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Effect of different solid and liquid organic fertilizers on growth, yield and quality of tomato (*Solanum lycopersicum* L.) hybrid under Prayagraj agro-climatic condition

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Abstract
The investigation was carried out to study the "Effect of different solid and liquid organic fertilizers on growth, yield and quality of tomato (*Solanum lycopersicum* L.) hybrid" at Horticulture Research Farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, Uttar Pradesh during the *Rabi* season 2023-24 with a view to determine the effect of different solid and liquid organic fertilizers on tomato hybrid 'SS-846' for its growth, quality and yield and to work out the economics of various treatments. Under this experiment, over all 9 treatment was taken which were replicated thrice in RBD. T_0 No treatment (only 100% recommended doses of fertilizers will be incorporated), T_1 Farm yard manure (15-25 t/ha) (NPK+ 1.5-2.5 kg/ m^2), T_2 Crop residues (20-50 t/ha) (NPK + 2-5 kg/sqm), T_3 Vermicompost (7.5 t/ha) (NPK+ 0.75 kg/sqm), T_4 Poultry manure (10-40 t/ha) (NPK+ 1-4 kg/sqm), T_5 Biogas spent slurry (10 t/ha) (NPK + 1 kg/sqm), T_6 Vermiwash (50 ltr/ha) (NPK + 5 ml/sqm), T_7 Panchgavya (50 ltr/ha) (NPK + 5 ml/sqm), T_8 Jeevamruth (500 ltr/ha) (NPK + 50 ml/sqm) spray. From the above experimental finding it was found that the treatment T_8 Jeevamruth (500 ltr/ha) (NPK + 50 ml/sqm) was found to be best in the terms of growth Yield and quality of tomato. While, the highest net return was found in the T_8 with Rs. 6,62,926 and the highest B:C ratio was found in the same with 4.55.

Keywords: Tomato, vermicompost, vermiwash, poultry manure, FYM, etc

Introduction
Tomato, (*Solanum lycopersicum*), flowering plant of the nightshade family (Solanaceae), cultivated extensively for its edible fruits. Labelled as a vegetable for nutritional purposes, tomatoes are a good source of vitamin C and the phytochemical lycopene. The fruits are commonly eaten raw in salads, served as a cooked vegetable, used as an ingredient of various prepared dishes, and pickled.

It originated in western South America, and domestication is thought to have occurred in Central America. Because of its importance as food, tomato has been bred to improve productivity, fruit quality, and resistance to biotic and abiotic stresses.

Solanum lycopersicum L. (Solanaceae) fruit production is globally important with an annual production of 170 million tons. Tomato production requires significant investment with pest control accounting for 40% of the total cost.

Tomatoes are a significant source of umami flavour. They are consumed in diverse ways: raw or cooked, and in many dishes, sauces, salads, and drinks. While tomatoes are fruits—botanically classified as berries—they are commonly used culinary as a vegetable ingredient or side dish.

The tomato is grown worldwide for its edible fruits, with thousands of cultivars. A fertilizer with an NPK ratio of 5–10–10 is often sold as tomato fertilizer or vegetable fertilizer, although manure and compost are also used. On average there are 150,000 seeds in a pound of tomato seeds.

Materials and Methods

The investigation was carried out to study the "Effect of different solid and liquid organic fertilizers on growth, yield and quality of tomato (*Solanum lycopersicum* L.) hybrid" at Horticulture Research Farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, Uttar Pradesh during the *Rabi* season 2023-24 with a view to determine the effect of different solid and liquid organic fertilizers on tomato hybrid 'SS-846' for its growth, quality and yield and to work out the economics of various treatments. Under this experiment, over all 9 treatment was taken which were replicated thrice in RBD. T_0 No treatment (only 100% recommended doses of fertilizers will be incorporated), T_1 Farm yard manure (15-25 t/ha) (NPK+ 1.5-2.5 kg/ m^2), T_2 Crop residues (20-50 t/ha) (NPK + 2-5 kg/sqm), T_3 Vermicompost (7.5 t/ha) (NPK+ 0.75 kg/sqm), T_4 Poultry manure (10-40 t/ha) (NPK+ 1-4 kg/sqm), T_5 Biogas spent slurry (10 t/ha) (NPK + 1 kg/sqm), T_6 Vermiwash (50 ltr/ha) (NPK + 5 ml/sqm), T_7 Panchgavya (50 ltr/ha) (NPK + 5 ml/sqm), T_8 Jeevamruth (500 ltr/ha) (NPK + 50 ml/sqm) spray. The research was carried out with an objective of evaluating growth and yield of tomato.

