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THE EFFECT OF DECOMPOSED SAWDUST AND RICE HULL AS GROWTH MEDIA ON THE GROWTH AND YIELD OF *CORCHORUS OLITORIUS*

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Abstract

A research was carried out at the Nursery of the Horticulture Department, Faculty of Agriculture, Nyankpala Campus, University for Development Studies (UDS), to evaluate how decomposed sawdust and rice hull affect the growth and yield of Corchorus olitorius. Randomized Complete Block Design (RCBD) with three replications was used for the experiment. Sawdust (SD), rice hull (R) that had been heaped for about eight months in Tamale and topsoil (S, used as the control treatment) were collected and utilized as media for the growth of the Corchorus plants. C. olitorius seeds were sown on the three media and three weeks later they were transplanted into polyethylene bags. Findings of the study indicate that the treatments differed significantly (p < 0.05) in the parameters used, and S performed best, which was followed by R. The findings nevertheless show that (sawdust) and R (rice hull) can be used as growth media for Corchorus olitorius. More investigation should however be done to find out how the duration of decomposition of sawdust and rice hull affects the growth and yield of C. olitorius.

Keywords: *Corchorus olitorius*, Decomposed, Growth Media, Optimum Yield, Growth Parameters

Introduction

Corchorus olitorius L., generally called 'wild okra' (and in Ghana referred to as 'ayoyo') is a leafy vegetable grown seasonally and belongs to the family *Tiliaceae* (Masarirambi et al., 2012; Madisa et al., 2013). Regardless of the uncertainty of the origin of *Corchorus*, it basically grows in the wild and for centuries has been cultivated in Africa and Asia (Fondio & Grubben, 2011). According to Khandakar and van der Vossen (2016), *C. olitorius* is an erect, annual herbaceous plant, 1-2.5 m tall (when cultivated as a fibre crop, but when it becomes a well-branched herbaceous crop it grows up to approximately 30 cm in height when cultivated as a vegetable crop), its base usually becomes woody, and branches close to the top by means of glabrous, slightly angular or narrow, deep branchlets.

The leaves of *C. olitorius* are largely rich in β-carotene, protein, calcium, iron, folic acid, vitamins B and C (Sinha et al., 2011; Mavengahama, 2013) and they make up a portion of food of Asians, some Africans and people of Middle East (Fondio & Grubben, 2011; Sinha et al., 2011). *C. olitorius* grows in tropical lowlands with humidity ranging between 60% and 90%. It is dependent on rainfall and can thrive on minimum applications of fertilizers and/or pesticides. It is a multipurpose fibre crop. Apart from being grown as a vegetable crop for its edible leaves and fresh, soft, tender shoots, it is also grown for other purposes. When cultivated for its jute fibre, yields of approximately two tons per hectare of dry jute fibre can be obtained. It is one of the greatest inexpensive natural fibres and apart from cotton, it is thought to produce the largest quantity and highest diversity of usages of vegetable fibres (FAO, 2019).

C. olitorius is an exceptional source of fibre, vitamins A and C, minerals including iron and calcium. It is purportedly eaten as a healthy vegetable in countries such as Japan due to its high amounts of carotenoids, minerals, vitamins B_1, B_2, C and E (Ndlovu et al., 2008). In addition, it also provides high levels of carbohydrates, lipids and proteins (Adeniyi et al., 2012; Nyadanu & Lowor, 2015). The consumption of *C. olitorius* offers essential antioxidants required for general fitness and good health (Chipurura *et al.* 2011; Kumawat *et al.* 2012; Barku *et al.*, 2013). *C. olitorius* is one of the vegetables generally grown and eaten throughout Ghana. The leaves are used in preparing soup and consumed by both rural and urban dwellers with a popular dish known as "Tuo Zaafi" or "TZ" which is prepared from maize and cassava flour (Kwenin *et al.*, 2011).

