COMPARATIVE EFFECT OF GEOTEXTILES ON SOIL PROPERTIESAND PUMPKIN (*Cucurbita maxima*) PERFORMANCE IN OWERRI, NIGERIA.

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ABSTRACT
Woven and non- woven geotextiles were prepared from organic geotexiles such as coir plantain pseudo-stem and palm mat. The pumpkin seeds were planted after the clearing of the vegetation and the woven and non-woven geotextiles were laid immediately on the soil after planting. The chemical composition of the three geotexiles and properties of soil before planting were determined. Heights of the crop were recorded weekly for 6 weeks and the properties of soil such as pH, organic carbon (OC), organic matter (OM), total nitrogen (TN) available phosphorus (Av.P), total exchangeable acidity (Tea), calcium (Ca) ,magnesium (Mg), potassium (K), sodium (Na) and particle size distribution were determined after harvesting . The following substances were determined on the pumpkin after harvesting; moisture content (MC), protein, ash, crude fiber, fat, carbohydrate (CHO), Na, K, Ca, Mg and Av.P. It was observed that for woven geotextile, pseudo-stem treated soil has the highest pumpkin height in all the weeks studied apart from week 3 and 4 (37.79, 48.57, 78.86 and 270.71 cm). For non- woven, the maximum pumpkin height was recorded for palm mat at week 2 (47.43cm), week 5 (197.14cm) and at week 6 (211.86cm) while coir yielded the maximum height at week 3, (199.83cm) and 4 (234.43 cm) .Furthermore, soil amended with non- woven pseudo-stem gave the highest soil pH (5.96), organic matter content (2.265), TN (14.5), Ca (2.148), Mg (0.73) K (0.046) Na (0.087) and Av.P (14.5).

INTRODUCTION
Due to the need for eco-friendly, renewable, abundantly available and economically viable, the alternative for synthetic geotexiles becomes the necessity for the use of organic geotexitles. Organic geotexiles are the set of geotexiles that originated from the use of organic fibres such as jute, sisal, palm mat, rafia fibre. Organic geotextiles can improve the soil properties and plant performances. They can absorb moisture and are suitable in areas of low rainfall and situation where the establishment of vegetation takes a long time, leaving slopes susceptible to erosion. They form organic mulch which can degrade forming organic matter and nutrients that can be added to the soil, thereby enhancing soil microbiological activity and promotes soil health, fertility and aggregate stability (Ranjan, 2009). They might help reduce intense solar radiation, suppress extreme fluctuation of soil temperature, reduce water loss through evaporation and increase soil moisture.

Coir an organic geotextile finds its application in the following soil situation; separation, application in unpaved roads, railways, parking and storage areas, channels for storm water, stabilization of shore line, stabilization of slope in railway and highway cuttings and embankment, protection of water course, unpaved roads and temporary walls reinforcement (providing suitable lands in road pavement), reinforcement of mud, road drains and land reclamation filtration, (Beena, 2010).

Soil fertility is one of the most important factors controlling the crops yield. Soil- related limitations affecting the crop productivity including nutritional disorder can be determined by evaluating the fertility status of the soils. Soil testing provides the information about the nutrient availability of soil upon which the geotexiles are laid. The aim of this study was to determine the effect of the woven and non woven geotexiles on the soil properties and plant (pumpkin) performance.

MATERIAS AND METHODS
Study location
The study location was Federal university of Technology Owerri. Owerri lies between latitudes 5°21'and 5°27'N, and longitudes 7°02' and 7°15'E. It has a mean annual rainfall range of about 2500 mm, mean daily temperature range of 26-27^{0}C and mean relative humidity of 70-90 % (IPEDC, 2006). Climax vegetation of the area was dominated by cassava (*manihot esculentum*) interspaced by some oil palm tree (*Elaeis guineensis*).

