Original Research Article

Mother RhizomeGrowth of Turmeric Varieties [*Curcuma longa* (L.)] Under Eucalyptus (*Eucalyptus tereticornis*) Based Agroforestry System in Chhattisgarh Plain, India

ABSTRACT: The experiment was conducted during the year 2022-23 and 2023-24 in Kharif seasons at the Herbal Garden of IGKV, Raipur, Chhattisgarh. Two production systems were studied: F1 involved sole Turmeric, while F2 involved Eucalyptus intercropped with Turmeric in both the production systemused FRBD (Factorial Randomized Block Design). Eight turmeric varieties were used i.e.: T1 - Suranjana, T2 - Selam, T3 – Chhattisgarh Haldi-1, T4 – Chhattisgarh Haldi-2, T5 – Roma, T6- Ranga, T7- NDH-98 and T8- Sonali. From the two year of investigation its found that mother rhizome length and width (cm) was found maximum in variety Chhattisgarh Haldi-2 and variety NDH-98 under sole turmeric as well as Eucalyptus intercropped with turmeric, while variety Sonali showed the minimum growth of mother rhizome in both the year of investigation and on mean data.

Keywords: Turmeric, Eucalyptus, Varieties, Mother Rhizome, Production system.

INTRODUCTION

Agroforestry is a land use system that combines trees, crops, and animals in a manner that is scientifically sound, ecologically beneficial, practically achievable, and socially acceptable to farmers (Nair, 1979). With the rising demands due to rapid population growth, urbanization, and industrialization (Tripathi and Rani, 2018), it is crucial to increase the production of food grains and fuel wood for human consumption, along with green and dry fodder for livestock. Agroforestry provides an effective solution for optimizing land use and boosting agricultural productivity in confined spaces. As a result, the multitier 'Agroforestry' system has gained international recognition for maximizing output (Sahoo and Wani, 2019).

Communities in the dry-land regions of India already possess significant knowledge regarding tree management. These knowledge systems are "open," promoting the exchange of information, which can foster innovation more effectively than rigidly combining local knowledge with global scientific approaches. Extension agents encourage local ownership of knowledge by enabling participants to innovate beyond their existing capabilities. This strategy improves program outcomes and fosters long-term farmer and community commitment (Chandra *et al.* 2011). In India, eucalyptus is grown for its short-term benefits and diverse uses as a Multipurpose Tree (MPT), providing timber, fuel, essential oils, and pulp. Large-scale eucalyptus plantations are maintained in various sectors, including roadside and canal-side plantings, and farm forestry, to produce bole wood and pulp, while also offering aesthetic benefits. Eucalyptus tereticornis, known for its shorter rotation period, better coppicing ability, and adaptability to different soils and climates, is widely cultivated in India (Tewari, 2007).

Agriculture in India significantly influences the country's social, political, and cultural dimensions, and is regarded as one of its major success stories. It has transitioned from being the primary source of livelihood for over two-thirds of the workforce to becoming the foundation of the Indian economy (Sarkar et al., 2014). Despite these advances, the FAO reports that around 820 million people worldwide still suffer from hunger, underscoring the enormous challenge of achieving zero hunger by 2030. This food insecurity forces people to compromise on both the quality and quantity of the food they consume (Singh & Chattopadhyay, 2023).

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MATERIAL AND METHOD

The field experiment was conducted at the Herbal Garden of Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.), during the periods of 2022 to 2024. Raipur is situated in the mid-eastern part of Chhattisgarh, at a latitude of 21°16'N, longitude of 81°36'E, and an elevation of 289.56 meters above mean sea level. During the crop growth period, the weekly average maximum and minimum temperatures ranged between 39.51°C and 27.14°C, and 28.52°C and 8.31°C, respectively. The highest weekly average temperature recorded was 39.51°C, while the lowest was 8.31°C. The weekly mean maximum and minimum relative humidity during the experiment ranged from 92.71% to 50.34%, and from 80.85% to 15.14%, respectively. The average weekly maximum rainfall during experiment period was 30.34 mm, while the minimum was 0.16 mm. The experiment followed a Factorial RBD design, with three replications of eight treatment combinations across two production systems applied to eight crop varieties. Each treatment combination was randomly replicated three times. NPK fertilizers were applied at the rate of 120:60:60 kg per hectare using urea, single superphosphate, and muriate of potash. Turmeric rhizomes were manually planted following an experimental design in a cropping system with row and plant spacing of 40 cm × 30 cm, involving eight varieties and three replications. Sowing was carried out in 48 plots, each measuring 2.5 m × 2.5 m, using AFS and a monocrop system.

