**Effect of different organic manures and biofertilizers on production and associated traits of Chilli *(Capsicum annuum* l.*)***

 **ABSTRACT**

A field trial was carried out at the Horticulture Research Farm, Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, from July to October 2024 to assess how various organic manures and a biofertilizer influence the growth, yield and quality of chilli (Capsicum annuum L.). The experiment followed a randomized block design with three replications and nine treatments: T0: 100% recommended NPK (100:50:50 kg ha⁻¹), T1: Farm yard manure (20 t ha⁻¹) + Azotobacter (2 g plant⁻¹), T2: Poultry manure (15 t ha⁻¹) + Azotobacter (2 g plant⁻¹), T3: Vermicompost (5 t ha⁻¹) + Azotobacter (2 g plant⁻¹), T4: Azotobacter (2 g plant⁻¹) alone, T5: 50% FYM (10 t ha⁻¹) + 50% poultry manure (7.5 t ha⁻¹) + Azotobacter, T6: 50% FYM (10 t ha⁻¹) + 50% vermicompost (2.5 t ha⁻¹) + Azotobacter, T7: 50% poultry manure (7.5 t ha⁻¹) + 50% vermicompost (2.5 t ha⁻¹) + Azotobacter, T8: FYM : poultry manure : vermicompost (1 : 1 : 1 at 5 + 3.75 + 1.25 t ha⁻¹) + Azotobacter

Across all treatments, T8, the combined application of FYM, poultry manure and vermicompost in equal proportions plus Azotobacter, produced the greatest improvements in vegetative growth, fruit yield, and post-harvest quality. This treatment also delivered the highest benefit–cost ratio of 3.97, underscoring its economic as well as agronomic superiority.

**Keywords:- organic manure, biofertilizers, growth, yield, quality and chilli**

**INTRODUCTION**

**Vegetables are pivotal to Indian agriculture, addressing malnutrition while bolstering rural livelihoods and national food security.** As labour-intensive crops, vegetables generate substantial employment in villages and small towns. India ranks second only to China in vegetable production, accounting for roughly 12 percent of global output (Nayak et al., 2016).

**Chilli (Capsicum annuum L.), a Solanaceae member with 2n = 24 chromosomes, exemplifies the dual vegetable–spice role.** Domesticated in South and Central America around 7000 BC, the genus Capsicum today includes 30 species—five of which are cultivated: C. annuum L., C. frutescens L., C. chinense Jacq., C. pubescens Raf., and C. baccatum L. (Patel et al., 2016).

**India leads the world in chilli production, consumption, and export, prized for a spectrum of pungency and vivid hues.** According to the Spices Board of India’s 1st Advance Estimates (2024–25), global chilli cultivation spans 18.03 lakh ha, yielding 58.22 lakh t at 3 229 kg/ha. India alone produced 27.82 lakh t, followed by Bangladesh (6.63 lakh t), Thailand (3.29 lakh t), China (3.26 lakh t), and others. Major export destinations include China, Sri Lanka, Malaysia, Bangladesh, Singapore, Thailand, and the UAE.

**Beyond culinary uses, chilli offers industrial and health benefits.** Its oleoresin—valued in food colouring and flavouring—drives a thriving processing sector. Nutritionally, green and red fruits are rich in antioxidants and provitamins A, C, and E, compounds linked to cancer prevention and analgesic effects (Khushal et al., 2023).

**MATERIALS AND METHODS**

The investigation entitled “Effect of Different Organic Manures and Biofertilizers on Production and Associated Traits of Chilli (Capsicum annuum L.)” was carried out at the Horticulture Research Farm, Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (formerly Allahabad), during the winter (kharif) season of 2024–25. The site lies in the subtropical belt of southeastern Uttar Pradesh, with mean annual rainfall of 1 013.4 mm, relative humidity from 20–94 %, maximum summer temperatures of 32–34 °C and winter minima of 4–5 °C.

