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Effect of micronutrients on growth, yield and quality of tomato (*Solanum lycopersicum* L.)

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Abstract
The experiment was conducted at Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during the rabi season 2023 - 2024. The experiment was laid out in randomized block design with three replications, and the study consists of thirteen treatment combinations including control. The best treatment was T_{12} (NPK-25 g/m² + micronutrients -4 g/L) which shows highest values in all the parameters viz., plant height (cm) 120 DAS (59.56 cm), number of leaves/plant 120 DAS (67.56), number of branches/plant 120 DAS (12.53), days of 50% flowering (71.93), days to first flowering (55.81), days of first harvesting (110.60), no. of flower/cluster (7.49) , no. of fruiting cluster/plant (6.44), no. of fruits/cluster (6.53) fruit set% (86.87%), fruit weight (61.18 g), no. of fruit/plant (106.19), fruit yield per plant (2.02 kg), fruit yield/ha (13.18 t/ha), TSS (5.20 °brix), Lycopene content (6.43 100mg/kg), Hardness (0.82 kg/inch^2), Vitamin C content (35.33 mg/1000 gm). Increased flowering, fruit yield and quality might be due to the increased absorption of nutrients when given as foliar application.

Keywords: Tomato, micronutrient, growth, yield, NPK, quality

1. 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. Tomato has its origin in Peru, Equador and Bolivia. From its centre of origin it first moved to Mexico for domestication and cultivation. Thus, Mexico is the region of origin of cultivated tomato that was transported to the whole world. 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) [3].

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) [11] Botanically, the fruit exhibits all of the common characteristics of berries; a simple fleshy fruit that encloses its seed in the pulp. The outer skin is a thin and fleshy tissue that comprises the remainder of the fruit wall as well as the placenta. The colour of the fruit is derived from the cells within the fleshy tissue. Tomato fruits can be either bilocular or multilocular. Between 50 and 200 seeds are located inside the locular cavities and are enclosed in gelatinous membranes. On an average, the seeds are small (5 x 4 x 2 mm) and lentil shaped. The seed contains the embryo and the endosperm and is covered by a strong seed coat, called the testa. The development of the fruit takes seven to nine weeks after fertilization (Ranganathan and Perumal, 1995) [21]. Tomato fruit contains 93.1 g water, protein 1.9 g, fat 0.1 g, carbohydrate 3.6 g, mineral matter 0.6 g, calcium 20 mg, phosphorus 36 mg, iron 0.8 mg, carotene (as Vit. A) 320 IU, thiamine 2.27 mg, nicotinic acid 0.4 mg, riboflavin 0.01 mg and ascorbic acid 31 mg per 100 g of pulp of fruit. It also contains folic acid, pantothenic acid,

biotin, Vit. K and inhibitols which is related to vit. E (Aykroyd *et al.*, 1963) [4].

Tomato can be grown on a wide variety of soils. However, a well-drained fertile loam soil with good moisture holding capacity is ideal. Climate is the most important factor for tomato cultivation. The critical factor for setting of fruit is night temperature, the optimum range being 15 to 21 ℃. Fruits fail to set at 13 ℃ or below. Fruit set is also reduced markedly when average maximum day temperature goes above 32 ℃ and average minimum night temperature goes above 21 ℃ (Singh *et al.*, 2010) [26].

According to Ranganathan and Perumal (1995) [21], micronutrients play an important role in plant growth and development and they are necessary for plants to thrive vegetatively, yield more and they are required in a very little quantity. The soil, organic fertilizers, and other sources all contribute to meet the micronutrient needs to some extent. Mineral nutrients regulate a variety of physical and metabolic functions.

Micronutrients such as zinc, iron, manganese, copper, boron, and magnesium play a vital role in tomato crop physiology and are necessary for physiological activities. As a result, micronutrient supplementation is critical (Azeem and Ahmed, 2011) [5].

The study was conducted to find out suitable combination of fertilizer and micronutrients on growth, yield and quality of tomato and to estimate the economics of different treatments of tomato.

