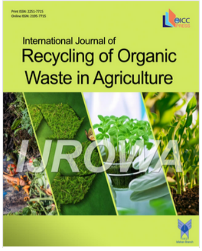

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Utilizing rice-husk waste as an effective weed control mulch for Holy Basil (*Ocimum sanctum*) production in a tropical environment

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Original Research

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Abstract:

Purpose: The growing adverse effects of agrochemicals on environmental health and safety warrant an examination of ecologically safe alternatives for weed control. The objective of this study was to determine the effect of rice-husk waste on the growth performance and weed management (WM) of *Ocimum sanctum*.
Method: In a randomized complete block design with three replications, nine weed management (WM) methods were assessed. These methods included black, red, and transparent polyethylene mulches; rice-husk; sawdust; hoe-weeding at 30 days after transplanting (DAT); a one-time application of 0.2 kg/ha Haloxyfop-P at 30 DAT; daily weeding; and no-weeding. Data were collected on weed parameters and growth attributes of *Ocimum sanctum*. All data were subjected to analysis of variance.
Results: The use of rice-husk mulch resulted in the most significant ($p < 0.05$) increase in plant height (41.70 cm), leaf number (206.80), branch number (50.50), stem girth (2.76 cm), and leaf yield (7.15 t/ha) of *Ocimum sanctum* compared to the other weed control methods. It was comparable to black polyethylene (BP) in these traits except in leaf number where BP recorded a lower value (165.00). BP mulch was significantly more effective in weed suppression as it recorded the least number of broad leaves (0.00), sedges (0.00) weed biomass (0.00), and the highest weed control efficiency (WCE) (100%) at 10 WAT. The treatments ranked BP>Daily-weeding>Hoe-weeded>Rice-husk>Haloxyfop-PEHS>Red-polyethylene>Sawdust>Transparent-polyethylene>Control in WCE at 10 WAT.
Conclusion: The study revealed that rice-husk mulch was the most effective in enhancing the growth and yield attributes of *Ocimum sanctum*, ranking fourth in weed control efficiency (WCE) at 72.60%, following black polyethylene (BP) mulch (100%), daily-weeding (96%) and hoe-weeded (95.7%).

Keywords: Black polyethylene; Ecofriendly crop production; Mulching; Organic waste recycling; Sustainable agriculture; Weed management

1. Introduction

In recent years, the rising global awareness of sustainable agricultural practices and the growing demand for organically produced crops have sparked a renewed interest in exploring innovative solutions to enhance both crop productivity and weed management (Hussain and Luqman, 2022; Khan et al., 2022). The tropical agricultural landscape, known for its diverse and rich biodiversity, offers unique challenges and opportunities for farmers seeking to adopt environmentally friendly practices that promote optimal crop growth while minimizing ecological impact. One such practice gaining attention is the utilization of rice-husk waste as a dual-purpose agricultural input: an effective weed control mulch material and an organic manure source for crop cultivation (Dakshayani et al., 2021). For example, Rahman et al. (1999) and Ramli (2017) reported increased growth and improved yield attributes in onion and cabbage crops when cultivated with rice-husk mulch.

Rice (*Oryza sativa*) serves as a staple food for millions of people worldwide. The production of rice frequently generates a significant quantity of agricultural waste in the form of rice-husks. From an estimated annual global agricultural waste production of 4.389 billion tons Mengqi et al. (2023), the five most crucial crops in the world, namely sugarcane, maize, wheat, rice, and oil palm, collectively contribute approximately 1.3 billion tons (Duque-Acevedo et al., 2020). Once regarded as a by-product with limited utility, rice-husks have recently gained recognition as a viable solution to two pressing issues in tropical agriculture: the rampant spread of weeds and the depletion of essential nutrients.

Weeds are plants that invade cultivated crop environments, competing with and potentially inhibiting the growth and development of crops. Brenchley (1917) expressed the view that achieving weed-free cultivation of cropland is virtually impossible because weeds inherently compete with crops for vital resources like sunlight, water and nutrients. This competition often leads to diminished yields and compromised crop quality (Kanatas et al., 2020a; Kanatas et al., 2020b; Naeem et al., 2022). At the same time, the ongoing depletion of soil nutrients through consecutive cropping cycles poses a significant threat to sustainable agricultural productivity. Promisingly, the utilization of rice-husk waste as a mulch material holds the potential to address these challenges comprehensively and in an environmentally friendly manner.

