FERTILITY STATUS OF SOILS AMENDED WITH SOME GEOTEXTILES IN RELATION TO HEIGHTS OF SELECTED CROPS.

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ABSTRACT

The organic geotexiles (coir, plantain pseudo stem and palm fruit empty bunch) were prepared by decortications process, spun into yarns and were constructed into woven and non-woven geotextile fabrics. Vegetation was cleared, ridges made and three seeds were planted (ground nut, water leaf and green) before the laying of geotextiles on the ridges. The heights of the crops were measured and recorded weekly for 8 weeks. Soil sample was collected before planting for the determination of some mineral nutrients on the soil. After the degradation of plantain pseudo stem and palm fruit empty bunch (three months), the laboratory test was carried out on the soil for the determination of sodium (Na), potassium (K), available phosphorus (Av P), calcium(Ca), magnesium(Mg), organic carbon (OC) and total nitrogen (TN). The results showed that the three geotextiles improved the yield of the crops planted by increasing the amount of the soil nutrients of the soil. The use of non woven fibre yielded significantly (p= 0.05) higher Ca ,Mg, OC and TN using non woven plantain fibre relative to the control and the other non woven geotextile materials Na , P and available K were significantly (p= 0.05) better with non- woven coir fibre, Plantain pseudo stem fibre and control, respectively relative to others. General concentrations of most chemical properties were better with amendments using woven geotextile materials while the reverse was the case for using non woven plantain geotextile.

INTRODUCTION

Natural geotextiles especially coir and jute absorb moisture and as such soluble in areas of low rainfall and those susceptible to erosion. Degradation form organic materials that help hasten the establishment of vegetation. Generally, natural geotextiles are considered valuable in areas where establishment of vegetation constitutes solution to slope protection and erosion control. They provide protection against rain splash; absorb more than five times their weight of moisture thus reducing the velocity and erosivity of runoff. Geotextiles are useful mulching materials that can reduce intense solar reaction, suppress extreme fluctuation of soil temperature, reduce evaporative water loss and thus increase soil moisture (Linda, 2007).

When added to the soil, natural geotextiles undergo degradation, releasing important plant nutrient elements, increase soil organic matter, promote microbial activities, soil aggregation, health and fertility status (Ranjan, 2009). According to Multigeo (2013), rate of their degradation varies depending on site conditions.

Importance of geotextiles in promoting soil fertility is very critical as it supplies plant essential nutrients and helps eliminate constraints to sustainable crop production. Nutrients released include microelements like N, P, K, S, Ca, Mg and Cl and microelements especially Fe, Zn, cu, Co, Mn, and B (Whitehead, 2000). Amount and types of nutrients released vary depending on the original geologic substances, and subsequent geochemical and pathogenic regimes and may be influenced by soil properties especially pH, OM, sorption capacity and other physical, chemical and biological conditions (Gopan *et al.*, 2009).

Crops grown in natural geotextile amended soils show varying responses. It can promote yield due to enhanced nutrient availability and suitable soil conditions for root growth or depress crop performance due to increased toxicity of certain elements (Efefe, 2013).

In Ihiagwa and most tropical soils, information of influence of amendments on plant performance and soil properties have been conducted with such materials as inorganic fertilizers and most common organic materials as livestock and municipal wastes. There appears to be a dearth of information on the effect of geotextile materials on crop performance and soil properties (Akpabio et al., 2012).

The aim of this study was to determine the fertility status of soils and response of crops to some woven and non-woven geotextile materials in Ihiagwa, Imo State.

MATERIALS AND METHOD

Study Location

The study location was Federal University of Technology, Owerri. Owerri lies between latitudes $5^0 21^1$ and $5^0 27^1$ N and longitudes $7^0 02^1$ and $7^0 15^1$ E. It has a mean annual rainfall range of about2500 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 (*Elaeis guineensis*) trees.

Experiment

Farm land measuring 0.2 ha was cleared and prepared. Three geotextiles of coconut husk (coir), plantain pseudo stem and oil palm bunch obtained from Umuagwo (Ohaji L.G.A), Umuayo, Eziobodo (Owerri area) and Umuogbom, Ihitte Okwe (Ngor-Okpala area of Imo state) respectively were decorticated, spruned and constituted into woven and non-woven fibres. 22kg of these fabrics were laid on the soil and seeds of groundnut (*Arachis hypogea*), water leaf (*Talinum triangularis*) and green amaranth (*Amaranthus Spp*) obtained from Obinze market in Owerri West L.G.A planted. The seeds were allowed to germinate and grown for three months during which period plant height measured from the base of the plant to the apex of the last leaf were measured at weekly intervals. The experimental design was a randomized complete block with three replications.

Surface soil samples were collected from 0-20 cm depth before and after treatment applications. The soil samples and the geotextiles were air dried, sieved to pass through 2mm diameter mesh and the fine earth fractions analyzed for the following properties using standard methods; Exchangeable Na, Ca and Mg (Thomas 1996), OC and N (Nelson and Sommers,1996).

