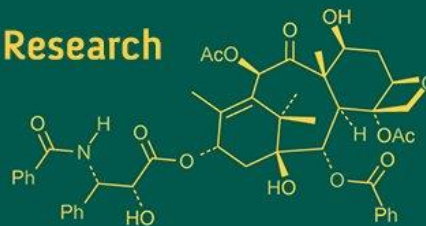


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Mahendra Belagumpi
Ph.D. Scholar, Department of
Plantation, Spices, Medicinal
and Aromatic Crops, College of
Horticulture, Bagalkot,
Karnataka, India

HP Maheswarappa
Principal Scientist, ICAR-
Central Plantation Crops
Research Institute, Kasaragod,
Kerala, India

Vijayakumar B Narayanpur
Department of Plantation,
Spices, Medicinal and Aromatic
Crops, UHS, Bagalkot,
Karnataka, India

YC Vishwanath
Department of Plantation,
Spices, Medicinal and Aromatic
Crops, UHS, Bagalkot,
Karnataka, India

SM Prasanna
Department of Natural
Resource Management, UHS,
Bagalkot, Karnataka, India

DL Rudresh
Department of Natural
Resource Management, UHS,
Bagalkot, Karnataka, India

Sanjeevraddi G Reddi
Department of Natural
Resource Management, UHS,
Bagalkot, Karnataka, India

Corresponding Author:
Mahendra Belagumpi
Ph.D. Scholar, Department of
Plantation, Spices, Medicinal
and Aromatic Crops, College of
Horticulture, Bagalkot,
Karnataka, India

Organic nutrient interventions for improving biochemical quality of sacred basil

Mahendra Belagumpi, HP Maheswarappa, Vijayakumar B Narayanpur, YC Vishwanath, SM Prasanna, DL Rudresh and Sanjeevraddi G Reddi

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Abstract

Sacred basil is a medicinal and aromatic plant valued for its therapeutic properties, largely attributed to its rich biochemical constituents such as chlorophyll and carotenoids. A field experiment entitled “Organic nutrient interventions for improving biochemical quality of sacred basil” was conducted during summer-2024 at MHREC, University of Horticultural Sciences, Bagalkot, Karnataka, to assess the effect of organic inputs on chlorophyll and carotenoid content. The experiment was laid out in a Randomized Block Design with 13 treatments and 3 replications, including combinations of vermicompost, microbial consortium, Panchagavya, humic acid, Jeevamrutha and an inorganic control. Pigment contents were estimated at 45 DAP and at harvest using the DMSO extraction method followed by spectrophotometric analysis. Significant differences were observed among treatments for chlorophyll a, chlorophyll b, total chlorophyll and carotenoids. The treatment T₆ (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 pigment values with chlorophyll a (2.29 and 1.91 mg g⁻¹), chlorophyll b (0.93 and 0.78 mg g⁻¹), total chlorophyll (3.21 and 2.69 mg g⁻¹) and carotenoids (1.56 and 1.36 mg g⁻¹) at 45 DAP and harvest, respectively, followed by T₁₂ and T₂. The lowest pigment values were recorded in T₁₃ (only 100% NPK). The enhanced pigment levels can be attributed to better nutrient uptake, hormonal stimulation and photosynthetic efficiency under organic inputs. The study highlights that integrated organic nutrient management is a sustainable approach to improving the biochemical quality and productivity of sacred basil.

Keywords: *Ocimum sanctum* L., chlorophyll, carotenoids, organic nutrient management