Holy Basil (*Ocimum sanctum*) commonly known as Tulsi or Tulasi, is a versatile herb belonging to the mint family, Lamiaceae. It is revered for its medicinal properties, spiritual significance, and aromatic qualities. It is proven to have both therapeutic and curative properties in the treatment of diverse health-related diseases (Mondal et al., 2011; Mohan et al., 2011; Kumar et al., 2013; Dakshayani et al., 2021). Cultivating Holy Basil offers a chance to blend cultural traditions with contemporary agricultural methods, as its demand steadily increases owing to its well-documented health advantages and surging popularity in the wellness sector. Nevertheless, achieving successful *Ocimum sanctum* cultivation in tropical environments demands meticulous attention to weed control and nutrient management (Upadhyaya and Blackshaw, 2007). Over the last two decades, there has been a noticeable rise in the utilization of synthetic herbicides to control weeds within *Ocimum sanctum* fields in the derived savannah agroecology (Warra and Prasad, 2020). Concerns regarding environmental and health safety linked to the excessive use of these chemicals are growing, as they have been found to have detrimental impacts such as food poisoning, groundwater contamination, and increased soil acidity (Khanna and Gupta, 2018). The improper utilization of synthetic agrochemicals is a matter of escalating global apprehension (Umesha et al., 2018). Consequently, there is a pressing need to explore an alternative method of weed management that prioritizes safety, health, and sustainability. The study hypothesized that the utilization of rice-husk waste as mulch material could potentially improve the growth and yield attributes of Holy Basil in addition to its weed-suppressing role compared to other weed control methods.

The aim of this study was to assess the influence of rice-husk waste on the growth and weed control of *Ocimum sanctum* in tropical agricultural environments. By examining the effects of rice-husk mulching on weed suppression, as well as the overall growth and yield of *Ocimum sanctum*, in comparison to alternative weed management techniques, this research strives to provide valuable insights for both agricultural and environmental sciences. The outcomes of this study have the potential to foster the development of sustainable agricultural practices that are culturally aligned, enhance crop yield, conserve natural resources, and promote the resurgence of traditional crops like *Ocimum sanctum* in an ever-evolving agricultural landscape.

2. Materials and methods

Study area

The experiment was carried out at the Teaching and Research Farm situated within the Department of Crop Science, University of Nigeria, Nsukka. The research farm is geographically located at Latitude 06°51′ and longitude 07°23′E with an elevation of 427 meters above sea level. Nsukka falls under the tropical savanna (wet and dry) climate category based on the Koppen-Gieger climate classification scheme (Onyenucheya and Nnamchi, 2018). The soil types prevalent in the area are primarily sandy clay and loamy sand (Kayode et al., 2019).

Nursery and field preparation

The Holy Basil seeds were initially sown in a nursery basket. The nursery medium consisted of a mixture of topsoil, poultry manure, and river sand in a 3: 2: 1 ratio. After four weeks of growth in the nursery, robust and uniform seedlings were transplanted into the field.

The experimental field measuring 13 meters by 5 meters, was manually cleared using cutlasses. Stumps and weeds were removed, and the field was divided into three blocks, with each block containing plots measuring 1 meter by 1 meter. These blocks were spaced I meter apart, while the individual plots within each block were spaced 0.5 meters apart. Poultry manure was added to each plot at a rate of 20 t/ha and thoroughly mixed with the soil two weeks before transplanting of the seedlings (Table 1).

Experimental design and treatments

The study included nine weed management practices, which comprised: three types of plastic mulches (black, red and transparent polyethylene), two types of organic mulches (rice-husk waste at 180,000 kg/ha and sawdust at 120,000 kg/ha), two manual weeding methods (daily removal of weeds [weed free] and one- time weeding with a hoe at 30 days after transplanting [hoe weeding]), one post-emergence application of Haloxyfop herbicide (0.2 kg/ha Haloxyfop-P) at 30 days after transplanting (DAT), and no

Table 1. The field layout consisted of nine distinct weed control methods, each replicated three times.

