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COMPARATIVE ASSESSMENT OF INORGANIC AND WATER HYACINTH INTEGRATED COMPOST-BASED TOP-DRESSING ON GROWTH AND YIELD PARAMETERS IN TURMERIC (*Curcuma longa* L.)

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ABSTRACT

Turmeric (Curcuma longa L.) is a nutrient valuing crop which responds effectively and positively to fertilizer application. However, the application of chemical fertilizer continuously can affect negatively on soil health and environment. The integrated use of inorganic and organic fertilizer appears to be a good alternative approach as organic sources help to maintain soil health. Compost produced using water hyacinth (WH) (Eichhornia crassipes) has been effective in substituting inorganic fertilizers. The objective of this study was to investigate the replacement of some inorganic fertilizers in top dressing by WH compost while increasing yield in turmeric cultivation. The control experiment was 100% inorganic fertilizer (T1), according to the Department of Export Agriculture recommendation, while other treatments were 25% inorganic fertilizer + 20 Mt ha^{-1} compost (T2), 50% inorganic fertilizer + 20 Mt ha^{-1} compost (T3), and 75% inorganic fertilizer + 20 Mt ha^{-1} compost (T4). The experiment was conducted in an RCBD design with three replicates with 12 plants in each replicate. Plant height, number of leaves, number of tillers, leaf blade length, leaf width, leaf petiole length, number of mother rhizomes, number of primary fingers, number of secondary fingers, fresh yield per plant, and canopy biomass were measured as parameters. The results indicated that all parameters were significantly affected by the treatments ($p<0.05$). The significantly highest fresh yield per plant (680.32 g) associated with moderate to strong correlations in most of the parameters in T3, suggested that 50% recommended dose of inorganic fertilizer combined with 20 Mt ha^{-1} compost is the best option for integrated fertilizer application. T4 (75% inorganic fertilizer + 20 Mt ha^{-1} compost) recorded the significantly highest vegetative growth with no significant correlations of the parameters with the yield. These results suggest that T3 (50% inorganic fertilizer + 20 Mt ha^{-1} compost) is the most effective combination of inorganic and compost fertilizer as the top dressing among the tested combinations for maximum turmeric growth and yield.

Keywords: Compost, Growth, Inorganic fertilizer, Integrated, Turmeric, Yield

INTRODUCTION

Turmeric (*Curcuma longa* L.) is one of the major spice crops that belongs to the family Zingiberaceae. Turmeric originated in tropical South-East Asia (Alam *et al*., 2024) and grown throughout the tropical and subtropical zones (Prasath *et al*., 2018; Harish *et al*., 2022). This is extensively used as a spice, colouring agent, and medicinal herb (Jyotirmayee *et al*., 2022; Alam *et al*., 2024; Khanna *et al*., 2024). Its medicinal properties are attributed primarily to curcumin, which acts as the primary bioactive compound (Farzaneh *et al*., 2024). Curcumin has numerous medicinal properties (Phukan *et al*., 2022; Mishra *et al*., 2023; Beganovic and Wittmann, 2024; Khanna *et al*., 2024). The essential oil of turmeric contributes to flavor and quality of preservation (Kumar *et al*., 2024; Qiang *et al*., 2024). Turmeric is also widely used as a natural dye in the cosmetics industry and in numerous spiritual ceremonies around the world (Beganovic and Wittmann, 2024). The global turmeric market is expanding, driven by the popularity of food, cosmetics, and pharmaceuticals (Navyashree *et al*., 2024; Nguyen *et al*., 2024). These multiple purposes of turmeric emphasize the necessity for effective cultivation practices to meet global demand.

Turmeric cultivation involves several key practices to ensure high yield and quality (Pandey, 2024). Harvesting of turmeric occurs 7-9 months after planting depending on the planting month (Darekar *et al*., 2021). It can lead to a decline in soil nutrients. This indicates the importance of high-input fertilizers and their management (Adekiya *et al*., 2019). Fertilizer application is important to improve soil and plant nutrient contents and enhance soil enzyme activities (Jabborova *et al*., 2021).

