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Effect of potting media on the growth and leaf yield of Lettuce (*Lactuca sativa*) in Agbani, Nkanu west, Enugu state, Nigeria.

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ABSTRACT

Agricultural by–products have been found useful in solilless crop production as a means to sustainability because it maximally utilizes available resources. Four growth media; coconut fiber, rice mill waste, sawdust and soil (control) were used to determine the effect of the growth and leaf yield of lettuce in the high-tunnel of the Faculty of Agriculture and Natural Resource Management, Enugu State University of Science and Technology during 2015 cropping season. The experiment was laid out in Completely Randomized Design (CRD) replicated six (6)times. The data collected revealed that coconut fiber significantly enhance lettuce growth, in terms of plant height, number of leaves, plant girth, leaf area index and fresh weight of the plant. Sawdust had no appreciable effect on most of the parameters taken, but coconut fiber produced greater yield when compared with rice mill waste. However, among various combinations, coconut fiber produced maximum yield and will fit well as a soilless medium for lettuce growth and production.

1.0 Introduction

Lettuce, (Lactuca saliva) is a vegetable grown for its edible leaves. It is the most popular among the salad vegetables (Hartmann, et al, 1991). It is native to the Mediterranean area. Leafy types have been cultivated for over 2500 years and were grown by the ancient Greeks (Whitaker et al., 1999). Lettuce is a fairly hardy annual crop and cool weather vegetable. It has a short stem initially but when it gradually blooms, the stem and branches lengthens and produce many flower heads. It is grown year round in many homes and community gardens. It grows best on soils with pH range of 5.8-6.7. A pound of lettuce contains 95% water, 56 calories, 3.9g protein, 0.3g fat, 86mg calcium, 2.2mg iron and 1.420mg vitamin. When eaten, it calms the nerves and satisfies the stomach (Pamplona-Roger, 1998). It does not grow well on mineral soils that are strongly acidic, but it is not advisable to completely neutralize the acidity by liming. Lettuce is a poor forage crop because of its small root system. It therefore does not perform optimally when planted in the open field.

Seedling production is an important step in the horticultural production system because it influences the final crop yield. Growing media is a major factor that influences seed germination, seedling emergence, seedling

growth and quality of seedlings in a nursery (Corti et al., 1998; Wilson et al., 2001; Baiyeri, 2003; Sahin et al., 2005; Agbo and Omaliko, 2006; Baiyeri and Mbah, 2006; Bulut and Demir, 2007; Ugese, 2010; Aklibasinda et al., 2011; Unal, 2013; Baiyeri et al., 2015;). The quality of the growing media used in containerized seedling production is largely influenced by physical, chemical and biological properties (Wilson et al., 2001; Grigatti el al., 2007; Herrera et al., 2008), the growing environment and plant management (Nwofia and Okwu, 2015). Growing media is not only a place where seeds are sown and seedlings raised, but is also a source and reservoir of plant nutrients (Indriyani et al., 2011). It also anchors the root system and therefore supports the plant (Abad el al., 2005). A good growing media should be composed of mixtures that are tender enough for seeds to easily germinate, retains moisture, drains excessive water and provide sufficient plant nutrients for seedling growth and development (Abad et al., 2002; Bilderback et al., 2005; Olle et al., 2012; Olaria et al., 2016). Several growth media had been evaluated on various plants by previous researchers (Atiyeh et al., 2000; Baiyeri, 2003; Baiyeri and Mbah, 2006; Manenoi et al., 2009; Indriyani et al., 2011; Bhardwaj, 2013; Kumar el al., 2016). A wide range of growth media or substrates of different origin are used in vegetable production. Some media are of natural origin while others are produced artificially in factories (Verdonck et al., 1982; Olle et al., 2012; Bhat et al., 2013). Growth media can include organic materials such as peat, compost, tree bark, coconut fiber, vermicompost, rice husk ash, or inorganic materials such as perlite and vermiculite (Grunert et al., 2008; Nair et al., 2011; Vaughn et al., 2011). The growth media from organic materials are usually used in greenhouses to produce bedding plants and vegetable transplants (Atiyeh et al., 2000). Mineral soil or sand is also used for growing vegetable (Olle et al., 2012; Mathowa et al., 2014a) and tree seedlings (Sekepe et al., 2013; Mathowa et al., 2014b; Mathowa et al., 2014c). Growth media provide aeration and water, enhance root growth and physically support the plant (Olle et al., 2012). Organic media such as vermicompost are recommended as the best media for enhancing seedling growth (Atiyeh et al., 2002; Canellas et al., 2002; Hashemimajd et al., 2004; Hidalgo et al., 2006; Arancon et a/., 2008). Studies show that a high proportion of the hydroponic industry uses inorganic growing media such as vermiculite and others (Bohme et a/., 2001; San Bautista et al., 2005; Bohme et al., 2008), whereas approximately 12% uses organic growing media (Donnan, 1998) such as peat, bark, leaf mould, sawdust and others (Olle et al., 2012). Commercial mixtures are often used because they are sterilized, ready to use and may even contain some fertilizer (Hochmuth et al., 1996). Most of the materials that make up the commercial mixtures of growth media are usually cheap and or recycled material. However, both inorganic and organic derived media can have adverse effect on overall performance of seedlings. The aim of this study was to evaluate the effect of locally available commercial mixtures on Lettuce growth and leaf yield development.

