

Original Research Article

EFFECT OF POULTRY MANURE AND UREA ON SOIL CHEMICAL PROPERTIES, NODULATION AND YIELD OF GROUNDNUT (*Arachis hypogaea*) IN AKANULBIAM FEDERAL POLYTECHNIC, UNWANA AFIKPO EBONYI STATE

ABSTRACT

A Green House study was carried out at the Teaching and Research Farm, Department of Horticulture and Landscape Technology to investigate the influence of the integrated application of poultry manure and urea on soil nutrient properties, nodulation, growth and yield of groundnut (*Arachis hypogaea*) in Akanulbiam Federal Polytechnic, Unwana Southeastern Nigeria. The experiment was laid out into Complete Randomized Design with different levels of poultry manure (0, 1 and 2 tons ha⁻¹) and urea (0, 1 and 2 tons ha⁻¹) replicated three times. Results showed that poultry manure applied alone or combined with urea significantly ($P < 0.05$) improved almost all the soil nutrient properties. Relative to control, best improvements on soil fertility indices such as soil pH, available phosphorus, total nitrogen, organic carbon, Total Exchangeable Acidity (TEB) and Effective Cation Exchange Capacity (ECEC) were obtained in the pot treated with poultry manure 2 tons ha⁻¹ poultry manure and urea 1 ton ha⁻¹ urea. Similarly, poultry manure integrated with urea significantly ($P < 0.05$) improved number of leaves and number of pods. Application of urea without poultry manure increased number of leaves better than the lone application of poultry manure, while poultry manure and its integration with urea had significant higher improvement on the number of pods compared with alone application of urea. The maximum highest improvement on the number of leaves and pod was obtained when poultry manure was applied at 2 tons ha⁻¹ poultry manure was integrated with urea at 1 ton ha⁻¹ urea. It was also observed that the number of nodules increased with poultry manure application while inverse relationship existed between the number of nodules and decreased with application of urea application. The highest number of nodules and hence nodulation occurred when 2 tons ha⁻¹ poultry manure was applied, while the least was noted when 2 tons ha⁻¹ urea was added. Integration of urea with poultry manure is therefore recommended to improve soil fertility conditions and grain yield of groundnut. Also, large amount of urea should not be used in groundnut production; rather poultry manure should be incorporated to enhance nodulation and nitrogen availability in soils of Unwana Southeastern Nigeria.

Key words: Poultry manure, urea, nodulation and groundnut.

INTRODUCTION

Groundnut is an edible legume which serves as one of the main sources of income for small holders and commercial farmers. It is mainly grown for its edible seed, and is widely grown in tropics and subtropical regions as grain legume. Because of its high oil content, it has also been classified as oil crop. The seeds contain sufficient amount quantities of protein (19%), carbohydrate (63%), fat (6.5%) and essential amino acid such as lysine, cysteine and methionine (Lineman 1988; Brough and Azam Ali, 1992). It is cultivated in at altitude ranging from 0-1550m and is generally intercropped with cereals, cassava, yam and cow pea. By fixing It fix atmospheric nitrogen, groundnut and hence improves the soil supply of nitrogen that play its role as a restorative crop is of benefit to other crops (Mukurumbia, 1985). In Nigeria, it is cultivated the cultivation of groundnut is done majorly in the northern regions, characterized by yellow ferratitic soil, with low fertility due to sandy texture structure (Duchaufor, 1976). Since the nitrogen requirement for the other crop (intercropped) is met through nitrogen fixation, therefore the interest has

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43 been developed in cultivation of groundnut for its tremendous potentials both as food and in soil fertility
44 maintenance (Somasegaran *et al.*, 1992).

45 Crop production in Nigeria is hindered by several factors such as low soil fertility as well as restricted access to
46 mineral fertilizer (Nyanabgara and Nyaguambo, 2010). In Nigeria, farmers are always faced with the problem of soil
47 fertility decline which has been considered the most important biophysical constraints to crop yield and productivity
48 (Odendo *et al.*, 2004).

49 Developing soil fertility management options for increasing productivity of staple food crops is a challenge in most
50 part of Nigeria, where soils are constrained by the major mineral element such as potassium, nitrogen and
51 phosphorus deficiencies (Jemo *et al.*, 2010). Nitrogen, Phosphorus and potassium are among the limiting nutrients
52 for legumes production (Christianson and Vick, 1991). Adequate supply of nitrogen is beneficial for carbohydrates
53 and protein metabolism, promoting cell division and cell enlargement (Shehuet *et al.*, 2010).

