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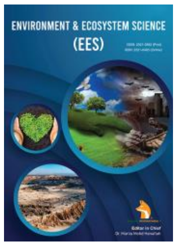

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RESEARCH ARTICLE

IMPACT OF CREEPING VEGETABLE COVER CROPS ON MINERAL N AND MICROBIAL GROUP POPULATION OF A SANDY LOAM ULTISOL UNDER IMMATURE RUBBER PLANTATION IN SOUTHERN NIGERIA

OKORE, Ikokwu Kalu.[a*], NWAGWU, Francis Aniezi.[b] and EGWUNATUM, Anslem Enwelem[c]

[a]*Department of Soil Science and Land Res. Managt., Nnamdi Azikiwe University, Awka, Nigeria*
[b]*Department of Crop Science, University of Calabar, Calabar, Nigeria and*
[c]*Department of Forestry and Wildlife Managt. Nnamdi Azikiwe University, Awka, Nigeria.*
**Corresponding Author Email: Ikokwuokore2@gmail.com*

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ABSTRACT

The use of forage legume species as cover crops in the management of immature rubber plantation soils is not attractive to smallholder rubber farmers (owners of about 75% of the global acreage under rubber production). We sampled immature rubber plantation soils under the following respective creeping vegetable cover crops: Vegetable cowpea *(Vigna unguiculata L., Walp. Ssp. Sessquipedallis.), Egusi* melon *(Cucumeropsis manni* Naaudi*) and* Broadleaf pumpkin *(Cucurbita pepo*) and a forage legume species (*Centrosema pubescens)* for four consecutive years at the Rubber Research Institute of Nigeria, Benin. The samples were analyzed for mineral N (NO_3^- and NH_4^+) content, and microbial group populations at the onset and end of rains, as well as selected physical and chemical properties. Generally, the result showed that the creeping vegetable cover crop species had a comparative positive effect on the soil properties assessed relative to the forage legume species. The two sampled period mean values of NO_3^- and NH_4^+ (10.62 and 8.18 $mgkg^{-1}$, respectively) obtained from the plantation that had vegetable cowpea were significantly ($P \leq 0.05$) higher than those of the Egusi melon and Broadleaf pumpkin, but slightly (not significant) lower than that of the *Centrosema pubescens*. The soil microbial groups (Fungi, Bacteria and Actinomycetes) populations were significantly affected by the cover crop species. At the onset and end of rains, plantations that had vegetable cowpea and *Centrosema pubescense* cover crops had the maximum number of bacteria (29.58 and 29.50 $C.fug^{-1}drywt.soil \times 10^{-6}$, in that order), while the maximum number of fungi was found in the broadleaf pumpkin (23.66 $C.fug^{-1}drywt.soil \times 10^{-6}$) and Egusi melon (22.92 $C.fug^{-1}drywt.soil \times 10^{-6}$) cover crop plantations. The broadleaf pumpkin and *Egusi* melon had significant positive effect on the soil surface layer (0-15cm) pH, Org. C, base cations, bulk density and percentage water filled pore space. These findings suggest that the creeping vegetable cover crops could be considered as alternative to the forage legumes in the management of immature rubber plantation soils.

KEYWORDS

Cover Crop Species, fungi, bacteria, NH_4^+, NO_3^-, Water filled pore spaces,

1. INTRODUCTION

Natural rubber tree - *Hevea brasiliensis (Wild, Ex. Juss). Mull. Arg* is primarily grown for its latex production. The latex (a milky liquid) is of great significance in the automobile and construction Industries. The traditional growing regions of the tree are characterized by high erosive rains and erodible soils when left bare (Lal, 1983 and Verheye, 2011).With the recommended planting density of 450 to 500 trees per hectare, more than 70% of the soil surface is left as inter-row during the early phase of plantation development (Esekhade and Okore, 2012). Such inter-rows, if left bare, are prone to raindrop impact and its attendant problems. The standard practice is integration of cover crops and/or compatible component crop as intercrop (Delanbarre and Serier, 2000).

Leguminous cover crop species such as *Calapogonium mucuniodes. Desv*., *Centrosema pubescence Benth* and *Pueraria phaseoloides (Roxb) Benth* are often recommended as suitable cover crops. These species are known to protect and preserve not only the soil physical properties, but also the chemical and biological qualities. An enhanced soil moisture characteristics and eight-fold reduction in soil loss by erosion in a 12-year-old rubber plantation have been recorded with integration of such cover crop species (Berzeniber et al., 2006; Liue et al., 2016;). It has a reported on the nutrient reservoir potentials of leguminous cover crops in immature rubber plantation with an enhanced nutrient content of rubber saplings and annual girth increment (Broughton, 1997 Daulphen et al., 2016).

