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Enhancing growth attributes of sacred basil through organic nutrient management

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Abstract
Holy Basil (*Ocimum sanctum* L.) is a medicinal and aromatic plant of high therapeutic, cultural and economic importance in India and tropical regions. To enhance its productivity sustainably, a field experiment titled "Enhancing growth attributes of sacred basil through organic nutrient management" was conducted during summer 2024 at MHREC, UHS Bagalkot, Karnataka, in a Randomized Block Design with 13 treatments and 3 replications. Treatments included combinations of vermicompost, microbial consortium, Panchagavya, humic acid, Jeevamrutha at 100% and 75% N levels, alongside RDF and inorganic control. Significant differences were observed for plant height, number of primary and secondary branches and plant spread at different growth stages. T_6 (100% N through Vermicompost + Microbial consortium @ 15 kg ha^{-1} + Panchagavya @ 3% + Humic acid @ 2.5 L ha^{-1} + Jeevamrutha @ 500 L ha^{-1}) recorded the highest plant height (39.67 cm, 73.77 cm and 87.50 cm at 30 DAP, 60 DAP and harvest), primary branches (6.42, 10.93 and 14.72), secondary branches (13.90, 30.35 and 46.81) and plant spread (1185.03 cm^2, 2229.69 cm^2 and 4657.54 cm^2). In contrast, T_{13} (only 100% NPK) showed the lowest values for plant height (31.50 cm, 43.27 cm and 59.97 cm), primary branches (3.33, 6.13 and 8.25), secondary branches (7.12, 17.83 and 29.38) and plant spread (428.41 cm^2, 1028.25 cm^2 and 2856.01 cm^2). These results demonstrate the clear superiority of integrated organic nutrient management over inorganic fertilization in improving growth parameters of sacred basil.

Keywords: Organic inputs, bioformulations, humic acid and growth parameters

Introduction

Ocimum sanctum L., commonly known as Holy Basil, is a sacred and highly valued medicinal and aromatic plant extensively cultivated across India and other tropical regions. Belonging to the family Lamiaceae, it holds immense cultural, religious and therapeutic significance. The plant is revered in traditional systems of medicine such as Ayurveda for its adaptogenic, antimicrobial, anti-inflammatory and antioxidant properties. Rich in essential oils, phenolic compounds and flavonoids, Tulsi is used in herbal formulations, cosmetics and nutraceutical industries. Its ease of cultivation, wide adaptability and growing market demand make it a potential high-value crop for sustainable farming systems. In addition to its medicinal importance, Tulsi contributes to agro-ecosystem resilience through its pest-repellent properties and compatibility in diversified cropping systems (Farooqi and Sreeramu, 2005) [5].

In recent years, the use of organic inputs in the cultivation of Holy Basil has gained significant attention due to their positive impacts on soil health, crop productivity and essential oil quality. Inputs such as vermicompost, farmyard manure, microbial consortia, humic acid, Panchagavya and Jeevamrutha enhance nutrient availability, improve soil structure and stimulate beneficial microbial activity. Unlike chemical fertilizers, organic amendments release nutrients gradually, ensuring balanced plant growth and better secondary metabolite accumulation. These inputs also contribute to carbon sequestration and ecological sustainability, aligning with the principles of regenerative and climate-resilient agriculture (Naveen Kumar and Maheswarappa, 2019) [14]. Integrating such organic practices in Tulsi cultivation not only improves yield and quality but also promotes environmental health and long-term soil fertility (Naskar *et al.*, 2024) [13].

Materials and Methods

The field investigation titled "Enhancing growth attributes of sacred basil through organic nutrient management" was undertaken during summer-2024 at the Main Horticultural Research and Extension Centre (MHREC), under the University of Horticultural Sciences, Bagalkot, Karnataka. The experimental site falls within the northern dry zone (Zone III) of Karnataka, situated at 16°16′ N latitude and 75°65′ E longitude with an elevation of 537 m above mean sea level. The soil of the experimental field was classified as clay loam, characterized by good moisture retention capacity and moderate fertility status, making it suitable for medicinal and aromatic crop cultivation.