54 ~~In order to ensure sustained crop production in the inherently low fertility status of tropical soils, several nutrient~~
55 ~~and fertility management options have been developed by many researchers and these include the addition of~~
56 ~~organic and inorganic fertilizers, conservational tillage, mulching and crop rotation (Brady and Weil 2008).~~
57 ~~Integration of inorganic manures such as urea and poultry manure into the farming system can be a cheaper~~
58 ~~alternative to alleviating low soil fertility and erosion problems (Odendo *et al.*, 2004).~~

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59 ~~Poultry manure is a nutrient source of crop production (Soremi *et al.*, 2017) and its addition to the soil has been~~
60 ~~shown to increase soil nutrient indices. Similarly, incorporation of poultry manure into soil promotes transformation~~
61 ~~and mineralization of less labile inorganic and organic phosphorus into labile phosphorus in the rhizosphere, which~~
62 ~~results in higher root phosphorus concentration and higher total phosphorus uptake by plants (Waldrip *et al.*, 2011).~~
63 ~~Therefore, poultry manure could be a valuable fertilizer and could serve as a suitable alternative to chemical~~
64 ~~fertilizer in Nigeria.~~

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65 Apart from the addition of both mineral and organic nitrogen fertilizers, there is another viable and ecologically
66 friendly strategy for improving nitrogen content of soils. This process which is called biological nitrogen fixation is
67 specifically reserved for leguminous crops (Brady and Weil 2008). A relatively small amount of nitrate or ammonia
68 is produced by lightening, some are produced industrially by the Haber-Bosch process, but the major conversion of
69 Nitrogen (N₂) to ammonia and hence protein is achieved by microorganisms that inhabit the root nodules of legumes
70 in the process of nitrogen fixation (Sorensen and Sesitch, 2007). The process of biological nitrogen fixation in
71 legume nodules is an important soil fertility improvement strategy especially nitrogen economy in many tropical
72 ecosystem (Frankow-Lindberg and Dahlin, 2013). ~~Legumes offer the potential of fixing nitrogen to the soil through~~
73 ~~biological fixation process which provides a more sustainable nutrient recycling that can enhance crop yields and~~
74 ~~improve soil fertility, with the ability to fix nitrogen (Amba *et al.*, 2013). Almost all the fixed nitrogen goes directly~~
75 ~~into the plant, however, Walley *et al.*, (1996), stated that most of the nitrogen eventually returns to the soil when~~
76 ~~vegetation of legume dies and decomposes and this can be made use of by the up coming crop non-leguminous~~
77 ~~crops~~

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78 Even though several literatures have stated that leguminous crops can derive their maximum nitrogen requirement
79 from biological nitrogen fixation and therefore require no external nitrogen fertilizer application, there is still need to
80 practically investigate the effect of different fertilizer sources on nodulation of groundnut. This study was therefore
81 designed to evaluate the effect of poultry manure and urea on soil chemical properties, nodulation and yield of
82 groundnut (*ArachisHypogea*) in Unwana, south South eastern Eastern Nigeria.

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83 MATERIALS AND METHODS

84 The study was carried out at Horticultural Farm of Akanulbiam Federal Polytechnic Unwana. Unwana is located
85 within the South Eastern ecological zone of Nigeria and lies at latitude 5° 48N and longitude 7° 55E (Njoku and
86 Okpara, 2006). The climatic condition and vegetation types are generally humid tropical rain forest with mean
87 annual rainfall of about 3,500mm and mean daily temperature of 21°C to 32 °C (Odurukwe *et al.*, 1995).

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88 POT EXPERIENCE

89 Soils sample which was collected from 0 – 20cm depth, was air dried, sieved through 2mm sieve after which 5kg of
90 sub-samples were weighed into 10 litre capacity buckets perforated at the bottom.

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91 Appropriate weights of poultry manure and urea were added to each pot. The experiment was laid out into Complete
92 Randomized Design with different levels of poultry manure (0,1 and 2 tons ha⁻¹) and urea (0, 1 and 2 tons ha⁻¹)
93 replicated three times. Four groundnut seeds were sown in each pot after one month of treatment application and
94 later thinned down to two seeding per bucket after germination. Adequate watering was observed throughout the
95 growing period.

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96 DATA COLLECTION

97 At full bloom (50 days after planting) number of nodules per plant was determined from one plant in each pot. The
98 seedlings was carefully uprooted and washed, all the soil particles was removed and then the nodules were counted
99 (Faizah, 1980; Osodeke, 2002). At full maturity, the other plant in each pot was uprooted and both the number of
100 leaves and pods were obtained by counting.