Turmeric has specific nutrient requirements that are essential for its growth and development (Chitdeshwari, 2019; Qazi *et al*., 2020). It demands a balanced supply of macronutrients like nitrogen, phosphorus, and potassium, as well as micronutrients such as zinc and boron (Hnamte *et al*., 2018; Bairagi, 2022). Deficiencies in these nutrients can lead to stunted growth, poor rhizome development, and reduced yield. For instance, nitrogen deficiency may result in pale, yellowing leaves, while a lack of potassium can cause leaf browning and weak plant structure (Kavitha, 2024; Muneer *et al*., 2024; Rajareddy *et al*., 2024). Further, turmeric is a crop which response well to fertilizer application (Jabborova *et al*., 2021).

Nitrogen is vital for vegetative growth, promoting the development of lush, green foliage, which is essential for photosynthesis (Mu and Chen, 2021; Fathi, 2022). Applying nitrogen enhances the quality attributes of turmeric in addition to increasing its yield (Khan *et al*., 2023). Phosphorus is crucial for root development and energy transfer within the plant (Dissanayaka *et al*., 2021), while potassium enhances disease resistance, water regulation, and overall plant vigor (Kumar *et al*., 2020; Sardans and Peñuelas, 2021; Johnson *et al*., 2022).

Though inorganic fertilizer provides all necessary nutrients directly accessible to plants faster and immediately (Roba, 2018), organic materials are essential to improve physical and chemical properties of soil (Chejara *et al*., 2021). This improves rhizome output (Kamal and Yousuf, 2012).

Integrated nutrient management (INM) enhances crop yields by 8-150% compared to conventional practices (Wu and Ma, 2015) by improving water-use efficiency, improving crop production quality, and soil health towards sustainability since inorganic inputs usage in INM reduces the reactive N loses, greenhouse gas emissions lowering human and environmental costs (Kumar *et al*., 2013; Wu and Ma, 2015; Kadam and Kamble, 2020; Tripathi *et al*., 2021). Several studies have shown that INM is a viable strategy for improving turmeric yield and quality while reducing excessive reliance on chemical fertilizers (Amin *et al*., 2013; Patil *et al*., 2012; Kanaujia *et al*. 2018; Lohar and Hase, 2021; Tripathi *et al*., 2021). Amin *et al*. (2013) reported significant highest yield in the treatment of 1.2 kg poultry litter + NPK. Kumar *et al*. (2022) found that combining vermicompost + 100% NPK + biofertilizer resulted in significantly maximum plant height while neem cake + 100% NPK + biofertilizer produced widest leaves. Patil *et al*. (2012) also reported that combining vermicompost with recommended NPK doses resulted in higher yields. Additionally, Kanaujia *et al*. (2018) found that using poultry manure + NPK + *Azospirillum* biofertilizer significantly enhanced rhizome weight in turmeric.

Water hyacinth (WH) (*Eichhornia crassipes*) is an invasive weed usually found in freshwater ecosystems (Onyari *et al*., 2024). Despite this invasion and threat, it is being used to address in the field of food, and energy (Nandiyanto *et al*., 2024). WH compost substituted 50% of the chemical fertile requirement in lettuce and teff grain (Berhe *et al*. 2024; Gezahegn *et al*. 2024). However, the use of WH compost as an organic source for INM in turmeric fields has not been reported. Therefore, the objective of this present study was to evaluate the effectiveness of replacing a portion of chemical fertilizer requirement of turmeric top dressing by WH based compost as an organic input source. Research findings of this study can be helpful in turmeric farmers to make their decisions on fertilizer management practices while maintaining economic and environmental sustainability of their turmeric cultivation.