In spite of the numerous merits of leguminous cover crop species in the management of soils of immature rubber plantations; their use among smallholder rubber plantation owners is rare (Obouage et al., 2016). This group (smallholder) of plantation owners which cultivate over 75% of the global acreage under rubber (Mohlner and Wessel, 2016) prefers intercropping young trees with annual or quasi perennial crops which could provide food and/or monetary income during the zero income (immature) phase of the plantation (Esekhade et al., 2014; Bomyen et al., 2018; Romyen et al., 2018). There are reports on the effect of some quasi-

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perennials and annual food crops respectively, on some soil fertility indices (Esekhale and Okore, 2012; Liuel et al., 2020). These authors working in different locations of the humid tropics showed the beneficial effects of annual or quasi-perennials to the tree during the early stage of plantation development, but added that they do not provide the required ground coverage for the conservation of soil nutrient, biological and physical attributes.

In the rainforest area of Southern Nigeria, some creeping vegetative plants that are primarily grown as food crops have been evaluated as cover crop substitute to forage leguminous species for weed control in immature rubber plantation (Okore and Akpabome, 2009). The result was impressive with the creeping vegetable crops producing higher biomass and more effective in weed control relative to forage legumes. However, the effect of these creeping vegetable crop species on soil characteristics has not been evaluated. Therefore, following the repot on cover crop specie specific effect on soil characteristics especially the microbial community and its related soil qualities; the objective of this study was to evaluate the impact of the creeping vegetable crops on mineral nitrogen content, population of culturable microbial groups and selected physical and chemical characteristics of an immature rubber plantation soil of (Finney et al., 2017).

2. Materials and Methods

2.1 Site Description and Field Experimentation

A field experiment was established in 2016 at the Rubber Research Institute of Nigeria to evaluate the potentials of selected creeping vegetable crops as a substitute to the conventional cover crop specie (legumes) in the management of soils under immature rubber plantation.

Rubber Research Institute of Nigeria is situated at Iyanomo (Lat. 6^0 00' and $7^0$00'N and Long. 5^0 00' and 6^0 00'E) near Benin City, Edo State. The location is characterized by tropical rainforest climate with a mean annual rainfall of 2516mm in bimodal pattern. The mean minimum and maximum temperatures are 23.6 and 31.5^{0}C respectively with relative humidity of 75% (Umar et al., 2017).

The soil is described as a very deep and well drained Typic Kandiult – an ultisol of acid sand formation (Ojo-Atere et al., 1987). Physico-chemical properties of the upper layer of the soil (0-20cm), are contained in (Okore et al., 2019). The vegetation at the commencement of the experiment was predominantly shrubs (*Chromolaena odorata; Cnestis ferruginea*; and *Newbouldia laevis*) with some grasses such as *Panicum maximum* and *Adrogon gayanus* being sparsely distributed.

Land preparation for the establishment of the field was manual. The residues generated during clearing were partially burnt and the unburnt portions were packed out of the field.

The treatments which consisted of

i. Vegetable cowpea (*Vigna unguiculata* L. Walp *subspp: Sesquipedallis*) + Rubber

ii. Egusi melon (*Cucumerospsis manni*) + Rubber

iii. Broad leaf pumpkin (*Cucurbita pepo*) + Rubber

iv. *Centrosema pubescence*+ Rubber (as check),

were laid out in randomized completely block design with six replications. Each of the experimental units measured 222m^2 with the rubber budded stumps (NIG 800 clone) being planted at the spacing of 6.0×3.7m between and within rows. The cover crops were seeded at 1X1m spacing within and between the rubber avenues in each experimental unit.

Due to the short gestation period of the creeping vegetable crops, seeding was done twice (March and August) in each year (2016-2020), except for the conventional cover crops (*C. pubescence*) which was planted only once yearly because of its longer gestation.

2.2 Soil Sampling and Processing

Four sub-samples of each of the six replicates of a given treatment were taken at the depth of 0-15, 15-30 and 30-45cm, respectively at five years after plantation establishment. Sub samples at each depth for each treatment replicate were bulked to obtain a composite sample consisting of three (3) depths, six (6) replicates and four (4) treatments. The composite samples were dried at room temperature and sieved with 2mm mesh sieve for routine laboratory analysis.

Samples for the determination of mineral nitrogen (NO_3^- and NH_4^+) were taken following the same pattern as those for routine analysis, except that the sampling was done twice (at the onset and end of rains). However, for the microbial group population determination, sampling was restricted to the surface layer of 0-10cm at the onset and end of rains also.

