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Effect of Different Seed Rhizome Weight and Nutrition Levels on Yield, Quality and Economics of Mango Ginger (*Curcuma amada* Roxb.) Cultivation

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A B S T R A C T

Mango ginger (*Curcuma amada* Roxb.) is popular in Southern and Eastern India mainly due to its typical pleasant flavor. It is a spice cum medicinal plant that has been reported to possess anti-inflammatory, antioxidant and antitumor properties. The rhizomes find an extensive application in the preparation pickles because of its exotic mango aroma. A field experiment was conducted at College of Horticulture, Mudigere to standardize the nutrition levels and seed rhizome weight for getting higher yields. The treatments consisted of two factors viz., rhizome weight (W_1-20, W_2-40, W_3-60g) and nutrition levels (N_1-Control, N_2-60:50:100 kg NPK/ha, N_3-90:75:150 kg NPK/ha, N_4-120:100:200 kg NPK/ha, N_5-150:125:250 kg NPK/ha, N_6-180:150:300 kg NPK/ha). Among 18 treatment combinations, W_3N_6 (rhizomes weighing 60g with 180:150:300 kg NPK /ha) recorded maximum yield per hectare, essential oil content and it was observed that maximum B:C ratio was recorded in the treatment combination W_1N_6 (2.11) followed by W_3N_6 (2.05).

Introduction

Mango-ginger (*Curcuma amada* Roxb., Zingiberaceae) is a perennial herb cultivated as an annual with rhizomes having characteristic odour of raw mangoes. The rhizome finds extensive use in the indigenous systems of medicine. The quality of mango-ginger is mainly determined by its volatile oil, non-volatile ether extract (NVEE), fibre and starch contents.

They also reported to have antimicrobial, antioxidant, anticancer, anti-inflammatory, antidepressant, antitubercular and platelet aggregation inhibitory activities (Policegoudra *et al*., 2010).

The geographical distribution of the genus ranges from India to Thailand, Indo-China, Malaysia, Indonesia and Northern Australia. It is found wild in parts of West Bengal and is cultivated in Gujarat, Uttar Pradesh, Kerala,

Karnataka, Tamil Nadu and the North-Eastern states. Nitrogen, Phosphorus and Potassium are considered as the three major nutrient elements which influence the growth and yield of crops. However, plants get some amount of nutrition from the soil, but an external supply of these nutrients in the form of fertilizer is necessary. In crops where the propagules are the economic part, it is necessary to consider the seed rate and standardize it which is economically feasible to the grower. Considering these facts, the present investigation was undertaken to standardize the major nutrient requirements and seed rhizome weight of mango ginger for commercial cultivation.

Material and Methods

The experiment was laid out in Factorial Randomized Complete Block Design in existing arecanut plantation as an intercrop at College of Horticulture, Mudigere. The treatments were replicated thrice. The raised beds of 3m X 1 m size were prepared in between existing 10 years old arecanut palms spaced at 2.7m X 2.7 m in hexagonal system. A space of 45 cm was left between adjacent plots. The spacing followed was 30 cm between rows and 30 cm between plants. There were totally 30 plants in each plot. The plots were kept weed-free by hand weeding at an interval of 40-50 days. The plots were irrigated at an interval of 2-3 days in initial growth period. Later the irrigation interval increased to once in a week depending on the soil moisture conditions. Earthing up was done to keep the plant base covered. Totally four weedings, two earthing up and four irrigations were taken up during the entire crop growth period.

The yield of rhizomes per hectare was worked out by weight of rhizomes obtained from each net plot and expressed in tonnes per hectare. Essential oil content on the fresh weight basis was obtained by steam distillation of freshly harvested rhizome using Clevenger apparatus (AOAC, 1975). B:C ratio was obtained by dividing gross returns with total cost of cultivation.

The data obtained were statistically analyzed as per the procedure and design given by Panse and Sukhatme (1985). The statistical significance was tested by applying 'F' test at 0.05 level of probability and critical differences were calculated for those parameters which turned significant ($P < 0.05$) to compare the effects of different treatments.

Results and Discussion

The effect of major nutrients and seed rhizome weight on yield and essential oil content of mango ginger is presented in Table 1. Maximum yield per hectare (31.47 t/ha) and essential oil content (0.73) were recorded at higher NPK level 180:150:300 kg/ha (N_6). The yield per hectare increased from 16.32 t/ha to 31.47 t/ha with the increase in nutrient levels from no application of fertilizers to 180:150:300 kg NPK/ha. So, increasing trend in yield per hectare, was observed with increase in nutrient levels. This might be due to nitrogen being the constituents of chlorophyll, protein and plant cell, promotes vegetative growth and increased the photosynthesis process of the plants. Similarly phosphorus and potassium also promote crop growth by activating a number of enzyme system involved in photosynthesis, carbohydrate metabolism and protein synthesis. Which is ultimately synthesizes more food material for increasing yield attributes. The results are in close conformity with the findings of Dayankatti and Sulikeri (2000), Medda and Hore (2003), Haque *et al.*, (2007), Hikaru *et al.*, (2007), Karthikeyan *et al.*, (2009), Tripathi and Singh (2010) and Reddy *et al.*, (2015) (Table 2).

