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ORIGINAL PAPER

Composted *Melia azedarach* L. (Chinaberry tree) Sawdust Mixtures Regulate the Sprouting and Growth of Single Bud Node Seedlings of Sugarcane

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Abstract

Raising sugarcane nurseries by single bud nodes cutting and using peat moss or coco peat as growth substrates are getting popular in many top sugarcane-producing countries worldwide. However, to reduce production costs, commercial growers involved in the sugarcane nursery raising business want to avoid peat moss or coco peat, which are expensive as growth substrates. We hypothesized that composted *Melia azedarach* (Chinaberry tree) sawdust can be a suitable replacement. The objective was to assess the viability, sprouting, and seedling establishment of single bud nodes of sugarcane in composted *M. azedarach* sawdust mixtures in two independent pot culture experiments. The experimental treatments were, T_1: soil (control) (100%) (v/v), T_2: composted sawdust of *M. azedarach* (100%) (v/v), T_3: composted sawdust of *M. azedarach* (80%) (v/v) + composted peels of banana (20%) (v/v), T_4: composted sawdust of *M. azedarach* (60%) (v/v) + composted peels of banana (20%) (v/v) + composted shells of eggs (20%) (v/v), and T_5: composted sawdust of *M. azedarach* (60%) (v/v) + composted peels of banana (20%) (v/v) + composted shells of eggs (20%) (v/v) + Urea at the rate 225 kg N ha^{-1}. The results exhibited that composted *M. azedarach* sawdust mixtures provoked early sprouting and triggered the growth of single bud node seedlings of sugarcane than in soil (control). The composted *M. azedarach* sawdust mixtures produced taller seedlings, more number of leaves $plant^{-1}$, an increase in stem diameter, chlorophyll content index, leaf area, and root and shoot dry weight. It was concluded that composted *M. azedarach* sawdust mixture [T_5: composted sawdust of *M. azedarach* (60%) (v/v) + composted peels of banana (20%) (v/v) + composted shells of eggs (20%) (v/v) + Urea at the rate 225 kg N ha^{-1}] may be a suitable and productive alternative soilless substrate to raise single bud node seedlings of the sugarcane for nursery production.

Keywords Soilless culture · Organic amendments · Growth substrates · Plant · Nursery

1 Introduction

Sugarcane (*Saccharum officinarum* L.) occupies an imperative place among the commercially cultivated crops in the world. It is commonly propagated by using stem cuttings containing two to three bud nodes. However, the planting material having 2–3 buds, consumed around 6 to 8 tons ha^{-1} of cane (Musa and Bahrun 2021). This utilization of a large quantity of planting material is the main concern in the handling, transportation, and storage of sugarcane setts. In contrast, the development of sugarcane nurseries from single bud nodes provides an opportunity to overcome these issues. However, the production of quality seedlings from single bud nodes is still an important challenge for scientists under nursery conditions. Only quality seedlings can adopt a new environment and grow well when transplanted into the field (Irwan and Edi 2012).

The single bud nursery growing is one of the most successful nursery strategies for the production of superb sugarcane seedlings (Musa and Bahrun 2021). One of the

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main features of the single-bud nursery technique is that it does not require a long time and the sprouted seedlings could be sown in the field. In addition, uniform growth, higher tillers, and less space and cost were experienced under the single bud nursery technique because they can be grown using small polybags (Rukmana 2015). Although there are benefits identified for the single bud node technique, some limitations such as lower food reserves in contrast to three nodes budded setts and less viability of single bud node under field conditions were also noticed (Mall et al. 2018). In the single bud node of sugarcane, the moisture and food reserves diminish quickly as compared to three bud nodes (setts), which sometimes causes poor sprouting and premature growth of bud nodes (Jain et al. 2010).

One aspect that influences the single-bud nursery technique is the selection of suitable growing media (Budi 2016). A good combination of growing media can effectively enhance the sprouting and growth of sugarcane from a single bud node. The selection of suitable growing media is considered a primary step to regulate the success of sugarcane nurseries. Chand et al. (2011) mentioned that poor germination is a major concern in sugarcane cultivation that requires proper attention through a selection of suitable planting materials. The selection and use of growing media or substrate are crucial for producing quality seedlings of sugarcane from one bud node. A good growing media has the quality to offer proper aeration, sufficient anchors or support to roots, good water holding capacity, and nutrients reservoir and allows the gaseous exchange between the roots as well as outside the atmosphere of roots substrate and discharge of oxygen to the roots (Abad et al. 2002). Under nursery conditions, the seedling's quality is greatly influenced by the type and quality of growth media (Agbo and Omaliko 2006).

The different growing media which are used under nursery conditions such as peat moss, cocopeat, compost, vermiculite, sedge peat, and perlite in raising the sugarcane nursery from one bud node, but these substrates are expensive (Kalaivanan and Selvakumar 2016). On a commercial scale, an alternate growing substrate that is conveniently available and cost-effective is required. In this regard, sawdust as a growth medium is cheap, easily available, and contains high moisture retention ability. *Melia azedarach* L. (Chinaberry tree), is a tree associated with the Meliaceae family and is mostly growing in many countries (Taverna and Corrado 2017). The sawdust from the trunk and bark of this tree can be used as growing media as it can effectively enhance the different biological activities for the acquisition of nutrients which speed up plant growth (Ntalli et al. 2010; Rachokarn et al. 2008; Zahoor et al. 2015).