A randomized complete block design (RCBD) with three replications and nine treatments (including an unfertilized control) was used to evaluate the effect of organic manures and the biofertilizer Azotobacter on chilli. Seedlings of cv. Sadabahar were transplanted into 1 × 1 m plots at 30 × 45 cm spacing (six plants per plot). The treatments were: T0 – 100 % recommended NPK (100:50:50 kg ha⁻¹) T1 – Farmyard manure (20 t ha⁻¹) + Azotobacter (2 g plant⁻¹) T2 – Poultry manure (15 t ha⁻¹) + Azotobacter (2 g plant⁻¹) T3 – Vermicompost (5 t ha⁻¹) + Azotobacter (2 g plant⁻¹) T4 – Azotobacter alone (2 g plant⁻¹) T5 – 50 % FYM (10 t ha⁻¹) + 50 % poultry manure (7.5 t ha⁻¹) + Azotobacter (2 g plant⁻¹) T6 – 50 % FYM (10 t ha⁻¹) + 50 % vermicompost (2.5 t ha⁻¹) + Azotobacter (2 g plant⁻¹) T7 – 50 % poultry manure (7.5 t ha⁻¹) + 50 % vermicompost (2.5 t ha⁻¹) + Azotobacter (2 g plant⁻¹) T8 – FYM : poultry manure : vermicompost (1 : 1 : 1 at 5 + 3.75 + 1.25 t ha⁻¹) + Azotobacter (2 g plant⁻¹)

Observations on five randomly selected plants per plot included: • Vegetative traits – plant height (cm), number of leaves and branches per plant • Phenology – days to first flowering, 50 % flowering and first harvest • Yield components – number of fruits per plant, number of seeds per fruit, fruit yield per plant (g) and per plot (kg) • Fruit morphology and quality – fruit length (cm), fruit diameter (mm), total soluble solids (°Brix) and ascorbic acid (mg 100 g⁻¹)

Data were subjected to two‐way classification analysis of variance (ANOVA) following Panse and Sukhatme (1985). Where the F-test was significant, treatment means were compared by the critical difference (CD) at the 5 % probability level.

**RESULTS AND DISCUSSION**

The data on growth parameters at 90 days after transplanting (DAT) are summarized in Table 1. All three vegetative traits—plant height, number of leaves and number of branches per plant—were significantly influenced by the source of nutrition. The combined organic–biofertilizer treatment (T8: FYM: poultry manure: vermicompost in 1: 1: 1 at 5 + 3.75 + 1.25 t ha⁻¹ + Azotobacter 2 g plant⁻¹) produced the tallest plants (43.00 cm), the most leaves (175.08 leaves plant⁻¹) and the greatest number of branches (12.33 branches plant⁻¹). These values were statistically at par with T7 (50 % poultry manure + 50 % vermicompost + Azotobacter) and, for height only, with T2 (100 % poultry manure + Azotobacter). The lowest vegetative growth occurred under the sole NPK treatment (T0), which recorded just 32.54 cm height, 88.50 leaves and 7.80 branches per plant. The enhanced growth under T8 likely reflects the dual benefit of readily available nutrients from organic manures and the nitrogen-fixing activity of Azotobacter, which together accelerate cell division and enlargement.

Phenological traits days to first flowering, 50 % flowering and first harvest—also varied significantly among treatments (Table 1). T8 again led to the earliest flowering (first flower at 44.58 days), closely matched by T7, whereas the NPK control (T0) flowered latest (50.17 days). Organic amendments, especially vermicompost and poultry manure in combination with Azotobacter, can accelerate nutrient mineralization and microbial activity in the rhizosphere, raising root-zone temperature and hastening floral initiation. These results align with findings from Adhikari et al. (2016), Turemis (2002) and Abu-Zahra (2012), who reported that organic manures shorten time to flowering by enhancing soil biological and thermal properties.

Table 1 shows that T8 (FYM: P.M.: V.C. at 1: 1: 1 plus Azotobacter) consistently accelerated phenology and maximized yield and quality traits in chilli. Days to 50 % flowering, T8 recorded the fewest days (53.67 d), significantly lower than the NPK control (T0: 60.67 d), and was followed by T2 (100 % poultry manure + Azotobacter, ~56.4 d) and T6 (50 % FYM + 50 % vermicompost + Azotobacter, ~57.3 d). Organic manures improve soil structure, moisture retention, and nutrient availability, while vermicompost supplies humic acids and bio-regulators that hasten floral initiation (Bajeli et al., 2016; Okokoh & Bisong, 2011). Days to first harvest mirrored flowering trends: earliest under T8 and latest under T0, with T1 and T2 statistically at par with T8. Fruits per plant increased from 59.3 (T0) to 71.3 (T8), reflecting more flowers, higher fruit set, and reduced abscission (Tripathy & Maity, 2011). Seeds per fruit rose from 60.6 (T0) to 70.6 (T8), indicating improved pollination and assimilate flow.

