International Journal of Agronomy and Agricultural Research (IJAAR)
ISSN: 2223-7054 (Print) 2225-3610 (Online)
http://www.innspub.net
Vol. 13, No. 4, p. 7-14, 2018

RESEARCH PAPER OPEN ACCESS

Response of oil palm nursery seedlings to soil amended with oil palm mesocarp fibre

F. Ekhator*[1], O. A. Ogundipe[1], B. Gansah[2], C. E. Ikuenobe[1]

[1] *Agronomy Division, Nigerian Instit. for Oil Palm Res. (NIFOR), Benin City, Nigeria*

[2] *Okomu oil palm Plc. Benin City, Nigeria*

Article published on October 19, 2018

Key words: Mesocarp, Fibre, Seedlings, Nutrient, Fertilizer

Abstract

In processing fresh fruit bunches into palm oil in Nigeria; enormous waste including monocarp fibres discharged from the mill has great potentials to be recycled as valuable agricultural input. In view of this, eight months old oil palm mesocarp fibres (OMF) from the dump site at the Okomu Oil Palm estate were mixed with soil in the ratio of 0gOMF + 100%soil(v/v), 25% OMF + 75% soil (v/v), 50%OMF + 50% soil (v/v), 75% OMF + 25% soil(v/v) and 100% OMF+ 0% soil (v/v); to substitute for the whole soil which is the conventional practicein growing oil palm nursery seedlings. The results showed that fibre/soil based media had better seedlings dry weight of 0.95kg, 0.95kg and 0.9 kg respectively and also had superior leaf Mgup take of 0.44%, 0.43% and 0.44% respectively. Leaf K uptake was highest in soil based media alone with value of 0.91%.Soil/fibre based media of 25% mesocarp fibre and 75% soil(v/v)had better leaf nitrogen uptake of 3.9%. Phosphorus uptake by leaf was similar in all the treatments with value of 0.03% each. Soil/fibre based media of 25% mesocarp fibre and 75% soil(v/v)had the highest base circumference, height, number of leaves, leaf area and dry weight of 26.66cm, 152.3cm, 13.35, 0.43m^{-2}and 1.2 kg seedlings^{-1} respectively. This result concluded that media of 25% mesocarp fibre and 75% soil (v/v) will be sufficient in growing oil palm seedlings.

* **Corresponding Author:** F. Ekhator ✉ kenekh2003@yahoo.co.uk

Introduction

In oil palm production and processing, large quantities of palm biomass ranging from fronds, trunks and empty bunch refuse (EFB) to palm oil mill effluent (POME) and oil palm mesocarp fiber (OMF) are produced annually. The oil palm biomass can potentially be recycled as energy sources and agricultural input (Shuit *et al.*, 2009). Currently, EFB has been reported to have agronomic values as mulching to oil palm tree which in turn increase the yield and also improve the nitrogen (N) and potassium (K) availability in the soil (Lim and Zaharah, 2000). Besides EFB, the oil palm fruit mesocarp fibre (OMF) has great potential to be recycled as agricultural input (Hoe, 2014).