Regardless of the substantial role of this crop to food, medicine and supporting livelihoods, it is somehow deserted by scientific studies. *C. olitorius* is referred to as an ignored as well as less-used leafy vegetable, particularly in Africa (Dansi *et al*., 2012; Nyadanu & Lowor 2015). Notwithstanding these, some studies have been done to increase the performance of *Corchorus olitorius*. Among these are changing planting distances and fertilizer application (both inorganic and organic). Studies carried out so far have been inadequate especially on the growth of *Corchorus oiltorius* as well as its yield on different media like decayed sawdust and rice hull. This research was thus undertaken to evaluate the growth as well as yield of *Corchorus olitorius* on a variety of growth media that could increase farmers' incomes. Cultivation of the crop on these growth media could as well be situated near homes for security and convenience. Such plants will thus assist as a vegetative protection/cover to cut down on how they are swept into aquatic bodies, triggering additional problems in the environment. The research was therefore aimed at assessing how *C. olitorius* performs on decomposed sawdust and rice hull and top soil, as well as find out which of these growth media could produce optimal crop harvest.

Materials and Methods

Description of Research Area

The research was carried out in the Horticulture Department Nursery, UDS Nyankpala Campus. Nyankpala is situated between latitudes 9˚24' N and 9˚40' N and longitudes 0˚59' W and 0˚98' W (Tolon District Assembly Report, 2015) in Ghana within the Guinea Savannah agro-ecological zone and at 183 m above sea level (Kombiok, 2013).
Temperature mostly varies around a minimum of 15 ^{o}C in December-January and a maximum of 42^{o}C in March-April with 28^{o}C as the average yearly temperature as well as 54 % as the average yearly relative humidity (SARI, 2004). The rainfall regime is mono-modal starting in April/May, increasing to the highest in August and halting in November. With respect to rainfall, 1,000 mm is recorded as the annual average (SARI, 2004). The soils are brownish, sandy loam, abstemiously drained without concretion. Under USDA classification system, it is regarded as an alfisol, while under the Ghana classification system it is referred to as a savanna ochrosol. It is considered to be among the Nyankpala series (NAES, 1984).

Treatments for the Experiment

Three experimental media for growing plants were utilized in the research. The media were sawdust (SD), rice hull (R) and top soil (S, used as the control treatment). The sawdust was collected from sawmills at the Timber Market in Tamale. It was carried in a truck and sent to the Horticulture Department Nursery, Nyankpala Campus of the UDS and composted for about eight months to ensure that it had properly decomposed and used as a growth medium for the *Corchorus olitorius* experimental plants. Rice hull was similarly obtained from a rice mill in Nyankpala and was carried in a truck to the same site as the sawdust. It was also composted for a period of approximately eight months and used as experimental growth medium for the *Corchorus olitorius* experimental plants. The topsoil was gotten from the Horticulture Department Nursery, Nyankpala Campus of the UDS.

Research Planting Material

Seeds of C. olitorius were gotten from the Seed Inspection Unit, Ministry of Food and Agriculture (MoFA), Tamale. Arrangements were made with the Seed Inspection officers who were contacted for the seeds about three months before the start of the experiment. The seeds were however obtained from the officers a day before they were sown at the experimental site to determine the germination percentage.

Field Preparation

In total, 10 m^2 of land was prepared and unwanted plants (weeds) as well as other forms of vegetation were cleared. Raking and levelling of the soil were done using a rake to make the soil surface of the experimental field uniform.

Nursery Establishment

It took three weeks to establish the nursery and the processes entailed preparation of the land as well as creation of a shed. In addition, three beds, each measuring 4 m long and 1.2 m wide (Cicek, 2007) and 10 cm high (Kozanoglu *et al*., 2006; Dutta *et al.,* 2014), were made using the three growth media (sawdust, rice hull in addition to soil) for nursing the seeds. A germination test of the *C. olitorius* seeds (which produced a germination percentage of 90 %) done prior to the seeds being nursed. Three days after nursing the seeds, they began germinating, and three weeks later the seedlings were transplanted in their corresponding growth media in polyethylene bags. Polyethylene bags (each with dimensions of 15 cm x 21 cm) were filled with rice hull, sawdust and topsoil. The polyethylene bags were filled up to 75 % of the space, leaving the remaining 25 % of the space for easy irrigation to prevent over-spilling of water. Holes were punctured on the polyethylene bags to permit passing out of surplus water and increase aeration (in the polyethylene bags).

