Afropolitan Journals

ISSN: 2730-7603X www.afropolitanjournals.com

Growth Component of Lowland Rice (*Oryza Sativa L.*) Varieties as Influenced by Planting Method and Fertilizer Management in Nigeria Sudan Savanna

Babaji M.,[1] Musa A. B.,[2] Hassan H. A.,[3] and Muhammad U. L.[4]

[1&2]Aminu Saleh College of Education, Azare, Bauchi State. [3]College of Agriculture and Animal Science, Ahmadu Bello University, Mando-Kaduna. [4]Federal University Kashere, Gombe State.

Corresponding author: mohammedbabaji24@yahoo.com

Abstract

Field trial was conducted at the Gadau Village, Itas-Gadau Local Government Area of Bauchi State (11^0 50′, 4.79″ N,) (10^0 10′ 1.20″ E), in the Sudan Savanna ecological zone of Nigeria, during the 2022 dry season, to determine, growth components of lowland rice (*oryza sativa L.*) varieties as influenced by planting method and fertilizer management in Nigeria sudan Savanna. The treatments consisted of two lowland varieties (FARO 44, and FARO 52), five rates of combined NPK and poultry manure fertilizers (0tha^{-1} of poultry manure plus 120:60:60 kg NPK ha^{-1}, 60:30:30 kg NPKha^{-1}plus poultry manure 5tha^{-1}, No NPK plus 10tha^{-1} , 30:15:15 kg NPKha^{-1} plus poultry manure 10tha^{-1} and 0 kg NPKha^{-1} plus poultry manure 0tha^{-1}), and three planting method (dibbling, drilling and broadcasting). The treatments was factorially combined and laid out in a split plot design with fertilizer rate and planting methods as main plot and lowland rice varieties as sub plot. Gross plot size will be 3.0m x 4.0m (12m^2) and net plot size of 2m x3m (6m^2) respectively. The results revealed that FARO 52 performed better on plant height, number of tillers at 9WAS. Drilling planting method performed better on plant height, leaf area index at 3, 6 and 9WAS, total dry weight at 3 and 6WAS, crop growth rate at 6AWS, relative growth rate at 6WAS, net assimilation rate at 6AWS, grain yield and NPK and Poultry Manure Mixture on growth and yield of lowland rice, 120:60:60 NPK and 30:15:15 NPK + 10tha^{-1}PM were performed better on plant height, leaf area index, total dry weight, crop growth rate, number of tillers at 9WAS, grain yield. Based on the research finding it was concluded that FARO 52 variety, drilling planting method and 120:60:60 NPK and 30:15:15 NPK + 10tha^{-1} PM performed better in almost all the growth and yield components of lowland rice at Gadau.

Keywords: Dibbling, Drilling, Broadcasting, Poultry Manure.

Introduction

Rice (*Oryza Sativa*) is a staple food in many countries of Africa and other parts of the world. It is also the most import staple food for about half of human race (Udemezue, 2014). (Imolehin and Wada, 2000) rice has become the second most important cereal in the world after wheat in terms of production due to a recent decline in maize production. However, it is widely cultivated throughout the tropics, and where flood controls are affective. Majority of foreign rice imported into West Africa is from south-East Asia. In sub-Saharan Africa, West Africa is the leading producer and consumer of rice (WARDA, 1996). West Africa accounts for 64.2% and 61.9% of total rice production and consumption in sub-Saharan Africa. Nigeria ranks highest both the producer and consumer of rice in the sub-region with figures slightly above 50% (Imolehin and Wada, 2000).

FAO estimated that annual rice production should be increased from 586 million metric tons in 2001 to meet the projected global demand of about 756 million metric tons by 2030 (Udemezue, 2014). One of the overarching goals of Nigeria agriculture development programs and policies is increasing agricultural productivity for accelerated economic growth. The increase in production is due to an increase in land under rice cultivation and not increase in yield. The difference between potential and actual yields is also very high. A yield of 4.4 -7.2t/ha has been recorded on research farm. However, average rice yields are consistently low and stand at around 1.5t/ha (Singh *et al.*, 1997).

