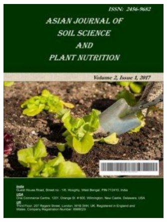

Asian Journal of Soil Science and Plant Nutrition

2(4): 1-11, 2017; Article no.AJSSPN.39905
ISSN: 2456-9682

Effects of Green Manuring and Nitrogen Levels on the Yield and Yield Attributes of Maize (*Zea mays* L.)

A. K. Ibrahim[1*], S. A. Ibrahim[2], N. Voncir[2] and A. M. Hassan[2]

[1]Department of Soil Science, Federal University, Kashere, Gombe State, Nigeria.
[2]Department of Soil Science, Abubakar Tafawa Balewa University, Bauchi, Nigeria.

Authors' contributions

This work was carried out in collaboration between all authors. Author AKI designed the study, performed the experiment and statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors SAI, NV and AMH assisted in the design of the study and protocol. Authors SAI, NV and AMH supervised the study. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJSSPN/2017/39905
Editor(s):
(1) Abhishek Naik, Department of Area Manager in Technology Development, Vegetable Crops Organization-United Phosphorus Limited, India.
Reviewers:
(1) Ahmed Karmaoui, Morocco.
(2) Leyla Idikut, Sutcu Imam Universty, Turkey.
(3) Rahim Foroughbakhch, University of Nuevo Leon, Mexico.
Complete Peer review History: http://www.sciencedomain.org/review-history/23632

Original Research Article

Received 4th January 2018
Accepted 9th March 2018
Published 14th March 2018

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 yield and yield attributes of maize. The treatments consist of four legumes crops (Centrosema, Lablab, Mucuna, Sesbania and control) and NPK fertilizer (0, 60 and 120 kg ha^{-1}) laid out in a Randomized Complete Block Design (RCBD) with three replicates. The results of the experiment revealed that, growing maize on lablab plots had significant (P≤0.05) effect on all the characters measured than other treatments. The results further revealed that, application of nitrogen fertilizer at the rate of 60kgN/ha gave significantly (P≤0.05) higher effects on all the characters studied than when the other rates were used. Control plots on the other hand recorded the least.The results indicated that maximum cob yield (3280 kg ha^{-1}), stover yield (2115 kg ha^{-1}), and grain yield (2359 kg ha^{-1}) of maize were obtained with plots incorporated with lablab combined with 60 kg N ha^{-1} respectively. Studies on interaction revealed that, combined application of lablab green manure and 60 kg NPK ha^{-1}, are the most viable combinations for maximum grain yield. The combination saves 60 kg NPK ha^{-1} when

**Corresponding author: Email: ibrahima764@gmail.com;*

compared with the recommended rate of inorganic nitrogen (120kg NPK ha^{-1}) for maize production. Based on the results obtained, application of 60kg ha^{-1} N as top dress to maize grown on lablab residue plots should be adopted by farmers in and around the study area for higher yield.

Keywords: Legume; residue; nitrogen; maize; yield; Sesbania.

1. INTRODUCTION

Maize (*Zea mays* L.) is the major subsistence arable cereal in the guinea savanna zone of Nigeria [1] with the stalks used as fodder for feeding livestock especially during the dry season and the stalk for constructing houses and as fuel [2]. Nigeria is currently the fourteen largest producer of maize in the world and the largest maize producer in Africa behind South Africa [3,4] indicated that Nigeria current maize production is about 8 million tones 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, [4] pointed out that the yield is lower when compared to average yield from other African countries like South Africa (2.5t/ha), Mauritius (5.8t/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 [5]. Increasing human population and high consumption of maize has led to its continuous intensive production in Nigeria. According to [6] 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 [7].

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 [8].

The study was design to determine the effect of four leguminous green manure crops (*Centrosema pubesscens, Dolichos lablab, Mucuna pruriens and Sesbania rostrata*) on the growth, yields and yield components of maize.

2. MATERIALS AND METHODS

2.1 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, (9° 55′ N and 10°58′ E at 325 m above mean sea level). [9] Opined that the area is characterized by tertiary continental sandstone to the west of the Kari Keri escarpment, clay and siltstone. However, the area is characterized by dry sub humid zone [10]. 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 30^{0}C and 32°C respectively [11]. Previous crop grown on experimental site was soybeans.

2.2 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 variety SYN 8 PVA seeds were dressed with Apron Star 42 WS at the rate of 10 g sachet per 4 kg seeds for protection against soil and seed borne pests and diseases, and was sown at the rate of two seeds per hole at spacing of 25 cm within ridges. The experimental plot consisted of seven ridges of 5m apart and 4m long (gross plot) and net plot was 3.5 m x 3 m (10.5 m^2).

The seedlings were thinned to one plant per stand at two weeks after sowing (WAS). NPK fertilizer (20-10-10) was applied two weeks after sowing (2WAS) according to treatment. Weeds were controlled using Paraquat (Gramaxone) at 3 litres ha-1 to kill weeds that were not properly incorporated and hoe weeding was done at 6WAS.

All data collected were subjected to Analysis of Variance (ANOVA) using SAS package version 9.0 of Statistical Analysis Software package as described by [12]. Differences between treatment means were compared using Duncan Multiple Range Test (DMRT) at 5% level of probability [13].

