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EVALUATION OF SOIL MOISTURE PATTERNS AND GROWTH PARAMETERS OF LETTUCE (*Lactuca sativa* L.) USING SELECTED ORGANIC PLANTING MEDIA UNDER DRIP IRRIGATION SYSTEMS

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Abstract
This study investigated the suitability of three organic planting media (sawdust, rice husk, and loamy soil) for growing lettuce (Lactuca sativa L.) in an open environment in Kaduna North Local Government Area, Kaduna State, Nigeria. A randomized complete block design with three treatments (media types) replicated five times was employed. The pH values of the media ranged from 8.5 (loamy soil) to 11.7 (sawdust). Porosity values were highest in sawdust (0.84) and lowest in loamy soil (0.20). Rice husk exhibited the highest moisture retention capacity, followed by sawdust and then loamy soil. Lettuce grown in the loamy soil medium had the highest total number of leaves (573), followed by sawdust (370) and rice husk (56). These findings suggest that while rice husk offered superior moisture retention, it may not provide optimal conditions for lettuce growth compared to other media with lower porosity but higher initial nutrient content (loamy soil). This research highlights the importance of considering both moisture retention and inherent nutrient content when selecting organic growth media for lettuce production under specific climatic conditions.

Key Words: *Lettuce, Soil Moisture, Organic Planting Media, Drip Irrigation, Soilless Cultivation*

Introduction

Lettuce (*Lactuca sativa L.*) is a member of the Asteraceae (Compositae) family, one of the most diverse and widespread plant families globally, encompassing approximately 23,000 to 30,000 species (Alifar *et al*., 2010). In Nigeria, lettuce has become a staple vegetable crop, integral to various dishes, particularly salads. Its consistent presence in Nigerian cuisine underscores its commercial viability and growing demand.

The cultivation of lettuce in Nigeria has evolved, ranging from backyard farming to extensive commercial operations. Lettuce's versatility in raw consumption, juicing, and culinary applications, coupled with its appealing appearance and nutritional value, has cemented its place as a substitute for traditional vegetables like waterleaf, bitter leaf, and pumpkins in

Southern Nigeria. Its availability abroad also allows Nigerians to recreate traditional dishes such as Edikang Ikong, Ekpang Nkokwor, Affang soup, and Egusi soup, fostering a sense of home (Bohme *et al*., 2001). The increasing demand for lettuce in Nigeria underscores the need for expanded and efficient production. Bridging the production gap offers a lucrative opportunity for farmers, promising significant returns on investment.

Lettuce, a highly nutritious leafy green, is rich in vitamins, minerals, and antioxidants. Despite its global popularity, cultivating lettuce poses challenges due to its specific growing requirements, including well-drained soil, adequate moisture, and proper nutrients (Bunt, 2000).

Recent interest in soilless cultivation methods for lettuce production highlights several advantages over traditional soil-based agriculture, such as:

i. Enhanced control over the growing environment,
ii. Reduced risk of pests and diseases,
iii. More efficient use of water and nutrients,
iv. Lower environmental impact.

However, the adoption of soilless cultivation is hindered by a lack of comprehensive data on the performance of various planting media under different climatic conditions (Donnan, 1998). This knowledge gap is a significant barrier for farmers considering the transition to soilless methods. Moreover, conventional agriculture's reliance on chemical inputs has led to issues such as soil degradation, water pollution, and increased pest and disease resistance, complicating and increasing the cost of lettuce production. Therefore, research is needed to evaluate the performance of different planting media and nutrient solutions for lettuce under varying climatic conditions, aiming to develop sustainable and productive lettuce cultivation systems (Evans *et al*., 2000).

The primary objective of this study is to investigate the soil moisture retention patterns of selected organic planting media (sawdust, rice husk, and loamy soil) and their impact on the growth parameters of lettuce plants. Specific objectives of the study include, determining the soil moisture retention patterns of rice husk, loamy soil, and sawdust under drip irrigation systems.

Soilless cultivation methods offer the potential to produce crops of superior quality, higher yield, faster harvest, and greater nutrient content compared to traditional soil-based methods. These advantages stem from the enhanced control over the growing environment, including nutrient levels, pH, and moisture content (Landis and Morgan, 2009). In Nigeria, there is a lack of actionable data regarding the use of alternative planting media like rice husk and sawdust. This study aims to fill this gap by evaluating these media in terms of crop yield, quality, and nutrient content.

The findings will inform and encourage farmers about the benefits of adopting alternative planting media, presenting a viable and economical approach to agricultural production. Given the challenges posed by climate change, such as drought and salinity, soilless cultivation methods offer a more resilient and sustainable solution, adaptable to various environments including urban and arid regions.

Overall, this study is justified by its potential to enhance sustainable and productive crop production systems in Nigeria, thereby contributing to the country's agricultural development.

