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Evaluation of Farmyard Manure and Urea on Growth, Yield and Cost benefits of Rice (*Zea mays* L) (*Oryza sativa L*) in Southern Guinea Savanna, Nigeria.

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ABSTRACT

Chemical fertilizers are become more and more expensive, making them unaffordable for smallholder farmers in Nigeria. This study compared the combined effects of farmyard manure and inorganic fertilizers (prilled and granular urea) on growth, yield and cost benefits of rice**.** Field experiments were carried out in two locations (Malete and Shao) Kwara State, Nigeria during 2018 and 2019 cropping seasons. Seven treatments combinations in a Randomized Complete Block Design (RCBD), namely: T1: Control, T2: Recommended dose of NPK (100 % N through Indorama Granular Urea), T3: Recommended dose of NPK (100 % N through prilled urea),T4: Full dose of P&K + 75% N through Indorama Granular Urea +25 % N through FYM, T5:Full dose of P&K + 75% N through prilled Urea +25 % N through FYM, T6: Full dose of P&K + 75% N through Indorama Granular Urea, T7: Full dose of P&K + 75% N through Prilled Urea replicated three times each. The highest plant height, leaf area, number of tillers, number of grain /panicle were recorded in T4. The highest grain yield (3332.9, 3,125.3 and 3,400.9, 2,794.7 kg/ha for Malete and Shao respectively in 2018 and 2019. with highest economic returns were also observed in application of T4. It can be concluded from the findings that integrated application of farmyard manure and inorganic fertilizer, has the potential of producing a high yield of rice, increase farm income, and enhance farmers' quality of life.

1.0 Introduction

Rice (*Oryza sativa* L.) belongs to the family Poaceae and is one of the most consumed staples in Nigeria (PwC, 2018). More than 90 per cent of total rice is cultivated in South and East Asia, having China and India as the leading producers (Remison, 2005). In 2020, rice production in Nigeria amounted to around 8.2 million metric tons, making the country the leading rice producer in Africa followed by Egypt and Tanzania with an output of about 4.9 million and 4.5 million metric tons of rice, respectively (Saleh, 2022). The recent increase in demand for rice products has become a source of worry to people both locally and internationally. The problem stems from the fact that the world's population is increasing astronomically, which has put more pressure on the consumption of rice and its use as raw materials in industries.

In most tropical farming communities, the use of inorganic fertilizers to boast yield of rice cannot be underestimated as they have been found to increase crop performance as well as the chemical properties of soils (Ojeniyi, 2000). However, its continuous use could cause nutrient in-balance and soil acidity (Pahalvi *et al,* 2020). Against all these, it has been suggested that organic manures should be used in rice production as they are known to increase yield (Egbuchua and Enujeke, 2013). Prilled urea is a nitrogenous fertilizer that releases quickly and is frequently dispersed in splits, resulting in significant losses such as ammonia volatilization, immobilization, denitrification, and surface runoff which is harmful to the environment and has led to a series of agroecological issues (Olowoake *et al*., 2022). However, the alarming problem associated with the granular urea fertilizer use is its high nitrogen loss and low nitrogen use efficiency (NUE) which ranges from 10–50% (Motasim *et al*., 2021). The application of farmyard manure to soil is considered as a good management practice in any agricultural production system because it increases microbial biomass and activity, which increases the processing rate of organic N such as proteins, peptides, and amino acid (Ma *et al*., 2020). Furthermore, the application of organic manure together with inorganic fertilizers helps to neutralize soil pH, and leads to higher levels of organic carbon and improved macro- and micronutrient availability, physical properties, and microbial activity], thereby increasing crop yields (Liu *et al*., 2009 ; Olowoake, 2014 and Adane *et al*., 2020).

