

EFFECT OF FERTILIZER APPLICATION AND METHODS ON THE PERFORMANCE OF RICE (FARO 57) IN DELTA MANGROVE WETLAND

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Abstract

Field experiments were carried out in a Delta mangrove wetland to determine the effect of different application of fertilizer methods on the performance of rice (Faro 57) during 2017 and 2018 cropping seasons. The treatments consisted of combined application of basal NPK fertilizer and varying split application (in two doses and three) of urea fertilizer either by broadcasting or foliar spray at different rates (23 Kg Nha⁻¹ each), which were combined and laid in a randomized complete block design (RCBD) with four replications. Data on number of tillers, plant height, number of panicles, days to 50% heading and grain yield were generated and subjected to analysis of variance test. Results obtained shows that plot where urea is applied in split doses (T3 and T4) resulted in higher yields in both 2017 (3.04 tha⁻¹ and 3.48 tha⁻¹) and in 2018 (3.13 tha⁻¹ and 3.39 tha⁻¹), respectively. The performances of treatment T3 in both 2017 and 2018 in terms of days to 50% heading (94) and plant heights (133.48 cm and 133.47cm) was better than other treatment combinations. Therefore, it is recommended that basal (NPK) + 2 splits urea (Foliar method) (T3) be adopted in the experimental area and other areas of similar ecological conditions for maximum utilization of nutrients for optimum yield of rice productivity.

Keywords: Fertilizer, Performance, Rice and Mangroove Wetland

INTRODUCTION

Rice belongs to the grass family *Poacea*, and it is being domesticated in Asia (*Oryza sativa*) and Africa (*Oryza glaberrima*), (FAO, 2004). It is an important cereal in the world and can be cultivated under diverse ecologies, ranging from irrigated, rain fed upland, rain fed lowland and to deep water/mangrove ecology. In Nigeria the potential area for rice production is between 4.6-4.9 million hectares. Out of this, only about 1.7 million hectares (35%) of the available land area is presently utilized for rice production. (IRRI, 2009a).

Rice productivity in general has high demand for nitrogen, phosphorus and potassium and other trace elements. The deficiency of these nutrients has been reported by Bhuyari *et al* (2012) to limit growth, yield, and good seed quality. Increase in Rice yield depends on several factors: climate, physical conditions of the soil, soil fertility, water

management, sowing date, cultivar, seed rate, weed control, and fertilization (Jing *et al.*, 2008). According to De-Xi *et al.* (2007) and Jing *et al.* (2008), nitrogen is the most important limiting nutrient that gives maximum yield. Its availability contributes to the progress of crop growth and tillering as well as determining the number of panicles and spikelet's during the early panicle formation stage. This nutrient also provides sink during the late panicle formation stage (Artacho *et al.*, 2009). According to Zhang *et al.* (2009), the dominant form of nitrogen is in the form of nitrate with relatively little ammonia volatilization after fertilizer nitrogen application, even with high nitrogen applications in rice; grain filling may be limited by a low contribution of post-anthesis assimilates.

To meet the need of the crop to obtain its maximum nutrient uptake there is every need to split the required nutrient and given as at when

the crop needs it most. According to Jing *et al.*, 2008, the N application in different splits increased crop yield and also increased N use efficiency.

Therefore, the objective of this research was to investigate the effect of different split and application methods of urea fertilizer on the performance of rice under the mangrove wetland ecology.

MATERIALS AND METHODSSite Description

The field experiment was carried out at the National Cereals Research Institute farm under the Department of Rice Research Program Warri Delta State during the 2017 and 2018 cropping season. The study area, Warri, lies between latitude 5°31 N and longitude 5° 45 E. The area is characterized by tropical equatorial climate with mean annual temperature of 32.8 °C and annual rainfall amount of 2673.8 mm. The natural vegetation is of rainforest with swamp forest in some areas. The soil is of marine alluvium, transported as sediment and deposited by river. It is classified as Entisol or Histosol (Ukpong, 1995; Soil Survey Staff, 1998). The soil colour is usually dark grey or black.

