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EVALUATION OF DIFFERENT ORGANIC SUBSTRATES AS A SUBSTITUTE FOR COCOPEAT IN RAISING TOMATO SEEDLINGS IN SOILLESS MEDIUM

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ABSTRACT

Tomato (Solanum lycopersicum L.*) is a globally important vegetable crop, valued for its nutritional and economic significance. With the increasing demand for sustainable and efficient tomato production, soilless cultivation has gained prominence, relying heavily on suitable substrates for optimal seedling emergence, growth and yield. Cocopeat is widely used as a substrate in Nigeria's greenhouse farming; however, its high cost and limited availability necessitate the evaluation of alternative, locally available materials. This study investigated the potential of milled groundnut shells, shredded maize cobs, and carbonated rice husk as substitutes for cocopeat in raising tomato seedlings in seed trays. The experiment was conducted at the Horticulture Nursery of the Federal University of Technology, Minna, using a completely randomised design and three replicates. Tomato seeds were sown in seed trays filled with each substrate, watered and data on emergence percentage, speed of emergence, and seedling growth parameters were collected. The results revealed that cocopeat recorded the highest seedling emergence percentage, followed closely by milled groundnut shells. Conversely, seeds sown on groundnut shell substrate demonstrated superior speed of emergence and seedling height compared to other substrates. Maize cob and carbonated rice husk substrates showed moderate performance. The soil-based substrate consistently resulted in the poorest seedling vigour and growth, indicating its unsuitability for tomato seedling production. It is therefore concluded that milled groundnut shells could be used as a suitable alternative to cocopeat for tomato seedling production in soilless media.*

Key words: Cocopeat, Groundnut shell, Seedling growth, Substrate, Tomato,

INTRODUCTION

Tomato (*Solanum lycopersicum* L.), classified within the Solanaceae family, is a widely cultivated and consumed versatile vegetable with global popularity due to its adaptability, suitable for both fresh consumption and diverse processing methods (Dewapriya *et al.,* 2024). It is a rich source of essential nutrients, including vitamins A, C, and E, potassium, and dietary fibre. It is particularly rich in lycopene, a potent antioxidant that has been linked to a reduced risk of certain cancers and cardiovascular diseases (Kheyrodin and Kheyrodin, 2017).

Climate change, soil degradation, and urbanisation have all placed pressure on traditional soil-based farming systems. These issues pose a threat to sustainable crop production and food security. Soilless cultivation, particularly hydroponics and substrate-based systems, is emerging as a transformative solution to these challenges. In soilless systems, the substrate replaces soil as the medium for root anchorage, water retention, aeration, and nutrient exchange. Substrates are materials in which plants are grown. These can include organic materials such as peat, compost, tree bark, coconut coir, or cocopeat, as well as poultry feathers, and inorganic materials such as clay, perlite, vermiculite, and mineral wool (Vaughn *et al*., 2011).

The choice of substrate is pivotal to the success of seedling emergence and subsequent growth. A suitable growth medium should have low transportation costs, stability, and be lightweight to ensure economic viability (Khomami *et al*., 2024). A good growing medium should be composed of a mixture that is tender enough for seeds to germinate easily, retains moisture, drains excessive water, and provides sufficient plant nutrients for seedling growth and development.

The production of healthy and vigorous tomato seedlings is a crucial factor in the successful cultivation and yield of tomato fruits. The germination and emergence of the seed are critical stages, as the rest of the plant's life is directly dependent on them (Mahala and Sharma, 2020). The substrates used for growing plants play an important role in germination rate, as well as in many other growth parameters, including plant height, number of leaves, spike length, number of florets per spike, spike diameter, and yield (Olaria *et al.,* 2016).

In Nigeria, cocopeat has become the substrate of choice for greenhouse vegetable seedling production, especially for tomatoes and peppers. Its popularity is attributed to its lightweight nature, ease of handling, and ability to retain both water and air in proportions conducive for robust root development. However, cost and availabilityare some of the challenges associated with its use (Ebrahimi and Ebrahimi, 2024). Much of the cocopeat used in Nigeria is imported, making it expensive and sometimes difficult to access, particularly for smallholder farmers. While cocopeat remains the standard in many greenhouse operations, particularly in Nigeria, exploring alternatives is essential for reducing costs, enhancing sustainability, and promoting the circular use of agricultural by-products. Therefore, the objective of this study was to evaluate the potential of various organic substrates as substitutes for cocopeat in soilless tomato production.