Mahmud *et al.* (2016) reported that inorganic fertilizers along with manure greatly influence the yield contributing characters and yield of rice. There is evidence from field research that high and sustainable yields are possible with integrated use of fertilizers and manure.(Sarker et al., 2015; Olowoake, 2023) However, it is important to identify the optimum dose of chemical fertilizer required for maintaining adequate supply of nutrients for increased yield, and reduced environmental pollution. Farmyard manure is mostly available and produced in farms, and is an important organic resource for agricultural production in livestock-based farming systems in Nigeria. Thus, there is a lot of potential for use of farmyard manure in the fertilizer schedule of rice and to reduce total dependence on inorganic fertilizers. With the move towards increased rice production, it has become necessary to study how yield of rice is affected by application of farmyard manure in combination with granular and prilled urea so as to allow a good economic comparison between these fertilizers. Hence, the present research was therefore conducted to study the influence of combined application of farmyard manure and different levels of inorganic fertilizer that will promote high rice yield and net farm income.

2.0 Materials and Methods

2.1 Description of the Study Location

The study was conducted at the Teaching and Research farm of Kwara State University, Malete (Fig. 1) and Kwara ADP farm at Shao Moro Local Government Area, Kwara State, Nigeria, in 2018 and 2019 cropping seasons respectively. The region has temperature that varies between 33□C and 34□C, annual rainfall in the region is about 1200mm and during the period, with a dry spell from December to March. The Kwara State University land area forms part of the South-western region of Nigerian basement complex, a region of basement recurrence and plutonism during the Pan-African orogeny. The Pan-African Orogeny manifests itself most prominently in Nigeria and areas of West Africa. (Olowoake, 2022).

