Poultry Manure and NPK 15 15 15 Fertilizer Application and their Residual Effect on White Yam (*Dioscorearotundata*) Storage in the Forest Derived Savanna Ecological Zones of Edo State, Nigeria

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ABSTRACT

Field experiments were conducted in Igueben, located in the forest derived savanna ecological zone of Edo state. In 2012 and 2013 cropping seasons to determine the effect of poultry manure, NPK 15 15 15 fertilizer and their combinations on the storage of white yam (Dioscorearotundata). The treatments consisted of four levels of poultry manure, 0,4,8 and 12 tons/ha and three levels of NPK fertilizer 0, 100 and 200kg/ha. The treatments were replicated three times and were fitted into randomized complete block design. The poultry manure was applied by broadcasting 2 weeks before planting while the NPK fertilizer was applied during planting. The tubers were carefully harvested after 7months of planting and stored in a barn. Tubers were observed and determined for duration of dormancy, weight loss and the number of tubers that rotted. Result showed that tuber weight loss and rot increased significantly with high levels of poultry manure NPK fertilizer and their combinations. The period of dormancy reduced as level of treatment increased it was concluded that the application of combination of low rate of chemical fertilizer with poultry manure boost yield and storage of white yam. Consequently a combination of 100kg NPK 15 15 15/ha with 12 tonspm/ha is recommended for yam farmers for good storage in the forest derived savanna ecological zone.

Keywords: *Poultry manure, Fertilizer, Storage, Rotted, Period, Savanna, Treatment.*

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Highlights of this paper

- Field experiments were conducted in Igueben, located in the forest derived savanna ecological zone of Edo state.
- In 2012 and 2013 cropping seasons to determine the effect of poultry manure, NPK 15 15 15 fertilizer and their combinations on the storage of white yam (*Dioscorearotundata*).
- The treatments consisted of four levels of poultry manure, 0,4,8 and 12 tons/ha and three levels of NPK fertilizer 0, 100 and 200kg/ha.

1. INTRODUCTION

Yam constitutes the predominant starchy food in sub-sahara African where food security for a growing population is a critical issue [1]. It represents 20% of daily calories intake of Nigerians living in forest and forest derive savanna regions. Yam has potentials for livestock feed and industrial starch manufacture [2]. Though Nigeria accounts for 68% of the Global yam production there are evidence of decline in yam production in Nigeria over years [3]. This is due to decline in soil fertility among others. Consequently chemical fertilizer is used to boost production. This is especially true where long fallowing is no longer possible as an essential part of the cropping system. Yam is a heavy feeder exploiting greater volume of soil nutrients and water [4]. NPK 15:15:15 was recommended at 200 kg/ha for optimum yield of yam [4]. That high rate of chemical fertilizer application increase tuber yield is not in doubt but there is the danger of poor tuber storage quality. To corroborate this view Osagie [5] stated that yam grown with chemical fertilizer were susceptible to pathological deterioration during storage.

Asadu [6] reported that yam tubers grown with organic manure had longer shelf life than those treated with chemical fertilizer in the field. Lombin, et al. [7] conclusively said that the use of organic + inorganic fertilizer holds the key for sustainable agricultural productivity food security and has proved to be a sound fertility management strategies in mainly countries of the world. However, the optimal level of combining organic + inorganic fertilizer needs to be investigated. Accordingly, the study was conducted with the objective to determine the effect of poultry manure, NPK fertilizer and their combinations on the storage of white yam (*Dioscorearotundata*) in the forest derived savanna zone of Edo State. Nigeria.

2. MATERIALS AND METHOD

2.1. Soil Sampling and Analysis

Soil samples (0-20cm) depth were collected from the experimental site at Igueben. The soil pH (1:1 soil/water ratio) was read on the pH meter [8]. Organic matter was determined using [9] method. Exchangeable bases were extracted with 1M NH_4 OAC, pH 7. K and Ca were determined with flame photometer while the Mg was read with atomic absorption spectrophotometer [10]. Exchangeable acidity (H^+ and Al^{+++}) was measured from 0.01mole KCl extract by titrating with 0.1m HCl [8]. Available P was extracted with Bray 1 solution and measured with technician auto analyzer as modified by Nelson and Sommers [11]. Total N was determined by the Micro Kjedal method(AOAC, 2006). Mechanical Analyses was done with Hydrometer method [12].