At each season, fresh samples meant for mineral N and microbial group population determination were also sieved (>2mm) and stored at a temperature of 4^{0}C for not more than 14 days after collection for analysis.

For bulk density (BD) determination, metal core samplers (216.12cm^{-3}) as described by Blake and were used (Hartge, 1986). Fifteen core samples were taken randomly at each depth across the experimental units.

2.3 Soil Analysis Determination of Mineral N and Microbial Group Population

The soil pH was measured using digital electronic pH meter in 1:2.5 w/v (soil : water).

Organic carbon was determined by Dichromate wet oxidation method as described Total Nitrogen was determined using the micro-kjeldahl digestion and distillation approach as described by (Bremner, 1996; Nelson and Sommer, 1982). Available Phosphorus was determined following the procedure described using Bray 1 extractant followed by molybdenum blue colorimetry by (Frank et al., 1998).

Exchangeable bases (Ca^{2+}, Mg^{2+}, K^+ and Na^+) were extracted with 1N Ammonium Acetate as described by Hendershort and Lalande, 1993. The concentration of K^+ and Na^+ in the extract were determined using flame photometer, while Ca^{2+}, Mg^{2+} concentrations were read in atomic absorption spectrophotometer.

Exchangeable acids (Al^{2+}, H^+) were extracted using 1.0 N KCl, followed by titration with 0.1M NaOH with phenolphthalein indicator.

Bulk density and water filled pore were determined as described by (Arshad et al., 1990). Mineral nitrogen (NH_4^+ and NO_3^-) was determined by using 2MKCl extractant (Rowell, 1992). Extracts were analyzed for NH_4^+ and NO_3^- by automated colorimeter using a Technicon auto analyzer.

The populations of three microbial groups (bacteria, fungi and actinomycetes) in the samples were measured by using the serial dilution and plating technique. Samples were serially diluted in 90ml ringer's solution up to 10^{-4} dilution. This was followed by pour plating of 1ml of aliquot in selective media: Nutrient Ager for bacteria, Martin's Rose Bengel Agar for fungi and Ken Knight's and Munaier's Agar for actinomycetes (Chhonkar et al., 2002; Allen, 2013; Martin's, 1950).

2.4 Data Analysis

Data generated were subjected to analysis of variance as described for randomized complete block design experiment. Where significance differences occurred among the means, they were separated using the least significance difference (LSD) approach as described by (Little and Hill, 1978; Gomez and Gomez, 1984).

3. Results and Discussion

3.1 Soil Chemical Properties

Effects of the non-conventional (creeping vegetables) relative to the conventional *(Centrosema pubescence*) cover crop species on an immature rubber plantation soil chemical properties at 0-15, 15-30, and 30-45 cm depths are shown in Table 1.Generally, the cover crop species effect on the soil pH did not differ significantly ($p \geq 0.05$) across the depth evaluated, except at 0-15 layer. At that depth (0-15cm), the broadleaf pumpkin and *Egusi* melon plots had a significant high value compared to the legume species (vegetable cowpea and *C. pubescence* in that order). While the non-conventional cover crop species consistently had higher pH values at 0-15 and 15-30cm depths; the reverse was the case at the lower depths of 30-45cm. The highest PH values recorded from the non-conventional cover crops plots at the soil surface layer relative to the conventional ones could be attributed to the differences in the chemical and biochemical compositions of the plant species as reported by (Doran, 2019). Previous work showed that the creeping vegetable cover crop species provided early and rapid ground cover (shade) compared with the forage legume (Okore and Akpbome, 2010). This may have resulted to reduced leaching of the base cations, hence higher pH values within the upper soil layer in the nonconventional cover crops compared to the conventional cover crop plots.

Table 1: vegetable cover crop impact on selected chemical properties of immature rubber plantation at three (0-15, 15-30 and 30-45) depths

