Effect of different sources of nitrogen and bio fertilizers on growth and yield of cherry tomato" [Solanum lycopersicum (L.) var. Cerasiforme in polyhouse conditions

Abstract

The present investigation was carried out atResearch Farm, Department of Horticulture, Naini Agricultural Institute, SHUATS, Naini, Prayagraj, Uttar Pradesh during the *Kharif*-2022 with aview to identify the effects of different combinations of organic and inorganic fertilizers and its role in growth, yield and quality of Cherry Tomato variety Pusa Cherry-1. The experiment was laid in Randomized block design with 9 treatments and 3 replications with different combination in RDF and application of organic nutrition. Under this experiment, overall, 10 treatment was taken T_0 (Control), T_1 (100% N through urea+ 25tha^{-1} FYM), T_2 (75% N through urea + 25% N through FYM), T_3 (50% N through urea + 25% N through FYM), T_4 (75%N through urea + 25% N through FYM+ Azotobacter (4Kgha^{-1}), T_5 (50% N through urea + 50% N through FYM + Azotobacter (4Kgha^{-1}), T_6 (75% N through urea +25% N through FYM + Azotobacter (4Kgha^{-1}), T_7 (50% N through urea + 50% N through FYM + PSB), T_8 (75% N through urea + 25% N through FYM + Azotobacter (4kgha^{-1}) + PSB) and T_9 (50% N through urea + 50% N through FYM + Azotobacter (4Kgha^{-1}) + PSB). From the above experimental finding it may be concluded that the treatment T_9 (75% N through urea + 25% N through FYM + Azotobacter (4kgha^{-1}) + PSB(4Kgha^{-1})was found to be best in the terms of growth parameters like highest plant height (283.35 cm) at 120 DAT, maximum number of branches per plant (72.33 branches) at 120 DAT. In terms of earliness, it was found to have minimum days to attain 50% flowering (55.93 DAT). In terms of yield T_9 had highest number of fruits per cluster (5.57 fruits), and fruit yield per hectare (25.88 t ha^{-1}). TSS (9.50 °Brix) and ascorbic acid content (20.67 mg 100 g^{-1} of pulp) was found to be best in T_9in Cherry Tomato. The highest net return was found in the T_9 (75% N through urea + 25% N through FYM + Azotobacter (4kgha^{-1}) + PSB(4Kg/ha)with (Rs 2,40,210 ha^{-1}) and the highest BC ratio was found in the same with 2.62.

Keywords :- *Cherry Tomato,FYM, Azotobacter, PSB, Growth, Quality, Yield and Economics*

INTRODUCTION

Cherry tomato (*Solanum lycopersicum* var. *cerasiforme* Mill.) is a highly priced culinary as well as ornamental vegetable. One of the most popular high value exotics, it is a favourite among chef's who cook for high profile restaurants and hotels. Nevertheless, it is becoming increasingly popular among common people, who are now interested in garnishing their dishes and diversifying their nutritional intake. Cherry tomatoes look not only attractive in kitchen gardens but are commercially valuable horticultural commodity and have impressive nutritional and pharmaceutical properties. According to the USDA nutritional information, one cup of cherry tomatoes (149 g) provides 26.8 calories, 1.3 g protein, 4.5 mg omega-3 fatty acids, 119 mg omega-6 fatty acids, 1241 IU of vitamin A, 18.9 mg vitamin C, 22.3 mcg folic acid, 11.8 mcg vitamin C, 353 mg potassium, 35.8 mg phosphorus and 14.9 mg calcium(**Choudhary, 2013**).

Farm manure is primarily made from cow dung, cow urine, straw, and other milk waste. A small amount of Nitrogen (N) is directly available to plants, but more N becomes available as FYM degrades. Mixing cow dung with urine gives plants a balanced diet. The availability of potassium and phosphorus from FYM is like that from inorganic sources. Applying FYM improves soil fertility.On an average well decomposed farmyard manure contains 0.5 per cent Nitrogen (N), 0.2 per cent Phosphate(P_2O_5)and .0.5 per cent Potassium(K_2O).FYM also increases the availability of soil phosphorus. In addition to the effect of FYM on soil P content, the application of FYM in presence of fertilizer phosphorus may also affect the solubility and hence the potential availability of applied P. It is widely recognized that neither use of organic manure alone nor chemical fertilizers can achieve the yield sustainability under the modern intensive farming (**Singh, 2019**).

