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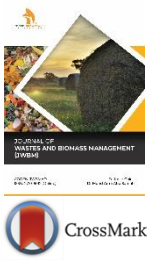

RESEARCH ARTICLE

IMPACT OF MULCH MATERIALS AND MULCHING RATES ON THE GROWTH AND YIELD OF TURMERIC (*CURCUMA LONGA* L.) IN THE SOUTHERN GUINEA-SAVANNAH REGION OF NIGERIA

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ABSTRACT

Research experiment was carried out at the Biotechnology Advanced Research Centre Farm, Garki-Abuja from June 2023 – February 2024 to examine the performance of mulch materials and mulching rates on Margina Local variety of turmeric. The experiment was laid out using Randomized Complete Block Design (RCBD), replicated three times. Data were collected on plant height per plant (cm), number of leaves per plant, leaf length (cm), number of rhizome, rhizome length (cm), rhizome weight (g) and rhizome yield (t/ha). ANOVA was used to analyze the data, and the Duncan Multiple Range Test was used to compare the significant means (DMRT). The plants mulched with rice husk (3.74 t ha^{-1}) produced the maximum amount of rhizome yield, while sawdust (2.84 t ha^{-1}) produced the least amount of rhizome. As such, farmers in Nigeria's Southern Guinea Savannah zone may find it beneficial to use rice husk mulch material for their turmeric production.

KEY WORDS

Turmeric, Rhizome, Mulch, Rates, Growth, Yield

1. INTRODUCTION

The perennial herbaceous plant known as turmeric (*Curcuma longa*) belongs to the Zingiberaceae family and is rhizomatous. It is indigenous to Asia and India, where it makes up around 6% of the country's spice and condiment land. It is marketed commercially as an industrial starch supply, oleo-resin, spice, and color. The main ingredient in turmeric is curcumin, which possesses features that include anti-inflammatory, anti-tumor, anti-cancer, anti-bacterial, anti-oxidant, anti-fungal, and anti-parasitic effects (Akter et al., 2019; Tomeh et al., 2019; Ahmad et al., 2020). Turmeric is primarily used for a broader range of purposes, including oleoresin, flavor, and therapeutic purposes. It is also used as an orange coloring powder in the food and textile industries. Dry turmeric comprises around 69.43% carbohydrates, 6.30% protein, 5.1% oil, 3.5% mineral, and other significant components (Sidhu et al., 2016). It is old, precious, and sacred spice with significant amounts of protein (6.3%), fats (5.1%), carbs (69.45), and fiber (2.6%). Minerals including phosphorus, calcium, iron, and vitamin A are also abundant in it. One of the active ingredients in turmeric (3-5%) is called curcumin, which gives food, fiber, wood, and various preparations of their color and is also responsible for biological activity. When compared to other significant producing nations, Nigeria's turmeric crop productivity and output are still poor. Reduced soil fertility and a lack of relevant and sufficient research data are two of the causes contributing to this production gap. Turmeric is said to be a nutrient-exhaustive crop in a number of studies, particularly because it is a high N feeder (Singh et al., 2001; Agere and Shiferaw, 2015). Turmeric has a high nutritional need because of its shallow rooting and capacity to produce a lot of dry matter per unit area (Singh et al., 2001). In order to increase rhizome yield, the crop's extended growth period of eight to nine months also lengthens the time needed for nutrient requirements.

The spice known as "turmeric" is actually the rhizome of a plant that has been cooked, dried, cleaned, and polished, with an underground swelling modified stem (Shirish et al., 2013). Mulching is a crucial part of turmeric management techniques. It retains moisture in the soil and raises soil temperature throughout the dry months to ensure that the rhizome germinates properly (Kumar et al., 2022). Furthermore, the physical characteristics of the soil are improved, and its fertility is reduced (Qin et al., 2014). According to Bhardwaj (2011) and Iqbal *et al.* (2020), organic mulches seem to be effective in mitigating nitrate leaching, promoting soil biological activity, preventing erosion, and improving soil physical qualities (Bhardwaj, 2011; Iqbal et al., 2020). Since ancient times, natural mulches such leaves, straw, sawdust, wasted materials, and crop leftovers have been utilized (Indulekha and Thomas, 2018). Organic mulches improve the physical, chemical, and biological qualities of the soil after decomposition, restoring organic matter and plant nutrients to the soil and ultimately increasing agricultural output (Thakur and Kumar, 2021). Moreover, it keeps soil nutrients from being washed away during prolonged rainstorms (Iqbal et al., 2020; Mohanty, 1991). As a result, it helps regulate temperature fluctuations, increases soil moisture retention, and improves the physical, chemical, and biological qualities of the soil. These actions contribute nutrients to the soil, which in turn promotes crop growth and yield (Kumar et al., 2010). In light of these facts, the current study was conducted to assess the impact of mulching rates and materials on the growth and yield of turmeric.

