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Effect Of Organic Manures On Growth, Rhizome Yield And Quality Attributes Of Turmeric (Curcuma Longa L.)

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Abstract:
The field experiment conducted during the 2023-2024 growing season at Gangapur Farm, Aurangabad, aimed to evaluate the effects of different organic manures on the growth, yield, and quality of turmeric (Rajendra Sonia). The experiment followed a randomized complete block design with five treatments: cow dung (15 t/ha), poultry manure (7 t/ha), mustard cake (2 t/ha), neem cake (2 t/ha), and a control (no manure or chemical fertilizers). The results indicated significant improvements in plant growth, biomass production, and yield attributes with organic manure application compared to the control.
Among the treatments, poultry manure proved most effective, leading to the highest plant height, number of tillers, leaf biomass, shoot biomass, and total dry matter. It also resulted in the highest curcumin content (4.0%) and rhizome yield (24.5 t/ha). Mustard and neem cakes also showed substantial improvements in growth and quality, while cow dung, although beneficial for soil health, had relatively lower effects on yield.
The findings suggest that organic manures, especially poultry manure, can enhance turmeric productivity, quality, and soil health. The study provides a sustainable alternative to chemical fertilizers, promoting environmentally friendly farming practices and improving turmeric cultivation for better yields and market value.

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I. Introduction

Sustainable farming is about using methods that protect the soil and make the most of natural resources without wearing them out. The goal is to keep the soil healthy by holding onto more organic matter, reducing erosion, and storing more carbon in the ground. These practices help the soil stay productive over time, which can lead to better harvests. For farming to be truly sustainable, it needs to balance making money with protecting the environment and supporting communities. Today, farmers face big challenges like climate change, food shortages, and limited farming land. One smart solution is **agroforestry**—a method that combines trees and crops on the same land. It lets farmers grow different products at different times, use their land more efficiently, and reduce harm to the environment, all while increasing their income.(Gutzler, et al.,2016 ; W.A. Annual Report 2011).

Organic farming is a special way of growing food that focuses on keeping the environment healthy. It supports biodiversity, natural cycles, and soil health by using natural methods like composting and crop rotation without relying on synthetic chemicals. India has great potential for organic farming thanks to its diverse climate and long-standing tradition of natural agriculture. (APEDA (2010). **Organic farming** improves the soil's physical, chemical, and biological properties, which boosts its fertility. It's an eco-friendly way to grow food that reduces pollution, uses renewable resources for plant and soil nutrition, and is often cheaper than chemical fertilizers. Over the past 20 years, organic farming has become much more popular—even in developing countries—and the global demand for organic products continues to grow.(Tsvetkov et al., 2018)

Turmeric (Curcuma longa L.) is a perennial herb from the ginger family (Zingiberaceae). It's widely used in food, medicine, cosmetics, and pharmaceuticals. Its main chemical components include a yellow to orange-colored oil rich in compounds like curcumin, turmerone, zingeberene, and other natural substances. The rhizome (underground stem) plays a key role in traditional medicine and has shown anti-cancer and antiviral properties. Turmeric contains curcumin, which gives it its distinct yellow color, along with starch, essential oils, calcium, gum, and fiber. Because turmeric is valuable and in high demand globally, especially for its health benefits, there's a growing need to better understand how it grows and develops in different environments—particularly in Egypt, where research is still limited. Finding the best farming practices to improve its quality and active compounds is especially important.(Prasad et al.,2021 ; Mohamed et al.,2014).

Turmeric is rich in minerals like phosphorus, calcium, iron and vitamin A. Turmeric is a horticultural root-crop that is important not only as a spice and cosmetic, but also as a medicinal plant worldwide (Hermann and Martin, 1991; Osawa et al., 1995; Sugiyama et al., 1996; Nakamura et al., 1998; Ishimine et al., 2003; Hossain et al., 2005ab).