Nigeria is currently the largest rice producing country in Africa. This is as the result of conscientious efforts by the government to place more emphasis on agrarian production. Annual rice production in Nigeria has increased from 5.5 million tons in 2015 to 5.8 million tons in 2017. In 2015, Nigerians spent not less than N1bn on rice consumption, adding that while spending had drastically reduced, consumption had increased because of increased local production of the commodity. The consumption rate now is 7.9 million tones and the production rate has increased to 5.8 tons per annum. The increase was as a result of the Central Bank of Nigeria (CBN)'s Anchor Borrowers Program with a total of 12 million rice producers and four million hectares of FADAMA rice land (RIFAN, 2017). The country is taking steps to control the rampant smuggling that has had a negative impact on local market prices (RIFAN, 2017). Nigeria's rough rice production in 2019/20 at 7.4 million metric tons, down about three percent or 200,000 metric tons lower than 2018/19 estimate of 7.6 million metric tons. The drop is attributable to a nearly three percent reduction in forecasted area harvested, representing a falloff of around 100,000 hectares compared to 2018/19. Rice consumption in 2019/20 at 7.1 million metric tons, 100,000 metric tons lower than 2018/19 estimate of 7.2 million metric tons (USDA, 2019).

Direct planting method reduce labour needs by more than 20% in terms of working hours required (Srilatha and Srilatha, 2013). The raising of nursery and manual transplanting are both labour intensive and costly (Das, 2003). So, direct planting is much helpful due to less labour and time requirement by skipping the operation of nursery raising and transplanting to the field manually. Expansion of irrigated area, availability of short duration high yielding rice varieties, effective weed control methods, increased transplanting costs and declining profit-ability of rice production forced many farmers to shift from transplanting to direct sown paddy. For this, seed drill implement is a great helper to the rice farming community (Srilatha and Srilatha, 2013). The performance of a seeder is mainly dependent on type of soil and field conditions, preparation of seed bed, speed of operation and power source (Kepner *et al.*, 2000). Hence new innovations and initiatives are required to make rice production system more sustainable and economically profitable. Under these circumstances, direct sown paddy with seed drill appears to be a viable alternative for rice cultivation that saves expensive inputs, water and labour (Srilatha and Srilatha, 2013).

Nitrogen (N), phosphorus (P), and potassium (K) are applied as fertilizers in large quantities in rice fields, and a deficiency of one of the nutrient leads to yield losses. There are many factors that influence the nutrient absorption including cultivar, soil type, fertilizer type, fertilization technology, and environmental factors (Zhang *et al.*, 2006). Imbalanced N, P, and K fertilization application can affect soil productivity (He and Cui, 2008). Wu *et al.*, (1998) increasing the rates of N, P, and K fertilizers favoured vigorous growth of the rice plant.

In recent times, attention has been directed towards organic manure because of the rising cost of inorganic fertilizers coupled with their inability to give the soil the desired sound health. Poultry manure, sometimes called chicken manure, is an excellent soil amendment that provides nutrients for growing crops and also improves soil quality when applied wisely, because it has high organic matter content combined with available nutrients for plant growth (van *et al.*, 1993). The chemical composition of poultry manure varies with factors such as source of manure, feed of the birds, age and condition of the birds, storage, handling of manure, and litter used (Mariakulandai and Manickam, 1975). Poultry waste consists of droppings, wasted feed, broken eggs, feathers, and sometimes sawdust from poultry floor. It also includes the dead birds and hatchery waste, all of which are high in protein and contain substantial amount of calcium and phosphorus due to high level of mineral supplement in their diet. Poultry manure has been reported to contain more plant nutrients than all other organic manures (Ali, 2005).