RESULTS AND DISCUSSION

Yield attributes of turmeric i.e. size of mother rhizome length (cm) at harvest of turmeric is very essential parameter for yield estimation of turmeric. The data regarding size of mother rhizome length (cm) of rhizome has been presented in Table 1 and Fig 1 & 2.

The results of the size of mother rhizome length (cm) for the different treatments during the 2022-23 and 2023-24 growing seasons, as well as the Pooled Mean. The production system had a significant effect on the size of mother rhizome length (cm), with the sole turmeric system (F1) producing significantly maximum size of mother rhizome length (cm) than the eucalyptus + turmeric system (F2). The mean size of mother rhizome length (cm) was 9.6 cm for F1 (Sole turmeric) and 9.36 cm for F2 (Eucalyptus+turmeric).

Among the crop varieties also had a significant effect on the size of mother rhizome length (cm). NDH-98 (T7) produced the maximum size of mother rhizome length (cm), with a mean of 20.88 cm, followed by Chhattisgarh Haldi-2 (T7) with a mean of 9.54 cm whereas Sonali (T8) produced the minimum size of mother rhizome length (cm), with a mean of 6.75 cm.

The interaction effect of production system and crop varieties on size of mother rhizome length (cm) of crop recorded

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significant effect in both year and their mean data.

The observed differences in the size of mother rhizome length (cm) among the treatments can be attributed to the different production systems and crop varieties used in the experiment. The sole turmeric production system (F1) may have provided a more favorable environment for rhizome growth and development, resulting in maximum size of mother rhizome length (cm) compared to the Eucalyptus + turmeric (F2). The different crop varieties used may have also had varying size of mother rhizome length (cm), with some varieties producing maximum size of mother rhizome length (cm) due to genetic traits such as rhizome size and weight. The size of mother rhizome length (cm) per plant serves as an indicator of the suitability of the various production systems and crop varieties for supporting turmeric yield formation. Maximum size of mother rhizome length (cm) point to treatments that conditioned the plant growth environment in a way that promoted higher mother rhizome length. Other factors such as soil fertility, water availability, and pest and disease pressure may have also influenced the size of mother rhizome length (cm) of plant. Similar result was also found by Painkra et al. (2020) and Sahu et al. (2022).

The data regarding size of mother rhizome width (cm) of rhizome has been presented in Table 2 and Fig. 3 & 4.

The results of the size of mother rhizome width (cm) for the different treatments during the 2022-23 and 2023-24 growing seasons, as well as the Pooled Mean.

The production system had a significantly not affect the size of mother rhizome width (cm), with the sole turmeric production system (F2) producing minimum size of mother rhizome width (cm) than the Eucalyptus + turmeric system (F1). The mean size of mother rhizome width (cm) was 6.68 cm for F1 (sole turmeric) and 6.59 cm for F2 (Eucalyptus+turmeric).

The crop variety also had a significant effect on the size of mother rhizome width (cm). Chhattisgarh Haldi-2 (T4) produced the maximum mother rhizome width (cm), with a mean of 7.43 cm, followed by NDH-98 (T7) with a mean of 7.10 cm whereas Sonali (T8) produced the minimum size of mother rhizome width (cm), with a mean of 6.09 cm.

The interaction effect of production system and crop varieties on size of mother rhizome width (cm) of crop recorded significant effect in both year and their mean data.

The observed differences in the size of mother rhizome width (cm) among the treatments can be attributed to the different production systems and crop varieties used in the experiment. The sole turmeric production system (F1) may have provided a more favourable environment for rhizome growth and development, resulting in maximum size of mother rhizome width (cm) compared to the Eucalyptus + turmeric (F2). The different

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crop varieties used may have also had varying size of mother rhizome width (cm), with some varieties producing maximum size of mother rhizome width (cm) due to genetic traits such as rhizome size and weight. The size of mother rhizome width (cm) per plant serves as an indicator of the suitability of the various production systems and crop varieties for supporting turmeric yield formation. Maximum size of mother rhizome width (cm) point to treatments that conditioned the plant growth environment in a way that promoted higher mother rhizome width. Other factors such as soil fertility, water availability, and pest and disease pressure may have also influenced the size of mother rhizome width (cm) of plant. Similar result was also found by Painkra et al. (2020) and Sahu et al. (2022).

