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IMPACT OF ORGANIC FERTILIZERS ON GROWTH AND YIELD OF TOMATO (*Solanum lycopersicum* L.)

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Abstract:

A study conducted in Prayagraj, India, using a randomized complete block design, examined the impact of different fertilizer treatments on tomato yield. Tomatoes are a widely grown and consumed fruit around the world, with demand for high-quality products increasing. The use of synthetic fertilizers and pesticides in tomato cultivation has raised concerns about their environmental and health impacts. Organic fertilizers offer a sustainable and eco-friendly alternative, providing gradual release of nutrients from natural sources like compost and animal manure. These organic fertilizers can improve soil structure, crop yields, and biodiversity. Results showed that a combination of organic and inorganic fertilizers led to higher yields and profitability compared to using chemical fertilizers alone. The application of organic manure alongside chemical fertilizers improved soil nutrient absorption, root and shoot development, and overall crop output.

Keywords: Bio-fertilizers**,** Organic fertilizers, Tomatoes, Profitability Vegetable and Yield.

Introduction:

Tomatoes, also known as *Solanum lycopersicum*, are one of the fruits that are grown and consumed the most all over the world. The need for product of a high quality is continually growing. The cultivation of tomatoes is an important economic activity in a number of nations, and it is anticipated that the demand for both fresh tomatoes and tomatoes that have been processed will continue to increase over the next several years. On the other hand, the widespread application of synthetic fertilizers and pesticides in tomato cultivation has given rise to worries over the effects these substances have on both the environment and human health. Organic fertilizers, on the other hand, offer an alternative to synthetic fertilizers that is both sustainable and kind to the environment. Plants can benefit from a gradual release of nutrients that are produced from natural materials such as compost, animal manure, and plant leftovers. These materials are derived from natural sources. It has been demonstrated that organic fertilizers may both enhance the structure of the soil and boost crop yields, as well as encourage biodiversity in the soil.

The reduction of greenhouse gas emissions, the conservation of water, and the promotion of ecosystem services are other ways in which they might lessen the negative

effects that agriculture has on the environment. There is a lack of awareness regarding the influence that organic fertilizers have on tomato development and productivity, despite the fact that organic fertilizers may have potential benefits.

By fixing atmospheric nitrogen, both in conjunction with plant roots and independently, biofertilizers (Azotobacter and Azospirillum) solubilize insoluble soil phosphates and generate plant growth components in the soil, so contributing significantly to improved soil fertility. (Lokendra *et el.*, 2024). In fact, one of the biggest environmental problems of the twenty-first century is climate change. Natural variations and outside factors, such as variations in solar radiation, volcanic eruptions, and natural variability within the climate system, have influenced the Earth's climate throughout its history and contribute to the overall natural variability of the climate system. These changes persist over long periods, frequently spanning decades or even longer. But over the past few centuries, human activity particularly since the industrial revolution has significantly altered the makeup of the atmosphere. In spite of a changing climate, climate-resilient agronomy aims to maintain sustainable food production and stable livelihoods for farmers. (Singh *et al.*, 2023).

How Changing Soil Organic Matter Affects Tomato Quality After Applying Organic Fertilizer

Various tomato cultivars exhibited various responses to different levels of soil organic matter in terms of the amount of soluble solids, soluble sugar, sugar/acid, and volatile compounds (VC) they found in the soil. When the soil organic matter level was varied, there was no discernible variation in the amount of soluble solids that were present in tomato production. According to the previous study, there was no significant change in tomato soluble sugar when organic fertilizers were added to the soil when the soil organic matter was equal to or greater than twenty grams per kilogram. This finding is in line with the previous research, which said that tomato soluble sugar declined as the amount of fertilizers applied increased. When the soil organic matter was equal to or greater than twenty grams per kilogram, it had a good impact on the sugar-to-acid ratio and the VC content of tomatoes. There is a significant contribution that organic matter makes to the fertility and function of soil.

