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Effect of Some Indigenous Legumes on Soil properties and Yield of Maize Crop in anultisol in South-Eastern Nigeria

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ABSTRACT: *The effects of some leguminous cover crops on soil properties and yield of maize grown on an ultisol in Enugu, Southeast Nigeria were evaluated. Five treatments comprising of Africa Yam bean, velvet bean, pigeon pea maize and bare soil were laid out in an RCB Design, replicated three times. At 90 DAP, plant height (cm) and leaf area index of maize were 187 (cm) and 39.1 cm. This was higher ($P<0.05$) compared to African yam bean by 54 and 86% respectively. African yam bean produced relatively higher nodule number (172) at 90 DAPS than pigeon pea which had 69. Result also indicated an increase in organic carbon% N-NH4% and N-N030% status between 30 — 90DAP in plots treated with legumes. At 90DAP, organic carbon and N-NH4, were low in bare plots (1.25 and 0.013%) when compare to plots treated with legumes. Bulk density mg/m^3 was higher (p.0.05) in maize plots at 90 DAP (1.35) than in Africa yam bean plots by 8%.Result of the study showed that average grain yield in African yam bean plots was higher 10.07 mg/ ha than in bare plots by 57%. Based on the above result, the African yam bean is highly recommended as an indigenous legumes species capable of improving fertility status of ultisols and yields of maize in South-Eastern Nigeria.*

Keywords: *Indigenous. Leguminous, soil properties, maize, ultisols.*

I. INTRODUCTION

Soil fertility decline is one of the factors limiting food production in the south-eastern part of Nigeria. Increased awareness by small holder farmers of the role of indigenous legumes as sources of food and fodder and for soil fertility improvement has stimulated research on the influence of herbaceous legumes in various soils and cropping system.Legumes have been extensively planted over the century mainly for food and for maintaining soil fertility (Anikwe, et al, 2003). As agriculture continues to develop in the tropics, soil fertility decline increase, thereby limiting food production. Smallholder framers in the study area have not been able to explore the new roles emerging for indigenous legumes in the new farming system. Such roles according to Anikwe et al (2003) include the continued expansion of pulse crops into infertile more stressful soils and exploration of new soil improving legumes which can retrieve lost nutrients from beyond the subsoil. Leguminous species achieve this by sourcing nitrogen (N) from the atmosphere through N_2 — fixation, nutrient pool and to capture available nutrients through their extensive root systems (Stanley et al, 2003).

One of the goals of sustainable agriculture lies in identifying a range of legumes that could be used in rotation with crops or inter-sown with them to improve the productivity of soil. Beckmann (2002) outlined some qualities which selected or identified soil improving legumes should possess and which make them adaptable and dependable in the farming system. The qualities include adaptability to local climate and soil type, quick establishment, ability to colonize an area and to cope with pests and disease in the local environment.

Farmers in Nigeria are experiencing lower maize yields due to a number of reasons viz, continuous cropping of maize, removal of field crop residue for feeding livestock, overgrazing and burning of stover in situ to ease ploughing which have resulted in the deterioration of both the physical and chemical properties of the soil (Onyango et al, 2001). According to Clement et al, (1998) legumes can be used in rotation with cereals or as green manures to compliment fertilizers particularly for subsistence farmers whose resources based are small. Some legume species (e.g. Mucuna spp) which have deep root systems help to alleviate compaction in intensively cultivated soils.

Rather than work on characterizing and selecting indigenous soil improving legumes for development and use in Africa, most effort are currently focused on introducing exotic varieties and use of fertilizers that have been proven in other environments. Exotic legumes find it difficult to persist in tropical environments. Thus, current research should be geared towards characterizing, selecting and using of soil improving legumes from a wide range of untapped genetic resources available in the tropics especially as this region holds one of the largest reserves of different kinds of legumes in the world (Anikwe et al, 2003).

The reason for carrying out this work is to enable farmers developed better practices on managing ultisols for optimal production using indigenous legumes. This will encourage the use of legumes as management strategy for replacement of fertilizers in soil fertility improvement. The objectives of this work was to study the effects of three indigenous soil improving legumes, maize and bar soil on soil properties and yield of subsequent maize crop in an ultisol in southeastern Nigerian.