Azotobacter in plant growth enhancement are as biofertilizer, bio stimulant, and bioprotectant. Nitrogen fixation by Azotobacter is the mechanism to provide available nitrogen for uptake by roots. Azotobacter stimulates plant growth through phytohormones synthesis; indole acetic acid, cytokinin, and gibberellins are detected in the liquid culture of Azotobacter. An indirect effect of Azotobacter is exopolysaccharide production and plant protection. Inoculation of Azotobacter in the field integrated with organic matter and reduced chemical fertilizer are reported to improve plant growth and yield (**Hindersah *et al.*, 2020**).

Urea, or $CO(NH_2)_2$, is a simple amide of carbamic acid used as a solid nitrogenous fertilizer due to its high nitrogen content, low transportation cost, and ability to break down into ammonium ions (NH^{+4}) and nitrate (NO^{-3}) in the soil. Synthetic urea's most common impurity is biuret, which impairs plant growth. Urea contains 46.6% nitrogen and is taken up by plants through their roots as ammonium, which can be oxidized to nitrate by bacteria in some soils.Nitrogen (N) is an important macro-nutrient required for crop production and is considered an important commodity for agricultural systems. Urea is a vital source of N that is used widely across the globe to meet crop N requirements (**Anas *et al.*, 2020**). It plays a vital role in forming chlorophyll, proetids and proteins, and other essential compounds like plant hormones; however, plants are inefficient in the acquisition and utilization of applied nitrogen (**Tiong *et al.*, 2021**).

Phosphate-solubilizing bacteria may solubilize the insoluble phosphate from organic and inorganic phosphate sources, such as *Pantoea agglomerans* strain P5 or Pseudomonas putida strain P13 **(Pandey *et al.*, 2005**) The rate of accessible phosphate (Pi) in soil is much lower than what plants require since it has been immobilised by mineral ions like Fe, Al, and Ca or organic acids. Less than 20% of applied fertiliser is taken by plants due to the quick immobilisation of chemical Pi fertilisers in the soil.

MATERIALS AND METHODS

This experiment was laid out during the July 2023 to August 2023 at Horticulture Research Farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.). The horticulture research farm is situated at 25^0 39” 42” N latitude, 81^0 67” 56” E longitude and at an altitude of 98 m above mean sea level.The treatment consisted of T_0 - Control, T_1- 100% N through urea+ 25t ha^{-1}FYM, T_2- 75% N through urea + 25% N through FYM, T_3 - 50% N through urea + 50% N through FYM, T_4- 75%N through urea + 25% N through FYM+ Azotobacter (4Kg ha^{-1}), T_5 - 50% N through urea + 50% N through FYM + Azotobacter (4Kg ha^{-1}), T_6 - 75% N through urea +25% N through FYM + PSB (4Kg ha^{-1}), T_7 - 50% N through urea + 50% N through FYM + PSB(4Kg ha^{-1}), T_8 -75% N through urea + 25% N through FYM + Azotobacter (4Kg ha^{-1}) + PSB(4Kg ha^{-1}), T_9 -50% N through urea + 50% N through FYM + Azotobacter (4Kg ha^{-1}) + PSB(4Kg ha^{-1}). TheexperimentwaslaidoutinaRandomizedBlockDesignwith10treatmentsand replicatedthrice.Datarecordedondifferentaspectsoffruit crop,*viz.*,growth,yieldwere subjected to statistically analysis by analysis of variance method. (**Gomez and Gomez, 1976)** and economic data analysis mathematical method.

RESULTS AND DISCUSSION

Growth parameters

Plant height (cm)

The results pertaining to the effect of organic and inorganic fertilizers on plant height of Cherry Tomato are presented in table 1

The height of plant at 120 DATvaried significantly among different treatment combinations.The maximum height of plant (283.35 cm) was observed with treatment T_9 (50% N through urea + 50% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1})) followed by T_8 (75% N through urea + 25% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1}) having232.27 cm. Minimum plant height (210.67 cm) was observed in T_0 (Control), while the remaining treatments were moderate in their growth habit.

