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Standardization of organic cultivation practice for enhancing yield and quality of turmeric (*Curcuma longa*) in terai region of West Bengal

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Abstract

A field experiment was conducted at ICAR–National Institute for Research on Commercial Agriculture, Research Station, Dinhata, West Bengal to standardize organic nutrient management for turmeric (*Curcuma longa*) (Lakadong). The trial was laid out in randomized block design with twelve treatment combinations. The results revealed that application of recommended fertilizer dose (120:80:120 kg ha-¹) gave total fresh rhizome yield of 9.7 t/ha which was on a par with FYM (40 t/ha) + microbial consortium with total fresh rhizome yield (9.5 t/ha). The highest curcumin (4.5 %) was obtained in the application of Vermi compost @ 10 t/ha followed by 4.3 % in application of FYM (40 t/ha) + microbial consortium which were statistically at par. Therefore, application of FYM (40 t/ha) + microbial consortium can be recommended for cultivation of Lakadong turmeric in terai region of West Bengal.

Key words: Turmeric, Organic, Yield, Curcumin

Turmeric (*Curcuma longa* L.), a perennial spice of the family Zingiberaceae, is one of India's most important crops, valued for its culinary, medicinal, and cultural uses. In Ayurveda, it is known for its antioxidant, antimicrobial, anti-inflammatory, and anticancer properties (Verma *et al.*, 2019; Mandi *et al.*, 2025). India leads globally in turmeric production and export, noted for high curcumin content and superior quality. However, in West Bengal, the area (18,000 ha) and productivity (2.5 t ha-¹) remain below the national average (4.7 t ha-¹) (Dutta *et al.*, 2017; Verma *et al.*, 2019; Mandi *et al.*, 2025). Being a nutrient-exhaustive crop, turmeric requires balanced nutrition for optimum yield. Overuse of chemical fertilizers deteriorates soil health, while organic manures enhance soil structure, microbial activity, and sustainability (Dinesh *et al.*, 2010; Parikh *et al.*, 2020). Previous studies reported higher yield and quality in Lakadong with integrated organic nutrient management involving vermicompost, FYM, and microbial inoculants (Verma *et al.*, 2019; Yumnam and Swami, 2022). However, such organic practices are yet to be standardized for the *terai* region of West Bengal. Hence, the present study aimed to identify suitable organic nutrient sources for enhancing yield and quality of Lakadong turmeric under *terai* conditions.

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MATERIALS AND METHODS

The experiment was carried out at ICAR-NIRCA Research Station Dinhata, Cooch Behar, West Bengal, during 2021-22, 2022-23 and 2023-24. The experiment was laid out in Randomized Block Design (RBD) with three replications in variety Lakadong. Different treatments in this experiment were as T_1: Control; T_2: Recommended dose of NPK (120: 80:120), T_3: FYM (40 t/ha); T_4: maize straw compost (MSC) (50 t/ha); T_5: pond settled mud (50 t/ha); T_6: vermicompost (10 t/ha); T_7: FYM (40 t/ha) + microbial consortium ; T_8: maize straw compost (40 t/ha) + microbial consortium; T_9: pond settled mud (50 t/ha) + microbial consortium; T_{10}: FYM (20 t/ha) + vermicompost (5 t/ha); T_{11}: maize straw compost (20 t/ha) + vermicompost (5 t/ha) + microbial consortium; T_{12}: Pond setlled mud (25 t/ha) + vermicompost (5 t/ha) + microbial consortium.

Observations on different morphological and yield attributing characters were recorded from three randomly selected plants from each plot. Rhizome yield per hectare was calculated on the per plant weight basis. Curcumin content of dry turmeric rhizome was estimated as suggested by Jansirani *et al.* (2014). The replicated data of yield and quality parameters of three years were pooled and subjected to statistical analysis using software available at https://www.kaugrapes.com/analysis-of-experiments/rbd-analysis. Data were subjected to analysis of variance (ANOVA) to evaluate the significance of treatment means. Means were separated using at 5 % level of significance (Gomez & Gomez, 1984). Correlation was also performed between different growth, yield and quality parameters and correlated them with total fresh rhizome yield.