II. MATERIALS AND METHODS

The study was carried out at the teaching and research farm of the federal college of agriculture Isagu. During two planting seasons the Teaching and Research Farm is located within Latitude 06°04 °N and longitude 08° 65° E southwest of the derived savannah zone of Nigeria. It has a pseudo — bimodal rainfall pattern from April to November, where July to August rainfall, which varies between 1700- 2060 mm, is received during April through the year. Humidity is quiet high, with the lowest levels (32%) during the dry season and the highest 80% in May- June as the rainy season begins. The soil is classified as a Tropaquept (Anikwe et al., 1999).

2.2 Field Methods

A total area of 137.75m^2 (14.5m by 9.5m) was mapped out for the experiment.

In the first season five treatments comprising three soil improving legumes, namely velvet bean (Mucuna Pruriens var cochinchensis), africa yam bean (Sphensostylis stenocarpa), and pigeon pea (Cajanue cajan); and maize (Zea mays L) and Bare Soil were laid out in the field using Randomized Complete Block Design (RCBD) with three replications. Each replication contained 5 plots, each plot measuring 2.5cm by 2.5m and demarcation by 0.5m wide pathway. The “Oba super 11” hybrid variety of maize was planted in the first planting season.

In the second planting seasons, maize was planted in all the plots using the “Oba supper 11” hybrid variety.

Maize, velvet beans, pigeon pea and African yam bean were planted manually at a spacing of 0.50m inter and intra row. Two seeds were planted per hole, which was later tinned down to one, two weeks after planting leaving each plot with 25 plants. Lost stands, were replanted within this period. 3 were weeded completely and left as ‘bare soil’ and no treatment applied on them throughout the first planning seasons.

The experimental area was kept relatively weed-free throughout the span of the experiment. Weeding was done at 3 weeks interval from planting date. 8.79 mg/ ha quantity of legume plant biomass was in corporated into the legume treated plots.

2.3 Data Collection.

The emergence count of all the crops were taken between 4-14 DAP (days after planting). Measurements for above ground biomass, leaf area index and plant height were recorded at 30, 60 x 90 DAP. Soil properties examined included bulk density; hydraulic conductivity, total porosity, organic carbon, ammonium nitrogen and nitrate nitrogen.

Since destructive sampling was employed, nodulation was checked at 30, 60 and 90 DAP. In the plots where legumes were planted, 3 plants were randomly selected and carefully lifted from the soil. The uprooted ones were cut at the base of their stems. Their roots saturated with water in a wash basin and the soil carefully and gradually washed, the roots were recovered in a wooden sieve, thereafter all the nodules were recovered, counted, even- dried and put in seed envelops.

2.4 Laboratory Methods

A composite soil sample (collected from 6 points in each plot) was analyzed in the laboratory. The physicochemical analyses of samples collected were carried out in the laboratory. However, Subsequent samples were collected from each plot at 30, 60, and DAP in the first planting season, which were analyzed in the laboratory for their organic carbon and nitrogen status. Total Nitrogen was determined using the procedure outlined by (Griffin, 1995). Particle size analysis was done by the Hydrometer method as described by (Gee and Bauder, 1986).

Ammonium was determined by the specific ion electrode method (Mulvaney, 1996). Organic carbon was determined by the Walkley and Black procedure described by (Nelson and Sommers, 1996). Available P, K, MgandPH were determined using the method described by (Eckert and Thomas 1995).

2.5 Data Analysis

Statistical analysis of data collected using analysis of Variance for a Randomized Complete Black Design (using F- LSD at P. 0.05) was carried out according to procedures outlined by Marray and Larry (1999).

III. RESULTS AND DISCUSSION

Table 1 Above Ground Biomass Yield (Mg Ha1) of three Soil Improving Legumes and Maize at 30, 60 And 90 DAP in the 2005 planting

Days after Planting Yield	Above	Biomass	
TREATMENT	30	60	90
Maize	2.7	4.0	5.3
Velvet bean	1.8	2.9	3.5
Pigeon pea	1.2	1.8	2.5
African Yam Bean	1.2	2.5	3.2
FLSD ($p<0.05$)	0.51	0.65	0.45

Table 2. Leaf area index of soil improving legumes and maize 2009 planting season.

