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Effect of different levels of panchagavya and photosynthetic bacteria on growth, yield and quality of cherry tomatoes

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Abstract
This study investigates the effect of Panchagavya and Photosynthetic bacteria on the growth, yield, and quality of Cherry tomatoes. The purpose of the study is to evaluate the plants in terms of various parameters such as plant height, number of branches, days to first flowering, number of flowers per cluster, number of fruit set per cluster, number of fruits per plant, fruit weight, total soluble solids (TSS), ascorbic acid, and benefit-cost ratio. The treatments applied in the study include control, PSB at different concentrations (30 ml/l, 60 ml/l, 90 ml/l, and 120 ml/l), and Panchagavya at different concentrations (30 ml/l, 60 ml/l, 90 ml/l, and 120 ml/l). The results of the study indicate that the application of PSB and Panchagavya significantly improved the growth and yield of Cherry tomatoes. The highest fruit yield, fruit weight, TSS, and ascorbic acid content were observed in the plants treated with PSB at a concentration of 90 ml/l and Panchagavya at a concentration of 120 ml/l. 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 PSB and Panchagavya can be an effective and sustainable method for enhancing the growth, yield, and quality of Cherry Tomatoes.

Keywords: Cherry tomato, photosynthetic bacteria, panchgavya

1. Introduction
Cherry tomato (*Lycopersicon esculentum* var. *cerasiformae*) is a small-sized tomato cultivar with a sweeter taste than the traditional larger-sized tomato. Cherry tomatoes are believed to be the ancestor of Tomato (*Solanum lycopersicum*). They have become increasingly popular in recent years due to their versatility, nutritional value, and unique flavor. Maharashtra is the leading state in cherry tomato production, with around 30% of the total cherry tomato production in India. The state has a suitable climate for cherry tomato cultivation and an established export market. The other major cherry tomato producing states are Karnataka, Tamil Nadu, and Andhra Pradesh.

Panchagavya is a natural product made from five cow products, namely milk, curd, ghee, urine, and dung. It is a traditional Indian formulation that has been used for centuries for various purposes, including medicine, worship, and agriculture. Panchagavya has several benefits due to its unique combination of cow products. It is rich in essential nutrients, such as nitrogen, phosphorus, and potassium, which are necessary for plant growth. It also contains beneficial microorganisms that can help improve soil health and promote the growth of healthy crops. Several studies have reported that the application of Panchagavya results in better plant growth compared to inorganic fertilizers. Application of Panchagavya results in higher plant height, stem girth, and leaf area of tomato plants compared to chemical fertilizers [1, 2].

Photosynthetic bacteria are a group of microorganisms that are capable of photosynthesis. They are commonly found in soil, water, and various plant surfaces. In recent years, photosynthetic bacteria have gained attention as a potential natural fertilizer for use in agriculture due to their ability to improve plant growth, yield, and quality. Photosynthetic bacteria have been shown to promote plant growth through various mechanisms. For example, they can produce plant growth-promoting substances such as phytohormones, amino acids, and vitamins. They can also improve nutrient uptake and utilization by plants by solubilizing nutrients such as phosphorus and fixing nitrogen from the air. Additionally, photosynthetic bacteria can enhance plant stress tolerance by reducing oxidative stress and increasing antioxidant activity [3, 4, 5].

The use of Panchgavya and Photosynthetic bacteria in agriculture has several potential benefits. First, they can reduce the reliance on chemical fertilizers, which can be expensive and harmful to the environment. Second, they can improve soil health by increasing soil organic matter and microbial diversity. Third, they can improve crop yield and quality, resulting in higher profits for farmers.
The study was conducted under the objective to evaluate the effect of different levels of Panchgavya and Photosynthetic bacteria in growth, yield, quality and economic parameters of cherry tomato.

2. Material and Methods

2.1 Experimental Site

Field experiments for studying the effects of different levels of Panchgavya and Photosynthetic bacteria on growth, yield and quality of Cherry tomato were performed during August to December in 2021 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. The minimum average temperature is 2-4 °C which may fall as low as 1.5 °C during peak winter months (Dec.-Jan.) The average rainfall of the district is 960 mm and the monsoon season is spread between July-September.

