RESPONSE OF TOMATO (*LYCOPERSICON ESCULENTUM*) AND OKRA (*ABELMOSCHUS ESCULENTUS* (L.) MOENCH) TO RATES OF NPK NUTRIENTS APPLIED AS MINERAL, POULTRY MANURE AND OIL PALM RESIDUE IN THE GUINEA SAVANNA AGRO-ECOLOGICAL ZONE IN NIGERIA

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Abstract

Experiment was conducted at the Kogi State University Research and Demonstration Farm (latitude 7^0 30^1 and longitude 7^0 09^1E), Anyigba in the Southern Guinea savanna agro ecological zone of Nigeria. The study evaluated the effect of different nutrient sources (inorganic (MF), poultry manure (PM), oil palm residue (OPR), MF + PM, MF + OPR), and rates on the growth and yield of tomato and okra in the Guinea savanna agro-ecological zone in Nigeria. The aim of the research was to apply three rates of N: 0, 150 and 300 kg N ha^{-1} using inorganic, organic sources or their combination. Integrated nutrient applications performed better than individual application for all the nutrient sources, with the best performance obtained in MF + PM combinations. With integrated application of N at the rate of 150 kg PM ha^{-1} + 150 kg MF ha^{-1} being recommended for higher tomato and okra yield.

Key words: *Height, plant gilt, growth, development and yield*

PREAMBLE

Consumers' fears, caused by increasing potential for agricultural products to carry diseases or contain harmful additives, coupled with the economic premiums, for certified organic grains in most developed countries: United States of America and Europe have been driving many transition decisions relating to organic farming (Delate and Camberdella, 2004). The concept of organic farming is based on the assumption that soil with sufficient organic matter content, good soil structure, rich and variegated living organisms can provide a base for healthy crops.

Generally, soil productivity maintenance is a major constraint in tropical agriculture. Without the use of fertilizers, crops are moved between fields to utilize only fertile soils for some years, which may not meet the yearning for global food security. Thus, the efficient use of nutrients within crop production systems has been the focus of research for several decades. This experiment is set, therefore to determine the appropriate nutrient that will give best yield returns.

High cost of inorganic fertilizers in Nigeria coupled with the problem of product availability (Oyewole and Mera, 2010) justifies an investigation into alternative source of nutrients, this time, organic manure (poultry manure and oil palm residue), which is more readily available and cheaper; more so, it has been found that most farmers engaged in incorrect nutrient application due to inadequate technical knowledge and understanding of fertilizer best practice (Saliu and Obasi, 2011). More importantly, with regard to organic fertilizers, increasing awareness and availability of information on man's dietary habits has led to strong steady growth in the sale and consumption of organic foods. Therefore, organic farming has become the most highly valued method of sustainable production in agriculture and food trade (Bavec and Bavec, 2007).

It should be noted that while manure needs to be applied in large amounts to meet crop nutrient needs, nutrient composition of most mineral fertilizers is often high, with pronounced crop response with little application, in addition to ease of application, among other advantages of mineral nutrients. In any case, mineral fertilizers do not improve soil physical structure or enhance soil biological activity (McGuiness, 1993). They must therefore be used in conjunction with strategies that are designed to manage and maintain soil organic matter. One of such strategy is the use of organic manure. The enhancement of soil fertility factors by using organic fertilizers causes an immediate improvement in the utilization of mineral fertilizers. There is growing interest in the use of organic manures due to soil fertility depletion in most African soils coupled with scarcity and cost of mineral fertilizers, as earlier observed.

1. INTRODUCTION

Crop outputs in Nigeria is often severely constraint by complex interacting factors such as soil fertility; farmers' resources (which will directly impact on all farming operations, including ability to purchase conventional fertilizers), pests, diseases, crop management and crop related factors (Kumar *et al*., 1986; Dike, 1987; Selim *et al*., 1993; Alofe *et al.*, 1996; Smaling *et al*., 1996; Sinclair *et al.*, 1997 and Tian *et al.*, 2000). The alternating wet and dry seasons in the Nigerian savanna characterized by intense heat leads to rapid decomposition of soil organic matter (Adams, *et al*., 1998). In addition, indiscriminate burning of fallow and crop residues by farmers also reduces the accumulation of organic matter in the soil. Thus, soils rapidly lose their fertility and productivity under cultivation, necessitating a form of nutrient replenishing. Because soil organic matter is low, native soil N is also low coupled with wide spread P and S deficiencies in most soils of the savanna (FMARD, 2002). The ultimate aim of nutrient addition is to improve the productivity of the soil, thus impacting on the overall crop growth and consequently increases yield in crops (Adeyemi *et. al.*, 2001) and monetary returns that accrue to farmers.

