The treatments consist of four legumes - 0.5 tons per hectare. The average yield is very low when compared to the world 2.3 tons/ha. However, FAO (2009) pointed out that the yield is lower when compared to average yield from other African countries like South Africa (2.5 t/ha), Mauritius (5.8 t/ha) and Egypt (7.1t/ha) respectively. Thus, there has been a growing gap between maize demand and its supply arising from low productivity.

In Nigeria over 10 million hectares are under maize cultivation, but the productivity is low. Farmers yields of maize range between 200 and 2000 kg ha\(^{-1}\). Researchers have shown that under improved agronomic management practices, maize can produce grain yield of 4000 to 5000 kg ha\(^{-1}\) (FPDD, 2011). Increasing human population and high consumption of maize has led to its continuous intensive production in Nigeria. According to Eche N M et al., (2013) continuous cultivation of land requires continuous application of synthetic fertilizers and organic amendments to maintain soil productivity. The continuous intensive cultivation with application of especially sole urea fertilizer could alter the soil physical and chemical properties by decreasing soil pH and reducing the exchangeable base contents which leads to soil degradation (Odunze A C et al., 2012). To arrest this declining agricultural productivity, there is need to build up organic matter and restore soil fertility. Fertility restoration can be achieved through bush fallowing, heavy manuring with inorganic fertilizers/farmyard manure or through the use of leguminous green manure (Busari N A et al., 2004). The study was design to determine the effect of four leguminous green manure crops (Centrosema pubesscens, Dolichos lablab, Mucuna pruriens and Sesbania rostrata) NPK levels and their interaction on the soil chemical properties of maize grown soil.

**INTRODUCTION**

Maize (Zea mays L.) is the major subsistence arable cereal in the guinea savannah zone of Nigeria (FAO, 2014) with the stalks used as fodder for feeding livestock especially during the dry season and the stalk for constructing houses and as fuel (LCRI, 2007). Nigeria is currently the fourteenth largest producer of maize in the world and the largest maize producer in Africa behind South Africa (USAID, 2016). FAO (2009) indicated that Nigeria current maize production is about 8 million tonnes and the average yield is 1.5 tons per hectare. The average yield is very low when compared to the world 2.3 tons/ha. However, FAO (2009) pointed out that the yield is lower when compared to average yield from other African countries like South Africa (2.5 t/ha), Mauritius (5.8 t/ha) and Egypt (7.1t/ha) respectively. Thus, there has been a growing gap between maize demand and its supply arising from low productivity.

Effect of Some Leguminous Green Manure Crops and Nitrogen Levels on Soil Chemical Properties of Maize (Zea mays L.) Grown Soil

**Abstract:** A Field experiments were conducted from 2015 to 2016 wet seasons at the Teaching and Research of the Leventist Farm, Tumu Akko local Government area, Gombe State to evaluate the effect of incorporated legumes and nitrogen levels on the soil chemical properties. The treatments consist of four legumes crops (Centrosema, Lablab, Mucuna, Sesbania and control) and NPK fertilizer (0, 60 and 120 kg ha\(^{-1}\)) that were fitted into Randomized Complete Block Design (RCBD) and replicated three times. Results indicated that incorporation of green manure crops significantly (P<0.05) increased organic carbon, total nitrogen, available phosphorus, exchangeable bases, over control while soil pH decreases when green manure was incorporated. Moreover, application of 60kg NPK ha\(^{-1}\) invariably lower soil pH while total nitrogen increases. Moreover, application of 120kg NPK ha\(^{-1}\) significantly increased available Phosphorus and soil exchangeable potassium. Interactions revealed that, combined application of lablab green manure and 60 kg NPK ha\(^{-1}\), are the most viable combinations for increase plant nutrients. To achieve increased and sustainable maize production in the study area, with less use of inorganic fertilizers, there is need to adopt a green manure cropping system that is environmentally friendly and can improved nutrient availability to crops and moisture retention in the soil.

**Keywords:** Legume; residue; nitrogen; maize; yield; Sesbania.
MATERIALS AND METHODS

Experimental Site

The field experiment was conducted during rainy seasons of 2015 and 2016 at the Teaching and Research Farm of the Leventist Farm, Tumu Akko local Government area, Gombe State, (9º 55′ N and 10º58′ E at 325 m above mean sea level). The area is characterized by tertiary continental sandstone to the west of the Kari Keri escarpment, clay and siltstone (Mustapha S et al., 2011). However, the area is characterized by dry sub humid zone (Ojanuga A G, 2006). The total rainfall received during the crop growth period was 369.4 mm and 2183.2 mm (2015 and 2016), with mean annual minimum and maximum temperatures were 30ºC and 32ºC respectively (Ibrahim A K et al., 2017).