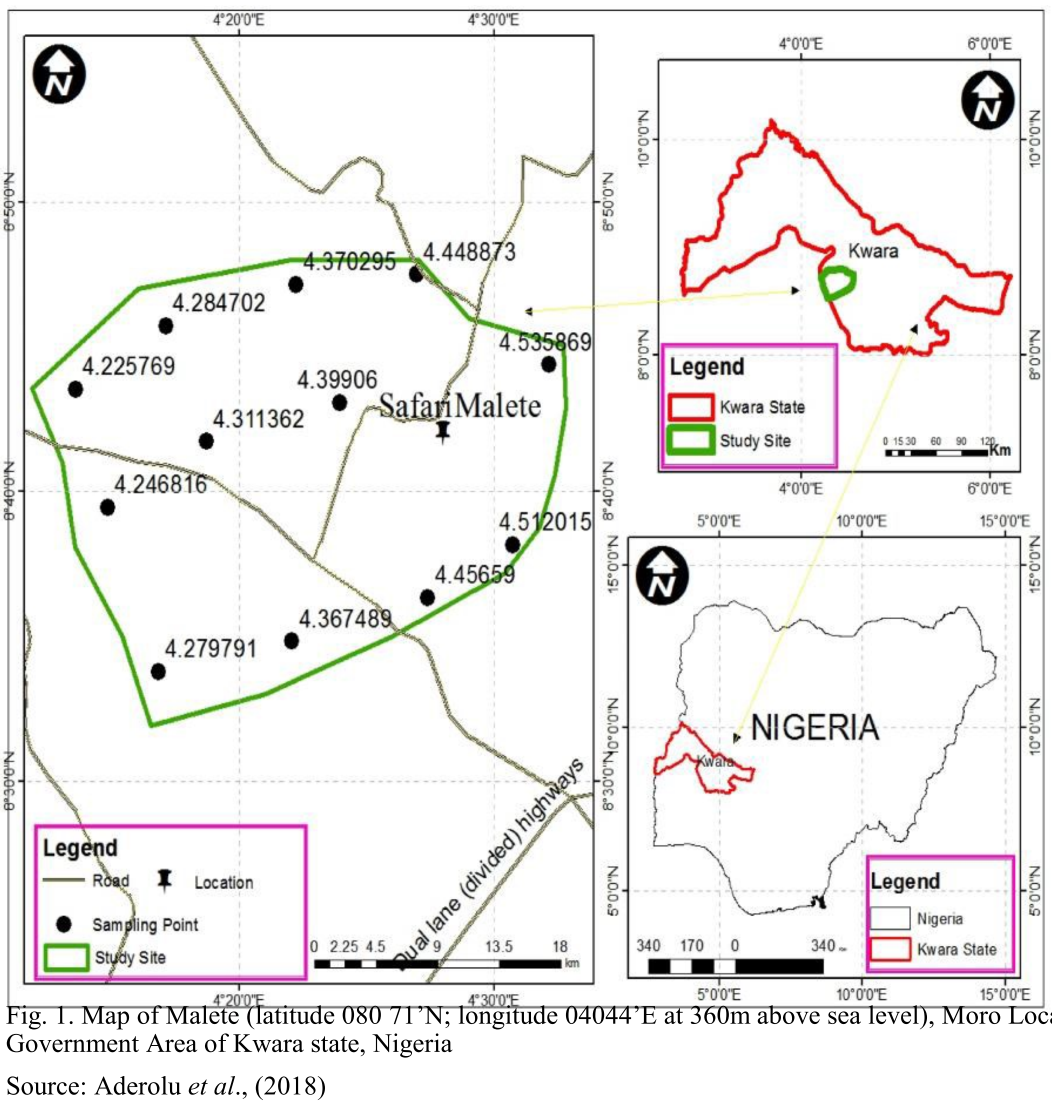

Fig. 1. Map of Malete (latitude 080 71'N; longitude 04044'E at 360m above sea level), Moro Local Government Area of Kwara state, Nigeria

Source: Aderolu *et al*., (2018)

The relative humidity and Average temperature registered during the field experiment in 2018 and 2019 are presented in Table 1. The mean maximum temperature was found to be the lowest in August while the mean maximum temperature was the highest in the month of March. The mean maximum temperature was 30.9°C from January to December 2018 and the mean maximum temperature was 31.2°C from January to December 2019. The relative humidity was 19.3% in January and 21.6 % in December 2018. Higher relative humidity from May to September 2019 was associated with higher number of rainy days and the maximum rainfall during the period.

Table 1. Total rainfall, relative humidity and Average temperature registered during the field experiment (2018–2019).

Months	Amount of Rainfall mm		Relative Humidity %		Maximum Temperature (^{O}C)	
	2018	2019	2018	2019	2018	2019
January	0.0	0.0	19.3	20.8	33.3	33.7
February	13.5	13.5	22.6	22.5	35.0	34.3
March	49.5	94.9	23.4	24.7	35.1	34.4
April	70.4	147.8	24.4	24.2	33.6	31.3
May	323.6	349.6	22.2	25.8	32.9	31.2
June	144.2	235.7	22.5	23.5	31.1	30.8
July	184.1	186.1	23.2	22.5	28.0	27.7
August	126.0	126.7	22.4	21.9	26.7	27.4
September	451.6	181.9	22.6	24.4	27.1	28.4
October	87.0	96.4	23.2	22.3	28.0	27.7
November	0.0	0.0	23.1	23.4	32.1	34.0
December	0.0	0.0	21.6	22.1	27.6	33.0

Source: Lower Niger River Basin Development Authority, Ilorin (Hydrology Section, 2019).

Laboratory Analysis

Soil samples from the experimental area were analyzed prior to experimentation after collection with the aid of soil auger from each block. The samples were bulked, air-dried and crushed to pass through a 2mm sieve. Chemical and physical properties were determined in the laboratory. Particle size distribution was determined by the hydrometer method (Bouyoucos, 1951) and the soil pH was determined in 0.01M CaCl . Soil organic carbon and the total N were evaluated by the Walkley and Black (1934) method and the micro-Kjeldahl digestion method (Bremmer and Mulvaney, 1982), respectively. Available P was extracted by the method of Bray and Kurtz (1945), while exchangeable bases (Ca, Mg, K and Na) were extracted with neutral 1M NH OAc at a soil solution ratio of 1:10 and measured by flame photometry. Magnesium was determined with using Perken-Elemer Atomic Absorption Spectrophotometer Model 305 B as described in A.O.A.C. (1992). Micronutrients were extracted with 0.1 EDTA and determined using atomic absorption spectrophotometer