2.2 Experimental details

The experiment was carried out in open field conditions. The variety used in the experiment was Pusa Golden Cherry Tomato-2. Plants were sown in nursery beds in the on December 10th, 2022 and transplanted to open field on December 24th, 2022 with a spacing of 45 cm row to row and 30 cm plant to plant. Panchagavya was prepared by mixing cow dung (500 gm), cow urine (300 ml), cow milk (200 ml), cow curd (200 ml) and cow ghee (100 ml) while the Photosynthetic bacteria was cultured in the lab which was isolated from a natural sample and scaled up later. After ten days of preparation, both the manures were ready for field application. The experiment was designed in Randomized Block Design with three replications. The application of Panchgavya and Photosynthetic bacteria was given as per the treatment twice a week with the help of a knapsack sprayer. The treatments details are as follows:

Table 1: Details of Treatment

S.no.	Treatment	Treatment Combination
1	T_0	Control
2	T_1	PSB @ 30 ml/l of water
3	T_2	PSB @ 60 ml/l of water
4	T_3	PSB @ 90 ml/l of water
5	T_4	PSB @ 120 ml/l of water
6	T_5	Panchgavya @ 30 ml/l of water
7	T_6	Panchgavya @ 60 ml/l of water
8	T_7	Panchgavya @ 90 ml/l of water
9	T_8	Panchgavya @ 120 ml/l of water

The recommended dose of fertilizers was applied to the crop with a dose of Nitrogen at 100 kg/ha, Phosphorus at 60 kg/ha, Potassium at 60 kg/ha. The half dose of nitrogen was applied as a basal dose and rest as fertigation. All other fertilizers were applied as fertigation using drip. FYM at 5 t/ha was applied 15 days before transplanting.

2.3 Observations

Growth Parameters (Plant Height, Number of Branches), Earliness Parameters (Days to 1st Flowering, Days to 50% Flowering), Yield Parameters (No of flower per cluster, No of fruit set per cluster, No of fruits per plant, Fruit yield per hectare), Fruit Characteristics (Fruit Weight, Fruit diameter), Qualitative Parameters (Total soluble solids, Ascorbic Acid), Economic Parameters (Net Return, Gross Income/Return, Benefit Cost Ratio) were observed in the population.

3. Result and Discussion

The performances of the cherry tomato under different levels of Panchgavya and Photosynthetic bacteria as recorded through crop growth and yield were as follows:

a. Growth parameters

Growth Parameters such as Plant Height and Number of Branches recorded are given in Table 2

Table 2: Growth parameters

Treatment	Treatment Combination	Plant height (m)	Number of branches
T_0	Control	1.15	29.0
T_1	PSB @ 30 ml/l of water	1.20	32.33
T_2	PSB @ 60 ml/l of water	1.34	33.66
T_3	PSB @ 90 ml/l of water	1.45	30.66
T_4	PSB @ 120 ml/l of water	1.52	33.66
T_5	Panchgavya @ 30 ml/l of water	1.21	31.0
T_6	Panchgavya @ 60 ml/l of water	1.32	32.33
T_7	Panchgavya @ 90 ml/l of water	1.38	32.0
T_8	Panchgavya @ 120 ml/l of water	1.59	36.66

The Plant height and Number of Branches in Cherry tomato increased with increasing concentrations of Photosynthetic Bacteria and Panchagavya. Maximum plant height was observed in treatment of Panchgavya @ 120 ml/l of water (1.59 m) followed by treatment of PSB @ 120 ml/l of water (1.52 m). Maximum number of branches was observed in treatment of Panchgavya @ 120 ml/l of water (36.66) followed by treatment of PSB @ 120 ml/l of water (33.66). Panchagavya was found more efficient to increase Plant height and number of branches in comparison to Photosynthetic bacteria and Control. Panchagavya contains natural growth hormones such as auxins, cytokinins, and gibberellins, which can stimulate plant growth and development. This is evident from previous studies too [6, 7, 8]. The application of photosynthetic bacteria to the leaves increases the availability of nitrogen to the plants, which is essential for plant growth [9, 10, 11]. These factors may attribute to increased Plant height and Number of Branches in Cherry Tomato.

