

Effect of foliar application of micronutrients on growth, yield and quality of tomato

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ABSTRACT

A field experiment was carried out to study the response of tomato to foliar application of micronutrients from 2011 to 2014 at the Department of Vegetable Crops, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore. The hybrid COTH 2 was chosen for this study. The results based on three years mean revealed that out of fourteen different treatments, Different combinations of all the micronutrients were applied in three replications. The pooled analysis revealed that among the different combinations. In tomato hybrid COTH 2, spraying of mixture of all micronutrients (Boric acid @100 ppm, ZnSo₄ @ 100 ppm, Ammonium molybdate @ 50 ppm. Copper sulphate @ 100 ppm, Ferrus sulphate @ 100 ppm, Manganese sulphate @ 100 ppm) (3 sprays at an interval of 40 days from DAP) recorded the highest plant height (95.7cm), number of fruits per plant (46.4) fruit weight (61.9g), fruit yield per plot (63.5kg) and highest yield of 564.1 q/ ha followed by spraying of commercial formulation (Multiplex) (558.8 q / ha). The highest BC ratio of 3.04 was recorded in Mixture of all treatment which was followed by spraying of Zinc Sulphate @ 100 ppm (3.00).

Key words: Tomato hybrid, foliar application, micro nutrients, growth, yield.

Tomato (*Lycopersicon esculentum* Mill, 2n=24), a popular solanaceous vegetable crop, is cultivated throughout the world. It occupies prime place amongst the processed vegetables. It is one of the most highly praised vegetables consumed in salad as well as curry. In India, tomato is grown throughout the country. The leading tomato growing states are Karnataka, Andhra Pradesh, Orissa, Bihar and West Bengal. Tomato is a high yielding crop, for a good stand and yield of tomato, a rich and fertile soil is necessary. Although in recent times balanced nutrition to the crop plants is being advocated through the use of organic manures, but that may be helpful only for low yield levels. For harnessing the higher yield potential, supplementation of micronutrients is essential. Amongst the vegetables, tomato is very responsible to the application of micronutrients. The micronutrients improve the chemical composition of fruits and general condition of plants and are known to acts as catalyst in promoting organic reaction taking place in plants (Ranganathan and Perumal, 1995). Applications of micro- nutrients i.e. zinc and boron have been reported in increasing growth and

seed yield in tomato. However no information is available as regards to the effect of other micronutrients on vegetative and reproductive growth parameters of tomato. In order to study the effect of different micro nutrients viz., zinc, boron, molybdenum, copper, iron and manganese, application on tomato growth parameters, the present investigation was initiated.

Micronutrients are not only essential for better growth, yield and quality but also important like other major nutrients in spite of their requirement in micro quantity. These also helps in uptake of major nutrients and also vital to the growth of plants acting as catalyst in promoting various organic reaction from cell development to respiration, photosynthesis, chlorophyll formation, enzyme activity, hormones synthesis and nitrogen fixation. Considerable research work has been done on the aspect of foliar application of micronutrient indifferent crops and the experimental results indicated not only increase in yield up to 20 per cent but also helpful to sustain crop production. Arora *et al.* (1979) reported that micronutrients like boron, copper, molybdenum and

zinc through foliage can also improve the vegetative growth, fruit set and yield of tomato. Working with tomato, Mallick and Muthukrishnan (1980) reported that the role of micronutrients in the “nutrient element balance” of the plant is of considerable interest.

MATERIALS AND METHODS

The present investigation was carried out at the All India Co-Ordinated Vegetable Improvement

Project (AICVIP) at the Department of Vegetable Crops, Horticultural College and Research Institute, Coimbatore from April, 2010 to March, 2014. Field trials were laid out in randomized block design with fourteen treatments replicated thrice. Tomato hybrids CO TH 2 were taken for this study. The micronutrients viz., Boric acid @ 100 ppm, ZnSO₄ @ 100 ppm, Ammonium molybdate @ 50 ppm.

