MICRONUTRIENTS FOR HORTICULTURAL CROPS

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The nutrient elements which are required comparatively in small quantities are called as *micro or minor nutrients* or trace elements. 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, chloride and molybdenum) is only in traces, which is partly met from the soil or through chemical fertilizer or through other sources. 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. 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 crops fruits are briefed here nutrient wise.

1. 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 concentrations of 50-100 ppm are often quoted as satisfactory leaf analysis values for most crops. But leaf analysis is not a reliable guide as there is poor mobility between tissues. 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 utilise 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.

Banana: Banana requires more nutrients than any other commercially cultivated crop and various nutritional disorders affecting the yield and quality of banana have been

reported. Iron deficiency is comparatively very rare in banana plantations. However, foliar spray of 0.2 –0.5 % ferrous sulphate checks the disorder effectively. The recent researches suggest that iron deficiency in banana can be identified using chlorophyll fluorescence. Fe deficiency decrease the ratio of variable fluorescence to maximum fluorescence as observed from fluorescence induction curves indicating the involvement of Fe in both chlorophyll biosynthesis as well as in components of phosphorylation.

Citrus: The element acts as a catalyst in chlorophyll synthesis. The deficiency of iron causes network of green veins against a light green or yellow background in leaves followed by bronzing of leaves.

Grapes: The leaves turn yellow (*chlorosis*) during iron deficiency and the entire shoot become yellow to yellowish green under extreme conditions. The corrective measure is two sprays of 0.2% ferrous sulphate, one before bloom and the second after fruit set.

Papaya: Iron deficiency is comparatively very less in papaya. However, it is reported that foliar application of ferrous sulphate 0.15% at monthly intervals from fifteen days after planting improved the total sugars and TSS of papaya.

Pomegranate: Pomegranate responds well to foliar application of iron. Ferrous sulphate 0.4 % prior to flowering, at full bloom and at fruit set increases the yield of fruits. Combined foliar application of 0.25 % each of sulphates of zinc, ferrous and manganese with 0.15% boric acid increased the yield and juice content.

Tomato: Marginal and interveinal scorching develops on the young expanded leaves with slight purpling of the petioles and veins of chlorotic young leaves. Degreening of the smallest veins and irregular development of brown patches is also seen over the lamina.

Brinjal: Young as well as older leaves will exhibit chlorotic symptoms in the form of yellowing and there is a decline in photosynthesis due to which fruit yield will be greatly reduced. Foliar spray of solution containing 500g of ferrous sulphate and 100 g of urea dissolved in 100 lit of water added with 100 ml of soap solution for an acre of land is taken up two or three times at an interval of 20 days depending upon the degree of severity, to manage the disorder.

Jasmine: The foliage will exhibit interveinal chlorosis as a result of iron deficiency in the soil. When the plant is infested with nematodes, availability of iron and other nutrients by translocation to the plant tissues is hampered due to blockage of vascular bundles. The leaves will have fade yellow colouration; the growth of the plant is stunted which may eventually lead to the wilting of the entire plant. The flower yield will be substantially reduced. Iron chlorosis is a common occurrence in jasmine as many of the areas where it is widely grown has been infested with nematode. So, control of nematode infestation has to be taken up on priority basis. After digging the soil around the tree, the following are applied to the soil : 10 g of Temic or 20 g of Furadon, 250 g of Neem cake and 50 g of Murate of potash. It is followed by irrigation and application of 0.1% Emisan solution. After one week, foliar application of 500 g of ferrous sulphate and 100g of urea along

with 100 ml of soap solution mixed in 100 lit of water is done two to three times at 20 days interval depending upon the extent of severity.

Crossandra: Crossandra is also affected by nematode induced chlorosis just like jasmine. In this crop, the typical symptom is characterized by the purple colouration of the leaves. The package of recommendation mentioned for jasmine also holds good in this case as well except for the fact that it is enough that half of the recommended chemicals is given.

Brusselsprouts: Chlorosis of young leaves, reduced storage roots are the typical symptoms. Foliar application of 0.25 % of sulphates of iron checks the problem.

Peas : Chlorosis of young leaves is the common symptom and the disorder can be managed well by foliar application of 0.1 % ferrous sulphate.