Study Area

Description of the Experimental Site

The study was conducted at the School of Pest Control within the College of Agriculture and Animal Science (CAAS), located in Mando, Kaduna, Kaduna North Local Government Area, Kaduna State. The experimental farm is situated in Igabi Local Government Area of Kaduna state as shown in Figure 1. The research was carried out in an open experimental field. The growing media used in this study included: Loamy soil, Rice husk and Sawdust.

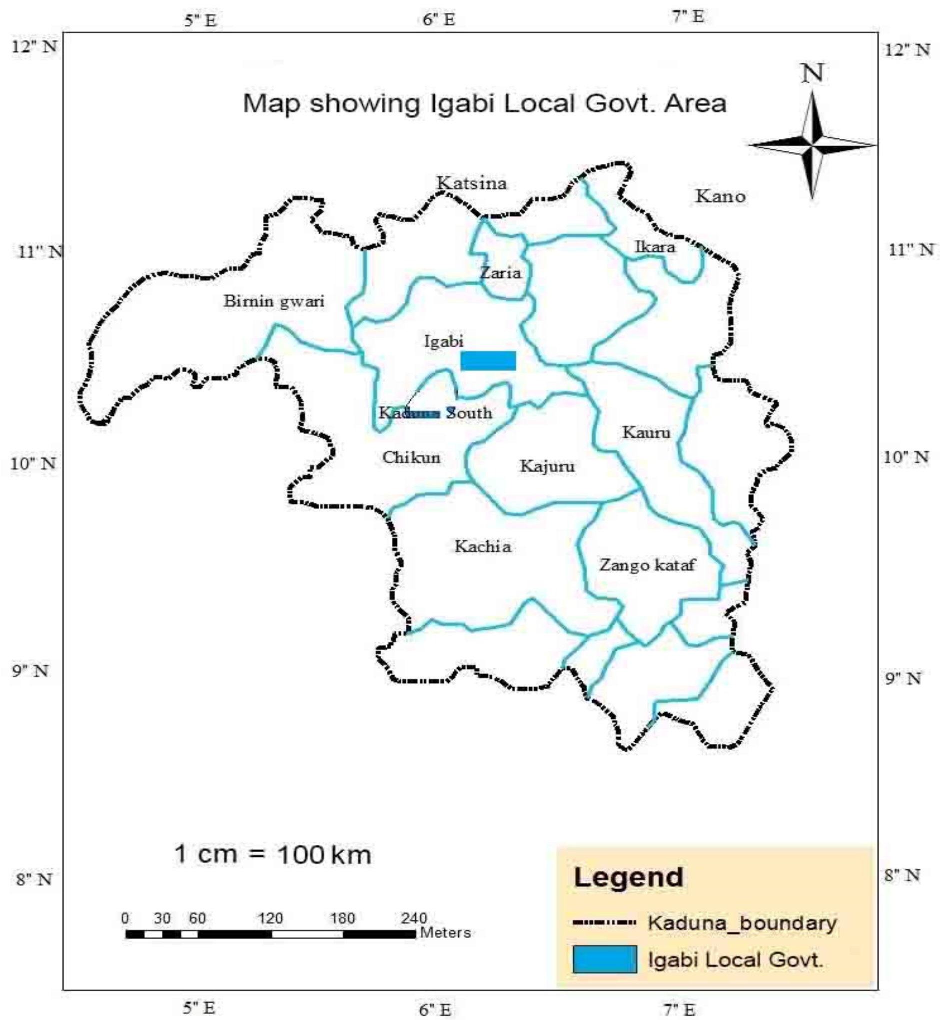

Fig. 1: Map indicating the location of experiment site

Methodology

Experimental Design

The field experiment was conducted over one growing season for lettuce (*Lactuca sativa L.*). An improvised gravity flow drip irrigation system, using hospital drip sets, was employed for the potted plants, each with a capacity of 75 cl, which were refilled after each irrigation. The experiment involved one factor: different growing media (sawdust, rice husk, loamy soil as the control), with equal volumes of 4000 cm³. This factor was replicated three times (Nair *et al*., 2011). Irrigation was applied once every two days, with 75 cl of water. Soil moisture content was measured before and one hour after irrigation to determine the moisture retention capacity of each growing medium.

The experimental layout was designed using a randomized complete block design. Table 1 describes the various planting media, and the layout ensures that each treatment was replicated three times. Water was applied using the irrigation kits, with 75 cl per volume of water applied once every two days.

