# Comparative Analysis of Inorganic and Organic Sources on Economic Viability Productivity of Turmeric (Curcuma Longa L.)


## Abstract

Turmeric (*Curcuma longa* L.) (Family: *Zingiberaceae*), Known as "Indian Saffron," a long-used and revered spice, is a significant commercial spice crop farmed in India. Known by many as the "Golden Spice of life," it is one of the most vital spices and a staple in cuisine all over the world. A tropical perennial plant native to Indonesia and India, turmeric is grown all over the world's tropics. India grows this significant commercial spice. It is ingrained in Indian tradition. The world's best turmeric is thought to come from India. In many Asian nations, Indian colloquial names are known as pasupu, haldi, manjal, and kunyit. Just 6% of India's land is used for growing spices and condiments, despite the country being the world's top producer, exporter, and supplier of 78% of the world's supply of turmeric. Furthermore, among Indian spices, turmeric is the second-biggest earner of foreign cash. India being one of the major producers of turmeric, contributes 80% to global production. In the year 2018-19, turmeric production was 389 thousand tonnes, with area and productivity 246 thousand hectares and 5646.34 kg per hectare respectively. The growth pattern of the area, production, and productivity of turmeric over the period of time indicate the growing contribution of production over the area expansion to the increased yield. India uses almost 80% of the world's turmeric. It makes up 80% of global production. With the largest proportion of 38% of all India's turmeric area, Andhra Pradesh is referred to as the "Turmeric Bowl of India," with Orissa coming in second. Another important policy strep i.e. “One District One Product” under Centrally Sponsored Scheme PMFME (PM Formalization of Micro food processing Enterprises Scheme), Turmeric is listed in the selected product in all states, this is an additional scope under which states can be encouraged to adopt cluster approach and group approaches such as FPOs, SHGs (Self Help Groups) and producer cooperatives. This will help to bring the win-win situation to both farmers and the microenterprises. Also, except Assam, the spread of formal/organized food processing units are scanty, the innovation center for developing value-added products from the traditional knowledge can be encouraged so that in the long run the product can be easily scaled up.




Introduction:

In general, turmeric reacts to increasing soil fertility and the amount of applied fertilizers (both organic and inorganic), and it requires more mineral nutrients. Due to its extended growth period and elevated yield, a greater amount of fertilizers is needed. The use of inorganic fertilizers raises yields significantly, but they are unable to maintain the soil's fertility and have a number of negative effects on the delicate soil eco-system, which causes productivity to gradually fall. In addition to applying chemical fertilizers to turmeric, an integrated nutrient management strategy that incorporates many sources of organic manures, organic cakes, and biofertilizers is required given the current state of soil quality and environmental security. "The soil's fitness to support crop growth without becoming degraded or otherwise harming the environment" is the definition of soil health. The physical, chemical, and biological characteristics of the soil—such as its texture, the kind and quantity of nutrients that are available, its organic matter content, its moisture content, its degree of aeration, its pH, its temperature, and its microbial diversity—determine it. Certain intrinsic and extrinsic elements, such as the crop grown, the source of external nutrients supplied, and the quantity of microorganisms present, have an impact on all these features. A clear and vital role for microorganisms is played in soil fertility. Despite making up less than 1% of a soil's total mass, soil organisms are essential to the survival of all plants and, by extension, all animals. A typical healthy soil contains thousands of different species of microorganisms per gram.

Apart from bacteria, the soil supports microscopic fungi, algae, cyanobacteria, Actinomycetes, protozoa, and nematodes, as well as larger organisms including insects, wombats, and earthworms. In addition to aiding in the breakdown of hazardous waste and other contaminants, microorganisms are crucial to the breakdown of organic materials. More types and quantities of life than in any other ecosystem can be found in the soil. Microorganisms are essential to the health of the soil and the growth of plants. Plant nutrition is greatly impacted by the use of biofertilizers, an inexpensive and environmentally friendly input that can be used in conjunction with both organic and inorganic fertilizers as part of an integrated nutrient management approach.

In addition to biological nitrogen fixation, biofertilizers are thought to play a role as growth regulators, which together result in a significantly stronger response on a variety of growth and yield-related characteristics (Avitoli et al. 2012). Turmeric is grown well in Jammu's Shivalik foothills due to the region's various agroclimatic conditions, variety of soil types, and copious amounts of rainfall. However, there is currently no information accessible regarding the management of turmeric's nutrients in the area, particularly beneath Jammu's Shivaliks' foothills. Considering the aforementioned, the current study was carried out to examine the impact of integrated nutrient management on the economics and production of turmeric in the Jammu and Kashmir foothills.