3. RESULTS AND DISCUSSION

The physico-chemical analysis of the top soil (0-30 cm depth) of the experimental field before planting in 2015 was determined by standard procedures as described by [14]. The results showed that the soils was Sandy Loam with the following properties: pH (0.01M CaCl2), 5.0; organic carbon, 5.4 g kg^{-1}; total nitrogen, 0.04 g kg^{-1}; available phosphorus, 6.8 mg kg^{-1}; and exchangeable cations (cmol kg^{-1}) of Ca^{2+}, 2.32; Mg^{2+}, 0.50; K^{+}, 0.15; and Na^{+}, 0.12; and CEC, 4.0 cmol kg^{-1}. The chemical analysis of the incorporated leguminous green manure crops is shown in Table 1.

3.1 Yield Attributes

The results of the experiment revealed that yield attributes and yields of maize were significantly influenced by different sources of nutrients (Tables 2 and 3).

Incorporation of green manure crops significantly increased cob length and cob girth in the two years of study and in the combined means (Table 2) but there was no significant difference among incorporation of mucuna, sesbania and centro green manure crops on cob length. This shows the importance of green manure as it contributes to nutrient enhancement of soils with positive results toward yield attributes. Cob length and cob diameter contribute significantly to grain yield by influencing both number of grains per ear and grain size [15]. These results supported by the findings of [16,17] who reported a significant increase in cob diameter and cob length after legumes incorporation. It has been reported by many researchers that green manure has ability to increase soil N, release P and maintain and renew the soil organic matter and improved soil physical and chemical characteristic [18,19,20]. Application of 60kg NPK ha^{-1} significantly increased cob length and cob girth but further NPK increase from 60kg NPK ha^{-1} upwards did not produce any significant increase. In 2015, 2016 and combined mean application of 120kg NPK ha^{-1} produced significantly thicker cob than the control (Table 2). The increase in cob length and cob girth with increase in nitrogen fertilizer application clearly indicates the importance of inorganic fertilizer in the performance of maize. This indicated the effect of nitrogen as a basic component of many physiological processes in plants.

Significant interaction between green manure and NPK was observed on cob length and cob girth per plant in 2015 and combined means (Figs. 1 and 2). The interaction between green manure and NPK on cob length of maize in combined means showed that highest cob length was obtained with a combination of lablab and 60kg NPK ha^{-1} At a given green manure, increasing NPK rate beyond 60kg NPK ha^{-1} did not significant effect on cob length and cob girth of maize. Significant interaction between green manure crops and NPK on cob length and cob girth showed that the combination of Lablab green manure with 60kg NPK ha^{-1} was the best interaction combinations for increased cob length and cob girth of maize. This might be due to more photo-assimilates production in Lablab incorporated plots having 60 kg ha^{-1} nitrogen applied [21]. Optimum supply of nitrogen had affected yield components. In control plots the lower cob length and cob girth were reported by [22] and the possible reason was unavailability of nitrogen and less dry matter accumulation.

Green manure incorporation significantly increased 100-seeed weight in all the two years of study and their combined mean (Table 2). In 2015, 2016 and combined mean incorporation of lablab green manures significantly resulted in more 100-seed weight compared to other green manure crops. In 2016 and combined mean incorporation of centro, mucuna and sesbania green manure crops were statistically the same on their effect on 100-seed weight which were higher than weedy fallow. In combined mean, incorporating of green manure crops gave 22.2, 33.7, 23.0 and 24.4% more 100-seed weight than weedy fallow for centro, lablab, mucuna and sesbania, respectively. NPK application was significant on 100-seed weight in 2015, 2016 and combined mean (Table 2). Increasing level of NPK from 0 to 60kg NPK ha^{-1} significantly increased 100-seed weight but a further increase of NPK rate from 60 to 120kg NPK ha^{-1} did not significantly increase 100-seed weight. Results are corroborating with [23,24] who reported that maize yield contributing characters such as thousand grain weights, number of grains per cob with increased nitrogen doses applied. Interaction between green manure and nitrogen on 100-seed weight was significant in 2015 and combined means. The interaction between green manure and NPK on 100-seed weight of maize in combined means showed that at a given N rate, weedy fallow produced the lowest 100-seed weight while lablab green manure and 60kg NPK ha^{-1} produced highest 100-seed weight (Fig. 3). At a given legume green manure, increasing NPK rate beyond 60kg NPK ha^{-1} produced no significant difference. The increase in 100 grain weight with lablab and 60kg NPK was mainly due to the balanced supply of food nutrients from both NPK and green manure throughout the grain filling and development period [25].

3.2 Yield

Incorporation of green manure significantly increased cob yield in all the two years of study and combined mean (Table 3). In 2015 and 2016, incorporation of lablab green manure performed significantly better than mucuna, sesbania, centro and weedy fallow on cob yield. In combined mean, incorporating of green manure crops significantly increased cob yield by 41.3, 69.8, 54.5 and 45.0% for centro, mucuna, lablab and sesbania over weedy fallow.

Table 1. Laboratory analysis of the shoot of the green manure crops used in the experiments

Parameters	Description				
	N (%)	P (%)	K (%)	C (%)	C: N
Centrosema					
2015	1.33	0.38	1.20	18.4	14
2016	1.37	0.33	1.23	20.9	15
Lablab					
2015	2.96	0.49	1.35	29.4	10
2016	3.61	0.53	1.22	38.9	11
Mucuna					
2015	2.07	0.37	1.05	18.6	9
2016	2.74	0.49	0.87	36.3	13
Sesbania					
2015	3.25	0.43	1.25	29.4	9
2016	3.44	0.38	1.36	36.8	11

Table 2. Effects of treatments on cob length, cob girth 100-grain weight of maize in 2015, 2016 and combined