METHODOLOGY

This research was conducted at the Horticulture Nursery of the Federal University of Technology, Minna, Niger State, Nigeria. UC82B seeds of tomato and cocopeat were obtained from an agro-store in Minna. The other substrates were sourced locally from farmers, and rice husk biochar was sourced from rice milling sites. The treatments consisted of six substrates, namely: cocopeat (T1), groundnut shell (T2), rice husk biochar (T3), maize cob (T4), topsoil mixed with poultry manure at a 6:1 ratio (T5), and topsoil alone (T6). These were arranged in a completely randomised design with three replicates. The groundnut shells and maize cobs were dried and milled to a particle size of approximately 2-3 mm. Seed trays were filled uniformly with the substrates (one substrate per tray), and one seed was sown per cell at a depth of approximately 1 cm. The substrates were watered daily. Data were collected on the number of days to emergence, and Emergence Percentage (EP) was calculated as:

$EP = \frac{\text{Number of emerged seeds}}{\text{Total seeds sown}}$ (AOSA, 1983)

Speed of emergence (SE) was calculated as:

$ES = \frac{N1}{T1} + \frac{N2}{T2} + \frac{N3}{T3} \ldots \frac{Nn}{Tn}$ (AOSA, 1983)

Where Nn = new seedlings on day Tn.

Seedling growth parameters (number of leaves per plant, plant height) were collected at two weeks after planting. The data collected were subjected to analysis of variance using the Statistical

Analysis System (SAS 9.2). Where significant differences existed, means were separated using the Duncan Multiple Range Test (DMRT) at a 5 % level of probability.

RESULTS

The effect of different substrate types on the emergence percentage of tomato is presented in Figure 1. The results revealed that seeds sown in cocopeat had the highest emergence percentage (73.81 %). This was, however, in line with the value recorded in seeds sown in groundnut shells (61.9 %) and rice husk biochar. Values recorded in seeds sown in rice husk biochar and maize cobs were 45.24 % and 30.95 %, respectively. Emergence percentage of seeds sown in topsoil mixed with poultry manure (9.52 %) was at par with those sown in topsoil alone (21.43 %).

Substrate type significantly affected ($P<0.05$) the speed of emergence of tomato seedlings. Seeds sown in groundnut shell substrate had the highest speed of emergence (6.7). This was followed by plants sown in cocopeat (6.23). The speed of emergence recorded in seeds sown in rice husk biochar and maize cob was intermediate (4.46 and 3.68, respectively), and the slowest to emerge were seeds sown in top soil mixed with poultry manure (0.17), similar to top soil alone (0.38) (Figure 2)