The treatment combination of 50% N via urea + 50% N through FYM + Azotobacter (4kgha^{-1}) + PSB (4kgha^{-1}) fosters superior plant height in cherry tomatoes by orchestrating a holistic nutrient symphony. The balanced nitrogen sources fuel robust foliage development, while Azotobacter's symbiotic nitrogen fixation enriches the soil, promoting extensive root growth. Additionally, PSB's role in enhancing phosphorus uptake fortifies stem strength and overall plant vigour. This comprehensive approach synergizes nutrient availability, root establishment, and structural integrity, cultivating taller, more resilient cherry tomato plants. In contrast, Control treatment, lacked this synchronized nutrient blend, leading to comparatively limited plant stature.Findings were in accordance with**Baba *et al.*,(2018); Verma*et al.*,(2020); Pinkee*et al.*,(2020)** in Tomato.

Number of branches per plant

The results pertaining to the effect of different sources of nitrogen and biofertilizers on number of branches per plant of Cherry Tomato are presented in Table 1.

It is evident that the number of branches per plant of plant was influenced by different different sources of nitrogen and biofertilizers appliedfor growth observed at different stages of growth. There was significant difference presentamong the treatments applied. The highest number of branches (72.33branches) at 120DATrespectively was observed with treatment T_9 (50% N through urea + 50% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1})) followed by T_8 (75% N through urea + 25% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1}) having71.60 branches observed at 120 DAT. Minimum plant height (63.27 branches) was observed in T_0 (Control) at 120 DAT.

The treatment combination of 50% N through urea + 50% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1}) orchestrates a thriving environment for cherry tomatoes, manifesting in an augmented number of branches per plant. This combination provides a balanced nitrogen supply for sustained growth, fostering abundant foliage. Azotobacter's nitrogen fixation enriches soil, encouraging robust root development, a precursor to lateral branching. Meanwhile, PSB enhances phosphorus uptake, vital for branching proliferation. This synergy of nutrients and soil enhancement fosters an optimal ecosystem, encouraging lateral shoot formation and branching. In contrast, control treatment missed this balanced nutrient synergy, resulting in comparatively limited lateral growth and fewer branches per plant in cherry tomatoes. Similar findings were reported by **Khan*et al.*, (2013); Khan*et al.*, (2021); Olagnuju*et al.*, (2023)** in Cherry Tomato.

PHENOLOGICAL PARAMETERS

Days to first flowering

The results related to days to first floweringare presented in table 1. Days to first floweringshowed significant difference present among the treatments applied. The minimum days to first flowering (34.07 days) was observed with treatment T_9 (50% N through urea + 50% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1})followed by T_8 (75% N through urea + 25% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1}) having34.14 days. Maximum days to first flowering (42.90 days) was observed in T_0 (Control).

The treatment mix of 50% N through urea + 50% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1}) expedites the days to first flowering in cherry tomatoes by orchestrating an optimal growth environment. This balanced nitrogen blend fuels early vegetative vigour, crucial for triggering flower initiation. Azotobacter's nitrogen-fixing prowess enriches soil fertility, stimulating root growth, a precursor to earlier flowering. Concurrently, PSB's role in bolstering phosphorus uptake accelerates metabolic processes essential for flowering induction. This combined approach cultivates an enriched soil ecosystem, fostering expedited vegetative growth stages and consequently, earlier flowering in cherry tomatoes. Conversely, control treatment did not have this balanced nutrient synergy, leading to delayed flowering due to inadequate nutritional support for the plant's early developmental stages.Similar findings were reported by **Shafi*et al.*, (2019); Verma *et al.*, (2020); and Pinkee*et al.*, (2022)** in Tomato.

Days to 50% flowering

Days to 50% floweringshowed significant difference present among the treatments applied. The minimum days to 50% flowering (55.93 days) was observed with treatment T_9 (50% N through urea + 50% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-}

^{1}))followed by T_8 (75% N through urea + 25% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1})) having56.88 days. Maximum days to 50% flowering (64.26 days) was observed in T_0 (Control).The results related to days to 50% floweringare presented in table 1.

The treatment blend of 50% N through urea + 50% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1}) accelerates the days to reach 50% flowering in cherry tomatoes by orchestrating an optimal nutrient environment and soil symbiosis. This balanced nitrogen composition fuels early vegetative vigour, essential for advancing flowering stages. Azotobacter's nitrogen fixation enriches the soil, fostering robust root development, a pivotal precursor to early flowering. Simultaneously, PSB's role in enhancing phosphorus availability triggers metabolic processes crucial for flower initiation and maturation. This holistic approach creates a nutrient-rich, symbiotically balanced soil, expediting vegetative growth stages and subsequently hastening the onset of 50% flowering in cherry tomatoes. Conversely, control treatments lacked this synchronized nutrient blend, resulting in delayed flowering due to inadequate nutritional support during critical growth phases.Similar findings were reported by **Nishant *et al.*, (2021) and Olagunju*et al.*, (2023)** in Tomato.