In a growth medium, mixing the various components in a suitable proportion can enhance its chemical and physical properties that increase plant growth (Abad et al. 2001). Different kinds of organic (vermicompost and manure) and inorganic (vermiculite and perlite) amendments in growth media have been perceived as seedling improvements in various crops (Lazcano and Domínguez 2011). A significant improvement in the sugarcane seedling raising from a single bud node was observed under growth media (coir pith + vermicompost) amended with urea fertilizer (Rao et al. 2016). Banana peels and eggshells are often used as organic fertilizers in plant production. The peels of bananas supply different essential plant nutrients, particularly they are a good source of potassium (Panwar 2015). While eggshells are an inexpensive and appropriate source of calcium that can be used for plants suffering from calcium insufficiency (Gaonkar and Chakraborty 2016). Hence, peels of bananas and shells of eggs can be amended into the soil or soilless substrates as organic fertilizers.

Therefore, the objective was to assess the viability, sprouting, and seedling establishment of single bud nodes of sugarcane in composted *M. azedarach* (Chinaberry tree) sawdust mixtures amended with peels of banana, shells of eggs, and urea to validate it as alternative soilless media for nursery production.

2 Materials and Methods

2.1 Collection of Material for the Formulation of a Growth Substrate

To develop a growth substrate, the *Melia azedarach* sawdust was amended with eggshell powder, banana peel powder, and urea fertilizer in different mixtures. Sawdust is a common waste and is leftover from the timber and furniture industry. It's usually available in large quantities and easily be collected in bulk. But for our experimentation, the *M. azedarach* sawdust was prepared from the healthy and tall tree trunk of a chinaberry tree approximately 9 years of age, to ensure non-mixing of any other kind of sawdust. Similarly, eggshells can also be collected in bulk from commercial egg hatcheries. Banana peels can be collected from fruit juice shops and fruit and vegetable markets of each city or town in bulk on daily basis. The trunk of *M. azedarach* tree was chopped into small sawdust particles of size 8–16 μ m and was acquired by employing a sawdust grinding machine (Zhengzhou Yuxi Grinding Machine, Zhengzhou Yuxi Machinery Equipment Co., Ltd, Zhengzhou, China). The shops of fresh fruit juices and domestic kitchens were visited for the collection of banana peels. The banana peels were dried under the sun and ground into a fine powder with the help of a spice grinder. The eggshells were obtained from an eggs hatchery, then sun-dried and ground into powder form by using a spice grinder. We used composted sawdust whereas, powdered forms of banana peels and eggshells were used as organic fertilizers. In the substrate, the urea fertilizer was mixed manually.

2.2 Experimental Treatments

The experiments were comprised of treatments, T_1: soil (control) (100%) (v/v), T_2: composted sawdust of *M. azedarach* (100%) (v/v), T_3: composted sawdust of *M. azedarach* (80%) (v/v) + composted peels of banana (20%) (v/v), T_4: composted sawdust of *M. azedarach* (60%) (v/v) + composted peels of banana (20%) (v/v) + composted shells of eggs (20%) (v/v), and T_5: composted sawdust of *M. azedarach* (60%) (v/v) + composted peels of banana (20%) (v/v) + composted shells of eggs (20%) (v/v) + Urea at the rate 225 kg N ha^{-1}.

2.3 Composting Process of *Melia Azedarach* Sawdust Mixtures

The fresh *M. azedarach* sawdust was taken. Each sawdust treatment mixture was prepared separately and amendments were mixed manually. An independent triangular pile was set up in an open shed for 12 weeks for each treatment. The piles were 0.8 m in width and 0.4 m in height and turned over twice a week. Before turning the piles, the variations of air temperature as well as the pile's temperature at a depth of 40 cm were examined two times a week. Water was applied to the piles on days 14, 28, and 56 to retain the desired moisture contents. The sawdust piles were left for further composting and maturation for 90 days. After the composting process, each sawdust substrate mixture was used in the experiment.

2.4 Experimental Location, and Design

Two independent pot experiments during the spring and autumn of 2020 were executed at Research Area, University of Sargodha, Sargodha, Punjab, Pakistan (32.07° N, 72.68° E). The research trials were conducted with a completely randomized design with four replications (5 growing substrates × 4 replications × 2 experiments = a total of 40 pots).

2.5 Experimental Protocols

Experiment 1 was executed on 12 February 2020, and plants were harvested on 30 March 2020. However, experiment 2 was performed on 08 September 2020, and plants were harvested on 26 October 2020. The plastic pots of size 11.5 × 9 cm (480 ml) were used in this study with three minor holes beneath the pots to enable the appropriate drainage of water. The 80 g of growth substrates was used to fill the pots. Every growth substrate mixture differs in density and weight. A single bud node of sugarcane (*Saccharum officinarium* L.) cultivar CP-77400 was used and the size of the bud node was 2 inches. One bud of sugarcane per pot at 2 cm depth was sown. Appropriate water was applied for bud node sprouting to the pots. The weeds were uprooted from control pots (soil) only after emergence. Irrigation water was applied at regular intervals from the top of the pot as the water did not become the restraining factor for plant growth. Table 1 portrayed the compositions of various sawdust mixtures used. The physicochemical properties of all mixtures of composted *M. azedarach* sawdust as well as the soil are presented in Table 2.

2.6 Measurements of Variables

The number of days to bud node appearance and the number of leaves $plant^{-1}$ were noted from each pot. The height of the plants was recorded from tip to the base of the plant. A digital cardinal vernier caliper (Mitutoyo 500–196-20 DVC, Motutoyo Corporation, Japan) was used to measure the stem diameter of cane seedlings. One plant of sugarcane bud node from each treatment was uprooted and the root and shoot fresh as well as dry weight (DGH-9240A Oven, California, USA; biomass desiccated at 85 °C for 48 h) were calculated by using a cardinal weight balance (Model Sartorius # BSA-2235, China). Chlorophyll content index (CCI) was measured by using a CCI meter ("CCI Meter", Beijing Yaxinliyi Science and Technology Co., Ltd. China).