Chemical Composition of Geotextiles
The chemical compositions of the three geotextiles (Palm mats, pseudo-stem and coir) used in the study is shown in table 1. It is observed that coir has the highest organic carbon (43.23%) and organic matter (74.52%) followed by palm mat with organic carbon (38.03%) and organic matter (64.20%) and pseudo-stem (37.24% & 64.03%), this is in agreement with Ranjan (2009). In addition, pseudo-stem has the highest nitrogen and protein contents (1.021% and 6.38%), than coir and palm mat [Akpabio *et al (2009)]*. Furthermore, pseudo-stem contains highest values of Ca, Mg, Na, and K concentration compared to the other geotextiles used.

Table 1 Chemical Composition of the Three Geotextiles

Parameter (%)	Palm mats	Pseudo-stem	Coir
Organic carbon	38.03	37.24	43.23
Organic matter	65.56	64.20	74.52
Nitrogen	0.452	1.021	0.679
Protein	2.82	6.38	4.23
Calcium	0.979	2.55	0.216
Magnesium	0.0807	0.1438	0.1387
Sodium	1.164	1.396	0.956
Potassium	2.011	2.162	1.1478

Experimental

Geotexiles such as coir, plantain pseudo-stem and palm mat were obtained from Umuagwo (Ohaji Local Government Area), Umuayo Eziobodo (Owerri West L.G.A) , Umuogbom Ihitte Okiwe (Ngor Okpala L.G.A) and Umuezeala (Ehime Mbano L.G.A) respectively. Farm land measuring 0.1 ha was cleared, prepared and the three geotexiles were decorticated, spun and constructed into woven and non- woven geotexiles. About 20kg of these geotexiles were laid on the soil after planting the pumpkin seeds bought from Umuagwo market in Ohaji L.G.A. The seeds were allowed to germinate and grow for three months during which period plant heights from the base of the plant to the apex of the last leaf were measured at weekly intervals. The effect of the three geotexiles on the pumpkin performance was also determined. The experimental design was a randomized complete block with three replications.

Surface soil samples were collected from 0-30cm depth before and after treatment applications. The soil amended with the three geotexiles were air-dried, sieved to pass through 2mm diameter mesh and the fine earth fractions analyzed for the following properties using standards method; Exchangeable Na, Ca and Mg (Thomas 1996). Silt, sand and clay were determined using the hydrometer method (the buoy-an method). Av.Phosephorous was determined by Bray 1 method and the organic matter was determined using Walkley- Black procedure.

Results and Discussion

The results and data generated were analyzed using ANOVA (Genstat statistical package version 18) in table 5-7 for woven and non-woven geotextiles.

Least Significant Difference (LSD) at 5% probability level was used in separating the mean value

Pre-planting Soil Analysis

The result of soil analysis obtained before planting is shown in table 2. The soil was moderately acidic (5.68) and had low organic carbon (0.77%), organic matter (1.33%) and nitrogen content of (0.071%). Moreover, the soil had low phosphorus (<8.85ppm) and high total exchangeable acidity (2.32cmol/kg). The basic cation (Ca, Mg, K, and Na) of the soils were low, this could be as a result of the intense rainfall and subsequent leaching of the basic cat ion.

Height of Pumpkin

The heights of the Pumpkin for woven and Non-woven geotextiles are shown in Table 3 and 4 respectively. It is shown that woven pseudo-stem has the highest pumpkin height in all the weeks studied apart from week 3 and 4 (37.79, 48.57, 78.86 and 270.71cm) while woven coir has the highest (175cm) pumpkin height compared to other woven geotextiles. It was observed that although woven pseudo-stem had the highest height, it's influence on pumpkin height was more significant in 4-6 weeks after planting.

However, as regards effect of non-woven geotextiles on pumpkin height, different geotextiles relatively and significantly ($p = 0.05$) improved pumpkin height in week 3 to week 6. The highest pumpkin height was recorded in control (28.83cm) at week 1, non-woven palm mat (47.43cm) at week 2, non-woven pseudo-stem (199.83 cm) at week3, non-woven palm mat (234.43cm) at week 4, non-woven palm mat (197.14 cm) at week 5 and non-woven palm mat (211.86 cm) at week 6 after planting. This is in agreement with onuegbu et al; (2017) that worked on Fertility state of soil amended with some geotextiles in relation to the heights of selected crops.

Post planting soil properties.

The properties of soil amended with woven and non-woven natural geotextiles are shown in Table 5 and 6.

