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Evaluation of integrated natural farming components on quality of turmeric (*Curcuma longa* L.) and soil health

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Abstract

Natural farming is a sustainable approach that improves soil health and crop quality without chemical inputs. A field experiment was conducted during *Kharif-Rabi* 2025-26 at Gujarat Natural Farming Science University, Halol, to evaluate the effect of different natural farming components on turmeric (*Curcuma longa* L.). The experiment was laid out in a Randomized Block Design with seven treatments and four replications. Treatment T₁ (all natural farming components) recorded the highest curcumin content (5.51%) and essential oil content (6.90%). It also significantly improved soil organic carbon (0.92%), available nitrogen (173.3 kg/ha), and available potassium (321.3 kg/ha). The highest populations of bacteria, fungi, actinomycetes and earthworms were also observed under T₁. In contrast, omission of individual natural farming components reduced crop quality and soil biological activity. The study concludes that the integrated application of *Beejamrit*, *Jeevamrit*, *Ghanjeevamrit*, mulching, mixed cropping and raised-bed planting enhances turmeric quality, soil fertility and microbial activity, making natural farming a sustainable production system for turmeric under middle Gujarat conditions.

Keywords: Natural farming, turmeric, *Beejamrit*, *Jeevamrit*, *Ghanjeevamrit*, mulching, mixed cropping, raised-bed planting, curcumin, essential oil, soil fertility, soil organic carbon, microbial activity, earthworm population

Introduction

Turmeric (*Curcuma longa* L.) is one of the most important spice crops cultivated in India, China and Southeast Asia. Besides its use as a spice, natural food colorant and preservative, it has long been valued in traditional medicine for treating various ailments such as liver disorders, biliary diseases, cough, loss of appetite, diabetic wounds, rheumatism and sinusitis. The principal bioactive compound in turmeric, curcumin (diferuloylmethane), is responsible for most of its medicinal properties. Scientific studies have demonstrated that curcumin possesses a broad range of pharmacological activities, including anti-inflammatory, antioxidant, anticancer, antimutagenic, antidiabetic, antimicrobial, antifungal, antiviral, anticoagulant, antifertility, antifibrotic, antiulcer, antiprotozoal, antivenom, hypotensive and hypocholesterolemic effects. Its anticancer activity is mainly associated with the induction of programmed cell death (apoptosis) in cancer cells. Due to its strong anti-inflammatory and antioxidant properties, curcumin has shown potential in the prevention and management of chronic inflammatory diseases, cancer and oxidative stress-related disorders. It has also been used clinically to reduce post-operative inflammation. Toxicological studies indicate that both turmeric and curcumin are safe and well tolerated even at relatively high doses, making them promising natural compounds for the development of therapeutic agents for various human diseases.

The development of farming practices to feed the continuously increasing global population is a requirement at a given time. However, intensive agricultural practices for increased yield have resulted in increasing carbon emissions and adverse effects on soil health, the surrounding environment, and the quality of the food chain due to excessive conventional/chemical farming (CF) practice using chemical pesticides and fertilizers and less attention to environmentally friendly farming practices (Ozlu *et al.*, 2022) [9]. Natural farming (NF), the sustainable alternative farming approach, is based on basic ecological principles considered as the “natural way of farming” which includes no use of chemicals and the adoption of an ecological farming approach

that is believed to support more diverse and resilient microbial communities to maintain balance in biodiversity in the ecosystem (Choudhary *et al.*, 2022; Saharan *et al.*, 2023) ^[2, 11]. In India, natural farming gained attention through the work of Subhash Palekar, who established the model of Zero Budget Natural Farming (ZBNF). The approach encourages the usage of locally accessible resources, e.g., cow urine, cow dung, and green manure, to restore soil health and to enhance crop yield without using expensive external inputs (Dev *et al.*, 2022) ^[3]. Natural farming practice includes the use of mulching and various NF inputs/bioformulations such as *Ghanjeevamrit*, *Jeevamrit* and *Beejamrit* to improve the soil health, nutrient composition, and plant growth and survival against biotic and abiotic stresses (Saharan *et al.*, 2023) ^[11]. *Beejamrit* acts as a natural seed treatment solution that enhances germination, protects against soil-borne and seed-borne pathogens, and promotes early seedling growth (Panchal *et al.*, 2026; Mukherjee *et al.*, 2022) ^[10, 8]. *Jeevamrit* and *Ghanjeevamrit* serve as biofertilizers that enrich soil fertility, stimulate beneficial microbial activity, and improve nutrient uptake efficiency in plants (Saharan *et al.*, 2023) ^[11]. Mulching further contributes to soil health by conserving moisture, improving aeration and temperature regulation, and minimizing erosion and nutrient loss, thereby supporting long-term soil sustainability (Lakhani and Bodar, 2025) ^[6].