Results and Discussion

Growth characters

The height of plant significantly varied among different treatment combinations. The maximum plant height (100.78cm) was observed with treatment T_8 (Jeevamruth + NPK) followed by T_7 (Panchgavya + NPK) with 99.01 cm. Minimum plant height (76.27 cm) was observed in T_0 (NPK), while the remaining treatments are moderate in their growth habit.

Jeevamruth, a bio-fertilizer rich in beneficial microbes, enhances the growth of tomato plants by improving nutrient uptake and soil fertility. The application of Jeevamruth stimulates root development, leading to increased nutrient absorption and water uptake. This results in healthier and more vigorous plants, leading to taller growth. Additionally, the microbial activity in Jeevamruth promotes symbiotic relationships with the plant roots, further enhancing growth.

It is evident that the Number of branches per plant was influenced by different treatments at all successive stage of growth. There was significant difference between the treatments among the treatments applied, T_8 (Jeevamruth + NPK) with 11.51 increase significantly better Number of branches per plant followed by T_7 (Panchgavya + NPK) with 11.49 whereas the minimum score was observed in treatment T_1 (NPK) with (8.85).

The application of Jeevamruth, a bio-fertilizer containing beneficial microbes, triggers several mechanisms leading to increased branching in tomato plants. Firstly, the microbes present in Jeevamruth promote the synthesis and secretion of plant growth hormones such as auxins, cytokinins, and gibberellins, which play crucial roles in cell division and differentiation. These hormones stimulate the formation of new branches and lateral shoots in tomato plants.

Yield attributes

Among the application of solid and liquid organic fertilizers the minimum Days to 1st flowering T_8 (Jeevamruth + NPK) with 39.11 days, followed by T_7 (Panchgavya + NPK) with 42.99 days whereas maximum Days to 1st flowering 50.78 days was recorded in T_1 (NPK).

Firstly, the microbes in Jeevamruth interact with the plant's hormonal pathways, particularly auxins and cytokinins, promoting earlier initiation of floral meristems. These hormones stimulate cell division and differentiation in the shoot apical meristem, leading to the formation of flower buds. Additionally, Jeevamruth enhances nutrient availability and uptake, providing the essential elements and energy required for the metabolic processes involved in flowering. Furthermore, the symbiotic relationship between the beneficial microbes and plant roots improves overall plant health, reducing stress and promoting early flowering.

At harvest time maximum number of flowers per cluster 6.45 was recorded in T_8 Jeevamruth + NPK) followed by 6.13 T_7 (Panchgavya + NPK) whereas minimum fruits per cluster 4.76 were found in T_1 (NPK).

At the cellular level, the application of Jeevamruth, a bio-fertilizer enriched with beneficial microbes, accelerates the production of flowers per cluster in tomato plants through several mechanisms. Firstly, the microbes present in Jeevamruth interact with the plant's hormonal pathways, particularly auxins and cytokinins, which play key roles in floral development. These hormones promote the initiation and development of flower primordia within the inflorescence meristem, leading to an increased number of flowers per cluster. Additionally, Jeevamruth enhances nutrient availability and uptake, providing the essential elements and energy needed for the formation of multiple flowers. Moreover, the symbiotic relationship between the beneficial microbes and plant roots enhances overall plant health, reducing stress and promoting greater flower production. Overall, Jeevamruth facilitates earlier and increased flower production per cluster in tomato plants by modulating hormone levels, improving nutrient uptake, and enhancing plant vigor at the cellular level. The findings of the present investigation are in conformity with the reports of Meiliana *et al.* (2021) [10] and Rijal *et al.* (2021) [13] as reported in tomato.