The oil palm mesocarp fibre which remains after palm oil has been extracted and nuts removed are often heaped and left to decay at the oil palm processing mill environment. About 2.71 tonnes of OMF is generated per 20.08 tonnes of EFB and constitute about 13 % of the total FFB production (Sumiani, 2006). Because the process of decay can be long, their disposal and management can become a menace to the mill environment thereby creating significant environmental problems (Sreekala *et al.*, 1997). Therefore, an alternative disposal method is essential to overcome the abundant amount of OMF generated in the mills every year. Although they are used as source of energy in firing boilers or sterilizers, other than occasional use as mulching material in the nursery, very little use is made of them in the field. The OMF is reported to be high in carbon (51.27%) with a Carbon / Nitrogen ratio of 53.1, total Nitrogen of 0.96%, low in moisture content (7.6%), moderately acidic with pH of 5.2 and Electrical Conductivity of 1.9m S-cm (Pengnoo *et al.,* 2002). Since it is generated in enormous amounts, it is important that this waste be utilized for various purposes to reduce the environmental problem associated with its disposal. The OMF due to its properties may serve as a good substrate in the raising oil palm nursery seedlings. When mixed with soil, its fibrous nature will help in modifying the soil structure for crop use. A high C/N ratio may be advantageous as an energy source for soil organisms. Studies have shown that amending soil with organic materials like oil palm waste improves soil fertility with little possibility of increasing plant disease problems (Kajanamaneesathain *et al.,* 1999). Amendment materials such as dry effluent and coir dust (Hashim *et al.*, 1987), organic based substrate (Khairil *et al.*, 2012), and oil palm waste compost (Adeoluwa and Adeoye, 2008) in soil growing media for oil palm seedling have been reported. Earlier reports of oil palm waste application on oil palm seedling were mainly on raw EFB during the main nursery stage. The potential of OMF for agronomic use has not been fully exploited. Little is known of the utilization of OMF for crop production. Incorporating OMF as a substrate for raising oil palm nursery seedlings can be a major way of utilizing this waste for crop production to mitigate its environmental nuisance.

This study sought to determine the potential of utilizing OMF as growing medium for oil palm nursery seedlings.

Materials and methods

Status of Mesocarp fibre materials

Due to the heat generated immediately after oil extraction from the palm fruits and separation from palm kernel, OMF might not be suitable as a substrate in it fresh state, therefore its agronomic value in the field will better after the heat generated has reduced significantly. OMF was collected from 8 month's old stacked heap near the mill site at Okomu.

The fresh OMF from the mill which had been stacked about 5m high on soil surface in the mill environment and exposed to weather conditions to wash out the oil residues by rain water for up to eight months and to allow its colour change from light brown to dark brown to indicate its readiness for use were collected for the experiment.

The experiment

The nursery experiment was conducted at the Nigerian institute for oil palm research (NIFOR) main station in May 2015 to June 2016 nursery season.

The soils used were obtained in-situ at the Nursery site. Prior to experimentation, soils were analyzed for chemical and physical properties using standard laboratory procedures. Also, mersocarp fibre waste (OMF) used for the study was also analyzed for its chemical properties.

The experimental design was a randomized complete block design (RCBD) with four replications. There were 15 oil palm seedlings per treatment. Treatment consisted of oil palm mesocarp fibre (OMF) (OMF + Soil as follows);

Treatment1 = 0gOMF + 100 % soil(v/v)
Treatment 2 =25 % OMF + 75 % soil (v/v)
Treatment 3 = 50%OMF + 50% soil (v/v)
Treatment 4 = 75 % OMF + 25 % soil (v/v)
Treatment 5 =100% OMF+ 0 %soil (v/v)
Fertilizer NPKMg 12-12-17-2 was applied uniformly to the treatments at 42g seedling^{-1} in three split doses at 3, 5 and 8 months after planting of oil palm seed as practiced in NIFOR (Ugbah, 2008).

Data Collection

Data collected included number of leaves, base circumference, leaf area, plant height, and plant biomass and leaf nutrient uptake by the seedlings at 12 months after planting.

Statistical analysis

Data were subjected to analysis of variance. Significant limit of differences in treatment were also constructed from all pairwise comparison tested using Duncan Multiple Range Test (DMRT). Data were analyzed using Genst at Version 8.1

Results and discussion

The physiochemical properties of soil used for the study are shown in table 1.

Table 1. Physico-chemical properties of the soil used for the nursery experiment.

Soil parameters	Pre-nursery	Main nursery
pH	6.94	5.21
EC (μS)	368	173.5
C (%)	1.12	0.29
N (%)	0.24	0.06
P (mg/kg)	54.07	11.03
Ca(cmol / kg)	13.04	0.8
Mg (cmol / kg)	2.16	1.20
Na (cmol / kg)	0.57	0.44
K (cmol / kg)	0.26	0.06
H^+(cmol / kg)	0.2	0.3
Al^{3+}(cmol / kg)	-	-
Clay (%)	2.6	3.1
Silt (%)	3.3	3.3
Sand (%)	94.1	93.6

Table 2. Chemical characteristics of mesocarp fibre used for the study.