TREATMENT	DAYS	AFTER	PLANTING
	30	60	90
Maize	6.9	37.3	39.1
Velvet	3.8	15.9	19.9
Pigeon pea	1.25	10.9	11.1
African Yam bean	1.21	5.2	5.2
FLSD ($p<0.05$)	2.31	23.9	23.13

Table 3. Nodules numbers of three soil improving legumes (2009 plant season)

TREATMENT	DAYS	AFTER	PLANTING
	30	60	90
Peagon pea	20	59	69
African	83	153	172
Velvet bean	42	102	105
FLSD ($p<0.05$)	32	41	48

Table 4: Effect of treatment on soil organic carbon, ammonium n and nitrate n (2009 cropping season).

ORGANIC CARBON $N\text{-}NH_4$ (%) $N\text{-}NO_3$ (%)									
	30	60	90	30	60	90	30	60	90
Maize	1.27	1.23	1.25	0.015	0.012	0.15	0.012	0.019	0.012
Velvet bean	1.23	1.38	1.44	0.021	0.023	0.035	0.12	0.015	0.013
Pigeon pea	1.14	1.28	1.48	0.030	0.021	0.029	0.020	0.009	0.015
African yam bean	1.8	1.29	1.50	0.043	0.043	0.045	0.015	0.011	0.013
Bare soil	1.18	1.25	1.25	1.25	0.016	0.009	0.06	0.006	0.010
FLSD ($P<0.05$)	**0.05**	**0.07**	**0.06**	**0.04**	**0.019**	**0.009**	**0.019**	**0.007**	**0.017**

Table 5: Effect of treatments of soil bulk density, saturated hydraulic conductivity and total porosity (2009 planting season).

	BULK DENSITY (MG M^{-3})			HYDRAULIC CONDUCTIVITY			TOTAL POROSITY		
TREATMENT	30	60	90	30	60	90	30	60	90
Maize	1.22	1.26	1.30	54	41	23	54	53	51
Velvet bean	1.21	1.23	1.26	43	39	39	55	54	52
Pigeon pea	1.21	1.24	1.26	41	38	38	54	53	52
African yam bean	1.24	1.23	1.24	39	49	36	55	54	53
Bare soil	1.24	1.34	1.35	25	21	23	53	49	49
FLSD (P<0.05)	**0.02**	**0.03**	**9.16**	**8.5**	**9,54**	**Ns**	**3.5**	**3.2**	

Table 6. Plant height of maize (cm) (2010 planting season)

TREATMENT	**DAYS**	**AFTER**	**PLANTING**
	30	60	90
Maize	47.3	67.3	83.0
Velvet bean	88.3	151.0	184.3
Pigeon pea	80.0	104.0	122.0
African yam bean	105.0	192.3	212.0
Bare soil	45.0	65.0	96.0
FLSD (P<0.05)	14.8	14.04	8.19

Table 7 Leaf Area Index Of Maize At 30, 60 And 90 Dap In 2009

TREATMENT	**DAYS**	**AFTER**	**PLANTING**
	30	60	90
Maize	9.04	18.1	20.0
Velvet bean	22.0	38.4	38.3
Pigeon pea	22.4	37.4	40.0
African yam bean	39.0	67.0	75.0
Bare soil	6.7	16.3	17.0
FLSD (P<0.05)	**7.07**	**6.24**	**5.47**

Table 8 Seed of Maize (mg/ha) And Stover Weight At 90 DAP in 2006.)

Cob dry weight (Mg ha^{-1})		**Grain yield (Mg ha^{-1})**	**Stover weight (Mg ha^{-1})**
Maize	5.72	4.55	8.79
Velvet bean	7.84	6.25	9.59
Pigeon pea	6.57	5.3	9.32
African yam bean	10.81	10.07	12.91
Bare soil	5.3	4.24	2.36
FLSD (P<0.05)	**3.81**	**3.39**	**2.36**

4.1 ***Above Biomass Yield (mg/ ha) of Three Soil Improving Legumes and Maize at 30, 60 and 90 DAP in the 2005- Planting Season.***

Results of the study indicated differences (P < 0.05) in the above ground biomass production of three soil-improving legumes and maize at 30, 60 and 90 DAP (Table2).At 30 DAP, result showed that maize produced the highest (P< 0.05) above ground biomass with Mg ha'. maize plants biomass was significantly higher (P< 0.05) than velvet bean above ground biomass (1.8 Mg ha1). Similarly, the above biomass produced by maize was higher (P<0.05) than that produced by pigeon pea (1.2 Mg ha1) by 33%. Result also shown that the above ground biomass produced by maize was significantly higher (p< 0.05) than the above ground biomass produced by African yam bean (1.2 mg ha^{-1}) by 55%.