Fruit length expanded from 7.81 cm (T0) to 9.16 cm (T8) and diameter from 7.75 mm to 9.39 mm. Vermicompost’s ready to release N, P, and K boost protoplasmic protein synthesis and cell enlargement, while Azotobacter enhances nitrogen fixation, jointly spurring pericarp growth (Theunissen et al., 2010; Jaipaul et al., 2011).

Yield per plant observed from 601.6 g (T4: Azotobacter alone) to 710.0 g (T8).

Total soluble solids and ascorbic acid also peaked under T8, attributable to balanced nutrient supply, elevated microbial biomass and enhanced phytohormone production from vermicompost (Canellas et al., 2000; Atiyeh et al., 2001).

The superior fruit size under T8—9.16 cm length and 9.39 mm diameter versus 7.81 cm and 7.75 mm in the NPK control—can be attributed to vermicompost’s steady release of N, P and K in readily available forms, combined with Azotobacter’s biological N fixation. This nutrient synergy accelerates protoplasmic protein synthesis and cell division in the pericarp, while humic acids and microbial metabolites further promote meristematic activity and create a favorable rhizosphere (Theunissen et al., 2010; Jaipaul et al., 2011).

Yield per plant peaked at 710.01 g under T8—versus 601.62 g with Azotobacter alone—and plot yield reached 2.84 kg compared to 2.41 kg. The long-term fertility retention of organic manures, elevated microbial biomass and enriched humate content boost phytohormone production, flower retention and fruit set, driving higher yields (Canellas et al., 2000; Atiyeh et al., 2001; Prabha et al., 2007). Similar positive effects of vermicompost (and neem cake) on growth and yield have been reported by Dhanalakshmi et al. (2014) and Veena et al. (2017).

Nutritional quality also improved markedly under T8: ascorbic acid reached 120.00 mg 100 g⁻¹ (vs. 104.67 mg 100 g⁻¹ in NPK), and TSS climbed to 3.87 °Brix (vs. 2.43 °Brix with Azotobacter alone). Treatments T2, T5 and T7 were statistically at par with T8 for these parameters. The balanced nutrient supply and enhanced enzymatic activity during fruit ripening likely underpin these gains.

**CONCLUSION**

Based on the current investigation, it is concluded that treatment T8, which consists of farmyard manure (5 t/ha), poultry manure (3.75 t/ha), vermicompost (1.25 t/ha), and Azotobacter (2 g/plant), performed the best. This treatment showed significant improvements in various parameters, including the number of leaves, number of branches, plant height, days taken to first flowering, days taken to 50% flowering, days to the first harvest, number of fruits per plant, fruit length, fruit diameter, fruit weight, fruit yield per plot, ascorbic acid content, and total soluble solids (TSS).

Additionally, the highest benefit-cost ratio of 3.97 was recorded for this treatment. Therefore, the T8 treatment combination is recommended for farmers in the Prayagraj region (U.P.) as it provides the best fruit yield and quality, enhances soil health, and serves as a sustainable, chemical-free option for cultivation.