Soil pH

The pH is an important property of the soil that has to do with the degree of acidity or alkalinity of the soil. The following are arranged in the increasing order of acidity of the soil amended with geotextiles; Non-woven pseudo-stem < Woven pseudo-stem < Woven palm mat < Non-woven palm mat< woven coir < Non-woven coir < control. It showed that soil amendment significantly ($P< 0.05$) reduced the acidity of soil in both woven and non-woven

geotextiles for Pumpkin. Non-Woven pseudo-stem gives the least acidic value (5.96) on pumpkin planted soil compared to other soil amended with geotextiles. Control has the lowest pH.

Organic Matter

Organic matter is an important soil property which is accumulated by the decomposition of organic compound. The following geotextiles are arranged in the decreasing order of percentage organic matter content of the soil amended with geotextiles; Non-woven pseudo-stem > Woven pseudo-stem > Woven palm mat > Non- woven palm mat > Non-woven coir >woven coir > control. Organic matter content of the soil was significantly improved by the geotextiles in pumpkin planted soil. In this amended soil with geotextiles on post planting of Pumpkin, Non-Woven pseudo-stem has the highest organic matter contents (1.314 and 2.265%) due to its degradation ability. Liu *et al* (2014), Khurshid *et al* (2006) and Mohammed et al (2009) are in agreement that geotextiles improve the ecological environment of the soil, increases soil water contents, reduces infiltration rate, increases the total intake of water due to formation of loose soil surfaces, reduces sealing of soil particle pores, reduces wind, water erosion and weed problems. Decomposed crop residue, improves soil aggregation, fertility and increases crop yields (Erenstein, 2002) and converses higher soil moisture up to 55% (Abu Awwad,1999).

As the remain of the mulch were returned into the soil by ploughing after harvest, mulching material on decomposition would increase soil nutrient such as organic matter and total nitrogen, enhance microbial and macro-aggregate formation.

Total Nitrogen

Similarly, total nitrogen concentration of the soil was significantly improved by the geotextiles with the order; woven pseudo-stem > non woven pseudo-stem woven pal mat> non woven palm mat > woven palm mat>non woven coir> control. Soil treated with woven pseudo-stem has the highest TN value (0.139%). Hema *et al.,* (1999) reported that the use of mulch materials with different C/N ratios (which vary from low/moderate to high) produced differences in N numeration, C and N formation in soil. This perhaps may explain the reason for the highest total nitrogen value of pseudo stem treated soils.

Available Phosphorus (Av.P)

The arrangement of the geotextiles according to the fixing of phosphorus to the soil is shown as: Non-woven pseudo-stem > Woven pseudo-stem > Non-woven palm mat > woven palm mat > Non- woven coir > woven coir > control. Materechera and mkhabela (2001) have also reported that organic matter influences phosphorus in the soil solution by complexing phosphorus from adsorption site in ligand exchange and increase the mobility of organic phosphorus particularly in acid soils by decreasing chemical activity of iron and aluminum.

Total Exchangeable Acidity

The decreasing order of the effect of natural geotextiles on total exchangeable acidity of the soil is as follow; Woven coir > Non- woven coir > woven palm mat > Non-Woven palm mat > woven pseudo-stem > Non-woven pseudo-stem > control. The woven structure of the coir geotextile retained the soil particle from surface erosion which led to the preservation of the Al^{+} and the H^{+} content of the soil, this result implies that geotextiles increased acidity in pumpkin planted soils. Theoretically, soil acidity is quantified on the basis of hydrogen (H^{+}) and aluminum (Al^{3+}) concentration of soils (Fageria and Baligar, 2008). Soil acidity occurs when there is a buildup of acid forming elements in the soil, organic matter decay hence soil in high rainfall area is inherently acidic (Harlin, 2005) .

Basic Cations Concentration

Basic cations concentration of the soil is significantly improved by geotextiles irrespective of the form. Pseudo-stem significantly records the highest Ca concentration (2.14 and 2.148 cmol/kg) in pumpkin for woven and Non-woven geotextile respectively. In addition, other basic cations Mg (0.73) K (0.046) and Na (0.087) for the three non woven geotextiles studied were highest in pseudo-stem treated soil irrespective of the forms in pumpkin.