Table1: Description of the various planting media

Treatment No.	Treatment description
T1	Loamy soil
T2	Rice husk
T3	Sawdust

Materials Consideration

The soil media were sourced locally in Mando, Kaduna, in Igabi Local Government Area of Kaduna State. Raw sawdust, with its high Carbon/Nitrogen ratio, can affect nutrient availability, especially nitrogen, but its properties improve with composting (Vaughn *et al*., 2011). The suitability of sawdust as a growing medium varies due to chemical differences between wood types, and some sawdust can have phytotoxic effects. Only sawdust from sawmills should be used, as other wood residues may contain harmful chemicals. The sawdust used in this research was obtained from Alpha Timber Shell at Neco Junction in Igabi Local Government Area.

Rice husk also known as rice hulls, these are protective coverings of rice grains, composed of hard materials including silica and lignin. Each kilogram of milled white rice produces roughly 0.28 kg of rice husk as a by-product (Landis and Morgan, 2009). The rice husk used in this research was sourced from a rice milling plant on Sarki Street in Mando, Kaduna Nigeria.

Loamy Soil, lettuce was grown in cleared, ploughed, and drained loamy topsoil, enriched with organic matter to enhance fertility. The loamy soil was sourced from the School of Pest Control in Kaduna North Local Government Area.

Experimental Procedure

In the experimental procedure, we first gathered the planting media (loamy soil, rice husk, and sawdust). These media were then filtered to remove any unwanted particles, followed by washing to eliminate impurities like acidity and salinity. After drying the media for two to three days, they were placed in labeled bags for storage. Finally, seeds for planting were obtained and broadcasted on a nursery bed (Villagra and Cavana, 2006).

Adopted Farm Practices

The following farming practices were implemented:

Soil Preparation and Requirements

Lettuce was grown on cleared, drained, and enriched loamy topsoil, as well as other media like rice husk.

Mode of Propagation

Lettuce was propagated by seed in this research. Stem propagation is also possible if the parent plant is mature.

Nursery and Transplanting

Lettuce seeds were broadcasted on the nursery bed. Thinning was done to enhance growth, and transplanting occurred 10-12 days after sprouting, with a spacing of 40 cm x 40 cm. Transplanting took place 3-5 weeks after initial planting, with a final spacing of 6-10 inches.

Irrigation

A drip irrigation system was used, with irrigation intervals of 3-5 days.

Fertilizer Application

Due to lettuce's short growth cycle, timely application of potassium and phosphorus-rich manure or fertilizer is crucial. Fertilizer was added at 8-week intervals.

Disease and Insect Control

Common pests include leaf miners, aphids, and whiteflies. Chemicals such as Cypercal, Menab (fungicide), and Dacthal (post-emergence herbicide) were used to control pests and diseases (Evans *et al*., 2000). Chemical applications were done two and five weeks after planting. Continuous cutting of the lettuce encouraged new shoots and faster leaf production, allowing for continuous harvesting. Stems were also planted on new beds, yielding harvestable crops within 5-7 weeks.

Moisture Content Determination

The moisture content of the growing media was measured weekly, with readings taken before and after irrigation.

Results and Discussion

Chemical Composition of the Media

Table 2 shows essential macronutrient percentages necessary for plant growth. A deficiency in these nutrients can affect plant growth adversely. Carbon, forming about 50% of the biomass, is crucial for building most plant biomolecules, including proteins, starches, and cellulose. Carbon is fixed through photosynthesis, converting carbon dioxide from the air into carbohydrates, which are used to store and transport energy within plants.

Hydrogen is necessary for building sugars and the plant itself. It is primarily obtained from water. Hydrogen ions are imperative for creating a proton gradient that helps drive the electron transport chain in photosynthesis and respiration. The hydrogen content is 5.1% in loamy soil, 5% in rice husk, and 6% in sawdust.

Oxygen, a component of many organic and inorganic molecules within the plant, is acquired in many forms, including O_2 and CO_2, mainly from the air via leaves. Plants require O_2 to undergo aerobic cellular respiration, breaking down glucose to produce ATP. The oxygen content is 31.9% in loamy soil, 42% in rice husk, and 21% in sawdust.

An optimal yield is achieved with the given chemical composition of each soil medium, except for the rice husk, which was infested by rodents and worms.

Table 2: Chemical Composition of the Media

S/N	Soil Media	Nitrogen	Carbon	Hydrogen	Oxygen
01	Loamy Soil	0.9%	59.8%	5.1%	31.9%
02	Rice Husk	0.2%	36.0%	5.0%	42.0%
03	Sawdust	3.2%	4.0%	6.0%	21.0%

pH Levels of the Soil Media

Soil can be classified according to their pH values. In table 3, the percentage of soil pH suitable for cropping ranges from 6.5-7.5%, which is neutral. A pH value over 7.5% is alkaline, while less than 6.5-5.5 is considered strongly acidic. The results indicate that the soil samples are alkaline. Vegetables mostly grow on alkaline soil, ranging from over 6.5% to greater than 7.5% (Hamilton, 2018). Sawdust has the highest pH value of 11.7%.