Agronomic Practices and Harvesting

Agronomic practices undertaken comprised day-to-day irrigation in addition to pest and disease control. Water was supplied to the plants (by way of irrigation) two times per day (early in the morning as well as in the evening) excluding rainy days. Weeds between the polyethylene bags were removed thrice during the experiment by using a hoe or a cutlass whereas weeds in the growth media were removed by using the hand to pull them out on a weekly basis with utmost care not to disturb the *Corchorus olitorius* plants. The plants were harvested four weeks after transplanting by holding each plant at the base and uprooting it from the growth medium.

Experimental Design

A total of 9 plots (3 treatments x 3 replications) were obtained from a total land area of 10m^2. Randomized Complete Block Design (RCBD) was utilized to arrange the plots. Twenty *Corchorus olitorius* plants were grown in each plot with one plant in each polyethylene bag.

Data Collection

Plant Height

Five plants were sampled and their shoot lengths were measured to one decimal place using a metre rule. Measurement of the heights was done in centimetres from the base of the plant to the apical meristem of the plant shoot.

Leaf Length

Leaf length of each sampled plant was measured from the base of the leaf to the leaf apex, Measurement was in centimetres.

Number of Leaves

Counting of leaves of five sampled *C. olitorius* plants per plot was done and documented. One day after the last data was collected, harvesting of the five sampled plants for each plot was done and put together in envelopes. These sampled plants were instantly sent to the laboratory to work out both the fresh in addition to dry matter weights using an electronic digital weighing machine. Every envelope was firstly weighed and thereafter samples of each experimental treatment were placed into it (envelope). Fresh weight of leaves was calculated in grammes by deducting the weight of the envelope from the total weight of the leaves plus the weight of the envelope. Thereafter, the samples were oven-dried in an oven at 105 °C for a day (24 hours) after which, using an electronic digital weighing scale, the dry matter weight was estimated in grammes by taking the weight of the oven-dried leaf samples.

Results and Discussion

Plant Height

The three media did not significantly differ *($p > 0.05$)* in plant height at 4 weeks after transplanting (WAT) although S produced plants with the largest values (5.57 cm) in terms of plant height, and next was R (5.56 cm) producing plants that were taller than those produced by SD (3.95 cm). At 5 WAT, SD and R did not show any significant difference in terms of height of the plants, but S produced significantly taller *($p < 0.05$)* plants than R as well as SD. S produced the tallest plants (10.49 cm); next was R (7.21 cm), with SD producing the shortest plants (5.10 cm).

All the treatments showed significant differences *($p < 0.05$)* at 6 WAT and 7 WAT, with respect to plant height. S produced the tallest plants throughout the experiment (Table 1), followed respectively by R and SD. In terms of colour change, SD produced plants with yellowish stems while R and S produced plants with light green and green stems respectively.

Table 1: The Effect of Soil, Decomposed Rice Hull and Sawdust on Plant Height (cm) of *Corchorus olitorius*

Treatment	4WAT	5WAT	6WAT	7WAT
R	5.56^{a}	7.21^{ab}	10.97^{c}	16.37^{c}
SD	3.95^{a}	5.10^{b}	5.33^{b}	5.72^{b}
S	5.57^{a}	10.49^{a}	19.06^{a}	34.73^{a}
LSD	2.25	3.04	4.30	5.46

Means with different superscripts in a column differ significantly *($p < 0.05$)*.