Block 1	Block 2	Block 3
Rice-husk	Transparent Polyethylene	Haloxyfop spray (0.2 kg/ha)
Sawdust	No weeding	Red Polyethylene
Black Polyethylene	Daily weeded	Hoe weeded
Red Polyethylene	How weeded	No weeding
Transparent Polyethylene	Haloxyfop spray (0.2 kg/ha)	Daily weeded
Hoe-weeded	Red Polyethylene	Transparent Polyethylene
Haloxyfop spray (0.2 kg/ha)	Rice-husk	Black Polyethylene
Daily Weeded	Black polyethylene	Sawdust
No weeding	Sawdust	Rice-husk

Each cell represents a plot (1 × 1 m). Blocks were spaced 1.0 m apart and plots were spaced 0.5 m apart.

weeding (weedy or control). These treatments were organized in a randomized complete block design (RCBD) with three replications. The design was chosen to account for any noticeable variation in the experimental area's gradient.

Data collection

Weed parameters

Dominant weeds in the study area were identified at the species level using the handbook of West African Weeds (Akobundu and Ekeleme, 2002). Weed population counts were conducted in each plot using a 0.5 m^2 quadrat placed randomly at two different spots within the plot. Data on weed density and infestation were recorded at the 2^{nd}, 6^{th}, and 10^{th} week after transplanting (WAT). For weed density, the harvested weeds were categorized and weighed using an electronic scale (TS200) to obtain the fresh weight. Subsequently, the fresh weeds were placed in an oven at 80°C for 48 hours, and the dry weight was determined. Weed control efficiency was calculated following the procedure used by Osadebe et al. (2015) as follows:

$$\text{Weed control efficiency (WCE)} = \frac{\text{DMC-DMT}}{\text{DMC}} \times \frac{100}{1}$$

where; DMC = weed dry matter in the control plot; DMT = weed dry matter in the treated plot.

Plant growth parameters

Growth parameters data were collected from two mid-row plants bi-weekly. Standard procedures, as outlined in Ihejiofor et al. (2020), Ihejiofor et al. (2022), Muojiama et al. (2023), Ukwu et al. (2023a), and Ukwu et al. (2023b) were followed for measuring the number of leaves (NoL), number of branches (NoB),plant height, stem diameter, and crop yield. Canopy diameter per plant was determined as the average length of the canopy coverage for each sample.

Data analysis

All the collected data underwent analysis of variance (ANOVA) following the procedure for RCBD experiments as outlined in the 18^{th} Edition of Genstat. Significant treatment means were differentiated using Fisher's Least Significant Difference at a 5% probability level (LSD 0.05). Graphs were constructed using GraphPad Prism 6.

3. Results and discussion

Effect of weed control methods on weed species diversity, density, and biomass

In the various weed control treatments (Table 2), a total of eight (8) weed species were observed. Broad-leaf weeds constituted the majority of the identified weed species, with only *Eleusine indica* and *Cyperus rotundus* being recorded as grasses and sedges, respectively. Approximately 77.8% of the encountered weed species were broad leaves, while 11.1% were grasses, and another 11.1% were sedges. All the weed species were identified as annuals. At 2 weeks after transplanting (WAT), *Euphorbia heterophylla* was observed.

Eleusine indica, had more occurrence throughout the different weed control treatments while the other weed species occurred sparingly with absent in a few plots.

The effect of weed control methods on weed density and biomass showed significant ($p < 0.05$) difference at the later stages of the plant's development (4-12 WAT), while it was comparable at 2 WAT. The number of broad-leaf weeds per plot was significantly affected ($p < 0.05$) by the weed control methods. The highest number of broad-leaf weeds was recorded in the weedy plots (56.33) at 2 WAT, and (16.67) at 10 WAT, and in the transparent polyethylene mulch plot (35.00) at 6 WAT compared to the plots mulched with black polyethylene which consistently recorded the least number of broad-leaf weeds with mean of 20.33, 2.67, and 0.00 at 2, 6, and 10 WAT, respectively. There was no significant difference between black polyethylene and rice-husk mulch materials (Fig. 1).