## MATERIALS AND METHODS

The trials were conducted in 2021 and 2023 at Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu, at the Experimental Farm, Krishi Vigyan Kendra, Farm Science Center. The field was situated geographically at (N320 57.78 E 74-57.45 with elevation of 2465 m) and at an altitude of 304.8 m above mean sea level. The zone receives 1100 mm of rain on average. It was set up with four replications and thirteen treatments in a randomised full block design. The treatments were as follows: T1 - 75% of the recommended N organic by FYM; T2 - 100% of the recommended N organic (25 t ha-1 FYM equivalent to 125 kg N ha -1); T3 - 125% of the recommended N organic; T4 - 75% of the recommended N organic by FYM + biofertilizers; T5 - 100% of the recommended N organic + biofertilizers; T6 - 125% of the recommended N organic + biofertilizers; T7 - 75% of the recommended N inorganic; T8 - 100% of the recommended N inorganic; T9 - 12% of the recommended N inorganic; T10 - 75% of the recommended N inorganic + biofertilizers; T11 - 100% of the recommended N inorganic + biofertilizers; and T13 - Control (without organic and inorganic nitrogen and biofertilizers). Before planting, a consistent quantity of 25 kg ha-1 of potassium and phosphorus was sprayed. Before planting a crop, farmyard manure (a source of organic N with a N%=0.45) was applied in accordance with the procedures and thoroughly mixed with the soil. Four equal splits of urea were applied as a source of inorganic nitrogen, corresponding to planting, 75, 100, and 125 days after planting (DAP), depending on the treatments. The biofertilizer consortium (10 kg ha-1) consists of plant growth promoting rhizobacteria (PGPR), phosphate solubilizing bacteria (PSB), and Azotobacter that is sprayed during seeding time.

The sandy loam soil in the experimental field had a low organic carbon content of 0.45% (as determined by Piper in 1966 using Walkley and Black's quick titration method) and 182.4 kg ha-1 of accessible nitrogen (subbiah and Asija, 1956) The levels of accessible potassium (194.6 kg ha -1; Mervin and Peech 1950) and phosphorus (12.9 kg ha -1; 0.5 N sodium bicarbonate extractable P by Olsen et al., 1954) were both considered medium. The electrical conductivity (0.20 dSm-1) and pH (7.7) of the soil were also within the expected ranges. Using 20 q ha-1 of rhizomes, the planting was carried out in the first week of May at a spacing of 30 cm by 20 cm. Soon after the crop was sown, 6.25 t ha-1 of leucaena tree leaves were used as mulch. In the second week of February, the turmeric was manually harvested. Following

Corchran and Cox's advice, a statistical analysis of the data gathered at various phases of crop growth was conducted (1967). At the five percent significance level, treatment comparisons were conducted.

## RESULTS AND DISCUSSION

### Emergence count:

At 30 and 45 DAP, the findings (Table 1) indicated substantial effects on emergence count; at 60 DAP, the results were not significant. This might result from farm yard manure's (FYM) superior moisture-holding capacity over artificial fertilizers (Padmapriya and Chezhiyan, 2009), even with consistent irrigation. When comparing the treatments where biofertilizers were not applied to the emergence count, the effect of biofertilizers was determined to be non-significant. The outcomes demonstrated that the organic nitrogen source aided in the early phases of quicker emergence.

### Plant height and dry matter accumulation:

When nitrogen was applied through FYM as opposed to treatments where it was applied through inorganic source and control, Table 1 indicates a considerable increase in plant height and dry matter accumulation. The application of 100 and 125% of the prescribed organic manure over a lower dose considerably improved the plant height and dry matter accumulation. When treated with either organic or inorganic sources of nitrogen, biofertilizers showed very little improvement. Maximum plant height and dry matter accumulation were noted for each treatment, and the treatments containing 125% of the recommended organic manure were comparable to those containing 100% of the recommended organic manure, whether or not biofertilizers were used. Even when biofertilizers were used, there was no discernible increase in plant height or dry matter accumulation in response to an increase in inorganic nitrogen levels. In terms of plant height and dry matter accumulation by plant over inorganic nitrogen, the organic manure continued to outperform the inorganic fertilizers. This could be because organic manure has a longer-lasting nutritional effect than artificial fertilizers, which eventually causes the crop to develop faster and accumulate more dry matter (Gill et al., 2017).

