



International Journal of Research in Agronomy

E-ISSN: 2618-0618
P-ISSN: 2618-060X
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NAAS Rating (2026): 5.20
www.agronomyjournals.com
2026; 9(8): 769-773
Received: 14-05-2026
Accepted: 18-06-2026

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Influence of organic and inorganic nutrient sources of vegetative parameters in tomato (*Solanum lycopersicum* L.)

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DOI: <https://www.doi.org/10.33545/2618060X.2026.v9.i8j.6327>

Abstract

A field experiment was performed in 2025–2026 during the Rabi season at the School of Agricultural Sciences, Malla Reddy University, Hyderabad, Telangana, India, to evaluate the effect of integrated organic and inorganic nutrient sources on the growth of tomato (*Solanum lycopersicum* L.). The experiment was laid out in a Randomized Block Design (RBD), with eight treatments and three replications. The treatments consisted of various combinations of the recommended dose of fertilizers (RDF), farmyard manure (FYM), humic acid, lignite, and microbial consortium. Growth parameters, including plant height, stem diameter, number of primary branches, days to first flowering, days to 50% flowering, and number of flower clusters plant⁻¹ were recorded at optimal growth phases. The results revealed significant differences among the treatments. The combined application of 100% RDF, humic acid (5 L ha⁻¹), and microbial consortium (14 kg ha⁻¹) (T₃) recorded the maximum plant height (89.46 cm), stem diameter (1.65 cm), number of primary branches (9.60), and flower clusters plant⁻¹ (32.60), while also promoting earlier flowering with the lowest days to first flowering (27.07 days) and 50% flowering (32.00 days). The growth parameters recorded comparatively lower values for the control treatment (100% RDF alone). The increased microbial activity, better root development, improved soil physical attributes, and improved nutrient availability may all be beneficial to the improved vegetative growth under integrated nutrient management. The study indicated that integrating organic amendments with inorganic fertilizers achieves a balanced supply of nutrients and soil environment that is highly favourable to tomato growth. Therefore, under similar agroclimatic conditions, the combination of RDF, humic acid and microbial consortia can be recommended as an effective nutrient management method in improving tomato growth

Keywords: Tomato, growth attributes, organic amendments, humic acid, lignite, RDF

Introduction

Tomato (*Solanum lycopersicum* L.) is one of the worldwide most commonly cultivated vegetable crops, highly valued for its nutritional, economic, and commercial importance. It is rich in high amounts of vitamins A and C, minerals, dietary fiber, lycopene, and other antioxidants that are beneficial for human health. Tomato has emerged as an important source of income in India due to its adaptability and high market demand. However, to sustain vigorous vegetative growth under intensive cultivation remains a major challenge because of declining soil fertility, nutrient imbalances, and excessive use of chemical fertilizers. Plant height, stem diameter, and the number of primary branches are all most important indicators of crop vigor and production. Vegetative growth is essential for tomato growth because it forms a foundation for flowering, fruit development, and, ultimately, fruit yield. Growth parameters such as plant height, stem diameter, number of primary branches, number of flower clusters per plant, days to first flowering, and days to 50% flowering are important indicators of plant vigour and nutrient status. These characteristics are highly influenced by the availability and balance of essential nutrients throughout the crop's growth period. Adequate nutrition stimulates cell division, chlorophyll synthesis, enzyme activation, and photosynthetic efficiency, increasing vigorous vegetative development and improving reproductive efficiency (Rouphael and Colla 2020) [7]. The exclusive use of inorganic fertilizers has substantially boosted crop yield in recent decades; however, prolonged and indiscriminate application has contributed to soil degradation, nutrient imbalance, declining organic carbon, and reduced microbial activity. Organic nutrient sources, such as farmyard manure

(FYM), humic substances, microbial inoculants, composts, and other organic amendments, increase soil physical, chemical, and biological properties, in addition to nutrient availability and efficiency. However, organic sources alone may not always meet the nutritional demands of high-yielding tomato hybrids in intensive cultivation. Integrated use of organic and inorganic fertilizer sources has emerged as a sustainable nutrient management approach for increasing crop growth while maintain soil health. Organic amendments enhance soil structure, water holding capacity, cation exchange capacity, and microbial diversity, whereas inorganic fertilizers provide available nutrients during critical growth stages. The combined use of these nutrients sources frequently results in synergistic effects by improving nutrient uptake, root development, photosynthetic efficiency, and hormonal activity, which results in increased vegetative growth. Multiple studies have demonstrated that integrated nutrition management enhances plant height, stem diameter, branching pattern, and flowering characteristics compared to the application of organic or inorganic fertilizers separately (Backer *et al.*, 2018) [2].