At 60 DAP; the results followed the same trend as for the 30 DAP. Maize crops produced the highest quantity (P< 0.05) of above biomass (4.0 Mg ha^{-1}) when compared with African yam bean, which had d2.5 Mg ha^{-1}. This was higher than that of velvet bean (2.9 Mg ha^{-1}) and pigeon pea (1.8 Mg ha^{-1}) by 27.5 and 50% respectively. Pigeon pea had the lowest above ground biomass of 1.8 Mg ha1.

At 90 DAP, the result of the study showed significant differences in the above ground biomass of the treatments. The result indicated significant increase in the above ground biomass produced by African yam bean (3.2 Mg ha^{-1}) and velvet bean (3.5 Mg ha^{-1}) when compared to the above biomass produced by both crops at 30

DAP. Maize produced 5.3 Mg ha^{-1} of above ground biomass at 90 DAP and was significantly higher ($p< 0.05$) compared to that produced by pigeon pea. Pigeon pea produced the lowest quantity of above ground biomass of 2.5Mg ha^{-1} 90 DAP.

This result indicated that maize, which usually is a row and erect crop established early and had more above ground biomass ay 30 DAP. This perhaps indicated the availability and utilization of N, which promotes rapid growth in maize crops. Velvet bean and African yam bean established more ground cover at 69 and 90 Dap. This perhaps indicated greater nutrient accumulation, retention and soil moisture conservation in legume treated plots. This increases in the above ground biomass of legume probably led to a reduction in the impact of sunshine, which causes scorching and N volatilization.

4.2 ***Leaf Area Index of Soil Improving Legumes And Maize (2009 Planting Season)***

The result of the significant difference ($p<0.05$) in the leaf area index (LAI) treatments.

At 30 DAP African yam bean had the lowest ($p<0.05$) leaf area index of 1.21 while pigeon pea velvet bean had higher values of (1.25) and (3.8) respectively. The result also indicated that maize plants had the highest ($p<0.05$) leaf area index than African yam bean (1.21) and pigeon pea (1.25) by 82% and 45% respectively.

The result indicated no significant difference in the leaf area index of African yam bean and pigeon pea. Similarly, the result shown a significant increase (68.2%) in the leaf area index of velvet bean compared to African yam bean which had leaf area index of 1.21.

Maize plants had the highest leaf area index of at 60 DAP 37.3 and this was significantly higher ($p<0.05$) than leaf area index of velvet bean (15.9) and pigeon pea (10.9) by 57.3 and 7l% respectively. African yam bean produced the smallest leaf area index of 5.2 when compared with maize and velvet bean this was significantly lower leaf area index of both maize (37.3) and velvet bean (15.9) by 59 and 80%. Africa yam bean plots had the lowest (p<0.05. leaf area index obtained from plots where maize were planted (39.1) by 88%. The result of the study also showed that velvet bean pea plots had plants which produced leaf area index of 19.9 and 11.1 and were significantly lower ($p<0.05$) than the leaf area index of maize (39.1) by 49 and 72% respectively.

No significant increase in the leaf area index of maize was found between 60 and 90 DAP was statistically the same and also, that there was no significant increase in the leaf area of pigeon bean between 60 and 90 DAP.

There was a significant increase in the leaf area index of maize and velvet bean between 30 and 90 Dap, leaf area index of maize increased from 6.9 at 30 DAP to 39.1 at 90 DAP, leaf area index of velvet bean increased from 3.8 at 30 DAP, to 19.9 at 90 DAP by 80 and 82% respectively.

The result of the study also showed significant increase in the leaf area index of pigeon pea between 30 and 90 DAP, (1.25 and 11.1) by 89%. The result also indicated that the leaf area index of African yam bean at 30 and 90 DAP were 1.21 and 5.2, indicating a significant difference of 77%.

The result of the study showed that the increase in the leaf area index of maize between 30 and 90 DAP more than the soil improving legumes was a result if increase of its growth parameters including leaf numbers, area height.