Treatments and Experimental Design

The treatments consisted of combined application of basal NPK fertilizer and varying split application of urea fertilizer either by broadcasting or foliar spray at different rate. Faro 57 rice variety was used as test crop, which was sourced from NCRI, Baddegi, which has mandate for the said crop. The treatments were as follows: Treatment 1 = 0 application (control)

Treatment 2 = Basal (30 Kg NPK ha⁻¹) + 2 split 23 Kg Nha⁻¹ Urea each (broadcasting)

Treatment 3 = Basal (30 Kg NPK ha⁻¹) + 2 split 23 Kg Nha⁻¹ Urea each (foliar spray)

Treatment 4 = Basal (30 Kg NPK ha⁻¹) + 3 split 23

Kg Nha⁻¹ Urea each (foliar spray)

Treatment 5 = Basal (30 Kg NPK ha⁻¹) + single dose 23 Kg Nha⁻¹ Urea (broadcasting) + single dose 23 Kg Nha⁻¹ (foliar spray) The experiment was laid out in randomized complete block design (RCBD) with four replications.

Field Preparation

The fields were marked using a measuring tape, pegs and twines and a total land area of 266m² (14mx19m) was mapped out for the experiment, The area was cleared off grasses and stumps for easy cultivation. The field was divided into four blocks and five treatments making a total of 20 plots, with plot size of 4mx2m².

Crop Establishment

The rice variety (Faro 57) was sown in wet nursery bed and proper care was taken to raise the seedlings in seedbed. Twenty one (21) days old seedlings were uprooted carefully and three healthy seedlings were transplanted in each hill maintaining spacing of 20 cm × 20cm.

Fertilizer Application

Basal application of compound fertilizer NPK 15:15:15 was applied at the recommended rate of 30Kg ha⁻¹ for the three nutrients elements and different rate and different application of Urea at 2 split 23Kg Nha⁻¹ Urea each (broadcasting) at vegetative and booting stage (T2), 2 splits of 23Kg Nha⁻¹ each (foliar spray) at vegetative and booting stage (T3), 3 splits of 23Kg Nha⁻¹ each (foliar spray) at vegetative, booting and early milking stage (T4) and single dose 23Kg Nha⁻¹ Urea at vegetative stage (broadcasting) + single dose 23Kg Nha⁻¹ at booting stage (foliar spray) (T5) was also applied.

Data Collection and Analysis

Data were collected on the Number of tillers, Plant height (cm) at harvest, Number of panicles, Days to 50% flowering and Grain yield according to standard procedure by Manasseh *et al.* (2018). All data were analyzed using analysis of variance test based on randomized complete block design (RCBD) according to the procedure outline by Obi (1990), using Crop stat software version 3.9

RESULTS

The Mean performance of some agronomic traits of rice (Faro57) under different fertilizer treatments in 2017 planting season

Table 1 shows that the Mean performance of some agronomic traits of rice (Faro57) under different fertilizer treatments in 2017 planting season was significantly ($P < 0.05$) different.

Days to 50 % flowering was not significantly

influenced by the treatments, T3 had the highest 94.00 % while T5 had the least mean of 87 %

There was a significant difference in the applied treatments on panicle count. T4 had the highest 621 while T1 had the least mean of 234 but T2 and T5 are not significantly different.

T4 had the highest tiller count with a mean value of 837 while T1 had the least 549 but not significantly different from T5 with a mean value of 559.

Plant height was significantly influenced by the treatments, T3 had the highest with a mean value of 133.48 cm but not significantly different from T5 while T1 had the least height with a mean value of 102.05 cm.

The highest grain yield was obtained in T4 with a mean value of 3.48 T ha⁻¹ but not significantly different from T3 with a mean of 3.04 T ha⁻¹ while T1 had the least 0.95 T ha⁻¹ but not significantly different from T2 with a mean value of 1.51 T ha⁻¹.

Table 1: Mean performance of some agronomic traits of rice (Faro57) in response to different fertilizer treatments in 2017 planting season

Treatment	Days to 50% flowering	Panicle count	Tiller count	Plant height (cm)	Grain yield T/ha
T1	89a	234d	549d	102.05c	0.95b
T2	93.25a	342c	638c	116.93ab	1.51b
T3	94.00a	441b	720b	133.48a	3.04a
T4	93.25a	621a	837a	123.50ab	3.48a
T5	87.5a	279c	559d	125.15a	1.29b

Mean in the columns followed by different letters are significantly different at $P < 0.05$

- 1= control,
 2= Basal (30 Kg NPK ha⁻¹) + 2 split 23 Kg Nha⁻¹ Urea each (broadcasting)
 3= Basal (30 Kg NPK ha⁻¹) + 2 split 23 Kg Nha⁻¹ Urea each (foliar spray)
 4= Basal (30 Kg NPK ha⁻¹) + 3 split 23 Kg Nha⁻¹ Urea each (foliar spray)
 5= Basal (30 Kg NPK ha⁻¹) + single dose 23 Kg Nha⁻¹ Urea (broadcasting) +single dose 23 Kg Nha⁻¹ (foliar spray)

Correlations of some agronomics traits of rice for 2017 planting season

Table 2 shows the correlation coefficient between some agronomic traits of rice.