Type of creep vegetable and conventional cover crops/Rubber	pH (H20)	Org. C	Total N	AV. P	K+	Ca2+	Mg2+	Na+	H+	Al3+
		(%)		(mg/kg)	(Cmol/kg)					
0-15cm Depth										
Rubber + pumkin	5.45	1.08	0.07	12.50	1.09	2.8	1.73	0.26	0.30	0.57
Rubber + Melon	5.22	1.04	0.09	13.43	1.03	2.4	1.47	0.24	0.23	0.43
Rubber + Veg. Cowpea	5.06	1.09	0.11	16.03	0.53	2.01	1.23	0.15	0.21	0.32
Rubber + C. pubescence	4.97	1.19	0.19	14.95	0.43	1.73	1.07	0.15	0.34	0.24
LSD (0.05)	0.12	NS	0.1	2.21	0.06	NS	NS	NS	0.23	0.17
15-30CM DEPTH										
Ruber +Bl.Pumkin	5.21	0.76	0.05	11.4	0.10	2.27	1.33	0.28	0.17	0.17
Rubber + Melon	5.02	0.8	0.07	12.27	1.08	2.1	1.13	0.25	0.23	0.1
Rubber + Veg. Cowpea	4.86	0.74	0.09	14.6	0.13	2.4	1.33	0.11	0.19	0.08
Rubber + C. pubescence	4.58	0.81	0.11	13.87	0.13	2.07	1.1	0.13	0.33	0.06
LSD (0.05)	NS	NS	0.04	1.12	0.05	0.16	0.27	0.17	0.08	0.01
30-45CM DEPTH										
Rubber + pumkin	4.63	0.7	0.04	14.09	0.11	1.06	0.93	0.25	0.13	0.6
Rubber + Melon	4.71	0.79	0.06	12.93	0.12	1.35	0.67	0.23	0.11	1.2
Rubber + Veg. Cowpea	5.11	0.6	0.03	11.6	0.14	2.01	1.33	0.12	0.1	0.43
Rubber + C. pubescence	5.28	0.4	0.02	10.24	0.14	2.41	1.93	0.19	0.12	0.38
LSD (0.05)	NS	0.3	NS	NS	NS	0.58	NS	NS	NS	0.21

Non conventional cover crops

Conventional cover crops

Vegetable cowpea = Vigna unguiculata walp. Subseq

The treatments (cover crop species) effect on the soil organic C content did not differ significantly at 0-15 and 15-30 depths. However, at 30-45 cm depth, plots under *Egusi* melon and broad leaf pumpkin had highly significant values compared with those of the vegetable cowpea and *Centrosema pubescence* in that order. Total N concentration differed significantly at 0-15 and 15-30 cm depths across the treatments, with plots under *Centrosema pubescence* and vegetable cowpea having higher values respectively, compared with the other treatments. At 30-45 cm depth, the non-leguminous (non-conventional) cover crop species had higher total N, although not significantly different. The observed non-significant difference in organic C content of the soils at 0-15 and 15-30cm depths of the various cover crop species plots could be related to the quantity of residues generated by each of them. The observed no significant difference in the quantity of above ground biomass generated from these species with broadleaf pumpkin consistently having higher quantity of residues compared with others (Okore and Akpabome, 2010). As a reported that plants or any operation within the field that adds large quantity of organic residues to the soil may increase the soil organic C. Higher values of organic C recorded at 30-45cm soil depth in the non-leguminous cover crop plots compared to the legumes could be attributed to extensive rooting system of these species which sometimes go beyond 35cm depth (Nascente and Stone, 2018). It is observed that broadleaf cover crop species grow faster and deeper roots relative to other species (Thorup Kristensen, 2001). Similarly, noted that the effectiveness of some cover crop species is related to their root attributes (Dabney et al., 2014).

Significantly higher values of soil total N observed in the conventional and vegetable cowpea cover crop plots, may not be unconnected to the unique genetic similarity of the two compared to the other species evaluated.

At the lower depth (30-45cm; the higher total N values recorded from the non-conventional cover crop plots could be ascribed to the organic C content of those plots at that depth. As a reported on the relationship between below- ground biomass organic C and total N of soils of the humid tropics (Okore, 2003).

The effect of the cover crop treatments on the soil available P (Bray^{-1}) mirrored that of the total N across the three depths examined. Legume cover crop (*C. pubescence* and vegetable cowpea) plots had higher values at 0-15 and 15-30cm depths. The values obtained from the vegetable cowpea plots (16.03 and 14.60mgkg^{-1} at 0-15 and 15-30 cm depth, respectively) were significantly higher (P≥0.05) than those of broad leaf pumpkin and *Egusi* melon plots at those same depths. These results are in line with the findings of who observed higher values of Bray^{-1} P in rubber/cowpea intercrop compared with *Pureria* and *Centrosema* species plots in an acid sand soil of mid-western Nigeria (Esekhale, 2004). The author attributed that to the quality of residue generated from the cowpea relative to other species evaluated.

Exchangeable base cations (Ca^{2+}, Mg^{2+}, K^+ and Na^+) of the soil at 0-15cm depth across the various treatments (Table1) did not differ significantly except for the K^+ which was higher in the broadleaf pumpkin plot. However, at 15-30cm depth, the concentration of these nutrient elements differed significantly with the highest concentrations being recorded from the *Egusi* melon plots followed by the vegetable cowpea and *Centrosema* plots which had equal values (0.13 Cmol/kg each). At 30-45cm depth, higher concentrations of the exchangeable bases were recorded from the *Centrosema pubescence* plots with only Ca^{2+} having significantly higher value.