Sowing improved varieties using appropriate methods of seeding could produce a fast growing and uniform crop with higher yields which could compete with weeds effectively (Kawure *et al.*, 2018). According to Ali, (2007) direct planting rice when managed properly can yield as high as the transplanted one. Organic fertilizers have been used to improved soil chemical properties especially decreasing acidity and improving the humus content of the soil (Olanikan, 2006). Studies have also showed that they are highly effective, environmentally safe and biologically justified mostly on degraded soils (Ojobor *et al.*, 2009).

Therefore, the objectives of this study were to:

1. Determine the response of low land rice varieties to planting method and fertilizer mixture.
2. Evaluate the influence of planting method on growth of lowland rice.
3. Determine the Effect of NPK and Poultry manure fertilizers mixture on growth of lowland rice.

Materials and Methods

Field trial was conducted at the Gadau Village, Itas-Gadau Local Government Area of Bauchi State (11° 50′, 4.79″ N,) (10° 10′ 1.20″ E), in the Sudan Savanna ecological zone of Nigeria, during the 2022 dry season, to determine, Growth, Yield and Yield Components of Lowland Rice (Oryza Sativa L.) Varieties as Influenced by Planting Method and Fertilizer Management in Nigeria Sudan Savanna. The treatments consisted of two lowland varieties (FARO 44, and FARO 52), five rates of combined NPK and poultry manure fertilizers (otha^{-1} of poultry manure plus 120:60:60 kg NPK ha^{-1}, 60:30:30 kg NPKha^{-1}plus poultry manure 5tha^{-1}, No NPK plus 10tha^{-1} , 30:15:15 kg NPKha^{-1} plus poultry manure 10tha^{-1} and 0 kg

NPKha^{-1} plus poultry manure otha^{-1}), and three planting method (dibbling, drilling and broadcasting). The treatments was factorially combined and laid out in a split plot design with fertilizer rate and planting methods as main plot and lowland rice varieties as sub plot. Gross plot size will be 3.0m x 4.0m (12m^2) and net plot size of 2m x3m (6m^2) respectively. The treatment was replicated three times. Prior to planting, soil samples were randomly collected at different spots, from experimental field. The samples were taken randomly at 0-30cm depth prior to land preparation for physical and chemical analysis in the laboratory to determine the physical and chemical properties of the soil. The experimental site was harrowed to obtain a fine tilth. The site was then marked out into plots and replicates according to the layout. Check basins were constructed manually and the raised borders were carefully compacted to minimize seepage. Each main plot was separated by 1m pathway, the sub-plot by 0.5m and poultry manure was in-cooperated into the plots according to treatments (otha^{-1} of poultry manure, poultry manure 5tha^{-1}, 10tha^{-1} , poultry manure 10tha^{-1} and poultry manure otha^{-1}). Data collected was subjected to Statistical Analysis of Variance (ANOVA) as described by Snedecor and Cochran (1967). The differences between the treatments means were compared using Duncan Multiple Range Test (DMRT) (Duncan, 1955). The relationships between parameters were determined by correlation coefficient (Little and Hills, 1978). Plant height was measured using a meter rule from ground level of the plant to its fully opened leaves during vegetative growth from each plot at 3, 6, and 9, weeks after sowing. Leaf area was measured at 3, 6, and 9 WAT using samples of five randomly selected plants. PAR/LAI Ceptometer LP-80 model was used to measure leaf area index. The machine works by the means of sensor attached to it, at 3, 6, and 9 WAS. and the values observed recorded for each treatment. Dry matter per plant was determined at 3, 6, and 9 weeks after transplanting from net plot of each plot. Plants from the different plant/stand population were carefully uprooted from the net plot and washed to remove soil and other foreign particles. The sample was then oven dried at 70°C for 48 hours. The oven dried samples were weighed using Metler electronic precision balance and expressed in gram (g) per plant. The data collected was used for growth analysis. Crop growth rate were determined using the values of plant dry weight obtained at 6- and 9-weeks interval from the sampled plants after being oven dried at 70°C for 48 hours to a constant weight. The following formula by Radford (1967) was used.

$$CGR = \frac{W_2 - W_1}{T_2 - T_1} \; (g/m^2/wk)$$

Where = CGR crop growth rate

W_1 = total dry weight at t_1.