2.0 Materials and methods

2.1 Description of study Site

The study was conducted in a high-tunnel at the Faculty of Agriculture and Natural Resources, Enugu State University of Science and Technology, Agbani from the months of May to July, 2015. The campus is located between latitude 6°51'24"N, and 7°23'45"E, this area has two seasons, the wet season which is between April and October while the dry season is between November and March (Anikwe et al., 1999).

2.2 Experimental Design, Sampling and Planting Materials

The study was laid out in a completely randomized design (CRD) with four treatments (local growth media) replicated six times. The four local growth media were Coconut fiber (Tl),Sawdust (T2), Rice mill waste (T3) and Soil (T4 as control). Lettuce seeds were gotten from Songhai farms, the coconut fiber and rice mill waste were sourced from Affor market, Ugboka and the sawdust and Topsoil used as control from Umueze, Agbani, all of Enugu State. The lettuce seeds were first raised in nursery and it lasted for two weeks. Three seedlings per bag were transplanted into the media and later thinned to one (1) per bag. Thereafter, growth and development parameters were measured using the six (6) randomly tagged seedlings from each media throughout the eight (8) weeks after transplanting of the study.

2.3 Cultural practices

Liquid NPK 20-10-10 was applied to each media at 20ml three times every week. The NPK was measured at three 3g to 75cl of water and mixed thoroughly and applied after development of true leaves to boost the seedlings.

2.4 Measured Parameters

Number of leaves was measured cumulatively weekly after transplanting from each media and the mean was recorded. Whereas plant height was measured quantitatively using a 30 cm ruler from the base to the terminal leaf.
The girth of the plant was measured using vernier calliper placed around the middle of the plant and the average mean was taken. The fresh weight of the plant was weighed with a electronic weighing scale balance and it was measured on the whole plant, leaves, stems and roots respectively

2.5 Data Analysis

Data was subjected to analysis of variance (ANOVA) using Genstat statistical Software (2013). Where a significant F-test was used and means comparison tests carried out using Fisher's Least Significant Difference (F-LSD) at $p \leq 0.05$.

3.0 Results and Discussion

3.1 Number of Leaves

Growing media influences seed germination and succeeding emergence and growth of seedlings in a nursery (Baiyeri and Mbah, 2006) because it is a -reservoir of moisture and plant nutrients (Grower, 1987). In addition, it influences the performance of seedling before they are transplanted in the field (Adediran, 2005). In this study, results show significant differences ($p>0.05$) in Number of leaves among the four growing media from 3WAT to SWAT. The significant difference is probably due to difference in the physical characteristics of the media used. Coconut fiber revealed superior absolute numbers compared to rice mill waste and saw dust. The observed superiority exhibited by the coconut fiber could probably be attributed to its good physical properties and water holding capacity that supported the highest number of leaves. Sawdust con-

sistently had the least number of leaves because of its low level of nitrogen and inability to retain moisture (Table 1). This is largely in conformity with Awodun et al, (2007) who reported that the low level of nitrogen in sawdust could be attributed to immobilization of nitrogen by micro-organism acting on carbonaceous sawdust. At SWAT Soil as a control produced significantly the highest number of leaves, this is because when other media had exhausted their nitrogen nutrient, soil still had reserve for the plants due to its nutrient lasting capacity as the lettuce plant kept increasing gradually at the initial stages (Fig. 1). Bernal el al., (1998) also found that nitrogen uptake from soil alone was higher than soil amended due to more microbial activity in the amended soil resulting in immobilization of N. The significant effect of growing media observed in the study could probably be explained by Wilson et al, 2001; Sahin et al, 2005 and Ugese, 2010 who reported that physico-chemical properties of a growth media are influenced by the base materials used in their formulation.