2. Materials and Methods

This experiment was conducted to study the effect of micronutrients on growth, yield and quality on tomato was conducted during December to April during the rabi season of the year 2023-24 at Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom, University of Agriculture, Technology and Sciences, Prayagraj (Uttar Pradesh) which is located at 25° 39' 42"N latitude, 81° 67 56" E longitude, and 98 m altitude above the mean sea level (MSL). This area is situated on the right side of the river Yamuna by the side of Prayagraj Rewa Road about 5 km away from Prayagraj (U.P) city. The experiment was laid out in Randomized Block Design which consisting of ten treatments with T_0 – Control, T_1 – NPK-10 g/m² + micronutrients-2 g/L, T_2 – NPK-10 g/m² + micronutrients-3 g/L, T_3 - NPK-10 g/m² + micronutrients-4 g/L, T_4 – NPK-15 g/m² + micronutrients-2 g/L, T_5 – NPK-15 g/m² + micronutrients-3 g/L, T_6 - NPK-15 g/m² + micronutrients-4 g/L, T_7 – NPK-20 g/m² + micronutrients-2 g/L, T_8 – NPK-20 g/m² + micronutrients-3 g/L, T_9 - NPK-20 g/m² + micronutrients-4 g/L, T_{10} – NPK-25 g/m² + micronutrients-2 g/L, T_{11} – NPK-25 g/m² + micronutrients-3 g/L, T_{12} - NPK-25 g/m² + micronutrients-4 g/L.

3. Results and Discussion

3.1 Growth Parameter

The data on growth of tomato as influenced by micronutrient are summarized in table 1.

3.1.1 Plant height (cm)

At 120 DAS was significant differences observed statistically between different combinations of micronutrients on plant height of tomato. It was also found that T_{12} (NPK-25 g/m² + micronutrients -4 g/L) took maximum micronutrients on plant height of tomato (71.89 cm) followed by T_{11} (NPK-25 g/m² + micronutrients -3 g/L) with (66.52 cm). While minimum micronutrients on plant height of tomato was taken by T0 (Control)) (58.29 cm).

Singh *et al*., (2021) [27] in tomato, observed identical results where, plant height was maximum, when plants were sprayed with combination of micronutrients (B + Cu + Mo + Fe + Mn + Mg) at 0.1% concentration. Reason for the increase in the plant height is mainly due to role of zinc in auxin production and function of boron in cell wall formation and cell differentiation, both of which helps in development plant root and shoot growth as found by Basavarajeshwari *et al*., (2008) [6]. Shnain *et al*., (2014) [25] observed that increased plant height may be owing to increased nutrient absorption from the soil, which results in carbohydrate assimilation and other metabolic processes, resulting in a rise in several plant metabolites involved in cell division and elongation which in turn increases plant height.

3.1.2 Number of leaves/plant

At 120 DAS was significant differences observed statistically between different combinations of micronutrients on number of leaves of tomato. It was also found that T_{12} (NPK-25 g/m² + micronutrients -4 g/L) took maximum micronutrients on number of leaves of tomato (67.56) followed by T_{11} (NPK-25 g/m² + micronutrients -3 g/L) with (64.86). While minimum micronutrients on number of leaves of tomato was taken by T0 (Control)) (59.23).

The comprehensive RDF + zinc combination, significantly boosts number of leaves by addressing both macronutrient and zinc needs. Similar findings were reported by Kiran *et al*., (2010) [12]; Suganiya *et al*., (2015) [28] in tomato.

3.1.3 Numbers of branches/plant

At 120 DAS was significant differences observed statistically between different combinations of micronutrients on Numbers of branches/plant of tomato. It was also found that T_{12} (NPK-25 g/m² + micronutrients -4 g/L) took maximum micronutrients on Numbers of branches/plant of tomato (12.53) followed by T_{11} (NPK-25 g/m² + micronutrients -3 g/L) with (11.66). While minimum micronutrients on Numbers of branches/plant of tomato was taken by T0 (Control)) (10.21).

The comprehensive RDF + zinc combination, significantly boosts number of branches/plant by addressing both macronutrient and zinc needs. Similar findings were reported by Akanda *et al*., (2012) [2] in tomato**.**

3.1.4 Days to first flowering

There was significant differences observed statistically between different combinations of micronutrients on Days to first flowering of tomato. It was also found that T_{12} (NPK-25 g/m² + micronutrients -4 g/L) took minimum micronutrients on Days to first flowering of tomato (55.81) followed by T_{11} (NPK-25 g/m² + micronutrients -3 g/L) with (58.02). While maximum micronutrients on Days to first flowering of tomato was taken by T_0 (Control)) with (68.50).