Level of significance = 95 %

The research findings suggest that S produced the tallest plants, with R and SD following suit respectively. The results also show that the type of medium used had an effect on the height of plants. S produced plants with the highest values in plant height from 4 WAT to 7 WAT while SD produced the shortest plants. This indicates that the available nutrients from the medium had an influence on the height of plants. In general, S produced plants with the highest values (34.73 cm) in terms of height, and these fall within the approximate mean height of 30 cm range suggested by Khandakar and van der Vossen (2016) as *Corchorus olitorius* mean height when considered for use as a vegetable. At first, the treatments at 4 WAT did not significantly differ *($p < 0.05$)* with respect to plant height. This may be as a result of the seedlings not needing a lot of nutrients to establish themselves at the initial stages of growth. At 5 WAT, 6 WAT and 7 WAT, S significantly increased in height than the other two treatments. This may be as a result of nutrients in the soil being available to the plants. This confirms the assertion by Tindall (1993) and (Schippers, 2000) that most *Corchorus* cultivars are able to tolerate soil conditions, even though well-drained, moist soils are preferred. As crops such as tomato (Ayeni, 2010) and maize (Njoku & Mbah, 2012; Ogundare *et al.*, 2012) respond favourably to soils with organic manure, Norman (1992) indicated that *Corchorus* as well requires sandy loam soil rich in humus and well-drained, that is typical of the Nyankpala series (NAES, 1984). The low growth in SD might be as a result of the materials contained in the sawdust and this is in line with the Forestry Division's (1994) report and Aggie Horticulture (2019) that the tree species from which sawdust is obtained basically influences its quality as well as its worth as a medium for growing plants. In addition, the reports explain that some Walnut as well as undecayed redwood sawdust materials are said to have phytotoxic impacts on plant growth.

Number of Leaves

The research findings indicate that, in terms of leaves produced, there were no significant differences *($p > 0.05$)* among the three growth media at 4 WAT. Furthermore, S and SD did not significantly differ *($p > 0.05$)* at 5 WAT in the number of leaves produced. Nevertheless, S produced the most leaves (20.53), while R and SD respectively had 15.73 and 6.80 leaves. At 6 WAT, the three treatments differed significantly *($p < 0.05$)* while at 7 WAT, R and SD did not significantly differ *($p > 0.05$)* in the number of leaves produced. In all the data gathered, S produced the most leaves, with R and SD following in that order (Table 2). It was also noticed that R and SD produced plants with yellowish leaves that were curled with discoloured edges, while S produced plants with greenish leaves.

Table 2: The Effect of Soil, Decomposed Rice Hull and Sawdust on Number of Leaves of *Corchorus olitorius*

Treatment	4WAT	5WAT	6WAT	7WAT
R	4.20^{a}	15.73^{a}	26.30^{a}	42.51^{a}
SD	3.87^{b}	6.80^{b}	7.80^{b}	10.60^{a}
S	5.00^{c}	20.53^{c}	46.90^{c}	102.20^{c}
LSD	1.25	5.47	8.24	37.92

Means with different superscripts in a column differ significantly *($p < 0.05$)*.

Level of significance = 95 %

At 4 WAT, the three media did not significantly differ in the number of leaves. This might be due to plants not being significantly different in terms of height during that growth period. At 5 WAT, treatments S and R produced plants with more leaves than SD. Possibly, it can be attributed to the amount of nutrients in the media which promoted healthy growth in the leaves. The number of leaves produced by R supports an assertion by the Texas Poinsettia Producers Guide (TTPPG) (2000) that particle sizes of rice hulls and sawdust as well as their slow rate of decomposition are alike although depletion of nitrogen is not a critical challenge in media supplemented with rice hulls. At 6 WAT and 7 WAT, the leaf numbers doubled in S, which might be as a result of more side shoots that were produced during these growth periods.

The poor performance of SD supports findings of TTPPG (2000) that the C: N ratio in sawdust does not easily decompose; thus, its low performance might be due to the age of SD. It might as well be as a result of the existence of more lignin and cellulose content as well as inadequate supply of nitrogen, which possibly will greatly slow down plant growth. A Forestry Division (1994) report also showed that sawdust's beneficial effects are realized when the organic materials decompose and the lignin contained in them is transformed to humus. Even though organic manure may appear brownish, powdery, with sweet odour and properly-decomposed, it might just have incompletely decayed.

Leaf Length

The research findings showed that S and R did not significantly differ at 4 WAT in terms of leaf length although S differed significantly from SD. Analysis of the gathered data also showed that SD and S differed significantly at 5 WAT. At 6 WAT and 7 WAT, all the three treatments differed significantly, with S producing the longest leaves and SD produced the shortest leaves (Table 3). S produced the longest leaves during all the periods that the data was collected, with SD and R following in that order. The production of yellowish leaves by R and SD and other observed growth features such as curly leaves with discoloured edges suggested that specific nutrients were lacking. This agrees with findings of Widmer *et al.* (1996) that decomposing bacteria of any wood type will use up all of the nitrogen, and plants growing on such media will show such yellowish colourations except when there is addition of a significant quantity of nitrogen.