MATERIALS AND METHODS

Experimental location

This experiment was conducted at the Faculty of Technology, University of Ruhuna, Sri Lanka, between February 2022 and January 2023. The study site, situated at 6°03'46.8"N and 80°32'29.2"E, features favourable soil conditions, including a pH of 6.52 to 6.57, electrical conductivity (EC) in the range of 0.72 – 0.96 dS/m, and a silt loam texture. The location was in the low country wet zone, characterized by an annual rainfall exceeding 2500 mm and an average temperature of approximately 30°C.

Compost preparation

Water hyacinth (WH) (*Eichhornia crassipes* L.) was collected from *Gamachchiwewa, Weeraketiya*, located in the intermediate zone of Southern Sri Lanka. Cattle manure and sawdust were obtained from the research farm at the Faculty of Agriculture, Mapalana, Sri Lanka, and a nearby sawmill, respectively. Compost preparation was conducted in an open area with adequate ventilation using the aerobic windrow method. Cattle manure and Albizia sawdust were mixed in a 1:1 ratio based on fresh weight, and this basal mixture was then combined with the water hyacinth at a ratio of 1:2 (Jayaweera *et al*., 2024). The piles were manually turned once a week until maturation. Moisture levels were maintained at approximately 60% using the field method, with all piles covered with black polythene to prevent excessive moisture loss. The composting process was monitored for 120 days until the compost was matured and stabilized. This prepared compost was used in treatments.

Field establishment

The land was cleared, and raised beds were prepared 30 cm in height, 120 cm in length, and 90 cm in width. Beds were separated with a 15 cm width drainage system installed surrounding the beds

Turmeric rhizome of 35-45 g, as per the recommendation of the Department of Export Agriculture (DEA), Sri Lanka, was used as the planting material, and they were collected from a turmeric field grown by a village farmer in Thellijjawila, Sri Lanka. The spacing arrangement between rows and plants was 30 × 30 cm, as recommended (DEA, 2012).

Experimental design and treatments

As recommended by the DEA, Sri Lanka, 100 *kg ha^{-1}* TSP with 20 *Mt ha^{-1}* compost were added similarly to each treatment plot before the planting as the basal dressing. The recommended top dressing for turmeric was applied in two split doses, 45 days after planting and 90 days after planting (Urea at 65 *kg ha^{-1}* and MOP at 100 *kg ha^{-1}*) (DEA, 2012). Accordingly, 20 *Mt ha^{-1}* compost was applied in two split basis as top dressing. Different proportions of the recommended dose of inorganic fertilizer for top dressing and prepared WH compost were used in treatments in different combinations. This consisted of four treatments: T1- 100 % inorganic fertilizer only (control), T2- 25% inorganic fertilizer + 20 *Mt ha^{-1}* compost, T3- 50% inorganic fertilizer + 20 *Mt ha^{-1}* compost, and T4- 75% inorganic fertilizer + 20 *Mt ha^{-1}* compost. Treatments were applied in RCBD with three replicates in the field and 12 plants in each replicate. Weeding and earthing up were continued manually whenever necessary. A sprinkler system was installed, and the field was irrigated frequently.

Data collection and analysis

Plant growth data viz., plant height (cm), number of leaves per plant, number of tillers per plant, leaf blade length (cm), leaf width (cm), and leaf petiole length (cm) were collected when plants started drying and yellowing (Darekar *et al*., 2021). Yield data, viz., number of mother rhizomes per plant, number of primary fingers per plant, number of secondary fingers per plant, fresh yield per plant (g), and canopy biomass (g/plant), were collected at maturity when all leaves were dried. The collected data were analyzed using ANOVA, and mean separation was conducted using DMRT with SPSS statistical software (SPSS Inc., 2012). Further, Pearson correlation analysis was conducted to investigate the relationship of each parameter with the yield.