Materials and Methods

The field experiment was conducted during *Kharif-Rabi* 2025-26 at Plot No. 1, Gujarat Natural Farming Science University, Halol (Gujarat). Geographically, Halol is situated at 22°42' N latitude and 73°54' E longitude with an elevation of 104 m above mean sea level. The region experiences semi-arid and subtropical climatic conditions with hot summers and cool winters. The average annual rainfall of the region is about 1659 mm, mainly received during July to September. The soil of the experimental field was clay loam in texture with pH 7.8 and EC 0.225 dS/m. The soil contained 0.615 per cent organic carbon, 175 kg/ha available nitrogen, 31.29 kg/ha available phosphorus and 346.23 kg/ha available potassium. The experiment was conducted in Randomized Block Design with seven treatments replicated four times. The treatments consisted of T₁: All natural farming components (*Beejamrit* + *Jeevamrit* + *Ghanjeevamrit* + Mulching + Mixed cropping + Raised bed), T₂: All natural farming components except *Jeevamrit*, T₃: All natural farming components except Mulching, T₄: All natural farming components except *Ghanjeevamrit*, T₅: All natural farming components except Mixed cropping, T₆: All natural farming components except *Beejamrit* and T₇: All natural farming components except Raised bed planting. The total number of plots was 28 with gross plot size of 3.7 m × 10.37 m and total experimental area of 28.9 m × 42.9 m. Turmeric variety GNT 3 (Pitambari) was used as the test crop due to its high yield potential and suitability under Gujarat conditions.

Results and Discussion

Quality parameter

Curcumin content

Treatment-wise curcumin content of turmeric differed significantly (Table 1). The highest curcumin content was recorded in T₁ (all natural farming components) with 5.51%, while the lowest was observed in T₇ (except Raised bed) with 3.21%. Treatment T₆ (except *Beejamrit*) recorded 4.65% and remained statistically at par with T₃ (3.86%), indicating that omission of *Beejamrit* and Mulching had a comparatively lower effect on curcumin accumulation. The higher curcumin content under T₁ may be attributed to improved nutrient availability and

enhanced microbial activity under integrated natural farming practices.

Essential oil

Analysis of variance showed that essential oil content in turmeric was significantly influenced by omission of different natural farming components (Table 1). Treatment T₁ (all NF components of practices such as *Beejamrit*, *Jeevamrit*, *Ghanjeevamrit*, Mulching, Mix crop and raised bed) observed the significantly higher essential oil content (6.90%). But it remained at par with Treatment T₆ (omission of *Beejamrit*), T₂ (omission of *Jeevamrit*) and treatment T₃ (omission of mulching). This suggested comparatively lesser adverse effect of omission of *Beejamrit*, *Jeevamrit* and mulching on essential oil synthesis. The minimum value of essential oil in turmeric was recorded under treatment T₇ (5.81%).

Soil parameter

Organic Carbon (OC)

Soil organic carbon content after harvest was significantly influenced by different natural farming treatments (Table 1). The highest organic carbon content (0.92%) was recorded under T₁ (all natural farming components), which was statistically at par with T₂ and T₇ (0.86% each). The increased organic carbon under T₁ may be attributed to the continuous addition of organic inputs, enhanced microbial activity and greater decomposition of organic residues. T₆ (0.81%) remained statistically at par with T₃ and T₄ (0.79% each), while the lowest organic carbon content (0.78%) was recorded under T₅, likely due to the absence of mixed cropping.