Table 3: The Effect of Soil, Decomposed Rice Hull and Sawdust on Leaf Length (cm) of *Corchorus olitorius*

Treatment	4WAT	5WAT	6WAT	7WAT
R	2.32[ab]	2.99[ab]	4.02[a]	4.85[a]
SD	2.08[b]	2.33[b]	2.53[b]	2.70[b]
S	2.80[a]	3.73[a]	5.66c	7.12[c]
LSD	0.62	0.84	0.36	0.66

Means with different superscripts in a column differ significantly *($p < 0.05$)*.

Level of significance = 95 %

Edible and Non-Edible Fresh and Dry Matter Weight

SD and R fresh weight of the *Corchorus* plants did not differ significantly (Table 4) with respect to their edible as well as non-edible portions, even though S produced heaviest non-edible (65.8 g) and edible (43.11 g) fresh weight per plant. SD produced the lightest non-edible weight (2.01 g) and edible weight (0.54 g). Following the same pattern as the fresh weight was the oven-dried weight. There were no significant differences between SD and R in their non-edible and edible dry matter weight. S however differed significantly from SD and R. Nevertheless, SD produced significantly non-edible and edible dry matter weight and therefore differed from both S and R.

At harvest, the plants' fresh weight was influenced by the growth media utilized in the study in which S did better and differed significantly from both SD and R. Even though R and SD did not significantly differ in plant fresh weight, R produced heavier plants compared to SD. The plant fresh weight could have been as a result of the plant height, number of leaves and side shoots. The heavier dry matter weight produced by S might have been due to high water-soluble nutrient uptake. Consequently, the plant growth plant was improved, resulting in a lot of accumulation of dry m atter. Being one of the key constituents of plant biomass, carbon (C) forms up to 40–45 % of total dry matter. Hence, the leaves (with their many stomata) were able to sequester carbon dioxide from the atmosphere for photosynthesis (Nederhoff, 1994).

Table 4: The Effect of Soil, Decomposed Rice Hull and Sawdust on Edible Non-Edible Fresh and Dry Matter Weight (G) of *Corchorus Olitorius*

	Fresh weight (g)		***Dry matter weight (g)***	
Treatment	Edible	Non edible	Edible	Non edible
R	10.80^{b}	15.85^{b}	2.26^{b}	2.57^{b}
SD	0.54^{b}	2.01^{b}	0.21^{b}	0.56^{b}
S	43.11^{a}	65.87^{a}	9.79^{a}	11.23^{a}
LSD	17.78	32.27	3.06	4.64

Means with different superscripts in a column differ significantly *($p < 0.05$)*

Level of significance = 95 %

Number of Side Shoots at Harvest

The media showed significant differences with respect to plant side shoots. S produced the most (18.93), with R and SD also recording 16.13 and 4.00 respectively (Table 5). In addition, plant height and side shooting had a positive correlation, and this also had an effect on the number of leaves produced. This means, even though production of side shoots is typical of *Corchorus*, this was influenced by nutrients of the plants.

Table 5: The Effect of Soil, Decomposed Rice Hull and Sawdust on Number of side shoots at harvest of *Corchorus olitorius*

Treatment	***Number of side shoots***
R	16.13^{c}
SD	4.00^{b}
S	18.93^{a}
LSD	2.33

Means with different superscripts in a column differ significantly *($p < 0.05$)*.

Level of significance = 95 %

This supports an assertion by Fageria and Moreira (2011) that when essential nutrients are deficient, the ability of plants to produce mass shoots and roots is reduced during their growth and development up to time of harvesting.

Conclusion and Recommendations

The research findings indicate that the three media significantly differed *($p < 0.05$)* in the parameters considered, with S producing the best results, with R the next best performer. The findings nevertheless show that SD (sawdust) and R (rice hull) are capable of serving as growth media for *Corchorus olitorius.* Thus, further studies should be done to find out how the length of decomposition of sawdust and rice hull could affect the performance of *Corchorus olitorius.*

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