

Original Research Article

Effect of Biosoil conditioner and NPK 15:15:15 fertilizers on the growth and yield of Maize (*Zea mays* L.) in North- Central of Nigeria

ABSTRACT

Soil degradation and nutrient depletion have become serious threat to agricultural productivity in Nigeria. Substantial improvement in the systems is required to support the ever-increasing rural and urban population. During the 2013 and 2014 cropping season, field experiments were conducted to evaluate the effect of combined application of NPK fertilizer and Biosoil conditioner application on yield and growth of maize at Kilankwa (longitude 6.79316E, latitude 8.70545N) in Abuja, Nigeria. This experiment was done as a randomized complete block design with three replications. The treatments were T1 (300kgNPK/ha); T2 (300kgNPK/ha + 1 tablet of Biosoil conditioner in 50 litres of water); T3 (1 tablet of Biosoil conditioner in 50 litres of water) and control. Soil samples were collected for the determination of chemical and physical properties before planting. Data on growth parameters(plant height and number of leaves) and yield (fresh cob weight) were also collected and subjected to 2 ways Analyses of Variance (ANOVA) and means separated with Least Significant Difference (LSD) at P=0.05.

The study revealed that during dry season of 2013 cropping system, application rate of 300kg NPK/ha + 1 tablet of Biosoil conditioner in 50 litres of water had the highest fresh cob weight (6.0 t/ha), followed by 300Kg NPK/ha only (5.1 t/ha), 1 tablet of Biosoil conditioner only (3.2 t/ha) and control (2.3 t/ha) respectively. The field evaluation also showed that combined application rate of 300kgNPK/ha + 1 tablet of Biosoil conditioner in 50litres of water /ha produced the highest number of leaves (13) and plant height (251cm) compared to the least value of 10,123cm respectively obtained in the control.

Similarly in the 2014 wet season, the same trend as in the 2013 was obtained with the application rate of 300kg NPK/ha+1 tablet of Biosoil conditioner in 50 litres of water had the highest fresh cob weight (10.9 t/ha), followed by 300Kg NPK/ha only (9.0 t/ha), 1 tablet of Biosoil conditioner only (7.4 t/ha) and control (3.0 t/ha) respectively.

Considering the overall result, it can be concluded that combined application rate of 300kgNPK/ha + 1 tablet of Biosoil conditioner in 50litres performed best with the

33 highest values of the growth and yield than the sole application of either NPK or Biosoil
34 conditioner.

35 **Key words:** NPK 15:15:15 fertilizer, Biosoil conditioner, yield, maize, Nigeria

36 Introduction

37 The soil remains the main medium of growth in which plants obtain essential nutrients
38 for their growth, development and yield. The soil must therefore be in a good state to
39 support plants and animals including humans by producing highly in terms of yield and
40 nourishment. Seventeen elements have been shown to be essential to plants. They are
41 called macronutrients (N, P, K, Ca, Mg, S, O, H, and C) and micronutrients or trace
42 elements: B, Fe, Co, Zn, Cu, Mn, Mo, and Cl (Wet 1995). However, Soil degradation
43 and nutrient depletion have become serious threat to agricultural productivity in
44 Nigeria. Substantial improvement in the systems is required to support the ever-
45 increasing rural and urban population. Under the present trend of exploitive agriculture
46 in Nigeria, inherent soil fertility can no longer be maintained on the sustainable basis. It
47 is said that nutrient supplying capacity of soil declines steadily under continuous and
48 intensive cropping system. The optimum levels of N, P, K failed to maintain yield levels
49 probably due to increasing secondary and micronutrient deficiencies and also
50 unfavorable alterations in the physical and chemical properties of soil. Micronutrient
51 deficiencies are widespread in the world and have received the attention of research
52 workers since early nineteenth century (Bationo and Mokwunye 1991; Sillanpaa, 1972;
53 Murwira et al, 2002). Deficiencies of micronutrients have been increasing in some crops
54 and the reasons for this disorder include higher crop yields which increase plant nutrient
55 demands, use of high analyses NPK fertilizers containing lower quantities of
56 micronutrient contaminants, and decreased use of farmyard manure on many
57 agricultural soils. Micronutrient deficiencies have been verified in many soils through
58 increased use of soil testing and plant analyses. Micronutrient deficiencies in African
59 soils are assuming alarming rates and may be responsible for the declining yields and
60 quality of crops. (Forde, 1968; Anonymous, 1980; Swaine, 1955; Osiname 2017)

61 Apart from the soil fertility and productivity issues, use of chemical fertilizers is also
62 becoming more and more difficult for the farmers due to their high costs and scarcity
63 during peak season. On thus, increasing awareness is being created on the use of

64 organics including biofertilizers which are the sources of macro, micro and secondary
65 nutrients to sustain the soil fertility and productivity.