Available nitrogen

Available nitrogen content after harvest was significantly influenced by different natural farming treatments (Table 1). The highest available nitrogen (173 kg/ha) was recorded under T₁ (all natural farming components), likely due to enhanced microbial activity, organic matter decomposition and nutrient mineralization. Treatments T₂ (165 kg/ha), T₇ (163 kg/ha) and T₆ (160 kg/ha) were statistically at par, indicating a comparatively lower effect of excluding *Jeevamrit*, Raised bed and *Beejamrit*. The lowest available nitrogen (139 kg/ha) was recorded under T₅, followed by T₃ (149 kg/ha), while omission of *Ghanjeevamrit* (T₄) also reduced nitrogen availability.

Available Phosphorus

Available phosphorus content after harvest differed significantly among the natural farming treatments (Table 1). The highest available phosphorus was recorded under T₁, which may be attributed to enhanced organic matter mineralization and reduced phosphorus fixation under favourable soil biological conditions. T₃ (23 kg/ha) remained statistically at par with T₂ (21 kg/ha), indicating that omission of mulching and *Jeevamrit* had a comparatively lower effect on phosphorus availability. The lowest available phosphorus was recorded under T₆ (13 kg/ha), followed by T₄ and T₇ (17 kg/ha each), likely due to reduced microbial activity and lower phosphorus solubilization.

Available potassium

Available potassium content after harvest was significantly influenced by different natural farming treatments (Table 1). The highest available potassium (321 kg/ha) was recorded under T₁ (all natural farming components), likely due to enhanced organic matter decomposition, microbial activity and nutrient recycling. T₂ (251 kg/ha) remained statistically at par with T₄ (219 kg/ha), indicating a comparatively lower effect of excluding *Jeevamrit*

and *Ghanjeevamrit*. The lowest available potassium was recorded under T₅ (191 kg/ha), which was statistically at par with T₆ (192 kg/ha), T₇ (198 kg/ha) and T₃ (199 kg/ha). The higher N, P and K availability under T₁ may be attributed to the combined effect of integrated natural farming practices that enhanced soil biological activity and nutrient mineralization, which is in agreement with the findings of Harish *et al.* (2024) [5].

Soil microbial count after harvest
Bacterial count

Analysis of variance revealed that bacterial count in soil after harvest of turmeric was significantly influenced by omission of different natural farming components (Table 1). Significantly higher bacterial count (15.6×10^7 CFU/g) was recorded under treatment T₁ (all NF components of practices such as *Beejamrit*, *Jeevamrit*, *Ghanjeevamrit*, mulching, mixed crop and Raised bed), which remained at par with T₆ (11.0×10^7 CFU/g) and T₅ (6.6×10^7 CFU/g). The lowest bacterial count (3.7×10^7 CFU/g) was observed under the T₂ without *Jeevamrit* treatment, which was statistically at par with treatment T₇ (4.0×10^7 CFU/g) and T₃ (4.2×10^7 CFU/g). The higher bacterial population under T₁ may be attributed to the continuous supply of beneficial microorganisms and organic substrates through natural farming inputs, which enhanced microbial multiplication, nutrient mineralization and overall soil biological activity.

Fungal count

The fungal population in soil differed significantly due to omission of various natural farming components. Treatment T₁ recorded higher fungal count (12.5×10^4 CFU/g), but which was statistically at par with treatment T₆ (11.0×10^4 CFU/g) and T₅ (9.6×10^4 CFU/g). significantly lower fungal count (7.0×10^4 CFU/g) was registered under T₂, and it was at par with treatment T₇ (7.2×10^4 CFU/g) and T₃ (7.7×10^4 CFU/g). The increased fungal population under T₁ might be due to greater availability of organic matter and favourable soil conditions created by natural

farming practices, which supported decomposition processes and enhanced microbial growth in the rhizosphere.

Actinomycetes count

Actinomycetes population was significantly affected by different natural farming treatments. The maximum actinomycetes count (12.4×10^5 CFU/g) was recorded under treatment T₁, which was significantly superior over all other treatments. The minimum count (3.7×10^5 CFU/g) was observed under T₂, which remained at par with T₇ (4.6×10^5 CFU/g) and T₃ (5.3×10^5 CFU/g). The higher actinomycetes population under T₁ may be attributed to increased organic carbon availability and improved soil biological environment, which favoured the growth of actinomycetes involved in decomposition, nutrient recycling and maintenance of soil the health.