Materials and Methods

A field trial was carried out during the rabi season of 2025–2026 at the Experimental Farm of the School of Agricultural Sciences, Malla Reddy University, Hyderabad, Telangana, India, to assess the impact of organic and inorganic nutrient sources on the growth

characteristics of tomato (*Solanum lycopersicum* L.). The trial was organized in a Randomized Block Design (RBD) comprising eight treatments and three replications. Analysis of variance (ANOVA) suitable for a Randomized Block Design was employed to statistically examine the data collected for all vegetative parameters. The Critical Difference (CD) test was used to compare treatment means where significant differences among treatments were observed, and the significance of treatment effects was assessed at the 5% probability level.



Fig 1: Experimental layout

Results and Discussion
Plant Height

Table 1: Influence of different organic and inorganic nutrient sources on Plant Height

Treatment	Combinations	Plant Height (cm)		
		30 DAT	60 DAT	90 DAT
T ₁	100% Recommended Dose Fertilizer	33.24	62	65.84
T ₂	100% RDF + FYM (25 t ha ⁻¹)	35.43	63	66.47
T ₃	100% RDF+ HA (5 L ha ⁻¹) + MC (14 kg ha ⁻¹)	46.24	82.34	89.46
T ₄	100% RDF + Lignite (3 t ha ⁻¹) + MC (14 kg ha ⁻¹)	44.05	76.14	85.12
T ₅	75% RDF + HA (5 L ha ⁻¹)	40.56	72.86	78.57
T ₆	75% RDF + Lignite (3 t ha ⁻¹)	42.17	74.75	81.76
T ₇	FYM (25 t ha ⁻¹) + Lignite (3 t ha ⁻¹)+ MC (14 Kg ha ⁻¹)	38.56	68.56	73.46
T ₈	FYM (25 t ha ⁻¹) + HA (5 L ha ⁻¹)+ Lignite (1.5 t ha ⁻¹)	37.64	65.47	71.56
S.Em (±)		1.33	2.39	2.57
CD (p=0.05)		4.03	7.24	7.80

The height of the plants was significantly influenced by the application of different organic and inorganic nutrient sources at 30, 60, and 90 days after transplanting (DAT) (Table 1). At 30 DAT, the maximum plant height recorded was (46.24 cm) in T₃ (100% RDF + Humic acid at 5 L ha⁻¹ + Microbial Consortium at 14 kg ha⁻¹), followed by T₄ at (44.05 cm), T₆ at (42.17 cm), and T₅ at (40.56 cm). Conversely, the minimum plant height of 33.24 cm was noted in the control treatment T₁ (100% RDF). A similar trend was observed at 60 DAT, where T₃ reached the highest plant height of (82.34 cm), followed by T₄ at (76.14 cm), T₆ at (74.75 cm), T₅ at (72.86 cm), T₇ at (68.56 cm), T₈ at (65.47 cm), T₂ at (63.00 cm), and T₁ at (62.00 cm). At 90 DAT, T₃ achieved the highest plant height of (89.46 cm), followed by T₄ at (85.12 cm), T₆ at (81.76 cm), T₅ at (78.57 cm), T₇ at (73.46 cm), T₈ at (71.56 cm), T₂ at (66.47 cm), and T₁ at (65.84 cm). The ongoing superiority of T₃ throughout the growth period highlights that the combined application of humic acid and microbial consortium, along with the recommended fertilizer dosage, was more effective in enhancing vegetative growth compared to the individual application of inorganic fertilizers. The comprehensive

application of these nutrient sources significantly enhances the physical, chemical, and biological properties of the soil, resulting in improved photosynthetic activity, rapid cell division, and stem elongation, which ultimately contributes to increased plant height. This is in line with the findings of (Kushum *et al.*, 2022) [5], who reported that tomatoes exhibited significantly greater heights under integrated nutrient management involving organic manures, biofertilizers, and recommended fertilizer doses. Likewise, (Saini *et al.* 2024) [8] noted that the combined application of recommended fertilizers, vermicompost, and phosphate-solubilizing bacteria (PSB) significantly boosted plant height at different growth stages compared to the sole application of chemical fertilizers. The present findings are also supported by (Sepat *et al.*, 2012) [9], who indicated that the combined use of organic manures, fertilizers, and biofertilizers enhanced vegetative growth by improving nutrient availability, root development, and physiological activity in tomatoes. The superior performance of T₃ in this study confirms that integrated nutrient management is an effective strategy for enhancing plant growth and maximizing the vegetative potential of tomatoes.