2.2. Poultry Manure Collection

Decomposed manure was collected from poultry farm at Uromi, the manure was dried and milled. It was ashed in a furnace for 6 hours at 500^0c and extracted with nitric percloric acid mixture [13].

2.3. Field Experiment

The study was conducted in 2012 and 2013 planting seasons in Igueben (6.60'N and 6.24E in the forest derived transition zone of Edo state. The state experiences humid tropical climate with two distinct conditions of wet and dry seasons with a brief lull in August. The dry season is November-March while April-October is the wet season Table 1. The temperature across the state is relatively high with a very narrow variation in seasonal and diunal ranges of 22^{0}C-36^{0}C.

The experimental area was slashed, the debris were allowed to dry and packed out manually before the field was laid out into plots.

The experiment was 3x4 factorials which consisted of 3 levels of NPK, 0, 100 and 200kg/ha and 4 levels of poultry manure; 0,4,8 and 12 tons/ha. The above rates were based on Agbede, et al. [14] recommendations of 200kg/ha and 10-20tons/ha levels of NPK and poultry manure respectively. The various treatments levels resulted in 12 treatment combinations which were replicated 3 times and fitted into randomized complete block design. A spacing of 4m was allowed between blocks and 5m between replicates.

One whole tuber (0.44Kg was planted at a depth of 6cm in a heap at a spacing of 1m x1m [14]. The planting was done between 27th to 30th of April 2012 and 2013 planting seasons in the field. Each row had 5 stands and there were 15 stands on each plot with a total of 540 plants in the site. The poultry manure was applied by broadcasting 2 weeks before planting and worked thoroughly into the soil with a hoe in order to equilibrate with soil. The NPK was applied during planting to a groove of 10cm wide, 5cm deep and 8cm away from the test crop. The fertilizer was carefully applied uniformly on the groove and covered with soil. A stake of 3m was provided per stand, the young yams were trailed on the stakes to prevent vines from creeping on the soil surface. Weeding was manually done with a hoe when necessary.

The fresh tubers were stored in yam barn. The sides of the barn were fenced with live sticks, wire nettings were extended from the top to the bottom of the fence to prevent rodents and enhanced aeration. The storage structure consisted of long bamboo poles tied horizontally on vertically placed poles. To this structure were tied vertically, palm fronds on which yam tubers were tied vertically from the bottom to the top according to the replicates. The replicates of each treatment were demarcated on their respective poles by roping. Eventually the top of the barn was covered slightly with palm leaves to prevent the effects of the scotching of sun rays.

The tubers were carefully harvested after 7 months of planting for yield determination and the researcher made sure that injuries were not inflicted on the tubers to ensure unbias evaluation.

The tubers in the middle of row of every plot were selected and measured for weight the weight was determined using a weighing balance. The yield in kg/m^2 were converted to tones/hectare.

Tubers in the center role were cut into bits dried at temperature of 70^{0}c for 24hrs to a constant weight in an oven, ground to pass through sieve and analyzed for NPK content.

Tubers were observed for the presence or absence of sprout. The duration for complete dormancy was determined as the number of days from the start of storage to the first visible sign of sprouting.

Percentage weight loss was determined by the difference between the initial weight and final weight divided by the initial weight multiplied by 100.

Number of rotted tubers in each sampling unit were counted and the means were taken. Data collected from the field studies were analysed statistically using the analysis of variance (ANOVA) Ducan Multiple Range Test at 0.05% level of probability was used to compare the means where the F values were significant [15] and the use of genstat.

3. RESULT AND DISCUSSION

The soil at the experimental site was medium acid (pH 6.00), rich in plant nutrients and the textural class was loamy sand. This provides adequate condition for good growth and storage of yam (*Dioscorearotundata*) Table 2.