2. 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 important for the formation and activity of chlorophyll and in the functioning of several enzymes and the growth hormone, auxin. 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 blisterlike blemishes giving the leaf surface n uneven feel. The symptoms and corrective measures for zinc deficiency in different tropical fruit crops are mentioned below.

Banana: Compared to other micronutrients, Zn is the most commonly reported deficiency in banana plantations. A fruit yield of 50t/ha removes 500g of Zn/ha/year. In bananas, each successive leaf of the flush is smaller than the previous one and emerges with a reddish pink coloration on its underside. The opened leaf usually loses this pinkish colour but chlorotic bands develop parallel with lateral veins and alternate with green strips producing a rain bow leaf pattern.

Due to imbalanced fertiliser application and high density planting, incidence of Zn deficiency has become yield limiting. Disproportionate and high application of DAP as basal and top dressing create P induced Zn deficiency in banana. The leaf width is reduced more than the length and the leaf becomes lanceolate in shape. Spraying of Zinc sulphate 0.3% + 0.5% urea at 45 and 60 days after planting of main crop and 45 days after cutting of mother plant for ratoon crop corrects the disorder well. In Zn deficient soils, application of Zinc sulphate @ 30-50g/plant at the time of planting is recommended.

Recent studies at TNAU suggest that combined foliar spray of Zn (0.5%), Fe (0.2%), Cu (0.2%) and B (0.1%) influenced morphological, physiological and yield attributes. The treatment had significant improvement in bunch yield and quality parameters by showing higher total soluble solids and lower acidity.

Mango: The major nutritional disorder in mango is *little leaf* caused by the deficiency of zinc. This leads to stunted growth of roots, shoots and leaves. The lamina of leaves turn pale yellow while midrib remain green. Leaves become very small, little with interveinal chlorosis. Yellowing, necrotic patches develop on old leaves with drying of leaves.
In severe deficiency, flushing may stop and twigs or even whole branches die back. Subsequently necrotic patches turn grey and cover the entire surface. Two sprays of 1-2% Zinc sulphate, one at the time of flowering and the other at one month after the first spray correct the disorder..

Citrus: The deficiency is very common in sweet oranges, pummelos, lemons and mandarins in South India and some parts of North India. Zinc deficiency is also known as *mottle leaf* and indicates yellow blotches between veins or terminal shoot leaves, reduced leaf size, narrow pointed and chlorotic leaves and appearance of small green spots in yellowed areas, but veins remaining green followed by small sized and misshapen fruits. Internodes are short giving the shoot a rosette look and the fruits become small and hard with reduced yield. Spraying of zinc sulphate 0.3% with calcium chloride 0.5g/litre, sucrose 0.5g/ litre and urea 5g/litre once for a young tree and twice for old trees at fortnightly intervals in spring flush (Feb-March) corrects Zn deficiency very effectively. It is also reported that foliar application of Mg (2%), Cu (0.4%) and Zn (0.5%) increase fruit yield (48kg/plant) and juice content in sweet orange.

Jack: The deficiency symptom is characterized by small leaves with shorter stalks producing a rosette appearance. Interveinal chlorosis will be noticed. The fruits will be smaller in size and the yield will get affected because of higher proportion of fruit drops.
Foliar application of nutrient solutions contains zinc sulphate (500 gm) and lime (250 gm) mixed with 100 gm of urea and 100 ml soap solution dissolved in 100 litres of water is given thrice at 20 days intervals. When the tree putforths new growth, basal soil application of 250 g zinc sulphate along with compost FYM during March and September in equal doses is most beneficial.

Grapes: Small leaves (little leaf) or rosette , widened petioles and small sized fruits are the major symptoms. In some varieties, clusters become stagger and the size of berries range from very small with one or two seeds to normal sized ones with normal seed development. Smearing 10 % zinc sulphate on the pruned stem or spraying of 0.5 – 1% zinc sulphate 10 days before flower formation is the control measure.

Guava: Small leaf and leaf chlorosis are the major symptoms of deficiency. Interveinal chlorosis was also observed with reduction in leaf size. Die back, scant flowering, drying and cracking of the fruits are other symptoms. The disorder can be corrected with spraying of 0.5% zinc sulphate 15 days before flowering.