Tiller count was positively and significantly correlated with panicle count (0.922) but not significantly correlated with plant height (0.202) and grain yield (0.23) respectively. Days to 50% flowering was negatively and not significantly correlated with panicle count, plant height and grain yield (-0.012), (-0.256) and (-0.373) respectively.

Panicle count was negatively and not significantly correlated with plant height (-0.256) but positively and not significantly correlated grain yield (0.064) while plant height is positively and significantly correlated with grain yield (0.602)

Table 2: Correlation of Some Agronomic Traits of Rice

	Tiller count	Days to 50% flowering	Panicle count	Plant height (cm)	Grain yield
tiller count/M2					
days to 50% flowering					
panicle count	0.922*	-0.012ns			
plant height	0.202ns	-0.256ns	-0.256ns		
grain yield	0.23ns	-0.373ns	0.064ns	0.602*	

*= significantly different at $P \leq 0.05$, NS= not significant at $P > 0.05$

The Mean performance of some agronomic traits of rice (Faro57) under different fertilizer treatments in 2018 planting season

Table 3 shows that the Mean performance of some agronomic traits of rice (Faro57) under different fertilizer treatments in 2018 planting season was significantly ($P < 0.05$) different. Days to 50 % flowering was not significantly influenced by the treatments, T3 had the highest 94.00 % while T5 had the least mean of 87.75 %

There was no significant difference in the applied treatments on panicle count. T5 had the highest 468 while T2 had the least 288.

Tiller count was not significantly influenced by the

treatment were T5 had the highest with a mean of 773 while T1 and T2 had the least 585.

T3 had the highest plant height with a mean of 133.47 cm but not significantly different from treatment with T5 while T1 had the least height with a mean value of 102.05 cm.

The highest grain yield was recorded in T4 with a mean of 3.39 T ha⁻¹ but not significantly different from T3 (3.13 T ha⁻¹) while T1 had the least 0.85T ha⁻¹ but not significantly different from T2 with a mean value of 1.25T ha⁻¹.

Table 3: Mean performance of some agronomic traits of rice (Faro57) in response to different fertilizer treatments in 2018 planting season

Treatment	Days to 50% flowering	Panicle count	Tiller count	plant height (cm)	Grain yield T/ha
T1	89a	378a	585a	102.05c	0.85c
T2	93.25a	288a	585a	116.92b	1.25bc
T3	94.00a	450a	682a	133.47a	3.13a
T4	87.75a	341a	674a	123.25ab	3.39a
T5	87.50a	468a	773a	125.15ab	1.65b

Mean in the columns followed by different letters are significantly different at $P < 0.05$

- 1= control,
 2= Basal (30 Kg NPK ha⁻¹) + 2 split 23 Kg Nha⁻¹ Urea each (broadcasting)
 3= Basal (30 Kg NPK ha⁻¹) + 2 split 23 Kg Nha⁻¹ Urea each (foliar spray)
 4= Basal (30 Kg NPK ha⁻¹) + 3 split 23 Kg Nha⁻¹ Urea each (foliar spray)
 5= Basal (30 Kg NPK ha⁻¹) + single dose 23 Kg Nha⁻¹ Urea (broadcasting) + single dose 23 Kg Nha⁻¹ (foliar spray)

Correlation coefficients of some Agronomic Traits of Rice for 2018

Table 4 shows the correlation coefficient between some agronomic traits of rice.

Tiller count was positively and significantly ($P < 0.05$) correlated with panicle count (0.566), plant height (0.461) and grain yield (0.461) but negatively not significantly ($P > 0.05$) correlated with Days to 50% flowering (-0.151)
 Days to 50% flowering was positively but not significantly correlated with panicle count (0.170) and plant height (0.034) respectively but negatively and not significantly correlated with grain yield (-0.102)
 Panicle count was positively but not significantly correlated with plant height (0.356) and grain yield (0.227) while plant height is positively but significantly correlated with grain yield (0.679)

Table 4: Correlation of some Agronomic traits of Rice for the year 2018

	Tiller count	Days to 50% flowering	Panicle count	Plant height	Grain yield
tiller count					
days to 50% flowering	-0.151				
panicle count	0.566*	0.170			
plant height	0.550*	0.034	0.356		
grain yield	0.461*	-0.102	0.272	0.679*	

*= significantly different at $P \leq 0.05$, NS= not significant at $P > 0.05$

DISCUSSION

The mean performance of some agronomic traits of rice (Faro57) under different fertilizer treatments in 2017 and 2018 planting seasons were significantly ($P < 0.05$) different. Meanwhile, days to 50 % flowering was not significantly influenced by the treatments, T3 had the highest (94.00 %) while T5 had the least mean of 87 %. Narang *et al.*, (1997) however, reported that 3 split of Nitrogen as a foliar spray at vegetative and flag leaf stage and a third as foliar spray at grain development, gave an increase 50 % flowering.

