**Effect of Combined Micronutrients on Growth Yield and Quality of Tomato (*Solanum Lycopersicum* L.) var. Pusa Gaurav**

**ABSTRACT**

An investigation was undertaken to study the influence of **Combined Micronutrients on Growth Yield and Quality of Tomato (*Solanum Lycopersicum* L.) Var. Pusa Gaurav** during rabi 2024-2025 at Horticulture Research Farm, Faculty of Agricultural Sciences and Allied Industries, Rama University, Kanpur (U.P.), Kanpur. It indicated that the minimum days to 50%flowering (26.222), maximum plant height (51.68, 82.90 and 120.59), number of branches per plant (3.74, 8.07 and 14.99), no. of flower per cluster (6.70), no. of clusters per plant (6.13), minimum days to first fruit set (50.93) & days to first fruit picking (57.17), no. of fruits per cluster (6.17), no. of fruits per plant (37.84), average fruit weight (71.14), fruit length (cm) (5.29), fruit width (cm) (6.33), fruit yield per plant (kg) (2.692), fruit yield per plot (kg) (32.302), uit yield per hectare (q ha-1) (996.980), total Soluble Solids (0Brix) (5.163) and ascorbic acid content (mg/100gm) (16.427) was recorded in T1: FeSO4 50ppm + Boric Acid 100ppm. This treatment had the maximum net return B:C Ratio out all other treatments than over control.

**Key words:-** micronutrients, growth, yield, quality and tomato

**INTRODUCTION**

Tomato (*Lycopersicon esculentum* Mill. 2n=24) is commercially important throughout the world both for fresh fruit market and for the processed food industries, and it ranks 2nd in importance after potato in many countries **Yadav *et al.,* (2024).** It is a self-pollinated crop and Peru-Equator region is considered to be the centre of origin. Tomato was introduced to India by the Portuguese **Singh *et al.,* (2021).** Tomato is cultivated in tropics and subtropics of the world. In India, tomato is grown in 809.9 (000 ha) with an annual production of 19697 (000 MT) and productivity 24.4 MT/Ha **Singh *et al.,* (2021).** The leading tomato growing countries in the world are USA, several European Countries, Japan and China. In India tomato production is reported to be 21.00 million tonnes as compared to 20.55 million tonnes in the year 2019-20 **Anonymous. (2022).** The tomato fruits are globular or ovoid, they are eaten raw or cooked as vegetable. A large quantity of tomato is used to produce soup, juice, ketchup, puree, paste and powder. Tomato is very popular because it supplies vit. C and adds variety of colours, taste and flavours to the food. Green tomatoes are used for pickles and preserves. It is rich in medicinal value. The pulp and juice are easily digestible, mild apparent, promoter of gastric secretion, blood purifier and considered to be intestinal antiseptic. It stimulates torpid liver and is good in chronic dyspepsia. **(Joshi and Kohli, 2006).** Moreover, tomato enjoys a significant position based on nutritional view point as its 100 g encompasses virtually 48 mg calcium, 27 mg ascorbic acid, 20 mg phosphorus, 3.6 g carbohydrates, 0.9 g proteins, 0.8 g fiber, 0.4 mg iron, 0.2 g fats and 20 K calories of energy. Besides these nutrients it also comprises β-carotene and Lycopene pigments. Lycopene is extremely vital as it is responsible for the respective red colour characteristics of tomatoes. Tomatoes also keep the blood vessels in healthy condition and prevent scurvy **(Ejaz *et al.,* 2011).** Boron deficiency in fresh-market cherry tomatoes is a widespread problem that reduces yield and fruit quality **(Davis *et al.* 2003).** It is noticed that foliar spraying with boron significantly enhanced fruit B and K concentrations in comparison with no boron supply, which indicates firstly that B is translocated from the leaves to the fruit and secondly that B is also involved in K translocation within the plant **(Davis et. al , 2003).** Also, enhanced uptake of Ca, Mg, Na, Zn and B with higher B levels in the root zone has been reported **(Smit and Combrink ,2004)**. Boron is absorbed by the plants in form of borate ions and has antagonism with Calcium, potassium and other cations favours absorption of Calcium. It is also concerned with the nitrogen metabolism and oxidation reduction equilibrium in cells. Deficiency shows browning associated with hallow stem. Another recently investigated aspect related to boron nutrition in tomato is the interaction between boron and salinity or water stress. According to **Ben-Gal and Shani (2002, 2003)**, under conditions of simultaneous boron deficiency and salt or water stress, the extent of growth suppression is determined by the factor imposing the most severe stress and not by an addition of the effects of both restrictive factors. Hence, a dominant-stress-factor model following the Liebig-Sprengel law of the minimum may be used to describe the responses of tomato to simultaneous exposure to boron and salinity or boron and water shortage. Furthermore**, Ben-Gal and Shani (2002)** found that the yield response of tomato to boron nutrition correlates better with B concentration in the irrigation water and soil solution than with the levels of boron in the plant tissue. According to **Alpaslan and Gunes (2001)**, soil boron concentrations of 5 mg kg-1 or higher are expected to impose boron toxicity symptoms.