The higher concentration of exchangeable K^+, Ca^{2+} and Mg^{2+} at the upper layer in broadleaf pumpkin and the other non-conventional cover crop specie plots relative to the conventional one could be attributed to reduced leaching resulting from wider ground coverage often aissociated with the crops. In Denmark, observed that broadleaf cover crops grow faster, deeper roots and provided sufficient shade to checkmate leaching of mineral nutrients (Thorup Kristensen, 2001).

The value of exchangeable acid cations ($Al^{3+}$and H^+) at the upper layer of the soil (0-15cm) differed significantly, with higher concentrations of Al^{3+} being obtained from the respective legumes specie plots. The reverse was the case at the lower depths.

3.2 Soil Bulk Density and Water Filled Pores Spaces

Table 2: vegetable cover crop impact on selected Bulk density (BD) and water filled pores (WFPS) of an immature rubber plantation at 0-15, 15-30 and 30-45 depths

Type of creep vegetable and conventional cover crop/Rubber	SOIL DEPTHS (CM) 0-15cm depth BD (g/CM3)	WFPS (%)	15-30cm depth BD (g/cm3)	WFPS (%)	30-45cm depth BD (g/cm3)	WFPS (%)
Rubber + pumpkin	1.06	60.11	1.37	56.82	1.52	44.15
Rubber + Melon	1.08	58.62	1.44	49.78	1.64	43.71
Rubber + Veg. Cowpea	1.32	56.91	1.55	48.92	1.68	43.15
Rubber + Conventional	1.24	45.01	1.48	48.02	1.59	48.66
LSD (0.05)	0.14	12.56	0.21	5.72	NS	NS

Non conventional cover crops

Conventional cover crops

Vegetable cowpea = Vigna unguiculata walp. Subseq

Table 2 shows the impact of the cover crop species on the soil bulk densities (BD)and water filled pore spaces (WFPS) at 0-15, 15-30 and 30-45cm depths. Broadleaf pumpkin plots consistently had a significantly lower BD values relative to the vegetable cowpea *and Centrosema pubescence* plots in that order at 0-15 and 15-30cm depths. However, at 30-45cm depth, the treatment effects on the BD did not differ significantly, although broadleaf pumpkin plots maintained lower values (1.52cm^{-3}) compared with others.

The water filled pore spaces (%) differed significantly at 0-15 and 15-30 cm depth with maximum values being recorded from the broadleaf pumpkin and *Egusi* melon plots in that order. However, at the lower depth of 30-45cm, the maximum value was obtained from the *Centrosema pubescence* plots, although not significantly different from those of other treatments.

The lower bulk densities recorded from the broadleaf pumpkin and melon plots could be due to their above –below ground vigorous growth characteristics compared with other species (vegetable cowpea and *Centrosema pubescence*). The had similar observation and stated that cover crop species that have vigorous growth habit and deep root system contribute immensely to soil decompression and consequently reduces the BD (Salton et al., 2008).

The observed water filled pore species is within the rang (60 -75%) reported for optimum aerobic microbial activities and may have been influenced by the cover crop species growth characteristics by (Linn and Doran, 1984).

3.3 Soil Mineral Nitrogen (NO_3^- and NH_4^+ - N)

The concentration of NH_4^+ N across the treatments mirrored those of NO_3^- N in both seasons with the legume cover crop plots having a higher value, irrespective of the season of sampling (Table 3).

The higher mineral nitrogen (NO_3^- and NH_4^+) obtained from legume cover crop species *(Centrosema pubescence* and vegetable cowpea) relative to the Cucurbitaceae species (*Egusi* melon and Broadleaf pumpkin) could be attributed to differences in the quality of their residue as it affects decomposition and mineralization. The legumes tend to have narrow C:N while that of Cucurbitaceae are wider , hence the legumes decomposing faster with higher rate of mineralization

Table 3: vegetable cover crop impact on soil NO_3-N (mgkg-1) content of an immature rubber plantation at the onset and of rains across the depths of 0-15, 15-30 and 30-45cm

Type of creep vegetable and conventional cover crop/Rubber	Soil depths: Onset of rains 0-15	5-30	30-45	End of rains 0-15	15-30	30-45
Rubber + pumpkin	7.32	5.30	3.14	4.13	3.01	2.96
Rubber + Melon	5.81	3.40	2.75	3.73	2.10	2.33
Rubber +Veg. Cowpea	9.92	6.02	4.92	6.33	3.16	2.29
Rubber+C. pubescence	12.78	8.67	5.71	8.46	5.48	3.76
LSD (0.05)	4.06	2.81	NS	3.45	1.96	NS