Field Study

The land were cleared and harrowed twice after which it was marked into different sizes. The treatment were laid out in a randomized complete block design (RCBD) and replicated three times. The treatments were;

1. Control (zero application of fertilizer)

2. Recommended dose of NPK (100 % N through Indorama Granular Urea)

3. Recommended dose of NPK (100 % N through prilled urea)

4. Full dose of P&K + 75% N through Indorama Granular Urea +25 % N through FYM

5. Full dose of P&K + 75% N through prilled Urea +25 % N through FYM

6. Full dose of P&K + 75% N through Indorama Granular Urea

7. Full dose of P&K + 75% N through Prilled Urea

The results of analyses of the farm yard manure are summarized in Table 2

Table 2. Chemical composition of farmyard manure

Nutrient element	N (%)	P (g/kg)	K (g/kg)
Farmyard manure	2.8	19.9	20.9

Each plot size was measure 4.0 m x 4.0 m with 0.5 m between plots and 1.0 m between blocks. Rice (var. NERICA L-19, 120-130 days and tolerant to iron toxicity) was used for the experiments. The rice was planted at the rate of 40 kg/ha with drilling method.

Fertilizer application

The farmyard manure consist of cow dung, urine and bedding materials were collected from the cattle unit of Kwara State University Teaching and Research Farm. Farm yard manure were incorporated into the soil at two weeks before planting, while the inorganic fertilizers were applied at 3 and 6 weeks after planting using side placement method.

Weed/Insect management

Ronster mixed with pendimethaline was applied as preemergence herbicide immediately after planting while 2, 4 – D amine was applied as selective post emergence herbicide. Manual weeding was carried out at 4 weeks after planting to keep the experimental plot weed free. Cypermethrin + dimethoate was applied to control stem borer as need arises.

The following data were collected from five tagged plant at the inner rows at the two locations during the period of experiment. Plant height was measured with a measuring tape from the ground level to the base of the last leaf, leaf area was determined by measuring the width and length of each flag leaf and multiplying by 0.75 (Badaw *et al.,* 2019). Tiller numbers were determined by counting the number of tillers from 5 plant stands from each plot and average computed, number of grain per panicle, 100 grains weight from harvested grains were weighed from each plot using sensitive weighing balance. The panicles from two inner rows were cut using a sickle, allowed to dry, threshed and winnowed to obtain grain yield per hectare.

Economic analysis

Farm budgeting analysis was used to compute the farm income. Benefit cost analysis and the return on investment were used as economic indicators. To study the economic performance of different soil amendment on rice yield, total gross returns and net return were calculated based on the current market price of different inputs, transportation cost, weed management and labour wages, finally benefit cost ratio was calculate with the following equation by Pasqual *et al.,* 2013;

$$\text{Benefit cost ratio (BCR)} = \frac{\text{Net farm income}}{\text{Total cost of production}}$$

Total cost = Variabl cost + Fixed cost

Statistical Analysis

Data collected were subjected to Statistical Analysis System (SAS) for Analysis of variance (ANOVA) and the treatments means were compared at 5 % level of significance using the Duncan's Multiple Range Test (DMRT) with the aid of software SAS ® 9.4 version (SAS Institute Inc. 1996).

Results and Discussion

Table 3 shows the results of the physical and chemical analysis of the two experimental soils before cropping. Soils of the two sites (Shao and Malete) were generally low in total N, and P. Thus, the soil required fertilizers or soil amendment to improve its fertility. The available P of 2.77 and 3.1 mg/kg mg kg-1 was below the critical level of 10-16mg kg-1 (Adeoye and Agboola, 1985). The K status of the soil which was 0.28 and 0.38 cmol/kg was higher than the critical level of 0.2 cmol kg-1 (Adeoye, 1986). Exchangeable magnesium values of 0.78 and 0.64 cmol/kg were higher than the critical level of 0.20 - 0.40 cmol/kg-1 (Adeoye and Agboola, 1985). Calcium value of 0.58 and o.66 cmol/kg was below the critical level of 2.6 cmol/kg (Agboola and Corey 1972). Therefore, indicating that the soil may be poor in nutrients.