W_2 = total dry weight at t_2

T = time in weeks

Result and Discussion

Detail of physical and chemical properties of the soil taken for the experimental site (Gadau) at a depth of 0-30 cm; for analysis during 2022 dry season was shown in Table 1. The soil textural class was found to be sandy clay. Soil from location was also found as follow moderate in organic matter, neutral pH of 5.63, moderate organic carbon 9.4 gkg^{-1}, low in total nitrogen 0.6 gkg^{-1}, moderate and high available phosphorus 50.29 mgkg^{-1}, on exchangeable cations low K 0.28 cmolkg^{-1}, moderate mg 1.24 cmolkg^{-1}, moderate Ca 9.84 cmolkg^{-1}, moderate Na 0.35 cmolkg^{-1}, and high CEC 22.48 cmolkg^{-1}. Even though tillering is largely a varietal characteristic, plant environmental conditions, especially soil moisture and mineral nutrition plays a significant role. Chandrasekaran *et al*. (2007) reported that rice can be grown successfully on a variety of soil. The most important requirement of the soil is its ability to hold moisture. The textural classes of the soil samples was sandy clay and pH (5.63) (Table I), which was good for moisture retention capacity. Daudu *et al.* (2014) reported that rice plant required heavy soil, slightly acidic to neutral (pH 5.5-7.0) high clay content of 40-60% and moderate organic matter.

Table 2 shows growth components of lowland rice (*oryza sativa l.*) varieties as influenced by planting method and fertilizer management in Nigeria sudan Savanna. Plant height (cm), leaf area per index (m^2), total dry weight, Crop growth rate (CGR) (gm^2 wk^{-1}), Relative growth rate (g g^{-1} wk^{-1}), and Net assimilation rate (g m^{-2}wk^{-1}), number of tillers at 9WAS of lowland rice during the 2022 dry season at Gadau. FARO 52 Variety performed better on plant height, Comparing hybrids, inter specific lowland NERICA's and inbred for plant height, it was observed that hybrids were shorter than the inbred varieties which may be an important character for hybrid to withstand lodging (Malini *et al.*, 2006) and number of tillers at 9WAS. FARO 44 performed better on leaf area index only. There is no significant difference between varieties on total dry matter, crop growth rate, relative growth rate, net assimilation rate, grain yield.

Dibbling planting method performed better on leaf area index at 3WAS, total dry weight at 3 and 6WAS, crop growth rate at 6 and 9WAS, relative growth rate at 6 and 9WAS, net assimilation rate at 6 and 9WAS. Drilling planting method performed better on plant height, leaf area index at 3, 6 and 9WAS, total dry weight at 3 and 6WAS, crop growth rate at 6AWS, relative growth rate at 6WAS, net assimilation rate at 6AWS, grain yield. Broadcasting planting method performed better on total dry weight at 9WAS, relative growth rate at 9WAS, net assimilation rate at 9WAS. Increase in yield may be ensured through different sowing methods such as drilling and dibbling. Sowing improved varieties using appropriate methods of seeding could produce a fast growing and uniform crop with higher yields which could compete with weeds effectively (Kawure *et al.*, 2018).