RESULTS AND DISCUSSION

According to the results, T3 (50% inorganic fertilizer + 20 *Mt ha^{-1}* compost) recorded significantly ($p<0.05$) the highest fresh yield per plant (680.32 g), demonstrating the optimal balance of organic and inorganic fertilization (Table 1). Moreover, T1 (100% inorganic fertilizer) resulted in significantly the lowest yield (375.77 g/plant), indicating that applying inorganic fertilizers only may not be the best strategy for maximizing turmeric yield. Plants in the T4 (75% inorganic fertilizer + 20 *Mt ha^{-1}* compost) recorded significantly the tallest plants (110.69 cm), longest leaf blade (45.81 cm), widest leaves (11.71 cm), and longest petiole length (23.79 cm). Further, T4 plants were among the groups of plants that recorded the highest number of leaves, highest number of tillers, and greatest canopy biomass (Table 1).

Lohar and Hase (2021) have also reported that the application of 50% recommended dose of fertilizer (RDF) + 50% N through neem cake significantly improved the marketable yield of rhizome (25120 Kg ha^{-1}) compared to 100% RDF. Similarly, Tripathi *et al*. (2021) found that a combination of 50% RDF + 25 % FYM (farmyard manure) + 25% vermicompost produced higher fresh (24610 and 26810 Kg ha^{-1}) and cured (5120 and 5230 Kg ha^{-1}) yields over two years. Further, supporting our study, Chandravanshi *et al*. (2021) demonstrated that 50% RDF + 100% vermicompost recorded the highest fresh rhizomes yield (332.237 g plant^{-1}) with the highest net return and benefit: cost ratio (4.31:1) for the same treatment.

In contrast to our study, a study by Amala *et al*. (2022) found that application of 75% NPK (RDF) + FYM (25 t ha^{-1})+ vermicompost (5 t ha^{-1}) + neem cake (0.5 t ha^{-1}) + *Azotobacter* (0.002 t ha^{-1}) + phosphorous solubilizing bacteria (0.002 t ha^{-1}) has recorded the highest fresh rhizome yield (29690 kg ha^{-1}) and dry rhizome yield (6810 kg ha^{-1}) of turmeric. Kadam and Kamble (2020) reported that the maximum dry yield (6242 kg ha^{-1}) of turmeric was recorded by application of the general RDF (ex: 25 Mt FYM + 200:100:100 kg N: P_2O_5:K_2O ha^{-1}) which was at significant difference with the vermicompost. Painkra *et al*. (2020) analyzed various fertilizer treatments and found that 100 % FYM produced the highest fresh rhizome yield (18510 kg ha^{-1}) and dry weight yield (5060 kg ha^{-1}), whereas the lowest yields were recorded in the control (6680 kg ha^{-1} and 1970 kg ha^{-1} respectively) treatment with zero fertilizer. The highest gross and net returns and the benefit-cost ratio (2.11) were also associated with 100% FYM in this study.

Majeed *et al*. (2020) observed the highest yield (257.7 g plant^{-1}) in treatment with the lowest amount of organic and highest amount of inorganic fertilizer (2.5 t FYM + N:P: K 182: 172: 80 kg ha^{-1}). Sahoo *et al*. (2020) found that applying a 100% RDF + vermicompost + biofertilizers resulted in significantly higher rhizome yields (21920 kg ha^{-1}), followed by 75% RDF + vermicompost + biofertilizers (20660 Kg ha^{-1}), suggesting that 25% of inorganic fertilizers could be replaced with organic alternatives without yield loss. Similarly, Kumar *et al*. (2022) and Mondal and Hore (2022) reported that vermicompost + 100% NPK + biofertilizers resulted in significantly improved turmeric yields (38.50 t ha^{-1} and

38.55 t ha^{-1}, respectively), cost efficiency, and return on investment. Kumar and Chanchan (2024) confirmed this by reporting superior yields (38500 kg ha^{-1}) under vermicompost + 100% NPK + biofertilizer, compared to 100% NPK alone (24980 kg ha^{-1}). Kumar *et al*. (2024) emphasized that combining biofertilizers and organic manures (compost, vermicompost, mustard cake, and neem cake) enhances root biomass and nutrient absorption efficiency, leading to increased turmeric yield with reduced reliance on chemical inputs. Harisha *et al*. (2023) reported that supplementing biopolymer with 75% or 100% recommended dose of nitrogen significantly increased photosynthesis rates (22.95 - 24.50 µmol m^{-2} s^{-1}) and reduced canopy temperature (24.47 - 24.67 °C), leading to higher yield (7050 - 7820 Kg ha^{-1}) and improved nutrient use efficiency.

