

Original Research Article

Effect of Traditional fertilizer, nano-fertilizer and micronutrient on growth, yield and quality of Tomato (*Solanum Lycopersicum L.*)

Abstract

A trial was conducted at the Vegetable Research Farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology & Sciences, Prayagraj (UP) during 2022. This study investigates the “Effect of traditional fertilizer, nano fertilizer and micronutrient on growth, yield and quality of Tomato (*Solanum Lycopersicum L.*)” The purpose of the study is to evaluate the plants in terms of various parameters such as plant height, survival percentage, days to first flowering, days to 50% flowering, number of flower clusters per plant, number of fruit set per cluster, number of fruits per plant, fruit weight, fruit yield per plant, fruit yield per hectare, total soluble solids (TSS), ascorbic acid, and benefit-cost ratio. The results of the study indicate that the application of increased percentage of NPK, ZnSo₄ and Nano Zinc significantly improved the growth and yield tomatoes. The highest fruit yield (135.57 t/ha), fruit weigh (88.407 g), TSS (5.36 Brix) and ascorbic acid content (26.4 mg/100g) were observed in the plants treated with 100 % NPK + 25 % ZnSO₄ through traditional method + 75% spray through Nano zinc. The benefit-cost ratio was also found to be higher in the treated plants compared to the control. Overall, the study suggests that the application of 100 % NPK + 25 % ZnSO₄ through traditional method + 75% spray through Nano zinc can be an effective and sustainable method for enhancing the growth, yield, and quality of Tomatoes.

Keywords: Tomato, NPK, ZnSo₄, Nano zinc

Introduction

Tomato, botanically known as *Solanum lycopersicum L.* or *Lycopersicon esculentum Mill.* is one of the most popular and widely grown vegetable crops throughout the world and treated as “protective food” universally. It is rich source of vitamins, vegetable protein and minerals and holds a glorious position among vegetable after the potato and sweet potato. Tomato known as poor man’s apple (orange) in India & love of apple in England. Tomato is used as soup, salad, pickles, ketchup, puree, sauces, tomato paste, tomato juice and other products. The pulp and juice of tomato fruit are digestible and a mild aperient, a promoter of gastric secretion and a blood purifier. Tomatoes are horticulture crop belongs to the family Solanaceae bearing chromosome number $2n=2X=24$ (Karpechenko, 1925). It originated from South America (Vavilov, 1935). High productive ability of tomato puts tremendous pressure on soil for removal of nutrients. As such liberal application of nutrients is need to meet the nutritional requirements of the corps, however, wake of energy crisis, harmful effect on soil health and ever increased prices of chemical fertilizer becomes problem before the producers. Therefore, a dire need has been felt to apply fertilizers in more and more amount to fulfil the requirements of crop as well as to nourish the health and fertility status of soil, but should be applied in appropriate doses to reduce imparity of soil. **Nitrogen** is part of the chlorophyll molecule, which gives plants their green color and involved in creating food for the plant through photosynthesis. Deficiency in N result in a

stunted plant with paler looking leaves. Due to nutrient mobility within the plant, the older leaves show deficiency first. The flowers take on a deeper shade of yellow and in severe cases of N deficiency they drop and the remaining fruits are smaller, thus affecting the yield. Toxicity due to excess fertilization results in dark green leafage. Flower clusters are more numerous but bud abortion increases. It also inhibits flower development, fruit setting and formation, increase susceptibility to lodging, disease and insect invasion (Jones, 1999). **Phosphorus** is an essential element of the building blocks of life, the RNA, as well as being required for many additional biochemical and physiological processes including energy transfer, protein metabolism and other functions. Deficiency symptoms include a decrease in leaf expansion and leaf area and number. One of the most visible symptoms is the color of the leaves going to a dark green and then turning purplish, usually starting with the older leaves. On the other hand phosphorus excess is associated with micronutrients (zinc, copper, and iron) deficiency (Jones, 1999).