Parameters (%)	Result
C	52.02
N	0.26
P	0.19
K	0.023
Ca	0.40
Mg	0.06

The nutrient contents of the mesocarp fibre were below the critical levels reported for most plant. Its carbon content was very high with a C: N ratio of 200: 1 (Table 2).

Growth parameters of oil palm seedling

The base circumference of oil palm seedling was highest in seedlings raised on 25% mesocarp fibre and 75% soil (v/v)with value of 26.66cm.

Oil palm seedlings raised on 50% mesocarp fibre and 50% soil (v/v) had base circumference of 22.93cm and was not different from base circumference of seedlings raised in 25% mesocarp fibre and 75 % soil (Table 3).

Table 3. Effect of Mesocarp fiber treatment on seedlings growth parameters.

Treatment	Base circumference (cm)	Height (cm)	Number of leaves	Leaf area (m^{-2})	Dry weight of seedlings (kg)
0g OMF + 100 % Soil + NPKMg 12-12-17-2	20.96b	94.8b	12.21	0.27bc	0.75c
25% OMF + 75 % Soil+ NPKMg 12-12-17-2	26.66a	152.3a	13.35	0.433a	1.2a
50% OMF + 50% soil + NPKMg 12-12-17-2	22.93b	108.9ab	12.46	0.34b	0.95b
75% OMF+ 25 % Soil + NPKMg 12-12-17-2	21.41b	106.2ab	12.21	0.29bc	0.95b
100% OMF + 0 % Soil +NPKMg 12-12-17-2	21.03b	93.7b	13.14	0.233c	0.9b
CV	8.5	26.7	8.2	16.1	0.14
LSD	2.95	0.12	1.61	10.1	9.8
			NS		

Table 4. Effect of Mesocarp fiber treatment on seedlings nutrient uptake (%).

Treatment	K	Mg	P	N
0g OMF + 100 % Soil + NPKMg 12-12-17-2	0.91a	0.355	0.025	3.255
25% OMF + 75 % Soil+ NPKMg 12-12-17-2	0.51b	0.4375	0.025	3.940
50% OMF + 50% soil + NPKMg 12-12-17-2	0.62ab	0.4250	0.033	2.728
75% OMF+ 25 % Soil + NPKMg 12-12-17-2	0.54b	0.4425	0.025	3.683
100% OMF + 0 % Soil +NPKMg 12-12-17-2	0.86ab	0.3400	0.030	3.345
CV%	31.9	25.5	19.9	23.3
LSD	0.3377	0.1572	0.008	1.22
		NS	NS	NS

The height of oil palm seedlings followed the same trend, and the highest seedling height of 152.3cm occurring in substrate of 25% mesocarp fibre and 75 % soil (v/v). The least height was obtained in soil based media alone with value of 93.7 cm (Table 3).

Amending soil with mesocarp fibre did not affect the number of leaves of the seedlings. However, seedlings raised on 25% mesocarp fibre and 75 % soil (v/v) had the best number of leaves and the value was 13.35 (Table 3).

Table 5. Significant limit due to mesocarp fibre treatment on base circumference of oil palm seedlings.

	T1	T2	T3	T4	T5	Base circumference (cm)
		.... P >$t_{tab2.353}$				
T1	0.0000	4.2160	1.4570	0.3310	0.0550	20.960
T2		0.0000	2.7590	3.8850	4.1600	26.660
T3			0.0000	1.1260	1.4020	22.930
T4				0.0000	0.2760	21.410
T5					0.0000	21.030

$T_{tab\,(0.05)}$ significant or not significant according to the t-test on differences of least squares means.

Table 6. Significant limit due to mesocarp fibre treatment on height of oil palm seedlings.

	T1	T2	T3	T4	T5	Height (cm)
		.... P >$t_{tab2.353}$				
T1	0.0000	2.743	0.672	0.547	0.048	94.800
T2		0.000	2.071	2.196	2.791	152.300
T3			0.000	0.126	0.721	108.900
T4				0.000	0.595	106.200
T5					0.0000	93.700

$T_{tab\,(0.05)}$ significant or not significant according to the t-test on differences of least squares means.