3.2 *Plant Height and Leaf Area Index*

Studies using soilless growing media have been performed on plants (Ugese et al., 2008 Baiyeri, 2003; Nazari et al., 2009; Mehmood et al., 2013; Baiyeri et al., 2015). Significant differences were revealed in the plant height among the growing media in the period of this study (Table 2). Coconut fiber, rice mill waste and soil produced higher plant height but no significant difference was observed among these media but plant height obtained from these media was significantly different from saw dust which recorded the lowest plant height. However at SWAT, soil (control) obtained the highest plant height followed by coconut fiber while saw dust obtained the least. The linearity of increase in the plant height among the growing media could probably be due to the fact that seedlings were still in vegetative growth phase. The present findings are in agreement with Mathowa et al., (2016) who reported growing media significantly affected the growth of tomato seedling height and they concluded that a good growing media anchors or supports the plant and serves as reservoir for nutrients and water, allow oxygen diffusion to the roots and gaseous exchange between the roots and atmosphere outside the root substrate (Abad et al., 2002). Lettuce plant was higher in all the media except sawdust (Fig. 2). Hart and Schrander (1996) found that "lack of nutrient in sawdust is as a result of lack of maturity of compost in C/N ratio and high N-$NH4^+$". Potting media significantly influenced the leaf area index of lettuce plant (Table 3). At 3,4 and SWAT, coconut fiber gave the highest area index and differed significantly ($P \leq 0.05$) from the other media used while rice mill waste and soil were statistically the same (($P \leq 0.05$) but significantly higher than sawdust media. At 6, 7 and SWAT Topsoil (control) had the highest leaf area index followed by coconut fiber and this differ significantly from sawdust and rice mill waste (Fig. 3). Increased leaf area implies higher height interception and dry matter product which invariably promotes plant growth. Similarly findings have being reported by Ofosu-Anim and Leitech, (2009

3.3 *Plant Girth and Fresh Weight*

Potting media significantly influenced the plant girth of lettuce (Fig 4). Topsoil produced the highest girth of the plant followed by coconut fiber and rice mill waste while saw dust consistently recorded the lowest girth of lettuce plant at 6, 7 and SWAT (Table 4). This study agrees with the report of Baiyeri and Mbah (2006) that nursery media influences seedling growth parameters as seedlings raised in medium 1:4:3 RHB longer stem and thicker stem girth of African breadfruit at 24 week after planting (WAP) than other media as observed in this present study with lettuce. Coconut fiber and topsoil media obtained statistically same fresh weight of lettuce but was significantly different rice mill waste and saw dust. Saw dust recorded the lowest fresh weight of lettuce. The lower performance of the saw dust media as reported herein agrees sharply with results obtained by Baiyeri (2005) in the weaning of banana/plantain plantlets where the rice hull based media were better than the saw dust based ones. Even though saw dust is recognized as the commonest wooden material used in potting mix (Albery, 1975), it normally suffers from depletion of available nitrogen in the process of decomposition by microorganisms (Woolton et al., 1981). This fate is not suffered by coconut fiber which decays more slowly and easily incorporates into media where it impacts positively on the physical properties of drainage and aeration. In the fresh leaf weight, Topsoil (control) was superior as it gave the highest weight of lettuce leaf which was significantly higher than the other media (Table 5). Similar finding was reported by Okunlola (2016) that topsoil significantly produced higher growth parameters as compared to other nursery media. Fresh root weight of lettuce plant was significantly influenced by potting media as coconut fiber gave the highest root weight and was significantly different other potting media evaluated in the study (Fig. 5). Fresh stem weight was lowest at sawdust medium followed by rice mill waste. Topsoil and coconut fiber media obtained significantly the highest fresh stem weight. Superior performance of coconut fiber could be the structure, aside the moisture and nutrient it's able to give. It is not so closely packed as soil, so the lettuce plants found it easier to root more. This conforms to Hampshire, (2014) who reported that he "planted Cacti in coconut fiber which was originally meant to be a temporary home until he could make gritty mix, but observed that everything planted in the coconut fiber seems to be doing well as has been rooting like crazy".