The fertilizer combinations for this experiment included the following 120:60:60 NPK, 60:30:30 NPK + 5tha^{-1} PM, 10tha^{-1} PM, and 30:15:15 NPK + 10tha^{-1} PM and control. The influence of fertilizer on plant height observed that at 6WAS 120:60:60 NPK, 60:30:30 NPK + 5tha^{-1} PM, 10tha^{-1}, and 30:15:15 NPK + 10tha^{-1} PM recorded the almost the same, at 9WAS 120:60:60 NPK and 30:15:15 NPK + 10tha^{-1} PM performed better these findings were in accordance with Sarker, (2017) The chemical fertilizer used is readily soluble and hence can supply nutrients to rice plants within a short time after application. Djomo *et al.*, (2017) observed that Increased in the dosage of fertilizer N-P-K had a greater influenced on the height of the rice varieties. Gala *et al.*, (2011) reported that increasing amount of NPK improves considerably the vegetative growth of rice. The larger the leaf area of a plant the more the photosynthetic area and consequently the output is also high. Leaf area index at 3WAS no significant difference, at 6 and 9WAS 120:60:60 NPK and 30:15:15 NPK + 10tha^{-1} PM performed better Poultry manure in combination with inorganic fertilizers its could be available and actively participated in carbon assimilation, photosynthesis, starch formation, translocation of protein and sugar and thereby it increases the leaf area index, crop growth rate and absolute growth rate (Sunil *et al.* 2017). Total dry weight 6WAS 120:60:60 NPK, 60:30:30 NPK + 5tha^{-1} PM, 10tha^{-1} PM, and 30:15:15 NPK + 10tha^{-1} PM, at 9WAS 120:60:60 NPK and 30:15:15 NPK + 10tha^{-1} PM performed better. Crop growth rate at 6WAS 120:60:60 NPK, 60:30:30 NPK + 5tha^{-1} PM and 10tha^{-1} PM at 9WAS 120:60:60 NPK and 30:15:15 NPK + 10tha^{-1} PM performed better. Relative growth rate at 6WAS 120:60:60 NPK, 60:30:30 NPK + 5tha^{-1} PM, 10tha^{-1} PM, and 30:15:15 NPK + 10tha^{-1} PM, at 9WAS no any significant influence of fertilizers. Net assimilation rate at 6WAS 120:60:60 NPK, 60:30:30 NPK + 5tha^{-1} PM and 30:15:15 NPK + 10tha^{-1} PM performed better and it is statistically similar with 10tha^{-1}, 9WAS no any significant influence of fertilizers. Number of tillers at 9WAS 120:60:60 NPK and 30:15:15 NPK + 10tha^{-1} PM performed better. 120:60:60 NPK and 30:15:15 NPK + 10tha^{-1} PM were at par and recorded the highest Grain yield (kgha^{-1}).

Table 1: Physio-chemical characteristics of the experimental site during the 2022 dry season at Gadau.

Soil depth 0-30cm	
Soil Composition	
Particle size (g/kg)	
Clay	400.48
Silt	110.28
Sand	480.24
Textural class	Sandy clay
Chemical Properties	
pH in water	50.63
Organic carbon gkg^{-1}	9.4
Available P (gkg^{-1})	50.29
Total nitrogen (gkg^{-1})	0.6
Exchangeable Cation (cmolkg^{-1})	
K (cmolkg^{-1})	0.28
Mg (cmolkg^{-1})	1.24
Ca (cmolkg^{-1})	9.84
Na (cmolkg^{-1})	0.35
CEC (cmolkg^{-1})	22.48

Table 2: growth components of lowland rice (*oryza sativa l.*) varieties as influenced by planting method and fertilizer management in Nigeria Sudan Savanna.