Earliness in fruit maturity might be because of better absorption of the nutrients which involved in the metabolic activity and also the hormone which is involved in flower initiation is activated by these treatments. These findings are supported by Manjunath *et al*., (2017) [15] who have also reported that earlier fruiting with foliar feeding of micronutrients. Similar results had also been reported by Naz *et al*., (2012) [31] in tomato.

3.1.5 Days to 50 percent flowering

There was significant differences observed statistically between different combinations of micronutrients on Days to 50 percent

flowering of tomato. It was also found that T_6 (NPK-25 g/m² + micronutrients -4 g/L) took minimum micronutrients on Days to 50 percent flowering of tomato (71.93) followed by T_5 (NPK-25 g/m² + micronutrients -3 g/L) with (73.14). While maximum micronutrients on Days to 50 percent flowering of tomato was taken by T0 (Control)) with (83.62).

The application of micronutrients is responsible for better nutritional status of plant. The adequate availability of micronutrients particularly boron and molybdenum has increased the early flower induction in the plant. The results link with the findings of Ahirwar *et al.* (2019) [1], and Patil *et al.*, (2009) [19] in tomato.

3.2 Vegetative growth and yield parameter

The data on vegetative growth and yield of tomato as influenced by micronutrient are summarized in table 2.

3.2.1 No. of flowers cluster^{-1}

T_{12} (NPK-25 g/m² + micronutrients -4 g/L) took maximum number of flowers cluster^{-1} (7.49) among the different combinations applied followed by T_{11} (NPK-25 g/m² + micronutrients -3 g/L), (7.23). T0 (Control)) took minimum number of flowers cluster^{-1} (4.70).

The earliness in flowering of tomato plants treated with a combination of the Recommended Dose of Fertilizers (RDF) and zinc (Zn) at 0.5% is due to the optimal supply of both macronutrients and the critical micronutrient zinc. RDF provides essential macronutrients (nitrogen, phosphorus, potassium), which are fundamental for vegetative and reproductive growth. Zinc, specifically, plays a crucial role in the synthesis of plant hormones such as auxins, which regulate flowering and other growth processes. This combination ensures that plants have a balanced nutrient profile, promoting quicker transition from vegetative growth to the flowering stage. Enhanced nutrient availability accelerates metabolic processes, leading to earlier flowering compared to other treatments. Additionally, all other nutrient treatments showed earlier flowering than the control due to the alleviation of nutrient deficiencies that hinder growth and development. The control treatment, lacking these supplementary nutrients, exhibits delayed flowering. Therefore, the combination of RDF and zinc at 0.5% significantly advances flowering time by addressing both macronutrient and micronutrient needs efficiently. Results in tomato were consistent with those of Rab and Haq (2011) [20], Kumari (2012) [13].

3.2.2 No. of fruiting clusters plant^{-1}

There was significant differences observed statistically between different combinations of micronutrients on number of fruiting clusters plant^{-1} of tomato. It was also found that T_{12} (NPK-25 g/m² + micronutrients -4 g/L) took maximum micronutrients on germination% of tomato (6.44) followed by T_{11} (NPK-25 g/m² + micronutrients -3 g/L) with (6.18). While minimum micronutrients on number of fruiting clusters plant^{-1} of tomato was taken by T0 (Control)) with (3.65).

Increased number of fruiting per cluster was due to exogenous application of plant growth regulators and micronutrients at crucial phases of flowering and fruit set which may have improved source sink relationship, accumulation of photosynthates and efficient utilization of food reserves for the development of fruits as observed by Hussain *et al*., (1989) [10].

3.2.3 No. of fruits cluster^{-1}

T_{12} (NPK-25 g/m² + micronutrients -4 g/L) had highest number of fruit cluster^{-1} (6.53) among the different combinations applied followed by T_{11} (NPK-25 g/m² + micronutrients -3 g/L), which had 6.27. T_0 (Control)) had lowest number of fruit cluster^{-1} (3.74).