Bronzing in guava is a complex nutritional disorder. When fruiting starts in a soil marginal in P and K, the nutrients are mobilised from older leaves to the fruits, causing bronze coloured leaves which results in reduced photosynthate transfer to the roots and reduced uptake. In mild symptoms, mixture of 20 kg of FYM, 1 kg of SSP, 0.5kg MOP and 100g $ZnSO_4$ /tree should be applied in soil. In severe cases, the dose may be doubled except FYM and foliar spraying of DAP 0.3% and SOP 0.5% is to be given 45 days after the emergence of leaves. Crop regulation by deblossoming 50% of the flowers for moderate bronzing and foregoing the entire crop for a year in severe bronzing is essential to restore the tree.

Papaya: Micronutrient disorders are comparatively rare in papaya but zinc and boron deficiencies are commonly observed in the orchards where papaya is grown continuously. Zn 0.5% + B 0.1% foliar sprays at 4^{th} and 8^{th} month after planting increased the fruit yield (330.68 kg/tree) and latex yield (21.65 g/fruit at stage I), apart from improving the quality traits. Quality of fruits was improved in terms of TSS (12.94 %), total sugars(6.575%), reducing sugars(5.566%), non-reducing sugars(1.004%). Titrable acidity and ascorbic acid content was also found to be influenced significantly.

Tomato: Zinc deficiency inhibits both vegetative and reproductive growth. The deficiency results in shortened internodes, downward curling of leaflets, and chlorosis. Under severe deficiency, oozing of cell contents as brown fluid is seen from the leaves.

Chillies: The chillies crop has high affinity for zinc nutrition and hence large amount of zinc is taken up by the plant. If zinc is not replenished periodically, the crop is prone to suffer from zinc deficiency severely. The entire foliage of the crop will be reduced in size with interveinal chlorosis, when zinc is in short supply and the plant will present a stunted growth. Foliar application of zinc sulphate @ 500 g and urea @ 100 g dissolved in 100 lit of water along with 100 ml soap solution is to be given two to three times at an interval of 20 days depending upon the extent of severity. Foliar application has to be supplemented with soil application of zinc sulphate @ 8 kg/acre is given basally during last ploughing of the field.

Coconut: Pencil point disease is a physiological disorder affecting coconut palms to a great extent. The onset of this disorder is brought about by blockage of vascular bundles which may lead to disruption in the translocation process.

The typical symptom is characterized by the tapering of truck towards the crown, the fronds will become smaller, rigid and erect. The outer fronds will first show yellowing and drop off. As a result, the number of fronds will be reduced. The nuts will be fewer in number and smaller in size; most of the nuts will be hollow. Thus the yield of nuts is severally affected once this disorder sets in the coconut palm. Along with the recommended fertilizer dose, 225 g each borax, zinc sulphate, manganese sulphate, ferrous sulphate, copper sulphate and 10 g of ammonium molybdate may be dissolved in 10 litres of water and poured in the basin of 1.5 m radius from the trunk of the palm.

Peas: Leaves are narrow, pointed and curled in wards. Yellow mottling on the lamina started from the base of the midrib and move upwards. Poor pod set and seed development.

3. 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. 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.

Banana: The occurrence of boron deficiency is rare in banana. A fruit yield of 50 t/ha removes approximately 700 g B /ha/year. In B deficient plants, the veins are very close, raised above the lamina and leaves are brittle in the early stage. In the later stage, chlorotic spots parallel to midrib and corrugation and laddering symptoms also appear and unfolding of leaf is delayed in addition to the yield reduction. Breaking of leaf tip, torning of leaf tips and browning at the end. Severe boron deficiency may be confused with the symptoms of Ca deficiency. The pronounced thickening of secondary veins in Ca deficient plants can differentiate these two. The deficiency leads deformation of fruit bunches and necrosis of the root system also. Corrective measure is application of borax at 20 g/plant at the time of planting and foliar spray of 0.2% boric acid at fourth and fifth month of planting.

Mango: Stunted growth with shortened internodes and the small leaves showing pale green colour are the symptoms. The midrib will be brown in colour and the leaves dried and withered under extreme conditions. The symptoms resemble potassium deficiency in some conditions. Remedy is spraying of 0.2 % boric acid.