Table 1. Response of tomato to foliar application of micronutrients during *kharif* 2011-2012.

| Treatments | Plant height(cm) | Fruits / plant | Fruit weight(g) | Fruit yield per plot (kg) | Yield / ha (q) | Shelf life (days) |
|---|------------------|----------------|-----------------|---------------------------|----------------|-------------------|
| T0. Control (without spray) | 97 | 44.6 | 61.8 | 58.6 | 521.2 | 9.6 |
| T1. Boric acid @ 100 ppm | 96.6 | 46.4 | 62.6 | 60.2 | 535.3 | 10.3 |
| T2. Zinc sulphate @ 100 ppm | 97.9 | 45.9 | 62.5 | 60.9 | 542.4 | 9.5 |
| T3. Ammonium molybdate @ 50 ppm | 95.4 | 43.5 | 61.4 | 58.4 | 520.2 | 9.5 |
| T4. Copper sulphate @ 100 ppm | 96.4 | 45.6 | 61.9 | 60 | 534.3 | 9.4 |
| T5. Ferrous sulphate @ 100 ppm | 98.3 | 47 | 62 | 61.6 | 548.4 | 9.3 |
| T6. Manganese sulphate @ 100 ppm | 97.4 | 46.4 | 62.2 | 61 | 543.4 | 9.4 |
| T7. Mixture of all | 98.9 | 47.8 | 63.8 | 63.8 | 567.6 | 10.5 |
| T8. Mixture of all without B | 97 | 45.1 | 62.1 | 59.3 | 528.2 | 9.5 |
| T9. Mixture of all without Zn | 97.5 | 45.6 | 62.5 | 60.6 | 539.3 | 10.4 |
| T10. Mixture of all without Mo | 98.7 | 47 | 63.3 | 61.8 | 550.5 | 10.6 |
| T11. Mixture of all without Cu | 98.9 | 46.9 | 63.7 | 62.4 | 555.5 | 10.6 |
| T12. Mixture of all without Fe | 97.9 | 45.2 | 63.2 | 60.6 | 539.3 | 10.7 |
| T13. Mixture of all without Mn | 97.4 | 45.6 | 64.2 | 62.2 | 553.5 | 10.6 |
| T14. Commercial formulation (Multiplex) | 98.8 | 46.5 | 63.7 | 62.8 | 559.5 | 10.5 |
| CD (P=0.05) | 1.965 | 1.214 | 1.354 | 1.284 | 10.256 | 0.086 |
| CV % | 5.69 | 6.98 | 8.56 | 6.54 | 6.54 | 6 |

Table 2. Response of tomato to foliar application of micronutrients during *kharif* 2012-13

| Treatments | Plant height (cm) | Fruits / plant | Fruit weight (g) | Fruit yield per plot (kg) | Yield / ha (q) | Shelf life (days) |
|---|-------------------|----------------|------------------|---------------------------|----------------|-------------------|
| T0. Control (without spray) | 95.9 | 44.2 | 61.2 | 58 | 516 | 9.5 |
| T1. Boric acid @ 100 ppm | 95.5 | 45.9 | 62 | 59.6 | 530 | 10.2 |
| T2. Zinc sulphate @ 100 ppm | 96.8 | 45.4 | 61.9 | 60.3 | 537 | 9.4 |
| T3. Ammonium molybdate @ 50 ppm | 94.4 | 43.1 | 60.8 | 57.8 | 515 | 9.4 |
| T4. Copper sulphate @ 100 ppm | 95.3 | 45.1 | 61.3 | 59.4 | 529 | 9.3 |
| T5. Ferrous sulphate @ 100 ppm | 97.2 | 46.5 | 61.4 | 61 | 543 | 9.25 |
| T6. Manganese sulphate @ 100 ppm | 96.3 | 45.9 | 61.6 | 60.4 | 538 | 9.35 |
| T7. Mixture of all | 97.8 | 47.3 | 63.2 | 63.2 | 562 | 10.4 |
| T8. Mixture of all without B | 95.9 | 44.7 | 61.5 | 58.7 | 523 | 9.4 |
| T9. Mixture of all without Zn | 96.4 | 45.1 | 61.9 | 60 | 534 | 10.3 |
| T10. Mixture of all without Mo | 97.6 | 46.5 | 62.7 | 61.2 | 545 | 10.45 |
| T11. Mixture of all without Cu | 97.8 | 46.4 | 63.1 | 61.8 | 550 | 10.55 |
| T12. Mixture of all without Fe | 96.8 | 44.8 | 62.6 | 60 | 534 | 10.6 |
| T13. Mixture of all without Mn | 96.3 | 45.1 | 63.6 | 61.6 | 548 | 10.45 |
| T14. Commercial formulation (Multiplex) | 97.7 | 46 | 63.1 | 62.2 | 554 | 10.4 |
| CD (P=0.05) | 1.854 | 1.071 | 1.245 | 1.201 | 12.564 | 0.085 |
| CV % | 5.05 | 6.21 | 9.28 | 6.5 | 6.5 | 4.8 |