The effect of the weed control method on the number of grasses was significant throughout the study period ($p < 0.05$). Red polyethylene and transparent polyethylene mulches were found to influence a higher number of grass-

Table 2. The predominant weed species based on the treatments and their preponderance.

Weed management	Weeds present	2 WAP	6 WAP	10 WAP
Black polyethylene mulch	*Calopogonium muconoides*	++	+	-
	Mimosa invisa Mart	+	+	-
	Mitracarpus villosus	+	+	-
	Euphorbia heterophylla Linn	++	+	-
	Eleucine indica	++	+	-
	Cyperus rotundus	+	+	-
Hoe weeding at 30 DAT	*Calopogonium muconoides*	++	+	+
	Mimosa invisa Mart	+	-	+
	Mitracarpus villosus	+	+	++
	Euphorbia heterophylla Linn	+++	-	+
	Celosia leptostachyma Benth	++	+	++
	Ageratum conyzoides	+	-	+
	Eleucine indica	++	+	+
	Cyperus rotundus	++	+	+
Herbicide spray of haloxyfop	*Calopogonium muconoides*	+	+	+
	Mimosa invisa Mart	+	-	+
	Mitracarpus villosus	+	++	+++
	Euphorbia heterophylla Linn	+++	+	-
	Celosia leptostachyma Benth	++	-	+
	Cyperus rotundus	+	++	++
Rice-husk mulch	*Calopogonium muconoides*	-	+	+
	Mimosa invisa Mart	-	++	++
	Mitracarpus villosus	++	+	-
	Euphorbia heterophylla Linn	++	++	+
	Ageratum conyzoides	-	++	-
	Eleucine indica	+++	+	-
	Cyperus rotundus	+	+	+
Red polyethylene mulch	*Calopogonium muconoides*	++	+++	++
	Mimosa invisa Mart	+	+	–
	Mitracarpus villosus	+	++	++
	Euphorbia heterophylla Linn	+++	-	-
	Eleucine indica	++	+++	+++
	Cyperus rotundus	++	+	++
Sawdust mulch	*Calopogonium muconoides*	++	++	++
	Mimosa invisa Mart	-	+	+
	Mitracarpus villosus	+	++	++
	Euphorbia heterophylla Linn	++	+	+
	Eleucine indica	+	-	-
	Cyperus rotundus	+	+	+
Weedy plot	*Calopogonium muconoides*	++	++	++
	Mimosa invisa Mart	+	+	+
	Mitracarpus villosus	++	++	++
	Euphorbia heterophylla Linn	+++	+	++
	Ageratum conyzoides Benth	++	+++	++
	Sida acuta Burm	++	+	++
	Eleucine indica	+++	++	+
	Cyperus rotundus	+++	++	+
Weed free	*Calopogonium muconoides*	+++	++	++
	Mimosa invisa Mart	+	+	+
	Mitracarpus villosus	+	-	-
	Euphorbia heterophylla Linn	+++	–	–
	Eleucine indica	++	+	+
	Cyperus rotundus	+	+	+
Transparent polyethylene mulch	*Calopogonium muconoides*	+++	+++	+++
	Mimosa invisa Mart	+	+	+
	Mitracarpus villosus	+	++	-
	Euphorbia heterophylla Linn	++	++	++
	Eleucine indica	+++	+++	+++
	Cyperus rotundus	+	+	+

+ = Less severe, ++ = Severe, +++ = More severe, - = Weed absent.

weeds compared to sawdust, black polyethylene, herbicide spray, rice-husk, and hoe weeding, which were observed to be the least, and statistically comparable ($p > 0.05$) across the study duration (Fig. 2).