66 Organic matter improves water holding capacity of sandy soil and drainage in clayey soil.
67 Organic manure provides nutrients for the soil micro-organisms, thus increases the
68 activities of microbes in soil, which in turn help to convert unavailable plant nutrients
69 into available form for plant growth promotion. The biofertilizers and organics are found
70 to have positive effect on soil fertility, resulting in an increase in crop yield without
71 causing any environmental, water or soil pollution hazards. Nitrogen fixing and
72 Phosphorus solubilizing bacteria play an important role in nitrogen mobilization and
73 phosphorus solubilization for the benefit of plant growth (De Ridder and Van Keulen
74 1990).

75 According to study carried out by Arshad *et al.* 2004 and corroborated by Anup Das *et*
76 *al.* 2010 , the researchers found that application of organic and bio fertilizers had
77 positive effect on the root development and which resulted in more nutrient uptake
78 and, also promote vigorous plant growth.

79 In addition to this, Crops fed with organic and biofertilizers foliar spray has earlier and
80 more uniform maturity (e.g. attainment of 50% flowering about 21 days earlier in maize
81 plant) due to availability of micronutrients. Other significant evidences include; better
82 flavor of fruits and vegetables, higher nutritional levels, increase in stalk thickness and
83 yield (maize) , better keeping quality in fruits and root cellular storage, increased
84 growth, greater size and lush appearance of green leaves and fruits (Okra) and color
85 intensification of crops like carrots (Lombin, 1983a; Lombin,1985;Cherian,1969;
86 Griller, 1966; Cottenie et al , 1981; Heathcote, 1973 ; FMANR, 1990;). These are all good
87 reasons to turn our efforts toward soil-re – mineralization.

88 Farmers in Nigeria seldom apply micro nutrient fertilizers to their crops either directly or
89 indirectly inform of organic fertilizers apart from the traditional fertilizer (inorganic
90 fertilizer) because in Nigeria most fertilizer formulations are mostly based on the
91 primary nutrients like Nitrogen (N), Phosphorus (P) and Potassium (K) and to a lesser
92 extent on the micro-nutrients. This has serious implications on the attainment of
93 Millennium Development Goal-1 on having people suffering from hunger and
94 malnutrition in 2015 in Africa.

In order to address these limitations, there is need to increase the awareness on the use of organic fertilizers in combination with the chemical fertilizer to improve soil fertility and productivity in the Nigerian soils affected.

MATERIALS AND METHODOLOGY

Study Area

The study was conducted during dry seasons of 2013 and rain-fed season of 2014 at Kilankwa Village, Gwagwalada Local Government Area of Abuja, Nigeria. It falls under the sub-humid Agro ecological (guinea savanna vegetation) zone of Nigeria. The Kilankwa site lies at longitude of 6.79316E, latitude 8.70545N, and the altitude of the area is 209 m above sea level. The daytime temperature is 28-30 degrees. Climate of this area is arid with dry and hot summer. The mean annual rainfall is about 1100 mm to 1600 mm and the growing period of 180-239 days. Rainfall pattern is bimodal with the major rainy season from May to September. The soils at the study area are classified mainly Ferric luvisols according to FAO classification system (FAO, 1988) or Alfisols in USDA soil Taxonomy system (Soil Survey Staff, 1992). They are generally low in CEC owing to predominance of kaolinite in their clay fraction, low organic matter and inherent fertility. The soil characteristic of the research farm is sandy loam in texture (Table 1).