Treatments and Experimental Design

The treatments consisted of four legumes (Centrosema, Lablab, Mucuna, Sesbania and Weedy fallow) and NPK fertilizer (0, 60 and 120 kg ha$^{-1}$), tested on maize (SYN 8 PVA) variety. The experiment was laid out in a Randomized Complete Block Design (RCBD) and replicated three times. Green manure crops were planted on the flat at two seeds per hole with narrower spacing of 37.5 cm x 25 cm and mix in to soil at six weeks after sowing. A week after incorporation, Seeds of maize was sown at the rate of two seeds per hole at spacing of 25 cm within ridges and at two weeks after sowing (WAS) seedlings were thinned to one plant per stand. NPK fertilizer (20-10-10) was applied two weeks after sowing (2WAS) according to treatment. The physical and chemical analysis of the top soil (0-30 cm depth) of the experimental field before planting in 2015 were determined by standard procedures as specified by (Page A L et al., 1982).

Data collection and analysis

Data collected were subjected to Analysis of Variance (ANOVA) using SAS package version 9.0 of Statistical Analysis Software package as described by SAS (2002). Differences between treatment means were compared using Duncan Multiple Range Test (DMRT) at 5% level of probability Duncan (1955).

RESULTS

The soil was found to be sandy loamy on textural triangle and strongly acidic (pH 5.0) (Table 1). Total N value of 0.04 g/kg, was less than the critical level of 1.5 g/kg (Esu, 1991) and the phosphorus level was found to be lower than 10 mg kg$^{-1}$ critical level reported by Esu, (1991). The 0.15 cmol kg$^{-1}$ obtained in this study for potassium was less than the critical level of 0.15 cmol kg$^{-1}$ (Esu, 1991). This shows that the soil used for the study was very low in major nutrient elements, which justifies the application of fertilizers to the field.

Table 1. Soil physicochemical properties before experiment

<table>
<thead>
<tr>
<th>Parameter Value</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand content</td>
<td>76.5%</td>
</tr>
<tr>
<td>Silt content</td>
<td>12.5%</td>
</tr>
<tr>
<td>Clay content</td>
<td>11.0%</td>
</tr>
<tr>
<td>Textural class</td>
<td>Sandy loam</td>
</tr>
<tr>
<td>pH(CaCl$_2$)</td>
<td>5.0</td>
</tr>
<tr>
<td>Organic carbon (g/kg$^{-1}$)</td>
<td>5.4</td>
</tr>
<tr>
<td>Total nitrogen (g/kg$^{-1}$)</td>
<td>0.04</td>
</tr>
<tr>
<td>Available. P (mg/kg$^{-1}$)</td>
<td>6.8</td>
</tr>
<tr>
<td>Ca$^{2+}$ (cmol (+)/kg)</td>
<td>2.32</td>
</tr>
<tr>
<td>Mg$^{2+}$ (cmol (+)/kg)</td>
<td>0.50</td>
</tr>
<tr>
<td>K$^+$ (cmol (+)/kg)</td>
<td>0.15</td>
</tr>
</tbody>
</table>

3.1 Chemical Composition of the green manure crops

The chemical analysis of the green manure crops as presented in Table 2 showed that Centrosema, Lablab, Mucuna, Sesbania had 19.65, 34.15, 27.45 and 33.1% organic carbon, 1.35, 3.29, 2.41 and 3.35% total nitrogen, 0.36, 0.51, 0.43 and 0.41% total P, 1.22, 1.29, 0.96 and 1.31% total K, the C:N being 15.0, 11.0, 11.0 and 10.0.

Table 2: Chemical composition of the green manure crops used in the experiment

<table>
<thead>
<tr>
<th>Parameter Value</th>
<th>N%</th>
<th>P%</th>
<th>K%</th>
<th>OC%</th>
<th>C : N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centrosema</td>
<td>1.35</td>
<td>0.36</td>
<td>1.22</td>
<td>19.65</td>
<td>15.0</td>
</tr>
<tr>
<td>Lablab</td>
<td>3.29</td>
<td>0.51</td>
<td>1.29</td>
<td>34.15</td>
<td>11.0</td>
</tr>
<tr>
<td>Mucuna</td>
<td>2.41</td>
<td>0.43</td>
<td>0.96</td>
<td>27.45</td>
<td>11.0</td>
</tr>
<tr>
<td>Sesbania</td>
<td>3.35</td>
<td>0.41</td>
<td>1.31</td>
<td>33.10</td>
<td>10.0</td>
</tr>
</tbody>
</table>