Citrus: Granulation is a serious problem of citrus and is related to B deficiency especially under North Indian conditions. This abnormality is initiated at the stem end of the fruit which gradually extends towards the styler end. The affected juice sacs become hard and dry, fruits become grey in colour, enlarged in size, have flat and insipid taste and assume a granular texture. It is reported that in the areas with high incidence of granulation, the plant tissues contain high Ca and Mn, and low P and B.

Poor micronutrient status also leads to general decline of trees. To control various leaf deficiencies, a combined spray of different microelements at a concentration of 25-50 ppm depending on the intensity of deficiency is generally applied. It is very likely that some of the components of such a spray would be a waste, if the trees are really not

deficient in those elements. Copper and zinc are antagonistic when sprayed together. It is also observed that combined spray may cause tip burning of leaves in the absence of continuous stirring of spray fluid. It is, therefore, best to spray different micronutrients which are deficient individually rather than in combination based on leaf analysis.

Grapes: The presence of small sized fruits and large sized fruits in the same bunch is known as *hen and chicken* disorder. The fruits are sour in taste. The symptoms include death of growing tips, leaf fall and brittleness of young shoots. The leaves may be deformed with interveinal chlorosis spreading from margins to inwards and this is particularly evident after the fruiting. Spraying of 0.2% boric acid a week before bloom and another at full bloom control the disorder effectively.

Guava: The boron disorder is identified with appearance of red spots on the newly emerged leaves. Leaves become dry and brittle. Spraying of 0.3% boric acid 10-15 days before flowering correct the deficiency. In general, foliar applications of 0.5 per cent zinc sulphate and 0.4 per cent boric acid 10 to 14 days before flowering effectively eliminate the zinc and boron deficiencies. The size and quality of guava fruit can be increased greatly by foliar application of borax 1% and potassium chloride 3%.

Papaya: 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. Spraying of boric acid 0.1% at 3 months interval from sixth month after planting onwards correct the deficiency.

Sapota: When there is boron deficiency, the pollination of flowers is affected leading to sterility. Foliar spray of boron 0.3% twice i.e., at the time of flowering and 15 days after flowering help in proper pollination and fertilization of flowers.

Tomato: Yellowing of lower leaf tips and brittleness are the typical symptoms of deficiency. Under severe deficiency, the upper leaves show orange brown colouration along the margins. Poor fruit set, uneven ripening of and development of corky pits are the predominant symptoms.

Cucumber: The deficiency causes dark green discolouration and leathery texture of leaves. The older leaves show brownish yellow interveinal chlorosis and scoched margins while the younger leaves are often malformed and cupped with prominent veins. The number stoma on lower side of the leaves is also reduced.

Onion: The leaves become thick, brittle, mottled and blue green in colour due to deficiency. The tip of the leaves dry and become white in colour (white tips). The bulb scales become hard and rough and the internal scales become necrotic.

Cauliflower: Boron deficiency in cauliflower, turnip, radish, cauliflower and other root crops, commonly cause *brown heart*. It is manifested first by dark spots on the roots,

usually on the thickest parts. The plant gradually becomes stunted or dwarfened. The leaves are smaller than normal and fewer.In the case of cauliflower, the flower head will show hollow stem and bronzing due to the decay of the core tissues of the stalk.

To ameliorate this disorder, foliar spray of 500 g of borax along with 100 g of urea and 100 ml of soap solution dissolved in 100 lit of water has to be taken up in an acre of land. Spray is to be repeated two to three times at an interval of 20 days.

Peas: Stunted growth with small and thick leaves followed by death of the apical growing point results in development of lateral branches. Chlorosis of margins of leaves, later turn to dirty yellow and roll inward. Delayed flowering, shedding of flower poor fruit/pot set.

4. 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. The deficiency symptoms include restriction of terminal growth, die back of twigs, death of growing points and some times 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.

Mango: Tip burning of old leaves with grey brown patches is the typical symptom of copper deficiency. Spraying of 0.3% copper sulphate checks the disorder effectively. It is reported that spraying of Fe (0.1 %) and Cu (0.1%) reduced spongy tissue in mango.