**MATERIALS AND METHODS**

The present investigation entitled **“Effect of Combined Micronutrients on Growth Yield and Quality of Tomato (*Solanum Lycopersicum* L.) Var. Pusa Gaurav”** was carried out during the rabi season 2024-2025 at the Horticulture Research Farm, Faculty of Agricultural Sciences and Allied Industries, Rama University, Kanpur (U.P.), Kanpur. Positioned approximately 25 km from the district headquarters of Uttar Pradesh 208024. The farm is situated at 20°16' North latitude and 80°08' East longitude in the southwestern plains of Uttar Pradesh. It sits at an altitude of 180 meters above sea level, falling within the subtropical zone. The field was effectively leveled, equipped with adequate irrigation and drainage facilities. Prior to the current study, any stubble from the previous crop and weeds were manually removed from the field. The site is situated within the alluvial belt of the Indo-Gangetic central plain zone of Uttar Pradesh, falling within agro-climatic zone-V. Typically, the climate is semi-arid, characterized by hot, dry summers and moderate to severe cold winters. The average annual rainfall ranges from 800 to 900 mm, with a mean annual precipitation of approximately 818 mm. The experiment was taken under in order to find out the Effect of Combined Micronutrients on Growth Yield and Quality of Tomato (*Solanum Lycopersicum* L.) Var. Pusa Gaurav seedling were obtained from Kanpur Nursery. Experiment was laid out in randomized block design (RBD) and replicated three times on tomato Variety Pusa Gaurav. Seedling were transplanted in first experiment at 15th November 2024 at a spacing 60 x 45 cm. A total of tenth treatments using different concentration of each micronutrients viz., FeSO4, ZnS04, Boric Acid and Chelated Iron 0.5%. A total seventeen growth, yield and quality parameters viz., days to 50% flowering, plant height (cm), no. of branches per plant, no. of flower per cluster, no. of cluster per plant, days to first fruit set, days to first fruit picking, no. of fruit per cluster, no. of fruit per plant, average fruit weight(g), fruit length (cm), fruit width, fruit yield per plant (kg), fruit per plot (kg), fruit yield (q ha-1), TSS (0Brix) and ascorbic acid content (mg/100g of fruit pulp) of tomato were taken during the research experiment. The data on growth, yield and quality components were subjected to Fisher’s method of analysis of variance (ANOVA) as outlined by **Sundararaj *et al.* (1972)** where the ‘F’ test was significant for comparison of the treatment means, CD values were worked out at 5% probability level.