Effect of Treatments on Soil Chemical Properties

Soil pH

Incorporation of green manure crop significantly influenced soil pH at harvest (Table 3). Incorporation of green manure crops significantly resulted in lower soil pH at maize harvest when compare with weedy fallow. Incorporation of
Centrosema gave a significant lower soil pH than incorporation of lablab, mucuna and sesbania. Incorporation of lablab, mucuna and sesbania were statistically similar but significantly had lower soil pH by 18.0, 9.84, 9.84 and 9.84% over the weedy fallow.

Nitrogen application significantly influenced soil pH at harvest (Table 3). Increasing NPK rate from 0 to 60 kg NPK ha\(^{-1}\) produce significant different on soil pH. However, further NPK increase up to 120 kg NPK ha\(^{-1}\) rate significantly reduced soil pH. Application of 60 and 120 kg NPK ha\(^{-1}\) significantly reduce soil pH by 3.51 and 7.01% respectively.

**Organic carbon**

Incorporation of green manure crops was significant on soil organic carbon at harvest (Table 3). Incorporation of lablab, mucuna and sesbania produce statistically similar soil organic carbon which was higher than Centrosema and weedy fallow. Incorporation of Centrosema, lablab mucuna and sesbania significantly increased organic carbon by 3.39, 16.9, 11.6 and 15.3% over weedy fallow, respectively.

Applications of NPK significantly affect soil organic carbon at harvest in this study (Table 3). Increasing NPK rate up to 120 kg NPK ha\(^{-1}\) did not significantly differ from 60kg NPK ha\(^{-1}\) on soil organic carbon. Interaction between green manure and nitrogen on soil organic carbon was significant. The interaction showed that at a given NPK rate, there was significant difference among the green manures (Figure 1). At a given green manure, application of 60 kg NPK ha\(^{-1}\) for lablab green manure was the best combination for enhancing soil organic carbon.

### Table 3: Effect of Treatments on Soil pH, Organic C, Total N and Available P after harvest of Maize

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Soil pH</th>
<th>Organic C (gkg(^{-1}))</th>
<th>Total N (gkg(^{-1}))</th>
<th>Available P (mgkg(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Legume</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Centrosema</td>
<td>5.00(^{c})</td>
<td>6.1(^{b})</td>
<td>0.22(^{d})</td>
<td>9.12(^{b})</td>
</tr>
<tr>
<td>Lablab</td>
<td>5.50(^{b})</td>
<td>6.9(^{a})</td>
<td>0.30(^{a})</td>
<td>9.72(^{c})</td>
</tr>
<tr>
<td>Mucuna</td>
<td>5.50(^{b})</td>
<td>6.6(^{a})</td>
<td>0.25(^{c})</td>
<td>9.90(^{a})</td>
</tr>
<tr>
<td>Sesbania</td>
<td>5.50(^{b})</td>
<td>6.8(^{a})</td>
<td>0.26(^{b})</td>
<td>9.65(^{a})</td>
</tr>
<tr>
<td>Fallow</td>
<td>6.10(^{a})</td>
<td>5.9(^{c})</td>
<td>0.11(^{e})</td>
<td>5.12(^{c})</td>
</tr>
<tr>
<td>SE(^{±})</td>
<td>0.13</td>
<td>0.51</td>
<td>0.01</td>
<td>0.13</td>
</tr>
<tr>
<td><strong>Nitrogen kg ha(^{-1})</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>5.7(^{a})</td>
<td>6.6(^{a})</td>
<td>0.19(^{c})</td>
<td>8.4(^{c})</td>
</tr>
<tr>
<td>60</td>
<td>5.5(^{b})</td>
<td>6.7(^{a})</td>
<td>0.27(^{a})</td>
<td>9.6(^{b})</td>
</tr>
<tr>
<td>120</td>
<td>5.3(^{c})</td>
<td>6.6(^{a})</td>
<td>0.22(^{b})</td>
<td>10.6(^{a})</td>
</tr>
<tr>
<td>SE(^{±})</td>
<td>0.07</td>
<td>0.13</td>
<td>0.01</td>
<td>0.10</td>
</tr>
</tbody>
</table>

Means followed by different letters are statistically different following DMRT

**Figure 1:** Interaction between green manure and NPK rates on Organic carbon (gkg\(^{-1}\)), LSD 0.05 = 0.435

**Soil total nitrogen**

Incorporation of green manure crops significantly increased soil total N in the study (Table 3). However, there was significant difference among the green manure crop on soil total N which was higher than weedy fallow.
Incorporation of Centrosema, lablab mucuna and sesbania significantly increased soil total N by 100, 172.7, 127.3 and 136.4% over weedy fallow, respectively.