Next to nitrogen, **potassium** is the mineral nutrient required in the largest amount by plants. The potassium requirement for optimal plant growth is in the range 2-5% of the plant dry weight. Potassium (K) fertilization is essential, for all kind of crops especially long term vegetable crops like tomato (Gunter, 2010). **Micro-nutrients**, Plants are able sufficiently to accumulate most trace elements. Some plants are sensitive indicators of the chemical environment in which they grow (**Dunn 1991**), and some plants have barrier mechanisms that exclude or limit the uptake of a particular element or ion species, e.g., alder twigs commonly accumulate molybdenum but not arsenic, whereas the reverse is true of spruce bark (**Dunn 1991**). Zinc is required in a large number of enzymes and plays an essential role in DNA transcription. A typical symptom of zinc deficiency is the stunted growth of leaves, commonly known as "little leaf" and is caused by the oxidative degradation of the growth hormone auxin.

Nano fertilizers, the role of nano urea and nano zinc in the growth, yield, and quality of tomatoes has garnered significant attention in recent years due to their potential to improve nutrient uptake efficiency and enhance crop performance. Nano-scale materials, such as nano urea and nano zinc, possess unique physicochemical properties that make them promising alternatives to conventional fertilizers and micronutrient sources. The unique properties of **nano urea**, including its controlled release, improved solubility, and increased surface area, offer several advantages over conventional urea. **Nano zinc** offers unique advantages in terms of improved solubility, increased bioavailability, and efficient delivery to plants. These properties make it a promising source of Zn for enhancing the growth, yield, and quality of tomatoes.

These advantages contribute to enhanced nutrient availability, reduced nutrient loss through leaching and volatilization, and improved nitrogen use efficiency in tomato plants. This study aims to assess the effectiveness of these alternative fertilizers in comparison to traditional NPK, providing valuable insights into sustainable nutrient management practices. Nano urea and nano zinc are emerging innovations in agricultural science that hold significant promise for improving crop production. Nano urea is a nanoscale formulation of urea, which has been reported to enhance nutrient uptake efficiency, reduce nitrogen losses, and minimize environmental pollution. Similarly, nano zinc has demonstrated potential for enhancing plant growth, photosynthesis, and nutrient absorption. Investigating the effects of nano urea and nano zinc on tomato growth, yield, and quality can provide valuable knowledge about the application of nanotechnology in agriculture. The quality of tomatoes, including attributes such as taste, color, texture, nutritional value, and shelf life, is highly valued by consumers. The application of different fertilizer formulations, including nano urea, nano zinc, and zinc sulphate, may have significant impacts on the quality of tomato fruits. By investigating the effects of these fertilizers on tomato quality parameters, this study can provide valuable information

for tomato growers and contribute to the production of high-quality tomatoes that meet consumer demands.

Materials and Methodology

The details pertaining to the materials used and the methods adopted in the investigation entitled "Effect of Traditional fertilizer, Nano fertilizer and Micronutrient on Growth, Yield and Quality of Tomato (*Solanum Lycopersicum L.*)" during 2022, are presented in this chapter under appropriate heads and sub-heads. Field experiments for studying the effects of Traditional fertilizer, nano fertilizer and micronutrient on growth, yield and quality of Tomato were performed during June 2022 to November 2022 at the Horticultural Research Field, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj (25.43° N latitude 81.84° E longitude) India. The soil at the location is Loam and Sandy Loam. Prayagraj district has a sub-tropical climate and the average maximum temperature ranges between 43°C - 47°C which may go as high as 48°C during peak summers.

Result & Discussion

Effect of traditional fertilizer, nano fertilizer and micronutrient on growth, yield and quality of tomato on growth parameter: All the growth parameter such as plant height(cm) 30,60,90 and 1st harvest after transplanting, survival percentage were variably by affected by application of traditional fertilizer, nano fertilizer and micronutrient on growth parameters. The experiment result revealed that all growth parameters were significantly improved by using traditional fertilizer, nano fertilizer and micronutrient. The maximum **plant height** (56.18cm) at 30 DAT was observed with T7, The maximum plant height (83.60cm) at 60 DAT was observed with T7 and the maximum plant height (100.25cm) at 90 DAT was observed with T7 {100 % NPK + 25 % ZnSO₄ through traditional method + 75% spray through Nano zinc. The foliar application of fertilizers 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 nutrients. Similar findings were reported by *Sivaiah et al. (2013)*; *Meena et al. (2015)*; *Kumar et al. (2016)*; *Singh et al. (2018)* and *Swetha et al. (2018)* in tomato.

Survival percentage of plant significantly varied among different treatment combinations. The maximum survival percentage (99.48%) were observed with T7 {100 % NPK + 25 % ZnSO₄ through traditional method + 75% spray through Nano zinc.

