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EFFECT OF ORGANIC AND INORGANIC FERTILIZERS ON YIELD AND ECONOMIC RETURN OF ACHA (*DIGITARIA SPP*) VARIETIES IN LAFIA, NIGERIA

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ABSTRACT: *These studies were conducted at the Teaching and Research farm, College of Agriculture, Lafia, Nasarawa State, Nigeria during the wet seasons of 2013 and 2014. To determine the effect of poultry manure and NPK fertilizer on growth and grain yield of Acha varieties and profit margin for using these inputs in Lafia, Nasarawa state, Nigeria. The experiment was carried out in a randomized complete block design, replicated three times. The results showed that application of poultry and NPK fertilizer rates significantly enhance growth parameters in both two seasons. 10/ha of poultry manure and 120kg/ha of NPK produced plants with highest number of tillers (12.93 and 13.24); whil D. eburua variety produced the tallest plant (14.78 and 16.24) in both years. Application of 10t/ha of poultry manure produced the highest grain weight of 0.98t/ha and 1.27t/ha; while NPK fertilizer rate at 120kg/ha also produced the highest grain weight of 1t/ha and 1.21t/ha in both years. All these grain weight are statistically at par with application of 5t/ha of poultry manure and 60kg/ha of NPK fertilizer, but lower than the control in both years. Varieties also had a significant effect on the grain yield of Acha. Digitaria exilis proved its superiority agains D. eburua by producing the highest grain weight of 1.31t/ha and 1.52t/ha in both years. Interaction between poultry manure and NPK did not produce ant significant effect on the grain weight of acha in both years. The total revenue (TR) under organic manure was ₦54,775.00 and ₦54,950.00 under inorganic (NPK) fertilizer. The gross margin (GM) was estimated to be ₦27,575 and ₦25,900.00 under organic manure and inorganic fertilizer respectively. Various ratios calculated gave a positive value which shows that Acha production in the area is viable and profitable.*

KEY WORDS: Acha, Poultry manure, NPK, Fertilizer, Economic return.

INTRODUCTION

Acha (*Digiteria exilis Kippis Stapf*) and *Digitaria iburua Kipis Stapf*) also known with names such as Hungry rice, Fonio, Fundi, pom and Kabug, in different countries. It has been reported as the oldest West African cereal (NRC, 1996). The crop is known as acha in Nigeria and is considered as one of the neglected crops of Africa. Part of the reason it has been neglected is as a result of misunderstanding by scientists and other decision makers; but the crop still remain an import food crop for millions of people in west Africa. This crop is now being gradually "rediscovered" and considered for improvement as a cultivated species (Ibrahim, 2001). A lot of Research Institution in Nigeria are now working together in partnership to increase the knowledge of its distribution and genetic diversity (Kwon-ndung and Dachi, 2007). Acha grains are rich in methionine, an essential amino acid that is lacking in many major cereals (Temple and Bassa, 1991). The diets have relatively low free sugar and low glycemic content and this makes it adequate as a suggested diet diabetic patients. There is a clear indication that farmers do value acha because of its unique taste and nutritional value. The annual production

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of acha in west Africa, which is grown on about 380.000ha, is estimated at about 250.000 tones (Cruz, 2004). In Nigeria, annual yield of 112,000mt and 126, 0000mt have been reported (Abdullahi and Luka, 20003). Farmers generally cultivate acha on unproductive light sandy or stony soils as the crop do not demand much soil nutrients (Philip and Itodo, 2006). The late planted varieties, in particular, are well adjusted to poor soils s (Cruz 2004). However, moralespayan (2002), reported that organic fertilization (cow or goat manure) has been used to increase plant biomass and grain yield. He also, observed that an attempt to improve grain yield with chemical fertilizer have been successful, although not necessarily economic, because the crops appears to response slowly to chemical fertilizer (nitrogen fertilizer), especially when acha grows in association with legumes (possibly due to N fixation by the legumes). Nasarawa state with capital in lafia which was part of formers plateau state was well known for production of large quantities of acha by peasant small holder farmers. however, the unique small size (0.4-0.5mm) of acha grain, no mechanization for its production and coupled with several factors; among which are: no or very little documented information on its improved agronomic practices and unavailability of improved seed constituted a serious drawback to acha production in this region (Adigize, 2006). This research therefore, was conducted to determine optimal levels of both organic and inorganic fertilizer requirement for sustainable production of ach and the economic returns.

MATERIALS AND METHODS

Experimental site

The study was carried out at the teaching and research farm, college of Agriculture, lafia, nasarawa state, Nigerian during the wet seasons of 2013 and 2014. The study area falls within the Guinea savanna zone of North of central Nigeria and is located between latitude 08.33N and Longitude 08.32E. rainfall usually starts from March – October and the average monthly rainfall from 40mm – 350mm. the months of july and August usually records heavy rainfall. The daily maximum temperature ranged from 20.0 ^{0}C - 38.5 ^{0}C and daily minimum ranged between 18.7^{0}C – 28.2^{0}C. the months of February to early April are the months that have the highest maximum temperature, while the lowest maximum temperature months were recorded in December and January because of the prevailing cold harmattan wind from the northern part of the country at this period. The relative humidity rises as from April to a maximum of about 75 – 90 percent in July (Nigeria meteorological Agency, Lafia station 2014).