Number of Primary Branches plant⁻¹

Table 2: Influence of different organic and inorganic nutrient sources on Number of primary branches plant⁻¹

Treatment	Combinations	Number of Primary Branches plant ⁻¹		
		30 DAT	60 DAT	90 DAT
T ₁	100% Recommended Dose Fertilizer	2.8	3.7	4.6
T ₂	100% RDF + FYM (25 t ha ⁻¹)	3.4	4.3	5.9
T ₃	100% RDF+ HA (5 L ha ⁻¹) + MC (14 kg ha ⁻¹)	5.6	7.6	9.6
T ₄	100% RDF + Lignite (3 t ha ⁻¹) + MC (14 kg ha ⁻¹)	4.8	6.4	8.8
T ₅	75% RDF + HA (5 L ha ⁻¹)	3.9	5.7	6.8
T ₆	75% RDF + Lignite (3 t ha ⁻¹)	4.0	6.2	7.4
T ₇	FYM (25 T Ha ⁻¹) + Lignite (3 t ha ⁻¹)+ MC (14 Kg ha ⁻¹)	4.1	5.3	6.4
T ₈	FYM (25 t ha ⁻¹) + HA (5 L ha ⁻¹)+ Lignite (1.5 t ha ⁻¹)	3.7	4.9	6.2
S.Em (±)		0.14	0.19	0.24
CD (p=0.05)		0.42	0.57	0.72

The number of primary branches plant⁻¹ was significantly affected by the application of various organic and inorganic nutrient sources (Table 3). Among the treatments, T₃ (100% RDF + Humic acid @ 5 L ha⁻¹ + Microbial Consortium @ 14 kg ha⁻¹) recorded the highest number of primary branches per plant at 9.60, followed by T₄ (8.80), T₆ (7.80), T₅ (7.20), T₇ (6.40), T₈ (6.20), T₂ (5.40), and T₁ (4.60). The excellent performance of T₃ suggests that the combined application of humic acid and microbial consortium, along with the recommended fertilizer dosage, effectively enhanced vegetative growth and branching in tomato plants. The synergistic application of these inputs along with inorganic fertilizers boosts photosynthetic efficiency and enhances assimilate production, culminating in vigorous vegetative growth and increased branching. In contrast, the control treatment's fewer primary branches may be attributed to

its lower nutrient use efficiency and the lack of organic amendments that enhance soil biological activity. The findings currently presented are in line with those reported by (Kushum *et al.* 2022) ^[5], w ho reported that integrated nutrient management significantly boosted the number of branches plant⁻¹ through the combined application of organic manures, biofertilizers, and recommended fertilizer doses. In a similar vein, (Ali *et al.* 2024) concluded that integrated nutrient management enhances vegetative growth by improving nutrient availability, stimulating soil microbial activity, and optimizing physiological processes, thereby encouraging greater branching and plant vigor. Moreover, (Backer *et al.* 2018) ^[2] found that plant biostimulants enhance root development, nutrient uptake, and plant growth, leading to improved branching and overall crop performance.

Table 3: Influence of organic and inorganic nutrient sources on reproductive parameters

Treatment	Combinations	Days to First flowering	Days to 50% Flowering	No of flower clusters plant ⁻¹
T ₁	100% Recommended Dose Fertilizer	30.75	38	20.8
T ₂	100% RDF + FYM (25 t ha ⁻¹)	30.15	36	22.6
T ₃	100% RDF+ HA (5 L ha ⁻¹) + MC (14 kg ha ⁻¹)	27.07	32	32.6
T ₄	100% RDF + Lignite (3 t ha ⁻¹) + MC (14 Kg ha ⁻¹)	27.12	34	30.2
T ₅	75% RDF + HA (5 L ha ⁻¹)	28.25	37	26.5
T ₆	75% RDF + Lignite (3 t ha ⁻¹)	28.50	35	28.7
T ₇	FYM (25 t ha ⁻¹) + Lignite (3 t ha ⁻¹)+ MC (14 kg ha ⁻¹)	29.25	36	24.7
T ₈	FYM (25 t ha ⁻¹) + HA (5 L ha ⁻¹)+ Lignite (1.5 t ha ⁻¹)	30.50	37	23.9
S.Em (±)		0.96	1.19	0.89
CD (p=0.05)		2.92	3.61	2.69