Similarly, seedlings raised on 25% mesocarp fibre plus 75 soil % (v/v) had the highest leaf area with corresponding value of 0.433m^{-2} while seedlings raised on 100% mesocarp fibre had the least leaf area and it value was0.233m^{-2}((Table 3). Consequently, the highest seedling dry weight of 1.2kg seedling^{-1} was recorded on media of 25% mesocarp fibre and 75 % soil (v/v) while seedlings raised on soil mesocarp fibre based media alone had the poorest dry weight of 0.75m^{-2} (Table 3). Mesocarp fibre improved the soil structure and water retentive capacity.

Table 7. Significant limit due to mesocarp fibre treatment on number of leaves of oil palm seedlings.

	T1	T2	T3	T4	T5	Number of leaves
	………… P $>t_{tab2.353}$ …………					
T1	0.0000	1.4508	0.2441	0.0983	1.1626	12.210
T2		0.0000	1.2067	1.5491	0.2881	13.350
T3			0.0000	0.3424	0.9186	12.460
T4				0.0000	1.2609	12.210
T5					0.0000	13.140

$T_{tab\ (0.05)}$ significant or not significant according to the t-test on differences of least squares means.

Table 8. Significant limit due to mesocarp fibre treatment on leaf area of oil palm seedlings.

	T1	T2	T3	T4	T5	Leave area (m^{-2})
	………… P $>t_{tab2.353}$ …………					
T1	0.0000	4.6020	1.8410	0.4250	1.0620	0.2700
T2		0.0000	2.7610	4.1770	5.6630	0.4325
T3			0.0000	1.4160	2.9030	0.3350
T4				0.0000	1.4870	0.2850
T5					0.0000	0.2325

$T_{tab\ (0.05)}$ significant or not significant according to the t-test on differences of least squares means.

This factor coupled with the possible latent nutrient content of the fibre could account for the superior growth of seedlings in the mesocarp fibre /soil media. However, mesocarp fibre supplementation with soil beyond 25% did not significantly result in growth enhancement of the seedlings. Therefore, substrate of 25% mesocarp fibre and 75 % soil (v/v) could be sufficient for raising vigorous oil palm nursery seedlings.

Table 9. Significant limit due to mesocarp fibre treatment on dry weight of oil palm seedlings.

	T1	T2	T3	T4	T5	Dry weight (kg)
	………… P $>t_{tab2.353}$ …………					
T1	0.0000	6.8360	3.0380	3.0380	2.2790	0.7500
T2		0.0000	3.7980	3.7980	4.5570	1.2000
T3			0.0000	0.0000	0.7600	0.9500
T4				0.0000	0.7600	0.9500
T5					0.0000	0.9000

$T_{tab\ (0.05)}$ significant or not significant according to the t-test on differences of least squares means.

Rosenani *et al.* (2016) also reported that oil palm seedling growth and physiology improved with the application of oil palm waste probably due to the alteration of physicochemical properties of the growing medium.

Nutrient uptake of oil palm seedling

However, K uptake was highest inun-amended soil with value of 0.91 % (Table 4), while it was lower and similar in mesocarp fibre /soil based media and mesocarp fibre media alone. Treatments of 25% mesocarp fibre plus 75% soil (v/v), 50% mesocarp fibre plus 50% soil (v/v), 75% mesocarp fibre plus 25% soil (v/v) and 100% mesocarp fibre plus 0% soil (v/v) had K uptake values of 0.51%, 0.62%, 0.54% and 0.86 % respectively. This result indicated that K could have been leached out in mesocarp fibre / soil based media due to higher porosity than soil based media alone. K exists in ionic form (K^+) and can be easily dissolved. Sommer (2001) reported similar result due to the leaching losses of K in compost based media.

Table 10. Significant limit due to mesocarp fibre treatment on potassium uptake in oil palm seedlings.