### Number of tillers per plant:

When applied alone or in conjunction with biofertilizers, the increased levels of both organic and inorganic nitrogen did not significantly affect the number of tillers per plant (Table 1). This demonstrated that the administration of biofertilizers and the source of nitrogen had no effect on the number of tillers per plant. Higher doses, even with split delivery of inorganic nitrogen at different weeks after planting, did not affect the number of tillers per turmeric plant, according to Yamgar et al. (2019).

### Number of rhizomes per plant:

The data (Table 2) showed that the number of mother, primary, secondary rhizome individually or total number of rhizomes per plant was not substantially influenced by the source of nitrogen administered i.e. either organic or inorganic nitrogen alone and in combination with biofertilizers. Selvarajan and Chezhiyan (2019) also observed that integrated fertilizer management and varying quantities of organic manure (FYM) had non-significant effect on number of rhizomes per plant.

### Weight of rhizomes per plant:

In comparison to the inorganic nitrogen and control, there was a considerably greater increase in the rhizome weight per plant (Table 2) under the treatments where nitrogen was applied through organic sources alone and in combination with the biofertilizers. The treatment containing 125 percent of recommended organic manure with (T6) and without (T3), which is equivalent to the 100 percent of recommended organic manure with (T5) or without (T2) the biofertilizers, produced the maximum fresh weight of rhizome per plant (198.37 g and 208.23 g), respectively. With nitrogen supplied solely from inorganic sources and with the use of biofertilizers, the increase in the fresh weight of rhizome per plant was not statistically significant**.** According to Gill et al. (2019), the fresh weight of rhizomes per plant was not significantly affected by the amount or timing of nitrogen administration. According to Gill et al. (2017), there was a noteworthy rise in the weight of fresh rhizome per plant as a consequence of elevated levels of FYM.

**Fresh and processed yield:**

In comparison to inorganic nitrogen and control, the fresh and processed yield data (Table 3) demonstrated a statistically significant increase in yield under the treatments containing organic manure. The combination of 125% recommended organic manure and biofertilizers produced the highest fresh and processed yields, and this combination was statistically equivalent to using 100% recommended organic manure with (T5) or without biofertilizers (T2). When organic manures were applied, the fresh rhizome yield increased from 56 (T1) to 80 (T6) percent and the processed yield from 65.7% to 118.2 percent when compared to the control. Additionally, the data demonstrated that the yield of processed and fresh rhizomes was statistically equivalent to that of the various inorganic nitrogen levels, whether or not biofertilizers were used. According to Gill et al. (2017), there was a considerable increase in the fresh rhizome yield of turmeric with a level of FYM rise. Additionally, Kandiannan and Chandaragir (2019) noted that the production of dried rhizomes from turmeric was not significantly impacted by varying levels of inorganic nitrogen.

Economics:

When organic manures were applied instead of inorganic nitrogen and control, the data (Table 3) demonstrated a greater cost-benefit ratio. This resulted from the turmeric rhizome yield—both fresh and processed—being higher under the organic manures. Applying 125% of organic manure combined with the biofertilizers resulted in the highest cost-benefit ratio of 2.1. When compared to the treatment without biofertilizers, biofertilizers enhanced the production of processed and fresh rhizomes, boosting the overall returns and benefit cost ratio.

**Summary**

The investigation indicated that the development and yield of turmeric are positively impacted by organic manure, or FYM. In comparison to lower dosages and treatments where nitrogen was provided through an inorganic source (urea) and control, the application of 25 t ha-1 of organic manure (FYM) resulted in superior crop growth, yield, and net returns. Using varying amounts of inorganic nitrogen did not significantly boost growth or production. This shown that, in Punjabi circumstances, turmeric was not responsive to inorganic fertilizers alone. Turmeric yield and growth were marginally enhanced by the use of biofertilizers.