RESULTS AND DISCUSSION

The pooled data of different growth parameters varied significantly by application of different organic and inorganic treatments. The plant height varied from 61.2 cm to 136.4 cm. In pooled analysis, highest plant height (136.4 cm) was observed with application of recommended dose of NPK (120: 80:120 kg/ha) which was significantly different from all the treatments Table 1). The similar observation was recorded by Ronya *et al.* (2020) where maximum plant height was obtained in recommend fertilizer dose. The second highest plant height (114.6 cm) was observed with application of FYM @40 t/ha which was statistically at par with application of FYM (20 t/ha) + vermicompost (5 t/ha) with plant height of 109.4 cm. The higher values in plant height might be due to balanced availability of all the essential mineral nutrients resulted in better growth and development of the plant. Yumnam and Swami (2022) found higher plant height with the application of 50% RDN through urea + 50% N through vermicompost. Our study contradicts the finding of Dutta *et al.* (2017) where maximum plant height was found with application of green leaf manure @ 12 t/ha + rock phosphate @ 200 kg/ha + *Azospirillium* @5 kg/ha + wood ash @ 1 t/ha + PSB @ 5 kg/ha. The number of leaves/plant varied significantly under different treatment combinations. The maximum number of leaves/plant (10.2) was obtained in application of FYM @40 t/ha + microbial consortium which was statistically at par with the application of pond settled mud (25 t/ha) + vermicompost (5 t/ha) + microbial consortium having same number of leaves (10.2). The lowest number of leaves (5.4) was obtained in control treatment. Kadam and Kamble (2020) and Ronya *et al.* (2020) found maximum number of leaves/plant in recommended dose of fertilizer which contradicts the present findings.

There was significant difference between the treatments for fresh rhizome weight per plant. The highest fresh rhizome weight per plant (116.9 g) was observed in the application of recommended fertilizer dose followed

Table 1. Plant height, number of leaves per plant, total fresh rhizome weight per plant, total fresh rhizome yield of turmeric variety Lakadong under different treatments (Pooled data of 3 years)

	Plant height (cm)	Number of leaves/plant	Fresh rhizome weight (g) plant	Total fresh rhizome yield (t/ha)
T^1	67.7[ef]	5.4[i]	76.3[g]	6.3[g]
T^2	136.4[a]	9.1[b]	116.9[a]	9.7[a]
T^3	114.6[b]	8.8[bc]	108.1[b]	9.0[b]
T^4	77.7d[e]	6.6[h]	86.7[f]	7.2[f]
T^5	61.2[f]	7.2[fg]	101.9[cd]	8.4[cd]
T^6	75.5d[e]	7.5[ef]	88.7[f]	7.3[f]
T^7	105.2[bc]	10.2[a]	114.7[a]	9.5[a]
T^8	82.3[d]	6.9[gh]	91.5[ef]	7.6[ef]
T^9	76.3[de]	6.8[gh]	100.4[cd]	8.3[cd]
T^{10}	109.4[b]	8.0[de]	96.7[de]	8.0[de]
T^{11}	81.5[d]	8.4[cd]	114.8[a]	9.5[a]
T^{12}	95.6[c]	10.2[a]	105.2[bc]	8.7[bc]
S.Em.±	6.6	0.1	1.7	0.1
CD at 0.05 (P=0.05)	10.1	0.5	5.0	0.4
CV (%)	6.6	3.7	3.0	3.0

T_1: Control; T_2: Recommended dose of NPK (120: 80:120), T_3: FYM (40t/ha); T_4: maize straw compost (MSC) (50t/ha); T_5: pond settled mud (50 t/ha); T_6: vermicompost (10t/ha); T_7: FYM (40 t/ha) + microbial consortium; T_8: maize straw compost (40 t/ha) + MC; T_9: pond settled mud (50 t/ha) + MC; T_{10}: FYM (20 t/ha) + vermicompost (5 t/ha); T_{11}: maize straw compost (20 t/ha) + vermicompost (5 t/ha) + microbial consortium; T_{12}: pond settled mud (25 t/ha) + vermicompost (5 t/ha) + microbial consortium ([##]treatments with same letters are not significantly different)