4.0 Conclusion

The results of this experiment showed that coconut fiber and topsoil media were statistically the same in supporting lettuce growth with superior performance. These media produced the higher growth parameters evaluated in this study. Although rice mill waste medium aimed at catching up with

Table 1: Effect of Potting Media on the Number of Leaves of Lettuce

Treatments	Number of Leaves					
	3 WAT	4WAT	5WAT	6WAT	7WAT	8WAT
Coconut Fiber	4.17	4.97	5.80	7.20	7.60	7.60
Saw dust	1.33	2.23	2.60	3.00	3.80	4.00
Rice mill waste	3.33	4.11	4.80	5.20	5.80	7.20
Soil (control)	2.50	3.43	4.00	6.40	7.40	9.20
F-LSD ($P \leq 0.05$)	2.69	0.98	1.29	1.53	1.25	1.37

WAT = weeks after transplant

Table 2: Effect of Potting Media on the Plant Height (cm) of Lettuce in Enugu

Treatments	Number of Leaves					
	3 WAT	4WAT	5WAT	6WAT	7WAT	8WAT
Coconut Fiber	11.97	14.36	16.76	18.08	18.64	19.62
Saw dust	5.94	7.13	8.32	8.50	8.24	6.62
Rice mill waste	11.53	13.98	16.32	17.40	17.68	17.58
Soil (control)	11.97	14.36	16.76	19.00	22.44	24.84
F-LSD (P≤ 0.05)	2.38	2.35	3.38	3.32	4.64	5.54

WAT= Weeks after transplant

Table 3: Effect of plotting media on the leaf area index of lettuce in Enugu

Treatments	**Number of Leaves**					
	3 WAT	4WAT	5WAT	6WAT	7WAT	8WAT
Coconut Fiber	0.28	0.47	0.78	1.00	1.38	1.46
Saw dust	0.01	0.03	0.05	0.05	0.07	0.04
Rice mill waste	0.14	0.24	0.39	0.40	0.61	0.78
Soil (control)	0.12	0.24	0.37	1.09	1.46	2.46
F-LSD (P≤ 0.05)	0.03	0.04	0.04	0.18	0.12	0.19

coconut fiber but only succeeded in being the second best while sawdust medium had depression effect in all the parameters measured and its performance was significantly the lowest. Hence, coconut fiber medium is recommended as a soilless medium for the growth and production of lettuce, due to its ability to act as pH buffers. It also absorbsnutrients for plant use because it resists decomposition making it more desirable than rice mill waste or sawdust that have the tendency to breakdown and result in root suffocation and rot. Where availability becomes a problem it could be substituted with topsoil.

Table 4 : Effect of plotting media on the plant girth of lettuce

Treatments	**Plant Girth (cm)**		
	6WAT	7WAT	8WAT
Coconut Fiber	3.11	3.50	3.70
Saw dust	2.56	2.88	1.78
Rice mill waste	2.97	3.34	3.08
Soil (control)	4.46	5.02	5.02
F-LSD (P≤ 0.05)	0.82	0.97	1.13

WAT= Weeks after transplant

Table 5 : Effect of plotting media on the fresh weight of lettuce

Treatments	**Fresh Weight (g)**			
	Whole Plant	Leaf	Root	Stem
Coconut Fiber	72.90	35.40	19.29	16.23
Saw dust	5.50	3.30	1.51	0.69
Rice mill waste	50.70	21.10	7.31	6.45
Soil (control)	71.20	44.80	5.88	20.53
F-LSD (P≤ 0.05)	11.31	8.77	5.11	4.11