Treatment	Plant height (cm)	LAI (cm)	TDW(g)	CGR(gm^2wk^{-1})	RGR (gg^{-1} wk^{-1})	NAR (g cm wk^{-1})	Number of tillers per plant (m^{-2})	Grain yield ($kgha^{-1}$)
Varieties								
FARO 44	21.9044	1.60511	29.473	5.6778	0.12493	0.7865	5.0044b	2734.8
FARO 52	22.4067	1.66756	31.731	6.5687	0.12858	1.0002	6.1422a	2724.1
SE±	**0.0362**	**0.0095**	**0.1452**	**0.0508**	**0.0012**	**0.0143**	**0.0309**	**15.4012**
Planting Method								
Dibblling	21.7300b	1.4260b	38.017a	8.3000a	0.15185a	1.4293a	5.7000	2922.2a
Drilling	24.6000a	1.8043a	28.550b	5.1983b	0.09656b	0.6691b	5.4000	3256.7a
Broadcasting	20.1367c	1.6787a	25.240b	4.8714b	0.131185a	0.5816b	5.6200	2009.4b
SE±	**0.0543**	**0.0142**	**0.2178**	**0.0763**	**0.0018**	**0.0215**	**0.0465**	**23.1018**
Rate of Fertilizer application (kg ha⁻¹)								
120:60:60 NPK	25.3222a	2.0978a	34.961a	8.6224a	0.13507	1.1065	6.9000a	3314.8a
60:30:30 NPK + 5tha⁻¹ PM	21.7222b	1.5378b	29.489b	5.2074b	0.11661	0.7643	5.7667b	2740.7b
10tha⁻¹ PM	22.5222b	1.6883b	29.344b	5.2074b	0.11661	0.8155	4.4000c	2740.7b
30:15:15 NPK + 10tha⁻¹ PM	25.3222a	2.2089a	36.117a	7.1333a	0.13507	1.1065	6.9000a	3314.8a
Control	15.8889c	0.6489c	23.100c	4.4457b	0.13042	0.6739	3.9000c	1536.1c
SE±	**0.0905**	**0.0236**	**0.3629**	**0.1271**	**0.0029**	**0.0358**	**0.0774**	**38.5030**
Interaction								
P X F	**	**	**NS**	**NS**	**NS**	**NS**	**NS**	**
P X V	**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
F X V	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
P X F X V	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Means followed by same letter(s) within the same column and treatment group are not significant at 5% level of probability. WAS= weeks after Sowing, ** significant at 1% level of probability, NS= not significant, NPK= Nitrogen, Phosphorus and Potassium, PM= Poultry Manure.

There is significant interaction between fertilizers and planting methods at 6 and 9WAS at ($p < 0.01$) level of significant and between planting methods and varieties at 9WAS at (p<

0.01) level of significant on plant height (cm). There is significant difference between fertilizer and planting methods and planting methods and varieties at 9WAS at ($p < 0.01$) and ($p < 0.05$) level of significant on leaf area index. There is significant interaction between fertilizers and planting methods at ($p < 0.01$) level of significant on Grain yield (kgha^{-1}).

Table 3: Interaction between the rate of fertilizer and planting methods on plant height (cm) of lowland rice at 9 weeks after sowing at Gadau in 2022 dry season.

	Planting Method		
Rate of Fertilizer application (kg ha^{-1})	**Dibbling**	**Drilling**	**Broadcasting**
120:60:60 NPK	27.0000a	23.9000c	25.0667b
60:30:30 NPK + 5tha^{-1} PM	22.0000c	20.2333c	22.9333c
10tha^{-1} PM	23.7167c	20.9167c	22.9333c
30:15:15 NPK + 10tha^{-1} PM	27.0000a	23.9000c	25.0667b
Control	14.6667e	15.5667d	17.4333d
SE±	**0.2714**		

Means followed by the same letter (s) within location are not significant at 5% level of significant of probability using Duncan multiple rage test (DMRT).

Table 4: Interaction between varieties and planting methods on plant height (cm) of lowland rice at 9 weeks after sowing at Gadau in 2022 dry season.

	Planting Method		
Varieties	**Dibbling**	**Drilling**	**Broadcasting**
FARO 44	22.0733b	21.3867c	22.2533ab
FARO 52	23.6800a	20.4200d	23.1200a
SE±	**0.1085**		

Means followed by the same letter (s) within location are not significant at 5% level of significant of probability using Duncan multiple rage test (DMRT).