The number of sedges encountered per plot was variable ($p < 0.05$). Whereas hoe weeding at 30 DAT, weed-free plots, and transparent and black polyethylene mulches maintained a lower frequency (< 2.00) of occurrence throughout the study duration, a significantly higher number of sedges was favored by weedy plots at 2 WAT (5.33) and at 6 WAT (6.33), rice-husk at 6 WAT (6.33), herbicide spray (6.33) and red polyethylene mulch (4.67) at 10 WAT (Fig. 3).

At 2 WAT, fresh biomass of weed (WFB) showed no significant variation among treatments ($p > 0.05$). However, variation became evident at 6 and 10 WAT. Significantly higher ($p < 0.05$) WFB was recorded in weedy plots (233.00 g) at 6 WAT and sawdust mulch (121.00 g) at 10 WAT. Black polyethylene and rice-husk mulches consistently exerted the least influence on WFW (< 8.00 g) throughout the study (Fig. 4).

A similar trend was also observed in the effect of the weed control method on weed dry biomass (WDB). Significantly higher ($p < 0.05$) WDB was recorded in weedy plot (43.83 g) at 6 WAT, and (23.93 g) at 10 WAT. However, black polyethylene and hoe weeding had the least WDB (< 1.5 g) across the weeks of study (Fig. 5). The highest weed control efficiency (> 90%) was recorded in black polyethylene plots throughout the study. This was closely followed by plots weeded with hoe at 30 DAT (> 85% efficiency), in contrast to the un-weeded plots (Fig. 6).

The study revealed that the black polyethylene mulched plots had the least density, biomass weight, and the highest weed control efficiency. At 10 WAT, total suppression of the weed species was observed in the plots mulched with black polyethylene, while fewer occurrences of the various weeds were noted in the other weed control treatments, except in the weedy plots and the plots mulched with transparent polyethylene. Weed species diversity was found to be higher in hoe-weeded plots, rice-husk mulched plots, post-emergence herbicide-treated plots, hoe-weeded plots, and weedy plots. This suggests that weed flora composition was being altered by weed control practices, which agrees with the reports of Osadebe et al. (2015) and Naeem et al. (2022).

The higher weed control efficiency of black polyethylene mulch in contrast to the other weed control methods adopted in this study could be implicated on its ability to effectively block sunlight from reaching the soil surface which ultimately hinders the photosynthetic activities of the weeds. In addition, the impermeable nature of black polyethylene mulch makes it practically impossible for weeds to penetrate and emerge from the soil. Due to its synthetic nature, it could last for a very long time on the field in contrast to the mulch of organic sources which decompose with time, thus allowing the weeds to emerge. This report is in agreement with Li et al. (2018) who reported that protecting crops under plastic (polyethylene) generates changes in the environmental conditions of light, temperature, and relative humidity that may affect the yield. It also corroborates Anyakoha (2010) who suggested that darker surfaces are also a better absorber of heat, do not allow complete absorption of sun rays, and that the heat generated by the material smolders weed seeds and weed seedlings making them unable to survive; Ngouajio et al. (2004), Osadebe et al. (2015), and X Bo and Li (2021) who reported complete elimination of weeds with the use of black polyethylene mulch.

Effect of weed control method on growth performance of Holy Basil

The growth parameters of holy basil were impacted differently by the various weed control methods. For instance, the highest significant increase in leaf number from the 6th to the 12th WAT were influenced by rice-husk mulch, in contrast to weedy plots, and the post-emergence application of 0.2 kg/ha Haloxyfop-P sprayed at 30 DAT, which had the least impact on leaf number throughout the study (Fig. 7). Leaf numbers ranged from 68.00 in weedy plots to 200.83

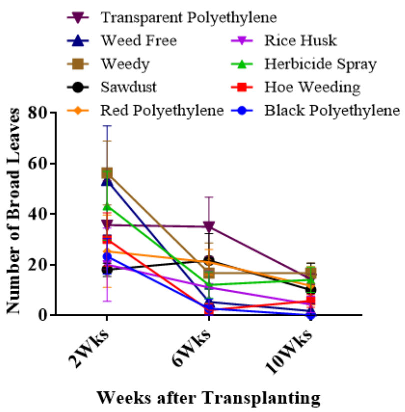

Figure 1. Effect of weed control method on the number of broad leaves per plot. The graph shows the mean values of three replicates. Error bars indicate standard deviations of means.