Number of earthworms

The data presented in Table 1 revealed that the number of earthworms was significantly influenced due to different natural farming components. Significantly higher earthworm population (32 No./m²) was observed under treatment T₁ (all NF components), which was at par with T₅ (31 No./m²) and T₆ (30 No./m²). however, the lower population of earthworm (17 No./m²) was recorded under T₇ (all NF components except Raised bed), which was at par with T₃ (19 No./m²) and T₄ (20 No./m²). The increased earthworm population under T₁ might be due to the combined application of natural farming components, which improved soil organic carbon content, microbial biomass and soil moisture regime. The addition of organic inputs and mulching provides a continuous source of energy and nutrients for soil biota, while improved soil aggregation, aeration and moisture availability create a congenial environment for earthworm proliferation. Earthworms are highly responsive to organic matter-rich conditions, which favour their feeding, burrowing and reproductive activities, resulting in higher population density.

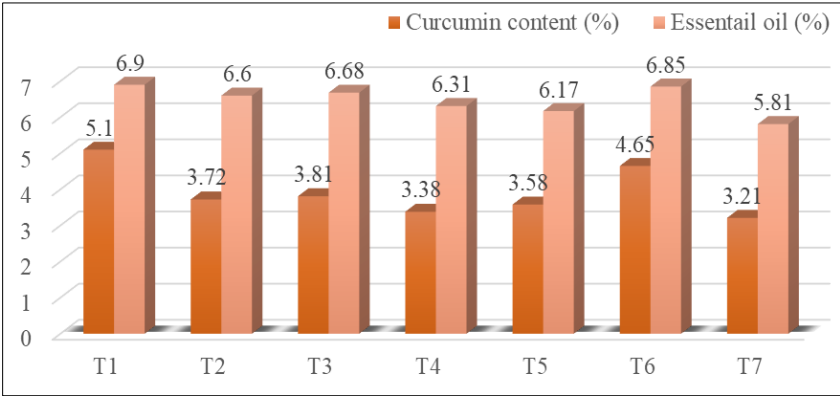


Fig 1: Effect of natural farming practices on curcumin content and essential oil in turmeric

Table 1: Effect of Natural Farming practices on chemical and biological soil properties

Treatment	OC (%)	Available Nitrogen (N)	Available Phosphorus (P)	Available Potash (K)	Bacterial count (CFU/g)	Fungal count (CFU/g)	Actinomyces Count (CFU/g)	No. of earthworms (No./m ³)
T ₁	0.92	173.3	29.1	321.3	15.6 × 10 ⁷	12.5 × 10 ⁴	12.4 × 10 ³	32
T ₂	0.86	165.1	21.6	251.0	3.7 × 10 ⁷	7.0 × 10 ⁴	3.7 × 10 ³	22
T ₃	0.79	149.6	23.9	199.8	4.2 × 10 ⁷	7.7 × 10 ⁴	5.3 × 10 ³	19
T ₄	0.79	156.9	17.6	219.1	5.9 × 10 ⁷	9.2 × 10 ⁴	6.7 × 10 ³	20
T ₅	0.78	139.0	30.8	191.0	6.6 × 10 ⁷	9.6 × 10 ⁴	6.7 × 10 ³	31
T ₆	0.81	160.7	13.0	192.0	11.0 × 10 ⁷	11.0 × 10 ⁴	1.2 × 10 ³	30
T ₇	0.86	163.8	17.9	198.2	4.0 × 10 ⁷	7.2 × 10 ⁴	4.6 × 10 ³	17
S.Em. ±	0.02	4.3	0.6	7.2	2835494	2920	164	0.71
CD (P= 0.05)	0.07	12.6	1.8	21.0	8.2 × 10 ⁶	8.4 × 10 ³	4.7 × 10 ²	2.05
C.V%	5.50	5.5	5.8	6.5	7.75	6.38	5.68	5.80

Conclusion

Based on the results of the present investigation, it can be concluded that integration of all natural farming components namely *Beejamrit*, *Jeevamrit*, *Ghanjeevamrit*, mulching, mix cropping and raised bed cultivation significantly improved quality, soil fertility, microbial activity of turmeric cultivation. Therefore, adoption of complete natural farming package may be recommended for sustainable and profitable turmeric production under Middle Gujarat conditions.

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