The various organic and inorganic nutrient sources had a notable effect on the time required to reach the first flowering in tomatoes (as demonstrated in Table 4). Among the treatments, T₃ (100% RDF + Humic acid at 5 L ha⁻¹ + Microbial Consortium at 14 kg ha⁻¹) achieved the earliest first flowering at (27.07 days), followed by T₄ at (28.36 days), T₆ at (30.24 days), T₅ at (31.18 days), T₇ at (33.42 days), T₈ at (34.15 days) and T₂ at (35.64 days). The control treatment T₁ (100% RDF) took the longest to reach first flowering at (37.75 days). The earlier flowering observed in the integrated nutrient management treatments indicates that the combined use of organic and inorganic nutrient sources hastened the transition from vegetative to reproductive growth. The observed reduction in the number of days to first flowering under T₃ can be ascribed to the synergistic effects of humic acid, a microbial consortium, and the recommended fertilizer dosage, which provided a continuous and balanced nutrient supply throughout the crop's growth period. Humic acid promotes root growth, chlorophyll synthesis, and nutrient uptake, while the microbial consortium enhances nutrient mineralization,

biological nitrogen fixation, and phosphorus solubilization, thus increasing nutrient availability and improving nutrient use efficiency. These processes encourage greater photosynthetic activity, efficient translocation of assimilates, and a favorable hormonal balance, resulting in earlier floral initiation and a shorter time to first flowering. Similar findings were reported by (Cirillo *et al.* 2023) ^[3], who noted that the inoculation with a microbial consortium improved agronomic performance and physiological efficiency in tomatoes by enhancing nutrient acquisition and plant growth. Likewise, (Li *et al.* 2025) ^[6] reported that integrated nutrient management strategies involving organic amendments, biostimulants, and balanced fertilization improved soil fertility, nutrient availability and crop development, leading to enhanced vegetative growth and reproductive performance in tomato.

Days to 50% Flowering

The influence of various organic and inorganic nutrient sources was considerable in determining the duration necessary for 50%

flowering in tomatoes (Table 4). Treatment T₃ (100% RDF + Humic acid at 5 L ha⁻¹ + Microbial Consortium at 14 kg ha⁻¹) recorded the earliest flowering at (32.00 days), followed by T₄ at (33.00 days), T₆ at (34.00 days), T₅ at (35.00 days), T₇ at (36.00 days), T₂ at (37.00 days), and T₈ also at (37.00 days). The control treatment T₁ (100% RDF) took the longest, requiring (38.00) days to achieve 50% flowering. The reduction in the time taken to reach 50% flowering under integrated nutrient management treatments suggests that the combined application of organic and inorganic nutrient sources facilitated a quicker transition from the vegetative to the reproductive phase. The earlier achievement of 50% flowering under T₃ may be attributed to the synergistic effects of humic acid, a microbial consortium, and the recommended fertilizer dosage, which ensured balanced nutrient availability throughout the crop growth period. Humic acid enhances root development, nutrient uptake, and photosynthetic efficiency, while the microbial consortium improves nutrient mineralization and phosphorus solubilization, thus increasing nutrient use efficiency. The continuous supply of nutrients promotes rapid vegetative growth, efficient assimilate production, and favorable hormonal regulation, leading to early floral initiation and synchronized flowering. Additionally, enhanced soil biological activity and physiological processes under integrated nutrient management contribute significantly to the early onset of flowering. The present results corroborate the findings of (Salvi *et al.*, 2023), who indicated that integrated nutrient management, which encompasses farmyard manure, biofertilizers, and recommended fertilizer doses, significantly decreased the number of days to first and 50% flowering in tomatoes by improving nutrient availability and promoting plant growth. (Saini *et al.*, 2024) [8] also reported similar findings, noting that integrated nutrient management practices resulted in earlier flowering in tomato due to enhanced nutrient uptake and improved physiological activity of the plants. These conclusions are further supported by (Li *et al.*, 2025) [6], who found that the integration of organic amendments, biostimulants, and balanced fertilization enhances nutrient use efficiency, plant metabolism, and reproductive development, thereby accelerating flowering

and improving productivity in tomato.