Field Experiment

Field preparation was done mechanically with one ploughing and harrowing, this was followed by manual ridging and mapping out of the plots. The plot size measuring 10m x 10m = 100m² with alley of 1m left in between plots was used. The plot sizes were manually prepared. The experimental design was randomized complete block design with three replications. The treatments consisted of: T1 (300kgNPK/ha); T2 (300kgNPK/ha + 1 tablet of Bio soil conditioner in 50 litres of water /ha; T3 (1 tablet of Biosoil conditioner in 50 litres of water /ha) and T4 (control).

An early maturing variety of maize (Zea mays) Oba super was planted on ridges, at inter row spacing of 75 cm and intra-row distances at 25cm. The seed rate was 2seeds per hole, giving a population density of 54,000 plants/ha and later thinned to one plant per

stand . The inorganic fertilizer (NPK 15-15-15) was applied at 2WAP as basal application and then top dress with Urea at 6 weeks after planting. Biosoil conditioner solution was sprayed evenly around the base of the crop and upward, to cover the underside of the leaf. Two applications of the Biosoil conditioner were carried out at 5- 6wap and silking stage respectively. Soil auger was used to collect surface soil samples (0 -15cm) from the experimental site before planting. All agronomical practices were duly observed. The agronomic parameters including plant height, number of leaves, and fresh weight of cobs were measured. At last data were subjected to 2 ways Analyses of Variance (ANOVA) and means separated with Least Significant Difference(LSD) at P=0.05

RESULTS AND DISCUSSION

Results of physical and chemical properties of soils of Kilankwa are shown in Table 1.

The textural class of the soil is sandy loam with sand values of 720 g kg⁻¹; silt (140g kg⁻¹) and clay (140g kg⁻¹) (Table 1).The sandy nature of this soil is attributed to the granitic and gneissic origin of the parent materials. This contributes to low cationic retention and water holding capacity. The pH (water) is 6.5 suggesting that the soils may not have acidity problems and therefore will not require liming. The organic carbon content is moderate, with a value of 4.40 g kg⁻¹. While the total nitrogen and available phosphorus values fall within the moderate fertility class. The Exchangeable cations (Ca, Mg, K and Na) values are low to moderate. (Table 1)

Cation Exchange Capacity is low to moderate. In soils of low cation exchangeable capacity (CEC), cationic holding capacity will be low. However, because of the higher percent base saturation of the soils of this study area, nutrients are readily available to plants and small doses of fertilizer could produce significant crop responses.(Table 1)

Table 1: Physical and Chemical Properties of soils of Kilankwa NPFS site.

PROPERTIES	VALUES
Sand (g/kg)	720
Silt (g/kg)	140
Clay (g/kg)	140
pH(H ₂ O)	6.5
pH(KCl)	5.2

153	Organic carbon (g/kg)	4.4
154	Nitrogen (g/kg)	0.35
154	Avail. Phosphorus (mg/kg)	15.6
155	<i>Exchangeable Bases (meq</i>	
156	<i>/100g)</i>	
156	Ca	1.8
157	Mg	1.2
158	K	0.16
158	Na	0.14
159	Al	0.3
159	CEC	4.3
160	BS (%)	79.07
161	<i>Extractable Micronutrients</i>	
162	<i>(mgkg⁻¹)</i>	
163	Zn	0.33
163	Mn	8.85
164	Fe	5.40
165	B	0.76

166

167 Analysis of Biosoil conditioner Fertilizers

168 The BioSoil **Conditioner** was subjected to laboratory analysis to determine some physical
 169 qualities and the concentration of some essential relevant nutrients and elements
 170 considered toxic to crops, man and environment. The results as stated below show that
 171 the physical and chemical properties of the product met the specifications and the
 172 minimum acceptable investigational allowance for organic fertilizers.