101 Post-harvest soils samples were collected from each pot and analyzed for routine chemical properties according to
102 standard laboratory procedures. Particle size distribution was determined using the Bouyocous hydrometer method
103 as describe by Benton (2001). The pH was determined in soil to water and soil to CaCl₂ at a ratio 1:2 soil water and
104 soil CaCl₂ respectively using glass electrode P^H meter (Udo *et al.*; 2009). Organic carbon was determined by the wet
105 oxidation method according to Pansu and Gautheyrous (2006) and converted to organic matter by multiplying by
106 1.792. Available P was determined using the Bray II method of Bray and Kurtz (1945) as described by Udo *et al.*;
107 (2009). The total nitrogen determination was done by the macro Kjeldahl digestion method (Simmone *et al.*, 1994).
108 Exchangeable acidity was determined by the nikel extraction procedure as described by Kamprath (1967).
109 Exchangeable basic cations (K⁺, Ca²⁺, Mg²⁺, Na⁺) were determined by the ammonium acetate method (Carter and
110 Gregoich, 2008). Ca and Mg in the extract were determined using the atomic absorption spectrophotometer, while K

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and Na were determined using the flame photometer. Effective cation exchange capacity (ECEC) was obtained by summation of all the exchangeable cations and exchangeable acidity as described by Udo, *et al*; (2009). The base saturation was obtained mathematically with BS (%) = $\frac{\text{Total cation}}{\text{Total cation} + \text{Total acidity}} \times 100$

ECEC 1

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STATISTICAL ANALYSES

Data from yield parameters, number of nodulation and soil chemical properties were subjected to analysis of variance (ANOVA) and the means separated using FLSD 0.005.

RESULTS AND DISCUSSIONS

Table 1. Physical and Chemical Properties of the Soil used for the Study experiment.

Properties	values
Sand %	40.13
Silt %	21.56
Clay %	38.31
Texture	clayey-loam
PH (H ₂ O)	4.27
PH (CaCl ₂)	3.78
Organic carbon %	1.90
Organic matter %	3.29
Total Nitrogen %	0.25
Available Phosphorus (mg/kg)	5.62
Ca (cmol/kg)	3.18
K (cmol/kg)	0.06
Mg (cmol/kg)	1.00
Na (cmol/kg)	0.02
TEA (cmol/kg)	4.10
ECEC (cmol/kg)	8.27
B.S %	51.51

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The physical and chemical properties of the soil used for the study is presented in Table 1 [above](#). The result showed that the sand, silt, and clay percentages were 40.13, 21.56 and 38.31% respectively. The textural class of the soil was a clayey – loam. [This These findings is are](#) in agreement with the result of Azu *et al.* (2017), who reported a clayey – loam soil in [some soils of](#) Ebonyi State. Soil [p^H](#) values both in H₂O and CaCl₂, showed that the soil was acidity, which suggest the need for liming in order to improve the soil productivity. Several other researchers (Onwuka *et al.*, 2007; Eneje and Azu, 2009) have also reported acidity in most soils of South – Eastern Nigeria. Both organic carbon and organic matter [were was](#) moderately low (1.90 and 3.29% [respectively](#)) [respectively](#). [The total nitrogen and phosphorus was found at low concentration also low](#) (0.25%). [The available phosphorus was also low](#) (5.62mg/kg) indicating high fixation and hence low phosphorus availability. The value of phosphorus was lower than the critical value of 15mg/kg⁻¹ suggested by Osodeke and Ubah (2005), [for tropical crops](#). Calcium was relatively high (3.18cmol/kg⁻¹). The [Total total Exchangeable exchangeable Acidity acidity](#) (TEA) was high (4.01cmol/kg) indicating the influence of aluminum and iron oxides [in this soil as noted by](#) (Azuet *al.*, 2017). The [Effective effective Cation cation Exchange exchange Capacity capacity](#) (ECEC) was moderate (8.27cmol/kg) and [Base base Saturation saturation](#) (BS) was also relatively moderate (51.51%). Most studies conducted across South [eastern Eastern](#) Nigeria showed that most soils are acidic, low in soil organic carbon (SOC), available N, [and available](#) P, K, [and S contents](#) and some micronutrients (Azu *et al.*, 2017; Eneje and Azu 2009). These nutrient deficiencies can affect not only plants but also soil microbes including rhizobia populations (Brady and Weil, 2008) and [its their](#) activities such as N₂ fixation (Osodeke, 2002).