Table 1 Composition of *Melia azedarach* sawdust substrate mixtures used before composting. After composting, 80 g of each mixture was taken into each pot for each treatment in two independent experiments. All treatments (T_1, T_2, T_3, T_4, T_5) were the same as described in Fig. 1

Treatments	Mixtures	Volume (%)	Volume (liter pot^{-1})	Weight (kg)
T_1	Soil	100	5.6	6
T_2	Sawdust	100	5.6	1
T_3	Sawdust	80	4.48	0.8
	Banana peels	20	0.112	0.35
	Total	100	5.6	1.15
T_4	Sawdust	60	3.36	0.6
	Banana peels	20	0.112	0.35
	Eggshells	20	0.112	0.85
	Total	100	5.6	1.80
T_5	Sawdust	60	3.36	0.6
	Banana peels	20	0.112	0.35
	Eggshells	20	0.112	0.85
	Urea			0.0017
	Total	100	5.6	1.8017

Table 2 Composted sawdust of *Melia azedarach* and soil with the basic physio-chemical properties. All treatments (T_1, T_2, T_3, T_4, T_5) were the same as described in Fig. 1

Media Characteristics	T_1	T_2	T_2	T_4	T_5
Soil texture	Sandy clay loam	Soilless	Soilless	Soilless	Soilless
Sand (g kg^{-1} of soil)	565	-	-	-	-
Silt (g kg^{-1} of soil)	197	-	-	-	-
Clay (g kg^{-1} of soil)	238	-	-	-	-
EC (μS cm^{-1})	876 ± 4.14	924 ± 5.41	979 ± 1.37	1002 ± 5.89	1016 ± 6.43
pH	7.17 ± 0.13	7.05 ± 0.09	6.99 ± 0.16	6.87 ± 0.07	6.89 ± 0.21
Dissolved organic C (mg kg^{-1})	37.26 ± 2.31	42.21 ± 1.57	44.24 ± 2.12	47.61 ± 2.23	51.57 ± 1.49
Water holding capacity (g g^{-1})	0.30 ± 0.12	0.34 ± 0.11	0.40 ± 0.23	0.43 ± 0.31	0.49 ± 0.27
C:N ratio	46.21 ± 0.35	54.13 ± 1.23	60.35 ± 0.31	63.18 ± 0.22	69.42 ± 1.31
Available P (mg kg^{-1})	4.76 ± 0.75	5.04 ± 0.42	5.56 ± 0.66	5.98 ± 0.34	6.75 ± 0.21
Available N (mg kg^{-1})	39 ± 1.12	45 ± 0.45	51 ± 0.32	55 ± 1.04	67 ± 0.18
Available K (mg kg^{-1})	162.13 ± 4.36	169.26 ± 5.61	175.34 ± 3.51	183.25 ± 5.27	190.31 ± 6.16

The single leaf area (mm^2) was measured by a Leaf Area Meter (Yaxin-1241 Leaf Meter, China).

2.7 Statistical Analysis

Separate analyses were performed on the two experiments. The recorded data were analyzed using a one-way analysis of variance, and the mean of four replicates plus standard error was provided (± S.E.). At $p \leq 0.05$, the significance of the treatments was evaluated. All pairwise comparisons were performed in a post hoc manner, and significance levels were evaluated using the test of Tukey's HSD at the 5% probability level. The statistical examination was done with Statistix 8.1 (Statistix, Tallahassee, FL, USA). The graphic representation of the data was done through the Sigmaplot 12.5 Software.

3 Results

3.1 Sugarcane Propagation Through Single Bud Node Using Composted *Melia Azedarach* Sawdust Soilless Mixtures

All soilless mixtures of composted sawdust of *Melia azedarach* imparted a productive impact on single bud node sprouting, early growth, and establishment of sugarcane seedlings (Fig. 1). The sprouting, plant development, and root phenology of sugarcane bud node seedlings were improved and triggered by using composted sawdust mixtures of *M. azedarach*, peels of banana, shells of eggs, and urea than in the soil (Fig. 2).

Fig. 1 Effect of the composted sawdust mixtures of *Melia azedarach* (Chinaberry tree) on sprouting, initial growth, and phenology of sugarcane bud node of cultivar CP-77400 at 47 days after sowing in experiment 1. Different composted *M. azedarach* sawdust mixtures are used as the soilless substrate from left to right were T_1: soil (control) (100%) (v/v), T_2: composted sawdust of *M. azedarach* (100%) (v/v), T_3: composted sawdust of *M. azedarach* (80%) (v/v) + composted peels of banana (20%) (v/v), T_4: composted sawdust of *M. azedarach* (60%) (v/v) + composted peels of banana (20%) (v/v) + composted shells of eggs (20%) (v/v), and T_5: composted sawdust of *M. azedarach* (60%) (v/v) + composted peels of banana (20%) (v/v) + composted shells of eggs (20%) (v/v) + Urea at the rate 225 kg N ha^{-1}

Similarly, leaf length and leaf area of sugarcane bud node varied significantly under all tested composted *M. azedarach* sawdust mixtures. The highest leaf length and leaf area were observed in T_5 followed by T_4 (Fig. 3). When individual **c**omparisons were made between four different composted *M. azedarach* (chinaberry tree) sawdust mixtures and soil. The composted sawdust

Fig. 2 Effect of composted sawdust mixtures of *Melia azedarach* (Chinaberry tree) on growth, development, root-shoot morphology, and initial progress of sugarcane bud node (cultivar CP-77400) at harvesting (48 days after sowing) in experiment 2. All treatments (T_1, T_2, T_3, T_4, T_5) were the same as described in Fig. 1