4.3 Nodule number of three soil improving legumes (2005 planting season).

Results of the study indicate significant differences the number of nodules produces by the three sc1 improving legumes at 30,60and 90 DAP, the result of the study indicate that low number of nodules were obtained from pigeon pea plots (20) and this was significantly lower ($p<0.05$) than that obtained from velvet bean plots (42). The result also showed that higher number of nodules were obtained from African yam bean plots (83). This was significantly higher ($p<0.05$). Than nodule number obtained from pigeon pea plots by 76%.

African yam bean produced higher number of nodules (153 nodules) at 60 DAP. The result also indicated that the total number of lower when compared to that produced by velvet bean which was on the medium range (102).

The smallest number of nodules were obtained at 90 DAP plots where pigeon pea were planted (69). The result followed a similar trend as velvet bean plots produced a total number of 105 nodules. The result also showed that the higher number of nodules was obtained from plots where plots where African yam bean were planted with a total number of 172 and when compared with velvet bean and pigeon pea, they differ by 39 and 60% respectively.

Significant treatment differences were indicated in the number of nodules obtained from each soil improving legume. The result indicated that African yam bean produced a total number of 408 nodules, velvet bean produced a total of 249 nodules and pigeon pea bad 148 nodules. These differ by (p<O.05) by 45 and 68% respectively.

Pigeon pea plots which produced 20 nodules increased to 69 nodules at 90 DAP. Velvet bean plots which produced 42 nodules at 30 DAP increased to 105 nodules at 90 DAP. The result also showed that at 30 DAP, African yam bean plots produced 83 nodules which increased to a total of 172 nodules at 90 DAP.

The variation in nodulation amongst the soil improving legumes may reflect their different capacities for growth under the same or varying edaphic and environmental conditions. The result show that if legumes are to be used as relay crops, species like sphenostylis stenocarpa and cajanus are selected for the benefit of subsequent crops.

4.4 Effect of treatment on soil organic carbon, ammonium and nitrate (2005 cropping season).

Result of the study indicated that the various treatments significantly affected the organic carbon contents of the study soil (table 4). At 30 DAP, the percentage organic carbon content was significantly higher (P<0.05) in maize plot (l.27%) when compared to plots planted with three soil improving legumes, velvet bean (l.23%), pigeon pea (1.14%) and African yam be (1.18%) by 3, 7 and l0% respectively.

Bare soil had organic carbon contents of l.l8%, this was lower than that in maize plots and velvet bean plots by 4 and 7% respectively.

The organic carbon level in bare plots increased to 1.25% at 60 DAP. The also showed a significant increase (P<0.05) in the organic carbon level in plots where African yam bean were planted (l.29%) when compared to the organic content at 30 DAP l.l8% and they differ by 8.5%. the result of the study also showed that the organic carbon content of maize plot was reduced by 3.l%. The result also showed that the organic carbon level in plots where velvet bean were planted increased, to l.38% and pigeon pea plots (1.28%) by 7.2%.

There was a significant difference in the organic carbon levels with treatments at 90 DAP. The highest organic carbon levels was obtained from plots where African yam bean were planted (l.50%), this wassignificantly higher (P<005) when compared with the organic carbon status obtained from bare plots (1.25%) by 16%. The result also indicated no significant in organic carbon content at 30 and 90 DAP in plots where maize as planted. The result of the study also showed increase organic carbon levels in plots with velvet bean and pigeon pea (1.44 and 1.40%).

Significant differences were recorded in ammonium nitrogen levels in all the plots (Table 4). The result showed that the ammonium nitrogen level obtained in African yam bean plots was 0.30% which was significantly higher (p<0.05) than ammonium nitrogen (N-NH4) status of bare plots (0.0l3%) by 95%. The result also indicated that the ammonium nitrate level in maize plots was 0.0l5%. However, no significance was found between ammonium nitrogen status of maize and bare soil spots. Results also indicated that the ammonium nitrogen levels of velvet bean and pigeon pea plots were 0.025% and 0.020% respectively. At 60 DAP, the result of the study followed a similar trend as the ammonium nitrogen level in African yam bean plots increased to 0.043%. this was significantly higher (P<0.05) that the percentage N — NH4 obtained from maize plots (O.0l2%) by 72%. The result atsc showed that the ammonium nitrogen level of bare plots was the same as that the ammonium nitrogen level of bare was the same as that obtained at 30 DAP and this was significantly lower (P<0.05) when compared with the ammonium nitrogen status of velvet bean and pigeon pea plots by 38 and 48% respectively. The result indicated no significant treatment difference between the ammonium nitrogen levels obtained from maize plots and bare plots.

