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Efficacy of Integrated Nutrient Management on Rhizome Productivity in Mango Ginger (*Curcuma amada* Roxb.)

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ABSTRACT

An experiment on the effect of integrated nutrient management on the rhizome productivity of mango ginger (*Curcuma amada* Roxb.) was conducted at a farmer's field in Vadapalani village, Erode district during 2022-2023. The research investigated how integrated nutrient management (INM) influences the growth performance of rhizomes in mango ginger (*Curcuma amada* Roxb.). A total of 11 treatments used in this experiments were as T1 - 75% RDF + Vermicompost @ 5 t/ha+ Panchagavya @ 3%,T_2- 75% RDF + Groundnut cake @ (200 kg/ ha) + Panchagavya @ 3%,T_3 - 75% RDF + Vermicompost @ 5 t/ ha+ Vermiwash @ 10%,T_4- 75% RDF + Groundnut cake @ (200 kg/ ha) + Vermiwash @10%,T_5- 75% RDF + Vermicompost @ 5 t/ ha+ Humic acid @ 0.2%,T_6- 75% RDF + Groundnut cake @ (200 kg/ ha) + Humic acid @ 0.2%,T_7- 75% RDF + Vermicompost @ 5 t/ ha+ Amrit Pani @ 3 %,T_8- 75% RDF + Groundnut cake @ (200 kg/ ha) + Amrit Pani @ 3 %,T_9- 75% RDF + Vermicompost @ 5 t/ ha + Chitosan @ 0.1 %,T_{10} - 75% RDF + Groundnut cake @ (200 kg/ ha) + Chitosan @ 0.1 % and T_{11} - Control. The results demonstrated significant improvements across various growth parameters in treatments integrating organic and inorganic nutrient sources. Treatment T_9, comprising 75% RDF, Vermicompost @ 5 t ha^{-1} and chitosan @ 0.1%, emerged as the most effective. It achieved the shortest sprouting duration (12.09 d), tallest plant height (124.39 cm), maximum tiller count (6.23 tillers/plant), the highest leaf count (21.85 leaves/plant), longest leaf length (73.27 cm) and the greatest leaf breadth (32.72 cm) and maximum pseudostem girth (11.26 cm). Additionally, T_9 recorded the highest curcumin content (2.48%). These outcomes highlighted the synergistic benefits of combining organic and inorganic nutrient sources in promoting superior plant growth and rhizome quality.

Keywords: Mango ginger, Vermicompost, Chitosan, Curcumin and INM

INTRODUCTION

Mango ginger (*Curcuma amada* Roxb.) is a distinctive rhizomatous spice belonging to the family Zingiberaceae. Although it bears a close visual resemblance to common ginger, its flavor is strikingly similar to that of raw mango. Morphologically akin to turmeric (*Curcuma longa* L.), mango ginger is considered to have originated in the Indo-Malayan region and is now cultivated widely across tropical areas (Sasikumar, 2005). The plant typically reaches a height of about 1 meter and is characterized by oblong to lanceolate leaves. Its rhizomes are fleshy, buff-colored, and exhibit a sympodial branching pattern, noted for their sharp, tangy mango-like aroma and pungency. Despite its rich composition of bioactive constituents, mango ginger remains an underutilized medicinal spice. The rhizomes are widely incorporated in Indian and Southeast Asian culinary traditions, contributing a zesty, citrus-like flavor to pickles and various dishes. Traditionally, the plant has been used to support digestion, alleviate inflammation, and manage respiratory conditions. Its therapeutic applications are well recognized in Ayurvedic and Unani medicine systems, where it functions as a laxative, diuretic, and a remedy for several ailments (Policegoudra *et al*, 2010). Scientific studies have highlighted its anti-inflammatory, antibacterial, antifungal, and antioxidant properties (Chandarana *et al*, 2005), enhancing its value in both food and health sectors. In the context of sustainable agriculture, Integrated Nutrient Management (INM) which combines organic manures with chemical fertilizers has been advocated to improve crop productivity and maintain soil health. This balanced nutrient approach enhances soil structure, water retention, and fertility while reducing ecological damage. Moreover, INM practices are instrumental in promoting better growth and

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Table 1. Impact of Integrated Nutrient Management on rhizome productivity of Mango Ginger (*Curcuma amada* Roxb.).