The trace elements that are found in organic matter have the ability to fulfill the requirements of soil microorganisms, encourage microbial activities, influence the relationship between soil and microorganisms, and indirectly influence crop quality. Under a variety of soil-organic-matter conditions, the application of organic fertilizer had a good impact on tomato soluble solids, and there was no discernible difference between the circumstances. A considerable rise in the ratio of tomato sugar to tomato acid was seen when organic fertilizers were applied to soil with a high organic matter content. This ratio is an essential component that influences the taste quality of tomatoes. The use of organic fertilizers has been demonstrated to raise the amount of organic matter in the soil, which in turn improves the activity of soil bacteria. These bacteria are responsible for breaking down the organic matter in the soil and releasing nitrogen, phosphate, and potassium. These elements have a beneficial influence on the enzyme activity in the soil, which in turn increases the sugar/acid radio. When the soil organic matter was equal to or greater than 20 grams per kilogram, the percentage change of organic fertilizers on tomato VC was 3.17 times greater than when the soil organic matter was less than 20 grams per kilogram. There

was a linear relationship between the use of organic fertilizers and the elevation of tomato VC as the amount of organic matter in the soil rose.

Changes in Tomato Quality in Response to Organic Fertilizer Application in the Presence of Total Soil Nitrogen

Tomato soluble solids, soluble sugars, lycopene, and VC are all positively affected by increasing the total soil nitrogen concentration with more organic fertilizers. Nitrate is the only nutrient that does not have this effect. However, when the overall amount of nitrogen in the soil grows, the amount of nitrogen that is absorbed by the roots may reach its maximum. This may result in an excessive buildup of nitrogen in the roots when organic fertilizers are applied again; ultimately, this will lead to a decreased nitrate content being delivered to the fruit. In the meanwhile, an excessive amount of nitrogen in the soil may have an impact on the tomato plant's ability to absorb water and nutrients from the soil, which will ultimately have a negative impact on the quality of the tomatoes. The incorporation of organic fertilizers has the potential to alter the microbial activity of the soil, therefore enabling microorganisms to convert inorganic nitrogen into organic nitrogen. Additionally, varied organic fertilizers have the ability to alter the physicochemical features of the soil, so improving the development and quality of tomatoes.

Nano-technology offers great potential to tailor fertilizer production with the desired chemical composition, higher nutrient use efficiency that may reduce environmental impact and boost the plant productivity. Nano- fertilizers are very effective for precise nutrient management in precision agriculture by matching with the crop growth stage for nutrient and by providing nutrient throughout the crop growth period. Nano-fertilizers are new generation of the synthetic fertilizers which contain readily available nutrients in nano scale range. Nano-fertilizers are preferred largely due to their efficiency and environment friendly nature compared to conventional chemical fertilizers. The nano-fertilizers deal with the elements in nano- meter dimensions (1-100 nm). (Singh et al., 2024) Phosphorus regulates protein synthesis in plants, because it is a component of the complex nucleic acid structure. Phosphorus is also important in cell division and development of new tissues. (Singh et al., 2022)

Varieties of Organic Fertilizer and Their Impact on Tomato Quality

Animal and plant organic fertilizer both raised the amount of soluble solids, soluble sugars, and volatile compounds (VC) in tomato plants, but there was no significant change in the ratio of sugar to acid. On the other hand, plant organic fertilizer had a beneficial impact on the amount of lycopene and nitrate in tomato plants. For instance, earthworm manure enhances the root vigor of tomato plants by influencing the ecology of the soil. This, in turn, encourages the growth of seedlings during the early stages of the crop, enhances the photosynthetic capacity of the leaves, and promotes the uptake and transport of nutrients, ultimately leading to an improvement in the yield and quality of tomatoes. A number of studies have demonstrated that increasing the concentration of rapeseed cake manure fermentation solution by a factor of twenty to fifty may greatly enhance the nitrogen metabolism of tomatoes, hence fostering the growth and development of tomato roots, and positively impacting both the yield and quality of tomatoes.

Development of semi dwarf varieties of crops reduced the problem to some extent, but not completely. Use of higher level of fertilizers, irrigation and sometimes reverting to

older cultivars for specific needs and increase in the mechanized harvesting may lead to further losses due to lodging. Presently, development of new varieties for higher yields has reached a plateau and no further increase is achieved unless biotechnological interventions are made. Lodging is the state of permanent displacement of the stems from their upright position. (Archna, *et al.,* 2023)