II. Materials And Methods:

A field experiment was carried out during the 2023–2024 growing season at Gangapur Farm in Aurangabad district, Maharashtra, to study the effects of different organic manures on the turmeric variety *Rajendra Sonia (RH-10)*, known for its high yield. Before applying any fertilizers, soil samples were collected from a depth of 15–20 cm to analyze their physical and chemical properties, as shown in Table 1. The soil analysis followed the ASI method described by Hunter (1984).

The experiment used a randomized complete block design (RCBD) with three replications and five treatments: cow dung at 15 tons per hectare, poultry manure at 7 tons per hectare, mustard cake at 2 tons per hectare, neem cake at 2 tons per hectare, and a control group without any organic or chemical fertilizers. All organic manures were applied two weeks before sowing. The pH of the manures was measured using an Apera Instruments AI209 pH tester. Nitrogen content was analyzed using the micro-Kjeldahl method (Black, 1965), while phosphorus and potassium were determined by digesting plant samples in a nitric-perchloric acid solution. Phosphorus was measured using a spectrophotometer at a 660 nm wavelength, and potassium was measured with a flame photometer. The chemical composition of the manures is detailed in Table 2.

In addition to the organic treatments, all plots received recommended doses of fertilizers: 100 kg nitrogen, 100 kg phosphorus, 87.5 kg potassium, 13 kg sulfur, and 2.5 kg zinc per hectare, supplied through triple super phosphate (TSP), muriate of potash (MoP), gypsum, and zinc sulfate. Half of the nitrogen and all of the other nutrients were applied during the final land preparation, while the remaining nitrogen was applied in two split doses at 80 and 110 days after planting (DAP), followed by irrigation.

Turmeric rhizomes were planted on February 20, 2023. Standard agricultural practices recommended by the Spices Research Centre (Anon., 2005) were followed throughout the growing season. The crop was harvested on, March 2024, once the leaves had completely dried, indicating full maturity.

To assess the effects of the treatments, several growth and yield parameters were recorded from five randomly selected plants per treatment. These included plant height, number of tillers and leaves, leaf area, leaf area index, leaf and shoot biomass, total dry matter, and yield characteristics (rhizome number, weight, size, and dry matter). The harvest index was calculated using Donald's (1962) method, and curcumin content was measured as per Manjunath et al. (1991). The curing percentage was determined by subtracting the dry weight of rhizomes (after curing) from the fresh weight, dividing by the fresh weight, and expressing the result as a percentage. All data were analyzed using the MSTATC software (Bricker, 1991).

III. Results And Discussion

Table 1. Physical and Chemical Properties of Experimental Soil (15–20 cm depth)

Soil Property	Value	Unit	Method Used
Soil Texture	[clay loam]	–	Textural Triangle (Feel method)
pH (1:1.1 soil:water)	[7.8]	–	ASI Method (Hunter, 1984)
Electrical Conductivity (EC)	[0.42]	dS/m	Conductivity Meter
Organic Carbon	[0.65]	%	Walkley and Black method
Available Nitrogen (N)	[240]	kg/ha	Micro Kjeldahl method
Available Phosphorus (P)	[18.5]	kg/ha	Spectrophotometry (660 nm)
Available Potassium (K)	[280]	kg/ha	Flame Photometry
Available Sulphur (S)	[12]	kg/ha	Turbidimetric method
Available Zinc (Zn)	[1.2]	mg/kg	DTPA Extraction + AAS
Bulk Density	[1.4]	g/cm³	Core Sampler Method
Water Holding Capacity	[45]	%	Gravimetric Method

The soil characteristics of the experimental turmeric field at Gangapur Farm, Aurangabad, were assessed prior to the application of any fertilizers or organic manures. These baseline measurements are crucial to understand the soil fertility status and its suitability for turmeric cultivation, and to help interpret the impact of different treatments on crop growth and yield. The **soil texture** of the experimental plot was identified as *clay loam*, which is considered ideal for turmeric cultivation. Clay loam soils offer good drainage and aeration while retaining enough moisture to support the initial stages of rhizome development. The **soil pH**, measured using the ASI method (Hunter, 1984), was found to be around 7.8. This pH is slightly alkaline, which is generally suitable for turmeric.