Treatment	Days taken for sprouting	Plant height (cm)	Number of tillers plant $^{-1}$	Number of leaves plant $^{-1}$	leaf length (cm)	leaf breadth (cm)	Pseudostem girth (cm)	Curcumin content (%)
T_1 - 75% RDF + Vermicompost @ 5 t ha^{-1}+ Panchagavya @ 3%	14.49	116.79	4.69	19.19	66.24	29.92	9.41	2.19
T_2 - 75% RDF + Groundnut cake @ (200 kg ha^{-1}) + Panchagavya @ 3%	20.27	98.72	2.72	12.48	54.17	22.88	6.89	1.6
T_3 - 75% RDF + Vermicompost @ 5 t ha^{-1}+ Vermiwash @ 10%	15.65	113.16	4.26	17.82	63.06	28.52	8.56	2.06
T_4 - 75% RDF + Groundnut cake @ (200 kg ha^{-1}) + Vermiwash @10%	21.39	95.13	2.33	11.17	52.27	21.43	6.66	1.46
T_5 - 75% RDF + Vermicompost @ 5 t ha^{-1}+ Humic acid @ 0.2%	13.30	120.41	5.11	20.54	69.75	31.33	10.31	2.33
T_6 - 75% RDF + Groundnut cake @ (200 kg ha^{-1}) + Humic acid @ 0.2%	19.17	102.33	3.11	13.78	56.30	24.30	7.31	1.73
T_7 - 75% RDF + Vermicompost @ 5 t ha^{-1}+ Amrit Pani @ 3 %	18.03	105.93	3.52	15.09	58.48	25.71	7.81	1.84
T_8 - 75% RDF + Groundnut cake @ (200 kg ha^{-1}) + Amrit Pani @ 3 %	22.44	91.53	1.98	9.83	50.32	19.96	6.46	1.35
T_9 - 75% RDF + Vermicompost @ 5 t ha^{-1} + Chitosan @ 0.1 %	12.09	124.39	6.23	21.85	73.27	32.72	11.26	2.48
T_{10} - 75% RDF + Groundnut cake @ (200 kg ha^{-1}) + Chitosan @ 0.1 %	16.83	109.52	3.88	16.42	60.63	27.10	8.16	1.94
T_{11} - Control	23.61	87.92	1.68	8.53	48.52	18.49	6.16	1.21
S.Ed	0.54	1.69	0.50	0.62	1.67	0.72	0.43	0.07
CD (p=0.05)	1.14	3.56	1.07	1.29	3.51	1.38	0.91	0.12

optimizing curcumin levels in *C. amada* by sustaining a stable nutrient environment within the soil.

MATERIALS AND METHODS

The present investigation was conducted at Vadapalani village in Erode district from July 2022 to January 2023. The experimental design followed a Randomized Block Design (RBD) comprising eleven treatments with three replications. A total of 11 treatments used in this experiments were as T1 - 75% RDF + Vermicompost @ 5 t/ha+ Panchagavya @ 3%,T_2- 75% RDF + Groundnut cake @ (200 kg/ ha) + Panchagavya @ 3%,T_3- 75% RDF + Vermicompost @ 5 t/ ha+ Vermiwash @ 10%,T_4- 75% RDF + Groundnut cake @ (200 kg/ ha) + Vermiwash @10%,T_5- 75% RDF + Vermicompost @ 5 t/ ha+ Humic acid @ 0.2%,T_6 - 75% RDF + Groundnut cake @ (200 kg/ ha) + Humic acid @ 0.2%,T_7- 75% RDF + Vermicompost @ 5 t/ ha+ Amrit Pani @ 3 %,T_8- 75% RDF + Groundnut cake @ (200 kg/ ha) + Amrit Pani @ 3 %,T_9 - 75% RDF + Vermicompost @ 5 t/ ha + Chitosan @ 0.1 %,T_{10}- 75% RDF + Groundnut cake @ (200 kg/ ha) + Chitosan @ 0.1 % and T_{11} - Control. In each replication, five plants were randomly chosen, tagged and labeled for recording various growth parameters. The average values of these five plants were used for analysis. The collected data were subjected to statistical analysis using the standard method outlined by Panse and Sukhatme (1985) using WASP 2.0. Critical differences (CD) were calculated at a 5% level of significance.

