RESPONSE OF UPLAND RICE TO DIFFERENT RATES OF NPK 15:15:15 IN ASABA, DELTA NORTH AGRO-ECOLOGICAL ZONE, DELTA STATE.

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Abstract
Field studies were carried out to determine the influence of different rates of NPK 15:15:15 on the growth and yield of rice, at the Teaching and Research Farm, Department of Agronomy, Delta State University, Asaba Campus for two years. The fertilizer were applied at 0, 50, 100, 150, 200 and 250 kg ha^{-1}) in three replications. NERICA 1 used was obtained from International Institute of Tropical Agriculture, Ibadan, while fertilizer was from Delta State ADP, Ibusa. Growth and yield parameters considered were: plant height, number of leaves, leaf area, plant girth, number of tillers, dry matter and paddy yield. Soil chemical properties were also evaluated after harvest at the second year. Pre-planting soil analysis was done. Data on rice were analyzed using analysis of variance and means separated with DMRT at 5% of level probability. Result of pre-soil analysis shows that the site was deficient in major elements and the fertilizer did not influence soil chemical properties appreciably, but it influenced growth and yield of rice significantly. Rates of fertilizer application greater than the 0 kg ha^{-1} increased growth and paddy yield. The 250 kg ha^{-1} had the highest paddy yield (1.55 and 1.54 t ha^{-1}) first and second year, respectively. It was significantly different from the lower rates except, 200 kg ha^{-1} (1.47 and 1.51 t ha^{-1}) in both years. Therefore, 200 kg/ha of NPK 15:15:15 fertilizer is recommended to farmers in Asaba and its environs for optimum upland rice production.

Key works – Inorganic fertilizer, Delta North, upland rice, NERICA 1, Soil fertility

Introduction

Rice is widely grown and consumed cereal crop in Nigeria, with per capita consumption of 3.5 kg and more than 14 kg per year per household. Its consumption has been accelerated and is estimated to be 2.1 million tons annually (FAO, 2002). This showed that rice is no longer a luxury food in the country, it has become a major source of calories both in the urban and the rural settings. Soil fertility depletion and inadequate fertilizer use are two major causes of its low production (Sanchez, 2002) and soil fertility maintainer is vital for the sustainable productivity. High cropping intensity has put pressure on soil nutrient supply and before now, farmers relied on shifting cultivation for soil fertility maintenances but due to population exposure the available land are now limited. As a result, intensive cropping is practiced. This practice has over stressed the soil, as a result nutrient elements that are essential for growth are inadequate supply. This is hindering sustainable rice production in Asaba and its environs.

Problems associated with the use of organic manure due to its bulkiness and slow decomposition rate have compelled farmers to opt for inorganic fertilizer despite its high cost and scarcity. This provides quick crop responses, increase in yield and boost in crop production (Idachaba, 2006). Use of fertilizer and high yielding varieties are necessary ingredients in achieving sustainable production of rice. Crop output and fertilizer application are strongly and positively correlates (Idachaba, 2006), this shows that without fertilizer it is difficult to attain sustainable rice production. No fertilizer recommended rate has been being adopted for the Asaba and environs unlike other regions that have received similar attention. Farmers apply different fertilizer rate, which lead to great variation on crop yield and chemical properties of soil (nutrients imbalance, soil acidity, toxicity). This will hinder the Federal Government Programme on the production and consumption of home grown rice. Hence, the objective of this study is to evaluate the effect of different rates of NPK 15:15:15 fertilizer on the growth and yield of upland rice, with the aim of proving information on the optimum rate for rice in the area.

Materials and Methods

The field studies were carried out at the Teaching and Research Farm, Department of Agronomy, Delta State University, Asaba Campus in two cropping seasons. Asaba is located at longitude 6^0 14^1 N and latitude 6^0 49^1 E. It has an annual rainfall of between 1500 mm-1849.3 mm and mean temperature of 23.3 °C (Asaba Metrological Office, 2016. The rainfall is humid with dry and rainy seasons. The rainy season runs between mid March to mid November while the dry seasons runs from early November to the end of March with bimodal pattern

New Rice for Africa (NERICA 1) was the test crop, and was obtained from WARDA Division, IITA, Ibadan. The NPK15:15:15 fertilizer was obtained from ADP, Ibusa, Delta State. The experiment was laid out in randomized complete block design. The fertilizer was applied at six rates (0, 50, 100, 150, 200 and 250 kg ha^{-1}) and replicated three times. It was applied two weeks after sowing using band application method. Post planting soil analysis was done after the second cropping season.

Soil sample for initial analysis was randomly collected from the experimental plot while the soil samples for post planting soil analysis were taken from each replicate then buck together according to treatment. The soil samples were dried at room temperature and were sieved with 2mm sieve before analyses. The soil samples were analysed in Analytical Laboratory, International Institute of Tropical Agriculture according to standard procedure (IITA, 1979). Growth and yield parameters considered were: plant height, number of leaves per plant, leaf area, number of tillers, dry matter and paddy yield per hectare. Analysis of variance was done for growth and yield data collected using linear model (GLM) routine of SAS Institute, Inc. (2002) and differences among mean were separated using DMRT at 5% level of probability.