Treatment details

Treatments	Description
T_1	100% *RDF (NPK=125:75:60 kg and 10t FYM ha^{-1})
T_2	100% N by Vermicompost + Microbial consortium @ 15 kg ha^{-1}
T_3	100% N by Vermicompost + Panchagavya @ 3%
T_4	100% N by Vermicompost + Humic acid @ 2.5 L ha^{-1}
T_5	100% N by Vermicompost + Jeevamrutha @ 500 L ha^{-1}
T_6	100% N by Vermicompost + Microbial consortium @15 kg ha^{-1} Panchagavya @ 3% + Humic acid @2.5 L ha^{-1} + Jeevamrutha @ 500 L ha^{-1}
T_7	75% N of *RDF (NPK = 93.75:75:60 kg and 10t FYM ha^{-1})
T_8	75% N by Vermicompost + Microbial consortium @ 15 kg ha^{-1}
T_9	75% N by Vermicompost + Panchagavya @ 3%
T_{10}	75% N by Vermicompost + Humic acid @ 2.5 L ha^{-1}
T_{11}	75% N by Vermicompost + Jeevamrutha @ 500 L ha^{-1}
T_{12}	75% N by Vermicompost + Microbial consortium @ 15 kg ha^{-1} Panchagavya @ 3% + Humic acid @ 2.5 L ha^{-1}+ Jeevamrutha @500 L ha^{-1}
T_{13}	Only 100% NPK (control)

The nutrient inputs were applied strategically based on crop growth stages to ensure optimum availability throughout the cropping cycle. Vermicompost enriched with the microbial consortium (Krishnaprabha Chaitanya) containing *Trichoderma harzianum*, *Azotobacter*, *Pseudomonas fluorescens*, phosphate-solubilizing bacteria, *Beauveria bassiana* and VAM was blended with FYM and incorporated into the soil a week before planting. Jeevamrutha was applied to the soil at planting and again at 30 and 60 days after planting (DAP). Panchagavya was sprayed as a foliar at 20, 40 and 60 DAP, Humic acid (12%, Tag Humic) was applied to the soil in three equal splits (2.5 L ha^{-1} each) at planting, 30 and 60 DAP. For inorganic treatments, chemical fertilizers were supplied with 50% N and full P and K as basal and the remaining N top-dressed at 30 DAP.

Results and Discussion

Significant variations were observed in the growth parameters of sacred basil at different stages of crop growth. At 30 DAP, the differences in plant height and primary branches were statistically non-significant, but marked variation was evident in secondary branches and plant spread. The treatment T_6 (100% N by Vermicompost + Microbial consortium @15 kg ha^{-1} Panchagavya @ 3% + Humic acid @2.5 L ha^{-1} + Jeevamrutha @ 500 L ha^{-1}) recorded the highest plant height (39.67 cm), secondary branches (13.90) and plant spread (1185.03 cm^2), followed by T_2 and T_{12}, while T_{13} (only 100% NPK) consistently registered the lowest values. By 60 DAP, significant differences were observed in all traits. T_6 maintained its superiority with maximum plant height (73.77 cm), primary (10.93) and secondary branches (30.35) and plant spread (2229.69 cm^2), followed by T_2 and T_{12}. In contrast, T_{13} recorded the lowest growth performance across all parameters.

At harvest, the effect of organic nutrient management was more pronounced, with T_6 consistently producing the tallest plants (87.50 cm), the highest number of primary (14.72) and secondary branches (46.81) and maximum plant spread (4657.54 cm^2), followed by T_2 and T_{12}. Inorganic control T_{13} recorded the lowest values (59.97 cm, 8.25, 29.38 and 2856.01 cm^2, respectively). The progressive increase in growth parameters under T_6 across stages indicates the synergistic effect of vermicompost enriched with microbial consortium, Panchagavya, humic acid and Jeevamrutha, which ensured better nutrient availability and enhanced vegetative vigor, resulting in superior plant architecture compared to sole inorganic fertilization.

Table 1: Growth parameters of sacred basil (*Ocimum sanctum* L.) as influenced by organic inputs