Table 3. Physico-chemical properties of experimental site (Malete and Shao)

Parameters	Soil test value	
	Malete	Shao
pH (H_2O)	6.7	6.8
Org.C (%)	7.9	0.3
Total N (%)	0.82	0.05
P (mg/kg)	2.77	3.1
Exchangeable bases (cmol/kg)		
Mg	0.78	0.64
Ca	0.58	0.66
Na	0.43	0.48
K	0.28	0.38
Extractable micronutrients (mg/kg)		
Cu	0.90	0.77
Fe	107	101
Mn	106	201
Zn	7.0	6.6
Sand (%)	82.0	79.0
Silt (%)	15.0	14.0
Clay (%)	3.0	7.0
Textural class	Loamy sand	Loamy sand

Effect of fertilizer treatments on rice growth parameters

The effect of fertilizer treatments on plant height and leaf area of rice is presented in Table 4. The treatment T4 performed better in terms of plant height and leaf area of rice at Malete as well as Shao during 2018 and 2019 planting seasons. At Malete in 2018, the highest value for plant height (47.3 cm) was observed in T4 which was statistically similar with those of T4 at Shao. The shortest plant of 30.5 and 33.2 cm was found in T1 treatment at Malete and Shao respectively. In 2019, the tallest plant of 28.4 cm at Malete was found in T4 which was statistically identical with that of T4 at Shao. Leaf area was statistically similar in all the treatments at both location in 2018. Similarly, higher significant (($P<0.05$) leaf area observed at Malete and Shao in 2019 were obtained from T4. The probable reason for the T4 produced taller plants than that of mineral fertilizer (T2, T3 and T6) might be attributed to the complementary effect of the manure on each other as both combinations had a conducive soil environment that were richer in nutrient supply for plant uptake. The results are in agreement with that of Azim *et al.* (1999) and Islam *et al.* (2014). The authors reported that plant height increased due to combined application of poultry manure, cow dung and inorganic fertilizers. Also, Sarker et al. (2004) also reported the increased leaf area with manure application in combination of inorganic N fertilizers.

Table 4. Growth parameters of rice as influenced by application of fertilizer treatments during 2018 and 2019 planting season

Treatment	Plant height (cm)		Leaf Area (cm^2)	
	2018			
	Malete	Shao	Malete	Shao
T1	30.5c	33.2c	54.78b	46.84bc
T2	35.9bc	36.7bc	48.51b	47.54bc
T3	40.1b	40.9b	55.07b	53.96b
T4	47.3a	48.2a	79.55a	77.96a
T5	40.2b	41.0b	55.83b	53.15b
T6	49.2a	50.1a	51.36b	50.53bc
T7	50.7a	51.8a	52.69b	51.84bc
2019				
T1	14.3c	16.9b	27.25c	27.89d
T2	24.9a	25.8a	32.92b	45.57b
T3	26.5a	27.5a	40.74b	45.38b
T4	28.4a	25.8a	44.89a	47.52a
T5	22.6b	23.8b	35.60b	39.27c
T6	24.5b	23.5b	39.06b	38.78c
T7	24.3b	23.2b	39.69b	38.28c

Means having the same letter along the columns indicate no significant difference using Duncan's Multiple Range Test at 5% probability level.