Number of flower clusters plant⁻¹

The application of various organic and inorganic nutrient sources significantly influenced the quantity of flower clusters plant⁻¹ (Table 4). Among the treatments assessed, T₃ (100% RDF + Humic acid at 5 L ha⁻¹ + Microbial Consortium at 14 kg ha⁻¹) exhibited the highest count of flower clusters per plant, (32.60). This was followed by T₄ (100% RDF + Lignite at 3 t ha⁻¹ + Microbial Consortium at 14 kg ha⁻¹), which recorded (30.80). Additionally, treatments T₆ (28.20), T₅ (26.40), T₇ (24.60), T₈ (23.40), and T₂ (22.60) also demonstrated higher numbers of flower clusters compared to the control group, while the lowest count of flower clusters was noted in T₁ (100% RDF), which had a total of (20.80). The enhanced nutritional condition of the plants led to improved photosynthetic efficiency and increased production of assimilates, which in turn resulted in robust vegetative growth and a higher rate of flowering node initiation. As a result, plants that were provided with integrated nutrient management yield a larger quantity of flower clusters compared to those that received only inorganic fertilizers. The current results align closely with those of (Kushum *et al.*, 2022) [5], who indicated that integrated nutrient management markedly enhanced flowering characteristics, such as the quantity of flower clusters and yield components in tomatoes, in comparison to the exclusive use of chemical fertilizers. Comparable findings were noted by (Salvi *et al.*, 2023), who discovered that the synergistic application of farmyard manure, prescribed fertilizer amounts, and biofertilizers improved flowering behavior and reproductive growth by augmenting nutrient availability and plant vigor. Additionally, (Acharya *et al.*, 2025) [1] reported that integrated nutrient management significantly boosted the number of fruit clusters per tomato plant by enhancing nutrient use efficiency, soil fertility, and physiological activity, thus contributing to better reproductive performance.

Stem Diameter

Table 4: Influence of organic and inorganic nutrient sources on Stem Diameter

Treatment	Combinations	Stem Diameter (cm)
T ₁	100% Recommended Dose Fertilizer	1.03
T ₂	100% RDF + FYM (25 t ha ⁻¹)	1.06
T ₃	100% RDF+ HA (5 L ha ⁻¹) + MC (14 kg ha ⁻¹)	1.65
T ₄	100% RDF + Lignite (3 t ha ⁻¹) + MC (14 kg ha ⁻¹)	1.42
T ₅	75% RDF + HA (5 L ha ⁻¹)	1.17
T ₆	75% RDF + Lignite (3 t ha ⁻¹)	1.28
T ₇	FYM (25 t ha ⁻¹) + Lignite (3 t ha ⁻¹) + MC (14 Kg ha ⁻¹)	1.12
T ₈	FYM (25 t ha ⁻¹) + HA (5 L ha ⁻¹) + Lignite (1.5 t ha ⁻¹)	1.15
S.Em (±)		0.04
CD (p=0.05)		0.13

The application of various organic and inorganic nutrient sources had a significant impact on stem diameter (Table 3). Among the treatments, T₃ (100% RDF + Humic acid @ 5 L ha⁻¹ + Microbial Consortium @ 14 kg ha⁻¹) achieved the largest stem diameter at (1.65 cm), followed closely by T₄ (100% RDF + Lignite @ 3 t ha⁻¹ + Microbial Consortium @ 14 kg ha⁻¹) with a measurement of (1.42 cm) other treatments such as T₆ (1.28 cm), T₅ (1.17 cm), T₈ (1.15 cm), T₇ (1.12 cm), and T₂ (1.06 cm) also exhibited greater stem diameters compared to the control treatment. The smallest stem diameter recorded was (1.03 cm) in T₁ (100% RDF). The steady increase in stem diameter observed with integrated nutrient management treatments suggests that the combination of organic

and inorganic nutrient sources fosters superior vegetative growth compared to the use of inorganic fertilizers alone. The findings of this research are in line with those reported by (Galambos *et al.* 2020) [4], who indicated that the combined application of humic acid and beneficial endophytic bacteria significantly enhances tomato growth by improving nutrient uptake, hormone metabolism, and growth-related physiological processes. Similarly, (Li *et al.* 2025) [6] found that the integration of organic amendments, biostimulants, and inorganic fertilizers improved vegetative growth and stem development through enhanced soil fertility and nutrient use efficiency. (Backer *et al.* 2018) [2] noted that plant biostimulants promote root development, nutrient

acquisition, and physiological activity, leading to stronger stem growth and improved overall plant vigor. Thus, the increased stem diameter observed in T₃ confirms that the integration of humic acid and microbial consortium with the recommended fertilizer dosage is a highly effective nutrient management strategy for enhancing stem development and overall vegetative growth.

Conclusion

The current investigation illustrated that the integrated use of organic and inorganic nutrient sources markedly improved the vegetative growth of tomato (*Solanum lycopersicum* L.) relative to the exclusive application of the recommended fertilizer dosage. Among the various treatments, T₃ (100% RDF + Humic acid @ 5 L ha⁻¹ + Microbial Consortium @ 14 kg ha⁻¹) consistently showed superior results for all vegetative parameters assessed, including plant height, stem diameter, number of primary branches plant⁻¹, number of flower clusters plant⁻¹, days to first flowering, and days to 50% flowering.

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