Table 3: pH Levels of the Soil Media

S/N	Soil Sample	Amount in %
01	Loamy Soil	8.5%
02	Rice Husk	9.7%
03	Sawdust	11.7%

Porosity of the Media

Porosity is a crucial factor influencing soil's ability to retain and transmit water and air, essential for root respiration and nutrient uptake. From Table 4, soil porosity is highest in sawdust and lowest in the Loamy soil. The implication of these is more nutrient retention in the Loamy soil and least in the sawdust.

Table 4: Porosity of the Media

S/N	Samples	Amount in %
01	Loamy Soil	0.20%
02	Rice Husk	0.35%
03	Sawdust	0.84%

Lettuce Growth Parameters

Leaf Measurement

Data obtained shows that sawdust produced more broad leaves with lengths of 6.25mm, 13mm, 10mm, 5.5mm, and 8.53mm, and breadths of 12.5mm, 5.54mm, 4.3mm, 2.5mm, and 4.5mm compared to the rice husk medium, which had leaf lengths of 7.5mm, 6mm, 5mm and breadths of 4mm, 3.5mm, and 3mm, respectively. This indicates that plants in sawdust produced a better yield than those in the rice husk medium. This is likely due to the lack of pest infestation in the sawdust medium, unlike the severe pest infestation experienced by the rice husk medium.

Total Number of Leaves

Table 5 shows that the lettuce plant in the loamy soil medium had the highest number of leaves, followed by sawdust and rice husk, respectively.

Table 5: Chemical Composition of the Media

S/N	Soil Medium	Number of leaves
01	Loamy Soil	573
02	Rice Husk	370
03	Sawdust	56

Root Height and Stem Diameter

Lettuce plants are shallow-rooted. From table 6, the soil medium with the deepest root was loamy soil with a root depth of 33mm, followed by sawdust with 23mm, and rice husk with 23mm. The medium with the least stem diameter was rice husk with 0.5-1mm thickness, followed by sawdust with 0.5-1mm, and loamy soil with 0.9-1.3mm. Loamy soil produced the best yield, followed by sawdust, and lastly, rice husk. Figure 1. Shows the process of measurement of stem diameter of lettuce plant.

Table 6: Root Height and Stem Diameter

Soil Medium	Root Height (mm)	Stem Diameter (mm)
Loamy Soil	33, 25, 25, 20, 18, 23, 18, 20, 21, 12, 23, 20, 13	1.3, 0.9, 0.9, 1, 1, 0.9, 1, 1, 0.9, 0.5, 1, 0.5, 0.9
Sawdust	23, 23, 20	0.5, 0.9, 0.9, 1, 1
Rice Husk	20, 18, 23	0.5, 0.9, 1

Affected Soil Media

The affected media during this experiment were primarily the rice husk, which was affected by rodents, domestic fowl, and worms during decay as shown in Figure 2. Measures taken to prevent total infestation included covering the media with a perforated net, serving as a local screen house to prevent insects and rodents. Also, use of chemical measures to prevent worms and insects from boring holes in the leaves and roots of the plant were adopted. The chemical used was Cypercal, which also prevents fungicides.

Conclusion

This study evaluated the effects of different growing media (loamy soil, rice husk, and sawdust) on the growth parameters of lettuce (*Lactuca sativa* L.) under drip irrigation systems. From the study, the growing media exhibited varying levels of essential macronutrients. Loamy soil showed the highest nitrogen content, which is crucial for plant growth, while sawdust and rice husk had lower nitrogen levels but varied significantly in carbon and oxygen content. All the media were found to be alkaline, with sawdust having the highest pH value. The alkaline nature of the media supports the optimal growth of lettuce, which thrives in slightly alkaline conditions. Sawdust demonstrated the highest porosity, followed by rice husk and loamy soil. Higher porosity generally facilitates better air and water movement, crucial for healthy root development. The study monitored the moisture retention patterns of the different media, which is vital for understanding the irrigation needs and optimizing water use in lettuce cultivation. Lettuce plants grown in loamy soil showed the best overall performance in terms of leaf number, root height, and stem diameter. Sawdust also performed well, producing broad leaves and significant root and stem growth, whereas rice husk was less effective due to pest infestation. Rice husk was notably affected by pests, which impacted the overall yield and growth quality. Protective measures such as using perforated nets and chemical treatments were necessary to mitigate these issues.

Recommendations

Based on the findings of this study, the following recommendations were drawn. For the rice Husk, to achieve optimum yield, more attention should be given to pest control. Water application should also be varied as rice husk retains more moisture. In addition, different growing media should be evaluated by mixing soil with other materials such as sawdust and rice husk to determine their effect on crop yield. Water Requirement: For future study, the total amount of water required from nursery bed to transplanting to maturity should be determined.

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