Soil fertility refers to the inherent capacity of a soil to supply essential nutrient elements to crops in adequate amount and in the right proportion for their optimum growth. The essential nutrient elements comprise the key component of soil fertility (ICAR, 2009). These elements can be supplied to the soil either in organic or inorganic forms or both. Organic manures contain high nitrogen, phosphorus, potassium and other essential nutrients (Oyewole and Oyewole, 2011). In contrast to chemical fertilizer, it adds organic matter to soil which improves soil structures, nutrient retention, aeration, soil moisture holding capacity and water infiltration (Deksissa *et al*., 2008). Specifically, poultry manure more readily supplies P to plants than other organic manure sources (Garg and Bahla, 2008). Although, poultry manure is an excellent nutrient source for plants, supplementing soil nutrients, require sound soil fertility management practices to prevent nutrient imbalances and associated animal health risks as well as surface - water and ground water contamination (Blay *et al*., 2002; Phan *et al*., 2002). In the absence of other constraints, nutrient uptake and yield are closely related (Hedge, 1997).

Organic fertilizers: farmyard manure (FYM), sheep manure (SM), poultry manure (PM), compost, among others have been used for crop production for centuries. The use of these forms of fertilizers certainly pre-date chemical (mineral) fertilizers, which is of more recent development in comparison with organic fertilizers. Organic fertilizers are more environmentally friendly, since they are of organic sources. Contrary, observations show that continuous use of mineral fertilizers create potential polluting effect on the environment (Oad *et al*., 2004), in addition to the fact that synthesis of this fertilizer form consumes large amount of energy with often huge financial implications. Although organic fertilizers exist in readily available forms; cheap and easy to assess, they need to be applied in large amounts to meet the nutrient requirements of crops (Prabu *et al*., 2003). Where large hectares are involved, this single fact play important role in the cost of organic fertilizer application; as it pushes up transportation cost. This salient factor thus introduces management component into an otherwise abundant nutrient source. Thus, a combination of organic and mineral nutrients has been advocated (Prabu *et al*., 2003). As the integration of organic sources and synthetic sources of nutrients not only supply essential nutrients but also have some positive interaction with chemical fertilizers to increase their efficiency and thereby reduce environmental hazards (Bocchi and Tano, 1994). Therefore, the broad objective of the study is to determine the response of tomato and okra to different levels of organic manure (poultry source and oil palm refuse), mineral NPK and the combined treatment in the study area. The trial thus:

i. Investigated the response of tomato and okra to different rates of N in OM and inorganic fertilizer.

ii. Determine the optimum rates of N for sustainable production of the study crops in the study area.

iii. Find out the response of tomato and okra to combined effect of OM and inorganic fertilizer in the study area.

iv. Investigate weed infestation in response to nutrient application.

v. Compute the gross margin and cost - benefit ratios for the nutrient treatments

2. MATERIALS AND METHODS

2.1 Experimental area

The experiment was conducted in 2012 and 2013 cropping seasons at the Kogi State University Research and Demonstration Farm (latitude 7^0 30^1 and longitude 7^0 09^1E), Anyigba in the Southern Guinea savanna agro ecological zone of Nigeria to determine the effect of organic and inorganic fertilizers and their combination on the growth, development and yield of tomato and okra. The study area which is Kogi State, lies between latitude 5^0 15^1 to 7^0 45^1 N and longitude 5^0 45^1 and 8^0 45^1 East of the equator. The mean annual rainfall ranges from 1,560 mm at Kabba in the West to 1,808 mm at Anyigba in the East. The dry season generally extends from November to March. During this period, rainfall drops drastically to less than 12.0 mm in any of the months. Temperatures show some variations throughout the years, with average monthly temperature varying between 17 ^{0}C and 36.2 ^{0}C. The state has two main vegetations: the forest savanna mosaic zone and the southern guinea zone. It also has two main geological formations, they are: the Basement complex rocks to the west while the other half is on Cretaceous sediments, to the north of the confluence and east of River Niger (Amhakhian, *et al*., 2010). The soils like most soils in north central agricultural zone of Nigeria have high erodibility, structurally weak, coarse textured with low organic matter status (Amhakhian, *et al*., 2010).