	T1	T2	T3	T4	T5	K (%)
	..........P > $t_{tab2.353}$..........					
T1	0.0000	2.581	1.887	2.387	0.355	0.9100
T2		0.0000	0.694	0.194	2.226	0.5100
T3			0.0000	0.500	1.532	0.6175
T4				0.0000	2.032	0.5400
T5					0.0000	0.8600

$T_{tab\,(0.05)}$ significant or not significant according to the t-test on differences of least squares means.

Table 11. Significant limit due to mesocarp fibre treatment on magnesium uptake in oil palm seedlings

	T1	T2	T3	T4	T5	Mg(%)
	..........P > $t_{tab2.353}$..........					
T1	0.0000	1.1436	0.9703	1.2129	0.2079	0.3550
T2		0.0000	0.1733	0.0693	1.3515	0.4375
T3			0.0000	0.2426	1.1782	0.4250
T4				0.0000	1.4208	0.4425
T5					0.0000	0.3400

$T_{tab\,(0.05)}$ significant or not significant according to the t-test on differences of least squares means.

Therefore, further supplementation of K will be required in mesocarp fibre/soil media and mesocarp fibre media alone. Conversely, uptake of Mg was better in mesocarp fibre/soil based media of 25% mesocarp fibre plus 75% soil(v/v), 50% mesocarp fibre plus 50 % soil (v/v) and 75% mesocarp fibre plus 25% soil(v/v)with values of 0.44%, 0.43%, and 0.44 % respectively indicating that amending soil with mesocarp could increase Mg uptake. Similarly, Marco *et al.* (2007) detected an increase in Mg level in the floriculture plant tissues as compost usage was increased in the growing media. Although N uptake was similar in all the treatments, seedlings planted in the media of 25% mesocarp fibre and 75 % soil (v/v) had the highest N uptake of 3.94 % (Table 4).

Table 12. Significant limit due to mesocarp fibre treatment on nitrogen uptake in oil palm seedlings.

	T1	T2	T3	T4	T5	N(%)
	..........P > $t_{tab2.353}$..........					
T1	0.0000	0.0000	0.1.936	0.0000	1.2910	3.255
T2		0.0000	1.9360	0.0000	1.2910	3.940
T3			0.0000	1.936	0.6450	2.728
T4				0.0000	1.2910	3.683
T5					0.0000	3.345

$T_{tab\,(0.05)}$ significant or not significant according to the t-test on differences of least squares means.

It is possible that complete microbial degradation of the mesocarp fibre could have enhanced the release and subsequent up take of N by the seedlings. Similar report by Pengnoo *et al.*(2002)found increased N content in soil amended with mesocarp fibre. However, P uptake with low value of 0.03 % was similar in all the treatments but further investigation of leaf P uptake will be needed in both soil media alone and mesocarp fibre /soil based media.

Critical limit of differences in the parameters

The significant limits of all the parameters measured using the t-test on differences of least squares means generated by Ducan Multiple Range Test (DMRT) as shown in tables 5 to 13 absolutely contributed to the interpretation of the parameters measured. The base circumference, height, leaf area and seedlings dry weight was significantly affected by mesocarp fibre/soil amendment. However, amendment of soil with mesocarp fibre did not affect the number of leaves of oil palm seedlings.

(Table 5-9)The amendment of mesocarp fibre with soil significantly affected K uptake only while uptake of Mg, P and N were not significantly different (Table 10-13).

Table 13. Significant limit due to mesocarp fibre treatment on phosphorus uptake in oil palm seedlings.

	1	2	3	4	5	P(%)
	.............................Estimate of the variance is zero...					
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0250
2		0.0000	0.0000	0.0000	0.0000	0.0250
3			0.0000	0.0000	0.0000	0.0340
4				0.0000	0.0000	0.0250
5					0.0000	0.0300

T $_{tab\ (0.05)}$ significant or not significant according to the t-test on differences of least squares means.

These tables certainly clarify which treatment actually differs. Previous report by Heo (2014) on differences in nutrient uptake by banana planted on mesocarp fibre based media collaborate this result.