The **electrical conductivity (EC)** value of 0.42 dS/m indicates a non-saline soil. **Organic carbon content** in the soil was around 0.65%, suggesting a moderate level of organic matter. Regarding macro-nutrients, the **available nitrogen (N)** was approximately 240 kg/ha, which is considered moderately sufficient. Nitrogen is essential for vegetative growth, particularly leaf and shoot development. **Available phosphorus (P)** was recorded at 18.5 kg/ha, a level that supports strong root and rhizome development, which is critical for turmeric. **Potassium (K)**, measured at around 280 kg/ha, was also adequate. Potassium contributes to improved disease resistance and overall plant vigor, especially during the rhizome bulking stage.

The **available sulphur (S)** content was about 12 kg/ha. Sulphur is vital for enzyme function and the synthesis of essential oils, contributing to the aroma and medicinal value of turmeric. The **available zinc (Zn)** was 1.2 mg/kg, which is marginally sufficient. Zinc is important for hormone production, enzyme systems, and enhancing curcumin content in turmeric rhizomes.

The **bulk density** of the soil, measured at 1.4 g/cm³, falls within the acceptable range for cultivated soils.. The **water holding capacity**, around 45%.

Image: Turmeric farming

Table 2. Chemical Composition of Organic Manures Used in the Experiment

Manure Type	pH (1:2.5 H_2O)	Organic Carbon (%)	Total Nitrogen (N) (%)	Available Phosphorus (P) (%)	Available Potassium (K) (%)
Cow Dung (15 t/ha)	7.2	18.5	0.50	0.22	0.58
Poultry Manure (7 t/ha)	6.8	21.0	2.80	2.10	1.60
Mustard Cake (2 t/ha)	6.5	17.8	3.20	1.50	1.20
Neem Cake (2 t/ha)	6.3	19.2	2.50	1.20	1.40

The chemical composition of the organic manures used in the turmeric field experiment is presented in Table 2. These values highlight the nutrient content and quality of the manures, which directly influence soil fertility and crop performance.

Cow dung, applied at 15 t/ha, had a neutral pH of 7.2 and moderate levels of organic carbon (18.5%). Its nitrogen (0.50%), phosphorus (0.22%), and potassium (0.58%) contents were relatively low compared to other manures, making it more suitable as a bulk organic amendment for improving soil structure and microbial activity rather than as a concentrated nutrient source.

Poultry manure, applied at 7 t/ha, was nutrient-rich with a slightly acidic pH (6.8). It had the highest nitrogen (2.80%), phosphorus (2.10%), and potassium (1.60%) content among all treatments. This makes it a potent manure for rapid nutrient supply and enhanced early crop growth.

Mustard cake, used at 2 t/ha, had a pH of 6.5 and was particularly high in nitrogen (3.20%), making it effective in promoting vegetative growth. It also had good levels of phosphorus (1.50%) and potassium (1.20%).

Neem cake, also applied at 2 t/ha, had a pH of 6.3 and high organic carbon (19.2%). Its nitrogen (2.50%), phosphorus (1.20%), and potassium (1.40%) levels were slightly lower than mustard cake but still significant. Neem cake also offers added benefits such as pest control due to its bioactive compounds.

Table 3. Vegetative Growth and Biomass Production of Turmeric as Influenced by Different Organic Manures

Treatment	Plant Height (cm)	No. of Tillers/Plant	No. of Leaves/Plant	Leaf Area (cm²)	Leaf Area Index (LAI)	Leaf Biomass (g/plant)	Shoot Biomass (g/plant)	Total Dry Matter (g/plant)
Control (No manure/fertilizer)	78.2	3.2	7.1	305.4	1.2	15.3	32.1	47.4
Cow Dung (15 t/ha)	91.5	4.1	8.5	387.6	1.6	21.8	42.6	64.4
Poultry Manure (7 t/ha)	105.6	5.3	10.2	485.3	2.0	28.7	53.4	82.1
Mustard Cake (2 t/ha)	102.3	5.0	9.8	470.1	1.9	27.4	51.2	78.6
Neem Cake (2 t/ha)	98.7	4.7	9.3	455.2	1.8	25.8	48.5	74.3

Table 3 presents the effect of different organic manures on the vegetative growth and biomass production of turmeric. The results clearly show that organic manure application significantly improved plant growth compared to the control (no fertilizer).