YIELD PARAMETERS

Number of flowers per cluster

Number of flowers per clustershowed significant difference present among the treatments applied. The highest number of flowers per cluster (11.33 flowers) was observed with treatment T_9 (50% N through urea + 50% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1}))at par with T_8 (75% N through urea + 25% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1})) having8.80 flowers. T_0 (control) had lowest number of flowers per cluster (6.51 flowers).The results related to number of flowers per clusterare presented in table 2.

The treatment blend of 50% N through urea + 50% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1}) fosters an increased number of flowers per cluster in cherry tomatoes due to a comprehensive nutrient amalgamation and soil enrichment. This balanced nitrogen composition sustains robust vegetative growth, pivotal for cluster initiation. Azotobacter's nitrogen-fixing ability enriches soil fertility, encouraging extensive root development, a crucial precursor to cluster formation. Simultaneously, PSB augments phosphorus availability, essential for reproductive processes and cluster development.This holistic approach cultivates an enriched soil ecosystem, nurturing accelerated vegetative growth and reproductive stages, thereby fostering more flowers per cluster in cherry tomatoes. In contrast, control do not had this synchronized nutrient synergy, resulting in limited cluster formation due to inadequate nutritional support during critical growth phases.**Khan *et al.*, (2013) and Reddy*et al.*, (2018)**came up with similar conclusions in Tomato.

Number of fruits per cluster

The results related to number of fruits per clusterare presented in table 2.Number of fruits per clustershowed significant difference present among the treatments applied. The highest number of fruits per cluster (5.57 fruits) was observed with treatment T_9 (50% N through urea + 50% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1}))followed by T_8 (75% N through urea + 25% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1}) having5.47 fruits. T_0 (Control) had lowest number of fruits per cluster (3.32 fruits).

The treatment combination of 50% N through urea + 50% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1}) fosters an increased number of fruits sets per cluster in cherry tomatoes due to a holistic nutrient synergy and soil enhancement. This balanced nitrogen supply sustains robust vegetative growth, crucial for fruits set initiation within clusters. Azotobacter's nitrogen fixation enriches soil fertility, stimulating extensive root growth, a fundamental precursor to fruits set formation. Additionally, PSB's role in enhancing phosphorus uptake facilitates reproductive processes, encouraging multiple fruits sets within clusters.This comprehensive approach creates an optimal soil environment, nurturing accelerated vegetative growth and reproductive phases, thereby encouraging more fruits sets per cluster in cherry tomatoes. **Poonia and Dhaka (2012); Saha *et al.*, (2019) and Shafi*et al.*, (2019)**drew similar inferences in Tomato.

Number of clusters per plant

Table 2 presents the results regarding the number of clusters per plant. Number of clusters per plantshowed significant difference present among the treatments applied. The highest number of clusters per plant (6.00 clusters) was observed with treatment T_9 (50% N through urea + 50% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1}))at par with T_8 (75% N through urea + 25% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1})) having5.60 clusters. T_0 (Control) had lowest number of clusters per plant (2.39 clusters).

Through a balanced nutrient blend and enhanced soil vitality, the treatment mix of 50% N through urea + 50% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1}) encourages more clusters per plant in cherry tomatoes. This well-balanced combination of nitrogen maintains strong vegetative growth, which is necessary for copious flower production. Because of its ability to fix nitrogen, Azotobacter improves soil fertility and encourages extensive root development, which is a necessary step before flower initiation. Simultaneously, PSB increases phosphorus availability, which is necessary for multiple flower formations and floral induction. With accelerated vegetative growth and reproductive stages fostered by this all-encompassing approach, cherry tomatoes produce more clusters per plant. **Poonia and Dhaka (2012); Saha *et al.*, (2019) and Shafi*et al.*, (2019)**came up with similar conclusions in Tomato.

Fruit setting percent

The results related to Fruit setting percentare presented in table2. Fruit setting percentshowed significant difference present among the treatments applied. The highest fruit setting percent (80.59%) was observed with treatment T_9 (50% N through urea + 50% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1}))followed by T_8 (75% N through urea + 25% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1})) having80.32%. T_0 (control) had lowest fruit setting percent (51.07%).