Treatment	Cob length (cm)			Cob girth (cm)			100-grain weight (g)		
	2015	2016	Mean	2015	2016	Mean	2015	2016	Mean
Legume									
Centro	10.42^c	11.33^b	10.87^b	12.18^c	12.77^b	12.47^b	17.30^c	19.43^b	18.36^b
Lablab	12.33^a	12.93^a	12.63^a	12.92^a	13.44^a	13.18^a	19.26^a	20.88^a	20.10^a
Mucuna	10.97^b	11.59^b	11.28^b	12.47^b	12.93^{ab}	12.70^b	17.75^b	19.24^b	18.49^b
Sesbania	10.94^b	11.56^b	11.24^b	12.45^b	12.78^b	12.62^b	17.70^b	19.70^b	18.70^b
Fallow	8.50^d	9.27^c	8.88^c	10.07^d	11.67^c	10.86^c	14.10^d	15.97^c	15.03^c
SE±	0.041	0.378	0.192	0.094	0.210	0.131	0.107	0.333	0.191
Nitrogen Kg ha-1									
0	10.76^c	10.98^c	10.87^c	12.85^b	12.71^b	12.78^c	16.42^c	17.33^c	16.88^c
60	13.18^a	13.32^a	13.25^a	13.68^a	13.74^a	13.71^a	20.76^a	23.22^a	21.99^a
120	12.20^b	12.23^b	12.21^b	13.43^a	13.30^a	13.37^{ab}	18.73^b	20.72^b	19.03^b
SE±	0.038	0.350	0.185	0.087	0.194	0.126	0.099	0.308	0.183
Interaction									
L X N	***	NS	**	***	NS	**	***	***	**

*LS = Level of significance, NS = Not significant, * and ** = significant at 0.05 and 0.01 respectively. Means followed by different letters are statistically different following Duncan Multiple Range Test (DMRT)*

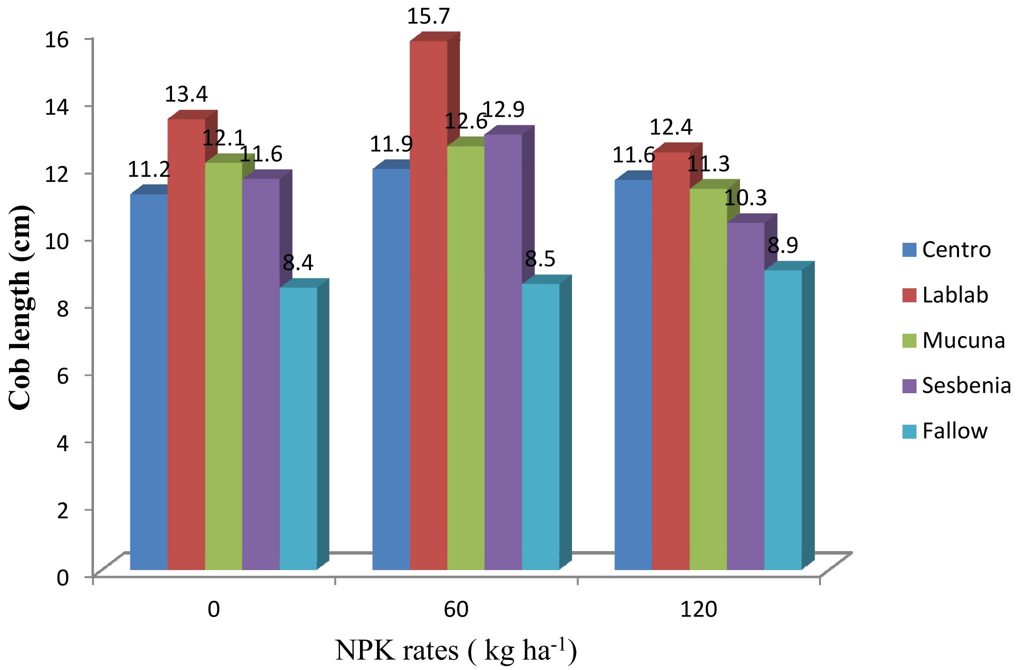

Fig. 1. Interaction between green manure and NPK rates on cob length (cm), LSD $_{0.05}$ = 1.57 (Combined analysis)

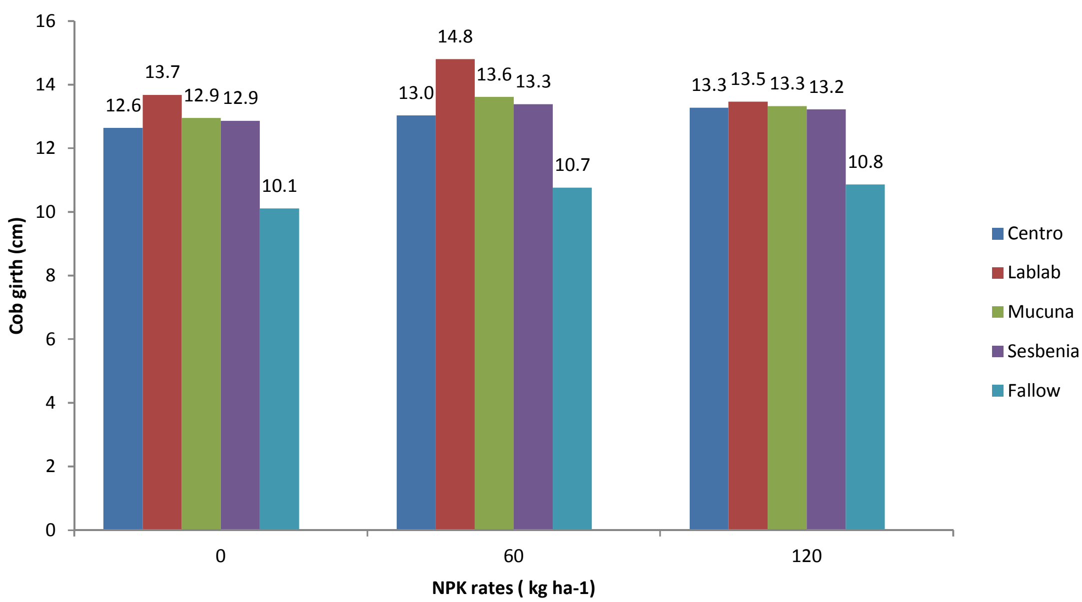

Fig. 2. Interaction between green manure and NPK rates on cob girth (cm), LSD $_{0.05}$ = 0.676 (Combined analysis)