2.2 Soil analysis

Soil samples were randomly collected from ten points at two depths: 0 – 15 cm and 15 – 30 cm, on the experimental plot thoroughly mixed together to form two composite samples. The samples collected were air dried, crushed with the aid of wooden roller and sieved through 2 mm sieve. The samples were then subjected to physical and chemical analysis as described by Chang and Jackson (1958) (Appendix I).

2.3 Treatment combination and experimental design

The treatment consisted of rates of inorganic and organic fertilizers or their combination supplying various rates of nitrogen.

2.4 Organic manure analysis

To calculate the required amounts of organic manure that will supply the needed experimental rates of N ha^{-1}, sample of organic manure to be used was analyzed for its total nitrogen, phosphorus and potassium, with emphasis on N content. The N contents in a unit of poultry manure (PM) and oil palm residue (OPR) were then used to calculate the required N rates.

2.5 Seed bed preparation

Conventional tillage operations: plough and harrowing, coupled with seed bed preparation were carried out before seed were sown on the flat fortified by high ridges to keep applied nutrients from being washed into other plots. Main plot was divided into sub plots of size 2 x 1.5 m separated by 1m leeway.

2.6 Study Crops

2.6.1 Tomato

2.6.1.1 Nursery operations and seedling transplant (Tomato)

Tomato seedlings were raised in nursery boxes, for four weeks before being transplanted onto experimental plots. In the nursery, the seedlings were shaded against direct impact of solar radiation. The boxes were kept weed free and watered every other day. Prior to seedling transplant into the field, the soil was heavily watered to enhance seedling removal. Vigorous seedlings were then transplanted onto the experimental plot at 4 weeks old after a heavy rain fall spaced 50 cm x 50 cm.

2.6.2 Okra sowing

The okra seeds were sown at a depth of 3 cm at the rate of two (2) seeds per hole and at a spacing of 30 cm x 50 cm. The emerged plant stands were later thinned to one (1) plant per stand after two weeks of sowing.

2.6.3 Weed control

Routine cultural operation such as hoe weeding at two weekly were carried out. Before weeding, weed count was determined using average of three quadrant throws (30 x 30 cm).

2.6.4 Nutrient management

Fertilizer and manure application were applied as in the treatment. For plots that were to receive organic manure (PM or OPR), the nutrient sources were incorporated a week to seed sowing (for okra) or seedling transplant (for tomato), while for those plots to be treated with NPK fertilizer, this was applied immediately after seed sowing or seedling transplant, respectively for okra and tomato crop. For those that were to receive combined nutrient application, the OM component were incorporated as in other sole manure treatments (a week prior to okra seed sowing or tomato transplanting), while the NPK components were came with either seed sowing (for okra) or tomato seedling transplant.

2.6.5 Data collection

On data collection, at two weekly data on plant height, stem gilt and number of leaves were determined per plot as means of four randomly sampled plants. Height was measured using a meter rule, stem diameter using Vanier calipers, while numbers of leaves were visibly counted. Individual treatment yields were computed on fresh weight basis as sum of all harvests from individual net plots (kg) extrapolated to one hectare. Other parameters taken include days to first flowering, pod length and pod diameter for okra. The growth and yield parameters collected were subjected to analysis of variance (ANOVA) (Statistical Analysis System (SAS) 1998) to evaluate the effect of organic and inorganic manures on okra growth, development and yield parameters. Significantly different means ($p \leq 0.05$) were separated using the Fisher Least Significant Difference (F-L S D) Test.