WAT= Weeks after transplant

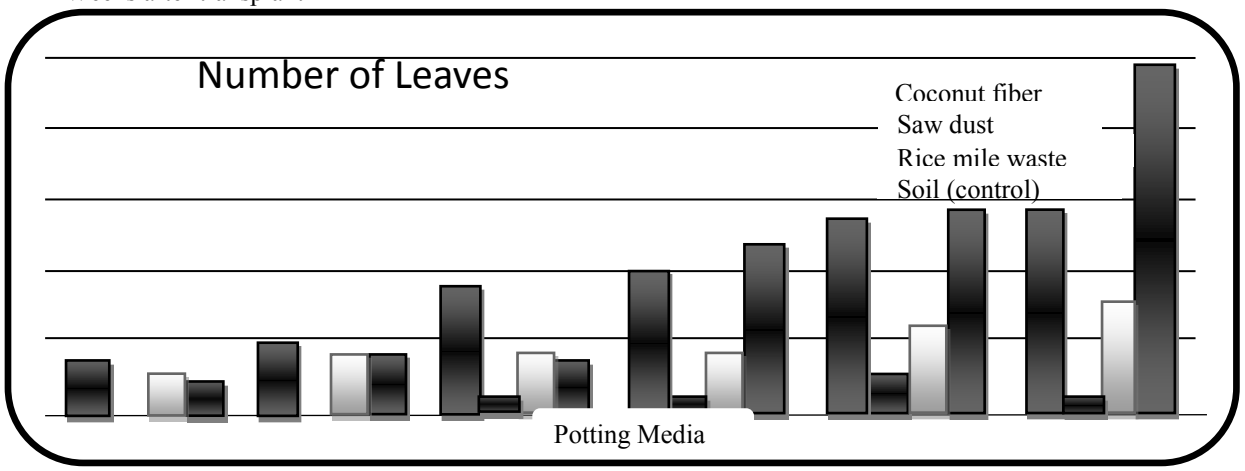

Figure 1 : Effect of plotting media on Number of leaves of lettuce in Enugu

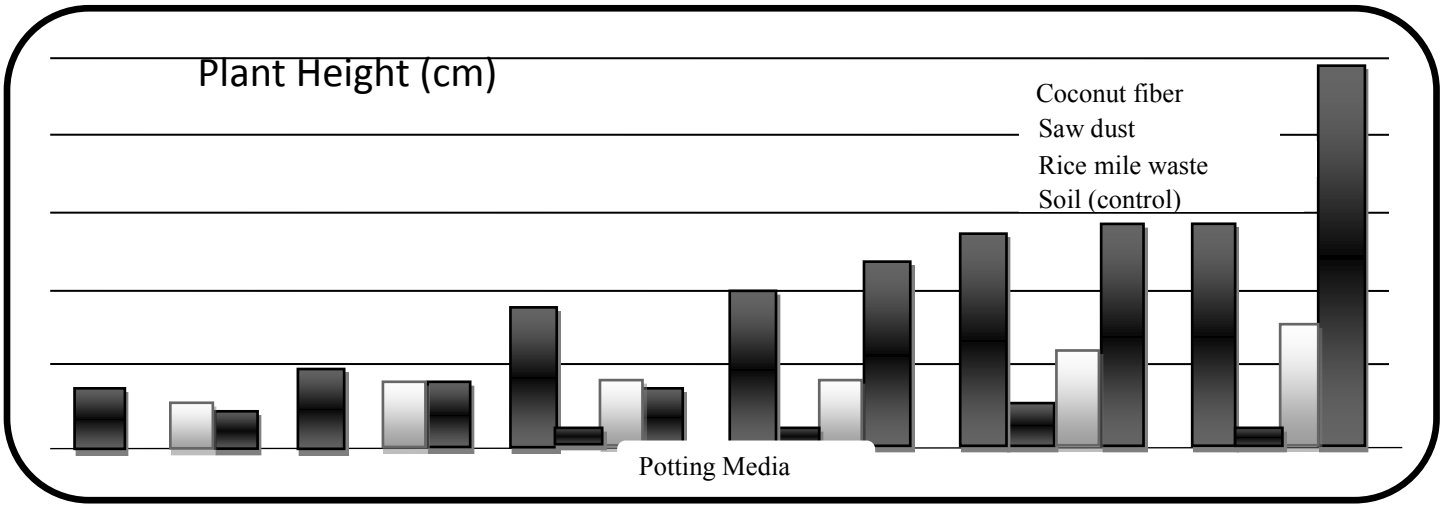

Figure 2 : Effect of plotting media