Table 1. Mean values of the parameters and differences between the treatments as analyzed by one-way ANOVA

Parameter	T1	T2	T3	T4
PH	91.33±17.69^{b}	87.39±18.95^{b}	90.97±25.01^{b}	110.69±21.09^{a}
LVS	29.31±3.06^{b}	34.11±4.93^{ab}	40.14±7.86^{a}	38.03±5.35^{a}
NT	6.22±3.33^{c}	7.61±3.01^{bc}	9.33±4.90^{ab}	9.56±3.71^{a}
LBL	35.46±10.45^{b}	38.82±8.17^{b}	37.94±12.73^{b}	45.81±7.14^{a}
LW	9.43±2.56^{b}	10.48±2.18^{b}	10.44±2.82^{b}	11.71±2.48^{a}
LPL	19.62±8.95^{b}	16.61±5.15^{b}	19.54±7.39^{b}	23.79±7.62^{a}
NMR	6.22±3.33^{b}	7.61±3.01^{b}	9.33±4.90^{ab}	9.56±3.71^{a}
NPF	20.81±10.01^{a}	27.00±10.26^{b}	27.83±13.46^{b}	29.78±10.91^{b}
NSF	44.94±35.48^{b}	61.42±32.07^{a}	58.89±13.09^{ab}	61.72±17.93^{a}
FYP	375.77+38.87^{c}	486.23+29.94^{b}	680.32+80.59^{a}	556.19±21.95^{b}
CBM	237.06±34.93^{b}	277.50±35.45^{b}	404.36±40.49^{a}	382.89±36.08^{a}

Data are means ± SD of three replications. Data with the same letter within each row for each experiment is not significantly different at the 5% level, based on the DMRT. PH: Plant height, LVS: Number of leaves per plant, NT: Number of tillers per plant, LBL: Leaf blade length, LW: Leaf width, LPL: Leaf petiole length, NMR: Number of mother rhizomes per plant, NPF: Number of primary fingers per plant, NSF: Number of secondary fingers per plant, FYP: Fresh yield per plant, CBM; Canopy biomass. T1- 100 % inorganic fertilizer, T2- 25% inorganic fertilizer + 20 Mt ha^{-1} compost, T3- 50% inorganic fertilizer + 20 Mt ha^{-1} compost, T4- 75% inorganic fertilizer + 20 Mt ha^{-1} compost.

Regarding growth parameters, Amala *et al*. (2022) reported the similar results to current study, as the highest plant height (80.01 cm), highest number of leaves per plant (26.88) and the highest number of tillers per clump (4.82) recorded for the application of 75% NPK (RDF) + FYM (25 t ha^{-1})+ vermicompost (5 t ha^{-1}) + neem cake (0.5 t ha^{-1}) + *Azotobacter* (0.002 t ha^{-1}) + phosphorous solubilizing bacteria (0.002 t ha^{-1}). Similarly, Majeed *et al*. (2020) reported the highest plant height, number of leaves, number of tillers per plant (3.8), leaf width (13.3 cm), the number of primary rhizomes per plant (6.4), and the number of secondary rhizomes per plant (14.2) at the combination of the lowest organic and the highest inorganic fertilizer application (2.5 t FYM + N:P: K 182: 172: 80 kg ha^{-1}). Kumar *et al*. (2022) supported this, recording the highest value for leaves per clump (13.37) and the tillers per clump (2.32) with vermicompost + 75% NPK + biofertilizer. However, they further reported the highest plant height (142.87 cm), with the combination of vermicompost + 100% NPK + biofertilizer, the longest clump length (18.76 cm) with the mustard cake + 100% NPK + biofertilizer, and the broadest leaves (18.97 cm) Neem cake + 100% NPK + biofertilizer.