RESULTS AND DISCUSSION

The data (Table 1) indicated significant variations among treatments regarding parameters such as sprouting duration, plant height, leaf count, tiller count, leaf length, leaf breadth, pseudostem girth and curcumin content. The shortest sprouting duration was observed in T_9 (75% RDF + Vermicompost @ 5 t/ha + Chitosan @ 0.1%), taking 12.09 d, followed by T_5 (75% RDF + Vermicompost @ 5 t/ha + Humic Acid @ 0.2%) at 13.30 d. Conversely, the longest sprouting duration was recorded for T_{11} (Control - 100% RDF) at 23.61 d.

Plant height also varied significantly across the treatments. The maximum plant height (124.39 cm) was observed in T_9, followed by T_5 (120.41 cm), while the minimum was recorded in T_{11} (87.92 cm). These findings aligned with prior studies by Anburani and Manivannan (2002), who reported that combining inorganic and organic NPK sources improves turmeric (*Curcuma longa*) plant height. Mahanthesh *et al* (2009) also demonstrated that integrated nutrient management (INM) enhances growth parameters in turmeric. The application of chitosan likely contributed to increased nitrogen metabolism, as reported by Thengumpally (2019) in Kasturi turmeric, where chitosan-treated plants exhibited superior growth.

According to Theunissen *et al* (2010), nitrogen supports photosynthesis, cell division, growth and protein synthesis, processes augmented by the addition of Vermicompost alongside inorganic fertilizers. Kadam and Kamble (2020) further emphasized that nutrient availability promotes luxuriant plant growth, facilitated by Vermicompost growth-promoting substances, enhanced microbial activity and reduced nitrogen leaching.

Similarly, the number of tillers per plant showed significant differences, with T_9 exhibiting the highest value (6.23), followed by T_5 (5.11) and T_{11} the lowest (1.68). Treatment T_9 exhibited superior performance across all measured leaf growth parameters, recording the highest leaf count per plant (21.85), the longest leaf length (73.27 cm) and the greatest leaf breadth (32.72 cm). Treatment T_5 followed with corresponding values of 20.54 leaves per plant, 69.75 cm leaf length and 31.33 cm leaf breadth, whereas T_{11} consistently displayed the lowest values, with 8.53 leaves per plant, a leaf length of 48.52 cm and a leaf breadth of 18.49 cm. The enhanced leaf growth observed in T_9 can be attributed to improved nutrient availability, particularly nitrogen and potassium, which play vital roles in cellular elongation and expansion processes.

The synergistic effect of integrating organic and inorganic fertilizers, augmented by chitosan application, likely facilitated optimized nutrient absorption and utilization, thereby promoting superior leaf development and overall plant vigor (Prabhu *et al*, 2010).

The pseudostem girth was significantly influenced by the nutrient management treatments, with T_9 exhibiting the maximum pseudostem girth (11.26 cm), followed by T_5 (10.31 cm), while T_{11} recorded the smallest girth (6.16 cm). These growth improvements can be attributed to enhanced enzymatic activity, such as chitinase and protease production, resulting from Vermicompost and other organic amendments. Such amendments improve soil microflora and nutrient availability (Kumar *et al*, 2018). Gradual nutrient release from organic sources, such as manures and biofertilizers, enriches soil humus content and fosters beneficial microbial activity, as reported by Amala *et al* (2019) and Lohar and Hase (2021). Consistent with Nagarjuna *et al* (2021), integrated application of organic and inorganic nutrients enhances turmeric growth. Furthermore, chitosan treatments improve nitrogen and potassium uptake while moderating calcium absorption, thus optimizing nutrient utilization and promoting plant growth.

Regarding curcumin content, the results in Table 1 revealed significant treatment effects. The highest curcumin content (2.48%) was recorded in T_9, followed by T_5 (2.33%), with the lowest in T_{11} (1.21%). According to Namdeo (2007), chitosan enhances secondary metabolite production by activating plant defense-related genes, as supported by Gorelick and Bernstein (2014).

CONCLUSION

The study highlighted the effectiveness of integrated nutrient management (INM) in enhancing mango ginger (*Curcuma amada* Roxb.) growth and productivity. Treatment T_9 (75% RDF, Vermicompost @ 5 t/ha and chitosan @ 0.1%) consistently outperformed others, demonstrating superior growth parameters and curcumin content. The results affirm the synergistic benefits of combining organic and inorganic nutrients with biostimulants for sustainable and high-quality mango ginger production.

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