of foliar application of nitrogen and zinc on growth and yield of cauliflower (*Brassica oleracea* var *botrytis* L). Scientific Horticulture **9:** 123-128.

Suganiya S and Kumuthini DH and 2015. Effect of boron on flower and fruit set and yield of ratoon brinjal crop. International Journal of Scientific Research and Innovative Technology **2(1):** 135-136.

Tamilselvi P, Vijayakumar RM and Nainar P 2002. Studies on the effect of foliar application of micronutrients on growth and yield of tomato (*Lycopersicon esculentum* Mill) cv PKM-1. South Indian Horticulture **53(1-6):** 46-51.

Tariq M and Mott CJB 2006. Effect of boron supply on the uptake of micronutrients by radish (*Raphanus sativus* L). Journal of Agricultural and Biological Science **1(2):** 1-8.

Vala JD and Savaliya AB 2014. Effect of zinc, iron and boron on yield of bitter gourd (*Momordica charantia* L) cv Pusa Vishesh. International Journal of Agricultural Sciences **10(2):** 751-754.