173 Analysis of Biosoil conditioner as validated by the Department of Soil Science, Faculty of
 174 Agriculture/Institute for Agricultural Research, Ahmadu Bello University Zaria, Nigeria
 175 February, 2013 are shown below:

176 Physical Analysis

177 State: Solid Tablet

178 Colour: Gray with green speckles

179 Odour: Odourless

180 **Table 2: Chemical Analysis**

Nutrient /Parameter	Concentration (%)	181
Nitrogen(N)	4.91	182
Phosphorus (P ₂ O ₅)	1.72	183
Potassium (K ₂ O)	1.14	184
Calcium (Ca)	0.18	185
Magnesium (Mg)	0.25	186
	mg/kg	
Iron (Fe)	29.25	187
Manganese(Mn)	2.25	188
Zinc (Zn)	25.93	189
Cadmium(Cd)	0.00	190
Chromium (Cr)	10.00	191
Lead (Pb)	29.75	192
Organic Matter (%)	0.70	193

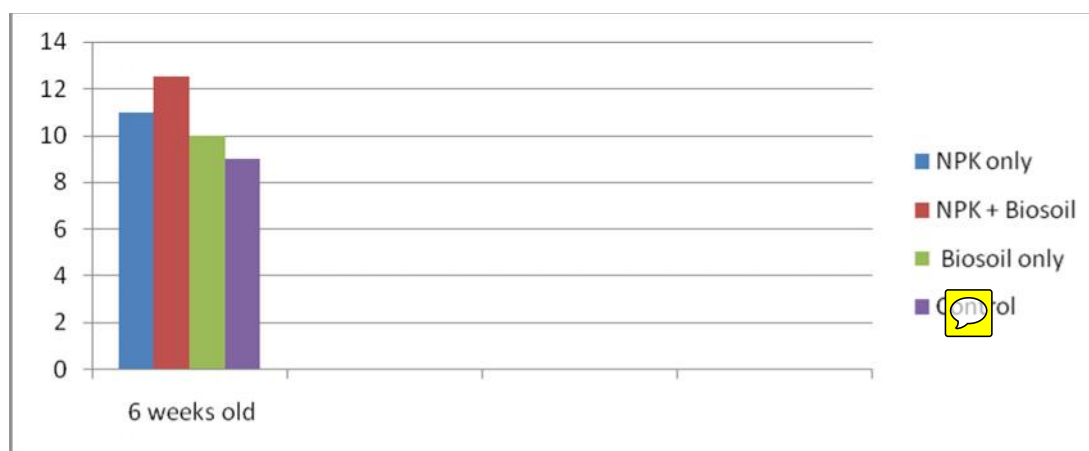
194

195 **Maize response to Biosoil conditioner application under dry season 2013 at**
 196 **Kilankwa NPFS site**

197 **Number of leaves:**

198 Maize leaf response to Biosoil conditioner treatments reveal that the highest average
 199 number of leaves (13/plot) was obtained with a combined application of NPK and Biosoil
 200 conditioner fertilizer followed by 12 leaves/ plot in crops treated with NPK only, and
 201 10.4 leaves/plot in the Biosoil treated plot .The control plot produced the lowest

202 average number of leaves (10/plot) (Fig. 1). The treatment differences are highly
203 significant.



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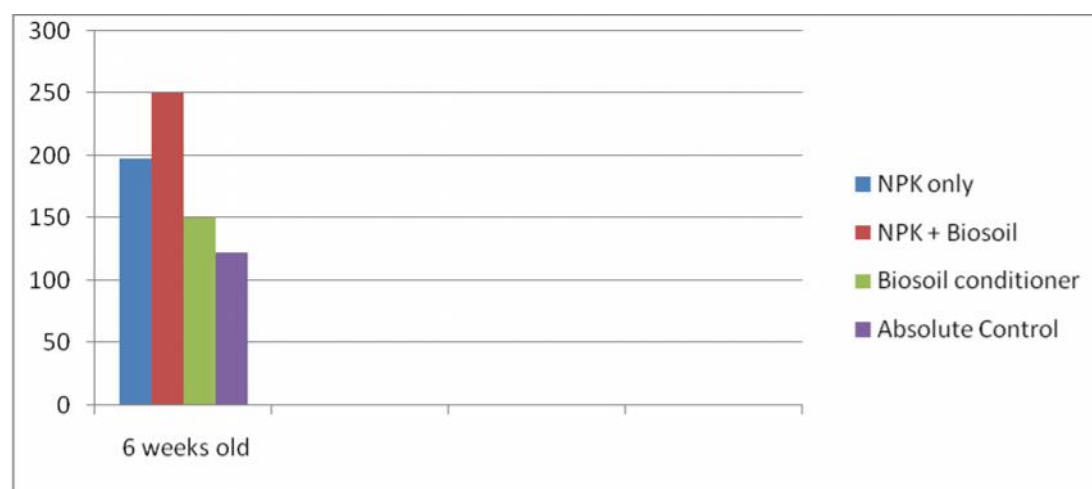
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206 Figure 1: Number of leaves of Maize as influenced by Biosoil **Conditioner** fertilizer at
Kilankwa NPFS site (2013).