Table 3. Response of tomato to foliar application of micronutrients during *kharif* 2013-14

| Treatments | Plant height (cm) | Fruits / plant | Fruit weight(g) | Fruit yield per plot (kg) | Yield / ha (q) | Shelf life (days) |
|---|-------------------|----------------|-----------------|---------------------------|----------------|-------------------|
| T0. Control (without spray) | 85.6 | 39.5 | 54.6 | 51.8 | 460.6 | 9.3 |
| T1. Boric acid @ 100 ppm | 85.5 | 40 | 55.4 | 53.2 | 473.3 | 10.2 |
| T2. Zinc sulphate @ 100 ppm | 86.4 | 40.5 | 55.3 | 53.8 | 478.9 | 9.4 |
| T3. Ammonium molybdate @ 50 ppm | 84.8 | 39.6 | 54.3 | 51.6 | 459.5 | 9.3 |
| T4. Copper sulphate @ 100 ppm | 85 | 40.3 | 54.7 | 53 | 471.9 | 9.5 |
| T5. Ferrous sulphate @ 100 ppm | 86.8 | 41.5 | 54.8 | 54.5 | 485 | 9.5 |
| T6. Manganese sulphate @ 100 ppm | 86.2 | 41 | 55 | 53.9 | 480 | 9.4 |
| T7. Mixture of all | 87.6 | 42.4 | 56.4 | 55.9 | 497.6 | 10.5 |
| T8. Mixture of all without B | 85.6 | 39.9 | 54.9 | 52.5 | 466.8 | 9.4 |
| T9. Mixture of all without Zn | 86.2 | 40.3 | 55.3 | 53.6 | 476.7 | 10.4 |
| T10. Mixture of all without Mo | 87.1 | 41 | 56 | 54.6 | 486.1 | 10.5 |
| T11. Mixture of all without Cu | 87.3 | 41.4 | 56.3 | 55.9 | 497.6 | 10.5 |
| T12. Mixture of all without Fe | 86.3 | 39.8 | 55.9 | 53.6 | 476.6 | 10.6 |
| T13. Mixture of all without Mn | 86 | 40.3 | 56.8 | 55 | 489.3 | 10.5 |
| T14. Commercial formulation (Multiplex) | 87 | 41.1 | 56.3 | 55.5 | 494 | 10.4 |
| CD (P=0.05) | 0.932 | 0.374 | 0.244 | 0.576 | 12.639 | 0.12 |
| CV % | 5.26 | 6.13 | 6.54 | 4.31 | 4.31 | 6.48 |

Table 4. Pooled mean of the trial on to study the response of tomato to foliar application of micronutrients during 2011-14