The application of poultry manure up to 8 tons pm/ha increased number of yam tuber that rotted, however. This was not significant in relation to the control Table 3 the same trend was observed when NPK fertilizer was applied; the highest numbers of yam rot (1.81) was obtained at 200Kg NPK/ha relative to 1.33 observed in the control. The effect of the various combinations of poultry manure + NPK fertilizer were not also significant. However the combination of 4tons pm/ha + 200Kg NPK/ha, 8tons Pm/ha+200Kg NPK/ha and 12tons pm/ha +200Kg NPK/ha resulted in highest number of tuber rot; 200. Residual effect of 12 tons Pm/ha resulted in significant yam tuber rot of 3.22 relative to 1.89 in the control. The control treatment was however not different from 4 and 8 tons pm/ha. Residual effect of 4 tons pm/ha resulted in significant tuber rot of 2.67 relative to 1.00 in the control. Residual effect of NPK fertilizer was not significant.

Table-1. Rainfall distribution of the experimental site during the study (cm).

Months	2012	2013
January	0.0	0.4
February	0.0	21.1
March	21.6	82.3
April	54.3	176.8
May	152.6	226.8
June	448.7	296.2
July	308.4	213.3
August	181.2	131.1
September	239.3	225.5
October	106.6	148.6
November	43.2	120.5
December	1.2	49.1
Total	1557.0	
Mean	129.8	144.3

Source: Edo State agricultural development programme Edo Central Zone Irrua.

Table-2. Soil physical and chemical properties (0-20cm) depth of the experimental site before planting and chemical composition of poultry manure.

Soil properties	Igueben site	Poultry manure
pH	6.00	7.75
Total nitrogen (g/Kg)	6.92	2.50
Organic C (g/kg)	10.72	170.88
C/N	11.65	68.35
Available P (Mg/Kg)	5.19	0.33
Exchangeable bases (cmol/kg)		1.85
Ca	5.60	0.33
Mg	2.04	1.85
Na	2.83	0.31
K	0.47	0.15
Exchangeable acidity (cmol/kg)		0.52
H^+		
Al^{+++}	0.0	
ECEC (cmol/kg)	11.14	
BS(g/kg)	98.20	
Particle size	(g/kg)	
Sand	8.26	
Clay	39	
Silt	135	
Textural class loamy sand		
Bulk density g/cm^3	1.38	

Source: Field analysis by the researchers.

In 2012, poultry manure application decreased the days of dormancy in relation to the control Table 3. The day of dormancy was highest in the control with a mean of, 94. 33days while the least days of dormancy was observed on plot treated with 12 tons pm/ha with a mean of 89.33. However, the effect of poultry manure on dormancy was not significant relative to the control. Sole application of NPK fertilizer decrease dormancy period with increased level of application; The highest number of days was recorded with a mean of 102.50 while the least number of days, 83.00 was recorded with the application of 200kg NPK/ha fertilizer. Application of 100kg NPK/ha also similarly showed reduced dormancy. The combination of poultry manure and NPK fertilizer also significantly decreased dormancy period with increased level of application. The control had a dormancy period of 105 days while the least period of 82, was observed in plots treated with 8 and 13 tons pm/ha in combination with 200 kg NPK/ha respectively. Residually, poultry manure, NPK fertilizer and their combinations significantly reduced dormancy period with increased level of application. Dormancy period was lowest due to residual effect of 12tons pm/ha and 200kg NPK/ha with means of 91.3 day and 90.50 days respectively. The lowest dormancy period of 85 days and 87 days were obtained from residual effect of 12 tons pm/ha + control, 12 tons pm/ha + 200Kg NPK/ha and 8 tons pm/ha + control and 100 Kg NPK/ha relative to the highest, 115days in the control.

In 2012, the application of poultry manure increased weight loss with increased level of application, however the effect was not significant in relation to the control (table). The application of NPK fertilizer however significantly increased weight loss with increased level of application in relation to the control. The highest value of 81.98% weight loss was obtained from the application of 200Kg NPK/ha fertilizer while the least mean of 65.83% was observed in the control. The combination of poultry manure and NPK fertilizer significantly increased weight loss in relation to the control from a mean of 58.50% to 85.60% on the application of 8 tons pm/ha + 100Kg NPK/ha fertilizer. Residual effects of poultry manure, NPK fertilizer and their combination were not significant in relation to the control, however the highest weigh loss of 61.10% resulted from the residual effect of 12tons +200KgNPK/ha relative to 33.60% on the control.