There was significant difference (P<0.05) in ammonium nitrogen level of maize plots and bare plots at 90 DAP. The result showed that the ammonium nitrogen level of maize plot (0.0l5%) was significantly lower (P<0.05%) when compared to that in velvet bean and pigeon plots (0.035 and 0.029) by 14, 48 and 57% respectively.

Ammonium nitrogen (N — NH4) status was significantly higher in African yam bean plots (0.045%) when compared to other soil improving legumes. The result also indicated no significant increase in ammonium nitrogen status of maize plots between 30 and 90 DAP and also in bare plots between 30 and 90 DAP.

The result of the study indicated significant difference in the nitrate nitrogen (N — N03) levels of various plots (Table 4). Nitrate nitrogen status of plots which was left bare (bare soU) was O.0O9% at 30 DAP. This was significantly lower (P.<0.05) when compared with the level of nitrate nitrogen obtained from pigeon pea plots (0.020%) by 55%. The result also showed that the nitrate nitrogen contents of velvet bean and African yam bean plots were statistically comparable at 30 DAP.

Nitrate nitrogen level decreased in the bare plots (0.006%) at 60 DAP. It however, indicated that there was an increased (P<0.05) the nitrate nitrogen level in maize plots (O.Ol9%) when compared to its level at 30 DAP. On the contrary, there was a significant decrease in N - N03 level in pigeon pea plots (0.009). The result indicated no significant difference in the nitrate nitrogen levels of velvet bean Africa yam bean plots at 60 DAP.Nitrate nitrogen levels of velvet bean and African ya' bean plots were statistically comparable at 90 DAP. The result also indicated that the nitrate nitrogen level in maize plot (0.012%) was lower than its level at 60 DAP. Results also showed no significance difference between the nitrogen level of pigeon pea and velvet bean plots.

The three soil improving legumes were able to increase the contents of organic carbon, NH4 — N and N03 - N of the study soil, whereas maize crops depleted the contents of same properties. This considered most promising plant-bacteria association. This association can lead to an increase in yield of crops through biological Non fixation in the tropics (Onyangu et al 2001). The nutrient level in maize plots was low. This may be because of high utilization capacity of N by maize.

4.5 Effect of treatments on dary bulk density, saturated hydraulic conductivity and total porosity (2009 planting season).

The bulk density in plots which were left bare (1.24 Mg m^{-3}) was higher ($p<0.05$) than the bulk density in other plots. The result also showed that in maize an velvet beanplots, bulk density by 2 and 4% respectively. The result also indicated that the bulk density of African yam bean and pigeon pea plots were statistically comparable.

The bulk density of maize plants at 60 Dap (1.26Mg m^{-3}) increased relative to its density at 30 DAP. The result also indicated that bulk density in velvet bean (1.23Mg m^{-3}) were statistically comparable. Bare soil had the highest ($p<0.05$) bulk density of (1.34Mg^{-3}).

Maize and velvet bean plots each had bulk density of 1.30 and 1.26Mg^{-3} at 90 DAP respectively and they differ by 3.l%. The result also shown that African yam bean plots had the lowest ($p<0.05$) bulk density of 1.24Mgm^{-3} and also, bare soil had 1.35 Mg m^{-3} and they differ by 8%. Bulk density of maize and bare plots were marginally higher, this could be due to direct raindrop impact energy led soil compaction. Maize is also a row crop and may not relate achieve as much ground cover as legumes. Bulk density is treated with legumes were lower. This could be that the ground biomass of the legumes covered more soil surface helped to reduce raindrop impact energy and degree of ability which are factors that increase soil dry bulk density were all, 2003).

The hydraulic conductivity (Ksat cm^{-3}/h) in maize plots was 8cm/h at 30 DAP. Result also showed that the Ksat of velvet in (42.72cm^{-2}/h) and pigeon pea plots (41.03cm^{-3}/h) were statistically comparable. Result also showed that African yam bean is (38.96^{-3}/h) had higher ($p<0.05$) Ksat than bare plots (25.05cm) by 36%.

A decrease in the Ksat of most plots was recorded at 60 DAP receipt in African yam bean plots which had 48.52cm^{-3}/h. the result so showed that the lowest ($p<0.05$) Kast was recorded in bare plots (20.70cm^{-3}/h) and the highest Ksat was ($p<0.05$) in maize plots (10.52cm3/h) and they differ by 49%.