Effect of traditional fertilizer, nano fertilizer and micronutrient on growth, yield and quality of tomato on Earliness parameter: All earliness parameters are Days to first flowering, Days to 50% flowering were variably by affected by application of traditional fertilizer, nano fertilizer and micronutrient on earliness parameters were significantly improved by using traditional fertilizer, nano fertilizer and micronutrient, **Days to 1st Flowering** of plant significantly varied among different treatment combinations. The minimum days to 1st flowering (27.33) were observed with T7 {100 % NPK + 25 % ZnSO₄ through traditional method + 75% spray through Nano zinc. The reduced dose of chemical fertilizers supplemented with organic manures also reduce exploitation of micronutrients. Integration of organic fertilizers and biofertilizers favoured vigorous growth and synthesized more cytokinins in plants, which might have helped to the translocation of cytokinins as well as more quantity of available phosphorus through the xylem vessels and their accumulation in the axillary buds that would have favoured the plant to enter into reproductive phase (Dange et al., 2002). Similar results have also been reported by Singh and Tiwari (2013), Dixit et al. (2018) and Singh et al., (2018). Days to 50% flowering of plant significantly varied among different treatment combinations. The maximum **days to 50% flowering** (40.33) were observed with T7 {100 % NPK + 25 % ZnSO₄ through traditional method + 75% spray through Nano zinc, while the remaining treatments are

moderate in their growth habitat. Similar results have also been reported by Singh and Tiwari (2013), Dixit et al. (2018) and Singh et al., (2018).

Effect of traditional fertilizer, nano fertilizer and micronutrient on growth, yield and quality of tomato on yield parameter: were variably by affected by application of traditional fertilizer, nano fertilizer and micronutrient on yield parameters were significantly improved by using traditional fertilizer, nano fertilizer and micronutrient are No. of Flower cluster per plant, Fruit set per cluster, Individual fruit weight, Polar diameter, Equatorial diameter, No. of fruits per plant, fruit yield per plant, Fruit yield per hectare. The experiment result revealed that all yield parameters were significantly improved by using traditional fertilizer, nano fertilizer and micronutrient.

Number of clusters per plant of plant significantly varied among different treatment combinations. The maximum number of clusters per plant (8.46) were observed with T7 {100 % NPK + 25 % ZnSO₄ through traditional method + 75% spray through Nano zinc, These results are in close conformity with the findings of **Basavarajeshwari et al. (2008); Saravaiya et al. (2014); Kumar et al. (2016); Reddy et al. (2018) and Shnain et al. (2021)**. **Number of fruit set per cluster** of plant significantly varied among different treatment combinations. The maximum number of fruit set per cluster (8.00) were observed with with T7 {100 % NPK + 25 % ZnSO₄ through traditional method + 75% spray through Nano zinc due to increased number of flowers which might have formed into fruits due to adequate availability of major and minor nutrients during its growth and development. Similar findings were reported by Kazemi et al. (2013); Sivaiah et al. (2013); Pandiyan et al. (2018); Swetha et al. (2018) in tomato.

Fruit weight of plant significantly varied among different treatment combinations. The maximum fruit weight (88.40) was observed with T7 {100 % NPK + 25 % ZnSO₄ through traditional method + 75% spray through Nano zinc. Nutrients play an important role in improving productivity and quality of Tomato. Added dose of nitrogen, phosphorus and other essential nutrients increased the vigor of plants, assimilating area, size of fruit, thereby resulting into higher weight of fruit. These results are in close conformity with the findings of Ali et al. (2015); Haleema et al. (2017); Satyamurthy et al. (2017); Pandiyan et al. (2018); Singh et al. (2018) and Shnain et al. (2021) as reported in tomato.

Polar diameter significantly varied among different treatment combinations. The maximum fruit girth (69.51) was observed with T7 {100 % NPK + 25 % ZnSO₄ through traditional method + 75% spray through Nano zinc.