Table-3. Effects of poultry manure and NPK fertilizer on storage loss of yam tuber in forest-derived savanna transition zone.

2012 Number of tubers that rotted					**2013 Residual**				
Treatment (tons/ha) poultry manure	Kg/ha NPK fertilizer				Treatment (tons/ha) poultry manure	Kg/ha NPK fertilizer			
	0	100	200	Means		0	100	200	Means
0	1.00	1.67	1.67	1.44ns	0	1.00	1.67	3.00	1.89b
4	1.00	1.67	2.00	1.56ns	4	2.67	1.33	2.33	2.11b
8	1.67	2.00	1.67	1.78ns	8	2.00	2.33	2.00	2.11b
12	1.67	1.33	2.00	1.67ns	12	2.00	2.33	2.33	3.22a
	1.33ns	1.67ns	1.81ns		Means	1.90ns	1.19ns	2.41ns	

DMRT = 0.89 (PM). 1.50 (NPK + PM).

Period of tuber dormancy (Days)									
0	105.00	94.00	84.00	94.33ns	0	115.00	99.00	87.00	100.33a
4	100.00	97.00	84.00	93.67nsa	4	114.00	88.00	89.00	97.00b
8	103.00	90.00	82.00	91.67ns	8	87.00	87.00	101.00	91.67bc
12	102.00	84.00	82.00	89.32ns	12	85.00	104.00	85.00	91.30c
	02.60ns	91.25ns	83.00ns		Means	100.25a	94.50ab	90.50b	

DMRT =0.05. 18.3 (NPK + PM) **DMRT** = 2.80 (PM) 9.50 (NPK) 4.90 (NPK + PM).

Weight loss of yam tubers (%)									
0	58.50	80.10	87.10	75.23ns	0	33.60	54.30	44.20	44.03ns
4	64.20	80.00	75.90	73.37ns	4	43.30	49.80	55.30	49.46ns
8	62.40	85.60	82.80	77.00ns	8	45.60	42.00	45.00	42.20ns
12	78.20	75.00	82.10	78.70ns	12	43.10	51.50	61.10	51.90ns
Means	65.83b	80.18a	81.98a		Means	41.40ns	49.40ns	51.40ns	

DMRT =0.05. 7.37(NPK) 14.7 (NPK + PM) .

Means followed by the same letters are not significantly different at 5% level of probability.Nitrogen application was directly related to yam weight loss and rot. The tuber yield was highest with the application of 12 tonspm/ha +200Kg NPK/ha and 8 tons pm/ha + 200 kg NPK/ha in both years (Table 3), similarly tuber rot was highest at these levels of treatments. This is a reflection of highest nitrogen uptake as a result of higher application. This corroborates the report of Eze and Orkwo [16]. Tuber rot increased with higher nutrient application irrespective of source. Asadu, et al. [17] found that high rate of nitrogen combined with phosphorus results in substantial increase in nematodes in white yam. The damage caused by nematodes may aid bacteria penetration and cause rot of yam in storage Osuji and Umezuri [18] asserted that weight loss is one of the several reactions that result in deterioration of yam tuber in storage. Weight loss results in deterioration of yam in storage. This results from respiration which is largely due to oxidation of stored starch, desiccation and sprouting. Period of dormancy reduced with increased in level of pm and NPK fertilizer in the zone. Okwor and Ekanaya [19] found that sprouting was very active physiological process that results in high losses in dry matter and moisture. Imbalance between N P and K absorbed by the yam and their content in the tubers were responsible for tubers from fertilizer plot sprouting faster.

4. CONCLUSION

That high rates of fertilizer application to yam increases tuber yield was not in doubt in this study, but there was the danger of poor tuber storage quality. Consequently combination of 100kg NPK/ha with 12 tons pm/ha is recommended for yam tuber storage in this zone.

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