Grapes: Small green foliage, rough bark, short canes with short internodes, poor root development and reduced yield with inferior quality berries are the symptoms. Spraying of 0.2% copper sulphate between bloom and two weeks after bloom controls the disorder.

Citrus: The deficiency is called *exanthema* , red rust, die back, multiple bud or peach leaf conditions. The disorder is also called as foliocellosis. S shaped shoot, small swellings, bumps along the stem simultaneously with yellowish blotches and gummosis are the common symptoms. Die back of twigs, slits on the bark and multiple bud development resembling witch's broom are often witnessed under acute deficiency.

Tomato: The deficiency leads to retardation in growth, curling of leaf upwards and inwards with severe scorching. The first symptom of copper deficiency is overall grey green colour followed by chlorosis of lower leaves. The chlorotic leaves subsequently become bronzed and later into brown with development of necrosis at the margins and blackening of veins. Poor flower and fruit set is also noticed.

Peas: Thin and weak stem bend upward. Lower leaves are narrow and pointed but upper ones are broad and large. Older leaves yellow and shed. Poor fruit set is also witnessed.

5. MANGANESE

Manganese is necessary for chlorophyll formation for photosynthesis, respiration, nitrate assimilation and for the activity of several enzymes. The concentration of manganese in leaves can range widely from 10-15ppm when deficient and in thousands of ppm when it is toxic. 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.

Mango: The deficiency is exhibited by light green foliage gradually turning yellow with a band of green along the midrib and principal lateral veins. Brown dots will appear all over the leaf surface in later stage. The corrective measure is foliar spray of 0.1 % manganese sulphate.

Citrus: Manganese is immobile in plant and is essential for chlorophyll formation. The deficiency is common in soils with high calcium content. It causes green bands of varying width along mid-rib and veins followed by leaf mottling. Zinc and iron deficiency symptoms can mask symptoms of manganese deficiency. Zn and Mn deficiency in acid lime is commonly noted in Tamilnadu and Mn deficiency is observed in Andhra Pradesh. The young leaves show interveinal chlorosis in Mn deficient trees, but the leaf size is not reduced. Spraying Manganese chloride or Manganese sulphate at 0.5 % controls the disorder.

Guava: High calcium carbonate in the growing medium is likely to induce this deficiency Spraying of 0.5% manganese sulphate before flowering checks the disorder.

Tomato: Reduction in leaf size and development of interveinal orange yellow mottling over the tip are the most common symptoms. The mottling later turn yellow while the veins remain green. Mottling is usually followed by numerous small dark brown necrotic spots which perforate the leaf.

Cauliflower: The deficiency symptom appears in the older leaves with grey interveinal mottling and necrotic areas. Yound leaves retain their normal colour but become chlorotic between veins, which gradually spread to older leaves.

Peas: Marsh spots (Minute brown spots) on the older leaves during flowering which become yellow mottled in the interveinal areas. Flowers shed after fading and seed development is affected.

6. 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.

Cauliflower: Cauliflower requires high molybdenum. It is an indicator crop for this nutrient. Young plants show chlorotic and may turn white along the leaf margins, also become cupped and wither. In older plants, the lamina of the newly formed leaves are irregular in shape, frequently consisting of only a large midrib and hence the name *whiptail*. At low soil pH of 4.6, a mixed syndrome of Mo deficiency and Mn toxicity appear on the same plant

Tomato: Mottling of older leaves followed by scorching of margins and inrolling is often noticed due to deficiency. Extensive flower drop and death of growing point are very often noticed due to Mo deficiency.

Cucumber: The plants are stunted and the leaves show pale or yellow green colour along the edge and between the veins followed by marginal scorching. Reduction in leaf size, shortened internodes and death of older leaves and poor fruit development are the typical symptoms of Mo deficiency.

Peas: Mottling of leaves accompanied by death of most of the interveinal leaf. Yellowing of older leaves and curving upwards from the margins resulting in cup shaped appearance also occur. Flowering and fruiting reduced considerably.

Although general recommendations are available for most of the nutritional disorders in horticultural crops, application of micronutrients based on soil and plant nutrient status, at the critical stages of crop growth is absolutely necessary to achieve higher yield and quality.