Results and Discussion

Soil physical and chemical properties before sowing

The nutrient content of the experimental site is presented on Table 1. Soil texture was sandy loam, slightly acidic, low total N and available P. The total N of 0.68 gkg^{-1} is less than the critical level of 1.5 kg^{-1}, while the available P of 6.31 mg kg^{-1} is less than the critical level of 8-10 mg kg^{-1} indicating that the fertility of the soil is poor. The pH of 6.31 was moderate for rice production (Enwezor *et al.*, 1988).

Post planting soil chemical analysis

Table 2 shows the effects of the rates of the NPK 15:15:15 on soil chemical properties after harvest in the second year. Application of different rates reduced the soil pH lower than the control (6.30, 6.28 and 6.26, 6.25, 6.22 and 6.22 for 0 (control), 50, 100, 150, 200 and 250 kg ha^{-1} in 2009 respectively). Organic carbon of treated soils were slightly higher than the control, 200 kg ha^{-1} had the highest organic carbon, while control had the lowest organic matter (8.3 and 8.0 g/kg^{-1} respectively). Also, the 200 kg ha^{-1} had the highest total nitrogen, while the least was the control (0.67, and 0.64 g/kg^{-1} in second year respectively). Increase NPK fertilizer rate led to increase in the available phosphorus content of the soils. The control had the least available phosphorus (6.26 mg/kg^{-1}), while 250 kg ha^{-1} fertilizer had the highest available phosphorus (7.00 mg/kg^{-1}). Also, there were appreciable improvements of exchangeable potassium. The 200 and 250 kg ha^{-1} had the highest exchangeable K (0.78 $cmlkg^{-1}$, while the control had the least value K of 0.60 $cmolkg^{-1}$. Application of the mineral fertilizer slightly increased soil acidity over the control. This slight increase could be attributed to application of the NPK fertilizer, indicating that mineral fertilizer could not be used to improved soil acidity (Onwudike, 2010). There was no significant improvement in soil organic carbon in all the application treatments. This was because applied fertilizer was not capable to accumulate in the form of humus when mineralized (Vanlauwe *et al.*, 2001). There was no significant improvement in total N content in all the rates of fertilizer applied. The total N of the treated soil was generally low. Also there was no appreciable improvement of available phosphorus. The low total N, available P and exchangeable bases in soil treated could be attributed to the high rate of nutrient released that makes its nutrient readily available and also, make it easily leached out as could be affected by heavy precipitation (Onwudike, 2010).

Growth and paddy rice yield

Table 3 shows the effects of different rates of NPK fertilizer on plant height for both seasons, there were significant differences. Plant heights increases with weeks after planting and increased with rates of fertilizer application. The 250 kg ha^{-1} treatment fertilizer rate had the tallest plant, while the control had the smallest plant. All the rates of NPK fertilizer had higher number of leaves than the control. There were significant differences among the rates of application in both seasons. The control had the lowest number of leaves while the 150 kg ha^{-1} and 250 kg ha^{-1} treatment had the greatest number of leaves in first and second year, respectively. Effects of rates of application on the leaf areas are also shown on Table 3. Significant differences exist among the rates of application. The 200 kg ha^{-1} treatment had the highest leaf area in first year, while 250 kg ha^{-1} treatment had the highest leaf area in second year. Plant girth progressively increased with increase in weeks after planting and rates of NPK application, except for the control (Table 3). The control had the smallest plant girth and 200 and 250 kg ha^{-1} had similar plant girth in first year, while 250 kg ha^{-1} had the highest plant girth in second year. The control, 50 and 100 t ha $^{-1}$ treatments had no tiller growth in both years, 200 and 250 t ha^{-1} had two tillers each in first year, while one each in second year.

Table 3 also showed the effects of different rates of NPK 15:15:15 on dry matter yield after harvest. There were significant differences among the rates of fertilizer application. Application of 200 kg ha^{-1} of NPK 15:15:15 had the highest dry matter yield (6.80 and 19.5 t ha^{-1}) in both cropping years respectively. It was significantly different from the lower levels. The control had the least dry matter yield in both cropping years (4.40 and 3.53 t ha^{-1}) respectively. The effects of the different rates of NPK on paddy yield are also presented on Table 3. Significant differences were observed. The 250 kg ha^{-1} had the highest paddy yield (1.55 and 1.54 t ha $^{-1}$) respectively. It was significantly different from all the lower rates of application except, 200 kg ha^{-1} (1.47 and 1.51 t ha^{-1}) for both years. The control had the lowest paddy yield in both years (1.08 and 0.98 t ha^{-1}). The initial low nutrient status of the experimental site explained the significant response of rice plant to the treatments. Increase in NPK led to increase of the growth and yield parameters measured, this could be attributed to high rate of nutrient released by the highly soluble inorganic fertilizer. There was no significant difference between 200 and 250 kg ha^{-1} but 250 kg ha^{-1} had higher yield than 200 kg ha^{-1} treatment.