Mother rhizome length and width are higher in open conditions because to increased sunshine exposure, allowing for more efficient photosynthesis. In agroforestry environments, trees provide shade and compete for soil minerals and moisture, restricting turmeric's access to essential resources. Open fields also allow for improved air circulation, which reduces disease risk and makes weeding and irrigation easier to maintain. Open systems have higher yields than agroforestry setups since there is no competition and the growing conditions are higher.

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Table 1: Mother Rhizome length plant^{-1} (cm) as affected by production system and turmeric varieties under Eucalyptus-based agroforestry system

Treatments	Size of mother rhizome length (cm)		
	2022-23	2023-24	Pooled
Factor A (Production system)			
F_1- Sole turmeric	9.44	9.77	9.60
F_2- Eucalyptus+turmeric	9.20	9.51	9.36
SEm±	**0.076**	**0.074**	**0.075**
CD @ 5%	**0.154**	**0.15**	**0.152**
Factor B (Crop varieties)			
T_1 –Suranjana	7.11	7.45	7.28
T_2 –Selam	8.65	8.96	8.80
T_3 -Chhattisgarh Haldi-1	7.48	7.82	7.65
T_4 -Chhattisgarh Haldi-2	9.39	9.70	9.54
T_5 –Roma	7.25	7.55	7.40
T_6 –Ranga	7.38	7.71	7.54
T_7 -NDH-98	20.74	21.02	20.88
T_8 –Sonali	6.58	6.91	6.75
SEm±	**0.152**	**0.148**	**0.149**
CD @ 5%	**0.309**	**0.301**	**0.304**

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Table 2: Mother Rhizome width plant^{-1} (cm)as affected by production system and turmeric varieties under Eucalyptus-based agroforestry system

Treatments	Size of mother rhizome width (cm)		
	2022-23	2023-24	Pooled
Factor A (Production system)			
F_1- Sole turmeric	6.51	6.84	6.68
F_2- Eucalyptus+turmeric	6.43	6.75	6.59
SEm±	**0.071**	**0.073**	**0.071**
CD @ 5%	**NS**	**NS**	**NS**
Factor B (Crop varieties)			
T_1 –Suranjana	6.28	6.61	6.44
T_2 –Selam	6.33	6.68	6.50
T_3 -Chhattisgarh Haldi-1	6.37	6.69	6.53
T_4 -Chhattisgarh Haldi-2	7.28	7.58	7.43
T_5 –Roma	6.32	6.63	6.48
T_6 –Ranga	6.33	6.64	6.49
T_7 -NDH-98	6.95	7.25	7.10
T_8 –Sonali	5.90	6.28	6.09
SEm±	**0.143**	**0.147**	**0.143**
CD @ 5%	**0.291**	**0.299**	**0.291**

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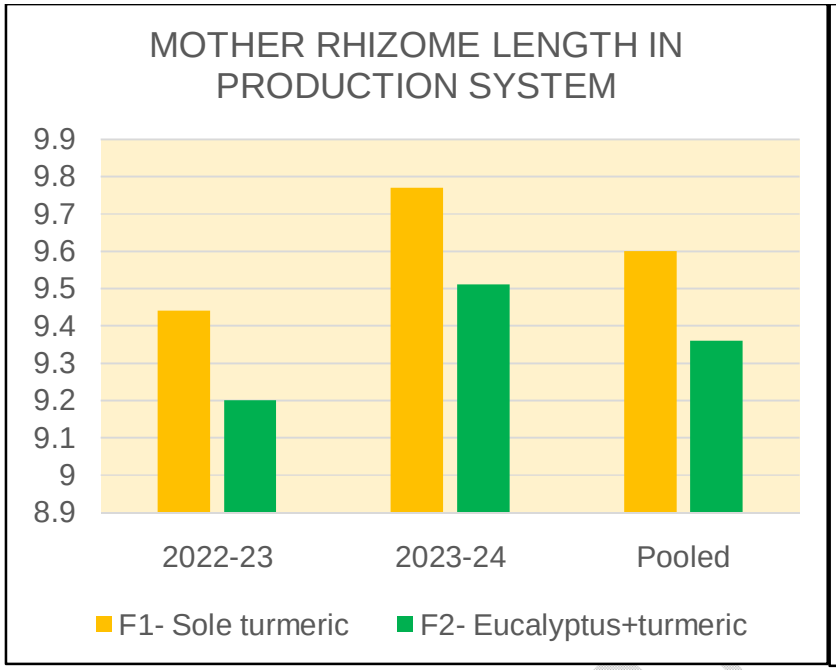