Particle Size Distribution

Particle size distribution of the soils was not influenced by geotextile application. Sand fraction varied from (88.96%-86.96%), (88 96%-86.96%), (86.96-86.96%) and (88.96-86.96%) woven and Non-woven geotextile application for Pumpkin soils respectively. Clay fraction also did not vary significantly. It ranged from 4.12-8.32%, 2.72-5.72%, 2.72-5.72% and 2.72-5.72% in woven and Non-woven geotextile treated soil of pumpkin. The sands were generally sand textured because of the parent material from which the soil was formed which is coastal plain sand (Akamigbo *et al.,* 2001).

Pumpkin Performance

Table 7 shows the effect of geotextile soil amendment on proximate and nutrient composition of pumpkin. It was revealed that geotextiles significantly ($p< 0.05$) improved fresh weight, carbohydrate (CHO), Potassium (K), Calcium (Ca), Magnesium (Mg), phosphorus (P) and Nitrogen (%N). Highest (1.80) means fresh weight was

recorded in Non-woven pseudo-stem and non woven coir followed by Non-woven palm mat (1.4%), woven palm mat (0.90%), Non-woven coir (0.80%) and control (0.60%). Highest (75.77%) and lowest (68.65%) moisture content was recorded in Non-woven coir and woven palm mat respectively. Highest (2.89 and 3.34%) mean protein and ash were witnessed in Non-woven pseudo-stem whereas the highest (2.90%) and lowest (2.25%) fibre was recorded in control and Non-woven pseudo-stem respectively. Highest (1.88, 6.757, 3.16 and 0.462%) Fat, Mg, P and %N respectively were recorded in pseudo-stem compared to other geotextiles. This shows that pseudo-stem is more superior in improving soil properties and hence it was reflected on performance of pumpkin.

Table 2 Pre-Planting Soil Analysis

Parameters	Values
Soil pH in H_20 (1: 2.5)	5.68
% Organic carbon	0.77
% Organic matter	1.33
% Nitrogen	0.071
Phosphorous(mg kg /m)	8.85
Exchangeable acidity (cmol/kg)	2.32
Exchangeable Ca (cmol/kg)	1
Exchangeable Mg (cmol/kg)	0.34
Exchangeable K (cmol/kg)	0.029
Exchangeable Na (cmol/kg)	0.068
Exchangeable Al (cmol/kg)	1.24
% Slit	7.99
Textural class	7.05
% sand	84.96

Table 3 Height of Cucurbita maxima (Pumpkin) woven (cm)

Treatment	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
Woven Pseudo-stem	37.79	48.57	75.14	89.14	178.86	270.71
Woven Palm Mat	18.14	33.49	56	67.42	118.57	133.86
Woven Coir	15.57	34.86	175	203	129.29	147.86
Control	28.83	41.83	71.68	112.29	104.01	139.50
LSD $_{0.05}$	13.72	10.55	35.25	26.96	42.42	26.52

Table 4 Height of Cucurbita maximum (Pumpkin) non-woven (cm)

Treatment	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
Non-woven Psuedo-stem	19.36	37.57	193.86	234.43	139.71	151.29
Non- woven palm mat	24.93	47.43	50.29	70.57	197.14	211.86
Non-woven coir	26.76	42.93	199.83	228.83	154.33	160.83
Control	28.83	41.83	71.66	112.29	104.01	139.50
LSD $_{0.05}$	14.02	8.6	26.96	31.88	46.09	34.89

Table 5: The Effect of woven geotextile on soil properties (post planting)