Table 2. Pearson's correlation between different parameters

	Plant Height (cm)	Number of leaves per plant	Fresh rhizome weight per plant (g)	Total fresh rhizome yield (t/ha)	Curcumin content (%)
Plant Height (cm)	1				
Number of leaves/plant	0.678*	1			
Fresh rhizome weight/ plant (g)	0.617*	0.819**	1		
Total fresh rhizome yield (t/ha)	0.628*	0.819**	1***	1	
Curcumin content (%)	-0.095	0.313	0.222	0.217	1

*** Correlation is significant at 0.001 level; ## ** Correlation is significant at 0.01 level; ## * Correlation is significant at 0.05 level

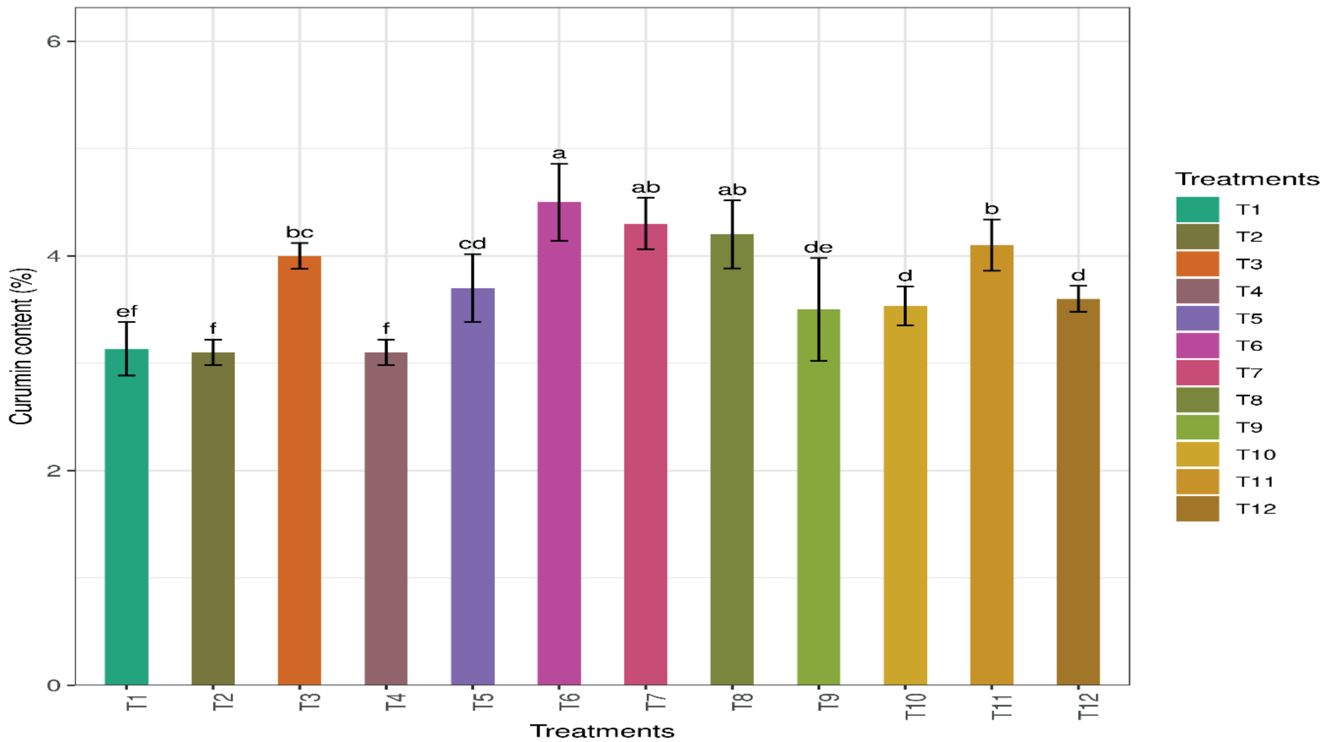

Fig. 1. Effect of different treatment combinations on curcumin content (%) (treatments with same letters are not significantly different at 5% level) T_1: control; T_2: recommended dose of NPK (120: 80:120), T_3: FYM (40 t/ha); T_4: maize straw compost (MSC) (50 t/ha); T_5: pond settled mud (50 t/ha); T_6: vermicompost (10 t/ha); T_7: FYM (40 t/ha) + microbial consortium; T_8: maize straw compost (40 t/ha) +MC; T_9: pond settled mud (50 t/ha) + MC; T_{10}: FYM (20 t/ha) + vermicompost (5 t/ha); T_{11}: maize straw compost (20 t/ha) + vermicompost (5 t/ha) + microbial consortium; T_{12}: pond settled Mud (25 t/ha) + vermicompost (5 t/ha) + microbial consortium (##treatments with same letters are not significantly different)