The treatment blend of 50% N through urea + 50% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1}) fosters an increased number of fruits setting per cent in cherry tomatoes due to a holistic nutrient synergy and soil enhancement. This balanced nitrogen supply sustains robust vegetative growth, crucial for fruit set initiation within clusters. Azotobacter's nitrogen fixation enriches soil fertility, stimulating extensive root growth, a fundamental precursor to flower set formation. Additionally, PSB's role in enhancing phosphorus uptake facilitates reproductive processes, encouraging multiple flower sets within clusters.This comprehensive approach creates an optimal soil environment, nurturing accelerated vegetative growth and reproductive phases, thereby encouraging more fruits set per cluster in cherry tomatoes. **Poonia and Dhaka (2012); Saha *et al.*, (2019) and Hariyali*et al.*, (2020)**drew similar inferences in Tomato.

Fruit yield per hectare

The fruit yield results for each plant are shown in Table 2. Fruit yield per hectareshowed significant difference present among the treatments applied. The maximum fruit yield per hectare (25.88 t ha^{-1}) was observed with treatment T_9 (50% N through urea + 50% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1}))followed by T_8 (75% N through urea + 25% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1})) having21.99 t ha^{-1}. Minimum fruit yield per hectare (11.75 t ha^{-1}) was observed in T_0 (Control).

By coordinating a balanced nutrient amalgamation and enhanced soil biology, the treatment combination50% N through urea + 50% N through FYM + Azotobacter (4 kg ha^{-1})

+ PSB (4 kg ha^{-1}) fosters superior fruit yield per hectare in cherry tomatoes. Strong vegetative growth is maintained by this nutrient synergy, which is essential for the development of flowers and subsequent fruit set. By fixing nitrogen into the soil, Azotobacter increases soil fertility and promotes deep root growth, which is essential for higher fruit yield. At the same time, PSB increases absorption of phosphorus, which is necessary for both increased fruit production and reproduction. This all-encompassing method creates the ideal soil conditions for faster vegetative and reproductive stages, which increases the amount of fruit produced by each cherry tomato plant. **Bilalis *et al.*, (2018) and Pinkee*et al.*, (2023)**concluded with similar results in Tomato.

Quality parameters

TSS °Brix

The fruit TSS results are shown in Table 3. TSSshowed significant difference present among the treatments applied. The maximum TSS (9.50 °Brix) was observed with treatment T_9 (50% N through urea + 50% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1}))followed by T_8 (75% N through urea + 25% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1}) having8.70 °Brix. Minimum TSS (5.31 °Brix) was observed in T_0 (Control).

The treatment mix of 50% N through urea + 50% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1}) contributes to superior Total Soluble Solids (TSS) in cherry tomatoes by fostering a balanced nutrient amalgamation and enriched soil biology. This blend sustains robust vegetative growth, critical for fruit development and sugar accumulation. Azotobacter enriches soil fertility via nitrogen fixation, stimulating extensive root growth, facilitating enhanced nutrient uptake for improved TSS. Simultaneously, PSB augments phosphorus availability, essential for carbohydrate metabolism and heightened sugar content.This holistic approach creates an optimal soil environment, nurturing accelerated growth stages, resulting in cherry tomatoes with higher TSS. Conversely, control treatment was deficit in this synchronized nutrient synergy, leading to lower TSS due to insufficient nutritional support during critical fruit development phases.**Bilalis *et al.*, (2018); Beyene and Molu (2019); Hariyali *et al.*, (2020) and Pinkee*et al.*, (2023)**concluded with similar results in Tomato.

Ascorbic acid content

The fruit ascorbic acid content results are shown in Table 3. Ascorbic acid contentshowed significant difference present among the treatments applied. The maximum ascorbic acid content (20.67 mg) was observed with treatment T_9 (50% N through urea + 50% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1}))followed by T_8 (75% N through urea + 25% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1}) having19.90 mg. Minimum ascorbic acid content (12.74 mg) was observed in T_0 (Control).