2. MATERIALS AND METHODS

A research experiment was carried out in the 2023–24 cropping season at the Sheda Science and Technology Complex in Garki–Abuja, at the Biotechnology Advanced Research Centre Farm, Federal Capital Territory, Nigeria. Abuja's climate is chilly and dry from November to March and warm and moist from April to October. It is situated at 8^{0}10'N and 7^{0} 10'N.

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The temperature at the maximum and minimum is 35^{0}C and 27^{0}C, respectively. The humidity of this area is high (74%) all the year round except in January when dry wind blows from the north. The average annual rainfall is over 1250 mm. Margina Local variety of turmeric was planted at the spacing of 50 X 50 cm on the bed size of 2 X 2 m (4m^2). Three types of mulch materials were used in the treatments: rice husk, sawdust, and soybean straw. Three different mulching rates were also applied: 0 (control), 5 t/ha, and 10 t/ha, respectively. At 3, 6, 9, and 12 weeks following planting (WAP), four manual weeding was conducted. Data were gathered about the number of leaves per plant, plant height (cm), leaf length (cm), number of rhizomes, length of rhizome roots (cm), rhizome weight (g), and rhizome yield (t/ha). Data was subjected to analysis of variance (ANOVA) and significant means compared using Duncan Multiple Range Test (DMRT) at 5% probability level.

3. Results

Mulch materials and mulching rates did not substantially (P≥0.05) affect plant height, nor did they significantly (P≥0.05) alter the interaction between mulch materials and mulching rates. Mulching materials and rates had no significant (P≥0.05) effect on the number of leaves on turmeric plants. There was no significant (P≥0.05) motivation for the interaction impact between mulch materials and mulching rates in the study. Mulching materials and rates had no significant (P≥0.05) effect on the leaf length of turmeric plants, although mulching rates had a significant (P≤0.05) effect on the plants. The control plots yielded the lowest mean (24.73 cm), whereas the mulching rate at 10 t ha^{-1} (30.95 cm) was significantly higher than the control and 5 t ha^{-1}.

Table 1: Effect of mulch materials and mulching rates on plant height, number of leaves and leaf length of turmeric in 2023-24 cropping season

Treatment	Plant height (cm)	Number of leaves	Leaf length (cm)
Mulch materials			
Rice husk	53.44	30.17	27.23
Soybean straw	47.70	31.93	27.18
Saw dust	48.84	27.05	28.72
Significant	ns	ns	ns
SE	3.34	2.01	1.21
Rate (t/ha)			
0	44.55	30.13	24.73b
5	52.30	29.18	27.45ab
10	53.12	29.84	30.95a
Significant	ns	ns	*
SE	3.34	2.01	1.21
Mulch X Rate	ns	ns	ns

SE-Standard Error. Means followed by the same letter (s) within the same column are not significantly different at 5% level of probability

Both mulch types and mulching rates had a substantial (P≤0.05) impact on the number of rhizomes. Compared to other mulches, rice husk mulch material had a much higher mean value (32.73). The plants mulched with saw dust (29.14) came in close second, and soybean straw yielded the lowest mean value. Plants mulched at a rate of 10 t ha^{-1} followed the 5 t ha^{-1} (32.92) mulching rate, which demonstrated its superiority over other rates. The control plots showed the lowest mean value. Mulching materials and mulch rates had a significant (P≤0.05) interaction effect. Plants mulched at rates of 5 and 10 t ha^{-1} had considerably (P≤0.05) longer rhizome roots than the control plots, but the length of the rhizome roots was not significantly (P≥0.05) prompted by the kind of mulch. The mulching rates (11.63 cm and 11.77 cm, respectively) in ascending order appeared to be comparable to one another. The types of mulch and the amount of mulch applied did not significantly (P≥0.05) affect rhizome weight. On the other hand, there was a substantial (P≤0.05) influence on the interacting effect of mulching rates and materials. Mulch material and mulching rate enhanced rhizome yield considerably (P≤0.05). As a result, saw dust and soybean straw yielded turmeric at comparable rates, whereas rice husk mulch material yielded the maximum output (3.74 t ha^{-1}). Both the individual mulching rates and the interaction between the mulch materials and mulching rates did not differ from one another significantly (P≥0.05).