by 114.8 g in application of maize straw compost (20 t/ha) + vermicompost (5 t/ha) + microbial consortium and 114.7 g in FYM (40 t/ha) + microbial consortium which were all statistically at par. Our result revealed that FYM have more effect in enhancing fresh rhizome weight per plant. Total fresh rhizome yield per hectare of turmeric varied significantly with the application of different treatments. The results revealed that application of recommended fertilizer dose with total fresh rhizome yield of 9.7 t/ha which was statistically at par with that of FYM (40 t/ha) + microbial consortium and maize straw compost (20 t/ha) + vermicompost (5 t/ha) + microbial consortium which showed same total fresh rhizome yield (9.5 t/ha). Our result showed that the organic treatment such as FYM, vermicompost, microbial consortium have great influence in enhancing yield of turmeric. Yumnam and Swami (2022) reported higher fresh rhizome yield in the same Lakadong variety. In our study, yield is less over the years which could be due to environmental effect as this variety recommended for Meghalaya region. Therefore, organic treatment combinations can be tested for other economically important commercial variety of the region for enhancing yield and quality of turmeric.

Application of organic components like FYM and microbial consortium improved soil fertility and yield in turmeric (Velmurugan *et al.*, 2007; Dinesh *et al.*, 2010). Organic manure and biofertilizers enhanced vegetative growth and biomass (Mohapatra and Das, 2009), while different organic combinations positively influenced growth and yield (Sarma *et al.*, 2015). Improved performance may result from enhanced nutrient availability and microbial activity promoting photosynthate translocation to rhizomes (Dinesh *et al.*, 2010). Parikh *et al.* (2023) reported the highest rhizome weight (301.4 g/plant) and yield (32.2 t/ha) with 5% organic liquid nutrients. Vermicompost also enhances microbial activity, N_2 fixation, and phosphate mobilization, improving nutrient uptake (Kale *et al.*, 1992).

Turmeric powder and curcumin are key value-added products, with curcumin content varying from 3.1% to 4.5% across treatments (Fig. 1). The highest curcumin (4.5%) was recorded with vermicompost @ 10 t/ha, followed by FYM (40 t/ha) + microbial consortium (4.3%), both being statistically at par. Similar enhancement with vermicompost was reported by Manohar Rao *et al.* (2005). Organic manures provide balanced nutrients throughout growth, improving curcumin content (Velmurugan *et* *al.*, 2007) and enhancing yield and quality over inorganic fertilizers (Singh *et al.*, 2015). Yamawaki *et al.* (2013) also observed higher curcumin with arbuscular mycorrhizal fungi application. Parikh *et al.* (2023) recorded 3.86% curcumin and 3.23% essential oil with 0.2% humic acid. According to Anandaraj *et al.* (2014), yield is mainly environment-dependent, while curcumin content is influenced by both genotype and environment, including factors such as temperature, rainfall, and soil fertility.

Total fresh rhizome yield showed a strong positive correlation with fresh rhizome weight per plant ($r = 1.0$, $p < 0.001$) and number of leaves/plant ($r = 0.819$, $p < 0.01$). Number of leaves/plant was also positively correlated with plant height ($r = 0.678$, $p < 0.01$). Fresh rhizome weight/plant and number of leaves per plant were similarly correlated ($r = 0.819$, $p < 0.01$). A weak, non-significant positive correlation was observed between fresh rhizome weight per plant and curcumin content ($r = 0.217$) (Table 2).

CONCLUSION

The total fresh rhizome yield of turmeric variety Lakadong was significantly influenced by different organic sources. Application of FYM (40 t/ha) + Microbial consortium and Maize straw compost (20 t/ha) + Vermicompost (5 t/ha) + Microbial consortium produced the best growth and yield. Among these, FYM + Microbial consortium proved most effective in maximizing rhizome yield and curcumin content, making it a suitable recommendation for Lakadong cultivation in the *Terai* region of West Bengal.

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