NPK application significantly affect soil total N in the study (Table 3). Application of 60 kg NPK ha$^{-1}$ had significantly higher soil total nitrogen than application of 0 kg and 120 kg NPK ha$^{-1}$. Application of 60 and 120 kg NPK ha$^{-1}$ increased soil total nitrogen by 42.4 and 15.8% compared to 0 kg NPK ha$^{-1}$. Interaction between green manure and nitrogen on soil total nitrogen was significant (Figure 2). Irrespective of green manure used for the study, fallow plots was observed to be consistently low on soil total nitrogen. Increasing NPK rates up to 120 kg NPK ha$^{-1}$ did not significantly increased soil total nitrogen.

**Figure 2:** Interaction between green manure and NPK rates on Total nitrogen (g kg$^{-1}$), LSD 0.05 = 0.019

**Soil Available Phosphorus**

Incorporation of green manure crops significantly influences soil available Phosphorus at harvest (Table 3). Incorporation of lablab, mucuna and sesbania were statistically similar but significantly had higher soil available phosphorus than Centrosema and weedy fallow. Incorporation of Centrosema, lablab, mucuna, and sesbania significantly increased soil available Phosphorus by 78.1, 89.8, 93.4 and 88.5%, over weedy fallow respectively. Application of NPK significantly influenced soil available P. (Table 3). Application of 60kg NPK ha$^{-1}$ significantly did not increase soil available phosphorus; however further NPK increase from 60 to 120 kg NPK ha$^{-1}$ significantly increased soil available phosphorus. Application of 60 and 120 kg NPK ha$^{-1}$ significantly increase available phosphorus by 14.3 and 26.2% higher soil available P than no NPK control.

**Exchangeable Calcium**

Incorporation of green manure significantly increased soil exchangeable Ca$^{2+}$, however, there was no significant difference between incorporation of lablab and mucuna. Incorporation of Centrosema, lablab, mucuna, and sesbania significantly increased soil exchangeable Ca$^{2+}$ by 136.4, 209.1, 264.0 and 190.9%, over weedy fallow respectively.

Application of nitrogen was significant on soil exchangeable Ca$^{2+}$ (Table 4). Increasing NPK rate up to 120 kg NPK ha$^{-1}$ significantly reduced soil exchangeable Ca$^{2+}$; although there was no significant difference between application of 0 and 60kg NPK ha$^{-1}$ on soil exchangeable Ca$^{2+}$. Application of 60 and 120 kg NPK ha$^{-1}$ significantly reduced soil exchangeable Ca$^{2+}$ by 3.13 and 9.38% when compared with no NPK. Interaction between green manure and nitrogen on soil exchangeable Ca$^{2+}$was significant (Figure 3). The interaction between green manure and nitrogen on soil exchangeable Ca$^{2+}$ showed that in a given NPK rate, there was significant difference among green manure crops. In a given green manure, increasing NPK rate up to 120 produced reduction in soil exchangeable Ca$^{2+}$ in Centrosema, lablab, mucuna and sesbania green manures.

**Table 4:** Effect of Treatments on Some Exchangeable Bases (cmol kg$^{-1}$) after harvest of maize

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Ca$^{2+}$</th>
<th>Mg$^{2+}$</th>
<th>K$^+$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Legume</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


### Nitrogen k/ha

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Nitrogen (kg/ha)</th>
<th>Soil Exchangeable Magnesium (cmol kg(^{-1}))</th>
<th>LSD 0.05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centrosema</td>
<td>0</td>
<td>0.72 (^a)</td>
<td>0.20 (^c)</td>
</tr>
<tr>
<td>Lablab</td>
<td>60</td>
<td>0.71 (^a)</td>
<td>0.29 (^b)</td>
</tr>
<tr>
<td>Mucuna</td>
<td>120</td>
<td>0.59 (^b)</td>
<td>0.35 (^a)</td>
</tr>
<tr>
<td>SE±</td>
<td></td>
<td>0.05</td>
<td>0.01</td>
</tr>
</tbody>
</table>

Means followed by different letters are statistically different following DMRT.