In contrast to our study, Sahu *et al*. (2022) reported the highest plant height, number of leaves, and number of tillers per plant in 100% RDF (N:P: K – 120: 60: 60 kg ha^{-1}) at different crop growth stages at 30, 60, 90, 120 and at harvest. Similarly, the highest plant height was recorded in the 100% RDF, which was at significant difference with vermicompost (Kadam and Kamble, 2020). The highest number of primary fingers per plant was recorded from the treatment of 1.2 kg poultry litter + NPK (106 g of urea + 76 g of TSP + 68 g of MOP) /plot) and the lowest from no fertilizer treatment (Amin *et al*., 2013). The combination treatment of vermicompost + 100% NPK along with a combination of nitrogenous biofertilizers resulted in the highest observed plant height, reaching 169.87 cm and the number of leaves per clump (17.14) (Kumar and Chanchan, 2024). An Increase in the amount of nutrients were found to cause an increase in the average width of leaves (Verma *et al*., 2019). Amin *et al*. (2013) found that turmeric leaf breadth increased with higher fertilizer application due to ideal cell size, highlighting the importance of nutrient availability for optimal growth.

Correlations of the parameters with the fresh yield per plant

According to the correlation analysis, T3 (50% inorganic fertilizers + 20 *Mt ha^{-1}* compost) was the most effective treatment, as it maximized both growth and yield performance with moderate to strong correlations in multiple traits (PH: r=0.533, α=0.01; LVS: r=0.394, α=0.05; NT: r=0.460, α=0.01; LBL: r=0.556, α=0.01; LPL: r=0.418, α=0.05; CBM: r=0.391, α=0.05; NMR: r=0.460, α=0.01; NPF: r=0.551, α=0.01; and NSF: r=0.634, α=0.01). Comparatively, T1 (100% inorganic fertilizer only), resulted in the lowest yield (375.77 g/plant) despite strong trait correlations, suggesting inefficient nutrient utilization. Moreover, T2 (25% inorganic fertilizer + 20 *Mt ha*$^{-1}$ compost) showed moderate effectiveness, favoring rhizome development and T4 (75% inorganic fertilizer + 20 *Mt ha*$^{-1}$ compost) had no significant correlations with yield (Table 2).

Table 2. Correlations between studied parameters and the yield per plant in different treatments

Treatment	PH	LVS	NT	LBL	LW	LPL	CBM	NMR	NPF	NSF
T1	0.438**	0.409*	0.495**	0.262	0.124	0.430**	0.330	0.495**	0.492**	0.672**
T2	0.183	0.357*	0.457**	0.107	-0.012	0.180	-0.139	0.457**	0.496**	0.635**
T3	0.533**	0.394*	0.460**	0.556**	0.267	0.418*	0.391*	0.460**	0.551**	0.634**
T4	0.040	0.199	0.048	0.161	0.040	0.065	0.220	0.048	0.099	0.113

***Correlation is significant at the 0.01 level (2-tailed)*
**Correlation is significant at the 0.05 level (2-tailed)*
PH: Plant height, LVS: Number of leaves per plant, NT: Number of tillers per plant, LBL: Leaf blade length, LW: Leaf width, LPL: Leaf petiole length, NMR: Number of mother rhizomes per plant, NPF: Number of primary fingers per plant, NSF: Number of secondary fingers per plant, CBM; Canopy biomass. T1- 100 % inorganic fertilizer, T2- 25% inorganic fertilizer + 20 Mt ha^{-1} compost, T3- 50% inorganic fertilizer + 20 Mt ha^{-1} compost, T4- 75% inorganic fertilizer + 20 Mt ha^{-1} compost

The correlations between the traits and the yield in four treatments can be summarized (Table 3). T3 (50% inorganic fertilizer + 20 *Mt ha*$^{-1}$ compost) had no traits in the very weakly or not correlated category; all traits showed at least some correlation. Further, T3 had only three traits in the weakly correlated category (LVS, LW, CBM), which was relatively low and T3 had the highest number of traits (6) in the moderately correlated category (PH, NT, LBL, LPL, NMR, NPF), suggesting broad moderate effects on plant growth.