2.6.5.1 Weed population

Data on weed population as influenced by nutrient application were determined at two weeks intervals prior to weeding operations. Data on weed population were transformed (Gomez and Gomez, 1984) using the square root transformation before been subjected to statistical analysis. Significantly different means ($p \leq 0.05$) were separated using the Fisher Least Significant Difference (F-L S D) Test.

2.6.5.2 Gross margin / cost – benefit ratios

Gross margin was computed based on inputs applied against output as in the formula below.

$$GM = TR - TVC$$

Where GM = gross margin

TR = total revenue in naira

TVC = total variable cost in naira

3. RESULTS AND DISCUSSION

Soil in the experimental site was predominately sandy (75.00 per cent) with 17.00 per cent clay and 8.00 per cent silt. Evidently, the organic content was low: 2.41 g kg^{-1}, observing that the critical level of organic matter required for optimum crop production is 30 g kg^{-1} (Agboola and Corey, 1972). The soil contains 0.07 g kg^{-1} total N (1.50 g kg^{-1} being critical level for optimum production of maize in Nigeria (Agboola and Corey, 1972), 1.102 cmol kg^{-1} value for K while available P was 14.29 ppm. The soil analysis is an indication that the soil of the experimental site is critically limited by various macro nutrients: N, P and K, based on the critical levels of these elements required for optimum crop production in Nigeria. While discussing the soil properties of Anyigba, Kogi State, Nigeria, Amhakhian (2010) observed that the sandy nature of the soils in this area could imply low organic matter content. The sandy texture of the soil would also encourage rapid leaching of cations into the subsoil from the surface soil (Amhakhian, 2010). While Guzel and Ibrika (1994) observed that the low P content of some tropical soils have been attributed to low apatite content of the soil forming minerals. The author also added that the low P content of most savanna soils may also be attributed to their level of maturity.

Results of analysis of poultry manure show average N was 4.52 per cent, while mean P and K were 2.64 and 1.19 per cent, respectively. Oyewole and Oyewole (2010) observed that poultry manure production occurs as a result of the normal everyday processes of the poultry industry. Svotwa, *et al*. (2007) earlier reported that, if one were looking strictly at the fate of the nutrient inputs, the major product of any animal feeding system is manure, not animal protein. Often manures are considered waste materials and a place to dispose of them has to be found. However, if the manure is considered a by-product of the industry, a possible use for it in a market economy can be found – soil enrichment (Svotwa, *et al*., 2007). Similarly, Oyewole and Oyewole (2010) reported that laboratory analysis of sampled poultry manure reveals varying levels of N, P and K. These components (N, P and K), they observed, are important plant nutrients required for plant growth and yield formation. They added that, it should therefore be expected that the fertility status of the soil would benefit from poultry manure application since manure is known to improve soil organic matter, as well as macro and micro-nutrient status of the soil (Maerere, *et al*., 2001; Adeniyan and Ojeniyi, 2003; Adediran, *et al*., 2003; Akande and Adediran, 2004). Adesodun, *et al.* (2005) had found that application of poultry manure to soil increased soil organic matter, N, P, soil physical properties and soil moisture. While Aluko and Oyedele (2005) attributed this improved soil moisture to the mulching effect of organic matter and improved moisture retention, in addition to water acceptance as a result of improved soil structure and macro porosity.

3.1 Tomato crop

3.1.1 Effect of plant nutrient on plant growth and yield parameters

Analyzed data revealed that final plant heights, stem gilt, number of harvested fruits/ha, and fruit weight/ha showed significant ($p \leq 0.05$) influence of nutrient application on these parameters of growth and yield (Table 1). In respect of individual nutrient application, poultry manure source gave the best growth and yield responses, followed by in-organic fertilizer and finally, oil palm residue. In respect of integrated nutrient application, combining poultry manure with in-organic fertilizer gave the best growth and yield responses, with the best overall responses obtained with the application of 150 kg PM/ha + 150 kg MF/ha.

Generally, previous observations have shown beneficial effects of fertilizers (organic or inorganic) on soil nutrient composition, structural aggregates, infiltration rate, microbial and other biological activities of the soil (Omueti *et al*., 2000), which must have improve tomato growth over the control, cumulating in better plant performance with nutrient application. Simpson (1986) reported that the application of organic manure significantly increased crop growth parameters and yield, and attributed it to the high level of N supplied by the organic manure, an essential plant nutrient for growth. Organic manures have been said to improve soil fertility by activating soil microbial biomass, which in turn leads to development in corps (Ayuso *et al*., 1996).