Incorporation of green manure crops increased cob yield of maize than maize grown in control plots. Increase in cob yield due to incorporation of green manure residues generated in situ is an indication that decomposed legume residues are a feasible source of N for growth of maize. Increased maize cob yields due to the use of Lablab green manure residues as a source of N have been reported in a semi-arid environment [26]. In the present study, the poor performance of Mucuna as a source of N for maize crop was attributed to the low quantity of biomass produced.

Applications of NPK significantly increased cob yield in all the two years and combined mean (Table 3). In 2015 increasing NPK rate from 0 to 60kg NPK ha^{-1} significantly increased cob yield but further NPK increase did not significantly increase in cob yield. In 2016, application of 60 and 120kg NPK ha^{-1} produced significantly similar and higher cob yield than 0kg NPK ha^{-1} (control). In combined mean, application of 60 and 120kg NPK ha^{-1} significantly increased cob yield by 26.5 and 18.9% over no NPK treatment.

At the various fertilizer rates, higher cob yield was obtained at 60kg NPK ha^{-1} which is just half of dose required for maize production. This shows that with inclusion in a cropping system, full dose N may not be necessary for optimum maize production. This corroborated with the findings of [27] that reported that, fixation of atmospheric nitrogen by legumes increases soil fertility and subsequently improves crop yield.

Interaction between green manure and nitrogen on cob yield was significant in 2015 and combined mean. The interaction between green manure and NPK on cob yield of maize in combined means showed that highest cob yield was obtained with a combination of lablab and 60kg NPK ha^{-1} (Fig. 3). At a given green manure, increasing NPK rate beyond 60kg NPK ha^{-1} did not significant effect on cob yield. The increase in cob yield with lablab and 60kg NPK ha^{-1} was mainly due to the balanced supply of food nutrients from both NPK and green manure throughout the grain filling and development period [25].

Incorporation of green manure crops was found to significantly affected grain yield in the two years of study and their combined mean compared with weedy fallow (Table 3). There was significant difference between green manure crops on grain yield in 2015 and combined mean where lablab green manure had significantly higher grain yield than centro, mucuna and sesbania green manure and weedy fallow. In combined mean, incorporation of centro, lablab, mucuna and sesbania produced 61.7, 96.4, 79.1 and 66.7% increases in grain yield over weedy

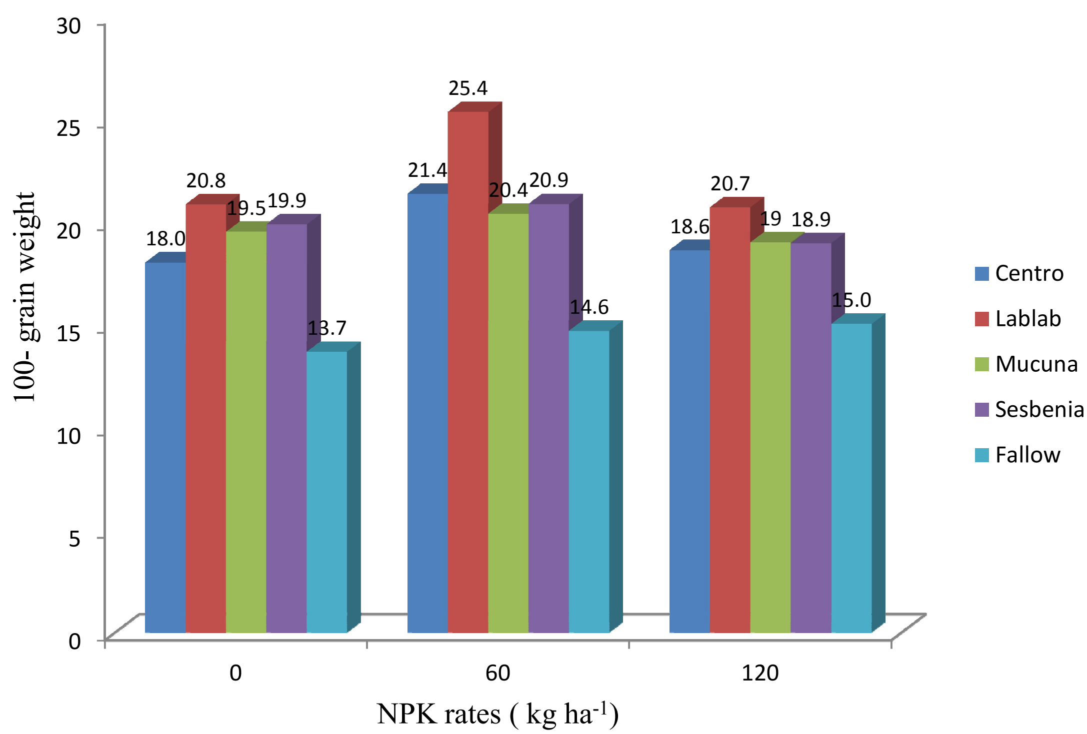

Fig. 3. Interaction between green manure and NPK rates on 100-grain weight (g), LSD $_{0.05}$ = 1.03 (Combined analysis)