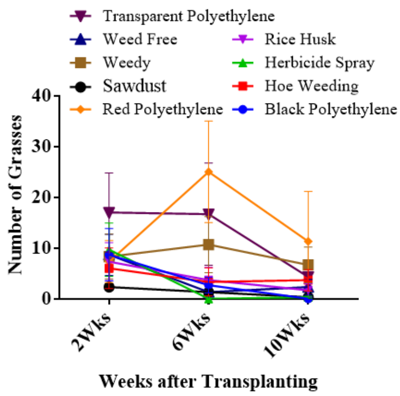

Figure 2. Effect of weed control method on the number of grasses per plot. The graph shows the mean values of three replicates. Error bars indicate standard deviations of means.

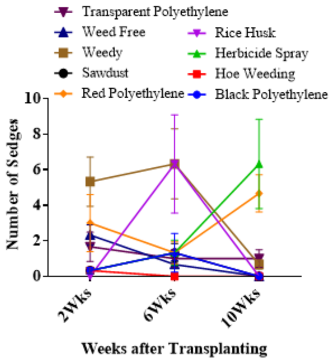

Figure 3. Effect of weed control method on the number of sedges. The graph shows the mean values of three replicates. Error bars indicate standard deviations of means.

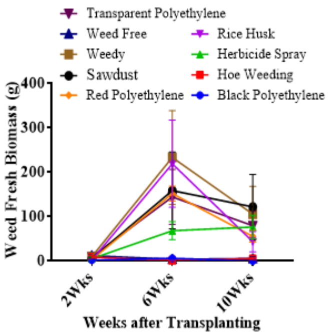

Figure 4. Effect of weed control method on weed fresh biomass. The graph shows the mean values of three replicates. Error bars indicate standard deviations of means.

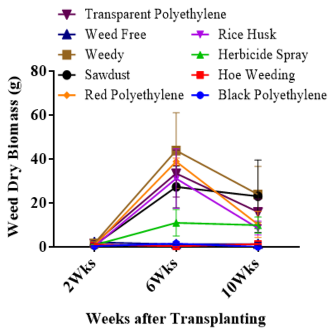

Figure 5. Effect of weed control method on weed dry biomass. The graph shows the mean values of three replicates. Error bars indicate standard deviations of means.

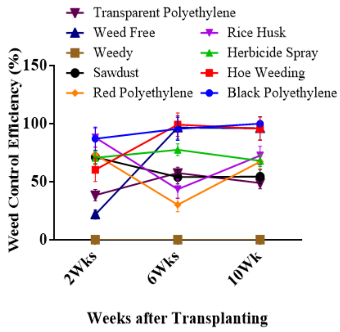

Figure 6. Effect of weed control method on weed control efficiency. The graph shows the mean values of three replicates. Error bars indicate standard deviations of means.

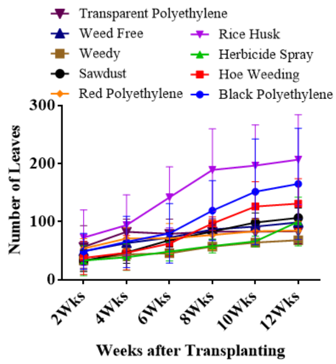

Figure 7. Effect of weed control method on leaf number of holy basil. The graph shows the mean values of three replicates. Error bars indicate standard deviations of mean.

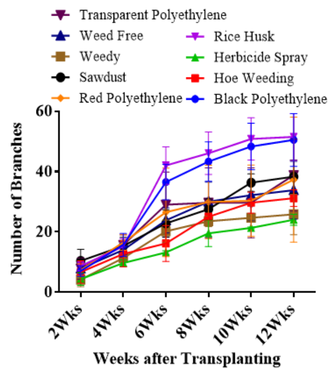

Figure 8. Effect of weed control method on the number of branches of holy basil. The graph shows the mean values of three replicates. Error bars indicate standard deviations of mean.

in rice-husk mulched plots at 12 WAT.