3.1.2 Economics of nutrient application

Application of in-organic nutrient at the rate of 150 kg N/ha yielded 88.15% return over the control (Table 2), while applying 300 kg N/ha in-organic nutrient yielded only 74.68% return over the control. Application of organic nutrient at the rate of 150 and 300 kg N/ha yielded 81.93 and 85.98 percent returns, respectively over the control treatment. The highest return on fertilizer investment was obtained with the application of 150 kg PM/ha + 150 kg MF/ha (90.17%) over the control, which was followed by application of 150 kg N OPR/ha + 150 kg N MF/ha (89.84%) over the control.

3.2 Okra crop

3.2.1 Effect of plant nutrient on plant growth and yield parameters

Analyzed data revealed that final plant heights, stem gilt, number of harvested pods/ha, and pod weight/ha showed significant ($p \leq 0.05$) influence of nutrient application on these parameters of growth and yield in okra (Table 3). In respect of individual nutrient application, poultry manure source gave the best growth and yield responses, followed by oil palm residue and finally, in-organic fertilizer. In respect of integrated nutrient application, combining poultry manure with in-organic fertilizer gave the best growth and yield responses, with the best overall responses obtained with the application of 150 kg PM/ha + 150 kg MF/ha.

As observed in respect of the tomato component, previous observations have shown beneficial effects of fertilizers (organic or inorganic) on soil nutrient composition, structural aggregates, infiltration rate, microbial and other biological activities of the soil (Omueti *et al*., 2000), which must have improve tomato growth over the control, cumulating in better plant performance with nutrient application. Simpson (1986) reported that the application of organic manure significantly increased crop growth parameters and yield, and attributed it to the high level of N supplied by the organic manure, an essential plant nutrient for growth. Organic manures have been said to improve soil fertility by activating soil microbial biomass, which in turn leads to development in corps (Ayuso *et al*., 1996).

3.2.2 Effect of nutrient source and rates on weed population m-^{2} and weed dry matter

The data given on Tables 4 indicates significant ($p \leq 0.05$) increase in weed population with nutrients application over the control in both 2012 and 2013 cropping seasons**.** In addition, data given on Tables 5 indicates significant ($p \leq 0.05$) influence of nutrient application on weed dry weight in 2012 and 2013 cropping seasons. Integrating nutrient sources (organic and in-organic) consistently gave the highest weed dry matter in 2012 and 2013 cropping seasons with the least result observed in the control treatment.

Major *et al.* (2005) in a similar experiment conducted on weed composition and cover after three years of soil fertility management in the central Brazilian Amazon observed that weed population responded positively to improved soil fertility management. The authors reported that while application of both inorganic and organic fertilizers significantly increased weed ground cover, the number of species within plots also significantly increased following the addition of inorganic fertilizer. These increases were even greater with the addition of chicken manure and compost, they added.

It should therefore be expected that improvements in the fertility of nutrient poor soils will increase weed pressure (Major *et al*., 2005). In addition, when organic manure is combined with in-organic nutrients, weed pressure is likely to be intensified, unless crop and weed emergence patterns are modified, such that they result in a competitive advantage for the crop (Major *et al*., 2005).

4. CONCLUSION

In many developing countries like Nigeria, farmers have limited financial resources and can rarely afford to purchase sufficient mineral fertilizer. The use of single super - phosphate and other synthetic fertilizers are usually beyond the reach of peasant farmers due to their high cost and scarcity. Crops have become so expensive to grow that nutrient deficiencies should not be allowed to limit their yields. With management practices such as continuous cropping and reduce fallow periods, the soil can hardly support cropping. The need therefore, arises for production practices that will ensure high yield. Therefore this experiment conducted during 2011 and 2012 cropping seasons investigated the effect of organic and inorganic fertilizer on growth, development and yield of okra in Kogi state, Nigeria with the aim of recommending the most appropriate rates. Based on the research outcome, it is recommended that if tomato or okra is to be grown on inorganic fertilizer, application of N at the rate of 150 kg ha^{-1} is appropriate for the experimental area, while application of organic fertilizer at the rate of 300 kg N ha^{-1} is recommended for both crops. However, integrated application of N at the rate of 150 kg PM ha^{-1} + 150 kg MF ha^{-1} is recommended for higher tomato and okra yield.