fallow, respectively. The consistently higher maize yields recorded in treatments where Lablab green manure crops was incorporated was attributed to higher amounts of nutrients than all the other treatments, mainly nitrogen that was availed by these inputs for maize growth. [28] stated that, grain yield is the end result of many complexes morphological and physiological processes occurring during the growth and development of crop. The increase in grain yield with Lablab was mainly due to more cob length and cob diameter and better grain development with the same treatment. Considering the soil analysis in Table 1 during both the years, it was found that the % of organic carbon was very low in the soil. It might be possible that the incorporation of Lablab green manure improved the organic matter status of the soil which ultimately improved the chemical and physical properties of the soil and the final results were in the form of better grain yield.

Application of NPK significantly influenced grain yield in all the two years of study and their combined mean (Table 3). In 2015, application of 60 kg NPK ha^{-1} significantly increase grain yield by 39.4% over zero NPK treatment but a further increase up to 120 kg NPK ha^{-1} did not produce any significant difference. In 2016, increasing NPK rate did not produce any significant difference among the NPK rate applied on grain yield. In combined mean, increasing NPK rate increased grain yield significantly from 0 to 60kg N ha^{-1}, which was not significantly different from application of 120kg N ha^{-1}. The increase in grain yield with increase in nitrogen fertilizer application clearly indicates the important role of nitrogen enhancing chlorophyll, nucleotides, alkaloids, proteins, enzymes, hormones and vitamins production and photosynthesis which improved assimilates production for subsequent translocation to grains [21]. This indicated the effect of nitrogen as a basic component of many physiological processes in plants. The significant increase in grain yield observed in this study could be attributed to the fact that maize plants that received NPK used effectively the applied nitrogen to enhanced better performance on yield components which could have led to better yield for NPK treated plants than plants in the zero NPK control plots [26]. The increased grain yield with nitrogen application is corroborates the findings of other who reported increases in grain yield of maize [29,30,31].

Interaction between green manure and NPK on grain yield was significant in 2015, 2016 and combined means (Fig. 4). The interaction between green manure and nitrogen on grain yield of maize in combined means showed that at a given N rate, weedy fallow produced the lowest grain yield while lablab green manure at 60kg NPK ha^{-1} produced highest grain yield. At a given legume green manure, increasing NPK rate beyond 60kg NPK ha^{-1} produced no significant difference on grain yield for centro, mucuna, lablab and sesbania green manures, respectively.

Interaction of green manure and nitrogen fertilizer rate indicated that, 60 kg NPK ha^{-1} can be applied to maize following lablab incorporation with significant increase in maize yield. The combined effect of lablab green manure and 60 kg NPK ha^{-1} gave a maximum yields which saved 60 kg NPK ha^{-1} when compared to the recommended rate of 120 kg NPK ha^{-1} for maize production in Nigeria savanna.

Incorporation of green manure crops affected stover yield in all the two years of study and their combined mean (Table 3). In 2015 and combined mean, lablab green manure produced significantly higher stover yield than centro and weedy fallow. In 2016, incorporation of lablab green manures gave higher stover yield than incorporation of sesbania, mucuna and centro which were statistically similar. In combed mean, incorporation of green manure crops significantly increased stover yield by 28.0, 50.1, 36.9 and 34.16% over weedy fallow for centro, lablab mucuna, lablab and sesbania, respectively. Similar results on the benefits of green manure residues incorporation on maize stover yield has been reported by [32,33]. In 2015, 2016 and combined mean (Table 3) application of 60kg N ha^{-1} significantly increased stover yield but a further increase produced no significant effect on NPK rates. In 2015 application of 60 and 120kg NPK ha^{-1} produced significantly similar but higher stover yield than control. Increased stover yields with increasing levels of nitrogen was due to significant increase in plant height, LAI and dry matter accumulation with application of nitrogen was mainly responsible for increasing stover yields [34]. The interaction between green manure and NPK on stover yield of maize in combined means showed that highest stover yield was obtained with a combination of lablab green manure and 60kg NPK ha^{-1}. The smallest stover yield was produced when weedy fallow received no NPK fertilizer. This is attributed to enhanced crop growth rate, net assimilation rate and dry matter production per plant which ultimately increased stover yield of maize [35].

Table 3. Effects of treatments on cob yield, stover yield and grain yield of maize in 2015, 2016 and combined

Treatment	Cob yield (kg ha-1)			Stover yield (kg ha-1)			Grain yield (kg ha-1)		
	2015	2016	Mean	2015	2016	Mean	2015	2016	Mean
Legume									
Centro	2013^{d}	2066^{a}	2039^{c}	651^{c}	2129^{b}	1390^{b}	1362^{d}	1385^{b}	1373^{c}
Lablab	2523^{a}	2379^{a}	245^{a}	740^{a}	2521^{a}	1631^{a}	1649^{a}	1685^{a}	1667^{a}
Mucuna	2283^{b}	21.80^{a}	2231^{b}	662^{c}	2313^{b}	1487^{ab}	1490^{b}	1551^{ab}	1521^{b}
Sesbania	2092^{c}	2119^{a}	2105^{bc}	697^{b}	2217^{b}	1457^{b}	1396^{c}	1435^{b}	1415^{c}
Fallow	1405^{e}	1482^{b}	1441^{d}	589^{d}	1583^{c}	1086^{c}	816^{e}	882^{c}	849^{d}
SE±	11.03	105.4	52.66	11.96	62.75	56.61	6.328	71.74	32.38
Nitrogen Kg ha-1									
0	2266^{c}	2009^{b}	2138^{c}	638^{b}	2229^{c}	1434^{b}	1365^{c}	1379^{b}	1372^{b}
60	2674^{a}	2735^{a}	2705^{a}	773^{a}	2783^{a}	1778^{a}	1902^{a}	1931^{a}	1916^{a}
120	2565^{b}	2517^{a}	2541^{b}	751^{a}	2583^{b}	1667^{a}	1814^{b}	1863^{a}	1839^{a}
SE±	10.21	97.59	50.59	11.07	58.10	54.39	5.859	66.42	31.11
Interaction									
L X N	***	NS	**	***	***	**	***	NS	**