Table 5: Interaction between the rate of fertilizer and planting methods on Leaf Area Index (cm) of lowland rice at 9 weeks after sowing at Gadau in 2022 dry season

	Planting Method		
Rate of Fertilizer application (kg ha^{-1})	**Dibbling**	**Driling**	**Broadcasting**
120:60:60 NPK	2.4500a	1.7217b	2.1217b
60:30:30 NPK + 5tha^{-1} PM	1.4817b	1.3883b	1.7433b
10tha^{-1} PM	1.9933b	1.5350b	1.5367b

30:15:15 NPK + 10tha^{-1} PM	2.4500b	2.0550b	2.1217a
Control	0.4900b	0.4317b	1.0250b
SE±	**0.0646**		

Means followed by the same letter (s) within location are not significant at 5% level of significant of probability using Duncan multiple rage test (DMRT).

Table 6: Interaction between the rate of fertilizer and methods of planting on Grain yield (kgha^{-1}) of lowland rice at Gadau in 2022 dry season

	Planting Method		
Rate of Fertilizer application (kg ha^{-1})	**Dibbling**	**Driling**	**Broadcasting**
120:60:60 NPK	3944.4444a	2861.1111ab	3138.8889a
60:30:30 NPK + 5tha^{-1} PM	2666.6667ab	2027.7778bc	3527.7778a
10tha^{-1} PM	2666.6667ab	2027.7778bc	3527.7778a
30:15:15 NPK + 10tha^{-1} PM	3944.4444a	2861.1111ab	3138.8889a
Control	2138.8889b	1461.1111bc	1008.3333c
SE±	**115.5090**		

Means followed by the same letter (s) within location are not significant at 5% level of significant of probability using Duncan multiple rage test (DMRT).

Conclusion

Based on the research finding it was concluded that FARO 52 variety, drilling planting method and 120:60:60 NPK and 30:15:15 NPK + 10tha^{-1} PM performed better in almost all the growth components of lowland rice at Gadau.

The following recommendations were made:

- Hybrid lowland rice varieties should be make available and affordable price to the farmers.
- There is need for educating farmers on agronomic practices for sustainable and profitable rice farming.
- Farmers should be informed on using organic farming for healthy environment.

References

Chandrasekarai, B, Annadurai, K, Kavimani R, (2007). *Textbook of Rice Science*, Scientific Publishers (India), P 8-45.

Daudu C. K., Yakubu A. A, Sambo I. J, Okwore J (MRS.), Adeosun J. O, and Onyibe J. E, (2014). Rice Production Processing, Utilization and Marketing in Nigeria (WAAPP and NAERLS). *Extension Bulletin* NO. 230.

Das, F. C. (2003). CRRI drum seeder for sowing pre-germinated paddy seeds in puddle field. In: International seminar on downsizing technology for rural development (ISDTRD- 2003). 139-142. Regional Research Laborato-ry, Bhubaneswar, India.

De Datta S. K, (1981). *Principles and Practices in Rice Production*, John Wiley and Son, New York, Pp 618.

Djomo Sime Hervé, Mbong Grace Annih, Malla Dorothy Kenyi and Suh Christopher (2017). Effect of different doses of NPK fertilizer on the growth and yield of rice in Ndop, North West of Cameroon, African Journal of Agricultural Research, Vol. 12 (15), pp 1244-1252.

Duncan, D. B., (1955). Multiple Range and Multiple F-test Biometrics. 11:1-24.

Gala B, Camara Y, Keli Z (2011). Rentabilités des engrais minéraux en riziculture pluvial de plateau cas de la zone de Gagnoa dans le centre ouest de la cote d'ivoire. J. Appl. Biosci. 46:3153-3162.

G. A. Ali, (2005). "Uses of manure and fertilizer as soil management Technique for sustainable crop production," Paper presented at workshop organized by Taraba State Local Government Service Commission.

He J. H. F. and K. H. Cui. (2008). "Determination of optimal nitrogen rate for rice varieties using a chlorophyll meter," *Field Crops Research*, vol. 105, no. 1-2, pp. 70–80.