The maximum number of clusters per plant (15.67) were recorded in treatment T_8 (Jeevamruth + NPK) followed by T_7 (Panchgavya + NPK) i.e., 14.45 and T_6 (Vermiwash + NPK) with 14.11 and the lowest number of clusters per plant (9.11) were observed in T_0 (NPK).

Jeevamruth promotes an increase in the number of clusters per tomato plant by fostering robust vegetative growth and enhancing flowering potential. Its nutrient-rich composition, including essential elements like nitrogen, phosphorus, and potassium, supports healthy plant development. This encourages the formation of additional flower clusters, leading to higher fruit set and ultimately more clusters per plant. Moreover, Jeevamruth organic nature promotes beneficial microbial activity in the soil, which further enhances plant vigor and reproductive capacity, contributing to increased cluster numbers. These results are in close conformity with the findings of Kibria *et al.* (2016) [9] and Gopal *et.al* (2022) [5] as reported in tomato.

The maximum number of fruits per plants (14.90) were recorded in treatment T_8 (Jeevamruth + NPK) followed by T_7 (Panchgavya + NPK) i.e., 14.75 and the lowest number of fruits per plant (7.68) were observed in T_1 (NPK).

Jeevamruth enhances fruit set in tomatoes at a cellular level by promoting nutrient uptake and assimilation, bolstering photosynthetic activity, and regulating hormone levels. Beneficial microorganisms and organic compounds in Jeevamruth facilitate nutrient absorption, while increased

photosynthesis provides energy for fruit development. Hormonal regulation influences flower initiation and fruit setting, resulting in a greater number of fruits per plant. These cellular-level effects collectively contribute to improved fruit yield in tomato plants treated with Jeevamruth. According to these the similar findings are reported by Kachave *et al.* (2021) [8], Gore and Sreenivasa *et al.* (2011) [6] and Ashraful *et al*. (2017) [3] in tomato.

The maximum number of fruits per plants (14.90) were recorded in treatment T_8 (Jeevamruth + NPK) followed by T_7 (Panchgavya + NPK) i.e., 14.75, T_6 (Vermiwash + NPK) i.e., 13.48 and the lowest number of fruits per plant (7.68) were observed in T_0 (NPK).

Jeevamruth enhances tomato fruit yield at the cellular level by stimulating root development, optimizing nutrient uptake, and modulating hormone levels. Beneficial microbes and organic matter in Jeevamruth foster root growth, expanding the plant's capacity for nutrient absorption. This boosts metabolic processes, including photosynthesis, crucial for fruit production. Hormonal balance regulated by Jeevamruth influences flowering and fruit set, leading to increased fruiting. These cellular mechanisms synergistically contribute to higher fruit yields in tomato plants treated with Jeevamruth. Similar findings were reported by Reddy *et al.* (2018), and Kachave *et al.* (2021) [8] in tomato

The maximum number of Days to 1st harvesting were recorded in T_8 (Jeevamruth + NPK) with (87.33) days, followed by T_7 (Panchgavya + NPK) with (88.44) days and T_6 (Vermiwash + NPK) with (90.00) days and the minimum number of days to 1st harvesting were recorded in T_0 (NPK).

At a cellular level, Jeevamruth may extend the time to first harvesting in tomatoes due to its focus on enhancing plant health and vigor. While promoting robust root development and nutrient absorption, it encourages vegetative growth over reproductive processes initially. This prioritization leads to prolonged vegetative stages before flowering and fruit set. However, in the long term, the strengthened plant foundation and optimized nutrient uptake facilitated by Jeevamruth can yield higher-quality fruits, compensating for the initial delay. Similar findings were reported by Kibria *et al.* (2016) [9] and Adekiya *et al.* (2017) [1] in tomato.