Treatment and Experimental Design

The treatment consisted of three levels of compound fertilizer (NPK 1:15:15) at 0, 40 and 80kg/ha, three levels of poultry manure: 0.5 and 10t/ha and two species of acha were laid in a Randomized Complete Black Design (RCBD) and replicated three times to form fifty four plots. Seed beds were well prepared by ploughing and harrowing in each season and plots were marked out into 12m^2 plot. Acha seeds were sown through broadcasting. Soil samples were taken at a depth of 0.15cm in each season and also poultry manure were analyzed. The result is presented in table 1. Poultry manure was incorporated based on treatments two week before sowing. Weeds were controlled through hand hoeing and subsequently by hand pulling as the acha grew.

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Data Collection and Analysis

The data collected on grain yield were subjected to analysis of variance using GESTAT, and where there is a significant difference; the means separated using F –LSD at 5% probability level.

RESULTS AND DISCUSSION

The chemical analysis of the poultry manure used in boh cropping season showed that the manure used in 2014 was superior in nutrient compared to the one used in 2013 (Table 1). The soil contained very high proportion of sand (85% and 84%) but low in clay content (11.6% and 12.6%) in both years. Nitrogen, phosphorus, potassium, organic carbon, organic matter and CEC, were low in the soil in both years (Table 2). However, the soil was moderate to slightly acidic in nature (6.08 – 6.10): the percent base saturation of the soil was very high (87 and 90.39) in 2013 and 2014 cropping seasons.

Table 1. chemical composition of the poultry manure used during the study

% Chemical Properties	2013	2014
N	3.14	3.89
P	0.48	0.59
K	4.95	5.34
Ca	5.52	5.65
Mg	0.45	0.56
Na	0.32	0.30
OC	45.90	49.23

Table 2: Laboratory analysis of soils at 0 30cm before cropping in both years

Properties	2013	2014
Mech. Composition		
Clay (g/kg)	11.6	12.6
Silt	3.4	3.4
Sand	85.0	84.0
TCL (USD)	SL	SL
Chemical composition		
pH (H20)	6.08	6.10
pH(0.01MKC12)	6.00	5.44
TN%	0.04	0.07
%OC	0.64	0.86
%OM	1.10	1.48
Avail. P(ppm)	4.57	12.29
K(mg/kg)	0.31	0.38
Mg(mol/kg)	1.78	1.28
Ca(mol/kg)	3.41	4.83

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Na(mol/kg)	0.67	0.43
Al+H(acidity)	0.83	0.76
CEC(mol/kg)	6.17	7.91
%Base saturation	87	90.39

Poultry manure and NPK fertilizer rates showed a significant (p=0.05) effect on grain yield of acha varieties in 2013 and 2014 cropping season (Table 3). Application of 10t/ha of poultry manure produced the highest grain weight of 0.98 t/ha and 1.27t/ha; while NPK fertilizer rate at 120kg/ha also produced the highest grain weight of 1t/ha and 1.21t/ha in both years. All these grain weights are statistically at par with application of 5t/ha of poultry manure and 60kg/ha of NPK fertilizer, but lower than the control in both years. Varieties also had a significant effect on the grain yield of acha. *Digitatria exilis* proved its superiority against *D. eburua* by producing the highest grain weight of 1.31t/ha and 1.52t/ha in both years. Interaction between poultry manure and NPK did not produce any significant effect on the grain weight of acha in both years.

Table 3: Effects of poultry manure and NPK fertilizer on yield of Acha Spp

Treatments	Yield (kg/plot)		Yield (t/ha)	
Poultry manure (t/ha)	2013	2014	2013	2014
0	0.87	0.85	0.73	0.71
5	1.08	1.35	0.90	1.13
10	1.18	1.52	0.98	1.27
NPK (kg/ha)				
0	0.88	086	0.73	0.72
60	1.06	1.23	0.88	1.03
120	1.20	1.45	1.00	1.21
LSD (0.05)	0.22	0.18	0.16	0.15
Species				
D. exilis	1.57	1.82	1.31	1.52
D. eburua	0.52	0.72	0.43	0.60
LSD (0.05)	0.17	021	0.14	0.18
Interaction				
PM x NPK	NS	NS	NS	NS

Table 4 showed the gross margin analysis for Acha under two different methods of treatment for two years 2013 and 2014. In 2013, under organic manure, the total variable cost was ₦27,200 and ₦25,900.00 under inorganic fertilizer on the farm size. The total revenue (TR) under organic manure was ₦54,775.00 and ₦54,950.00 under inorganic (NPK) fertilizer. The gross margin (GM) was estimated to be ₦27,575 and ₦25,900.00 under organic manure and inorganic fertilizer respectively. The difference was ₦1675.00 in favour of organic manure.