Imolehin, E. D. and Wada, A. C. (2000). Meeting the Rice Production and Consumption demand of Nigeria with improved Technologies. National Cereal Research Institute,Badeggi,PMB8,Niger State, Nigeria.pp1-11.

Kepner, R.A., R. Bainer, and E. L. Barger. (2000). Prin-ciples of farm Machinery. CBS Publishers and Distribu-tors, New Delhi, (India).

Little, T. M., and F. J. Hills, (1978). *Agricultural Experimentation; Design and Analysis*, John-Wilry, New York, p 350.

Mariakulandai A. and T. S. Manickam, (1975). "Phosphorus and phosphatic fertilizers," in *Chemistry of Fertilizers and Manures*, pp. 114–162, Asia Publishing House, New York, NY, USA.

Ojobor, S. A., Egbuchua, C. N., Nnaji, G. U. and Okonmah, L. U. (2009). Influence of Organic Manure Treatments on the Growth and Yield of Upland Rice. *Natural & Applied Science Journal* 10(3): 292-291.

Olanikan, P. C. (2006). Organic Manures as Soil Amendments in Eroded Tropical Soils of South Western Nigeria. In Soil and Nutrient. *Journal of tropical soils*. 5(3): 11-18.

Radford, P. J, (1967). Growth Analysis Formular. Their Uses and Abuses. *Crop Science* 3:171-173.

Rice Farmers' Association of Nigeria (RIFAN) (2017). Rice Production in Nigeria Increases to 5.8m Tones. RIFAN Annual Report 2017.

Sarker, U. K.; Uddin, M. R.; Sarkar, M. A. R.; Salam, M. A.; Khairul, A. (2017). Influence of organic and inorganic nitrogen on the growth and yield of irrigated rice. Asian-Aus. J. Biosci. Biotech. 2, 9–23.

Singh B. N, Fagade S, Ukwungwu MN, Williams C, Jagtap SS. (1997). Rice Growing Environments and Biophysical Constraints in different Agroecological Zones of Nigeria. Met J 2: 35-44

Snedecor, G. W and Cochran W. G., (1967). *Statistical Metods.* Sixth Edition; Iowa University Press, Iowa, USA. Pp. 606-607.

Srilatha P., Ch. Srilatha Vani (2013). Direct Sown Paddy with Seed Drill – A Low Cost Technology Enhancing Paddy Production in Krishna District of Andhra Pradesh, International Journal of Science and Research (IJSR) ISSN (Online): 2319-7064.

Sunil Kumar, GK Shrivastava, MO Navaz, S Navrang, GP Pali and N Pandey. (2017). Impact of various organic sources of nitrogen on growth, yield attribbutes and yield of scented rice (Oryza sativa L.) under irrigated conditions of Chhattisgarh plains. J. Pharma. Phytochem., 6(6): 1388-1391.

Udemezue Joseph, (2014). *Adoption of FARO-44 Rice Production and processing Technologies by farmers in Anambra State*, Department of Agricultural Extension, University of Nigeria, Nsukka, Msc. Research Work.

USDA (2019). Foreign Agricultural Service, Grain Report, Global Agricultural Information Network, Grain Report Number: NG-19002

Van J. B. J. Ryssen, S. vanMalsen, and A. A. Verbeek, (1993) "Mineral composition of poultry manure in South Africa with reference to the Farm Feed Act," *South African Journal of Animal Science*, vol. 23, no. 2, pp. 54–57.

Wu G., L. T. Wilson, and A. M. McClung, (1998). "Contribution of rice tillers to dry matter accumulation and yield," *Agronomy Journal*, vol. 90, no. 3, pp. 317–323.

Zhang Y. H., Y. L. Zhang, Q. W. Huang, Y. C. Xu, and Q. R. Shen, (2006). "Effects of different nitrogen, application rates on grain yield and nitrogen uptake and utilization by different rice cultivars," *Plant Nutrition and Fertilizer Science*, vol. 12, no. 5, pp. 616–621.