Introduction

Sacred basil (*Ocimum sanctum* L.), a member of the Lamiaceae family, is a revered medicinal and aromatic plant widely cultivated in tropical and subtropical regions. It is valued in Ayurveda and traditional medicine for its adaptogenic, antimicrobial, anti-inflammatory, antioxidant and immunomodulatory properties. These therapeutic attributes are largely attributed to its rich biochemical composition, including chlorophyll, carotenoids, phenolic compounds, flavonoids, tannins and essential oils. In addition to its pharmacological importance, the plant holds immense commercial value in the nutraceutical, cosmetic and herbal industries. As consumer demand for high-quality, naturally derived phytochemicals continues to rise, enhancing the biochemical potential of sacred basil through sustainable cultivation practices has become increasingly important (Pandey *et al.*, 2014) [7]. Organic nutrient management plays a critical role in improving the biochemical quality of medicinal and aromatic crops. Inputs such as vermicompost, microbial consortia, Panchagavya, humic acid and Jeevamrutha not only supply nutrients but also act as natural biostimulants, stimulating physiological and metabolic processes that enhance secondary metabolite synthesis. Unlike inorganic fertilizers, these inputs improve soil biological activity, structure and nutrient cycling, leading to balanced and sustained nutrient availability. The synergistic effect of these organic amendments is known to boost enzymatic activities and hormonal signaling, ultimately enhancing the accumulation of phytochemicals in plant tissues. Therefore, integrating such organic nutrient interventions represents a promising approach for improving the biochemical quality of sacred basil while promoting ecological sustainability and soil health (Naveen Kumar and Maheswarappa, 2019) [5].

Materials and Methods

The field investigation titled “Organic nutrient interventions for improving biochemical quality of sacred basil” was carried out during summer 2024 at the Main Horticultural Research and Extension Centre (MHREC), under the University of Horticultural Sciences, Bagalkot, Karnataka.

The experimental site is located in the northern dry zone (Zone III) of Karnataka 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.

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 in a stage-specific manner to ensure optimum availability throughout the cropping period of the main crop. 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 one week before planting. Jeevamrutha was applied to the soil at planting and again at 30 and 60 days after planting (DAP) at the rate of 500 L ha⁻¹ per application. 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 applied with 50% N and the full dose of P and K as basal, while the remaining 50% N was top-dressed at 30 DAP.

Estimation of Chlorophyll and carotenoid content

The total chlorophyll, chlorophyll *a* and chlorophyll *b* were quantified at 45 DAP and at the time of harvest using the Dimethyl Sulphoxide (DMSO) extraction method. The fully expanded third leaf from the apex of the plant was collected in polyethylene bags, leaf samples were cut into small segments and a known fresh weight was transferred into test tubes containing 7.0 ml of DMSO. The tubes were incubated at 65 °C for 30 minutes to facilitate pigment extraction. After incubation, the leaf residue was removed by decantation and the final volume of the extract was adjusted to 10 ml with DMSO. Spectrophotometric analysis of the extract was conducted using a UV-Visible spectrophotometer (Elico, SL-159). Absorbance readings were recorded at wavelengths of 645 nm, 663 nm and 440 nm, with DMSO serving as blank. The concentrations of

total chlorophyll, chlorophyll *a* and chlorophyll ‘*b*’ were calculated using standard equations outlined by Sadasivam and Manickam (1996) ^[10] and Carotenoids was calculated using the formula given by Bajracharya, (1996) ^[11] expressed in milligrams per gram of fresh leaf tissue.

Results and discussion

Significant differences were observed in chlorophyll and carotenoid content of sacred basil (*Ocimum sanctum* L.) as influenced by various organic nutrient treatments at both 45 DAP and harvest stages. T₆ (100% N through Vermicompost + Microbial consortium @ 15 kg ha⁻¹ + Panchagavya @ 3% + Humic acid @ 2.5 L ha⁻¹ + Jeevamrutha @ 500 L ha⁻¹) consistently recorded the highest values for chlorophyll *a* (2.29 and 1.91 mg g⁻¹ at 45 DAP and harvest, respectively), chlorophyll *b* (0.93 and 0.78 mg g⁻¹), total chlorophyll (3.21 and 2.69 mg g⁻¹) and carotenoids (1.56 and 1.36 mg g⁻¹). This was closely followed by T₁₂ and T₂, which also showed higher pigment accumulation compared to other treatments.

In contrast, the lowest values for all pigment parameters were recorded under T₁₃ (only 100% NPK) with chlorophyll *a* (1.61 and 1.37 mg g⁻¹), chlorophyll *b* (0.74 and 0.67 mg g⁻¹), total chlorophyll (2.35 and 2.04 mg g⁻¹) and carotenoids (1.19 and 1.04 mg g⁻¹). Among the intermediate treatments, T₈ showed relatively better performance than most other individual organic inputs, while T₄, T₅ and T₁₁ were at par with each other. A general decline in pigment content from 45 DAP to harvest was observed across treatments. The results clearly indicate that integrated application of vermicompost with biostimulants such as Panchagavya, humic acid and Jeevamrutha significantly enhanced chlorophyll and carotenoid synthesis in sacred basil compared to sole inorganic fertilization.