The number of branches (NOB) was significantly higher in rice-husk mulched plots than in the plots treated with a post-emergence application of haloxyfop herbicide (0.2 kg/ha HaloxyfopP) at 30 DAT, which consistently influenced the least NOB across the weeks of study (Fig. 8). NOB ranged from 24.00 in the post-emergence herbicide sprayed plots to 51.50 in the rice-husk-treated plots at 12 WAT (Fig. 8). Rice-husks, red polyethylene, and black polyethylene mulches influenced significantly taller plants compared to the weedy and hoe-weeded plots which were the shortest throughout the study. Plant height ranged from 29.83 in the weedy plots to 42.00 in the rice-husks and black polyethylene treated plots (Fig. 9). Rice-husks showed consistency in influencing higher canopy diameter than the other weed control methods. Canopy diameter ranged from 25.17 cm in the weedy plots to 53.67 cm in the rice-husks plots at 12 WAP (Fig. 10).

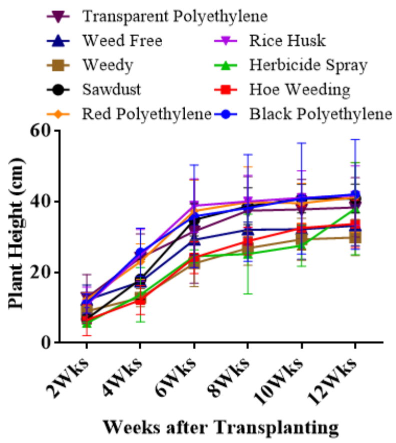

Figure 9. Effect of weed control method on leaf number of holy basil. The graph shows the mean values of three replicates. Error bars indicate standard deviations of mean.

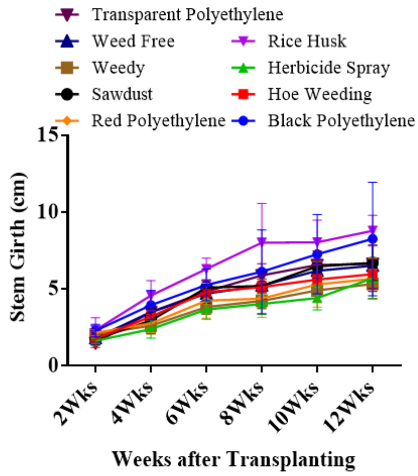

Figure 11. Effect of weed control method on stem girth of holy basil. The graph shows the mean values of three replicates. Error bars indicate standard deviations of mean.

Wider stem girth was significantly favored by rice-husks mulch followed by black polyethylene mulch, whereas the thinnest stems were recorded in the weedy plot (Fig. 11). This trend was consistently observed throughout the study. Stem girth ranged from 5.32 cm in weedy plots to 8.79 cm in rice-husk mulched plots at 12 WAT (Fig. 11). The Leaf yield of holy basil also exhibited variation based on the weed control method ($p < 0.05$). Rice-husk mulch maintained its superiority over other treatments in the leaf yield of holy basil. Although comparable to black polyethylene mulch (7.07 t/ha), rice-husk mulch recorded the highest leaf yield (7.15 t/ha) of holy basil compared to post-emergence herbicide spray at 30 DAT (1.54 t/ha), transparent polyethylene mulch (1.59 t/ha), and weedy (1.94 t/ha) plots which recorded the poorest yield (Fig. 12).

It was observed from the study that the growth and yield of holy basil were significantly enhanced by mulching. The increase in plant height, stem girth, NoB, NoL, and canopy diameter observed in this study as a result of mulching, is in tandem with the previous report of Mamkagh (2009) that soil surface mulching enhanced the morphological parameters of okra contrary to un-mulched soil which was attributed to improved soil temperature (Tuli and Yesilsoy, 1997). Holy basil plants in mulched plots were generally taller, with thicker stems, and produced the highest number of branches, and leaves. This could be attributed to the ability of mulching to enhance water use efficiency (Kouwenhoven et al., 2002). It is possible that soil moisture conservation was facilitated by the mulch materials through the reduction of surface soil evaporation (Adekalu et al., 2008), increased infiltration (Adekalu et al., 2007), enhanced water retention capacity (Anikwe et al., 2007) and improved condensation of soil water at night due to temperature reversals (Tisdall et al., 1991).