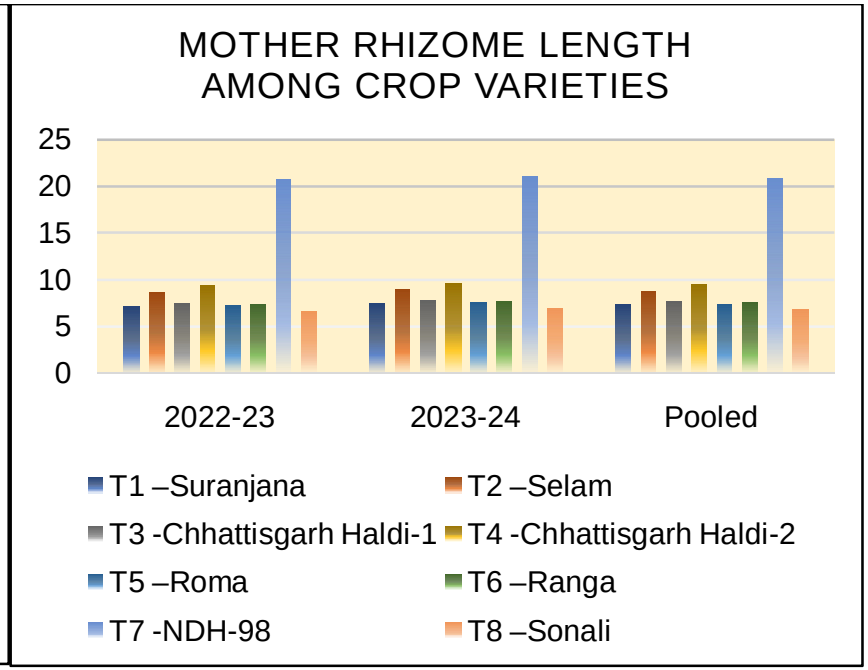
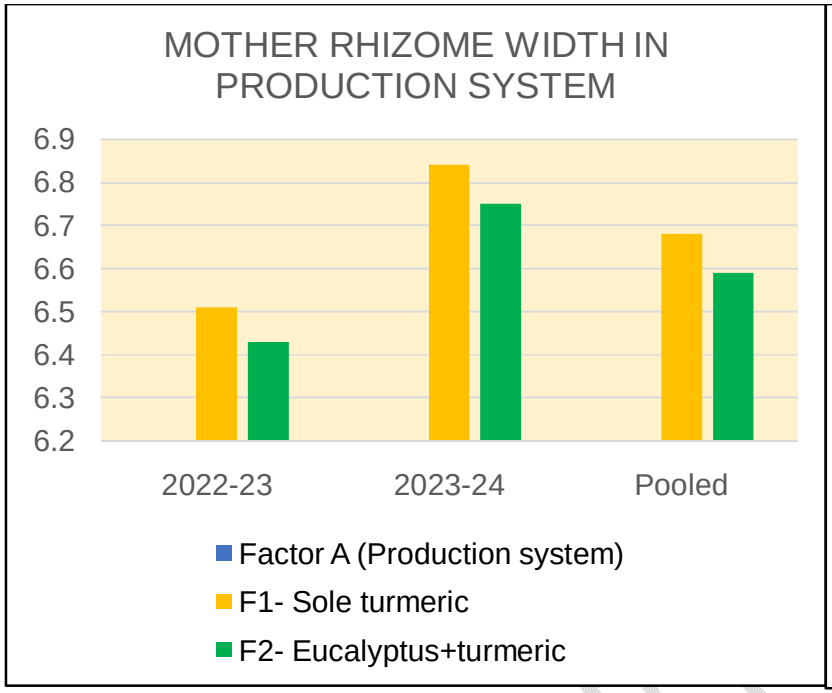