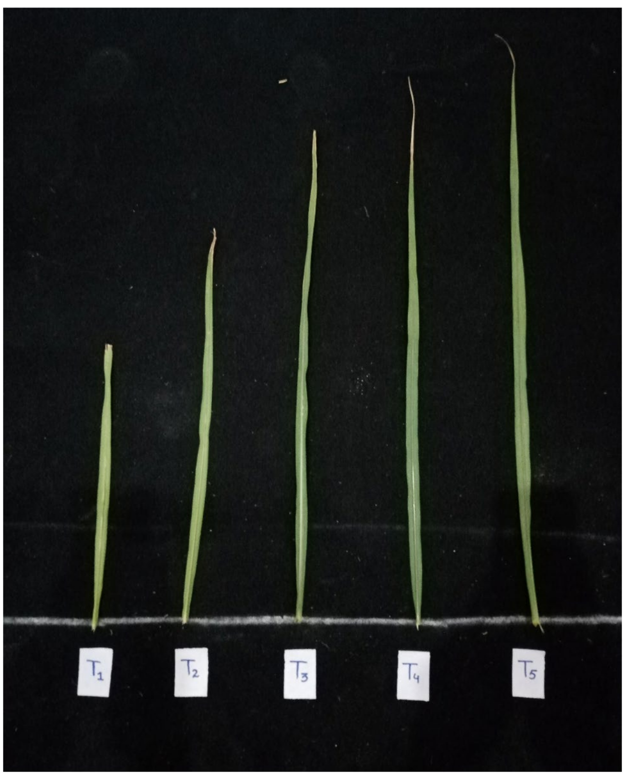


Fig. 3 Comparison of single leaf plasticity (length, and leaf area) of sugarcane bud node of cultivar CP-77400 as affected by composted sawdust mixtures of *Melia azedarach* (Chinaberry tree) at harvesting (47 days after sowing) in experiment 1. All treatments (T_1, T_2, T_3, T_4, T_5) were the same as described in Fig. 1

mixtures of *M. azedarach* substantially improved the sprouting, growth of sugarcane bud nodes seedlings.

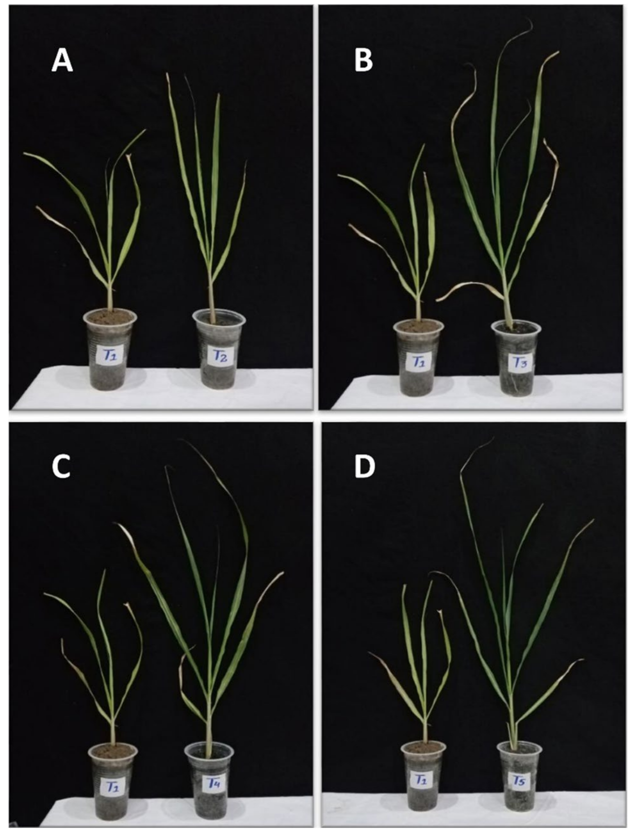


Fig. 4 Individual **c**omparison of the effects of the different composted *Melia azedarach* (Chinaberry tree) sawdust mixtures with control (soil) on the growth and development of sugarcane bud node (cultivar CP-77400) seedlings in experiment 1. All treatments (T_1, T_2, T_3, T_4, T_5) were the same as described in Fig. 1

T_5 and T_4 gave the best growth response compared to the control (Fig. 4A-D). The *M. azedarach* composted sawdust mixtures produced more root biomass of sugarcane bud node seedlings than soil. However, among all mixtures, T_5 produced the maximum root biomass (Fig. 5).

3.2 Effect of *Melia azedarach* (Chinaberry tree) Composted Sawdust Mixtures on Physical Attributes of Single Bud Node Seedlings of SugarCane

In both experiments, the emergence of sugarcane bud nodes was observed earlier in T_5 (11.75 average number of days in experiment 1 and 15.75 average number of days in experiment 2) than in all other treatments. Whereas T_4 and T_5 were statistically at par in both experiments. The maximum time (21.50 average number of days in experiment 1 and 24.75 average number of days in experiment 2) to sprouting was taken by sugarcane bud nodes seedlings in the pots of T_1 in both experiments