*LS = Level of significance, NS = Not significant, * and ** = significant at 0.05 and 0.01 respectively. Means followed by different letters are statistically different following Duncan Multiple Range Test (DMRT)*

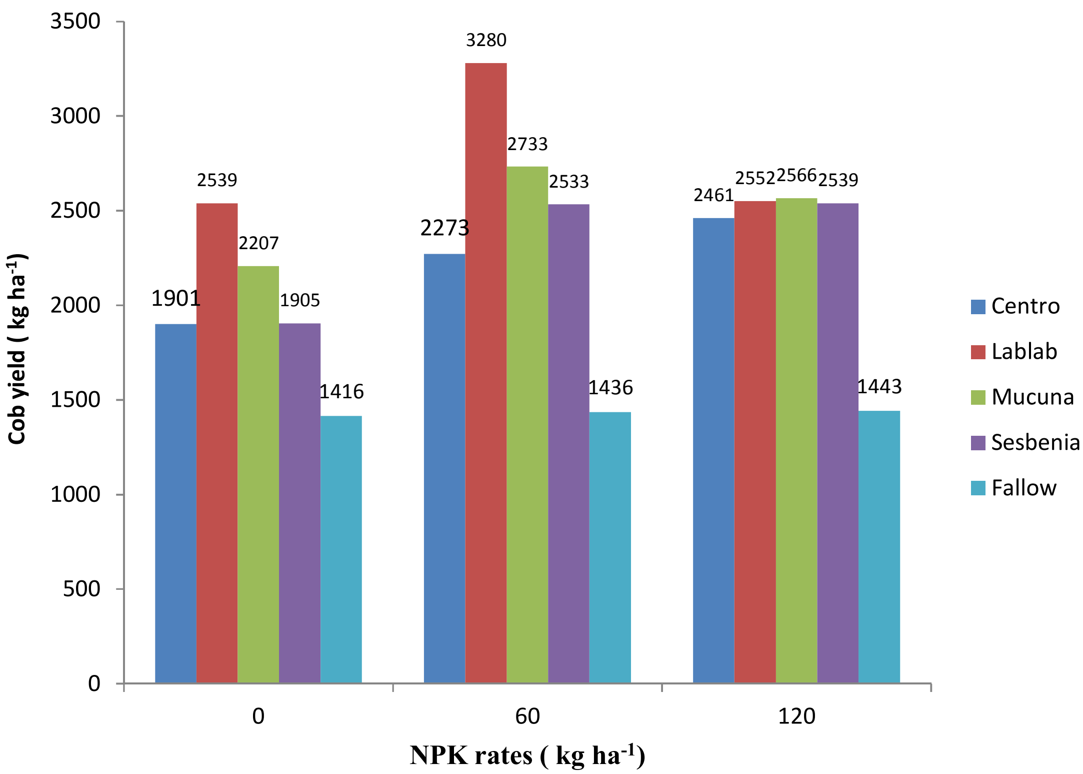

Fig. 4. Interaction between green manure and NPK rates on cob yield (kg ha-1), LSD $_{0.05}$ = 327 (Combined analysis)

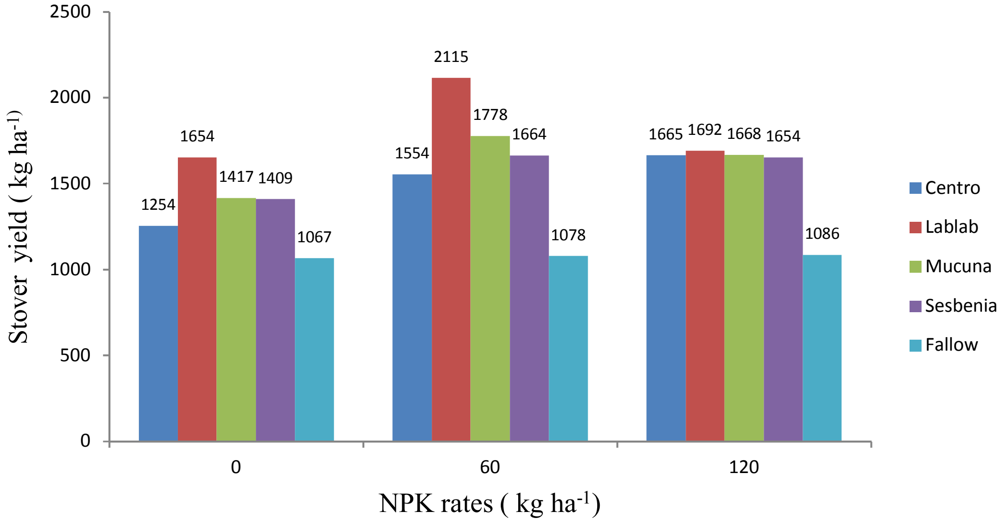

Fig. 5. Interaction between green manure and NPK rates on Stover yield (kg ha-1), LSD $_{0.05}$ = 179.9 (Combined analysis)