The combination of 50% N through urea + 50% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1}) results in a balanced nutrient amalgamation and enhanced soil vitality, which in turn raises the ascorbic acid content in cherry tomatoes. Robust vegetative growth is maintained by this balanced nitrogen composition, which is essential for fruit development and nutrient accumulation. Through the nitrogen fixation process, azotobacter increases soil fertility by encouraging a wide range of root growth and better nutrient uptake for increased ascorbic acid synthesis. As phosphorus is needed for metabolic processes that result in an increase in ascorbic acid content, PSB simultaneously increases phosphorus availability. This all-encompassing method creates an ideal soil environment, speeding up growth stages and producing ascorbic acid-rich cherry tomatoes. On the other hand, control treatment do not have this coordinated nutrient blend, which results in a decreased ascorbic acid content.**Bilalis *et al.*, (2018); Beyene and Molu (2019); Hariyali *et al.*, (2020); Olagunju *et al.*, (2023) and Pinkee*et al.*, (2023)**concluded with similar results in Tomato.

pH

The fruit pH results are shown in Table 3.PHshowed significant difference present among the treatments applied. The minimum pH (3.82) was observed with treatment T_9 (50% N through urea + 50% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1}))followed by T_8 (75% N through urea + 25% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1}) having3.89. Maximum pH (4.78) was observed in T_0 (control).

The combination of 50% N through urea + 50% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1}) results in a balanced nutrient amalgamation and enhanced soil vitality, which in turn favoured for lowering the pH in cherry tomatoes. Robust vegetative growth is maintained by this balanced nitrogen composition, which is essential for fruit development and nutrient accumulation. Through the nitrogen fixation process, azotobacter increases soil fertility by encouraging a wide range of root growth and better nutrient uptake for increased ascorbic acid synthesis. As phosphorus is needed for metabolic processes that result in decrease in pH, PSB simultaneously increases phosphorus availability. This all-encompassing method creates an ideal soil environment, speeding up growth stages and producing ascorbic acid-rich cherry tomatoes. **Bilalis *et al.*, (2018); Beyene and Molu (2019); Hariyali *et al.*, (2020); Olagunju *et al.*, (2023) and Pinkee*et al.*, (2023)**concluded with similar results in Tomato.

Acidity

The fruit acidity results are shown in Table 3.Acidityshowed significant difference present among the treatments applied. The maximum acidity (0.51%) was observed with treatment T_9 (50% N through urea + 50% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1})followed by T_8 (75% N through urea + 25% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1}) having0.48%. Minimum acidity (0.29%) was observed in T_0 (Control).

The combination of 50% N through urea + 50% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1}) results in a balanced nutrient amalgamation and enhanced soil vitality, which in turn raises the acidity in cherry tomatoes. Robust vegetative growth is maintained by this balanced nitrogen composition, which is essential for fruit development and nutrient accumulation. Through the nitrogen fixation process, azotobacter increases soil fertility by encouraging a wide range of root growth and better nutrient uptake for increased ascorbic acid synthesis. As phosphorus is needed for metabolic processes that result in an increase in acidity, PSB simultaneously increases phosphorus availability. This all-encompassing method creates an ideal soil environment, speeding up growth stages and producing ascorbic acid-rich cherry tomatoes. **Bilalis *et al.*, (2018); Beyene and Molu (2019); Hariyali *et al.*, (2020); Olagunju *et al.*, (2023) and Pinkee*et al.*, (2023)**concluded with similar results in Tomato.

Specific gravity

The fruit specific gravity results are shown in Table 3. Specific gravityshowed significant difference present among the treatments applied. The maximum specific gravity (1.16) was observed with treatment T_9 (50% N through urea + 50% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1}))followed by T_4 (75%N through urea + 25% N through FYM+ Azotobacter (4 kg ha^{-1}) having1.13. Minimum specific gravity (0.95) was observed in T_0 (Control).

The combination of 50% N through urea + 50% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1}) results in a balanced nutrient amalgamation and enhanced soil vitality, which in turn raises the specific gravity in cherry tomatoes. Robust vegetative growth is maintained by this balanced nitrogen composition, which is essential for fruit development and nutrient accumulation. Through the nitrogen fixation process, azotobacter increases soil fertility by encouraging a wide range of root growth and better nutrient uptake for increased ascorbic acid synthesis. As phosphorus is needed for metabolic processes that result in an increase in specific gravity, PSB simultaneously increases phosphorus availability. This all-encompassing method creates an ideal soil environment, speeding up growth stages and producing ascorbic acid-rich cherry tomatoes. **Bilalis *et al.*, (2018); Beyene and Molu (2019); Hariyali *et al.*, (2020); Olagunju *et al.*, (2023) and Pinkee*et al.*, (2023)**concluded with similar results in Tomato.