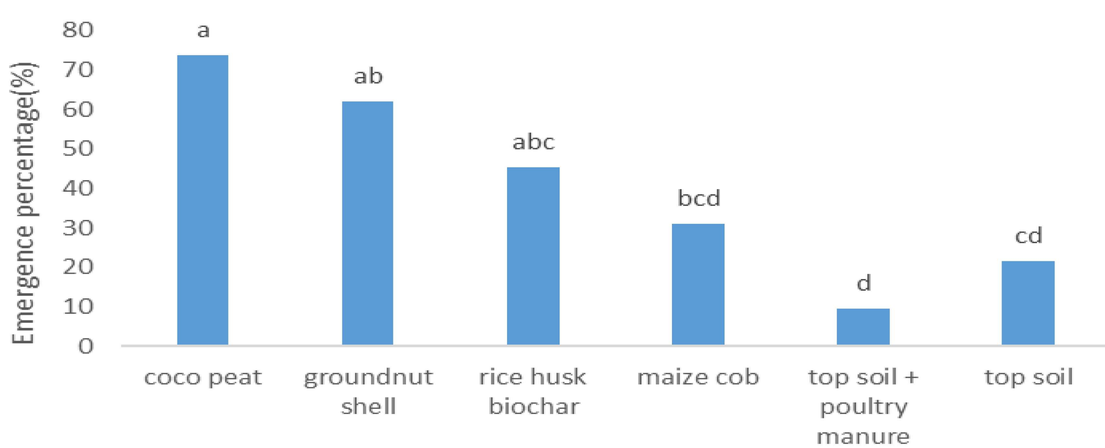

Figure 1: Effect of substrate type on the emergence percentage of tomato

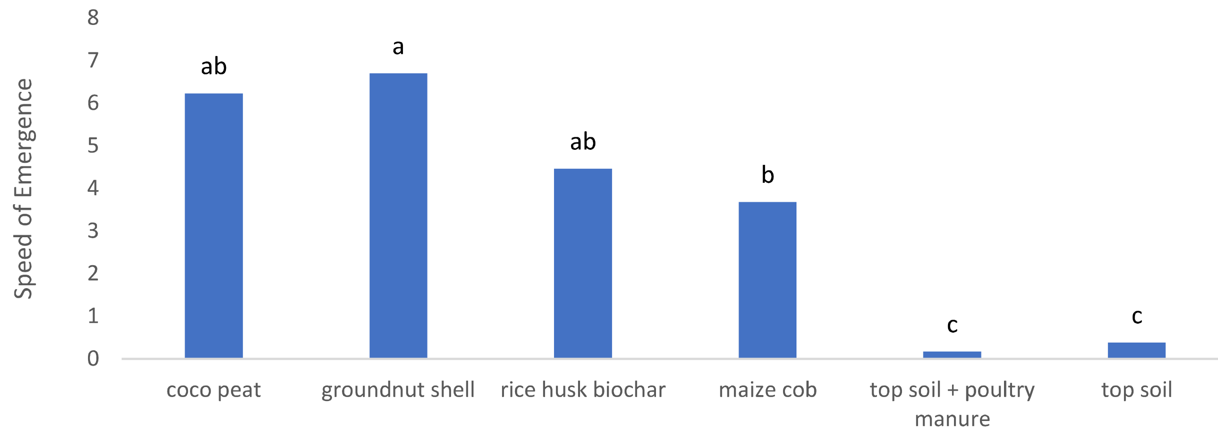

Figure 2: Effect of substrate type on the speed of emergence of tomato seeds

The effect of different substrates on the seedling height of tomato is presented in Figure 3. The substrate type has a significant impact (P < 0.05) on the height of tomato seedlings. Plants sown in groundnut shells had the highest seedling height (5.8 cm) before transplanting. This value, however, was at par with values recorded in plants sown in carbonated rice husk (5.1 cm). This was followed by the seedling height recorded in plants sown in maize cobs (4.8), similar to those in cocopeat (4.7). Plants sown in topsoil alone were the shortest (0.97 cm), followed by plants sown in topsoil mixed with poultry manure (1.8 cm) (Figure 3).

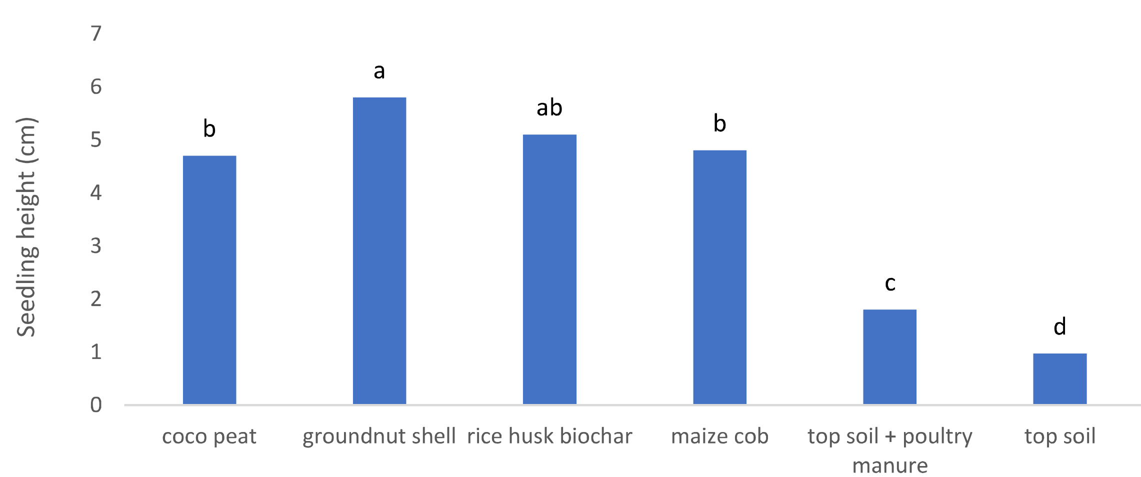

Figure 3: Effect of subtrate type on the seedling height of tomato.

The effect of different substrates on the number of leaves of tomato seedlings is presented in Figure 4. Plants sown in cocopeat produced the highest number of leaves (6), followed by plants sown in groundnut shell (5), which was comparable to plants sown in rice husk biochar. The number of leaves recorded in plants sown in maize cob was intermediate (4). Plants sown in topsoil alone and topsoil mixed with poultry manure produced the least number of leaves (2).