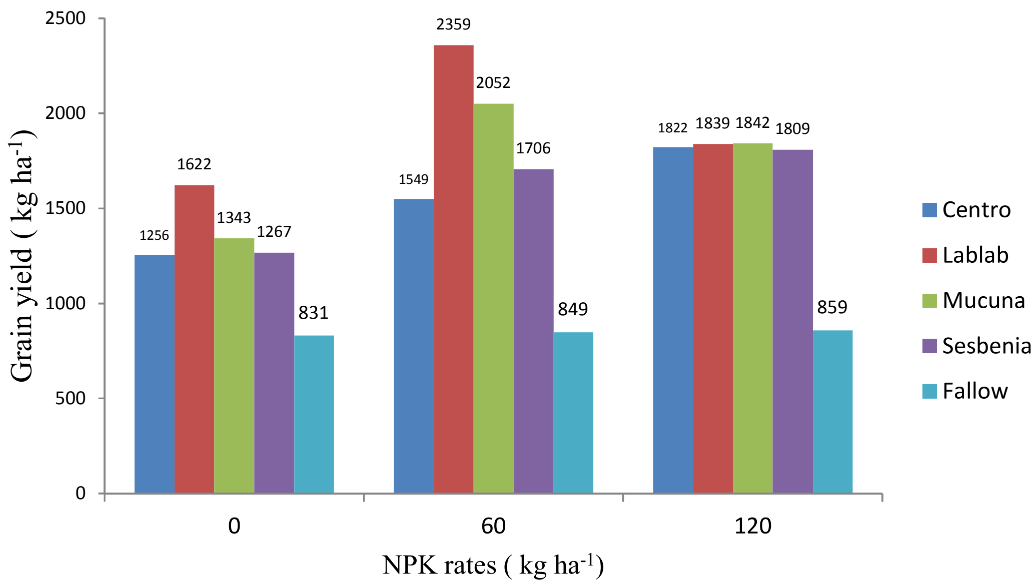

Fig. 6. Interaction between green manure and NPK rates on Grain yield (kg ha-1), LSD $_{0.05}$ = 224 (Combined analysis)

4. CONCLUSION

Evaluation of the overall results of this study showed that use of green manure not only solve increasing cost of chemical fertilizers and its environmental problems but also increased crop production and grain yield of maize grain. It was also reported that incorporated legumes alone can give grain yield increases comparable to ones that can be obtained at 60 kg N ha-1 and 120 kg N ha-1. Nitrogen fertilization showed marked increases on the yield attributes measured and application of 90 kg N ha-1 was found to be the best rate for grain yield and most of the yield components of maize studied. However, use of chemical fertilizers alone has not provided adequate measure in the improvement of soil fertility for sustainable maize production. This study has also revealed that N fertilizer application to sweet corn can be reduced by 60 kg ha^{-1} N if it is preceded by incorporated legumes.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. FAO. Faostat. Retrived August 10, 2014. Available:http://faostat.fao.org/site/339/default Aspx. 2012.
2. Lake Chad Research Institute (LCRI). Annual Report Maiduguri, Nigeria. 2007; 41.
3. USAID Foreign Agricultural Service, WASDE Report. (World Agricultural Supply and Demand Estimate), Factsheet no. 560; 2016.
4. Food and Agriculture Organization. FAOSTAT, Production Statistics. 2009. Available:http://faostat.fao.org/site/567/default.aspx#ancor, Accessed 24 July 2015.
5. Fertilizer Procurement and Distribution Division, (FPDD). Fertilizer use and management practices for Crops in Nigeria. 5th Edition; 2011.
6. Eche NM, Iwuafor ENO, Amapui IY, Bruns MV. Effect of application of organic and mineral soil amendments in a continuous cropping system for 10 years on chemical and physical properties of an Alfisol in Northern Guinea Savanna zone. International Journal of Agricultural Policy and Research. 2013;1(4):116-123.
7. Odunze AC, Jinshui W, Shoulong L, Hanhua Zhu, TG, Yi Wang, QL. Soil quality changes and quality status: A case study of the subtropical china region ultisols. Brazilian Journal of Environment and Climate Change. 2012;2(1):37-57.
8. Busari MA, Adekunle IOl, Azeez JO. Effect of poultry manure and Phosphorus application on the productivity and fodder quantity of two centrosema species in an Alfisol. In: Salako FK, Adetunji MT, Ojanuga AG, Arowolo TA, Ojeniyi SO. Managing soil resources for food security and sustainable environment. In proceeding of the 29th Annual Conference of Soil Science Society of Nigeria 6-10 December, 2004, University of Agriculture, Abeokuta; 2005.
9. Mustapha S, Voncir N, Abdulhamid NA. Status of some available micronutrient in the haplicusters of akko local government area of gombe state, Nigeria. International Journal of Soil Science. 2011;6:267-274.
10. Ojanuga AG. Agro-ecological zones of Nigeria manual. FAO/NSPFS, Federal Ministry of Agriculture and Rural Development, Abuja, Nigeria. 2006;124.
11. Ibrahim AK, Voncir N, Askira MS. Effect of incorporated legumes, NPK 20-10-10 and their combination on soil chemical properties of pearl millet grown soil (*Pennisetum Glaucum* (L.)). Dutse Journal of Agriculture and Food Security (DUJAFS). 2017;4(1):126–135.
12. SAS Institute, Statistical Analysis System (SAS) User's Guide (Version 9.0). SAS Institute, Inc. North Carolina. USA; 2002.
13. Duncan DB. Multiple Ranges and Multiple F-tests. Biometrics. 1955;11:1-42.
14. Page AL, Miller RH, Keeney DR. Methods of soil analysis, part-2. 2nd Edn. American. Soc. Agron. Inc. Madison, Washington, USA. 1982;98-765.
15. Khan HZ, Malik MA and Saleem MF. Effect of rate and source of organic material on the production potential of spring maize (*Zea mays* L.). Pakistan Journal of Agricultural Sciences. 2008;45:40-43.
16. Abreha K. Soil acidity characterization and effects of liming and chemical fertilization on dry matter yield and nutrient uptake of wheat *(Triticum Aestivum L.)* on soils of Tsegede District, Northern Ethiopia. PhD Dissertation, Haramaya University, Haramaya, Ethiopia; 2013.
17. Ganunga RP, Yerokun O, Kumwenda JDT. Contribution of Tithonia diversifolia to yield and nutrient uptake of maize in Malawian small-scale agriculture. South African Journal of Plant and Soil. 2005;22(4):240–245.
18. Singh Y, Singh B, Khind CS. Nutrient transformations in soils amended with green manures. Advance Soil Science. 1992;20:238–298.
19. Pushpavalli R, Natarajan K, Palaniappan SP. Effect of green manure on ammonia release pattern in rice soils. International Rice Research Notes, 1994;19:16-17.
20. Palm C, Nziguheba G, Gachengo C, Gacheru E, Rao MR. Organic materials as sources of phosphorus. Agroforestry Forum. 1999;9:30-33.
21. Bationo A, Ntare BR. Rotation and nitrogen fertilizer effects on pearl millet,