Table 4: Impact of vegetable cover crop on soil NH_4-N (mgkg-1) content of an immature rubber plantation at the onset and end of rains across the depths of 0-15, 15-30 and 30-45cm after four consecutive years of cover crop integration

Type of creep vegetable and conventional cover crop/Rubber	Soil depths (cm): Onset of rains 0-15	5-30	30-45	End of rains 0-15	15-30	30-45
Rubber + pumpkin	12.00	13.60	10.30	9.01	8.88	7.10
Rubber + Melon	13.10	12.80	10.04	8.85	7.75	6.92
Rubber + Veg. Cowpea	15.70	15.86	14.45	13.15	10.35	9.25
Rubber+ C. pubescence	17.68	14.02	11.04	15.44	13.50	8.68
LSD (0.05)	3.91	2.71	3.11	2.18	3.16	2.29

Also, the WFPS obtained from the legume-based cover crop plots relative to the other species (Table 4) may have influenced their respective mineral nitrogen concentration as reported by (Doran et al., 1990).

3.4 Soil Microbial Groups

Table 5: Impact of vegetable cover crop on the population (C.Fug-1 dry wt soil X 10-6) of selected soil microbial groups in an immature rubber plantation at the onset and end rain after 4yrs of continuous cover crop integration.

Type of creep vegetable and conventional cover crop/Rubber	Microbial group population at the onset of rains			Microbial group population at the end of rains		
	Bacteria	Fungi	Actinomycetes	Bacteria	Fungi	Actinomycetes
Rubber + pumpkin	24.90	28.30	2.33	11.58	19.02	2.10
Rubber + Melon	22.02	27.92	1.85	10.51	17.76	2.30
Rubber + Veg. Cowpea	36.01	17.16	3.18	23.16	14.13	4.80
Rubber + *C. pubescence*	32.12	20.37	4.43	26.89	13.05	5.10
LSD (0.05)	5.10	4.20	1.20	5.82	3.21	1.54

The cover crop species effect on three major soil microbial groups at the onset of rainy and dry seasons is presented in Table 5. The maximum bacteria population (36.10 c.fug^{-1} dry soil) at the onset of rains was recorded from the vegetable cowpea plot followed by the *Centrosema pubescence* (32.12 c.fug^{-1} dry soil). These values were significantly ($P \leq 0.05$) higher than those of the broadleaf pumpkin and *Egusi* melon plots in that order. The results at the onset dry season followed similar trend.

However, the reverse was the case for fungi population with maximum value (28.30 c.fug^{-1} soil) being recorded from the broadleaf pumpkin plot. This was followed by those of the *Egusi* melon plot (27.58 c.fug^{-1} soil). The values were significantly higher than those of C*entrosema pubescence* and vegetable cowpea plots in both sampling periods. This observation is in line with the report of (Finney et al., 2017). The authors reported that specific cover crop species promote the abundance of specific soil microbial group. According to microbial group population distribution is highly influenced by cover crop species due to specific chemical trait and plant: soil biota interaction (Martinez-Garcia, 2018).

Higher population of fungi group observed in the Broadleaf pumpkin and *Egusi* melon plots relative to the other two species, studied could be of an advantage by promoting soil organic accumulation and enhance soil aggregation and stability as reported by (Lennon et al*.,* 2012; Finney et al*.,* 2017).

The effect of the treatments on actinomycetes population mirrored those of bacteria with Centrosema pubescence and vegetable cowpea plots having higher values compared with the other treatments.

4. Conclusion

Results obtained from this study suggest that the creeping-edible vegetable crops evaluated have comparable positive effect on the immature rubber plantation soil relative to the conventional cover crop (*C. pubescence)*. The vegetable cowpea effects on the soil mineral nitrogen (NO_3^- and NH_4^+) and microbial group population were highly comparable to those of the *C. pubescence*. The Cucurbitaceae species (Broadleaf pumpkin and *Egusi* melon) had a significant positive effect on the soil BD, WFPS, fungi group population, the surface layer pH, and base cation values. Consequently, they could be considered as alternative to conventional cover crops in the management of immature rubber plantation soils, while serving as food and/ or monetary income source to the farm family during the zero income phase of the plantation.

References

Allen, O.N., 2013. Experiments in soil bacteriology. Burgess, Publishing, Minneapolis, M.N. USA. Pp. 140

Arshad, M.A., Lowery, B and Grossman. B., 1996. Physical Test for Monitoring Soil Quality. In J.W. Doran; A.J. Jones (Eds). Methods for Assessing Soil Quality. Soil Sci. Soc. America. Sep. Pub. 49: Pp. 115-141.