Table 3. Strength of the correlations of the traits with the yield

Treatment	Very Weakly / Not Correlated Traits	Weakly Correlated Traits	Moderately Correlated Traits	Strongly Correlated Traits
T1	LW	LBL , CBM	PH, LVS, NT, LPL, NMR, NPF	NSF
T2	PH, LBL, LW, LPL, CBM	LVS	NT, NMR, NPF	NSF
T3	None	LVS, LW, CBM	PH, NT, LBL, LPL, NMR, NPF	NSF
T4	PH, NT, LBL, LW, LPL, NMR, NPF, NSF	LVS, CBM	None	None

Correlation Coefficient (r) represents the strength of correlation, and it is classified as: 0.00–0.19 (very weak or no correlation), 0.20–0.39 (weak correlation), 0.40–0.59 (moderate correlation), 0.60–0.79 (strong correlation), and 0.80–1.00 (very strong correlation).
PH: Plant height, LVS: Number of leaves per plant, NT: Number of tillers per plant, LBL: Leaf blade length, LW: Leaf width, LPL: Leaf petiole length, NMR: Number of mother rhizomes per plant, NPF: Number of primary fingers per plant, NSF: Number of secondary fingers per plant, CBM; Canopy biomass. T1- 100 % inorganic fertilizer, T2- 25% inorganic fertilizer + 20 Mt ha^{-1} compost, T3- 50% inorganic fertilizer + 20 Mt ha^{-1} compost, T4- 75% inorganic fertilizer + 20 Mt ha^{-1} compost

Comparatively, T4 (75% inorganic fertilizer + 20 *Mt ha*$^{-1}$ compost) performed the weakest**,** as it had most traits in the very weakly or not correlated category and no traits in moderately or strongly correlated categories. T1 (100% inorganic fertilizer) and T2 (25% inorganic + 20 *Mt ha*$^{-1}$ compost) had several traits in the very weakly or not correlated category, reducing their effectiveness.

CONCLUSIONS

The results indicate that T3 (50% inorganic fertilizer + 20 *Mt ha*$^{-1}$ compost) is the most effective fertilization strategy for optimizing turmeric growth and yield. T3 recorded the highest fresh yield per plant (680.32 g), demonstrating a well-balanced organic and inorganic fertilizers. T3 exhibited no traits in the very weakly or not correlated category, showing a consistent and positive influence in all measured parameters and T3 also had the highest number of traits (6) in the moderately correlated category, displaying broad moderate effects on plant growth and yield-related traits. T1 (100% inorganic fertilizer) resulted in the lowest fresh yield (375.77 g/plant), suggesting that relying only on inorganic fertilizers is not the most effective strategy for turmeric production. T4 (75% inorganic fertilizer + 20 *Mt ha*$^{-1}$ compost) produced the tallest plants and longest leaves. However, T4 performed the weakest overall correlation due to most traits correlated very weakly or not correlated category and the absence of any moderately or strongly correlated traits. T1 and T2 had several traits in the very weakly correlated category, diminishing their overall effectiveness. These findings suggest that T3 (50% inorganic fertilizer + 20 *Mt ha*$^{-1}$ compost) as the best combination of top dressing for plant growth and yield in turmeric. Therefore, the 50% inorganic + 20 *Mt ha*$^{-1}$ compost treatment is the most suitable fertilization strategy for maximizing turmeric production among tested combinations.

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