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Table 4: Estimated Costs and Returns Analysis of Acha on a farmland of 648m^2

	Year 2013	%	Year 2014	%
Variable Cost:	Value (₦)		Value (₦)	
2 measures of black seed	300	1.1	300	1.1
2 measures of brown seed	300	1.1	300	1.1
Labour:				
Land clearing	4000	14.7	4100	15.7
Ridging	6800	25.0	6200	23.3
Weeding	3800	13.9	3000	11.5
Harvesting	4000	14.7	4000	15.3
Threshing (Processing)	6000	22.1	6200	23.8
Fertilizer Application:				
10 bags of Organic manure	2000	7.4	2000	7.7
2 measures of Inorganic (NPK)	700		700	
Total Variable Cost:				
Under organic manure	27,200		26100	
Under Inorganic (NPK)	25,900		24,800	
Total Revenue (Gross Income)				
Under organic manure	54, 775		56340	
Under Inorganic (NPK)	54,950		56520	
Gross Margin (GM) = (TR –TVC)				
Under organic manure	27,575		30,240	
Under Inorganic (NPK)	25,900		31,720	

Source: Experimental Farm (2013/2014)

Gross Ratio: Is a profitability ratio that measures the overall success of the farm. The lower the ratio, the higher the return per naira. According to Olukosi et al (2006), gross ratio is stated thus:

$$GR = \frac{TFE}{GI}$$

Where: GR = Gross ratio, TFE = Total Farm expenses, GI =m Gross Income (Total Revenue)
Operating Ratio: The operating ratio is directly related to the farm variable input usage. A ratio of one (1) revealed that the gross income (GI) is barely covers the expenses on various inputs usage on the farm. Musa et al (2006) stated that the lower the ratio, the higher the profitability of the farm business. According to Olukosi et al (2006), operating ratio is stated thus:

$$OR = \frac{TOC}{GI}$$

Where: OR = operating ratio, TOC = Total operating cost, GI = Gross income

Return on Capital Invested: Nasiru et al (2006) stated that return on every naira invested is defined as gross margin divided by total variable cost. It is express as thus:

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$$RI = \frac{GM}{TVC}$$

Where: RI = Return on capital invested, GM = Gross margin, TVC = Total variable cost

Table 5: Estimated profitability Ratios

Profitability Ratio	Estimated value			
	2013		2014	
	Organic manure	Inorganic (NPK)	Organic Manure	Inorganic (NPK)
Gross ratio	0.50	0.47	0.46	0.44
Operating ratio	0.45	0.45	0.42	0.42
Return on Capital Investment	1.01	1.0	1.2	1.3

Source: Experimental Farm (2013/2014)

Table 5 above shows various ratios on profitability analysis. It can be deduced that Acha (*Digitaria spp*) is profitable enterprise in the study area. Operating ratios gave the same values in the two years experiment because there was just a slight changed in the cost of farm operation which is less than one (1).

DISCUSSION

The soil of the study area was generally very sandy, low in organic matter and other soil macro-nutrient (NPK). The soil is moderate to slightly acidic in nature. This confirmed the findings of Jayeoba et al (2013). The increased in grain weight as a result of increase application rates of poultry manure and NPK fertilizer, could be attributed to the ability of PM and NPK fertilizer to supply the plants with nutrients and which improved the soil properties, thereby, resulting in the synthesis of more photo-assimilates, which is used in producing grains. This result is in tandem with the work of Morales-payan (2004). The superiority demonstrated by *D, exilis* against *D.eburua* in terms of higher grain yield may be attributed to the morphological differences of the two varieties. D. *exilis* possessed active buds that encourage production of more tillers, which subsequently are translated into more stems that can developed more grains. Generally, the 2014 cropping season was better than 2013 cropping season. This is because in the second year, there was complete mineralization of the organic materials into absorbable forms that plants can easily absorb for normal growth and yield. This agreed with the work of Omisore et al (2009). It can be deduced from the result in (table 4) that Acha (*Digitaria spp)* is a profitable venture under the two methods of fertilization, but more profitable under organic manure application. In 2014 farming season, the gross margin shows an increase. Under organic manure, it was ₦30,240 and under inorganic (NPK) it was ₦31,720.00. Although the difference between the two methods of fertilization was ₦1480.00; which was less than the previous year (2013).

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CONCLUSION

These studies have shown that acha can respond well when organic or inorganic fertilizers are applied. Acha cultivation seem to be a profitable venture under the two methods of fertilization, but more profitable under organic manure application.. Therefore, 5t/ha of poultry manure and 60kg/ha of NPK could be the optimal fertilizer level for a good growth and yield of acha in Lafia, Southern Guinea Savanna Agroecological Zone of Nigeria. However, further locational trials should be conducted within the zone to confirm this result.

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