Legend:

T1 - Control, **T2**- Recommended dose of NPK (100 % N through Indorama Granular Urea),**T3**- Recommended dose of NPK (100 % N through prilled urea) **T4**- Full dose of P&K + 75% N through Indorama Granular Urea +25 % N through FYM, **T5**-. Full dose of P&K + 75% N through prilled Urea +25 % N through FYM, **T6**- Full dose of P&K + 75% N through Indorama Granular Urea, **T7**- Full dose of P&K + 75% N through Prilled Urea

Effects of fertilizer treatments on yield parameters of rice

The effect of fertilizer treatments on yield parameters of rice is presented Table 5. At Malete, in 2018, the treatment T4 and T5 produced the highest number of tillers (12.1) and the higher number of grain /panicle (51.8.) which were statistically similar with those of treatments T4 at Shao. Interestingly, the highest hundred weight of grains (6.3 and 6.6 g) were recorded in T4 treatment at Malete and Shao respectively. At Malete teaching and research farm, the grain yield ranged from 261.4 to 3332.9 kg/ha whereas at Shao farm, the grain yield ranged from 2.66.7 to 3,400.9 kg/ha. For both locations in 2018, the maximum grain yield values were observed in T4 treatments. In 2019 planting season, for most of the yield parameters in Malete and Shao, the lowest values were observed in control treatments. Significant difference was found in the yield parameters of rice cultivated at Malete and Shao where the highest number of tillers (7.5 and 7.2), number of grain /panicle (58.6 and 52.4), hundred weight of grains (6.8, 6.9 g) were recorded in T4 respectively. Similarly, the highest grain yield (3,125.3 kg/ha) from T4 at Malete were statistically identical with the grain yields (2,794.7 kg / ha) from T4 at Shao farm respectively. Better yield components such as, increased number of tillers and increased number of grains /panicle with manure and inorganic fertilizers

Table 5: Yield parameters of maize as influenced by application of granular and prilled urea during 2018 and 2019 planting season.

Treatment	Number of tillers		Number of grain / panicle		Hundred weight of grains (g)		Yield (kg/ha)	
			2018					
	Malete	Shao	Malete	Shao	Malete	Shao	Malete	Shao
T1	10.7c	9.8c	33.3e	34.0b	3.0d	3.2c	261.4g	266.7f
T2	11.9a	10.3b	37.6d	38.4ab	4.5c	4.6bc	883.4e	901.3d
T3	11.4ab	11.7ab	40.1c	40.9ab	4.6c	4.7bc	634.2f	647.1e
T4	12.1a	12.3a	51.8a	52.8a	6.3a	6.6a	3332.9a	3,400.9a
T5	12.1a	11.1ab	45.0b	45.9ab	5.9b	6.4ab	2,912.9b	2,972.4b
T6	11.3ab	10.7b	48.1b	49.1ab	6.3a	6.4ab	2,879.1c	2,938.7b
T7	11.0b	11.3ab	50.2a	51.2a	6.3a	6.1ab	1919.9d	1,959.1c
			2019					
T1	4.7c	5.0c	30.2e	21.4d	3.7d	2.5c	1,610.7f	1,141.3f
T2	5.6bc	5.6	40.2c	34.6c	4.6c	4.8b	2,143.9d	1,845.3e
T3	6.1b	6.2b	35.8d	43.4b	4.9c	4.9b	1,909.3e	2,314.7c
T4	7.5a	7.2a	58.6a	52.4a	6.8a	6.9a	3,125.3a	2,794.7a
T5	6.8ab	6.6b	50.2b	38.4c	6.0ab	6.5ab	2,677.3b	2,047.9d
T6	6.4b	6.6b	40.8c	51.2a	5.7b	6.5ab	2,175.9d	2,730.7b
T7	5.8bc	6.2b	43.9c	52.0a	5.0b	6.4ab	2,341.3c	2,773.3ab

Means having the same letter along the columns indicate no significant difference using Duncan's Multiple Range Test at 5% probability level.