Conclusion

Effects of NPK 15:15:15 fertilizer on soil chemical properties and yield of upland rice were monitored for two years in Asaba. Results showed that all the rates greater 0 kg ha^{-1} increased growth and rice yield. The 250 kg ha^{-1} treatment was superior and had rice yield of 1.55 and 1.54 t ha^{-1} in first and second year, respectively. This was significantly higher than lower rates except 200 kg ha^{-1} (1.47 and 1.51 t ha^{-1}) in both years. No appreciable effect of fertilizer on soil chemical properties for the two year was recorded. Therefore, 200 kg $ha^{-1}$of NPK 15:15:15 could be recommended for farmers in Asaba and its environs.

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Table 1: Pre-cropping soil physical and chemical properties

Parameter	Nutrient Status
pH (H_2O) 1:2	6.31
Organic carbon (gkg^{-1})	9.10
Total Nitrogen (gkg^{-1})	0.68
Available P ($mgkg^{-1}$)	6.31
Exchangeable bases ($cmolkg^{-1}$)	
K	0.49
Mg	0.53
Ca	0.55
Na	0.72
Exch. Acidity	0.05
CEC	2.34
Particle Size (gkg^{-1})	
Sand	822
Silt	120
Clay	58
Textural Class	**Sandy loam**

Table 2: **Post soil chemical analysis**

Treatments Kg NPK ha^{-1}	**pH (H_2O 1:2)**	**Organic C (gkg^{-1})**	**Total N. (gkg^{-1})**	**Available P. ($mgkg^{-1}$)**	**Exchangeable bases ($cmolkg^{-1}$) K**	**Ca**	**Mg**	**Na**
0	6.30	8.0	0.64	6.29	0.60	0.52	0.50	0.58
50	6.28	8.2	0.64	6.31	0.63	0.54	0.52	0.73
100	6.26	8.2	0.64	6.31	0.64	0.65	0.61	0.74
150	6.25	8.2	0.65	6.33	0.72	0.54	0.64	0.78
200	6.22	8.3	0.66	6.34	0.78	0.56	0.69	0.82
250	6.22	8.5	0.67	7.00	0.78	0.55	0.60	0.80

Table 3: Effects of the rates of fertilizer application on growth and paddy yield of rice

Rates of application kg NPK ha^{-1}	Parameters measured: plant height (cm)	number of leaves	leaf area (cm^2)	plant girth (cm)	number of tillers	dry yield (t ha^{-1})	paddy yield (t ha^{-1})
First year							
0	47.1c	4.2a	30.0c	0.32c	0c	4.40c	1.08c
50	50.1c	4.6a	33.0b	0.36ab	0c	5.48b	1.13b
100	64.5b	5.0a	30.0c	0.35b	0c	5.90b	1.28b
150	65.1b	5.8a	34.1b	0.37a	1b	6.17b	1.31b
200	70.5a	5.4a	35.6a	0.38a	2a	6.80a	1.47a
250	71.9a	5.5a	36.1a	0.38a	2a	6.27a	1.55a
Second year							
0	35.1d	4.0b	27.6e	0.30c	0c	3.53d	0.96d
50	64.2b	5.4a	32.5b	0.34b	0c	10.5b	1.14c
100	64.5b	5.5a	31.1c	0.36b	1b	11.0b	1.19b
150	63.9b	5.4a	34.7b	0.38ab	1b	11.8b	1.29b
200	67.8a	5.7a	37.0a	0.40a	1a	19.5a	1.51a
250	68.3a	5.7a	37.1a	0.41a	1a	21.4a	1.54a

Treatments within each column with the same letter are not significantly different. ($P< 0.05$) DMRT

Table 4: Combined effects of the rates of fertilizer application on growth and paddy yield of rice

Rates of application kg NPK ha^{-1}	Parameters measured: plant height (cm)	number of leaves	leaf area (cm^2)	plant girth (cm)	number of tillers	dry yield (t ha^{-1})	paddy yield (t ha^{-1})
0	41.1d	4.1b	28.8e	0.31c	0d	4.00d	1.02d
50	51.2c	5.0a	32.8c	0.35b	0d	7.99c	1.14c
100	64.2b	5.3a	30.6d	0.36b	0.5c	8.59b	1.24b
150	64.5b	5.6a	34.4b	0.38a	1.0b	8.99b	1.30b
200	69.0a	5.6a	36.3a	0.39a	1.5a	13.15a	1.49a
250	70.1a	5.6a	36.6a	0.40a	1.5a	13.84a	1.55a

Treatments within each column with the same letter are not significantly different. ($P< 0.05$) DMRT