**RESULTS AND DISCUSSION**

The Result of different levels of micronutrients in different treatments combination was shown in table 1. There was significant effect of foliar application of micronutrients on days to 50%flowering. The minimum days to 50%flowering (26.222) was recorded in treatment T1: FeSO4 50ppm + Boric Acid 100ppm. It was followed by T2: FeSO4 100ppm + ZnS04 0.2% and T4: ZnS04 0.1%. Whereas the maximum days to 50%flowering (36.01) was found in Control T0  Untreated. As evident from the result of ANOVA table 1 the F (Cal) value (15.974) was greater than the table value of F (2.456) at 0.05% level of significance. Therefore the difference was significant, indicating significant effect of micronutrients different treatment combination on days to 50%flowering of tomato. The Result of different levels of micronutrients in different treatments combination was shown in table 1. There was significant effect of foliar application of micronutrients on plant height and number of branches per plant at 30, 60 and 90 DAT. The maximum plant height (51.68, 82.90 and 120.59) was recorded in treatment T1: FeSO4 50ppm + Boric Acid 100ppm, which was statistically at par with application of T2: FeSO4 100ppm + ZnS04 0.2%. Whereas the minimum plant height (cm) (35.04, 56.11 and 97.96) at 30, 60 and 90 DAT was found in Control T0  Untreated. The maximum number of branches per plant (3.74, 8.07 and 14.99) was recorded in treatment T1: FeSO4 50ppm + Boric Acid 100ppm, which was statistically at par with application of T2: FeSO4 100ppm + ZnS04 0.2% and T3: ZnS04 0.5%. Whereas the minimum number of branches per plant (2.12, 3.17 and 7.27) at 30, 60 and 90 DAT was found in Control T0  Untreated. Therefore the difference was significant, indicating significant effect of micronutrients different treatment combination on plant height at 30, 60 and 90 DAT of tomato. At height in the treatments T1 might be due to the spray of micronutrients might have improved the soil physical and chemical properties and leading to the adequate supply of nutrients to the plants which might have promoted the maximum vegetative growth while the minimum plant growth was due to non-availability of micronutrients. Similar findings were reported by **Kumari and Kumari (2021)** in tomato. The Result of different levels of micronutrients in different treatments combination was shown in table 2. There was significant effect of foliar application of micronutrients on no. of flower per cluster, no. of cluster per plant, days to first fruit set, days to first fruit picking, no. of fruit per cluster, no. of fruit per plant, average fruit weight(g), fruit length (cm), fruit width (cm), fruit yield per plant (kg), fruit per plot (kg), fruit yield (q ha-1), TSS (0brix) and ascorbic acid content (mg/100g of fruit pulp). The maximum no. of flower per cluster (6.70) was recorded in treatment T1: FeSO4 50ppm + Boric Acid 100ppm, which was statistically at par with application of T2: FeSO4 100ppm + ZnS04 0.2%. Whereas the minimum no. of flower per cluster (4.16) was found in Control T0  Untreated. The maximum no. of clusters per plant (6.13) was recorded in treatment T1: FeSO4 50ppm + Boric Acid 100ppm, which was statistically at par with application of T2: FeSO4 100ppm + ZnS04 0.2%. Whereas the minimum no. of clusters per plant (3.17) was found in Control T0  Untreated. Therefore the difference was significant, indicating significant effect of micronutrients different treatment combination on no. of flower per cluster of tomato. Similar findings were reported by **(Day, 2000)** in tomato. The minimum days to first fruit set (50.93) was recorded in treatment T1: FeSO4 50ppm + Boric Acid 100ppm, which was statistically at par with application of T2: FeSO4 100ppm + ZnS04 0.2%. Whereas the maximum days to first fruit set (73.83) was found in Control T0  Untreated. The minimum days to first fruit picking (57.17) was recorded in treatment T1: FeSO4 50ppm + Boric Acid 100ppm. Whereas the maximum days to first fruit picking (79.29) was found in Control T0  Untreated. The maximum no. of fruits per cluster (6.17) was recorded in treatment T1: FeSO4 50ppm + Boric Acid 100ppm, which was statistically at par with application of T3: ZnS04 0.5%. Whereas the minimum no. of fruits per cluster (79.29) was found in Control T0  Untreated. As evident from the result of ANOVA table 1 the F (Cal) value (89.483) was greater than the table value of F (2.456) at 0.05% level of significance. Therefore the difference was significant, indicating significant effect of micronutrients different treatment combination on no. of fruits per cluster of tomato. 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, **Singh and Tiwari (2013), Mishra *et al.* (2012), Patil *et al.* (2009), Sivaiah *et al.* (2013) and Sathya *et al.