The maximum average yield per hectare (566.48 q/ha) were recorded in treatment T_8 (Jeevamruth + NPK) followed by T_7 (Panchgavya + NPK) i.e., 547.72 q/ha and the lowest average yield per hectare (296.39 q/ha) were observed in T_0 (NPK)

Jeevamruth enhances tomato yield per hectare by fostering a nutrient-rich soil environment conducive to robust plant growth. Its organic composition enriches the soil with essential nutrients, including nitrogen, phosphorus, and potassium, crucial for plant development. This promotes vigorous vegetative growth, increased flowering, and fruit set, ultimately leading to higher yields. Additionally, Jeevamruth supports beneficial microbial activity in the soil, improving nutrient uptake by plants and ensuring efficient utilization of resources, thereby maximizing yield per hectare of tomato cultivation. These results are in close conformity with the findings of Panda *et al.* (2020) [12] as reported in tomato

Table 1: Effect of solid and liquid organic fertilizers on growth attributes of tomato

Notation	Treatment	Plant Height (cm)			No. of Branches	
		30 DAT	60 DAT	90 DAT	60 DAT	90 DAT
T_0	NPK	15.95	43.11	76.27	4.39	8.85
T_1	FYM+NPK	17.98	46.06	78.65	5.45	10.84
T_2	Crop residues+NPK	18.88	50.25	81.24	5.86	10.61
T_3	Vermicompost+NPK	18.67	46.52	89.46	6.10	9.59
T_4	Poultry manure+NPK	17.02	48.47	81.85	6.11	10.18
T_5	Biogas spent slurry+NPK	20.74	52.15	69.86	5.56	10.25
T_6	Vermiwash + NPK	21.95	51.97	92.80	6.37	10.62
T_7	Panchgavya + NPK	23.00	54.27	99.01	7.45	11.49
T_8	Jeevamruth + NPK	23.15	54.07	100.78	7.81	11.51
'F' test		S	S	S	S	S
SE. d (±)		1.03	1.41	2.83	0.58	0.66
C.D. at 5%		2.20	2.23	6.05	1.25	1.41
C.V.		6.41	6.34	4.05	5.74	5.77

Table 2: Effect of solid and liquid organic fertilizers on yield attributes of tomato

Notation	Treatment	Days of 1st flowering	No. of flower per cluster	No. of cluster per plant	No. of fruits per cluster	No. of fruits per plant	Days to 1st Harvesting	Yield per hectare
T_0	NPK	50.78	4.76	9.11	2.94	7.68	99.20	296.39
T_1	FYM+NPK	49.78	5.04	10.00	3.02	11.21	96.77	396.29
T_2	Crop residues + NPK	49.22	4.85	11.22	2.96	9.98	96.55	355.77
T_3	Vermicompost + NPK	48.66	5.03	13.34	3.24	12.21	95.89	445.21
T_4	Poultry manure + NPK	47.89	5.24	12.45	3.16	13.09	91.33	413.35
T_5	Biogas spent slurry + NPK	49.88	4.84	11.33	3.03	12.32	93.88	404.60
T_6	Vermiwash + NPK	46.66	5.56	14.11	3.50	13.48	90.00	461.57
T_7	Panchgavya + NPK	42.99	6.13	14.45	3.89	14.75	88.44	547.72
T_8	Jeevamruth + NPK	39.11	6.45	15.67	3.90	14.90	87.33	566.48
'F' test		S	S	S	S	S	S	S
SE. d (±)		1.14	0.17	0.88	0.15	1.29	1.10	2.63
C.D. at 5%		2.54	0.36	1.89	0.32	2.76	2.36	4.98
C.V.		2.97	3.92	8.74	5.62	5.46	1.45	8.97

Conclusion

From the above experimental finding it may be concluded that the treatment T_8 (Jeevamruth + NPK) was found to be best in the terms of growth, Yield and quality of tomato. While, the highest net return was found in the T_8 with Rs. 6,62,926 and the highest B:C ratio was found in the same with 4.55.

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