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Table 2: [Results of analyzed poultry manure used for the experiment](#) [Characteristics of the Poultry manure used for the Study](#)

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Properties	Values
pH (H ₂ O)	8.22
pH (CaCl ₂)	8.02
Av.P (PPM)	0.95
Nitrogen (%)	1.88
Calcium (%)	5.70
Magnesium (%)	1.90
Potassium (%)	0.51
Sodium (%)	0.069
Organic carbon (%)	4.07

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[Mean](#) [Effect of Poultry poultry Manure manure and Urea urea on Soil soil Chemical chemical Properties properties](#)

Result of the effect of poultry manure and urea on soil fertility properties is shown in Table 3. Relative to control, the application of poultry manure as lone treatments generally resulted in increased soil pH both in water and in salt. The observed increase was proportional to the rate of amendment. There were consistent decline in soil pH with increasing addition of urea as lone treatment. This observation may be attributed to the fact that poultry manure being an organic material contains large amount of basic cations which factored in the reduction of soil acidity.

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Table 3. Mean effect of Poultry manure and urea on soil chemical properties

Rate of Application (t/ha)	pH		Aval. P (mg/kg)	Org. C (%)	Total N (%)	Exc. Bases (Cmol/kg)	Exc. Acidity (Cmol/kg)	ECEC (Cmol/kg)	BS (%)
	H ₂ O	CaCl ₂							
0	4.13	3.85	4.68	0.89	0.19	4.17	2.97	7.14	58.40
0 + 1	4.00	3.69	4.99	0.76	0.23	5.00	3.23	8.23	60.75
0 + 2	3.79	3.44	5.55	0.90	0.29	4.94	3.60	8.54	57.85
1 + 0	5.40	4.71	5.63	2.60	0.21	6.63	2.21	8.84	75.00
1 + 1	5.64	5.08	6.02	2.60	0.28	8.92	2.33	11.25	79.29
1 + 2	4.32	4.24	5.10	1.99	0.39	8.71	2.42	11.13	78.26
2 + 0	6.07	5.65	7.15	3.02	0.34	9.76	1.00	10.76	90.71
2 + 1	6.08	5.76	7.39	2.93	0.42	10.81	1.09	11.90	90.84
2 + 2	5.59	5.09	6.48	2.77	0.44	9.54	1.11	10.65	89.58
Mean	5.06	4.59	5.89	2.05	0.31	7.61	2.22	9.83	75.63
SD(0.05)U	0.126	0.0055	0.192	0.127	0.019	0.0022	NS	NS	NS
SD(0.05)PM	0.121	0.0203	0.192	0.127	0.019	0.0030	0.00014	NS	2.114
SD (U XPM)	0.237	0.334	0.371	0.260	0.038	0.0065	0.0177	0.135	3.008

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This attribute of poultry manure can be harnessed and used as lime in reducing soil acidity. (Onwunka et al 2007). On the other hand, urea being a mineral fertilizer with no organic component may have been responsible for increased acidity as observed. This report is consistent with the results of other researcher (Azuet al., 2017). The interaction between the poultry manure and urea showed high significant (P<0.05) in improving in the soil acidity in consonant with the reports of other researchers (Adediran et al., 1999; Azuet al., 2017., FAO, 1976) who reported better performance in soil acidity when organic and inorganic fertilizers are combined. The pH

values ranged from 6.08 to 3.79 and the highest value was obtained at the treatment combination of 2t/ha¹ poultry manure and 1t/ha¹ urea. With the exception of ECEC, the lone application of poultry manure was significant (P<0.05) in **improving improvement** the soil nutrient indices, but the lone application of urea was only significant in influencing the **p^H**, N and the **Exchangeable exchangeable** bases. However, the interaction between the two **materials treatments** was highly significant (P<0.05) in influencing the pH, total nitrogen, exchangeable bases and exchangeable acidity. **The mean table showed that relative to control, the treatments especially their interaction showed greater improvement on soil chemical properties. Other researchers (Eneje and Azu, 2009; Soremiet *et al.*, 2017; Adekiya and Agbede, 2016) have reported improvement on soil chemical properties when poultry manure was used as fertilizer.**

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Mean Effect of Poultry poultry Manure manure and Urea urea on Number number of Nodules nodules