* (2013)** obtained higher yield and yield attributes with the application of micronutrient. The maximum no. of fruits per plant (37.84) was recorded in treatment T1: FeSO4 50ppm + Boric Acid 100ppm, which was statistically at par with application of T2: FeSO4 100ppm + ZnS04 0.2%. Whereas the minimum no. of fruits per plant (9.16) was found in Control T0  Untreated. The maximum average fruit weight (71.14) was recorded in treatment T1: FeSO4 50ppm + Boric Acid 100ppm. Whereas the minimum average fruit weight (33.49) was found in Control T0  Untreated. The maximum fruit length (cm) (5.29) was recorded in treatment T1: FeSO4 50ppm + Boric Acid 100ppm, which was statistically at par with application of T2: FeSO4 100ppm + ZnS04 0.2%. Whereas the minimum fruit length (cm) (3.17) was found in Control T0  Untreated. The maximum fruit width (cm) (6.33) was recorded in treatment T1: FeSO4 50ppm + Boric Acid 100ppm, which was statistically at par with application of T2: FeSO4 100ppm + ZnS04 0.2%. Whereas the minimum fruit width (cm) (4.40) was found in Control T0  Untreated. The maximum fruit yield per plant (kg) (2.692) was recorded in treatment T1: FeSO4 50ppm + Boric Acid 100ppm, which was statistically at par with application of T2: FeSO4 100ppm + ZnS04 0.2%. Whereas the minimum fruit yield per plant (kg) (0.306) was found in Control T0  Untreated. The maximum fruit yield per plot (kg) (32.302) was recorded in treatment T1: FeSO4 50ppm + Boric Acid 100ppm. Whereas the minimum fruit yield per plot (kg) (3.669) was found in Control T0  Untreated. As evident from the result of ANOVA table 1 the F (Cal) value (160.149) was greater than the table value of F (2.456) at 0.05% level of significance. The maximum fruit yield per hectare (q ha-1) (996.980) was recorded in treatment T1: FeSO4 50ppm + Boric Acid 100ppm. Whereas the minimum fruit yield per hectare (q ha-1) (113.244) was found in Control T0  Untreated. Therefore the difference was significant, indicating significant effect of micronutrients different treatment combination on fruit yield per plot (kg) of tomato. The differences in dry matter yield across various treatments were found to be significant, with the highest yield achieved through the foliar application of a mixture of all micronutrients. Additionally, the application of zinc, iron, multiplex, and boron also demonstrated a significant advantage over the control group in terms of dry matter production. The observed increase in yields from micronutrient spraying can be attributed to improved photosynthetic activity, which leads to greater carbohydrate production and accumulation, as well as positive effects on vegetative growth and the retention of flowers and fruits, potentially resulting in a higher fruit count. Similar increases in yield due to the foliar application of micronutrients have also been documented by **Swati *et al.* (2011), Yadav *et al.* (2018), and Solanki *et al.* (2018).** The maximum total Soluble Solids (0Brix) (5.163) was recorded in treatment T1: FeSO4 50ppm + Boric Acid 100ppm, which was statistically at par with application of T3: ZnS04 0.5%, T4: ZnS04 0.1% and T7 : FeSO4 100ppm. Whereas the minimum total Soluble Solids (0Brix) (2.503) was found in Control T0  Untreated. As evident from the result of ANOVA table 1 the F (Cal) value (10.442) was greater than the table value of F (2.456) at 0.05% level of significance. The maximum ascorbic acid content (mg/100gm) (16.427) was recorded in treatment T1: FeSO4 50ppm + Boric Acid 100ppm, which was statistically at par with application of T5: Boric Acid 50ppm, T6: Boric Acid 100ppm and T9: Chelated Iron 0.5%. Whereas the minimum ascorbic acid content (mg/100gm) (2.50314.242) was found in Control T0  Untreated. Therefore the difference was significant, indicating significant effect of micronutrients different treatment combination on total Soluble Solids (0Brix) of tomato. **Narayan *et al.* (2007)** reported similar findings, noting a significant effect of foliar application of micronutrients on the enhancement of ascorbic acid levels in tomato fruits. The application of zinc resulted in the highest increase in ascorbic acid content, followed closely by a combination of micronutrients. This rise in ascorbic acid levels may be attributed to the synthesis of certain metabolic intermediates that facilitate the production of ascorbic acid precursors. Additionally, **Salam *et al.* (2010) and Yadav *et al.* (2018)** confirmed the effectiveness of micronutrients in boosting ascorbic acid content in tomatoes. The total soluble solids (TSS) were found to range from 4.45 to 4.96 percent, with the highest TSS observed from the foliar application of zinc, followed by copper and a mixture of all micronutrients. The increase in TSS is likely a result of enhanced carbohydrate production during photosynthesis. These results align with the observations made by **Yadav *et al.* (2018).**