| Treatments | Plant height(cm) | Fruits / plant | Fruit weight(g) | Fruit yield per plot (kg) | Yield / ha (q) | Shelf life(days) | BC ratio |
|---|------------------|----------------|-----------------|---------------------------|----------------|------------------|----------|
| T0. Control (without spray) | 93.3 | 43.4 | 59.7 | 58.3 | 519.5 | 9.5 | 2.87 |
| T1. Boric acid @ 100 ppm | 93.3 | 44.6 | 60.8 | 60.1 | 535.9 | 10.3 | 2.9 |
| T2. Zinc sulphate @ 100 ppm | 94.6 | 44.4 | 60.9 | 60.9 | 543.3 | 9.5 | 3 |
| T3. Ammonium molybdate @ 50 ppm | 92.4 | 42.9 | 59.6 | 58.2 | 519.9 | 9.4 | 2.74 |
| T4. Copper sulphate @ 100 ppm | 93 | 44.1 | 59.9 | 59.6 | 531.6 | 9.4 | 2.8 |
| T5. Ferrous sulphate @ 100 ppm | 95 | 45.6 | 60.3 | 61.5 | 548.9 | 9.4 | 2.99 |
| T6. Manganese sulphate @ 100 ppm | 94.2 | 44.8 | 60.3 | 60.7 | 541.4 | 9.4 | 2.85 |
| T7. Mixture of all | 95.7 | 46.4 | 61.9 | 63.5 | 564.1 | 10.5 | 3.04 |
| T8. Mixture of all without B | 93.6 | 43.9 | 60.4 | 59.3 | 529.3 | 9.4 | 2.86 |
| T9. Mixture of all without Zn | 94.3 | 44.1 | 60.8 | 60.6 | 540.8 | 10.4 | 2.96 |
| T10. Mixture of all without Mo | 95.2 | 45.1 | 61 | 61 | 543.9 | 10.5 | 2.86 |
| T11. Mixture of all without Cu | 95.4 | 45.2 | 61.5 | 61.9 | 552.5 | 10.6 | 2.91 |
| T12. Mixture of all without Fe | 94.5 | 44.2 | 61.2 | 60.6 | 540.7 | 10.7 | 2.95 |
| T13. Mixture of all without Mn | 94.2 | 44.2 | 61.9 | 61.4 | 547.2 | 10.5 | 2.86 |
| T14. Commercial formulation (Multiplex) | 95.4 | 45.1 | 61.7 | 62.5 | 558.8 | 10.4 | 2.99 |
| CD (P=0.05) | 1.256 | 0.458 | 0.364 | 0.845 | 13.645 | 0.185 | |
| CV % | 6.36 | 6.85 | 6.74 | 4.95 | 4.36 | 7.25 | |

Copper sulphate @ 100 ppm, Ferrous sulphate @ 100 ppm, Manganese sulphate @ 100 ppm were sprayed individually and in combinations on tomato with three sprays at an interval of 10 days starting from 40 days after transplanting. A control without spray and commercial formulation (multiplex)

@ 4ml/lit also included in the treatment combinations to compare the results. The experiment was laid out in RBD with three replications. 25 days old tomato seedlings raised in the pro trays were transplanted at a spacing of 75 x 60 cm with the plot size of 3.0 x 3.6 m. The results of the three year trials were presented in

the Table 1, 2 and 3 and the pooled mean data are presented in Table 4.