Plant Height (cm):

The highest plant height of 251cm/plot was obtained from plot treated with NPK and Biosoil conditioner Fertilizer, followed by plot treated with NPK only (198 cm/plot),

211 the plot with Biosoil conditioner fertilizer only gave 150 cm/plot and the least was
212 obtained from the control treatment with value of 123 cm/plot.(Fig .2)The treatment
213 differences are highly significant.



214

Figure 2: Effect of Biosoil Conditioner fertilizer on plant height of maize (6weeks old) at Kilankwa NPFS site

Fresh
Weight of
Cobs

Fresh cobs weight:

Maize plots were harvested green, NPK+ FoliarBlend treated plots did much better in term of fresh cobs weight than other treated plots. (Fig 3).

The highest Fresh weight of cobs (10.4 t/ha)was obtained from the plot treated with NPK + Biosoil conditioner Fertilizer followed by 7.2 t/ha in plot treated with NPK only, while the plot treated with Biosoil only had the least value of 3.8t/ha (Fig.3). The treatment differences are highly significant.

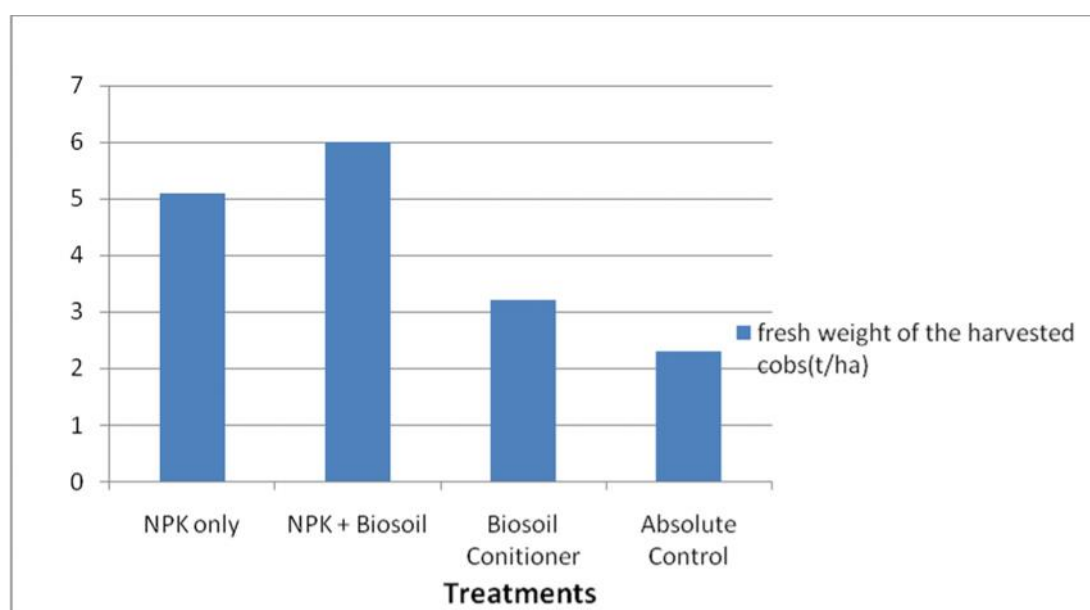


Figure 3: Fresh weight of maize cobs (t/ha) in response to Biosoil conditioner Fertilizer at Kilankwa NPFS site under dry season of 2013