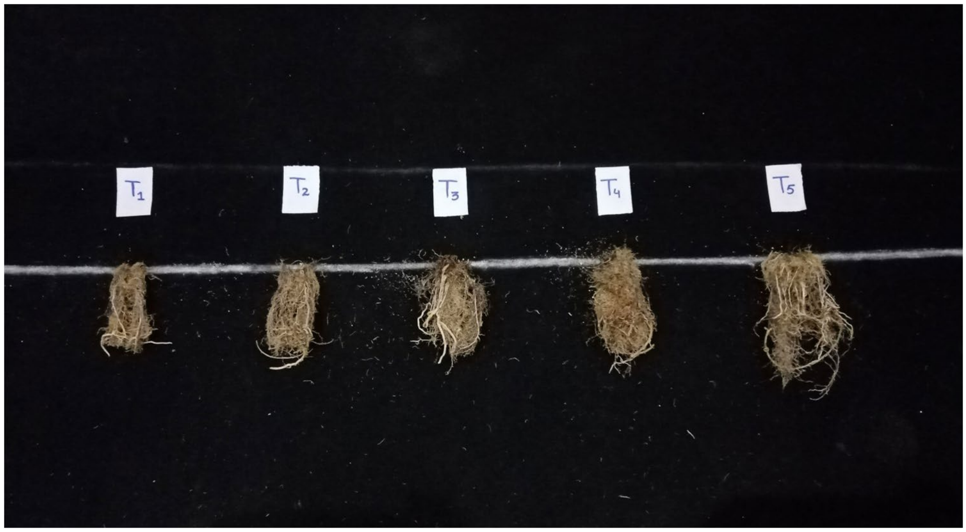


Fig. 5 Comparison of root biomass of sugarcane bud nodes seedling (cultivar CP-77400) as acquired by different *Melia azedarach* (Chinaberry tree) composted sawdust mixtures in experiment 2. All treatments (T_1, T_2, T_3, T_4, T_5) were the same as described in Fig. 1

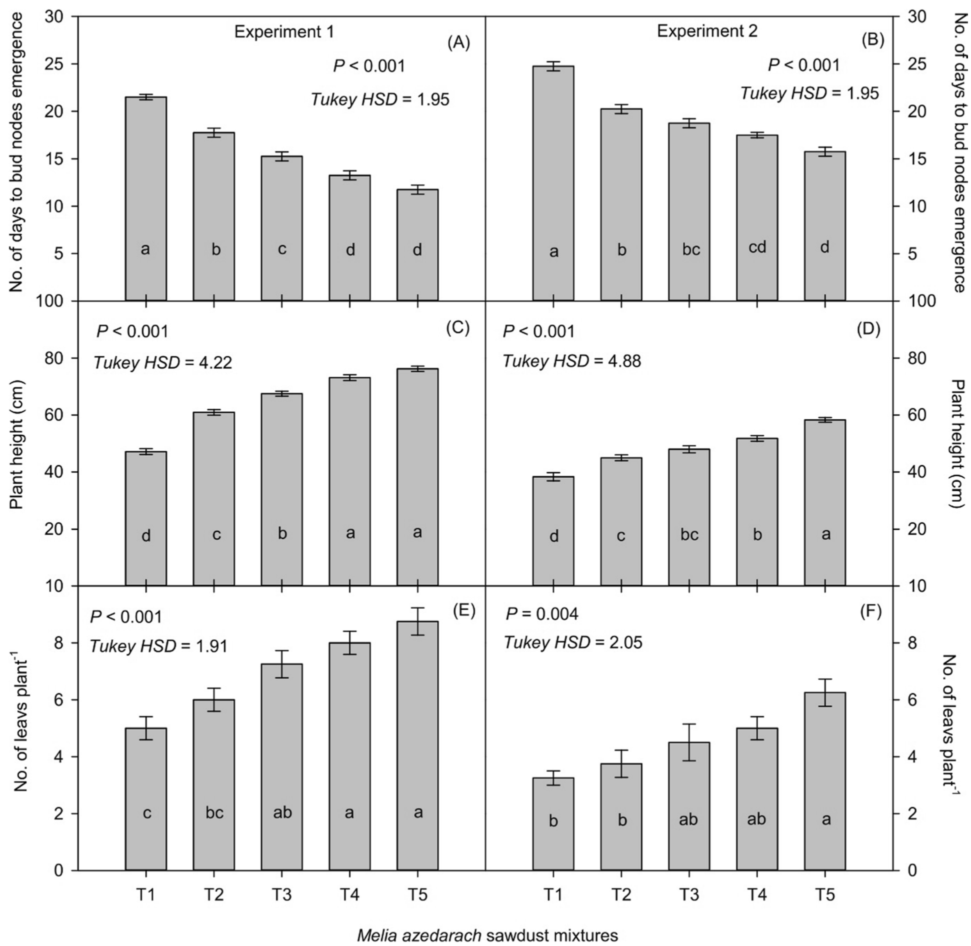


Fig. 6 Growth response of *Melia azedarach* (Chinaberry tree) composted sawdust mixtures to sugarcane bud nodes (cultivar CP-77400) for the number of days taken to bud node emergence (**A, B**), plant height (**C, D**), and the number of leaves plant^{-1} (**E, F**) in experiment 1 and experiment 2. All treatments (T_1, T_2, T_3, T_4, T_5) were the same as described in Fig. 1. Error bars indicate SE ($n=4$). Lettering on the vertical bars indicated a substantial difference among treatment's mean values noted by Tukey HSD at $p < 0.05$

(Fig. 6A, B). The plant height of sugarcane bud nodes was significantly influenced by all *M. azedarach* composted sawdust mixtures in both experiments. The tallest plant height (76.20 cm) was observed in T_5 but it is statistically at par with T_4 which produced a 73.07 cm plant height and the smallest plant (47.12 cm) was measured in T_1 in experiment 1. Similarly, in experiment 2, T_5 produced the tallest plant (58.22 cm) (Fig. 6C, D). The maximum number of leaves plant^{-1} (8.75) was measured in T_5, followed by T_4 (8) in experiment 1. The sugarcane bud node grown in T_1 had the lowest number of leaves plant^{-1} (5). In experiment 2, the same response of the sugarcane bud nodes was noted (Fig. 6E, F).