on plant height (cm) of lettuce in Enugu

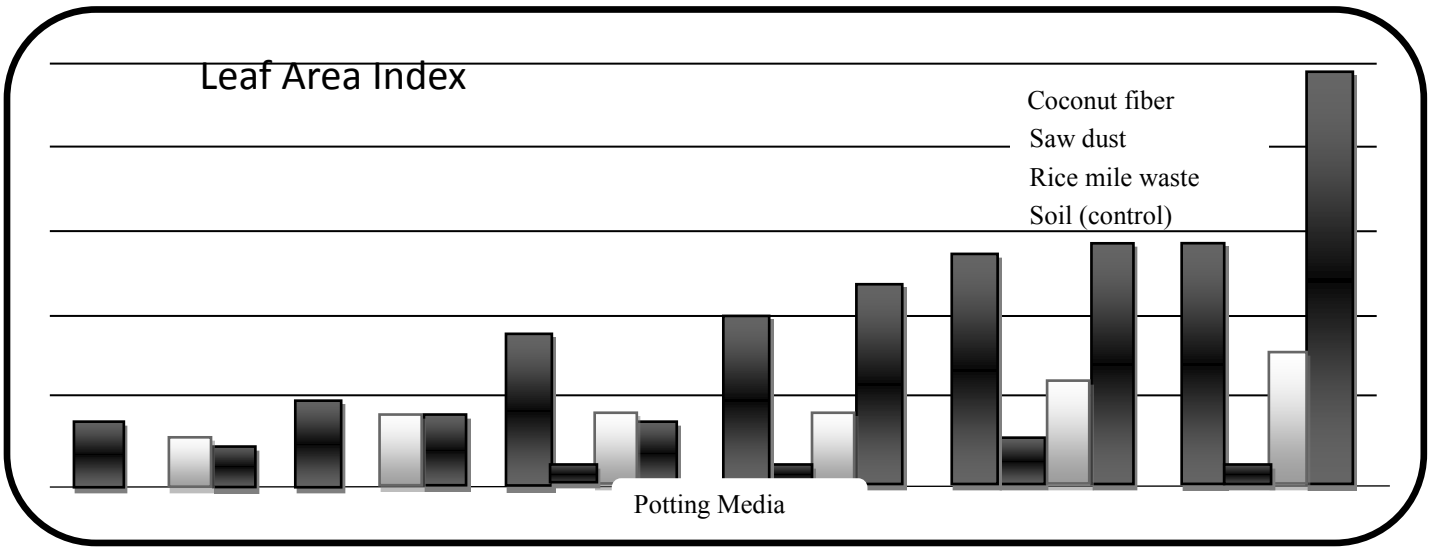

Figure 3 : Effect of plotting media on leaf area index of lettuce in Enugu

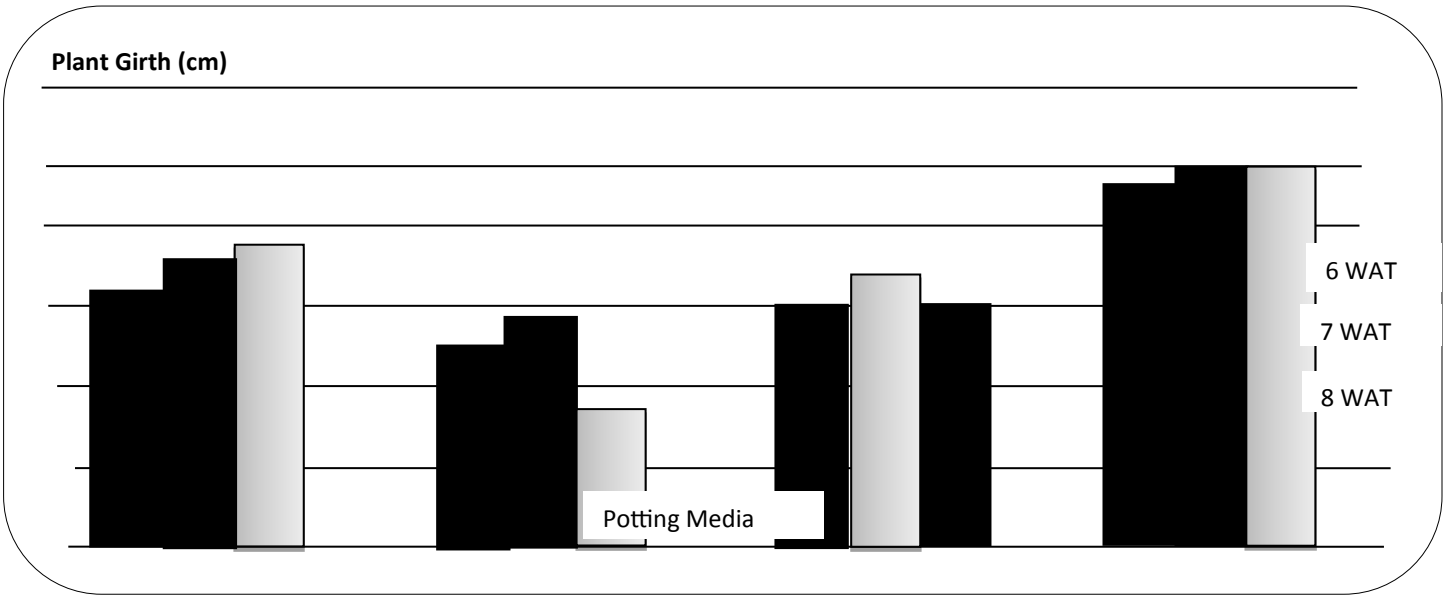