Blake, G.R and Hartage, K.H., 1986. Bulk density and particle size determination. In A. Kluto (ed.). methods of Soil Analysis. American Society of Agronomy, Madison, Winscosin, USA.

Bremner, J.M., 1996. Nitrogen –Total. In D.L. Sparks (Ed). Methods of Soil Analysis part 3. Chemical methods 2nd edition. SSA Book Series, No5 ASA and SSSA, Madison, W.I. USA. Pp. 1085-1121.

Broughton, W.J., 1997. Effect of various cover crops on soil fertility under Hevea brasiliensis. Mull.Arg and growth of the tree. Agro ecosystem 3(1); Pp. 147-170. https://doi.org/10./016/0304-3746(76) 90113 – X.

Chhonkar, P.K., Bhaadraray, S., Patra, A.K., Purakayastha, J.J., 2002. Experiments in Soil Biology and Biochemistry. Westville Pub. House, New Delhi, India. Pp. 180

Clermont-Daublin, C., Suvannang, N., Pongwichian, P., Cheylan, V., Hammeck, C and Hammay, J.M., 2016. Di nitrogen Fixation by legume cover crops – Pueraria phaseoloids and transfer of fixed into Hevea brasiliniensis – Impact on tree and vulnerability to drought agroecosystem. Environment 217:Pp. 79-88 https://doi.org/10.1016j.agee.2015.11.002.

Dabney, S.M., Delgod, J. A., Meisinger, J.J., Schomberg, H.H., Liebig, M.A., Kaspar, T., Mitchell. J., and Reeves, W., 2004. Using Cover Crop and Cropping System for Nitrogen Management . adv. In Nitrogen Management. Pp. 230-281.

Doran, N., 2019. The role of soil PH in plant nutrition and soil remediation. Applied and Enviromnmental soil science. Art.ID 5794869: Https://doi.org/10.1155/2019/5794869.

Esekhale, T.U., 2014. Effect of phosphorus and selected rubber based cropping system on the early development of rubber (Hevea brasiliniensis (wildex.adejuss) Mueller agroviensis on acid soil. Ph.D Thesis, Ibadan, Universit of Ibadan.

Esekhale. T.U and Okore, I.K., 2012. Impact of different spcooking aroung intercropped with rubber on soil fertility attributes and maturity rates of the tree in a humid forest area of South Eastern Nigeria. Open Jr. of Forestry. Vol. 2(2), Pp. 65-70. Doi.10.4236.off.201222009.

Finney, D.M., Buyer, J.S and Kaye, J.P., 2017**.** Living cover crops have immediate impact on soil microbial community structure and function. Journal of Soil Conservation 72 : Pp. 361-373.

Frank, K., Beegle, D and Denning, J., 1998. Phosphorous. In Brown, J.R (ed): Recommended Chemical Soil Test Procedure for the North Central Region. North Central Region Res. Publ. No221 (revised), Missouri Agric. Expt. Station Columbia. Pp. 21-26

Hendershort, W.H and Laland, H., 1993. Ion exchange and exchangeable cation. In M.R. Carter (ED). Soil Sampling and Methods of Analysis. Vol. 19. Canadian Soc. Of Soil Sci. Lewis Pub. London. Pp. 169-176

Lal. R., 1983. Soil erosion in the humid tropics with particular reference to agricultural land use and development. Proceedings of the Hamburg Symposium – Hydrology of Humid Tropical Region with Particular Reference to Hydrological Effect of Agriculture and Forestry Practices. August, 1983. JAHS Publ. No. 140: Pp. 221-239.

Lennon, J.T., Aanderud, Z.T., Lehmkuhl, B.K., and Schoolmaster, D.R., 2012. Mapping the niche space of soil microorganisms using taxonomy and traits. ecology 93(8) : Pp. 1867-1869.

Linn, D.M and Doran, J.W., 1984. Effect of water filled pore space on carbon dioxide and nitrous oxide production in tilled and non-tilled soils. Soil Sci. Soc. AM.J. 48:Pp. 1267-1272.

Little, T.M and Hills, F.J., 1978. Agricultural Experimental Design and Analysis. John Wiley and Sons. NewYork .

Liu, H., Blagodatsky, S. Gtese, M., Liu, F. XUJ, Cadiseh, G., 2016. Impact of herbicide application on soil erosion and induced carbon loss in rubber plantation in Southwestern China. CATENA 145: Pp. 18-192. Https://doi. Org/10./016/j. catena-2016.06.007.

Liu, Z., Liu, P., An., F., Cheng., L., Yun, I., and Ma, X., 2020. Effect of Cassava allelochemical on rubber tree pathogens, Soil microorganisms and soil fertility in rubber tree – cassva intercrop. Journal of rubber research: Pp. 1-15, 2020. https://doi.org/io.1007/542464-020-00055-7.