Increased number of fruits per cluster was due to exogenous application of plant growth regulators and micronutrients at crucial phases of flowering and fruit set which may have improved source sink relationship, accumulation of photosynthates and efficient utilization of food reserves for the development of fruits. The outcomes in the tomato aligned with the findings of Osman *et al.*, (2019) [18], Ullah *et al.*, (2015) [30].

3.2.4 Fruit set%

T_{12} (NPK-25 g/m² + micronutrients -4 g/L) had lowest days to fruit set (86.87%) among the different combinations applied at par with T_{11} (NPK-25 g/m² + micronutrients -3 g/L), which had 86.72%. T_0 (Control)) had highest fruit set (79.57%).

Fruit set (%) of tomato plants treated with a combination of the Recommended Dose of Fertilizers (RDF) and a zinc at 0.5% produce more seeds per pod due to the comprehensive and balanced nutrient support provided. The RDF supplies essential macronutrients (nitrogen, phosphorus, potassium), which are critical for robust plant growth and reproductive development. The inclusion of a full spectrum of micronutrients zinc ensures that the plants have all the necessary elements to support complex physiological processes like photosynthesis, enzyme activity, and hormone regulation, which are essential for seed development. This nutrient combination optimizes the plant's metabolic functions, leading to better fertilization and seed formation within each pod. Other treatments, while not as complete as the RDF + zinc, still improve seed production per pod compared to the control, which lacks additional nutrients and thus faces deficiencies that hinder optimal seed development. Consequently, plants receiving RDF and zinc at 0.5% produce the highest number of seeds per pod due to the enhanced and balanced nutritional environment. The outcomes in the tomato aligned with the findings of Begum *et al.*, (2018) [32].

3.2.5 Days taken for first fruit harvest

T_{12} (NPK-25 g/m² + micronutrients -4 g/L) had lowest days taken for first harvest (days) (110.60 days) among the different combinations applied at par with T_{11} (NPK-25 g/m² + micronutrients -3 g/L), which had 111.81 days. T_0 (Control)) had highest days taken for first harvest (days) (133.63 days).

Earliness in harvesting might be due to favourable environment under these treatments which provides suitable conditions for better growth and development of the fruit. The results of present investigation are similar to the findings of Kumari and Sharma (2006) [14] in tomato.

3.2.6 Average fruit weight (g)

T_{12} (NPK-25 g/m² + micronutrients -4 g/L) had average fruits weight (61.18 g) among the different combinations applied at par with T_{11} (NPK-25 g/m² + micronutrients -3 g/L), which had (59.63 g). T_0 (Control)) had minimum average fruits weight (35.12 g).

The fruit weight increased with the micronutrient mixture because of enhancement of photosynthesis resulting in balanced and better mineral utilization by plants, other metabolic activities and more redirecting of food material to the economic parts that eventually lead to increase in cell elongation and cell division. (Kumari and Sharma 2006) [14]. The rise of the fruit weight due to application of micronutrient mixture is because of

faster mineralization of organically bound nitrogen. In tomato, availability of nitrogen was enhanced due to micronutrient mixture which improved the growth parameters and also raised the uptake of other nutrients. This was revealed in significant increase in fruit size and fruit weight (Natesh *et al*., 2005) [17].

3.2.7 No. of fruit/plant

Number of primary fruit per plant was recorded in T_{12} (NPK-25 g/m² + micronutrients -4 g/L) having (106.19) followed by T_{11} (NPK-25 g/m² + micronutrients -3 g/L) having 105.82 whereas the minimum number of primary branches per plant was observed in treatment T_0 (Control) with 94.23.

Increased number of fruits/plant was due to exogenous application of plant growth regulators and micronutrients at crucial phases of flowering and fruit set which may have improved source sink relationship, accumulation of photosynthates and efficient utilization of food reserves for the development of fruits. The outcomes in the tomato aligned with the findings of Sharma *et al.*, (2016) [24], Singh *et al.*, (2021) [27].

3.2.8 Fruit yield /ha (t)

T_{12} (NPK-25 g/m² + micronutrients -4 g/L) took maximum fruit yield per ha (kg) (13.18 t) among the different combinations applied followed by T_{11} (NPK-25 g/m² + micronutrients -3 g/L), which had (12.78 t). T_0 (Control)) took minimum fruit yield per ha (6.69 t).