Table 2: Effect of mulch materials and mulching rates on number of root and root length of turmeric in 2023-24 cropping season

Treatment	Number of rhizomes	Rhizomes length (cm)
Mulch materials		
Rice husk	32.73a	11.32
Soybean straw	26.33b	10.63
Saw dust	29.14ab	11.61
Significant	*	ns
SE	1.48	0.46
Rates (t/ha)		
0	26.86b	10.16b
5	32.92a	11.63a
10	28.43b	11.77a
Significant	*	*
SE	1.48	0.46
Mulch X Rate	*	ns

SE-Standard Error. Means followed by the same letter (s) within the same column are not significantly different at 5% level of probability

Table 3: Effect of mulch materials and mulching rates on rhizome weight and rhizome yield of turmeric in 2023-24 cropping season

Treatment	Rhizome weight (g)	Rhizome yield (t/ha)
Mulch materials		
Rice husk	91.11	3.74a
Soybean straw	90.02	2.91b
Saw dust	83.60	2.84b
Significant	ns	*
SE	3.44	0.20
Rates (t/ha)		
0	91.65	3.37
5	87.61	2.98
10	85.46	3.14
Significant	ns	ns
SE	3.44	0.20
Mulch X Rate	*	ns

SE-Standard Error. Means followed by the same letter (s) within the same column are not significantly different at 5% level of probability

The number of rhizomes was significantly (P≤0.05) impacted by the interaction between mulch materials and mulching rates. The plants mulched at 5 t ha^{-1} with soybean straw recorded the greatest number of rhizomes (33.69), which was comparable to the plants mulched at 10 t ha^{-1} with rice husk; the control plots yielded the lowest mean value (18.53). Also, the interaction between mulch materials and mulching rates on rhizome weight was significantly (P≤0.05) influenced with the heaviest weight received from rice husk (105.27 g), but was not significantly different from plants mulched with soybean straw at 10 t ha^{-1}. Evidently, the least mean value (73.94 g) was obtained from rice husk mulch at 10 t ha^{-1}.

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Table 4: Effect of mulch materials and mulching rates interaction on number of rhizomes and rhizome weight of turmeric in 2023-24 cropping season

Mulch materials	Mulching rates	Number of rhizomes	Rhizome weight (g)
1	1	32. 15ab	105.27a
1	2	32.65ab	94.13ab
1	3	33.40a	73.94c
2	1	18.53c	84.07bc
2	2	33.69a	91.10abc
2	3	26.71ab	94.89ab
3	1	29.33ab	85.62bc
3	2	32.42ab	77.62bc
3	3	25.17bc	87.55abc
CV		15.10	11.70
SE		2.57	5.95

CV-Coefficient variation, SE-Standard Error. Means followed by the same letter (s) within the same column are not significantly different at 5% level of probability

4. Discussion

Plant cell number and size increases may be the cause of the leaf growth parameter's increase with age. The findings of this investigation showed that the various mulching rates examined had a substantial impact on leaf length. The findings of this investigation are consistent with those of research for potatoes, for lettuce, and for bell peppers (Li et al., 2018; Shan Jahan et al., 2018; Filipovic, 2016). Which found that leaf length may be extended and further developed with enough nutrition and mulching. The present study findings showed that plants with mulch applied materials and mulching rates had higher numbers of rhizome root growth than plants in unmulched plots. Plants mulched with saw dust, rice husk, dry leaves, and straws typically have high soil moisture contents and control temperature, which leads to nutrient availability and uptake for the best possible rhizome root development (Thakur et al., 2019). This study demonstrated a discernible increase in rhizome root length, which is consistent with the findings in 2015, where they suggested that further rhizome root length development of turmeric might be achieved using improved mulching techniques (Weraduwage et al., 2015). They believed that increased root and shooting growth could be facilitated by a larger biomass accumulation. The current findings corroborate the findings in 2017, where they found that; when mulching materials are used effectively, maximum rhizome root and rhizome length can be achieved (Reddy et al., 2017). The results of the current study demonstrated that the number of rhizome roots and rhizome weight were significantly impacted by the interaction effect between mulch materials and mulching rates. The results align with the previous study on the turmeric plant (Reddy et al., 2017). The current study results demonstrated that, among the mulch materials tested, rice husk had the maximum rhizome production (3.74 t ha^{-1}). On the other hand, the yield achieved was much less than the 42.99 t ha^{-1} yield obtained from the research conducted in 2023 (Srinivas and Mahender, 2023). The large disparity may have resulted from edaphic and environmental factors controlling the production areas.

5. Conclusion and Recommendation

Based on the findings of this study, it is possible to draw conclusions and suggest that farmers in the study area should use and adopt rice husk mulch material for high growth and rhizome yield. Additionally, more field trials should be carried out to increase the yield of turmeric in the study area.

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