Legend:

T1 - Control, **T2**- Recommended dose of NPK (100 % N through Indorama Granular Urea),**T3**- Recommended dose of NPK (100 % N through prilled urea) **T4**- Full dose of P&K + 75% N through Indorama Granular Urea +25 % N through FYM, **T5**-. Full dose of P&K + 75% N through prilled Urea +25 % N through FYM, **T6**- Full dose of P&K + 75% N through Indorama Granular Urea, **T7**- Full dose of P&K + 75% N through Prilled Urea

Economic analysis

The net farm income as influenced by combined application of different fertilizers treatments across the locations are presented in Table 6. Higher net benefit was obtained with the application of full dose of (T4) in both locations. Recommended dose of (T5) proved economical by giving higher income, but full dose of P&K + 75% N through Granular Urea + 25% N through FYM (T4) showed economical by giving higher income. It gave a net return of ₦2,902.060 (US$8005.68) and ₦2,677,060 (US$7,384.99) at Malete and Shao respectively. The lowest net benefit was observed from T1 (control) in Malete and Shao respectively. Among the various fertilizer treatments used, T4 recorded the highest benefit cost (18.4 and 16.9), followed by T5, T6 (15.6 and 16.6) at Malete and Shao respectively. However, control plots recorded lowest benefit cost ratios. The economic analysis amongst the treatments in the two sites (Malete and Shao) indicated higher net revenues on the rice plot with T4 treatments than other plots (BCRs >1). This could be due to excellent and balanced nutrient in the farm yard manure that was associated with the slow released that accompanied that of granular urea. According to Yusuf *et al.* (2018), balanced and adequate fertilizer application is essential for increasing crop yields and net returns, whiles ensuring sustainability. The results obtained for cost and returns analysis indicated that full dose of P&K + 75% N through Indorama Granular Urea +25 % N through FYM resulted in profits and this could be as a result of the efficiency of Urea, Single super phosphate, Potassium nitrate and farm yard manure to supply essential plant nutrients in optimum quantities and proportions required by rice plant to increase grain yield and consequently profit. This finding also confirmed the view of Ayoola and Makinde, (2007) who reported the organic fertilizer can be enriched with inorganic fertilizer to obtained optimum maize grain yield

Table 6. Economic analysis of rice yield as influenced by fertilizer treatments at Malete and Shao (Average of 2018 and 2019 planting season)

Treatment	Variable cost ₦	Fixed cost ₦	Total cost ₦	Revenue per treatment ₦	Net farm income ₦	Cost Benefit Ratio
	Malete					
T1	35000	49000	84000	1,130,000	1,007,950	11.9
T2	87050	49000	136050	2,070,000	1,933,950	14.2
T3	89050	49000	138050	1,890,000	1,751,950	12.7
T4	108940	49000	157940	3,060,000	2,902060	18.4
T5	110940	49000	159940	2,610,000	2,494,160	15.6
T6	104240	49000	153240	2,160,000	2,006.760	13.1
T7	106240	49000	155240	2,340,000	2,184,760	14.1
Shao						
T1	35,000	49,000	122,050	1,080,000	957,950	7.8
T2	87,050	49,000	136,050	1,800,000	1,663,950	12.2
T3	89,050	49,000	138,050	2,250,000	2,111,950	15.3
T4	108,940	49,000	157,940	2,835,000	2,677,060	16.9
T5	110,940	49,000	115,840	1,980,000	1,864,160	16.1
T6	104,240	49,000	153,240	2,700,000	2,546,760	16.6
T7	106,240	49,000	155,240	2,690,000	2,534,760	16.3

Average 1 USD is approximately ₦362.5 (between December 2018 and 2019)

Legend:

T1 - Control, **T2**- Recommended dose of NPK (100 % N through Indorama Granular Urea), **T3**- Recommended dose of NPK (100 % N through prilled urea) **T4**- Full dose of P&K + 75% N through Indorama Granular Urea +25 % N through FYM, **T5**-. Full dose of P&K + 75% N through prilled Urea +25 % N through FYM, **T6**- Full dose of P&K + 75% N through Indorama Granular Urea, **T7**- Full dose of P&K + 75% N through Prilled Urea

Conclusion

The findings of this study reveal that that combined application of organic fertilizers in form of farmyard manure and synthetic urea has a potential to increase the growth parameters, yield components and grain yield of rice. Therefore, Full dose of P&K + 75% N through Indorama granular urea +25% N through FYM, which shows higher results in responsiveness and economic evaluation, should be the farmers' primary priority because it would boost their incomes and improve their standard of living..

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