Fig 1: Mother Rhizome length at harvesting stage of Turmeric as influenced by control farming and *Eucalyptus tereticornis* based agroforestry system in production system

Fig 2: Mother Rhizome length at harvesting stage of Turmeric as influenced by control farming and *Eucalyptus tereticornis* based agroforestry system among crop varieties



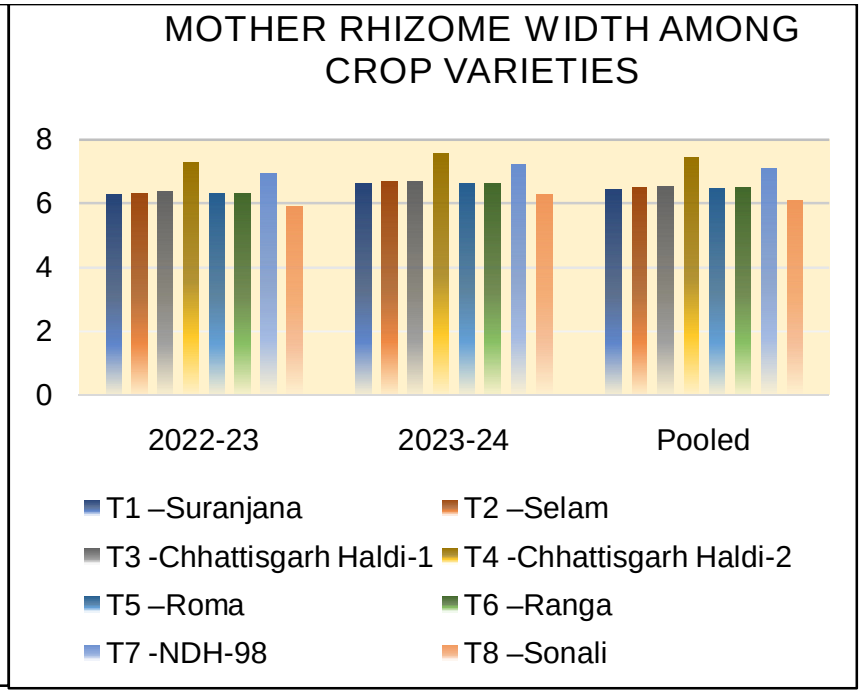


Fig 3: Mother Rhizome width at harvesting stage of Turmeric as influenced by control farming and *Eucalyptus tereticornis* based agroforestry system in production system

Fig 4: Mother Rhizome width at harvesting stage of Turmeric as influenced by control farming and *Eucalyptus tereticornis* based agroforestry system among crop varieties

CONCLUSION

Based on both production system pooled mean observation on mother rhizome length per plant (cm) was significantly maximum 9.6 cm under F1 (Sole turmeric) as compare to F2 9.36 cm (Eucalyptus+Turmeric) and among crop varieties significantly maximum mother rhizome length per plant (cm) was recorded in NDH-98 (20.88) as compare to other variety in both the year of investigation and on mean data.

Pooled mean observation on mother rhizome width per plant (cm) was significantly maximum 6.68 cm under F1 (Sole turmeric) as compare to F2 6.59 cm (Eucalyptus+Turmeric) and among crop varieties significantly maximum Mother rhizome width per plant (cm) was recorded in Chhattisgarh Haldi-2 (7.43) as compare to other variety in both the year of investigation and on mean data.

FUTURE SCOPE

The following relevant suggestions are recommended to highlight the future scope of the problem:

1. Similar research should be conducted in different tree species for AFS.
2. The Sonali turmeric variety is not recommended for agroforestry-based intercropping because to low tuber yield and quality in the Central Plain zone of Chhattisgarh.
3. To improve rhizome yield and quality, growers should use an agroforestry-based intercropping system that includes eucalyptus instead of planting turmeric alone.
4. Financial incentives might encourage farmers to adopt the eucalyptus + turmeric agroforestry system, leading to increased revenue and better resource utilization.
5. Optimize plant shape and spacing for eucalyptus trees and turmeric crops to enhance productivity and profitability.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

I hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

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