**Soil Exchangeable Magnesium**

Incorporation of green manure was significant on soil exchangeable Mg\(^{2+}\) (Table 4) where incorporation of green manure significantly increased soil exchangeable Mg\(^{2+}\). There was no significant difference between incorporation of Centrosema and mucuna which was statistically similar on soil exchangeable Mg\(^{2+}\) which was lower than lablab and sesbania. Incorporation of Centrosema, lablab, mucuna and sesbania significantly increased soil exchangeable Mg\(^{2+}\) by 62.8, 55.8, 65.1 and 69.8\% over weedy fallow.

NPK application was significantly affected soil exchangeable Mg\(^{2+}\) at harvest (Table 4) where no NPK had significantly higher soil exchangeable Mg\(^{2+}\) than 120 kg NPK ha\(^{-1}\) with exception of 60 NPK ha\(^{-1}\) which was statistically similar with 0 kg NPK ha\(^{-1}\). The interaction between green manure and nitrogen on soil exchangeable magnesium showed that in a given N rate, there was significant difference among green manures on soil exchangeable magnesium (Figure 4). In a given green manure, increasing NPK rate up to 120 kg NPK ha\(^{-1}\) reduces soil exchangeable magnesium in Centrosema, lablab, mucuna and sesbania green manures.

**Soil Exchangeable Potassium**

Incorporation of Centrosema, mucuna, lablab and sesbania significantly increased soil exchangeable K\(^+\) compared with weedy fallow but there was no significant difference between incorporation of mucuna and sesbania on...
soil exchangeable K\textsuperscript+ at harvest (Table 4). Incorporation of Centrosema, lablab and sesbania significantly increase soil exchangeable K\textsuperscript+ by 125.0, 166.7, 133.3 and 133.3\% over weedy fallow, respectively.

Application of NPK on maize was significant on soil exchangeable K\textsuperscript+ (Table 4). Application of 120 kg NPK ha\textsuperscript{-1} significantly increased soil exchangeable K\textsuperscript+ increasing NPK rate from 60 to 120 kg NPK ha\textsuperscript{-1} significantly increase soil exchangeable K\textsuperscript+ by 45 and 75\% over the control respectively.

![Figure 4: Interaction between green manure and NPK rates on Exchangeable potassium (cmol kg\textsuperscript{-1}), LSD 0.05 = 0.018](image)

**DISCUSSION**

**Soil physical and chemical properties before the start of the experiment and chemical composition of green manures used for the experiment**

The low levels of nutrients obtained in the experimental soils indicate low fertility status and may be attributed to the effects of intensive and continuous cultivation that may aggravate OM oxidation and their consequent leaching/erosion (Ayito E O, *et al.*, 2018 and Habtamu A D, 2015). Similar low values of organic C, total nitrogen and available phosphorus were reported by Ibrahim A K (2007) for soils in the guinea savannah zones of Nigeria. The chemical analysis of the green manure shows a considerably higher nutrient status when compared to that of the field soil. According to Law-Ogbomo K E *et al.* (2016) is an indication of the green manure’s capability of improving the soil nutrient status if allowed to mineralize for the release of its nutrients. The low C: N value indicates the ability of the green manure to enhance high decomposition and mineralization of nutrients in the incorporated legumes. This facilitated better uptake and accumulation of these nutrients for better maize growth and consequently, increased yield (Adesoji A G *et al. 2014*).

**Effect of Treatments on Soil Chemical Properties after Maize Harvest**

**Soil pH**

Incorporation of green manure crops in this study resulted in the reduction of soil pH. Ogunwole A G *et al.*, (2010) attributed the reduction in soil pH after green manure incorporation due to the decomposition of biomass of crop residues which released organic acids which might cause the pH depression in the soils. A decrease in pH in this study accords with the findings of Adesoji A G *et al.*, (2013), and Kalhapure A H *et al.*, (2013) who reported a general reduction in pH after application of fertilizer and legume biomass.

Significantly Soil pH was reduced with increasing N fertilizer which might be due to the nitrification of ammonium to nitrates that exacerbate the acidity levels of cultivated fields by liberating H\textsuperscript+ ion. This was ascribed by Abreha K, (2013) who opined that application of N fertilizers aggravated soil acidity through the activity of soil microorganisms that convert ammonia cations into nitrates with subsequent releases of H\textsuperscript+ cations as a by-product and NO\textsubscript{3}\textsuperscript{-} leaching.