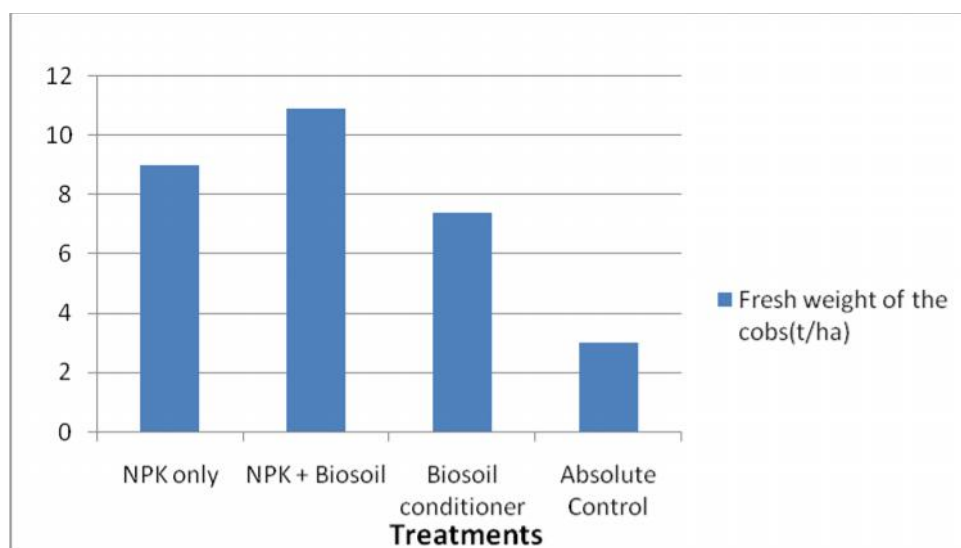
Maize Response to Biosoil Conditioner at FCTADP in Gwagwalada, Federal Capital Territory under 2014 Rain-fed season

Fresh weight of cobs (2014):

233 Maize plots were harvested green, NPK+ Biosoil Conditioner treated plots did much
234 better in term of fresh weight of cobs than other treated plots (Fig. 4).

235 The highest fresh weight of cobs (10.9 t/ha)was obtained from the plot treated with
236 NPK + Biosoil **Conditioner Fertilizer** followed by 9.0 t/ha in plot treated with NPK only,
237 while the plot treated with Biosoil conditioner only had the value of 7.4 t/ha and
the control with the least value of 3.0 t/ha. The treatment differences are not
highly significant.

*Fresh
Weight of
Cobs
(t/ha)*



243 Figure 4: Fresh weight of maize cobs (t/ha) in response to Biosoil conditioner **Fertilizer** at
244 FCTADP, Gwagwalada, Abuja (2014)

245 **Number of leaves:**

246 Maize leaf response to Biosoil **Conditioner** treatments reveal that the highest average
247 number of leaves (14/plot) was obtained with a combined application of NPK and Biosoil
248 conditioner fertilizer followed by 12 leaves/ plot in crops treated with NPK only, and 11
249 leaves/plot in the Biosoil conditioner only treated plot .The control plot produced the
250 lowest average number of leaves (10/plot) (Fig. 5) The treatment differences are highly
251 significant.

252

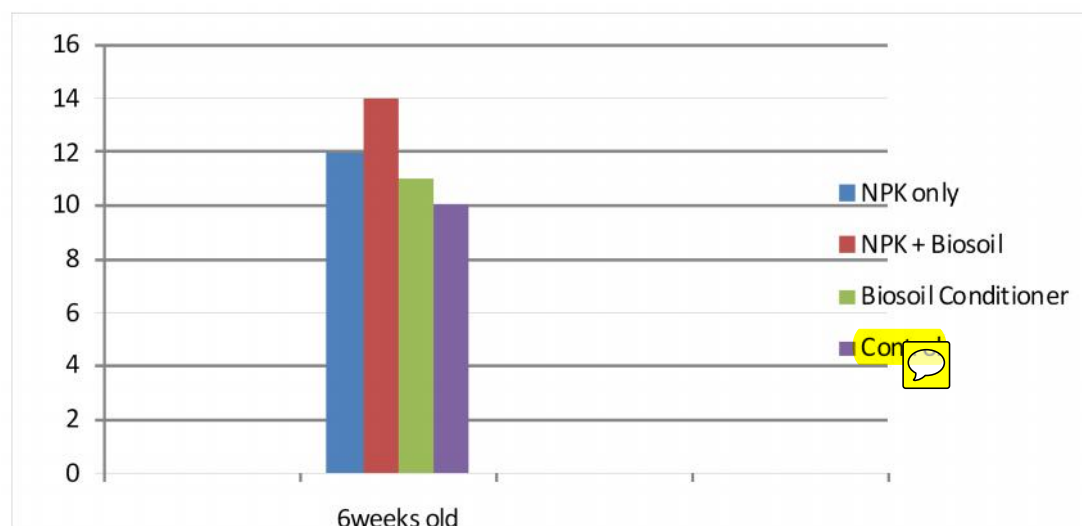


Figure 5: Number of leaves of Maize as influenced by Biosoil Conditioner fertilizer at FCTADP site, Gwagwalada, FCT (2014)