Equatorial diameter significantly varied among different treatment combinations. The maximum fruit girth (71.33) was observed with T7 {100 % NPK + 25 % ZnSO₄ through traditional method + 75% spray through Nano zinc

Number of fruits per plant of plant significantly varied among different treatment combinations. The maximum number of fruits per plant (67.74) were observed with T7 {100 % NPK + 25 % ZnSO₄ through traditional method + 75% spray through Nano zinc Maximum number of fruits per plant increase of T7 {100 % NPK + 25 % ZnSO₄ through traditional method + 75% spray through Nano zinc might be due to increased number of flowers which might have formed into fruits due to adequate availability of major and minor nutrients during its growth and development. Similar findings were reported by Sathyamurthy et al. (2017); Reddy et al. (2018); Singh et al. (2018) in tomato.

Fruit weight of plant significantly varied among different treatment combinations. The maximum fruit weight (88.40) was observed with T7 {100 % NPK + 25 % ZnSO₄ through traditional method +

75% spray through Nano zinc Nutrients play an important role in improving productivity and quality of Tomato. Added dose of nitrogen, phosphorus and other essential nutrients increased the vigor of plants, assimilating area, size of fruit, thereby resulting into higher weight of fruit. These results are in close conformity with the findings of Ali et al. (2015); Haleema et al. (2017); Satyamurthy et al. (2017); Pandiyan et al. (2018); Singh et al. (2018) and Shnain et al. (2021) as reported in tomato.

Fruit yield per plant significantly varied among different treatment combinations. The maximum fruit yield (5.99) was observed with T7 {100 % NPK + 25 % ZnSO₄ through traditional method + 75% spray through Nano zinc. Nutrients play an important role in improving productivity and quality of Tomato. Added dose of nitrogen, phosphorus and other essential nutrients increased the vigor of plants, assimilating area, size of fruit, thereby resulting into higher weight of fruit. These results are in close conformity with the findings of Sivaiah et al. (2013); Ali et al. (2015); Haleema et al. (2017); Satyamurthy et al. (2017); Pandiyan et al. (2018); Singh et al. (2018) and Shnain et al. (2021) as reported in tomato.

Fruit yield per hectare significantly varied among different treatment combinations. The maximum fruit yield per hectare (221.85) was observed with T7 {100 % NPK + 25 % ZnSO₄ through traditional method + 75% spray through Nano zinc. Nutrients play an important role in improving productivity and quality of Tomato. Added dose of nitrogen, phosphorus and other essential nutrients increased the vigor of plants, assimilating area, size of fruit, thereby resulting into higher weight of fruit. These results are in close conformity with the findings of Kazemi (2013); Saravaiya et al. (2014); Ali et al. (2015); Haleema et al. (2017); Satyamurthy et al. (2017); Pandiyan et al. (2018); Singh et al. (2018) and Shnain et al. (2021) as reported in tomato.

Effect of traditional fertilizer, nano fertilizer and micronutrient on growth, yield and quality of tomato on Qualitative parameters, TSS and ascorbic acid were variably by affected by application of traditional fertilizer, nano fertilizer and micronutrient on qualitative parameters were significantly improved by using traditional fertilizer, nano fertilizer and micronutrient, Total soluble solids significantly varied among different treatment combinations. The maximum total soluble solids (5.36) were observed with T7 {100 % NPK + 25 % ZnSO₄ through traditional method + 75% spray through Nano zinc Similar findings were also reported by Ali et al. (2015); Kumar et al. (2017); Satyamurthy et al. (2017); Pandiyan et al. (2018); Singh et al. (2018) and Shnain et al. (2021) in tomato.

Ascorbic acid significantly varied among different treatment combinations. The maximum ascorbic acid (26.4) was observed with T7 {100 % NPK + 25 % ZnSO₄ through traditional method + 75% spray through Nano zinc .

Table 1. Effect of traditional fertilizer, nano fertilizer and micronutrient on growth parameter and qualitative parameters;