RESULTS AND DISCUSSION

Response of tomato to foliar application of micronutrients during *khariif* 2011-12. The results revealed that the treatment mixture of all micronutrients recorded the highest plant height (98.8 cm), fruits per plant (47.8), fruit weight (63.8g), fruit yield per plot (63.8 kg), yield per ha (567.6 q). The highest fruits weight 64.2g was recorded in mixture of all without Mn spray. Mixture of all without Fe registered the highest shelf life of 10.7 days. While, control and commercial formulation recorded the yield of 521.2 and 559.5 q/ha respectively. Response of tomato to foliar application of micronutrients during *khariif* 2012-13. The results revealed that the highest plant height of 97.8 cm was recorded on the treatment T7 (Mixture of all) and T 8 (Mixture of all without Cu). The highest number of fruits per plant (63.6) recorded in the treatment Mixture of all without Mn and the highest yield per plot (63.2 kg) and yield per ha (562 q) recorded in the Treatment T7 (Mixture of all). The T14 (commercial formulation) registered the yield of 554 q/ha while the control recorded the yield of 516 q/ha registered the highest yield of 562q/ha followed by T 14 commercial formulation (554 q/ha). The treatment T12 (Mixture of all without Fe) recorded the highest shelf life of 10.60 days in ambient condition. Response of tomato to foliar application of micronutrients during *khariif* 2013-14. The highest plant height (87.6 cm), fruits per plant (42.4) and fruit weight (56.4 g) recorded in the treatment T7 (Mixture of all). The treatment T7 (Mixture of all) and T11 (mixture of all without Cu) registered the highest yield of 497.6 q/ha followed by commercial formulation (494.0 q/ha). The treatment T12 (Mixture of all without Fe) recorded the highest shelf life of 10.6 days in ambient condition. While, the control recorded the yield of 460.6 q/ha. The pooled data of three years trials revealed that among the different treatment combination sprayed in the Tomato hybrid COTH 2, spraying of mixture of all micronutrients (Boric acid @100 ppm, ZnSO₄ @ 100 ppm, Ammonium molybdate @ 50 ppm. Copper sulphate @ 100 ppm, Ferrussulphate @ 100 ppm, Manganese sulphate @ 100 ppm) (3 sprays at an interval of 40 days from DAP) recorded the highest plant height (95.7 cm), number of fruits per plant (46.4), fruit weight (61.9 g), fruit yield per plot (63.5 kg) and yield/ha (564.1 q).

The treatment T14 (commercial formulation (Multiplex)) recorded the yield of 558.8 q / ha. The highest BC ratio of 3.04 was recorded in Mixture of all treatment which was followed by spraying of Zinc Sulphate @ 100 ppm (3.00). Boron is associated with the development of cell wall and cell differentiation and hence, helps in root elongation and shoot growth of plant. The need of boron has been emphasized earlier for normal growth of tomato plant by Johnson and Fisher (1930). All the micronutrient treatments except manganese and iron were found significantly effective in increasing fruits per plant and fruit weight (g). Improvement in growth characters as a result of application of micronutrients might be due to the enhanced photosynthetic and other metabolic activity which leads to an increase in various plant metabolites responsible for cell division and elongation as opined by Hatwar *et al.* (2003). The photosynthesis enhanced in presence of zinc and boron was also reported by Rawat and Mathpal (1984). Mallick and Muthukrishnan (1979) explained that presence of zinc activates the synthesis of tryptophan, the precursor of IAA and it is responsible to stimulate plant growth. Iron plays an important role in promoting growth characters, being a component of ferredoxin, an electron transport protein and is associated with chloroplast. It helps in photosynthesis might have helped in better vegetative growth (Hazra *et al.*, 1987). The effect of boron application was more pronounced followed by mixture of micronutrients showing an increase of 35 percent in yield over control. The yield per ha was increased with boron application as reported by Govindan (1952). Increased yield due to micronutrients application may be attributed to enhanced photosynthesis activity and increased production and accumulation of carbohydrates and favorable effect on vegetative growth and retention of flowers and fruits, which increased number of fruits per plant besides increasing the size. Similarly, the Kumbhar and Deshmukh (1993) and Bose and Tripathi (1996) revealed that the increased dry matter production may be attributed to greater accumulation of photosynthates by vegetative parts and fruits in tomato.

CONCLUSION

From the above study, it could be concluded, that the pooled data of three years trials revealed that among the different treatment combination sprayed in the Tomato hybrid COTH 2, spraying of mixture of all

micronutrients (Boric acid @100 ppm, ZnSO₄ @ 100 ppm, Ammoniummolybdate @ 50 ppm. Copper sulphate @ 100 ppm, Ferrous sulphate @ 100 ppm, Manganese sulphate @ 100 ppm) (3 sprays at an interval of 40 days from DAP) recorded the highest plant height (95.7 cm), number of fruits per plant (46.4), fruit weight (61.9 g), fruit yield per plot (63.5 kg) and yield/ha (564.1 q). The treatment T14 (commercial formulation (Multiplex)) recorded the yield of 558.8 q / ha. The highest BC ratio of 3.04 was recorded in Mixture of all treatment which was followed by spraying of Zinc Sulphate @ 100 ppm (3.00).

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