Table 1: Effect of nutrient source and rates on tomato growth and yield in the Guinea Savanna Agro-ecological Zone in Nigeria

Plant nutrient application	Height (cm)	Mean stem gilt (cm)	Fruit number per ha	Fruit weight (t ha^{-1})
Control	5.95	0.63	109,871	1.5
Inorganic Nutrient (MF)				
150 kg N/ha	10.84	1.69	447,213	12.7
300 kg N/ha	12.91	1.82	414,399	6.0
Mean	**11.88**	**1.76**	**430,806**	**9.4**
Poultry Manure (PM)				
150 kg N/ha	20.21	1.88	501,666	8.3
300 kg N/ha	19.98	2.11	671,796	10.7
Mean	**20.10**	**2.00**	**586,731**	**9.5**
Oil Palm Residue (OPR)				
150 kg N/ha	9.95	1.53	321,876	7.3
300 kg N/ha	11.67	1.71	337,965	10.3
Mean	**10.81**	**1.62**	**329,921**	**8.8**
Poultry Manure + Inorganic Nutrient				
75 kg PM/ha + 75 kg MF/ha	15.58	2.75	735,435	14.2
150 kg PM/ha + 150 kg MF/ha	16.46	2.71	827,371	15.3
Mean	**16.02**	**2.73**	**781,403**	**14.8**
Oil Palm Residue + Inorganic Nutrient				
75 kg OPR/ha + 75 kg MF/ha	11.84	1.69	417,163	12.3
150 kg OPR /ha + 150 kg MF/ha	13.29	1.78	424,939	14.8
Mean	**12.57**	**1.74**	**421,051**	**13.6**
$LSD_{0.05}$	0.346*	0.826*	1311.65*	0.80*

* Statistically significant ($p \leq 0.05$)

Table 2: Effect of nutrient source and rates on economics of nutrient application in tomato in the Guinea Savanna Agro-ecological Zone in Nigeria

Plant nutrient application	Mean of two years (t/ha)	Total return on enterprise	Input cost (₦)	Net return on enterprise (₦)	Per cent returns (%)
Control	1.5	300,000	-	300,000	-
Inorganic Nutrient (MF)					
150 kg N/ha	12.7	2,540,000	7,500	2,532,500	88.15
300 kg N/ha	6.0	1,200,000	15,000	1,185,000	74.68
Poultry Manure (PM)					
150 kg N/ha	8.3	1,660,000	150	1,659,850	81.93
300 kg N/ha	10.7	2,140,000	300	2,139,700	85.98
Oil Palm Residue (OPR)					
150 kg N/ha	7.3	1460000	150	1,459,850	79.45
300 kg N/ha	10.3	2060000	300	2,059,700	85,43
Poultry Manure + Inorganic Nutrient					
75 kg N PM/ha + 75 kg N MF/ha	14.2	2,840,000	3825	2,836,175	89.42
150 kg N PM/ha + 150 kg N MF/ha	15.3	3,060,000	7650	3,052,350	90.17
Oil Palm Residue + Inorganic Nutrient					
75 kg N OPR/ha + 75 kg N MF/ha	12.3	2,460,000	3825	2,456,175	87,79
150 kg N OPR/ha + 150 kg N MF/ha	14.8	2,960,000	7650	2,952,350	89.84

Table 3: Effect of nutrient source and rates on okra growth and yield in the Guinea Savanna Agro-ecological Zone in Nigeria