Economics of different treatments:

Economics of all treatments were calculated according to the expenditure occurred from then nursery raising till harvesting of fruits viz. Cost of cultivation, gross return, net return, and benefit: cost ratio has been worked out and presented in table 4.

Maximum cost of cultivation was recorded in treatment T_1 (100% N through urea+ 25t ha^{-1} FYM)with (Rs 1,54,850 ha^{-1}) followed by T_9 (50% N through urea + 50% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1})) with Rs 1,47,990/ha and the minimum (Rs1,39,250 ha^{-1}) was recorded in treatment T_0 (Control).

Maximum gross returns were recorded in treatment T_9 (50% N through urea + 50% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1}))with (Rs 3,88,200 ha^{-1}) followed by T_8 (75% N through urea + 25% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1})) with Rs 3,29,900 $ha^{-1}$and the minimum (Rs1,76,300 ha^{-1}) was recorded in treatment T_0 (Control).

Maximum net returns were recorded in treatment T_9 (50% N through urea + 50% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1}))with (Rs 2,40,210 ha^{-1}) followed by T_8 (75% N through urea + 25% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1})) with Rs 1,85,509 $ha^{-1}$and the minimum (Rs37,050 ha^{-1}) was recorded in treatment T_0 (Control).

Highest benefit cost ratio(2.62) was recorded in treatment T_9 (50% N through urea + 50% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1}))followed by T_8 (50% N through urea + 50% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1})) with 2.28 and the lowest benefit cost (1.27) was recorded in treatment T_0 (Control).

Because farmers must consider economics when making decisions about the application of scientific knowledge and techniques, T_9 (50% N through urea + 50% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1})) produced one of the highest gross returns, net returns, and cost benefits because of its higher yield quality and productivity, which raises the fruit's market value.Similar findings were reported by **Baba *et al.*, (2018); Saha *et al.*, (2019) and Nishant*et al.*, (2021)**in Tomato.

Conclusion

From the above experimental finding it may be concluded that the treatment T_9 (50% N through urea + 50% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1})was found to be best in the terms of growth, yield and quality of Cherry Tomato. The highest net return was found in the T_9 (50% N through urea + 50% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1})with (Rs 2,40,210/ha) and the highest B:C ratio was found in the same with 2.62.

Table 1Effect of different sources of nitrogen and biofertilizers on growth and phenologicalof Cherry Tomato

Treatment Symbol	Treatment combinations	Plant height 120 DAT	Number of branches/plant	Days to first flowering	Days to 50% flowering
T_0	Control	210.67	63.27	42.90	64.26
T_1	100% N through urea+ 25 t ha^{-1} FYM	222.47	66.20	40.40	62.93
T_2	75% N through urea + 25% N through FYM	226.40	65.47	35.73	57.33
T_3	50% N through urea + 50% N through FYM	218.27	66.20	34.54	57.53
T_4	75%N through urea + 25% N through FYM+ Azotobacter (4 kg ha^{-1})	225.87	71.30	34.30	57.67
T_5	50% N through urea + 50% N through FYM + Azotobacter (4 kg ha^{-1})	226.33	70.80	35.40	57.47
T_6	75% N through urea +25% N through FYM + PSB (4 kg ha^{-1})	231.47	70.07	35.07	58.27
T_7	50% N through urea + 50% N through FYM + PSB (4 kg ha^{-1})	230.51	69.20	35.47	58.13
T_8	75% N through urea + 25% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1})	232.27	71.60	34.14	56.88
T_9	50% N through urea + 50% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1})	283.35	72.33	34.07	55.93
	F-test	**S**	**S**	**S**	**S**
	SEm(±)	0.82	0.72	0.59	0.98
	CD (p=0.05)	2.41	2.11	1.74	2.88

Table 2Effect of different sources of nitrogen and biofertilizers on yield of Cherry Tomato