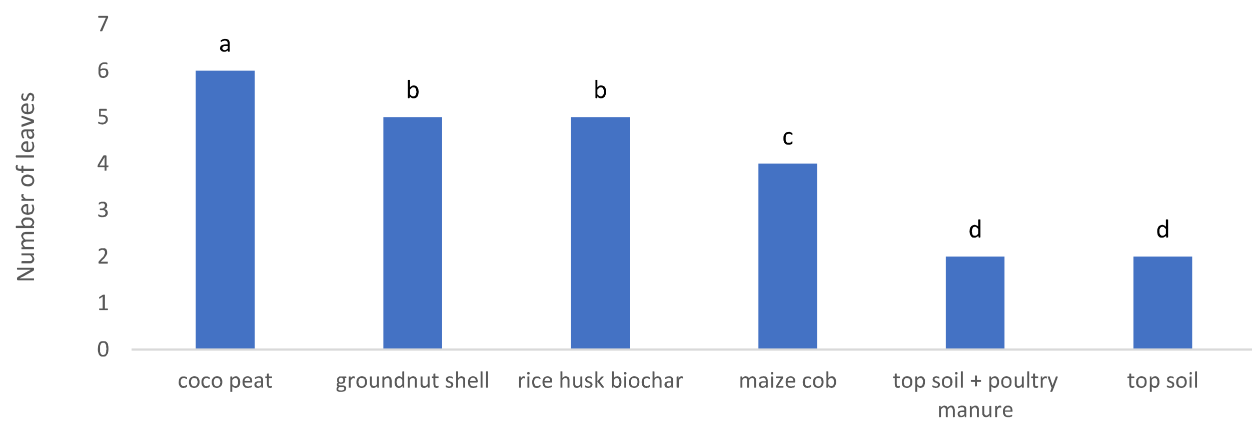

Figure 4: Effect of substrate type on the number of leaves of tomato seedling

DISCUSSION

Substrates play a fundamental role in seed germination and early seedling development by influencing water retention, aeration, nutrient availability, and microbial activity. Cocopeat's superior performance in terms of emergence percentage and number of leaves per seedling in this study can be attributed to its quality, including high porosity, good water-holding capacity, and a favourable air and water balance, which are necessary for rapid and uniform seed imbibition (Raza *et al.,* 2020), resulting in robust early development. Oti and Nwankwo (2021) similarly reported cocopeat's potential as a preferred soilless medium for seedling production, especially in nursery settings.

Rice biochar, although an organic amendment with known benefits, exhibited moderate performance, likely due to its variable porosity and potential for adsorbing nutrients. Biochar's performance aligns with its function as a soil conditioner that enhances microbial activity and nutrient retention but may not provide an optimal structure for initial root expansion (Abujabhah *et al.,* 2020). Maize cob substrate supported moderate germination (30.95 %) and seedling height

(4.83 cm), but was outperformed in other parameters, particularly the number of leaves and germination speed. This might reflect limited decomposition or poor nutrient availability, as raw maize cob lacks the immediate bioavailable nutrients required for seedling vigour (Kanengoni *et al*., 2015)

Similarly, topsoil and topsoil with poultry manure showed consistently poor performance across all parameters. This suggests physical and chemical limitations, such as reduced oxygen diffusion and potential toxicity due to inadequate manure decomposition, which inhibited both germination and seedling establishment (Nwachukwu *et al*., 2022).

Seedlings, however, emerged faster in groundnut shells and produced the tallest seedlings. This may be attributed to the fibrous structure of groundnut shells, which provides good porosity and aeration, favouring seed germination and essential for root respiration and water management (Ebrahimi and Ebrahimi, 2024). The lignocellulosic nature of groundnut shells may have contributed to sustained nutrient release during early growth, supporting shoot elongation. However, its low water-holding capacity compared to cocopeat might explain its slightly lower % emergence. From a financial perspective, groundnut shells offer significant advantages over cocopeat due to the latter's limited availability and high price. Availability and procurement costs can be a challenge for smallholder farmers. In contrast, groundnut shells are locally available in large quantities almost everywhere at minimal or no cost, as they are typically considered waste. Utilising this material can substantially reduce input costs for nurseries, increase profitability, and promote sustainable waste management by converting an agricultural residue into a valuable resource.

CONCLUSION

From the results obtained in this study, seedlings obtained from seeds sown in milled groundnut shell substrate performed comparably with those sown in cocopeat substrate in terms of speed of emergence, emergence percentage and seedling height indicating that milled groundnut shell could be used as a cost-effective, and locally available alternative to cocopeat for tomato seedling production in soilless media.

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