cowpea and groundnut yield and soil chemical properties in a sandy soil in the semi-arid tropics, West Africa. Journal of Agricultural Science. 2000;134:277–284.
22. Muhammad J, Khan A, Saeed K. Grain legume effect soil nitrogen, grain yield and nitrogen nutrition of wheat. Journal of Crop Sciences. 2005;37:734-739.
23. Amanullah KKM, Khan A, Khan I, Shah Z, Hussain Z. Growth and yield response of maize (*Zea mays L.*) to foliar NPK-fertilizers under moisture stress condition. Soil Environment. 2014;33(2):116-123. Www.se.org.pk Online ISSN: 2075-1141.
24. Gul S, Khan MH, Khanday BA, Nabi S. Effect of sowing methods and NPK levels on growth and yield of rain fed maize (*Zea mays* L.). Scientifica. 2015;6.
Article ID 198575.
Available:http://dx.doi.org/10.1155/2015/198575
25. Mohsin AU, Ahmad J, Ahmed AUH, Ikram RM and Mubeen K. Effect of N application through different combinations of urea and farm yard manure on the performance of spring maize (*Zea mays*). Journal of Animal and Plant Sciences. 2012;22(1): 195-198
26. Adesoji AG, Abubakar IU, Labe DA. Contributions of short duration legume fallow to maize (*Zea mays* L.) under different nitrogen levels in a semi-arid environment. American Journal of Experimental Agriculture. 2013;3(3):542-556.
27. Kaleen F. Biological nitrogen fixation in soybean sorghum intercropping system. In Karanja N & Kakindi, J.H (eds) Challenges and Imperatives for biological nitrogen fixation research and application in Africa for the 21st century. Ninth Conference of the Africa Association for biological nitrogen fixation. Nairobi, Kenya. 2000;50 – 62.
28. Shanwad UK, Aravindkumar BN, Hulihalli UK, Ashok Surwenshi, Mahadev Reddy, Jalageri BR. Integrated nutrient management (INM) in maize- bengal gram cropping system in Northern Karnataka. Res. J. Agric. Sci. 2010;1(3):252-254.
29. Inamulhaq A, Jakhro AA. Soil and Fertilizer Nitrogen. In: Soil Science. A. Bashir and R. Bantel (eds). National Book Foundations Islamabad, Pakistan. 1996; 261-289.
30. Usman A, Garba A, Voncir N, Ibrahim AK. Effect of legumes in residual and rates on the performance of maize in northern guinea savanna of Nigeria .In: Ojeniyi SO, Agbede OO, Agbede, Jayeoba OJ. Soil Science, Environmental Management and Food Security: In Proceeding of the 37th Annual Conference of the Soil Science Society of Nigeria: At Ta'al Conference Hotel, Lafia. 2013;54-61.
31. El-Gizawy NKB. Effects of nitrogen rate and plant density on agronomic nitrogen efficiency and maize yields following wheat and Faba bean. American-Eurasian Journal of Agricultural and Environmental Sciences. 2009;5(3):378–38.
32. Mureithi JG, Gachene CKK, Wamuongo JW. Participatory evaluation of residue management effect on green manure legumes on maize yield in the central Kenya highlands. Journal of Sustainable Agriculture. 2005;25:49-68.
33. Makinde EA. Effects of an organol-mineral fertilizer application on the growth and yield of maize. Journal of Applied Science Research. 2007;3:1152-1155.
34. Thirupathi I, Vidya Sagar GE, Suneetha Devi CPK, Band Harish Kumar Sharma S. Effect of nitrogen and sulphur levels on growth, yield, quality and economics of single cross hybrid maize (*Zea Mays. L*). International Journal of Science, Environment and Technology, 2016;5(5): 2989–2998.
35. Rasheed M, Mahmood T, Nazir MS. Response of hybrid maize to different planting methods and nutrient management. Pakistan Journal of Agricultural Science. 2003;40(1-2):39-42.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history/23632