3.2 Earliness Parameters

Earliness Parameters such as Days to 1st Flowering and Days to 50% Flowering recorded are given in Table 3

Table 3: Earliness Parameters

Treatment	Treatment Combination	Days to 1st Flowering	Days to 50% Flowering
T_0	Control	54.3	66.4
T_1	PSB @ 30 ml/l of water	53.0	68.6
T_2	PSB @ 60 ml/l of water	52.6	67.3
T_3	PSB @ 90 ml/l of water	52.0	66.8
T_4	PSB @ 120 ml/l of water	51.6	66.0
T_5	Panchgavya @ 30 ml/l of water	45.6	60.2
T_6	Panchgavya @ 60 ml/l of water	44.3	59.6
T_7	Panchgavya @ 90 ml/l of water	44	58.6
T_8	Panchgavya @ 120 ml/l of water	43.6	58.0

It was observed that application of Photosynthetic bacteria decreased Days to 1st Flowering which was maximum in the treatment of PSB @ 30 ml/l of water (53.0 days) and minimum in PSB @ 120 ml/l of water (51.6 days) as compared to control (54.3 days). Similarly increasing the concentration of Panchagavya decreased the Days to 1st flowering which was maximum in Panchgavya @ 30 ml/l of water (45.6 days) and minimum in Panchgavya @ 120 ml/l of water (43.6 days). A similar tre and was observed in Days to 50% flowering.

Panchagavya and Photosynthetic bacteria were found to increase earliness in Cherry Tomatoes. Panchagavya contains a variety of nutrients such as nitrogen, phosphorus, potassium, and micronutrients, which are essential for plant growth and flowering [12]. Photosynthetic bacteria can fix atmospheric nitrogen and make it available to plants. The application of photosynthetic bacteria to the soil or leaves can increase the availability of nitrogen to the plants, which is essential for plant growth and flowering [13].

3.3 Yield Parameters

Yield Parameters such as Number of flowers per cluster, Number of fruit set per cluster, Number of fruits per plant, Fruit yield per hectare (t/ha) were observed and listed in Table 4.

Table 4: Yield parameters

Treatment	Treatment Combination	No of flowers per cluster	Fruit set per cluster	No of fruits per plant	Fruit yield per hectare (t/ha)
T_0	Control	7.03	5.27	66.18	15.7
T_1	PSB @ 30 ml/l of water	7.3	5.29	80.14	21.33
T_2	PSB @ 60 ml/l of water	8.57	6.3	96.8	29.25
T_3	PSB @ 90 ml/l of water	8.83	6.2	100.3	34.22
T_4	PSB @ 120 ml/l of water	9.93	7.7	125.9	48.74
T_5	Panchgavya @ 30 ml/l of water	7.2	5.6	85.6	26.51
T_6	Panchgavya @ 60 ml/l of water	8.63	6.1	98.0	37.18
T_7	Panchgavya @ 90 ml/l of water	8.8	6.2	94.92	37.03
T_8	Panchgavya @ 120 ml/l of water	10.23	8.8	152.80	58.81

Application of Photosynthetic Bacteria and Panchgavya significantly increased the Yield Parameters such as Number of flowers per cluster, Number of fruit set per cluster, Number of fruits per plant and Fruit yield per hectare. Panchagavya was found more efficient in increasing yield as compared to Photosynthetic bacteria. Maximum Number of flowers per cluster, Number of fruit set per cluster, Number of fruits per plant and Fruit yield per hectare was observed in treatment of Panchgavya @ 120 ml/l of water (10.23, 8.8, 152.80, 58.81 tons/ha respectively). Panchagavya contains microorganisms that can improve soil health by increasing the population of beneficial microorganisms, such as nitrogen-fixing bacteria, mycorrhizal fungi, and phosphate solubilizing bacteria. These microorganisms can help plants access nutrients from the soil and improve their growth and yield [14]. Panchagavya contains plant growth regulators such as auxins, cytokinins, and gibberellins, which can stimulate plant growth and development. These plant growth regulators can enhance the vegetative growth, flowering, and fruiting of plants, leading to higher yields [15].

3.4 Fruit Characteristics

Fruit Characteristics such as Fruit Weight (g) and Fruit diameter (cm) were recorded and give in Table 5.