The maximum yield per hectare was recorded in T_{11} and T_{10} due to bigger size of the fruits as well as a greater number of fruits. It is reported that majorly micronutrients are involved in active photosynthesis, which in turn influences the fruit weight and yield per hectare. Similar results were also obtained by Hooda *et al*., (1984) [9], Rawat and Mathpal (1984) [22] in tomato.

3.3 Quality Parameters

The data on quality of tomato as influenced by micronutrient are summarized in table 3.

3.3.1 Total Soluble Solids {TSS ^{0}Brix}

Among the various combinations used, T_{12} (NPK-25 g/m² + micronutrients -4 g/L) had the highest Total Soluble Solids {TSS ^{0}Brix} (5.20 ^{o}Brix), followed by T_{11} (NPK-25 g/m² + micronutrients -3 g/L), which had 5.16 ^{o} Brix. The Total Soluble Solids {TSS ^{0}Brix} for T0 (Control)) was the lowest at 3.95 ^{o} Brix.

Namdeo *et al*., (2016) [16] observed in tomato that there was higher total soluble solids due to action of copper in the conversion of starch and polysaccharides into sugar during the ripening process. Enzymatic activities help in the conversion of starch to sugar, and it is probable that copper acts as a catalytic agent in these enzymatic processes, which may have accelerated this activity.

3.3.2 Lycopene Content (mg/100 g)

Among the various combinations used, T_{12} (NPK-25 g/m² + micronutrients -4 g/L) had the highest Lycopene Content (mg/100 g) (6.43 mg/100 g), followed by T_6 (NPK-25 g/m² + micronutrients -3 g/L), which had 6.39 mg/100 g. Lycopene Content (mg/100 g) for T_0 (Control) was the lowest at 5.35 mg/100 g.

The main reason for the higher lycopene content is the increase in chlorophyll content of the fruits which is influenced by application of micronutrients. These findings are in agreement with the those of Kumari (2012) [13] in tomato.

3.3.3 Hardness (kg/inch^2)

Among the various combinations used, T_{12} (NPK-25 g/m² + micronutrients -4 g/L) had the highest Hardness (0.82 kg/inch^2), followed by T_{11} (NPK-25 g/m² + micronutrients -3 g/L), which had (0.78 kg/inch^2). The s Hardness (kg/inch^2) for T0 (Control)) was the lowest at (0.51 kg/inch^2).

Rise in hardness oxidase enzyme activity which is involved in the production in hardness along with the presence of different micronutrients that are having close association with hardness production have led to the higher hardness in the tomato fruits (Kumari 2012) [13].

3.3.4 Vitamin-C content (mg/1000) gm

Among the various combinations used, T_{12} (NPK-25 g/m² + micronutrients -4 g/L) had the highest seed yield per plot (kg) (35.33 mg), followed by T_{11} (NPK-25 g/m² + micronutrients -3 g/L), which had 34.96 mg. The seed yield per plot (kg) for T0 (Control)) was the lowest at 25.12 mg.

The increase in the accumulation of photosynthates that are produced in the vit C. which are then translocated to the fruit led to the increase in the vit. C of tomato. (Salam *et al*., 2010 and Devi *et al*., 2013) [7, 23].

3.4 Economics

The data on economics of tomato as influenced by micronutrient are summarized in table 4.

3.4.1 Cost of Cultivation (INR/ha)

The lowest cost of cultivation was found in the control plot (INR 300000/ha) and the highest cost of cultivation (INR306500/ha) was observed treatment T_{12} (NPK-25 g/m² + micronutrients -4 g/L) as compared to other treatment.

3.4.2 Gross return

Gross return (INR 1318179.97/ ha) was found to be highest in treatment T_{12} (NPK-25 g/m² + micronutrients -4 g/L) as compared to other treatment.

3.4.3 Net return (INR/ha)

Net return (INR 1011679.97/ha) was found to be highest in treatment T_{12} (NPK-25 g/m² + micronutrients -4 g/L) as compared to other treatment.

3.4.4 B:C ratio (B:C)

Benefit cost ratio (3.30) was found to be highest in treatment T_{12} (NPK-25 g/m² + micronutrients -4 g/L) and minimum benefit cost ratio (1.23) was found to be in treatment T_1 (Control) as compared to other treatments.