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

Treatments	Chlorophyll a		Chlorophyll b		Total chlorophyll		Carotenoids	
	45 DAP	Harvest	45 DAP	Harvest	45 DAP	Harvest	45 DAP	Harvest
T ₁	1.70	1.57	0.78	0.68	2.47	2.25	1.35	1.16
T ₂	2.13	1.78	0.90	0.77	3.03	2.56	1.42	1.32
T ₃	1.78	1.52	0.71	0.61	2.49	2.13	1.44	1.25
T ₄	1.78	1.52	0.71	0.60	2.49	2.12	1.35	1.13
T ₅	1.77	1.51	0.71	0.60	2.48	2.11	1.35	1.13
T ₆	2.29	1.91	0.93	0.78	3.21	2.69	1.56	1.36
T ₇	1.70	1.43	0.73	0.64	2.43	2.07	1.22	1.04
T ₈	2.04	1.71	0.88	0.75	2.91	2.46	1.42	1.30
T ₉	1.65	1.42	0.76	0.67	2.41	2.09	1.43	1.25
T ₁₀	1.72	1.46	0.71	0.61	2.43	2.07	1.46	1.28
T ₁₁	1.67	1.42	0.74	0.65	2.41	2.06	1.32	1.14
T ₁₂	2.32	1.92	0.90	0.77	3.22	2.69	1.52	1.34
T ₁₃	1.61	1.37	0.74	0.67	2.35	2.04	1.19	1.04
S. Em ±	0.11	0.11	0.05	0.04	0.12	0.12	0.07	0.07
C.D. at 5%	0.32	0.31	0.14	0.11	0.34	0.34	0.19	0.20

The enhancement of chlorophyll and carotenoid content in sacred basil under organic nutrient management can be attributed to improved nutrient uptake, hormonal stimulation and microbial activity. Beneficial microbes such as *Pseudomonas fluorescens*, *Azotobacter* and *Trichoderma harzianum* enhance root growth and physiological activity, indirectly supporting chlorophyll biosynthesis and pigment stability (Pieterse *et al.*, 2014; Kour *et al.*, 2024) [8, 3]. Panchagavya and Jeevamrutha, rich in phytohormones and microbial metabolites, further stimulate photosynthetic activity and pigment accumulation (Uthirapandi *et al.*, 2018; Zhu *et al.*, 2022) [14, 15].

Humic acid and vermicompost contribute through auxin-like activity, enhanced root H⁺-ATPase function and improved nutrient availability, which collectively increase chlorophyll biosynthesis and carotenoid concentration (Canellas *et al.*, 2015) [2]. These inputs also support chloroplast development and maintain pigment levels, offering a distinct advantage over inorganic fertilization. Similar enhancements in biochemical attributes due to organic inputs have been reported in basil (Teliban *et al.*, 2020) [13], carrots (Srednicka-Tober *et al.*, 2022) [12], fenugreek (Salehi *et al.*, 2019) [11], *Cephalaria syriaca* (Rahimi *et al.*, 2021) [9] and tomatoes (Mitchell *et al.*, 2007; Niveditha *et al.*, 2025) [4, 6].

Conclusion

The present study clearly demonstrated that organic nutrient management significantly enhanced chlorophyll and carotenoid content in sacred basil (*Ocimum sanctum* L.) compared to inorganic fertilization. Among the treatments, T₆ (100% N through Vermicompost + Microbial consortium @ 15 kg ha⁻¹ + Panchagavya @ 3% + Humic acid @ 2.5 L ha⁻¹ + Jeevamrutha @ 500 L ha⁻¹) consistently recorded the highest pigment levels at both 45 DAP and harvest stages. The synergistic effect of vermicompost, beneficial microbes, Panchagavya, humic acid and Jeevamrutha enhanced nutrient uptake, hormonal stimulation and photosynthetic activity, resulting in improved pigment biosynthesis and stability. In contrast, the inorganic control (T₁₃) recorded the lowest chlorophyll and carotenoid content, highlighting the limited physiological response under only chemical fertilization.

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