Results and Discussion

Soil Chemical Properties

Soil chemical properties (exchangeable Na, K, Ca and Mg, available P, OC and TN) differed with woven and non woven geotextile applications. Potassium, Ca, OC and TN were significantly (p= 0.05) higher in the control relative to the applied woven materials, whereas Mg was distinctly better with woven plates and coir fibre than the control and other woven geotextile materials. Available P was with plantain fibre while Na^+ was non-significantly (p =0.05) better with coir fibre than other woven materials. Application of non woven fibre yielded significantly (P= 0.05) higher Ca, Mg, OC and TN using non woven plantain fibre relative to the control and the other non woven geotextile materials (Tables 1a and 1b). Sodium, P and available K were significantly (p= 0.05) better with non-woven coir geotextile, plantain geotextile and control, respectively relative to others. In general, concentrations of most chemical properties were better with amendments using woven geotextile materials while the reverse was the case for using non-woven plantain geotextile material. Depressed chemical concentration of soils amended with woven geotextile material could be due to its low organic matter content since the fertility of tropical soils have been related to their organic matter contents (Enwezor et al., 1990 and Uzoho et al., 2007). Non-woven plantain had significantly higher O.M concentration and hence most soil chemical properties.

Plant Height

Plant Heights of water leaf (*Talinum triangularis*), green amanth (*Amaranthus Spp*) and groundnut (Arachis hypogea) plants amended with woven and non woven geotextiles differed. Tables 2a and 2b showed heights of water leaf (*Talinum triangularis*) at various stages of growth amended with woven and non woven geotextiles respectively. Plant heights increased with growth periods for both the control and geotextile (woven and non woven) materials. Except between the 5-8 WAP, where plant height was significantly (p= 0.05) higher in the control, it was drastically better with woven plantain geotextile (Table 2a). This is due to high rate of degradation of plantain geotextile as a result of low lignin content (Akpabio *et al.*, 2015). Using non woven geotextile, plant (water leaf height) was significantly (p=0.05) better at the 3 WAP using palm bunch geotextile and then in the control between the 4-8 WAP (Table 2b). Generally, woven and non-woven geotextiles depressed height of water leaf for most of the growth periods probably due to their poor nutrient contents or additions of substances that negatively affected nutrient release, uptake and plant growth.

Effect of woven and non-woven geotextiles on the growth of green Amanth (Amanthius Spp) is shown in Tables 3a and 3b respectively. In table 3a, Green Amanttus height was distinctly better between the 5-8 WAP in the control and 1-4 WAP in plots amended with coir geotextile. Performance of green Amanth was however better in plots amended with palm bunch and coir geotextile relatively to the control and other non-woven geotextile at most growth stages. Palm bunch geotextile was significantly better than other non-woven geotextiles and the control. The high performance of palm bunch and coir geotextile is due to high content of cellulose present in the palm bunch and coir geotextiles respectively (Ibeawuchi *et al.*, 2007). Plots amended with most non-woven geotextiles performed better than the control compared to those with woven geotextiles probably due to the ability of the former to improve soil chemical properties than the later.

Performance of groundnut (Arachis hypogea) was better with woven geotextiles relative to the control for most of the growth periods (Table 4a). The woven geotextiles performed better due to its permeability and soil retention properties since it as about 3 to 6% open area (Davies,2017) Superiority of the different woven geotextiles (palm bunch, plantain and coir geotextiles) varied with different growth stages, with plantain dominating between 5-8 WAP, coir geotextile between 2-4 WAP and palm bunch in the first week after planting. Superiority of non-woven geotextiles on groundnut height was better in the 1-5 WAP using plantain geotextile than the control and other geotextiles but in the 6-8 WAP in none amended plots (Table 4b). Generally, using woven and non-woven geotextiles showed some promise with growth of groundnut indicating that it could be of a great utility for its growth and production.

Table 1a: Effect of woven geotextiles on soil chemical properties

Geotextiles	Na	K (cmolkg)	Ca	Mg	AvP (mg/kg)	OC (%)	TN (g/k)
Woven palm bunch	0.028	0.0696	5.5	1.5	12.53	1.476	0.136
Woven plantain	0.024	0.0693	6	2	27.3	1.456	0.129
Woven coir	0.085	0.0707	4.2	2	11.06	1.556	0.144
Control	0.024	0.0955	6.53	0.89	19.04	2.075	0.16
$LSD_{0.05}$	**0.0999**	**0.00875**	**0.6638**	**0.3929**	**4.93**	**0.1929**	**0.0107**

AvP=available phosphorus, OC=organic carbon, TN=total nitrogen,

Table 1b: Effect of non woven geotextile on soil chemical properties

Geotextiles	Na	K (cmol/kg)	Ca	Mg	AvP (mg/kg)	OC (%)	TN (mg/kg)
Non-woven palm bunch	0.06	0.07	4	0.96	28.28	1.496	0.138
Non-woven plantain	0.034	0.0689	5.5	1.67	11.62	1.716	0.156
Non-woven Coir	0.035	0.0711	5	1.34	19.18	1.496	0.14
Control	0.018	0.0716	4.9	0.67	14.28	1.556	0.12
$LSD_{0.05}$	**0.012**	**0.0034**	**0.39**	**0.29**	**4.88**	**0.069**	**0.062**