With the exception of urea as lone treatments, the number of nodules was observed to significantly (P<0.05) differ among the various treatments and their combinations. As shown in figure 1, the addition of poultry manure as lone treatment had significant (P < 0.05) increasing effect on the number of nodules relative to control and the increased was proportional to the rate of amendment. **Theseis** finding **are is** similar to those reported by Panda *et al.*, (2012) who found that poultry manure boosts the effectiveness of **Rhizobium rhizobium** in cowpea. Consequently, the highest number of nodules (196) was obtained in the pot that had **poultry manure at 2t/ha¹ poultry manure**. This observation can be attributed to the fact that poultry manure in addition to nitrogen and other elements contains large amount of organic **phosphorus phosphates** which **when** mineralized **and** enrich the soil with the **available availability forms** of phosphorus which **factors efficiently in increased** nodulation of legumes **as noted by other researchers** (Osodeke, 2002; Amba *et al.*, 2013; Thedchanamoorthy and Gurung, 1999; Lomoro, 2008; Naveenkurma *et al.*, 2015). Therefore the nodules produced by the **plant pot** that **had at 2t/ha¹ poultry manure** was significantly higher than the other treatment **levels considered in this study**. Result also showed that the number of nodules was only higher (110.00) in **pot plant** that had 1t/ha¹ urea **relative compare** to control (84.67) and subsequently, the number of nodules decreased with increased rate of urea application **(54.50). as lone treatments and the least amount of nodules (54.50) was recorded in pot that had 2t/ha urea**. Nodulation in legumes has been known to require initial nitrogen to boost the process, after which continuous addition of mineral nitrogen may adversely affect the nitrogen fixing organisms. High amount of nitrogen application have been reported to reduce the rate of nodulation, but little quantity have been reported to enhance early vegetative **crop** growth without compromising the process of nodulation (Anteneh, 2015, ; Amba *et al.*, 2013). Therefore increased application of poultry manure led to corresponding increase **on in** the number of nodules, while urea application rate was inversely proportional to the number of nodules.

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Mean Effect of Poultry poultry Manure manure And and Urea urea Number on number of Leaves.

As shown in figure 1 below, the The application of poultry manure and urea both **as single alone** and combined treatments had significant (P<0.05) effect on the number of leaves. Generally, these treatments increased the number of leaves **relative compare** to the control. **experiment and the observed increases were directed proportional to the rate of treatment application. Compared to the lone application of poultry manure, the single application**

239 | of urea gave higher number of leaves. The application of urea produced maximum number of leaves compared to
240 | lone application of poultry manure. This observation may be due to the quick release of nitrogen by urea in relation
241 | to poultry manure which takes longer time to release its nutrient content (Gunri and Nath, 2012). Nitrogen has been
242 | known to improve the vegetative growth of plants, therefore, the quicker its release the more the leaf growth
243 | (Brady and Weil, 2008). It was also observed that the interaction between the two fertilizer materials had better
244 | improvement on the number of leaves compared to the single application of either of the materials. This report is
245 | in accord with the report of Naveenkurma *et al.*, (2015). The highest number of leaves (110.00) was obtained in the
246 | plant pot that had 2t/ha⁻¹ poultry manure and 2t/ha⁻¹ urea while the least value (55.00) was obtained in the plant
247 | pot that had only 1t/ha⁻¹ urea. The most impressive report on the number of leaves observed in experimental pots
248 | that had different combinations of poultry manure and urea agreed with the recent emphasis of supplementation of
249 | mineral fertilizers with organic manures for better crop performances and sustainable soil fertility maintenance
250 | (Adediran *et al.*, 1999; Azu *et al.*, 2017).