The study hypothesis was confirmed as the highest significant increases in canopy diameter, number of branches,

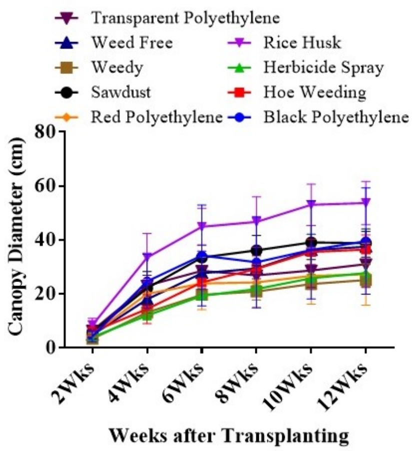

Figure 10. Effect of weed control method on canopy diameter of holy basil. The graph shows the mean values of three replicates. Error bars indicate standard deviations of mean.

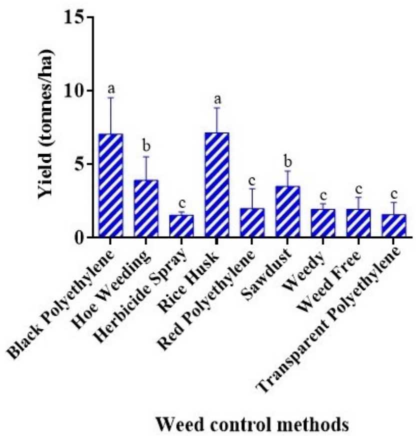

Figure 12. Effect of weed control method on leaf yield of holy basil. The graph shows the mean values of three replicates. Error bars indicate standard deviations of mean.

leaf number, plant height, stem girth, and leaf yield of *Ocimum sanctum* were recorded in plots with rice-husk mulch.. This enhanced performance may be attributed to the ability of rice-husk mulch to improve soil physicochemical properties when decomposed, thereby making nutrients readily available for crop use which is consistent with (Ramli, 2017) who reported enhanced leaf number and weight of cabbage with the application of rice-husk mulch; and (Rahman et al., 1999) who reported enhanced growth attributes in onion with the application of rice-husks. The rice-husk mulch could have enhanced growth and yield traits of *Ocimum sanctum* through enhanced soil qualities that included lowering soil bulk density, raising soil pH, adding organic carbon, boosting accessible nutrients, and removing heavy metals from the system (Williams et al., 1972). The comparable high yields obtained in rice-husk and black polyethylene mulched plots were further supported by the findings of Singh and Kamal (2012), and Osadebe et al. (2015) who reported higher yield in tomato and fluted pumpkin when black polyethylene mulch was used compared to other mulch materials.

4. Conclusion

The study demonstrated that the growth and yield attributes of *Ocimum sanctum* were best improved by rice-husk, which ranked fourth in weed control efficiency (WCE) at 72.60% following black polyethylene (100%), DROW (96%), and daily weeded (95.70%). This report has the potential to contribute significantly to sustainable agricultural practices, offering farmers a safe, eco-friendly, and cost-effective solution for weed management. The use of rice-husk waste presents numerous benefits for the cultivation of *Ocimum* species, including the conservation of soil moisture, suppression of weed growth, and enhancement of soil health. This makes it a sustainable and cost-effective option in crop production. Additionally, the recycling of rice-husk as mulch contributes to waste reduction and promotes environmental sustainability. As a versatile and eco-friendly choice, rice-husk mulch holds promise for enhancing crop yields and advancing sustainable farming practices in the future. Therefore, its utilization is recommended.

Author contribution
Conceptualization and design VOO, execution of field experiments and data collection ND and IMN, data analysis and first draft UNU, literature searches and supervision AEE and AIO, review ALL authors.

Conflict of interest statement
The authors declare that there is no conflict of interest associated with this study.

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