Figure 4: Effect of plotting media on plant girth (cm) of lettuce in Enugu

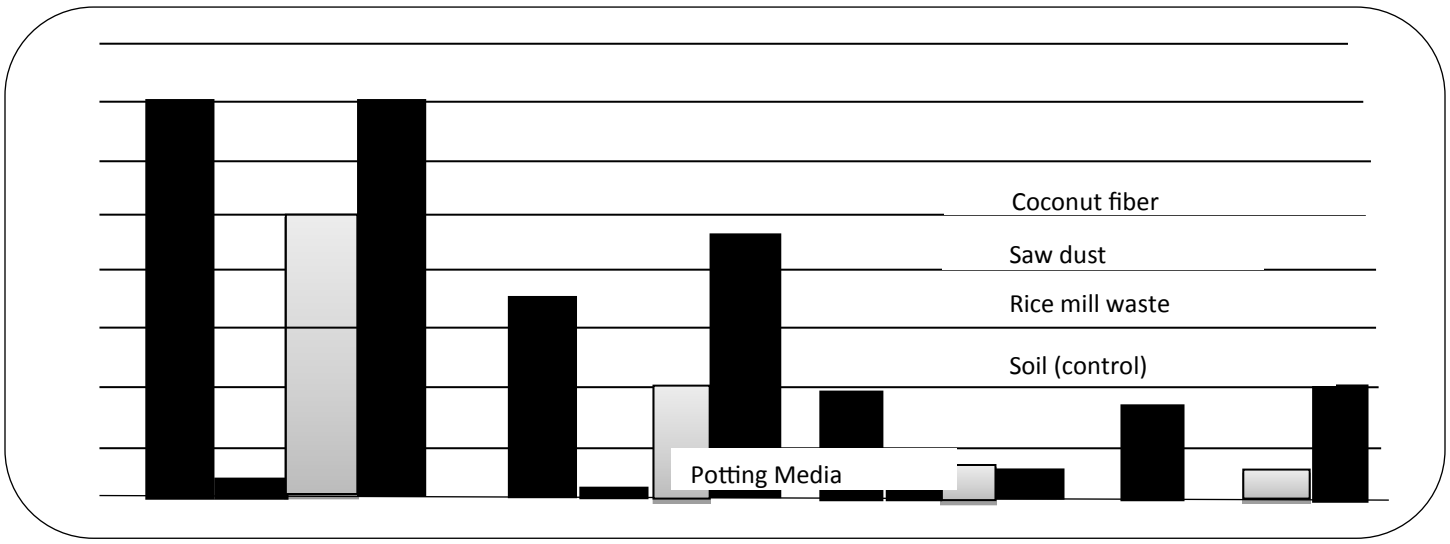

Figure 5: Effect of plotting media on fresh weight (g) of lettuce in Enugu

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