**CONCLUSION**

From the above experiment finding it may be concluded that the treatment T1: FeSO4 50ppm + Boric Acid 100ppm was found to be best in the terms of growth, fruit yield and quality viz,. days to 50%flowering, plant height (cm), number of branches per plant, no. of flower per cluster, no. of clusters per plant, days to first fruit set, days to first fruit picking, no. of fruits per cluster, no. of fruits per plant, average fruit weight, fruit length (cm), fruit width (cm), fruit yield per plant (kg), fruit yield per plot (kg), fruit yield per hectare (q ha-1), total Soluble Solids (0Brix) and ascorbic acid content (mg/100gm) of tomato.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

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**Table 1: Effect of Combined Micronutrients on Growth Yield and Quality of Tomato (*Solanum Lycopersicum* L.) Var. Pusa Gaurav**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Treatment Notation** | **Treatments details** | **Days to 50% flowering** | **Plant height (cm)** | | | **No. of Branches per plant** | | | **No. of flower per cluster** |
| **30 DAT** | **60 DAT** | **90 DAT** | **30 DAT** | **60 DAT** | **90 DAT** |
| T0 | Control | 36.01 | 35.04 | 56.11 | 97.96 | 2.12 | 3.17 | 7.17 | 4.16 |
| T1 | FeSO4 50ppm + Boric Acid 100ppm | 26.22 | 51.68 | 82.90 | 120.59 | 3.74 | 8.07 | 14.99 | 6.70 |
| T2 | FeSO4 100ppm + ZnS04 0.2% | 28.85 | 49.99 | 79.84 | 118.77 | 3.39 | 7.67 | 13.96 | 6.54 |
| T3 | ZnS04 0.5% | 31.55 | 47.33 | 75.77 | 114.50 | 3.37 | 7.05 | 12.63 | 5.65 |
| T4 | ZnS04 0.1% | 29.78 | 47.21 | 77.32 | 114.38 | 3.46 | 6.66 | 12.94 | 5.74 |
| T5 | Boric Acid 50ppm | 31.67 | 40.66 | 71.93 | 106.67 | 3.28 | 5.58 | 10.97 | 5.24 |
| T6 | Boric Acid 100ppm | 31.54 | 42.11 | 73.49 | 112.29 | 3.25 | 6.17 | 11.89 | 5.40 |
| T7 | FeSO4 100ppm | 32.47 | 41.43 | 74.10 | 112.84 | 3.15 | 6.34 | 10.82 | 5.44 |
| T8 | FeSO4 150ppm | 33.48 | 42.04 | 71.62 | 108.74 | 3.24 | 6.43 | 10.91 | 5.47 |
| T9 | Chelated Iron 0.5% | 32.12 | 42.42 | 70.80 | 110.71 | 3.18 | 6.37 | 12.18 | 5.34 |
|  | **F-Test** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **S** |
|  | **C.D. at 0.5%** | **1.953** | **2.409** | **1.874** | **2.887** | **0.204** | **0.336** | **0.648** | **0.469** |
|  | **S.Ed. (+)** | **0.930** | **1.147** | **0.892** | **1.374** | **0.097** | **0.160** | **0.309** | **0.223** |