Table 1: Effect of micronutrients on Growth of tomato

Treatment	Concentration	Plant height At 120 DAS	Number of leaves/plant At 120 DAS	Number of branches/plant At 120 DAS	Days to first flowering	Days to 50 percent flowering
T_0	Control (RDF 100%)	51.56	59.23	10.21	68.50	83.62
T_1	NPK-10 g/m² + micronutrients-2 g/L	52.67	61.01	11.09	67.11	82.23
T_2	NPK-10 g/m² + micronutrients-3 g/L	52.69	61.03	11.12	66.44	81.56
T_3	NPK-10 g/m² + micronutrients-4 g/L	53.99	62.33	11.15	65.24	80.36
T_4	NPK-15 g/m² + micronutrients-2 g/L	53.29	61.63	11.17	64.55	79.67
T_5	NPK-15 g/m² + micronutrients-3 g/L	54.31	62.65	11.18	63.35	78.47
T_6	NPK-15 g/m² + micronutrients-4 g/L	54.33	62.67	11.23	62.41	77.53
T_7	NPK-20 g/m² + micronutrients-2 g/L	54.39	62.73	11.25	61.14	76.26
T_8	NPK-20 g/m² + micronutrients -3 g/L	54.59	62.93	11.26	60.65	75.77
T_9	NPK-20 g/m² + micronutrients-4 g/L	55.86	64.20	11.28	59.84	74.96
T_{10}	NPK-25 g/m² + micronutrients -2 g/L	55.30	63.64	11.64	58.32	73.44
T_{11}	NPK-25 g/m² + micronutrients -3 g/L	56.52	64.86	11.66	58.02	73.14
T_{12}	NPK-25 g/m² + micronutrients -4 g/L	59.56	67.56	12.53	55.81	71.93
	F- Test	S	S	S	**S**	S
	S.Em. (±)	1.32	1.32	1.32	1.83	2.25
	C.D.at 0.5%	3.85	3.85	3.85	5.33	6.55

Table 2: Effect of micronutrients on Vegetative growth and Yield of tomato

Treatment	Concentration	No. of flowers cluster^{-1}	No. of fruiting clusters plant^{-1}	No. of fruits cluster^{-1}	Fruit set %	Days taken for first fruit harvest	Average fruit weight (g)	No. of fruit/plant	Fruit yield/ha (t/ha)
T_0	Control (RDF 100%)	4.70	3.65	3.74	79.57	133.63	35.12	94.23	6.69
T_1	NPK-10 g/m² + micronutrients-2 g/L	4.86	3.81	3.90	80.24	120.90	37.59	96.89	7.37
T_2	NPK-10 g/m² + micronutrients-3 g/L	5.25	4.20	4.29	81.70	120.23	39.88	97.91	7.91
T_3	NPK-10 g/m² + micronutrients-4 g/L	5.47	4.42	4.51	82.45	119.03	41.88	99.79	8.47
T_4	NPK-15 g/m² + micronutrients-2 g/L	5.58	4.53	4.62	82.78	118.34	44.63	100.78	9.10
T_5	NPK-15 g/m² + micronutrients-3 g/L	5.69	4.64	4.73	83.11	117.14	46.47	101.80	9.58
T_6	NPK-15 g/m² + micronutrients-4 g/L	6.71	5.66	5.75	85.68	116.20	48.58	102.11	10.04
T_7	NPK-20 g/m² + micronutrients-2 g/L	6.73	5.68	5.77	85.73	114.93	51.66	102.89	10.77
T_8	NPK-20 g/m² + micronutrients -3 g/L	6.85	5.80	5.89	85.97	114.44	53.72	103.96	11.31
T_9	NPK-20 g/m² + micronutrients-4 g/L	6.96	5.91	6.00	86.19	113.63	55.47	105.05	11.79
T_{10}	NPK-25 g/m² + micronutrients -2 g/L	7.01	5.96	6.05	86.30	112.11	57.64	104.81	12.24
T_{11}	NPK-25 g/m² + micronutrients -3 g/L	7.23	6.18	6.27	86.72	111.81	59.63	105.82	12.78
T_{12}	NPK-25 g/m² + micronutrients -4 g/L	7.49	6.44	6.53	86.87	110.60	61.18	106.19	13.18
	F- Test	S	S	S	**S**	S	S	S	S
	S.Em. (±)	0.20	0.25	0.24	0.22	3.40	1.59	1.64	3.43
	C.D.at 0.5%	0.70	0.74	0.73	0.74	9.94	4.65	5.04	10.09