Treatments	Plant height			Primary branches			Secondary branches			Plant spread		
	30 DAP	60 DAP	Harvest	30 DAP	60 DAP	Harvest	30 DAP	60 DAP	Harvest	30 DAP	60 DAP	Harvest
T_1	33.67	58.50	73.10	4.42	7.58	10.27	10.31	21.73	39.54	737.07	1514.98	3719.17
T_2	37.30	65.23	78.30	5.33	8.70	12.36	12.07	26.07	43.24	954.42	1899.85	4252.72
T_3	33.67	57.17	71.33	3.58	7.35	10.65	9.03	20.84	34.89	555.45	1527.28	3703.49
T_4	34.10	58.13	72.17	4.17	7.45	10.75	9.88	22.67	38.03	677.49	1498.84	3724.42
T_5	34.23	58.40	71.57	4.08	8.08	11.38	9.72	22.93	37.48	661.70	1464.41	3739.39
T_6	39.67	73.77	87.50	6.42	10.93	14.72	13.90	30.35	46.81	1185.03	2229.69	4657.54
T_7	34.23	54.20	67.30	3.92	7.10	9.65	9.47	20.32	33.17	575.48	1273.62	3516.83
T_8	34.21	59.37	72.23	4.67	8.37	10.27	11.03	23.00	40.64	756.02	1515.40	3745.37
T_9	33.07	52.50	63.87	4.07	7.36	10.28	8.95	20.78	33.78	537.61	1203.65	3282.73
T_{10}	32.80	55.43	67.47	4.08	7.33	10.25	8.80	21.28	34.81	586.48	1283.24	3390.52
T_{11}	33.40	53.37	69.73	4.00	7.28	10.40	8.93	20.69	33.93	569.05	1252.57	3351.93
T_{12}	35.07	59.60	76.53	4.97	8.43	10.50	11.15	23.23	40.69	768.38	1529.18	3773.12
T_{13}	31.50	43.27	59.97	3.33	6.13	8.25	7.12	17.83	29.38	428.41	1028.25	2856.01
S. Em ±	1.23	2.72	2.73	0.41	0.74	0.59	0.61	1.44	1.12	61.84	56.75	120.00
C.D. at 5%	3.58	7.95	7.95	NS	2.16	1.73	1.78	4.19	3.28	180.50	165.65	350.24

The significant enhancement in growth parameters of sacred basil under T_6 (100% N through Vermicompost + Microbial consortium @ 15 kg ha^{-1} + Panchagavya @ 3% + Humic acid @ 2.5 L ha^{-1} + Jeevamrutha @ 500 L ha^{-1}) can be attributed to the synergistic action of multiple organic inputs that stimulate hormonal activity, enhance physiological processes and improve nutrient availability. Panchagavya and Jeevamrutha, being rich in natural phytohormones such as IAA, GA_3 and cytokinins, promote cell division, elongation, apical dominance and lateral branching, thereby encouraging vigorous shoot elongation and canopy development (Choudhary *et al*., 2017) [4]. Humic acid further supports root activity and nutrient absorption by improving membrane permeability and enhancing photosynthetic efficiency, while also down-regulating stress-related ethylene and ABA pathways (Nardi *et al*., 2002; Souza *et al*., 2022) [12, 16]. The microbial consortium, comprising beneficial microorganisms such as *Trichoderma harzianum*, *Azotobacter*, *Pseudomonas fluorescens*, PSB, *Beauveria bassiana* and VAM fungi, plays a key role in nutrient mobilization and rhizosphere hormonal enhancement, contributing to improved plant vigor and biomass accumulation (Vessey, 2003; Glick, 2012; Harman *et al*., 2004; Smith and Read, 2008) [17, 6, 9, 15]. Vermicompost acts as a nutrient-rich base, supplying humic substances and microbial enzymes that stimulate chlorophyll synthesis and shoot growth (Arancon *et al*., 2004) [1]. In contrast, T_{13} (100% NPK only) lacks these biological and hormonal stimulants, resulting in comparatively poor growth performance. These observations are consistent with earlier findings in sacred basil (Beleri *et al*., 2024) [2], kalmeg (Gowda *et al*., 2025) [7], arrowroot (Maheswarappa *et al*., 1999) [11], *Kaempferia galanga* (Maheswarappa *et al*., 2001) [10], capsicum (Hameedi *et al*., 2018) [8] and dragon fruit (Chauhan *et al*., 2024) [3], highlighting the effectiveness of integrated organic inputs in promoting robust vegetative growth across diverse crops.

Conclusion

Integrated organic nutrient management significantly improved the growth of sacred basil (*Ocimum sanctum* L.) over inorganic fertilization. T_6 (100% N through Vermicompost + Microbial consortium @ 15 kg ha^{-1} + Panchagavya @ 3% + Humic acid @ 2.5 L ha^{-1} + Jeevamrutha @ 500 L ha^{-1}) recorded the highest plant height, branching and spread due to enhanced hormonal activity, nutrient uptake and physiological efficiency. In contrast, T_{13} (only 100% NPK) performed the lowest. This integrated organic input package offers a sustainable, eco-friendly strategy for improving basil growth and soil health.

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