3.3 Effect of *Melia azedarach* (Chinaberry tree) Composted Sawdust Mixtures on Physiological Attributes of Single Bud Node Seedlings of Sugarcane

All composted *M. azedarach* sawdust mixtures markedly improved the chlorophyll content index (CCI). The highest chlorophyll content index (59.70) was noted in T_5 for experiment 1. The treatments T_3 and T_4 produced statistically similar CCI. The minimum CCI (27.32) was observed in T_1. In experiment 2, the highest chlorophyll content index (41.62) was recorded with T_5 and statistically at par with that of T_4. The least chlorophyll content index (21.22) was measured with T_1 (Fig. 7A, B).

The single leaf area in both experiments was largest for T_5 (5494.3 mm^2 for experiment 1 and 4555.5 mm^2) followed by T_4 (5079.5 mm^2 for experiment 1 and 3959.6 mm^2 for experiment 2). The sugarcane bud node grown in T_1 developed the smallest leaf area in both experiments 1 and 2 (2474.0 mm^2 and 2029.3 mm^2 respectively) (Fig. 7C, D). The shoot diameter of the sugarcane bud node showed a substantial response to all mixtures of composted *M. azedarach* sawdust. T_5 exhibited maximum shoot diameter (13.21 mm and 11.60 mm) in experiments 1 and 2 respectively, which was followed by T_4 in both experiments. However, the minimum shoot diameter was recorded in T_1 for both experiments (Fig. 7E, F).

3.4 Effect of *Melia azedarach* (Chinaberry tree) Composted Sawdust Mixtures on Biomass Production of Single Bud Node Seedlings of Sugarcane

For the shoot, fresh weight T_5 and T_4 were statistically at par (19.37 g and 18.37 g, respectively) in experiment 1. In experiment 2, the largest shoot fresh weight (16.45 g) was noted in T_5, trailed by T_4 (14.47 g) whereas T_1 produced the minimum fresh weight of the shoot in both experiments (Fig. 8A, B). Similarly, T_5 produced maximum shoot dry

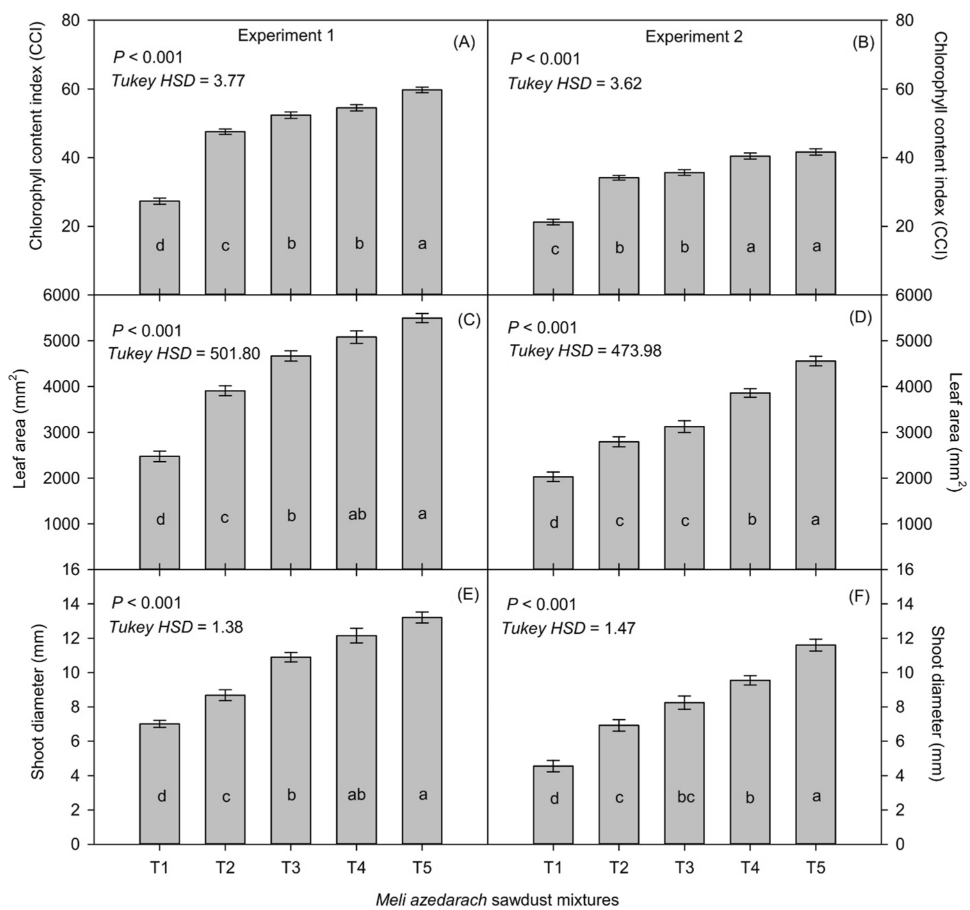


Fig. 7 Growth response of *Melia azedarach* (Chinaberry tree) composted sawdust mixtures to sugarcane bud nodes (cultivar CP-77400) for chlorophyll content index (**A, B**), leaf area (**C, D**), shoot diameter (**E, F**) in experiment 1 and experiment 2. All treatments (T_1, T_2, T_3, T_4, T_5) were the same as described in Fig. 1. Error bars indicate SE ($n=4$). Lettering on the vertical bars indicated a substantial difference among the treatment's mean noted by Tukey HSD at $p < 0.05$