Among all treatments, **poultry manure** at 7 t/ha led to the highest performance in all growth parameters. Plants under this treatment reached an average height of 105.6 cm, produced 5.3 tillers and 10.2 leaves per plant, and had the highest leaf area (485.3 cm²) and leaf area index (2.0). Consequently, poultry manure also resulted in the highest leaf biomass (28.7 g), shoot biomass (53.4 g), and total dry matter (82.1 g/plant), indicating its superior nutrient content and quick nutrient release.

Mustard cake and **neem cake** also showed considerable improvements over the control, with mustard cake slightly outperforming neem cake in most parameters. Cow dung, although less nutrient-dense, still improved growth significantly compared to the control, likely due to its role in enhancing soil structure and microbial activity.

The control treatment consistently recorded the lowest values across all parameters, emphasizing the importance of nutrient supplementation for turmeric. Overall, poultry manure proved to be the most effective organic amendment for maximizing vegetative growth and biomass in turmeric.

Table 4. Yield, Yield attributes & quality of turmeric as influenced by different organic manures

Treatment	No. of Rhizomes/Plant	Rhizome Weight/Plant (g)	Rhizome Size (cm)	Rhizome Dry Matter (%)	Curing Percentage (%)	Curcumin Content (%)	Harvest Index (%)	Yield (t/ha)
Control (No manure/fertilizer)	6.2	110.4	5.2	21.5	22.3	2.6	35.8	14.2
Cow Dung (15 t/ha)	7.5	135.6	5.8	23.2	24.1	3.1	41.2	18.7
Poultry Manure (7 t/ha)	9.2	162.3	6.5	25.6	26.8	4.0	47.6	24.5
Mustard Cake (2 t/ha)	8.7	155.7	6.3	25.1	26.0	3.8	46.0	23.2
Neem Cake (2 t/ha)	8.1	148.2	6.0	24.5	25.5	3.5	44.5	21.8

Table 4 shows that organic manures significantly influenced turmeric yield, yield attributes, and quality. **Poultry manure** resulted in the highest performance, producing 9.2 rhizomes/plant, 162.3 g rhizome weight, and the highest curcumin content (4.0%) and yield (24.5 t/ha). **Mustard cake** and **neem cake** also improved rhizome size, dry matter, and curing percentage over the control. **Cow dung** had moderate effects, while the **control** consistently recorded the lowest values. Overall, poultry manure proved most effective in enhancing both productivity and quality of turmeric, likely due to its high nutrient content and better availability compared to other organic sources.

The study demonstrated that organic manures significantly enhanced turmeric growth, yield, and quality compared to the control. Poultry manure showed the best results across all parameters—plant growth, biomass production, rhizome yield, and curcumin content—due to its rich nutrient profile and rapid nutrient release. Mustard and neem cakes also performed well, contributing to higher dry matter and quality traits. Cow dung improved soil health but was less nutrient-dense. The findings confirm that integrating nutrient-rich organic manures, especially poultry manure, can boost turmeric productivity and quality sustainably, offering an eco-friendly alternative to chemical fertilizers in turmeric cultivation.

IV. Conclusion

The study concludes that poultry manure is the most effective organic amendment for enhancing turmeric growth, yield, and quality. Mustard and neem cakes also showed promising results. Overall, organic manures significantly improve turmeric performance, offering a sustainable, eco-friendly alternative to chemical fertilizers for better crop productivity and soil health.

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