Table 2a: Effect of woven geotextiles on waterleaf height (cm)

Geotextiles	1 WAP	2 WAP	3 WAP	4 WAP	5 WAP	6 WAP	7 WAP	8 WAP
Palm bunch	1.4	2.3	5.5	6.6	11.7	13.6	16.5	19.3
Plantain	3.1	6.9	12.5	13.1	13.6	14.4	16.1	17.6
Coir	0.8	1.9	2.5	5.5	9.6	9.8	10.2	12.4
Control	1.5	3.9	6.8	12.2	14.9	19.2	23.6	24.1
$LSD_{0.05}$	**1.247**	**2.573**	**2.825**	**3.782**	**1.528**	**2.585**	**3.637**	**3.212**

Table 2b: Effect of woven non geotextiles on waterleaf height (cm)

Geotextile	1 WAP	2 WAP	3 WAP	4 WAP	5 WAP	6 WAP	7 WAP	8 WAP
Palm bunch	4.7	7.4	11.9	11.9	12.8	14	15.1	15.6
Plantain	2.8	4.7	7.5	9.2	10.4	10.5	11.9	12.1
Coir	2.7	5.1	7.2	8	8.7	9.1	10.7	12.1
Control	3.9	8.9	11.7	13.5	14.3	14.9	15.4	15.9
$LSD_{0.05}$	1.86	1.32	1.834	1.768	1.655	1.814	1.594	1.387

Table 3a: Effect of woven geotextiles on green height (cm)

Geotextiles	1 WAP	2 WAP	3 WAP	4 WAP	5 WAP	6 WAP	7 WAP	8 WAP
Palm bunch	3.7	5.9	10	14.5	23.9	30.8	35	37.1
Plantain	5.6	11.3	17.5	19.8	22.1	24.2	26.5	28.7
Coir	6.7	11.6	18.2	18.8	22.8	30	34.5	35.1
Control	4.9	10.3	16.1	21.4	28.6	35	39.2	42.6
$LSD_{0.05}$	0.834	1.765	4.189	1.961	1.978	2.961	3.503	3.834

Table 3b: Effect of non woven geotextiles on green height (cm)

Geotextiles	1 WAP	2 WAP	3 WAP	4 WAP	5 WAP	6 WAP	7 WAP	8 WAP
Palm bunch	5.2	12.4	16	18.5	20	20.9	22.5	23.9
Plantain	2.9	6	7.7	9.8	14.8	24	29.1	31
Coir	3.9	9.2	19.2	24.9	30.5	33.1	35.3	38.1
Control	4.5	9.8	13.3	17.9	19.5	20.9	24.6	25
$LSD_{0.05}$	**0.6767**	**1.767**	**3.262**	**4.134**	**4.39**	**3.875**	**3.758**	**4.352**

Table 4a: Effect of woven geotextiles on groundnut height (cm)

Geotextiles	1 WAP	2 WAP	3 WAP	4 WAP	5 WAP	6 WAP	7 WAP	8 WAP
Palm bunch	3.9	5.7	9.4	10.6	13.9	22.4	23.4	26.9
Plantain	3.2	5.1	9.6	12.6	19.9	26	29.5	31.5
Coir	3.7	6.8	11	13.7	19.9	24.2	25.8	28.2
Control	2.5	4.8	8.9	10.5	14.3	20.1	22	26.6
$LSD_{0.05}$	0.4146	0.5739	0.5338	1.023	2.252	1.667	2.19	7.35

Table 4b: Effect of non woven geotextiles on groundnut height (cm)

Geotextiles	1 WAP	2 WAP	3 WAP	4 WAP	5 WAP	6 WAP	7 WAP	8 WAP
Palm bunch	5.8	8.5	13	17	20.7	26.1	29.4	31.1
Plantain	5.5	10.5	15.5	19.8	22.4	30.5	31	31.6
Coir	3.9	7.8	12.9	16.5	19.8	27.1	30.5	32.4
Control	4.2	8.9	12.4	16.5	21.4	29.7	33.1	34.3
$LSD_{0.05}$	**0.6457**	**0.762**	**0.9**	**1.059**	**0.724**	**6.718**	**0.964**	**0.958**

Table 5a: Chemical Composition of Coir, Pal Bunch and Plantain geotextiles

Composition	Coir (%)	Palm bunch (%)	Plantain (%)
lignin	45.84	21.56	19
Cellulose	43.44	65	-
Hemi-cellulose	0.25	-	15.75
Pectin and related compound	3.0	-	4.08
Water soluble	5.25	-	-
Ash	2.22	2	-

Conclusion

Geotextiles especially non-woven types could be useful in promoting soil chemical properties (Ca, Mg, K, Available P, N and TN). Plant (water leaf, green Amanth and groundnut) height increased with growth stages in both amended and non-amended plots. Woven and non-woven textiles gave impressive water leaf growth while coir geotextile (woven and non-woven) and non-woven palm bunch geotextile were for green Amanth performance. Whereas all woven geotextile materials gave impressive groundnut performance, non-woven plantain geotextile was superior to other non woven geotextiles.

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