Fig. 8 Growth response of *Melia azedarach* (Chinaberry tree) composted sawdust mixtures on sugarcane bud nodes (cultivar CP-77400) for the fresh weight of shoot (**A, B**), dry weight of shoot (**C, D**) in experiments 1 and experiment 2. All treatments (T_1, T_2, T_3, T_4, T_5) were the same as described in Fig. 1. Error bars indicate SE ($n=4$). Lettering on the vertical bars indicated a substantial difference among treatment's means noted by Tukey HSD at $p < 0.05$

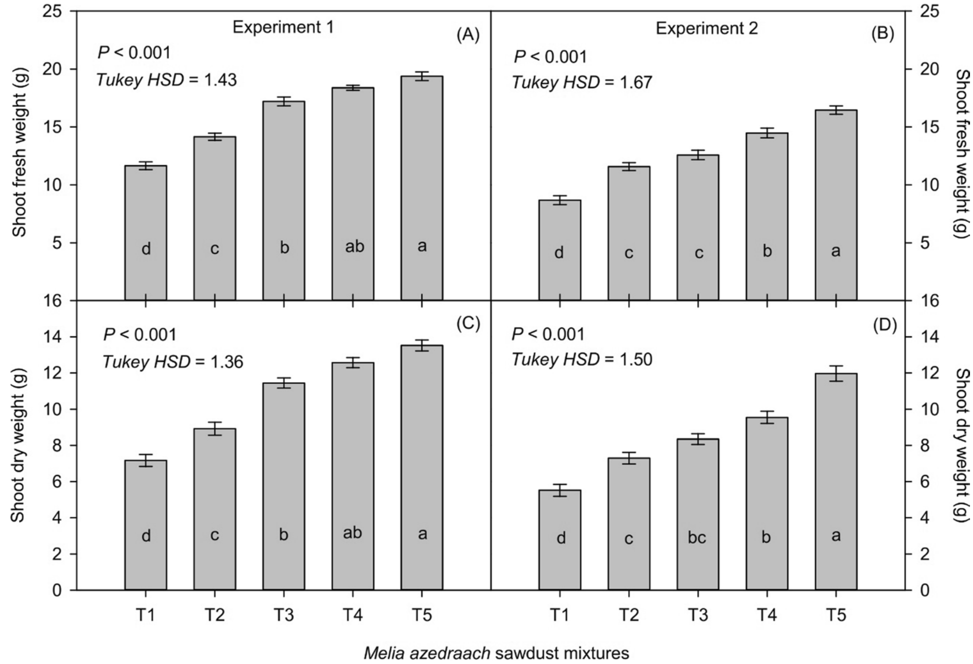
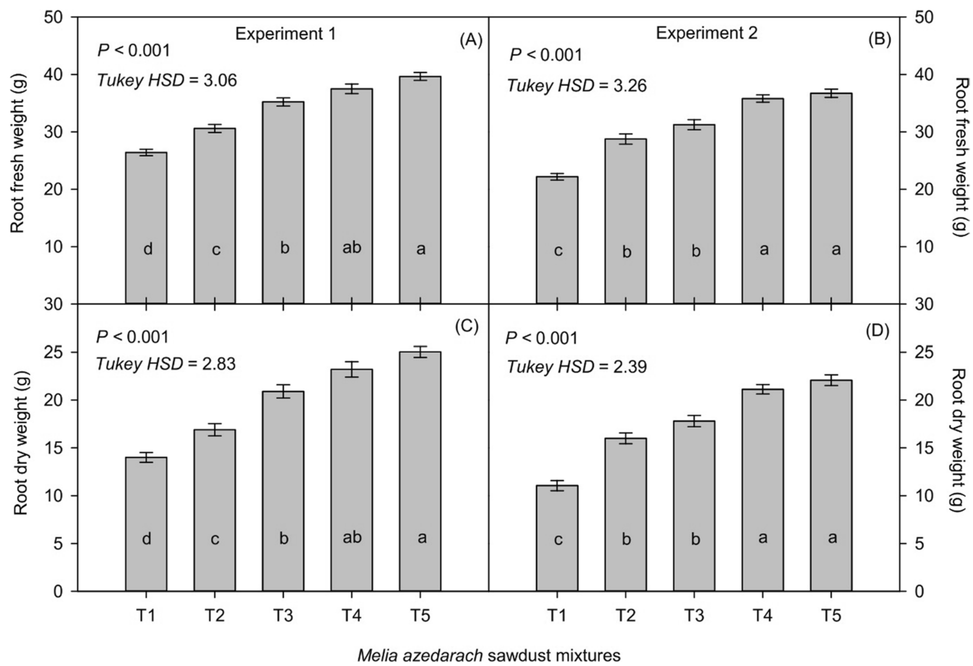


Fig. 9 Growth response of *Melia azedarach* (Chinaberry tree) composted sawdust mixtures on sugarcane bud nodes (cultivar CP-77400) for the fresh weight of roots (**A, B**), dry weight of roots (**C, D**) in experiments 1 and experiment 2. All treatments (T_1, T_2, T_3, T_4, T_5) were the same as described in Fig. 1. Error bars indicate SE ($n=4$). Lettering on the vertical bars indicated a substantial difference among treatment's means noted by Tukey HSD at $p < 0.05$



weight (13.52 g and 11.97 g) in both experiments 1 and 2 respectively. T_1 recorded the least shoot dry weight (7.17 g and 5.52 g respectively) in both experiments 1 and 2 (Fig. 8 C, D).

Plants grown in the T_5 produced the largest root fresh weight (39.65 g in experiment 1 and 36.725 g in experiment 2) but were at par with T_4 in both experiments (Fig. 9A, B). The root dry weight was higher (25.02 g and 20.07 g respectively) in experiments 1 and 2 with T_5. The lowest root dry weight of sugarcane bud nodes was recorded in T_1 (14 g in experiment 1 and 11.05 g in experiment 2) (Fig. 9C, D).