Martineze-Garcia, L.B., Korthal, G., Brussard, L., Jorgensen, H.B., and Deyin, G.B (2018). Organic Management and Cover crop species steer soil microbial community structure and functionality along with soil organic matter properties. Agroecosystem and environment: 263 : Pp. 7-17.https://doi.org/10.1016/j.agee2018.04.018.

Martins, J.P., 1950. Use of acid rose Bengel and Streptomycine in the plate method for estimating soil fungi. Soil Science 69:215.

Mohdmoor, A.G and Wessel, M., 2016. Hevea brasiliniensis (wild.ex.juss) mull. Arg. (Prosea)-plant Resources of South East Asia.105PP. Https://uses.plant-project.org/index.

Nascente, A.S. and Stone, L.F., 2018. Cover crops as affecting soil chemical and physical properties and development of upland rice and soyabean cultivated in rotation. Rice Sci. 25(6) Pp. 340-348.

Nelson, D.W and Sommers, L.E., 1982. Total carbon, Organic Carbon and Organic matter. In A.I. Page (Ed). Methods of soil Analysis part 2, Second Edition. Agronomy monograph 9. ASA and SSSA. Madison, WI PP, Pp. 539-594.

Obouayeba, S., BokoAmeck, Soumahim, E.F., Elabo, A.A.E., Dea, G.B., N'guessan, B.F.A, Kouame, C and Zehi, B., 2015. Natural Rubber based intercropping system in Cote D' ivoire: A review of Forty years work. Rubber Sci. 28(3): Pp. 211-226.

Ojo-Atere, J.A., Olomu, E.I. Fagbami, A., Omueti, J.A and Fapohunda, A., 1987. Environment of Southwestern Nigeria. In: Adepetu, J.A., Fagbami, A and Obigbesan, G.O (eds), Southwestern Nigeria. Federal Ministry of Agriculture, Water Rescources and Rural Development. Pp. 1-63.

Okore, I.K., 2003. Effects of Continuous Arable Crop Production under different land clearing methods on soil organic matter at Epemakinde, Ondo State, Nigeria. Ph.D Thesis, Ibadan, University of Ibadan. Pp. 320 .

Okore, I.K., and Akpobome, F.A., 2009. Impact of creeping vegetable cover crops on weed flora composition during the early growth Hevea (Natural Rubber) Saplings in a tropical rainforestzone. Jr. of Rubber Res. Inst. Srilanka. 89: Pp. 33-45.

Okore, I.K., Ogidi, E.G.O., Akpobome, F.A and Dike, J.C., 2019. Effect of Tillage methods and progragale types on the yield performance of yam, Dioscorea rotundata, intercropped with natural rubber, Hevea brasiliensis. Sapling, Nig. Jr. Crop Sc. 6(1):Pp. 8-13.

Romyen, A., Sausue, P and Charenjiratragul, S., 2018. Investigation of rubber based intercropping system in Southern Thailand. Kasetart. J.Social Sci. 39(1):Pp.135-142.https://doi.org/10.1016/J.KJSS.2017,121002.

Rowells, D.L., 1992. Soil Science Methods and Applications Longman, London. Pp. 218-243.

Salton, J.C., Mielniczuk, J., Bayer , C., Boeni, M., Conceicao, P.C., Fabricio, A.C., and Broch, D., 2008. Agregacaoe estabilidade dosolo emsistemnas agropecuarios emmato grossodo. Sus. Revista Brasileirade Ciencia do solo 32(1): Pp. 11-21. https://doi.org/10.1590/50100-06832008000/00002

Thornton, H.C., 1992. On the development of standardized agar medium for counting of bacteria with special regards to repression of spreading colonies. Anals. of Applied Biology 9:Pp. 241.

Thorup-Kristensen, K., 2001. Are differences in root growth of nitrogen catch crops important for their ability to reduce soil nitrate-N content and how can this be measured? Plant and soil 230; Pp. 185-195.

Umar, H.Y., Okore, N.E., Toryita, M., Asemota, B and Okore, I.K., 2017. Evaluation of Impact of Climatic Factors on Latex Yield of Hevea brasiliensis. Int. Jr. of Res. Stud. In Agric Sci. Vol. 3(5):Pp. 27-32.

Verheye, W., 2011. GROWTH AND Production of Rubber. In: Verheye W. (Ed). Land Use, Land Cover and Soil Science. Encyclopedia of Life Support System (EOLSS), UNESCO-EOLSS Publisher, Oxford, UK. https://www.eolss.net.

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