Materials and Methods

Prayagraj has a humid subtropical climate common to cities in the plains of North India, designated Cwa in the Köppen climate classification.The annual mean temperature is 26.1 °C (79.0 °F); monthly mean temperatures are 18–29 °C (64–84 °F).Prayagraj has three seasons: a hot, dry summer, a cool, dry winter and a hot, humid monsoon. Summer lasts from March to September with daily highs reaching up to 48 °C in the dry summer (from March to May) and up to 40 °C in the hot and extremely humid monsoon season (from June to September).The monsoon begins in June, and lasts until August; high humidity levels prevail well into September. Winter runs from December to February, with temperatures rarely dropping to the freezing point. The daily average maximum temperature is about 22 °C (72 °F) and the minimum about 9 °C (48 °F). Prayagraj never receives snow, but, experiences dense winter fog due to numerous wood fires, coal fires, and open burning of rubbish—resulting in substantial traffic and travel delays. Rain from the Bay of Bengal or the Arabian Sea branches of the southwest monsoon falls on Allahabad from June to September, supplying the city with most of its annual rainfall of 1,027 mm (40 in). The highest monthly rainfall total, 333 mm (13 in), occurs in August. The city receives 2,961 hours of sunshine per year, with maximum sunlight in May. A randomized complete block design (RCBD) was utilized for the experiment, and it consisted of three (3) compressed duplicate blocks, each of which included five treatments. T_1 consisted of 100% Recommended Chemical Fertilizer (RCF), T_2 consisted of 85% CF and 3 t ha^{-1} organic Fertilizer (OF), T_3 consisted of 85% CF and 1 ha^{-1} OF, T_4 consisted of 70% CF and 3 ha^{-1} OF, and T_5 consisted of 70% CF and 1 ha^{-1} OF. They were all treatments. Tomato-17 was the kind of crop that was grown. The dimensions of each allotment were 4 meters by 5 meters. The 17th of November, 2023, saw the transplantation of seedlings that were thirty days old.

Raising of seedlings

Raised nursery beds of 1.0 m × 1.0 m was prepared thoroughly. Then the seeds were sown on 7 October 2022-23. The nursery beds were maintained systematically till the seedlings were ready for transplanting.

Transplanting of seedlings:

After arriving seedling to second true leaves, uniform size and healthy seedlings were selected for the transplanting into the sack to planting seedlings separately. After arriving to the forth true leaves, Transplanting was done into the experimental plot which was prepared earlier 0n 16 th November, 2023.

Application of manure and fertilizers:

The fertilizer was applied @ recommended dose viz., 30.86 g N, 18.51 g P_2O_5 and 18.51 g K_2O / m^2 and 46.29 g N , 37.02 g P_2O_5 and 37.02 g K_2O / m2 half of the dose of nitrogen and entire quantity of P and K were applied as a basal dose before transplanting and well mixed with the soil and adding 1.5 kg and 2.5 kg farm yard manure (FYM) /m2

according to the treatments. Remaining dose of nitrogen was applied at 40 days after transplanting, micronutrient @ 2.5 ml / l was sprayed at two weeks after transplanting and at flowering, The fertilizers were given in the form of urea, SSP and MOP, FYM and Micronutrient SONAMIN-L.

Results and Discussion

The yield, which was the most relevant measure, was greatly altered by the varied doses of organic fertilizer that were applied to tomato cultivation. The findings that were reported in Table 1 demonstrated that there was a substantial difference between the treatments with regard to the number of fruit plants for each treatment, the weight of each fruit plant for each treatment, and the yield. It was found that T_2 had the largest number of fruit plant^{-1} (56), as well as the highest weight of fruit plant^{-1} (1.45 kg), while T_5 had the lowest weight of fruit plant^{-1}. It was found that T_2 had the highest yield (50.59 t ha^{-1}) due to the fact that it had a greater number of fruit plants and a greater weight of fruit plants. On the other hand, T5 had the lowest yield (35.32 t ha^{-1}). These results may be attributed to the fact that the parameters of growth components rose as the amount of organic and inorganic fertilizers that were placed to the plant grew.

Table 1. Effect INM plant height, number of fruit plant^{-1}, weight of fruit plant^{-1} (kg) and yield (t ha^{-1}) tomato.