261 5: Number of leaves of Maize as influenced by Biosoil Conditioner fertilizer at FCTADP
 262 site, Gwagwalada, FCT (2014)

263 Plant Height (cm):

264 The highest plant height of 106.7 cm/plot was obtained from plot treated with NPK and
 265 Biosoil conditioner Fertilizer, followed by plot treated with NPK only (91.4 cm/plot), the
 266 plot with Biosoil conditioner fertilizer only gave 75.6 cm/plot and the least was obtained
 267 from the control treatment with value of 60.3 cm/plot.(Fig .6)The treatment differences
 268 are highly significant

269

Number
of leaves

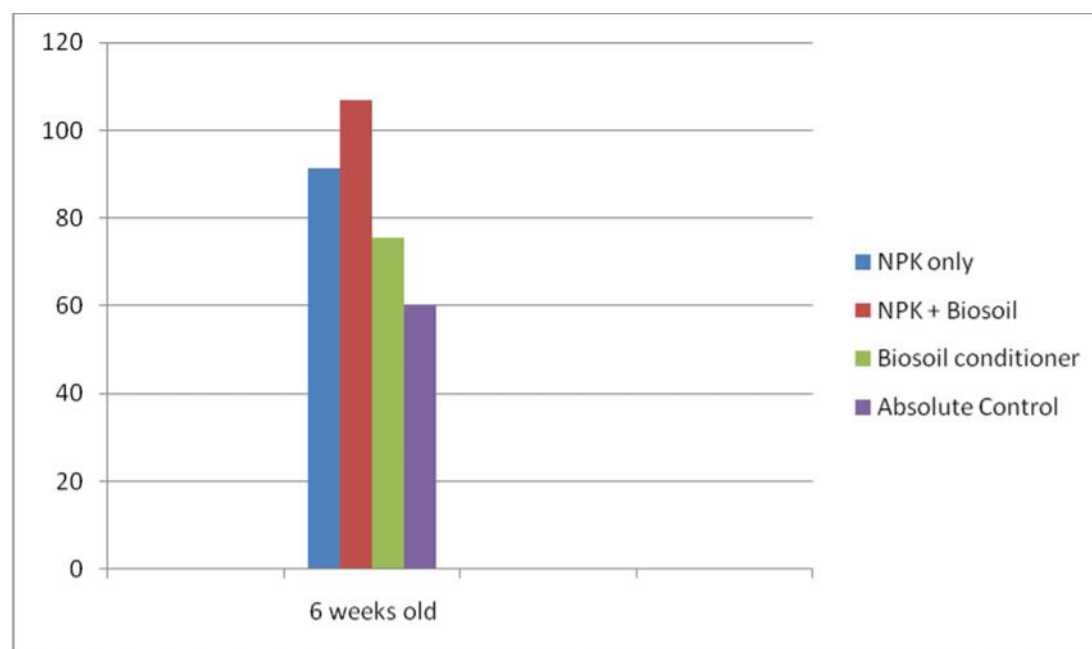


Figure 6: Effect of Biosoil conditioner fertilizer on plant height of maize at FCTADP site in FCT (2014)

Conclusion

The study has shown that the application of 300kgNPK/ha and Biosoil conditioner produced the highest growth and yield of maize compared to sole application of NPK alone and Biosoil conditioner only, during the dry and wet seasons of 2013 and 2014 respectively. Thus, an optimum fertilizer rate which would maximize yield and minimize cost of production should always be the concern of stakeholders in maize production in Nigeria. Therefore, in this study, we proposed 300kg NPK/ha and Biosoil conditioner as the optimum fertilizer recommendation for maize production in North-central Nigeria.

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