At 90 DAP, the Ksat (cm^{-3}/h) of maize plot decreased to 24.72cm^{-3}/h.

This suggests that the increase in Ksat in some plots at 30 and 60 DAP was due to more macro pore spaces usually determined by texture and structure. Soils with stable granular structure usually have higher saturated conductivities then those with unstable structural units,which break down upon being wetted (Brady and weil,1996).

Total porosity in maize plots was 53.9% at 30 DAP. This was higher than the total porosity in bare soil 53.2%. Result also showed that the highest ($p<0.05$) when compared to the total porosity of bare soil by 3%.

The highest ($p<0.05$) total porosity at 60 DAP obtained velvet bean (53.5%) and African yam bean (53.5%) plots which were statistically comparable. The result also showed that bare plots had 49.4% and maize plots 52.5% and they differ by 8 and 2% respectively when compared to the total porosity (%) in African yam bean plots.

The total porosity of velvet bean (52.4%) and pigeon pea (52.4%) at 90 DAP were also statistically comparable. The result also indicated that bare soil had the lowest ($p<0.05$) total porosity 49.l% and differs by 4% when compared to the total porosity obtained in maize plot (50.9%). African yam bean and pigeon pea plots had a porosity of 53.2 and 52.4% respectively.

Total porosity (%) which was high in some of the plots could have been due to low amount of ground covers and high saturated hydraulic conductivity in those plots. This perhaps led to increased infiltration and nutrient leaching. The soil macropores characteristically allow the ready movement of air and the drainage of water. High porosity depletes the soil of croups (Roldan et al 2003).

4.6 Plant Height of Maize (2006 Season).

The various treatment significantly affected plant height of maize at different number of days planting (Table 6).Tallest maize plants with plant height of 105 cm were found in plots with African yam bean (AYB) in the previous season. Maize plants in this plot were significantly taller than that found in plots without any treatment (bare soil) in the previous season which had plant height of 45cm (the lowest plant height). Similarly, maize plants in plots planted with African yam bean (AYB) in the previous season were taller ($p<0.05$) than those planted with velvet bean, pigeon pea and maize by 15,23, and 55% respectively.The result followed a similar trend as plots with African yam bean in the previous season with plant height of 192cm had maize plants that were significantly taller that plants with velvet bean (51cm), bare soil (56cm) representing 21,46,65 and

66% respectively. However no significant treatment differences in plant height of maize was found between plots left bare in the previous season and those planted with maize in the previous season.

Plots planted with African yam bean in the previous season were taller (P<O.05) than maize plants found on plots previously planted with velvet bean, pigeon pea and maize in the previous season by 13, 42, and 75% at the 90 DAP. Similarly. Result also show that maize plants in plots that were left bare in the previous season were no taller (P<0.05) than those where pigeon pea was planted in the previous season.

Maize plants in plots which were left bare in the previous season sere relatively shorter than maize plants in plots where the three soil improving legumes were planted previously. This can be attributed to low level accumulation of organic matter in the bare plots leading to poor performance of maize was plants therein. Similarly, maize plants in plots where maize was previously planted were shorter (P<0.05). This may also be attributed to the minimal levels of nutrients in the plots planted previously with maize. Maize is a heavy feeder and removes more nutrients from the soil (Caporali et al 2004).

This may be as a result of improvement made by these legumes on those plots by their legumes rhizobia symbiosis. Organic matter accumulation and increase in soil N may also have contributed to greater plant height of maize crops in legume treated plots.

4.7 Leaf Area Index (Lai) Of Maize (2006 Planting Season).

The leaf area index (LAI) of subsequent maize plants was affected significantly at different times after planting by the various treatments.At 30 DAP, the highest (P<0.05) leaf area index of maize plant (39.0) was recorded in plots where African yam bean was planted during the previous season.The leaf area index of maize plants in plots which were left bare during the previous season (2009) was not higher (P<0.05) than those where maize was planted in the previous season.