Table.1

	Yield per hectare (t/ha)							Essential oil content (%)						
Treatment	**N1**	**N2**	**N3**	**N4**	**N5**	**N6**	**Mean**	**N1**	**N2**	**N3**	**N4**	**N5**	**N6**	**Mean**
W1	15.27	17.93	18.94	25.21	26.07	28.43	**21.97**	0.53	0.57	0.55	0.67	0.69	0.71	**0.62**
W2	16.76	20.85	21.51	29.25	29.64	30.13	**24.69**	0.54	0.59	0.63	0.68	0.70	0.72	**0.64**
W3	16.93	23.82	26.07	31.79	33.33	35.86	**27.96**	0.65	0.64	0.73	0.74	0.75	0.78	**0.71**
Mean	**16.32**	**20.87**	**22.17**	**28.75**	**29.68**	**31.47**		**0.57**	**0.60**	**0.63**	**0.69**	**0.71**	**0.73**	
	SEm±				**CD (5%)**			**SEm±**				**CD (5%)**		
W	0.30				0.88			0.01				NS		
N	0.43				1.24			0.02				0.05		
W×N	0.75				2.16			0.03				NS		

Factor 1:Rhizome weight
W_1-Rhizomes weighing 20g
W_2- Rhizomes weighing 40g
W_3- Rhizomes weighing 60g

Factor 2:Nutrition
N_1-Control
N_2-60:50:100 kg NPK/ha
N_3-90:75:150 kg NPK/ha
N_4-120:100:200 kg NPK/ha
N_5-150:125:250 kg NPK/ha
N_6-180:150:300 kg NPK/ha

Table.2 Effect of seed rhizome weight and nutrition levels on economics of mango ginger (*Curcuma amada*Roxb.) per hectare

Treatments	Total cost of cultivation (Rs)	Gross returns (Rs)	Net returns (Rs)	B:C ratio
W_1N_1	236000	274860	38860	1.16
W_1N_2	237908	322740	84832	1.35
W_1N_3	238862	340920	102058	1.42
W_1N_4	239816	453780	213964	1.89
W_1N_5	240770	469260	228490	1.94
W_1N_6	241723	511740	270017	2.11
W_2N_1	272000	301680	29680	1.10
W_2N_2	273908	375300	101392	1.37
W_2N_3	274862	387180	112318	1.40
W_2N_4	275816	526500	250684	1.90
W_2N_5	276770	533520	256750	1.92
W_2N_6	277723	542340	264617	1.95
W_3N_1	308000	304740	-3260	0.98
W_3N_2	309908	428760	118852	1.38
W_3N_3	310862	469260	158398	1.50
W_3N_4	311816	572220	260404	1.83
W_3N_5	312770	599940	287170	1.91
W_3N_6	313723	645480	331757	2.05

The plants raised from the bigger seed rhizome (60g) produced higher yield (27.96 t/ha). The yield increased with increase in weight of the rhizome this might be due to increased accumulation of carbohydrates, proteins and starch in the heavier rhizomes which in turn is a result of better aerial growth or better translocation of assimilates from source to sink. The results are in close conformity with the findings of Girma and Kindie (2008), Monnaf *et al.,* (2010) and Sengupta and Dasgupta (2011) in ginger and Dhatta *et al.,* (2008) in turmeric. Interaction effect of rhizome size and major nutrients was found to be significant. Among the treatments, the combination of 60g rhizome size and NPK levels at 180:150:300 kg NPK/ha (W_3N_6) recorded highest values for yield per hectare.

A gradual increase in essential oil content was recorded with increase in the fertilizer dose. Fertilizer dose of 180:150:300 kg NPK/ha (N_6) recorded maximum essential oil content (0.73%) whereas, the minimum essential oil of (0.57%) was recorded in control (N_1) This might be due to potassium is known to influence quality of the rhizomes such as curcumin, oleoresin and essential oil content. Hence, the application of the higher dose of potassium enhanced the essential oil content of the rhizomes. Similar, results were noticed by Dayankatti and Sulikeri (2000) in ginger, Medda and Hore (2003), Akamine *et al.,* (2007), Hikaru *et al.,* (2007) and Rakesh and Singh (2010) in turmeric. The essential oil content did not found to vary significantly with varied rhizome weight. However, larger seed rhizomes of 60 g recorded higher oil content and interaction effect on seed rhizome weight and nutrition levels on essential oil content also did not differ significantly.

Economics of mango ginger was also influenced by different seed rhizome weight and nutrition. The maximum gross returns (Rs 6,45,480) and net returns (Rs. 3,31,757) were recorded in treatment combination W_3N_6. B:C ratio (2.11) was maximum in treatment combination W_1N_6 followed by W_3N_6 (2.05). Higher B:C ratio in W_1N_6 can be justified by better rhizome yield, less incidence of pest and diseases and less investment on planting material which altogether maximized net income and in turn higher profit.

In conclusion, the experimental results revealed that the seed rhizomes weighing 60g with plant nutrition at 180:150:300 kg NPK/ha has significantly increased the plant growth and rhizome yield in mango ginger. Further research on aspects like INM and micronutrients are proposed in mango ginger.

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