Treatment	pH (H_20)	OC →	OM (%)	← TN	AVP (ppm)	TEA →	Ca	Mg cmolkg^{-1})	K ←	Na	Sand →	Slit (%)	← Clay
Woven pseudo-stem	5.92	1.221	2.105	0.139	14.16	2.19	2.14	0.694	0.044	0.083	87.96	9.32	2.72
Woven palm mat	5.87	1.158	1.996	0.116	11.94	2.3	1.977	0.644	0.032	0.076	86.96	8.32	2.72
Woven coir	5.75	1.093	1.884	0.096	10.2	2.31	1.159	0.361	0.034	0.071	88.96	6.32	2.72
Control	5.7	1.084	1.869	0.089	9.89	2.09	1.112	0.298	0.029	0.068	86.96	7.32	5.72
LSD $_{0.05}$	0.0481	0.0053	0.0202	0.0021	0.2039	0.1109	0.0112	0.0018	0.0032	0.0039	2.154	2.234	4.812

Table 6: Effect of Non-woven geotextile on soil properties (post planting)

Treatment	pH (H_20)	OC →	OM (%)	TN	AVP Mg/kg	TEA →	Ca	Mg (cmolkg^{-1})	K ←	Na	Sand →	Slit (%)	← Clay
Non woven pseudo-stem	5.96	1.314	2.265	0.13	14.5	2.16	2.148	0.73	0.046	0.087	87.96	9.32	2.72
Non woven palm mat	5.8	1.14	1.965	0.119	12.43	2.22	1.983	0.68	0.035	0.073	86.96	8.32	2.72
Non woven coir	5.74	1.1	1.896	0.098	10.3	2.3	1.162	0.346	0.033	0.072	88.96	8.32	2.72
Control	5.7	1.084	1.869	0.089	9.89	2.09	1.112	0.298	0.029	0.068	86.96	7.32	5.72
LSD $_{0.05}$	0.3064	0.0993	0.1712	0.0076	0.1727	0.1376	0.0034	0.018	0.0031	0.0019	1.854	2.331	4.1381

% organic Matter= % organic Carbon x 1.724

Table 7: Effect of geotextile on pumpkin performance

Treatment	% fresh weight	%MC	% protein	% ash	% fibre	% Fat	% CHO	mg/100 g Na	mg/100g K	mg/100g Ca	mg/100 Mg	mg/100g P	% N
Non woven Coir	0.80	75.77	2.33	2.80	2.35	1.20	15.55	0.0244	0.0319	2.404	3.920	2.14	0.373
Woven Psuedo-stem	1.30	73.61	2.76	3.20	2.30	1.79	16.34	0.509	0.0738	4.004	5.520	3.40	0.442
Non woven Psuedo-stem	1.80	75.70	2.89	3.34	2.25	1.88	13.94	0.4091	0.0657	3.639	6.757	3.16	0.462
Non woven palm mat	1.4	77.04	2.68	3.16	2.35	1.37	13.44	0.4455	0.5273	2.818	5.546	2.70	0.429
Control	0.60	70.24	1.89	2.56	2.90	0.85	21.56	0.0789	0.0381	1.145	1.676	1.09	0.302
Woven coir	0.60	72.49	2.28	2.66	2.36	1.18	19.03	0.0112	0.010	0.074	1.878	1.38	0.365
Woven palm mat	0.90	68.65	2.59	2.98	2.40	1.29	22.09	0.1793	0.2061	1.310	1.925	2.30	0.414
LSD $_{0.05}$	0.0678	10.783	1.784	2.673	1.8765	1.237	1.234	0.127	0.0241	1.044	2.378	1.711	0.965

Conclusion

The woven and non-woven geotextiles contributed to the mineral content of the soil (Na, K, P, Ca, mg, organic matter and TN) . From the analysis, woven and Non- woven pseudo-stem increased the protein and Nitrogen content in the pumpkin and soil. Pseudo-stem also shows superiority in the basic cations concentration such as Calcium (Ca), Magnesium (Mg), sodium (Na) and potassium (K) compared to the other geotextiles. The pumpkin performed well in both the woven and Non-woven geotextiles amended soil. After six weeks (6) of planting and supervisions, we observed that both the woven and Non-woven plantain pseudo-stem and palm mat decomposed in the soil and could not be found. The woven and Non-woven coir geotextiles did not easily decompose. Therefore, comparing the geotextiles used the coir geotextile is a long term Non- degradable geotextile while the plantain pseudo-stem and palm mat geotextile are short term degradable. This is due to high lignin content found in the coir fiber.

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