**Table 1. Effect of different treatments on the growth of turmeric.**

| **Treatment** | **Emergence count (%)** | | | **Plant height (cm)** | **Dry matter accumulation (q/ha)** | **No. of tillers per plant** |
|---|---|---|---|---|---|---|
| | **30 DAP** | **45 DAP** | **60 DAP** | | | |
| T1 - 75 % Recommended Organic manure by FYM | 24.4 | 53.4 | 94.4 | 44.1 | 30.9 | 2.0 |
| T2 - 100 % Organic manure by FYM | 24.9 | 55.8 | 96.3 | 47.3 | 33.2 | 2.1 |
| T3 - 125 % Organic manure by FYM | 25.1 | 56.7 | 94.0 | 49.1 | 34.8 | 2.3 |
| T4 - 75 % Organic manure by FYM + Bio fertilizer | 24.3 | 54.7 | 95.0 | 45.6 | 31.8 | 2.1 |
| T5 - 100 % Organic manure by FYM + Bio fertilizer | 24.6 | 55.5 | 94.1 | 47.9 | 33.8 | 2.1 |
| T6 - 125 % Organic manure by FYM + Bio fertilizer | 25.9 | 57.0 | 94.4 | 50.3 | 35.5 | 2.4 |
| T7 - 75 % Inorganic fertilizer (RDF) | 21.5 | 51.9 | 93.7 | 40.9 | 25.1 | 1.9 |
| T8 - 100 % Inorganic fertilizer (RDF) | 22.3 | 52.1 | 94.2 | 41.6 | 25.9 | 1.8 |
| T9 - 125 % Inorganic fertilizer (RDF) | 22.2 | 52.3 | 94.1 | 42.6 | 26.9 | 1.9 |
| T10 - 75 % Inorganic fertilizer (RDF)+ Biofertilizer | 21.7 | 52.4 | 92.1 | 41.9 | 26.1 | 2.0 |
| T11 - 100 % Inorganic fertilizer (RDF)+ Biofertilizer | 22.5 | 53.0 | 93.5 | 42.4 | 26.8 | 1.9 |

| | | | | | | |
|---|---|---|---|---|---|---|
| T12 - 125 % Inorganic fertilizer (RDF)+ Biofertilizer | 22.5 | 53.1 | 92.4 | 42.9 | 27.2 | 2.0 |
| T13 Biofertilizer consortium | 20.7 | 51.6 | 94.0 | 34.9 | 24.2 | 1.9 |
| T14 - Control | 18.78 | 46.85 | 91.32 | 32.90 | 22.45 | 1.5 |
| CD (p=0.05) | 1.8 | 2.0 | N S | 3.2 | 3.0 | NS |

**Table 2. Effect of different treatments on the yield attributes of turmeric.**

| **Treatment** | **Mothers rhizome** | **Primary rhizome** | **Secondary rhizome** | **Total rhizome** | **Weight of rhizomes / plant (g)** |
|---|---|---|---|---|---|
| T1 - 75 % Organic manure by FYM | 1.3 | 6.1 | 7.1 | 14.5 | 174.9 |
| T2 - 100 % Organic manure by FYM | 1.1 | 5.8 | 7.3 | 14.3 | 189.8 |
| T3 - 125 % Organic manure by FYM | 1.3 | 6.3 | 7.7 | 15.1 | 198.4 |
| T4 - 75 % Organic manure by FYM + Bio fertilizer | 1.3 | 5.7 | 6.0 | 12.5 | 181.8 |
| T5 - 100 % Organic manure by FYM + Bio fertilizer | 1.3 | 5.6 | 8.1 | 14.9 | 195.3 |
| T6 - 125 % Organic manure by FYM + Bio fertilizer | 1.1 | 6.1 | 8.6 | 15.7 | 208.2 |
| T7 - 75 % Inorganic fertilizer (RDF) | 1.2 | 5.8 | 7.0 | 13.2 | 139.7 |
| T8 - 100 % Inorganic fertilizer (RDF) | 1.3 | 5.8 | 6.5 | 13.4 | 142.5 |
| T9 - 125 % Inorganic fertilizer (RDF) | 1.3 | 6.5 | 6.6 | 14.3 | 144.8 |
| T10 - 75 % Inorganic fertilizer (RDF)+ Biofertilizer | 1.4 | 6.1 | 7.5 | 14.8 | 140.6 |
| T11 - 100 % Inorganic fertilizer (RDF)+ Biofertilizer | 1.2 | 5.9 | 5.0 | 11.9 | 144.6 |
| T12 - 125 % Inorganic fertilizer (RDF)+ Biofertilizer | 1.1 | 5.2 | 6.3 | 12.6 | 145.9 |
| T13 Biofertilizer consortium | 1.1 | 5.9 | 7.6 | 12.9 | 141.7 |
| T14 - Control | 1.1 | 5.7 | 7.9 | 14.6 | 128.6 |
| CD (p=0.05) | NS | NS | NS | NS | 17.3 |