The result also followed a similar trend at 60 DAP as plots with African yam bean in the previous season (2009) had leaf area index of 67.0, this was significantly higher than the LAI of maize plants in plots where velvet bean (38.4), pigeon pea (37.4) and maize (18.1) were previously planted by 42, 44 and 72% respectively. Result also showed that the area indices of maize plants found in plots where African yam bean was previously differ by 76Io. However, no significant treatment difference in LAI of maize was found between plots previously left bare an those planted with maize in 2005.

Plots treated with African yam bean originally 2009 had higher (P<0.05) leaf area index (75.8) than maize plants found on plots previously planted with velvet bean (38.3), pigeon pea (40.0) and maize (20.0) by 47, 49 and 73% respectively. Similarly, results indicated that the LAI of maize plants in result which were left bare in 2009 was not higher (P<0.05) than the LAI of maize plants in plots previously planted with maize. The plots treated with African yam bean in 2009 produced subsequent maize plants with high leaf area indices. This may be ascribed to the fact that AYA improve the soil tremendously by increasing the levels, of organic matter ammonium nitrogen and nitrate nitrogen in those plots. Result also showed that plots left bare in 2009 and plots treated with maize in 2009 were statistically comparable. Both heights and their LAT were lower (P<0.05) compared with AYB, pigeon pea and velvet bean plots. This may be because decomposable organic carbon which would have been maize taken up by maize and because maize may have absorbed low LAI in 2006.

4.8 Seed Yield of Maize (Mg Hk1) And Stover Weight (mg/ha) at 90 DAP.

The result of the study showed that the different treatments significantly affected cob dry weight, seed yield and stover weight of maize at 90 DAP (Table 8).

The cob dry weight at 90 DAP was significantly higher (P< 0.05) in plots where african yam bean was previously planted. Dry cob weight of maize found in plots which were left bare in 2005 which had 5.3 mg/ha, (the lowest cob dry weight). Similarly, cob dry weight of maize plant in plots previously treated with african yam bean higher (P<0.05) than in plots where velvet bean (7.84), pigeon pea (6.57) and maize (5.72 Mg ha1) were previously planted by 22, 39 and 47% respectively. Results showed that dry weight of maize plants in plots left bare during the previous planting season (2005) were not higher (P<0.05) than that where maize was plant in the previous season (2005). Grain yield obtained from plots where African yam bean planted in the previous year was 10.07 (Mg/ ha). This was significantly higher than grain yield in plots where bean (6.25 mg/ ha1), pigeon pea (mg/ ha) and maize 55mg/ ha) were planted in the previous year by 37, 50 and 55% respectively.

The lowest quantity of grain yield was obtained in plots which were left bare in the previous season, (4.24 Mg ha1). The result showed that this significantly lower (P<0.05) than grain yield from plots which maize were planted in the previous season

The result followed a similar trend for stover weight (Mg ha1) as stover yield was higher (P<0.05) in plots were African yam were planted in 2005. Results showed that maize plants in AYB plots has stover weight of 17.91 Mg/ha, and this was significantly higher than stover weight in plots where velvet bean (9.59), pigeon pea (9.32) and maize (8.79) were planted in the previous season by 47, 50 and 91% respectively.

Stover weight in plots which were left bare during the first season were not higher (P<0.05) than those where maize was planted in the previous season. Indications from the results showed that plots treated the African yam bean during the previous season had higher stover weight than all other plots.

IV. CONCLUSION

In this study, the three indigenous legumes uses the experiment improved the soil fertility levels white maize depleted soil fertility. Fertility remained virtually stagnant in the plots left bare.

However, sphenostylis stenocrapa (African yam bean) improved some of the soil properties more than Mucuna cochinchinensis and Cajanus cajan. This led to an increase in both grain yield and stover weight (mg ha1) in plots where sphenostylis stenocarpa were planted in the previous planting season.

Growth parameters of subsequent maize crop were highly improved in plots where sphenostylis stenocarpa and Mucuna pruriens yarn cichinchinesis were planted previously. On the contrary, results showed that subsequent maize crops in plots found to have lower height, left area index (LAI) and yield.

It is therefore, highly recommended that indigenous legumes especially African yam bean (S. stenocarpa) and Velvet bean (M. pruriens Var. cochichinensis), in this order used by maize growers and mostly smallholder farmers in South- Eastern Nigeria area where predominant SHS ulitisols. It is also recommended that S stenocarpa d Velvet bean Var. cochinchinensis be used in relay cropping or incorporated as green manure in ultisols especially when maize or other cereal crops are to be planted subsequently.

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