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**Table1: Effect of different organic manures and biofertilizers on production and associated traits of Chilli *(Capsicum annuum* l.*)***

|  |  |  |
| --- | --- | --- |
| **Notation** | **Growth and flowering**  |  |
| **Plant height (cm)** | **Number of leaves****/plant** | **Number of branches****/plant** | **Days 1st flowering** | **Days to 50% flowering** | **Days to 1st harvest** | **No. of fruits per plant** | **No. of seeds per fruit** | **Fruit Length (cm)** | **Fruit Diameter (mm)** | **Fruit Yield/****Plant (g)** | **Fruit Yield/****Plot (kg)** | **Ascorbic Acid (mg/100g)** | **TSS (0Brix)**  |
| T0 | 44.71 | 88.50 | 7.80 | 7.80 | 60.67 | 85.33 | 59.29 | 60.56 | 7.81 | 7.75 | 632.34 | 2.53 | 104.67 | 2.50 |
| T1 | 51.33 | 98.67 | 8.50 | 8.50 | 57.00 | 77.83 | 60.09 | 63.80 | 8.32 | 7.81 | 619.43 | 2.48 | 108.00 | 2.70 |
| T2 | 51.79 | 104.33 | 8.43 | 8.43 | 55.00 | 77.58 | 61.67 | 66.85 | 8.22 | 8.19 | 654.06 | 2.62 | 112.00 | 3.10 |
| T3 | 50.50 | 96.67 | 8.92 | 8.92 | 58.00 | 79.92 | 63.47 | 62.47 | 8.18 | 7.75 | 652.69 | 2.61 | 109.33 | 2.90 |
| T4 | 48.92 | 89.42 | 8.25 | 8.25 | 59.00 | 81.67 | 59.69 | 59.53 | 7.63 | 7.52 | 601.62 | 2.41 | 102.00 | 2.43 |
| T5 | 53.33 | 123.58 | 8.67 | 8.67 | 56.67 | 79.25 | 63.47 | 64.57 | 8.27 | 8.10 | 642.08 | 2.61 | 113.33 | 3.27 |
| T6 | 55.00 | 151.83 | 8.58 | 8.58 | 55.33 | 78.25 | 65.17 | 65.80 | 8.29 | 8.10 | 658.76 | 2.64 | 109.67 | 3.03 |
| T7 | 49.88 | 97.00 | 10.42 | 10.42 | 57.33 | 78.42 | 68.00 | 67.83 | 8.54 | 8.53 | 695.66 | 2.78 | 116.00 | 3.33 |
| T8 | 57.84 | 175.08 | 12.33 | 12.33 | 53.67 | 76.42 | 71.25 | 70.55 | 9.16 | 9.39 | 710.01 | 2.84 | 120.00 | 3.87 |
| **F Test** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **S** | **S** |
| **S.E (d) (±)** | **1.94** | **3.23** | **0.33** | **0.33** | **0.61** | **0.38** | **1.00** | **0.73** | **0.19** | **0.25** | **7.76** | **0.02** | **3.85** | **0.06** |
| **CD (P = 0.05)** | **4.11** | **6.85** | **0.70** | **0.70** | **1.30** | **0.81** | **2.11** | **1.55** | **0.41** | **0.53** | **16.45** | **0.04** | **8.16** | **0.13** |
| **CV%** | **4.60** | **3.50** | **4.40** | **4.40** | **1.30** | **0.60** | **1.9** | **1.40** | **2.9** | **3.80** | **1.50** | **0.09** | **4.30** | **2.40** |

**Table 2: Effects of different organic manures and biofertilizers on economics of Chilli (*Capsicum annuum* L.)**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Notation** | **Yield(t/ha)**  | **Selling price (rs/t)** | **Cost of cultivation (rs/ha)** | **Gross return** | **Net return****(rs/ha)** | **B:c ratio** |
| **T0** | 29.19 | 30000 | 186488 | 875760 | 689271 | 3.70 |
| **T1** | 28.62 | 30000 | 202229 | 858452 | 656223 | 3.24 |
| **T2** | 30.23 | 30000 | 200229 | 906913 | 706684 | 3.53 |
| **T3** | 30.12 | 30000 | 207229 | 903452 | 696222 | 3.36 |
| **T4** | 27.81 | 30000 | 182229 | 834222 | 651992 | 3.58 |
| **T5** | 30.12 | 30000 | 201229 | 903452 | 702222 | 3.49 |
| **T6** | 30.46 | 30000 | 204729 | 913836 | 709107 | 3.46 |
| **T7** | 32.08 | 30000 | 203729 | 962297 | 758568 | 3.72 |
| **T8** | 32.77 | 30000 | 197979 | 983066 | 785087 | 3.97 |