Treatment	Plant height (cm)	Number of fruit plant^{-1}	Weight of Fruit plant^{-1} (kg)	Yield (t ha^{-1})
T_1: 100% Recommended Chemical Fertilizer (RCF)	122.20a	4.7333a	1.1067b	38.613b
T_2: 85% RCF + 3 tha^{-1} OF	122.40a	5.6667a	1.4500a	50.597a
T_3: 85% RCF + 1 tha^{-1} OF	115.47a	5.1333a	1.2967ab	45.360ab
T_4: 70% RCF + 3 tha^{-1} OF	115.73a	4.7333ab	1.1433b	39.933b
T_5: 70% RCF + 1 tha^{-1} OF	116.20a	3.8667 b	1.0100b	35.327b
CV (%)	8.5893	11.50	13.46	13.48
LSD	3.85	1.0449	0.3045	10.655

According to Sun *et al.* (2003), Lin *et al.* (2010), and Ferdous *et al.* (2014), this may be owing to the fact that organic fertilizer has a function in plant physiology, as well as in enhancing the amount and quality of growth characterisation. Additionally, organic fertilization can supply plants with the vital nutrients that they require. Research conducted by Anwar *et al.* (2012) and Ferdous *et al*. (2017) found that plots that were treated with a combination of organic and inorganic fertilizer generated a greater yield than plots that did not get the combination of organic and inorganic fertilizer.

Both Ahmed et al. (2017) and Anil et al. (2008) have reported findings that are comparable, namely that the application of phosphorus and organic manure leads to an

increase in the amount of fruit produced. Research conducted by Anil and colleagues (2008) found that the use of organic and inorganic fertilizers together resulted in an increase in seed production. Effectiveness of the economy: Table 2 presents the results of an examination of the costs and returns associated with the various therapies. T_2 therapy had the highest gross return (BDT. 607080), while T_5 treatment yielded the lowest gross return (BDT. 423840). Both treatments were judged to be effective. The T_2 product had the largest gross margin, which was calculated to be BDT 328520 /ha. The T_5 variety had the lowest gross margin, which was calculated to be 145280 ha^{-1}. A similar finding was reported by Ferdous *et al.* (2011a, 2011b), who found that the combination of organic and inorganic fertilizer treatment resulted in the highest gross margin. In the current investigation, the plants that were treated with chemical fertilizer in conjunction with organic fertilizer produced the maximum fruit production, whereas the control treatment produced the lowest yield.

Table 2. Effect of INM in cost of cultivation, net return and benefit ratio with tomato.

Treatments	Yield (t ha^{-1})	Gross return (Tk. ha^{-1})	Total variable cost (Tk. ha^{-1})	Gross margin (Tk. ha^{-1})
T1: 100% Recommended Chemical Fertilizer (RCF)	38.61	463320	278560	184760
T2: 85% RCF + 3 tha^{-1} OF	50.59	607080	278560	328520
T3: 85% RCF + 1 tha^{-1} OF	45.36	544320	278560	265760
T4: 70% RCF + 3 tha^{-1} OF	39.93	479160	278560	200600
T5: 70% RCF + 1 tha^{-1} OF	35.32	423840	278560	145280

In accordance with the findings also reported improved yields of field and vegetable crops with the application of organic fertilizer, the present findings are in agreement with these findings. As a result of higher nutrient concentrations, soil organic matter content, water-holding capacity, bulk density, and soil temperature, the application of organic manure in conjunction with chemical fertilizer helps enhance the efficiency with which nitrogen is used (Akanbi *et al.* 2010). According to Datta *et al.* (2015), an improvement in the efficiency with which nitrogen is used drives root and shoot development, which ultimately leads to an increase in crop output. The use of organic manure was shown to result in an improvement in both the yields and profitability of vegetable crops, as reported by Katuwal and Bohara (2009). It has been shown that the use of chemical fertilizer and organic manure together results in the maximum economic profitability from the production of spinach and chili (Muhmood *et al*. 2014). An increase in the growth, yield, and yield contributing characteristics of wheat and rice in wheat-rice cropping systems has also been documented with the integrated use of chemical fertilizer and cow dung or poultry biogas slurry (Haque et al. 2018). This is due to the increased plant absorption of total nitrogen, phosphorus, potassium, and sulphur because of the combination of these two crops.

Conclusion

In conclusion, organic fertilizers play a crucial role in enhancing soil quality, crop productivity, and environmental sustainability in tomato cultivation. Different types of

organic fertilizers, such as animal or plant-based, can affect tomato quality in various ways. These fertilizers can increase soluble solids, soluble sugars, volatile compounds, lycopene, and nitrate content in tomatoes. They also contribute to root vigor, seedling growth, and overall yield and quality of tomatoes. Their use can improve nutrient availability, soil structure, and microbial activity, leading to better tomato quality and higher yields. Integrating organic fertilizers with chemical fertilizers can optimize crop growth and increase economic profitability for farmers.

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