**Table 2: Effect of Combined Micronutrients on Growth Yield and Quality of Tomato (*Solanum Lycopersicum* L.) Var. Pusa Gaurav**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Treatment Notation** | **No. of cluster per plant** | **Days to first fruit set** | **Days to first fruit picking** | **No. of fruit per cluster** | **No. of fruit per plant** | **Average fruit weight(g)** | **Fruit length (cm)** | **Fruit width (cm)** | **Fruit yield per plant (kg)** | **Fruit per plot (kg)** | **Fruit yield (q ha-1)** | **TSS (0Brix)** | **Ascorbic acid content (mg/100g of fruit pulp)** |
| T0 | 3.17 | 73.83 | 79.29 | 2.88 | 9.16 | 33.49 | 3.17 | 4.40 | 0.306 | 3.669 | 113.244 | 2.503 | 14.243 |
| T1 | 6.13 | 50.93 | 57.17 | 6.17 | 37.84 | 71.14 | 5.29 | 6.33 | 2.692 | 32.302 | 996.980 | 5.163 | 16.427 |
| T2 | 5.72 | 55.00 | 59.93 | 6.03 | 34.47 | 62.41 | 5.18 | 6.10 | 2.153 | 25.839 | 797.493 | 5.057 | 16.413 |
| T3 | 4.74 | 53.41 | 61.63 | 5.11 | 24.23 | 56.19 | 4.29 | 5.44 | 1.361 | 16.338 | 504.251 | 4.370 | 16.373 |
| T4 | 4.13 | 55.76 | 62.74 | 4.41 | 18.18 | 59.34 | 4.44 | 5.28 | 1.079 | 12.945 | 399.552 | 4.370 | 16.340 |
| T5 | 4.19 | 56.18 | 61.96 | 4.50 | 18.89 | 49.93 | 3.83 | 5.49 | 0.942 | 11.308 | 349.005 | 3.997 | 15.400 |
| T6 | 4.47 | 54.96 | 64.26 | 3.57 | 15.94 | 50.59 | 4.10 | 5.64 | 0.807 | 9.680 | 298.766 | 3.913 | 15.397 |
| T7 | 4.49 | 55.34 | 62.73 | 4.65 | 20.91 | 46.00 | 4.11 | 5.16 | 0.964 | 11.568 | 357.045 | 4.103 | 14.663 |
| T8 | 4.36 | 57.29 | 61.60 | 4.37 | 19.09 | 47.61 | 4.09 | 5.23 | 0.910 | 10.920 | 337.023 | 3.960 | 14.257 |
| T9 | 4.23 | 56.44 | 61.89 | 3.37 | 14.23 | 43.15 | 3.97 | 5.23 | 0.614 | 7.371 | 227.513 | 3.923 | 15.313 |
|  | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **S** |
|  | **0.363** | **1.873** | **2.597** | **0.336** | **2.607** | **3.062** | **0.113** | **0.298** | **0.169** | **2.031** | **67.676** | **0.673** | **0.545** |
|  | **0.173** | **0.892** | **1.236** | **0.160** | **1.241** | **1.457** | **0.054** | **0.142** | **0.081** | **0.967** | **29.833** | **0.320** | **0.260** |