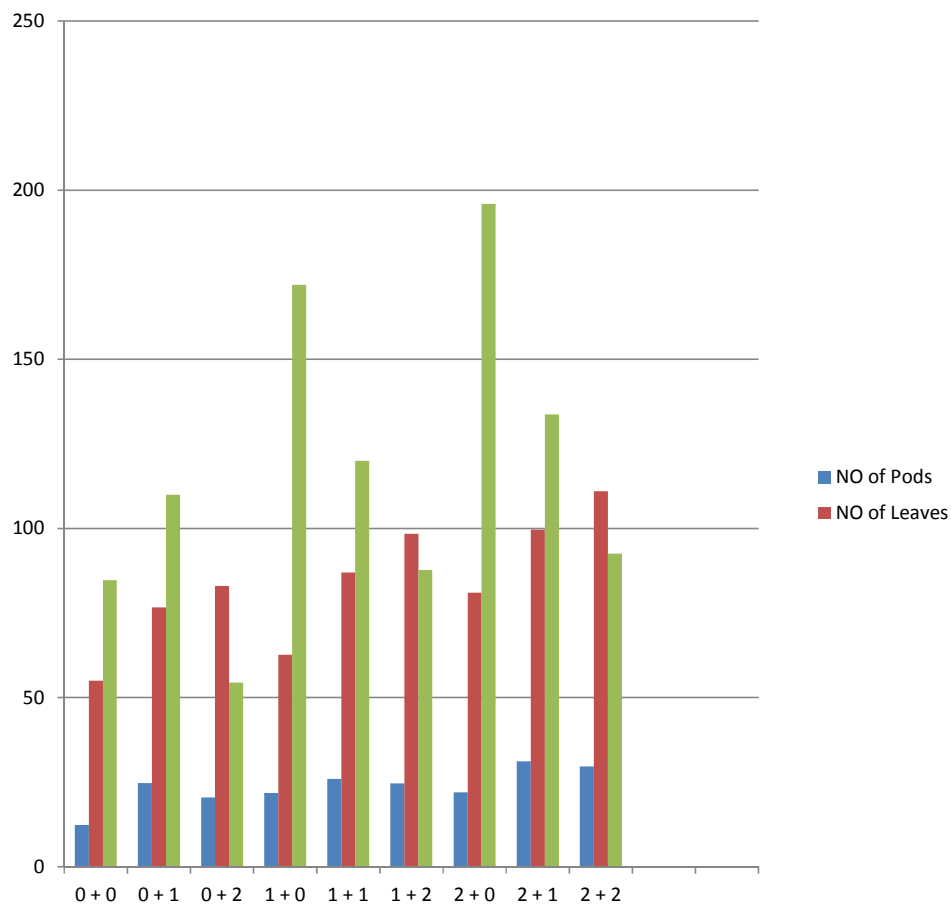
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252 | **Figure 1. Number of Nodules, growth and yield components of Groundnut as affected by**
253 | **the addition of Poultry manure and Urea.**

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Mean Effect of Poultry Manure and Urea on Number of Pod

Number of pods showed significant ($P < 0.05$) response to the application of poultry manure and urea both as single or combined treatments. Figure 1 showed that the number of pods ranges from 31 to 12. It was observed that the interaction between the two amendments consistently gave higher values of the number of pods compared to either application of both materials as lone treatments. It was also observed that the increase in the number of leaves did not necessarily have a corresponded increase in the number of pods. Naveenkurma *et al.*, (2015), also made similar observation. This observation can be explained on the fact that, while nitrogen may be responsible for the leave growth, other nutrient element especially phosphorus which is in abundance in the poultry manure might have factored more in the seed formation (Brady and Weil, 2008). Consequently, the pot that had $2t/ha$ poultry manure and $1t/ha$ urea had the highest number of pods. Gunri and Nath, (2012) have also reported greater yield of pods of

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groundnut when poultry manure was applied at different rates with a recommended dose of mineral nitrogen fertilizer. Similarly, Lomoro, (2008) reported significant **positive** effect of poultry manure combined with mineral fertilizer on the number and weight of groundnut pods.. Previous works on organic and inorganic fertilization **effect** on the soil have found to buildup of essential plant nutrients (i.e., N, P, K, S, Ca, Mg, Zn, Fe, Mn, and B) in the soil (Dotaniya *et al.*, 2016; Ogundare *et al.*, 2012; Rezig *et al.*, 2012). **This may have led to the substantial increase on the number and weight of groundnut pods observed in this study.**

CONCLUSION

In general, organic and inorganic fertilizer applications are relevant to boost the fertility status of soils and effectiveness of *Bradyrhizobium* for nodulation and yield of groundnut in **the** degraded sandy-loam soils of southeastern Nigeria. **While the combined** **Combined** application of poultry manure and urea is needed to increase the productivity of groundnut in the soils of southeastern Nigeria, increased application of urea may be detrimental to the process of nodulation, which may affect nitrogen economy especially residual nitrogen reserves for subsequent crop. **In view of this,** heavy mineral nitrogen application for groundnut production should be **discouraged harmful**, rather the addition of **poultry manure** 2 tons ha⁻¹ **poultry manure** with **urea at** 1ton ha⁻¹ **of urea** as booster dose should be emphasized in order to not only boost soil fertility and productivity, but also to enhance nodulation processes in groundnut for long lasting fertility **effect in terms of nitrogen.**

Improve your conclusion

Recommendation ????????????

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389 Remove the extra one and add the missing one. Also follow the proper pattern for
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