Table 3: Effect of micronutrients on Quality of tomato

Treatment	Concentration	Total Soluble Solids {TSS ^{0}Brix}	Lycopene Content (mg/100 g)	Hardness (kg/inch^2)	Vitamin-C content (mg/1000) gm
T_0	Control (RDF 100%)	3.95	5.35	0.51	25.12
T_1	NPK-10 g/m² + micronutrients-2 g/L	4.12	5.35	0.56	26.88
T_2	NPK-10 g/m² + micronutrients-3 g/L	4.19	5.42	0.58	27.33
T_3	NPK-10 g/m² + micronutrients-4 g/L	4.22	5.45	0.50	28.32
T_4	NPK-15 g/m² + micronutrients-2 g/L	4.25	5.48	0.60	29.87
T_5	NPK-15 g/m² + micronutrients-3 g/L	4.45	5.68	0.61	30.83
T_6	NPK-15 g/m² + micronutrients-4 g/L	4.86	6.09	0.63	31.88
T_7	NPK-20 g/m² + micronutrients-2 g/L	5.01	6.24	0.65	32.35
T_8	NPK-20 g/m² + micronutrients -3 g/L	5.08	6.31	0.67	33.57
T_9	NPK-20 g/m² + icronutrients-4 g/L	5.11	6.34	0.69	34.24
T_{10}	NPK-25 g/m² + micronutrients -2 g/L	5.14	6.37	0.72	34.25
T_{11}	NPK-25 g/m² + micronutrients -3 g/L	5.16	6.39	0.78	34.96
T_{12}	NPK-25 g/m² + micronutrients -4 g/L	5.20	6.43	0.82	35.33
	F- Test	S	S	S	S
	S.Em. (±)	0.16	0.24	0.14	0.97
	C.D.at 0.5%	0.47	0.71	0.40	2.83

Table 4: Effect of micronutrients on Economic of tomato

Treatment	Treatments combinations	Total cost of cultivation	Gross return	Net return	B:C ratio
T_0	Control (RDF 100%)	300000	668818.54	368818.54	1.23
T_1	NPK-10 g/m² + micronutrients-2 g/L	303000	737335.28	434335.28	1.43
T_2	NPK-10 g/m² + micronutrients-3 g/L	304000	790703.84	486703.84	1.60
T_3	NPK-10 g/m² + micronutrients-4 g/L	305000	846532.56	541532.56	1.78
T_4	NPK-15 g/m² + micronutrients-2 g/L	303500	910151.42	606651.42	2.00
T_5	NPK-15 g/m² + micronutrients-3 g/L	304500	957974.50	653474.50	2.15
T_6	NPK-15 g/m² + micronutrients-4 g/L	305500	1004161.26	698661.26	2.29
T_7	NPK-20 g/m² + micronutrients-2 g/L	304000	1076534.94	772534.94	2.54
T_8	NPK-20 g/m² + micronutrients -3 g/L	305000	1130859.74	825859.74	2.71
T_9	NPK-20 g/m² + micronutrients-4 g/L	306000	1179439.85	873439.85	2.85
T_{10}	NPK-25 g/m² + micronutrients -2 g/L	304500	1223697.53	919197.53	3.02
T_{11}	NPK-25 g/m² + micronutrients -3 g/L	305500	1277953.62	972453.62	3.18
T_{12}	NPK-25 g/m² + micronutrients -4 g/L	306500	1318179.97	1011679.97	3.30

4. Conclusion

From the present investigation, it is concluded that, treatment T_{12} (NPK-25 g/m² + micronutrients - 4 g/L) performed best in terms of growth (plant height 59.56 cm), yield (13.18 t/ha) and quality T.S.S. (5.20 ^{0}Brix) of tomato.

The maximum benefit cost ratio was also observed in same treatment with 3.30

5. References

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