Plant nutrient application	Height (cm)	Mean stem gilt (cm)	No of harvested pods per ha	Mean fruit weight (t/ha)
Control	16.7	1.0	241,667	1.4
Inorganic Nutrient (MF)				
150 kg N/ha	29.9	1.6	707,500	9.5
300 kg N/ha	57.6	1.5	706,667	9.4
Mean				
Poultry Manure (PM)				
150 kg N/ha	43.7	1.1	815, 000	10.2
300 kg N/ha	67.5	1.8	933,334	13.2
Mean				
Oil Palm Residue (OPR)				
150 kg N/ha	38.4	0.7	805,000	9.4
300 kg N/ha	43.1	0.8	823,333	10.3
Poultry Manure + Inorganic Nutrient				
75 kg N PM/ha + 75 kg N MF/ha	33.3	0.8	1,137,500	13.1
150 kg N PM/ha + 150 kg N MF/ha	41.2	0.8	1,151,667	14.1
Mean				
Oil Palm Residue + Inorganic Nutrient				
75 kg N OPR /ha + 75 kg N MF/ha	43.4	1.7	812,000	10.4
150 kg N OPR /ha + 150 kg N MF/ha	45.1	1.8	825,463	11.3
Mean				
F-LSD ($p \leq 0.05$)	9.87*	0.48*	48,904*	0.975*

* Statistically significant ($p \leq 0.05$)

Table 4: Weed population on experimental plots in Anyigba, Kogi State, Nigeria

Nutrient application	Weed population m-2					
	2012 cropping season			2013 cropping season		
	3WAT	5WAT	7WAT	3WAT	5WAT	7WAT
Control	09	06	11	09	11	27
Poultry manure (PM)						
200 kg N/ha organic	16	48	38	13	37	29
300 kg N/ha organic	18	54	53	13	41	38
Inorganic Nutrient (MF)						
200kg N/ha in-organic	11	30	34	9	23	32
300kg N/ha in-organic	14	31	36	13	25	36
Poultry manure + Inorganic Nutrient						
200kg N/ha (50% PM + 50% MF)	14	34	43	10	26	29
300 kg N/ha (50% PM + 50% MF)	15	46	54	14	35	45
Oil Palm Residue (OPR)						
200 kg N/ha organic	11	29	37	11	16	19
300 kg N/ha organic	12	41	51	12	25	35
Oil Palm Residue (OPR) + Inorganic Nutrient						
200kg N/ha (50% PM + 50% MF)	11	16	19	30	34	34
300 kg N/ha (50% PM + 50% MF)	18	19	27	48	37	38
F-LSD ($p \leq 0.05$)	**1.2***	**1.6***	**2.6***	**1.9***	**1.7***	**2.5***

* Statistically significant ($p \leq 0.05$)

Table 5: Effect of nutrient application on dry weight of weeds per net plot in Anyigba, Kogi state

Nutrient application	Weed dry weight (g) m-2					
	2012 cropping season			2013 cropping season		
	3WAT	5WAT	7WAT	3WAT	5WAT	7WAT
Control	1.50	1.09	1.40	1.35	0.97	1.14
Poultry manure (PM)						
200 kg N/ha organic	4.18	2.64	2.24	3.78	2.18	2.07
300 kg N/ha organic	4.48	4.71	3.90	4.27	3.11	3.37
Inorganic Nutrient (MF)						
200kg N/ha in-organic	0.88	1.30	2.08	0.79	1.17	1.98
300kg N/ha in-organic	2.24	1.34	2.21	2.02	1.20	2.15
Poultry manure + Inorganic Nutrient						
200kg N/ha (50% PM + 50% MF)	3.04	2.49	4.08	2.74	2.23	3.88
300 kg N/ha (50% PM + 50% MF)	6.35	4.40	4.47	5.71	3.90	4.17
Oil Palm Residue (OPR)						
200 kg N/ha organic	1.13	1.36	1.24	2.28	1.11	1.37
300 kg N/ha organic	1.47	2.75	2.34	2.37	1.18	2.37
Oil Palm Residue (OPR) + Inorganic Nutrient						
200kg N/ha (50% PM + 50% MF)	1.49	1.96	1.96	1.34	1.77	1.67
300 kg N/ha (50% PM + 50% MF)	3.78	2.95	2.31	3.40	2.65	2.13
F-LSD (5%)	0.711*	0.237*	0.272*	0.171*	0.24*	0.712*

* Statistically significant ($p \leq 0.05$)

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