NOTATION	Treatments	PLANT HEIGHT	SURVIVAL PERCENTAGE	TSS	ASCORBIC ACID
T0	CONTROL	88.78	93.12	3.256	15.325
T1	100 % NPK traditional fertilizer + 100 % ZnSO ₄ as basal	90.587	94.29	3.367	17.067
T2	75 % N through traditional method + 100 % PK + 100 % Zn + 25% spray through Nano urea	96.893	96.777	4.333	21.5
T3	50% N through traditional method+ 100%PK+ 100% ZnSO ₄ + 50% spray through Nano urea	96.037	96.37	4.197	20.667
T4	25%N through traditional method+ 100%PK+ 100% ZnSO ₄ + 75% spray through Nano urea	95.597	95.997	3.867	20.033
T5	100 % NPK + 75 % ZnSO ₄ through traditional method + 25% spray through Nano zinc	97.917	97.03	4.433	22.867
T6	100 % NPK + 50 % ZnSO ₄ through traditional method + 50% spray through Nano zi 100 % NPK + 25 % ZnSO ₄ through traditional method + 75% spray through Nano zinc	98.88	98.403	4.483	23.433
T7	100% N +Nano urea+ 100% PK+ 100% ZnSO ₄ as basal	100.253	99.483	5.367	26.3
T8	100% N +Nano urea+ 100% PK+ 100% ZnSO ₄ as basal	95.157	95.377	3.583	19.033
T9	100% Nano zinc+ 100% NPK through traditional method	95.363	95.58	3.6	20
T10	100% Nano urea + 100% Nano zn + 100% PK as basal	92.327	95.0673	3.533	18.4
	F-Test	S	S	S	S
	CD 0.05	3.829		0.571	1.413
	SE(d)	1.808		0.27	0.667
	C.V.	2.309		8.105	3.903

Table 2. Effect of traditional fertilizer, nano fertilizer and micronutrient on yield parameters:

NOTATION	Treatments	No. of flower cluster /plant	Fruit set/cluster	Fruit weight	Polar diameter	Equatorial diameter	No. of fruit/plant	Fruit yield /plant	Fruit yield /hectare
T0	CONTROL	4.12	3.911	78.76	60.432	64.123	30.12	2.51	98.21
T1	100 % NPK traditional fertilizer + 100 % ZnSO4 as basal	5.467	5.133	80.143	61.547	65.363	34.56	2.76	102.57
T2	75 % N through traditional method + 100 % PK + 100 % Zn + 25% spray through Nano urea	7.373	7.433	83.557	65.597	68.553	54.8	4.58	169.63
T3	50% N through traditional method+ 100%PK+ 100% ZnSO4+ 50% spray through Nano urea	7.267	7.2	82.473	65.403	68.023	52.31	4.317	159.877
T4	25%N through traditional method+ 100%PK+ 100% ZnSO4+ 75% spray through Nano urea	6.6	7	81.547	63.82	66.887	46.2	3.767	139.507
T5	100 % NPK + 75 % ZnSO4 through traditional method + 25% spray through Nano zinc	7.5	7.533	84.813	65.737	68.657	56.52	4.793	177.533

T6	100 % NPK + 50 % ZnSO ₄ through traditional method + 50% spray through Nano zi 100 % NPK + 25 % ZnSO ₄ through traditional method + 75% spray through Nano zinc	8	7.567	88.14	67.21 3	70.20 3	60.54	5.333	197.5 3
T7	100% N +Nano urea+ 100% PK+ 100% ZnSO ₄ as basal	8.467	8	88.40 7	69.51 7	71.33	67.74	5.99	221.8 53
T8	100% N +Nano urea+ 100% PK+ 100% ZnSO ₄ as basal	6.3	6.8	80.14 7	63.4	68.02 3	42.81	3.433	127.1 63
T9	100% Nano zinc+ 100% NPK through traditional method	6.5	7	80.44	63.62	66.08 3	45.49	3.66	135.5 57
T10	100% Nano urea + 100% Nano zn + 100% PK as basal	5.827	6.163	80.14 3	62.10 7	66.01 7	35.92	2.883	106.7 9
	F-Test	S	S	s	S	s	s	s	s
	CD 0.05	0.215	0.389	1.396	2.813	1.618	3.17	0.26	9.61
	SE(d)	0.072	0.13	0.466	1.329	0.764	1.49	0.123	4.54
	C.V.	1.793	3.226	0.973	2.512	1.384	3.74	3.661	3.661

Conclusion

From the above experiment finding it may be concluded that the treatment T₇(100 % NPK + 25 % ZnSO₄ through traditional method + 75% spray through Nano zinc) was found to be best in the terms of growth viz., plant height, survival percentage, days to first flowering, days to 50% flowering, days to first harvesting, number of flower cluster per plant, fruit set per plant, number of fruits per plant and in terms of yield viz., average fruit weight, Yield per plant, Yield per Hectare and in terms of quality viz., Ascorbic Acid content and TSS of fruit and in terms of economic viz., Net return and B:C ratio.

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