4 Discussion

Overall, all *Melia azedarach* composted sawdust mixtures improved the viability, sprouting, and early growth of sugarcane bud nodes seedlings than soil (control) (Figs. 1–5). This might be due to those mixtures of *M. azedarach* sawdust that may have good porosity and water drainage capacity than soil) which brought early emergence of sugarcane bud node. Yasin et al. (2020) showed that the emergence of garlic cloves was significantly influenced by various types of sawdust growth substrates and soil. They also mentioned that among all tested sawdust substrates, the growth substrate of *Azadirachta indica* (neem) sawdust produced early emergence due to good porosity which helps to grow garlic quickly.

We incorporated urea at the rate of 225 kg N ha^{-1} in T_5 to overcome nitrogen insufficiency in the growth substrate of sawdust due to the immobilization of nitrogen, as earlier have been reported by (Yasin et al. 2023). This amount of nitrogen merged into the composted mixture of sawdust and was very effective to improve the sprouting and growth of sugarcane bud nodes than soil (control). This optimum availability of nutrients enhances the ability of plants to attain higher growth and shoot biomass. Similarly, the addition of eggshells, banana peel, and urea in the composted sawdust growth medium was expected to guarantee more stable nutrition. This balance nutrition positively influenced the sprouting and growth of sugarcane bud nodes.

The composted *M. azedarach* sawdust was used with attention to accelerating the sprouting of sugarcane bud nodes and providing an alternative to peat moss by reducing the cost of production in commercial nursery raising. Yasin et al. (2022) mentioned that non-composted sawdust of *Melia azedarach* has been used for the production of okra. However, fresh sawdust of *M. azedarach* could not have the ability to enhance the plant growth and yield of okra (*Abelmoschus esculentus* (L.) Moench).

In experiments, the height of the sugarcane seedlings, the leaves number $plant^{-1}$, and the diameter of the stem after emergence have been increased significantly in *M. azedarach* composted sawdust substrates as compared to soil. This may be due to the more frequent accessibility of plant nutrients in the composted *M. azedarach* sawdust mixtures. Abubakari et al. (2018) stated that the plant height, as well as the number of leaves per $plant^{-1}$ of lettuce, obtained higher when grown in soilless *Daniellia oliveri* sawdust substrate. The findings of Ewulo et al. (2009) also exhibited that the use of sawdust ash with urea substantially enhanced the height of plants and leaves numbers in tomatoes as compared to the control (soil). Similarly, the findings of Iderawumi (2018) also suggested that the number of leaves $plant^{-1}$ of okra has been enhanced significantly in the growth medium of sawdust ash and ammonium nitrate (4.5 t ha^{-1} sawdust ash + 60 kg ha^{-1} ammonium nitrate) in contrast to control treatment (soil).

The leaf area and chlorophyll content index in T_5 were found maximum. This might have been due to the adequate accessibility of nitrogen in T_5 due to the incorporation of 225 kg N ha^{-1} in the form of urea than the rest of the other treatments. According to Giwa (2004), only the application of organic substrate is not adequate for the growth of crops however, farmers are aiming to use it in combination with mineral fertilizer. Nitrogen boosts photosynthetic activity, leading to more leaf formation and chlorophyll concentration (Rafiq et al. 2010). Our outcomes were also supported by Yasin et al. (2020) who described that the chlorophyll content index of the leaves of the garlic was observed higher when raised in *Acacia nilotica* sawdust substrate than in soil.

The shoot fresh and dry weight of sugarcane bud nodes increased in T_5, this may be that to a higher ability to provide an ample supply of plant nutrients. The optimum availability of nitrogen in T_5 enhanced the ability of sugarcane bud node seedlings to obtain their potential growth and influence the below and above plant biomass, which improved the shoot biomass. This enhanced the photosynthetic activity and resulted in maximum fresh and dry biomass of the shoot. Prajapati et al. (2017) supported our results and indicated that the growth media of cocopeat played an effective role in improving the dry weight of acid lime seedlings than soil. Yasin et al. (2023) also reported an increase in shoot fresh and dry weight of okra when non-composted *Bombax ceiba* sawdust was amended with peels of banana, shells of eggs, and urea.

Similarly, more root fresh and dry weight with composted *M. azedarach* sawdust mixtures than in soil may be due to the maximum porosity of tested *M. azedarach* sawdust mixtures which allowed the quick root penetration and give vigorous root growth, whereas, in the case of soil, root penetration has been restricted due to soil compaction. Rao et al. (2016) confirmed that rooting media of coir pith + vermicompost (1:1) in the combination of urea 5 kg/100 kg media provides the higher root fresh weight of sugarcane seedling. Similarly, Marjenah et al. (2016) reported a substantial increase in the dry and fresh weight of dipterocarps roots when grown under composted sawdust growing medium.

5 Conclusion

The composted *M. azedarach* sawdust supplied ample nutrition to the sugarcane single-bud node seedlings. The composted sawdust of *M. azedarach* (60%) (v/v) + composted peels of banana (20%) (v/v) + composted shells of eggs (20%) (v/v) + Urea at the rate 225 kg N ha^{-1} was found most effective combination to raise sugarcane seedlings. It was concluded that the composted *M. azedarach* mixture T_5 may be a suitable and productive replacement as soilless substrate to grow sugarcane bud node seedlings for nursery production.

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Declarations

Conflict of Interest We declare that we have no financial or personal affiliations with any individuals or organizations that might be perceived as influencing the perspective stated in, or the assessment of the manuscript.

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