Treatment Symbol	Treatment combinations	No of flowers per cluster	No of fruits per cluster	No of clusters per plant	Fruit setting percent (%)	Fruit yield per hectare (t ha^{-1})
T_0	Control	6.51	3.32	2.39	51.07	11.75
T_1	100% N through urea+ 25 t ha^{-1} FYM	8.47	5.00	2.97	59.42	14.22
T_2	75% N through urea + 25% N through FYM	8.59	4.87	3.40	56.92	17.22
T_3	50% N through urea + 50% N through FYM	7.00	5.47	3.23	78.06	19.10
T_4	75%N through urea + 25% N through FYM+ Azotobacter (4 kg ha^{-1})	8.07	5.33	2.77	66.14	20.44
T_5	50% N through urea + 50% N through FYM + Azotobacter (4 kg ha^{-1})	8.33	5.33	5.50	64.07	19.10
T_6	75% N through urea +25% N through FYM + PSB (4 kg ha^{-1})	7.67	5.23	5.00	68.87	19.77
T_7	50% N through urea + 50% N through FYM + PSB (4 kg ha^{-1})	7.87	5.13	4.37	65.36	21.77
T_8	75% N through urea + 25% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1})	8.80	5.47	5.60	80.32	21.99
T_9	50% N through urea + 50% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1})	11.33	5.57	6.00	80.59	25.88
	F-test	**S**	**S**	**S**	**S**	**S**
	SEm(±)	0.34	0.24	0.14	3.71	0.62
	CD (p=0.05)	0.99	0.69	0.40	10.89	1.82

Table 3Effect of different sources of nitrogen and biofertilizers on qualityof Cherry Tomato

Treatment Symbol	Treatment combinations	TSS (°Brix)	Ascorbic acid content (mg 100 g^{-1})	pH	Acidity (%)	Specific gravity
T_0	Control	6.45	12.74	4.78	0.29	0.95
T_1	100% N through urea+ 25 t ha^{-1} FYM	6.53	16.67	4.23	0.38	0.97
T_2	75% N through urea + 25% N through FYM	7.41	17.20	4.08	0.35	1.04
T_3	50% N through urea + 50% N through FYM	7.46	18.10	3.96	0.48	1.02
T_4	75%N through urea + 25% N through FYM+ Azotobacter (4 kg ha^{-1})	7.59	17.30	4.11	0.45	1.13
T_5	50% N through urea + 50% N through FYM + Azotobacter (4 kg ha^{-1})	7.96	18.23	4.05	0.43	0.98
T_6	75% N through urea +25% N through FYM + PSB (4 kg ha^{-1})	8.50	18.97	4.17	0.40	1.01
T_7	50% N through urea + 50% N through FYM + PSB (4 kg ha^{-1})	8.70	19.87	4.05	0.44	1.11
T_8	75% N through urea + 25% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1})	9.50	19.90	3.89	0.48	1.11
T_9	50% N through urea + 50% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1})	6.45	20.67	3.82	0.51	1.16
	F-test	**S**	**S**	**S**	**S**	**S**
	SEm(±)	0.13	0.30	0.08	0.01	0.03
	CD (p=0.05)	0.38	0.88	0.24	0.03	0.08

Table 4Effect of different sources of nitrogen and biofertilizers on economics of Cherry Tomato

	Treatment	Fruit Yield (t ha^{-1})	Total cost of cultivation (Rs)	Gross Return (Rs)	Net return (Rs)	BC Ratio
T_0	Control	11.75	1,39,250	176300	37050	1.27
T_1	100% N through urea+ 25 t ha^{-1} FYM	14.22	1,54,850	213250	58400	1.38
T_2	75% N through urea + 25% N through FYM	17.22	1,43,451	258250	114799	1.80
T_3	50% N through urea + 50% N through FYM	19.10	1,47,050	286550	139500	1.95
T_4	75%N through urea + 25% N through FYM+ Azotobacter (4 kg ha^{-1})	20.44	1,43,591	306600	163009	2.14
T_5	50% N through urea + 50% N through FYM + Azotobacter (4 kg ha^{-1})	19.10	1,47,190	286550	139360	1.95
T_5	75% N through urea +25% N through FYM + PSB (4 kg ha^{-1})	19.77	1,44,251	296550	152299	2.06
T_7	50% N through urea + 50% N through FYM + PSB (4 kg ha^{-1})	21.77	1,47,850	326600	178750	2.21
T_8	75% N through urea + 25% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1})	21.99	1,44,391	329900	185509	2.28
T_9	50% N through urea + 50% N through FYM + Azotobacter (4 kg ha^{-1}) + PSB (4 kg ha^{-1})	25.88	1,47,990	388200	240210	2.62

Rate of per kg Cherry Tomato: Rs 15/kg

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