**Soil organic carbon**

The soil organic carbon content increased significantly due to green manure incorporation compared to weedy fallow. This might be due to decomposition and mineralization of the incorporated green manure residues. This finding is in line with the reports of (Preston S, 2003 and Sharma A R *et al.*, 2009).

Application of 60 kg NPK ha\textsuperscript{-1} gave significant increases in soil organic carbon. The increase in soil organic carbon could be probably due to the fact that mineral N enhances microbial decomposition of plant residues which will definitely increase soil organic carbon (Pikul J L, *et al.*, 2008; Poirier V D A, *et al.*, 2009). However, significant
interaction recorded in this study might be probably due to high N concentration of green manure which is greater than 1.7%N considered threshold for transition from net immobilization to net mineralization (Wong M T F et al., 1995).

**Soil total nitrogen**

Ogunwole J O et al., (2010) and Adesoji A G et al., (2014) attributed the increase in soil total nitrogen probably due to the quality (i.e. nutrient composition) and small C: N ratio of incorporated legume, which is one indication of the rate of decomposition in the soil. Soil nutrients are better released in soil with low C: N ratio than soil with higher C: N ratio (Adesoji A G et al., 2014). Similar findings have been reported by Egbe O M (2010), who reported an increase in soil N when incorporated with food legumes in moist savannah of Nigeria.

These increases in soil total N observed might be due synergy between OM amendments and N fertilizers that was attributed to improvements in soil properties and N availability from such fertilizers which stimulate crop growth such as maize (Andrien N et al, 2001). This significant interaction observed could be attributed to the highest quality and quantity of green manure biomass incorporated.

**Soil available phosphorus**

This increase could be attributed to decomposition of organic materials releases organic acids which could dissolve inorganic P compounds (Musandu A A O, 1995). Another reason it might be due to high microbial activity induced by the added organic residues which speed up P cycling (Melero S et al., 2007). These results are also in parity to that of (Habtamu A D, 2015) who found that application of compost can enhance the availability of P and even fixed P can be made available to plants after solubilization by soil microorganisms, rise in soil pH and complexation of soluble Al and Fe by organic molecules. Significant increases observed in soil available P after N application could be attributed to the role of N in mediating the utilization of phosphorous, potassium and other elements in plant (Brady N C, 1984).

**Soil exchangeable bases**

The increase in soil exchangeable Ca$^{2+}$, K$^+$ and Mg$^{2+}$ after incorporation of Centrosema, mucuna, lablab and sesbania compared to control, might be attributed to the addition of organic matter into soils which in most cases increases CEC due to its humic acids which increase the negative charge (Lifeng P et al., 2006). The higher the organic matter content in a soil the higher the CEC that soil has and hence the higher its exchangeable bases (Ca$^{2+}$, K$^+$, Mg$^{2+}$ and Na$^+$). This explains the significant differences observed in exchangeable bases compared to control. These concur with the findings of (Kaiser M et al., 2008 and Brix H, 2008) who report increase in CEC and exchangeable bases in treatments where both mineral and organic fertilizers were incorporated. Similarly, World Bank, (1995) elucidated that a significant improvements were observed in soil total N, OC, available P and CEC by using organic amendments. The results presented herein show that the application of organic and mineral N sources improved the general soil fertility parameters with Ca$^{2+}$, Mg$^{2+}$ and K$^+$ increasing in all treatments.

Significant reduction, observed in soil exchangeable Ca$^{2+}$ and Mg$^{2+}$ after N fertilization could probably be that it had been accumulated in the maize plant which could reduce the amount of soil exchangeable calcium and magnesium. Egbe E A et al., (2012) attributed the reduction of exchangeable calcium and magnesium to uptake in grain filling. However, increase in cations such as K$^+$ and Na$^+$ might be due to the effects of organic matter. These results are in agreement with that of (Sarwar G et al., 2010) who found that cations such as Ca$^{2+}$, Mg$^{2+}$ and K$^+$ were produced during compost decomposition. However, interaction of green manure and NPK fertilizer on soil exchangeable calcium and magnesium were not consistent and did not follow any pattern.

**Conclusion**

Evaluation of the overall results of this study showed that use of green manure not only solves increasing cost of chemical fertilizers and its environmental problems but also improve soil fertility. It was also reported that incorporated legumes combined with 60 kg N ha$^{-1}$ can be a substitute for mineral fertilizer in a soil that is impoverished in plant nutrients. This study has also revealed that N fertilizer application to maize can be reduced by 60 kg ha$^{-1}$ N if it is preceded by incorporated legumes.

**Reference**