**Table 3. Effect of different treatments on the fresh yield, processed yield and economics of turmeric.**

| **Treatment** | **Fresh yield (q/ha)** | **Percent increase over control** | **Processed yield (q/ha)** | **Percent increase over control** |
|---|---|---|---|---|
| T1 - 75 % Organic manure by FYM | 177.5 | 56.7 | 23.7 | 65.7 |
| T2 - 100 % Organic manure by FYM | 191.2 | 68.8 | 28.3 | 97.9 |
| T3 - 125 % Organic manure by FYM | 202.4 | 78.6 | 30.9 | 116.0 |
| T4 - 75 % Organic manure by FYM + Bio fertilizer | 181.7 | 60.4 | 24.7 | 72.7 |
| T5 - 100 % Organic manure by FYM + Bio fertilizer | 193.7 | 71.0 | 29.4 | 105.5 |
| T6 - 125 % Organic manure by FYM + Bio fertilizer | 204.4 | 80.4 | 31.2 | 118.2 |
| T7 - 75 % Inorganic fertilizer (RDF) | 121.5 | 7.2 | 17.4 | 21.6 |
| T8 - 100 % Inorganic fertilizer (RDF) | 124.0 | 9.4 | 18.6 | 30.0 |
| T9 - 125 % Inorganic fertilizer (RDF) | 124.3 | 9.7 | 18.7 | 30.7 |
| T10 - 75 % Inorganic fertilizer (RDF)+ Biofertilizer | 122.9 | 8.5 | 17.9 | 25.1 |
| T11 - 100 % Inorganic fertilizer (RDF)+ Biofertilizer | 124.9 | 10.2 | 18.6 | 30.0 |
| T12 - 125 % Inorganic fertilizer (RDF)+ Biofertilizer | 125.4 | 10.7 | 19.4 | 35.6 |
| T13 Biofertilizer consortium | 123.3 | 9.0 | 18 | 25.6 |
| T14 - Control | 113.3 | | | |
| CD (p=0.05) | 14.7 | - | 3.4 | - |

**Table 4. Effect of different treatments on the economics of turmeric.**

| Treatment | Total Cost (Rs /ha) | Total Returns (Rs/ ha) | Benefit : Cost |
|---|---|---|---|
| T1 - 75 % Organic manure by FYM | 1,95,968 | 3,36,000 | 1.7 |
| T2 - 100 % Organic manure by FYM | 2,03,268 | 3,92,000 | 1.9 |
| T3 - 125 % Organic manure by FYM | 2,06,368 | 4,34,000 | 2.1 |
| T4 - 75 % Organic manure by FYM + Bio fertilizer | 1,97,868 | 3,50,000 | 1.8 |
| T5 - 100 % Organic manure by FYM + Bio fertilizer | 2,04,768 | 4,06,000 | 2.0 |
| T6 - 125 % Organic manure by FYM + Bio fertilizer | 2,07,668 | 4,34,000 | 2.1 |
| T7 - 75 % Inorganic fertilizer (RDF) | 1,79,368 | 2,38,000 | 1.3 |
| T8 - 100 % Inorganic fertilizer (RDF) | 1,80,868 | 2,66,000 | 1.5 |
| T9 - 125 % Inorganic fertilizer (RDF) | 1,81,768 | 2,66,000 | 1.5 |
| T10 - 75 % Inorganic fertilizer (RDF)+ Biofertilizer | 1,79,768 | 2,52,000 | 1.4 |
| T11 - 100 % Inorganic fertilizer (RDF)+ Biofertilizer | 1,81,968 | 2,66,000 | 1.5 |
| T12 - 125 % Inorganic fertilizer (RDF)+ Biofertilizer | 1,82,168 | 2,66,000 | 1.5 |
| T13 Biofertilizer consortium (10 kg ha-1) | 1,79,368 | 2,38,000 | 1.3 |
| T13 - Control | 1,75,068 | 1,96,000 | 1.1 |
| CD (p=0.05) | - | - | - |

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