Table 5: Fruit Characteristics

Treatment	Treatment Combination	Fruit Weight (g)	Fruit Diameter (cm)
T_0	Control	3.21	4.5
T_1	PSB @ 30 ml/l of water	3.6	4.56
T_2	PSB @ 60 ml/l of water	4.09	4.96
T_3	PSB @ 90 ml/l of water	4.61	4.53
T_4	PSB @ 120 ml/l of water	5.23	5.43
T_5	Panchgavya @ 30 ml/l of water	4.19	4.5
T_6	Panchgavya @ 60 ml/l of water	5.13	4.6
T_7	Panchgavya @ 90 ml/l of water	5.27	5.16
T_8	Panchgavya @ 120 ml/l of water	5.6	5.5

The application of Photosynthetic bacteria increased the Fruit weight and Fruit diameter significantly. The fruits with treatment of PSB @ 120 ml/l of water recorded fruit weight of 5.23 g and Fruit Diameter of 5.43 g as compared to the Control with fruit weight of 3.21 g and fruit diameter of 4.5 cm. Similar results are shown by the application of Panchgavya. The fruits with treatment of Panchgavya @ 120 ml/l of water recoded maximum fruit weight (5.6 g) and Fruit diameter (5.5 cm).

Panchagavya has plant growth-promoting substances. It has been reported to contain several plant growth-promoting

substances, such as auxins, gibberellins, and cytokinin, which are known to promote cell division, elongation, and differentiation [16]. This may be attributed as one of the reasons of increased Fruit weight and Fruit diameter.

3.5 Qualitative Parameters

Qualitative Parameters such as TSS (°Brix) and Ascorbic Acid (mg/100 g) were recorded and give in Table 6.

Table 6: Qualitative parameters

Treatment	Treatment Combination	TSS (°Brix)	Ascorbic Acid (mg/100 g)
T_0	Control	5.07	27.67
T_1	PSB @ 30 ml/l of water	5.49	32
T_2	PSB @ 60 ml/l of water	6.07	36.33
T_3	PSB @ 90 ml/l of water	6.05	46.33
T_4	PSB @ 120 ml/l of water	6.18	51
T_5	Panchgavya @ 30 ml/l of water	5.35	47
T_6	Panchgavya @ 60 ml/l of water	6.20	46.33
T_7	Panchgavya @ 90 ml/l of water	5.24	40.66
T_8	Panchgavya @ 120 ml/l of water	6.58	59.66

Application of Photosynthetic bacteria and Panchgavya resulted in more Total soluble solids and Ascorbic Acid content in the tomato fruit. Maximum TSS and Ascorbic Acid content was observed in the treatment of Panchgavya @ 120 ml/l of water (6.58 °Brix and 59.66 mg/100g respectively). Photosynthetic bacteria have been reported to enhance photosynthesis in plants by increasing chlorophyll content and photosynthetic efficiency [17] Similarly, panchgavya has been reported to enhance nutrient uptake and utilization in plants [18]. This could attribute to increase the qualitative parameters in tomato.

3.6 Economic Parameters

Economic Parameters such as Gross Return, Net Income/Return, Benefit Cost Ratio were calculated and listed in Table 7.

Table 7: Economic parameters

Treatment	Treatment Combination	Gross Return (₹)	Net Return (₹)	Benefit Cost Ratio (₹)
T_0	Control	1,57,000	75,071	0.91
T_1	PSB @ 30 ml/l of water	2,13,000	1,30,897.6	1.59
T_2	PSB @ 60 ml/l of water	2,92,500	2,10,223.8	2.55
T_3	PSB @ 90 ml/l of water	3,42,200	2,59,750.2	3.15
T_4	PSB @ 120 ml/l of water	4,87,400	4,04,776.7	4.89
T_5	Panchgavya @ 30 ml/l of water	2,65,100	1,81,012.2	2.15
T_6	Panchgavya@ 60 ml/l of water	3,71,600	2,85,355	3.30
T_7	Panchgavya @ 90 ml/l of water	3,70,300	2,81,897	3.18
T_8	Panchgavya @ 120 ml/l of water	5,88,100	4,97,539	5.49

The application of Photosynthetic bacteria and Panchagavya gave more Net and Gross returns as compared to Control. Maximum Benefit Cost ratio was obtained in the treatment of Panchgavya @ 120 ml/l of water (5.49).

4. Conclusion

The results of the experiment indicated that the application of Photosynthetic Bacteria and Panchagavya significantly improved most of the growth as well as yield parameters of tomato. However, Panchagavya at the rate of 120,l/l of water was found to be the best treatment in terms of growth, earliness, yield and economic parameters of cherry tomato. The yield of fruits also improved with application of these organics. Thus, Panchagavya at 120 ml/l of water can be recommended for achieving significantly higher growth and yield of tomato.

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