Conclusion

This study showed that substrate media of 25% mesocarp fibre and 75% soil (v/v) sufficiently enhanced the growth and marginal leaf nutrient uptake of nitrogen and magnesium in oil palm nursery seedlings. Therefore further supplementation of nutrients particularly P and K may be required for seedlings vigorous growth.

Acknowledgments

The authors are grateful Management of Okomu Oil Palm Plc. for providing mesocarp fibre for this research work. Further thanks goes to our Executive Director R&D/ CEO of NIFOR for providing further materials for the research work.

The authors are also grateful to colleagues in Agronomy Division, NIFOR for their support in data collection. In all, we appreciate God almighty for his guidance throughout the period of this research work.

References

Adeoluwa OO, Adeoye GO. 2008. Potential of oil palm empty fruit bunch (EFB) as fertilizer in oil palm (Elaies Guineensis L. Jacq.) nurseries, In Proceedings of the 16th IFOAM Organic Word Congress, Modena, Italy.
http://orgprints.org/view/projects/conference.html.

Hashim MT, Yelow KH, Poon YC. 1987. Recent development in nursery practice-potting media, in proceedings of the international oil palm/palm oil conferences; Progress and Prospects. Conference **1,** Agriculture, A.H.B. Hassan Ed., 369-371, palm oil research institute of Malaysia and incorporated society planter, Kuala Lumpur, Malaysia.

Hoe TK. 2014. Utilization of oil palm fruits mesocarp fibres waste as growing media for banana tissue culture seedling in Malaysia. Journal of advanced agricultural technologies **1(1),** 4pp

Khairil M, Kamarozaman AA, Arifin I, Ramadzan A, Nasir N. 2012. Evaluation of several planting media for oil palm (*Elaies Guineensis*) seedlings in main nursery: In Proceedings of the soil science conference of Malaysia, Kota Bharu, Malaysia. April 2012.

Kanjanamaneesathian M, Leowarin, W, Pengnoo A, Nooduang A. 1999. Evaluation of agricultural and industrial wastes for the control of damping-off of Chinese Kale (*Brassica alboglabra* Bailey) caused by Sacc. Thailand Journal of Agriculture Science **32(4),** 547-555.

Lim KC, Zaharah AR. 2000. Decomposition and N and K release by oil palm empty fruit bunches applied under mature oil palm. Journal of oil palm research **12(2),** 55-60.

Marco G, Maria EG, Claudio C. 2007. Compost–based growing media: Influence on growth and nutrient use of bedding plants, Bio resource Technology **98,** 3526-3534.

Pengnoo A, Leowarin W, Koedsub N, Kanjanamaneesathian M. 2002. Nitrogen mineralization in soil amended with mesocarp fiber of oil palm and other wastes: A greenhouse study. Songklanakarin Journal of Science Technology. **24(1),** 1-8

Rosenani AB, Rovica R, Cheah PM, Lim TC. 2016. Growth performance and nutrient uptake of oil palm seedling in prenursery stage as influenced by oil palm waste compost in growing media. Journal of Agronomy **2016,** 1-8. http//dx.doi.org/10.1155/2016/6930735

Shuit SH, Tan KT, Lee KT, Kamaruddin AH. 2009. Oil palm biomass as a sustainable energy source: A Malaysia case study. Energy **34,** 1225-1235.

Sommer SG. 2001. Effect of composting on nutrient loss and nitrogen availability of cattle deep litter. European Journal of Agronomy **14(2),** p 123-133.

Sreekala MS, Kumaran MG, Thomas S. 1997. Oil palm fibre: Morphology, chemical compostion, surface modification, and mechanical properties. Journal of Applied Polymer Science **66(5),** 821-835.

Sumiani Y. 2006. Renewable energy from palm oil –inovation on effective utilization of waste. Journal of Cleaner Production **14(1),** 87-93.

Ugbah MM. 2008.Response of oil palm seedlings to irrigation and fertilizer levels. Nigerian Agricultural Journal **39(1),** 76-81.