There was a significant different in the applied treatments on panicle count. T4 had the highest 621 while T1 had the least mean of 234. Fageria and Barbosa (2011) reported that number of effective tillers of rice increased significantly with increasing levels of nitrogen from 50 to 150 kg ha⁻¹. This result

is also in line with Rana *et al.*, (1989) as reported that 3 split of nitrogen application using foliar spray method is better than broadcasting with 2 splits. Moridani *et al.* (2013) also reported that increasing rate of N application up to 200 kg ha⁻¹ significantly increased the productive tillers. Fageria and Baligar (2001) also reported that increase in number of tillers resulted from the increased levels of nitrogen applied. This could therefore be the reason for the lowest number of tillers found in plots where fertilizer was not applied in this study.

Plant height was significantly influenced by the treatment; T3 had the highest with a mean value of 133.48 cm while T1 had the least height with a mean value of 1022.05 cm. Murthy *et al.* (2012) observed a significant increase in plant height with increasing nitrogen levels up to 120 kg N ha⁻¹

The highest grain yield was obtained in T4 with a mean value of 3.48 T ha^{-1} while T1 had the least 0.95 T ha^{-1} . These results indicate positive effects of foliar application of N fertilizers on rice yield. The increase in rice yield as observed in the present study is due to the direct supply of nitrogen from foliar spray throughout the growing period of rice that minimizes losses of nitrogen. These findings are well corroborated with Rahman (2010) who observed increased rice yield due to foliar application of nitrogen. Also Fagaria and Barbosa (2011) reported that grain yield of rice increased significantly with increasing levels of nitrogen at 23 Kg ha^{-1} .

Tiller count was positively and significantly correlated with panicle count ($r = 0.922$) but not significantly ($p > 0.05$) correlated with plant height and grain yield ($r = 0.202$) and ($r = 0.23$) respectively. Days to 50% flowering was negatively and not significantly ($p > 0.05$) correlated with panicle count, plant height and grain yield ($r = -0.012$), ($r = -0.256$) and ($r = -0.373$) respectively. Ghosh *et al.*, (2004) reported that the tiller number was significantly correlated with grain number per panicle

The result of the correlation of panicle count is in accordance with Miller *et al.*, (1991) who stated that Panicle production was highly correlated with grain yield.

The Mean performance of different fertilizer treatments of some agronomic traits of rice (Faro57) in 2018 is in line with Rahman (2010) as reported that foliar sprays and 2 split application increases seedling dry weight and seedling vigor index

There was no significant ($p > 0.05$) different in the applied treatments on panicle count. T5 had the highest 468 while T2 had the least 288. Similarly, Singh *et al.*, (2002) reported that foliar fertilization improved number of panicles, panicle count, weight of panicles grain, and straw yield.

Tiller count was not significantly ($p > 0.05$) influenced by the treatment with T5 having the highest with a mean of 773 while T1 and T2 had the least 585. This might be due to the fact that crop get more nutrients through foliar application which in return produces more tillers m^{-2} . Secondly it might be due to crop response was more to favourable environment in terms of increased vegetative growth like tillers production. These results are in the conformity with those of Shah and Saeed (1989) who reported that foliar spray of urea increased the number of productive tillers.

T3 had the highest plant height with a mean of 133.47 cm but not significantly ($P > 0.05$) different from T5 while T1 had the least height with a mean value of 102.05 cm. Monzoor *et al.*, (2006) opined that availability of nitrogen in early growth stage increases plant height.

The highest grain yield was recorded in T4 with a mean of 3.39 T ha^{-1} but not significantly different from T3 (3.13 T ha^{-1}) while T1 had the least 0.85 T ha^{-1} . The application through foliar practice can stimulate the increasing of yield components and rice grain yield (Mingotte *et al.*, 2013).

CONCLUSION

The results showed that plots where urea is applied in split (T4 and T3) provided a better condition for crop development when compared with T5, T2 and T1 respectively. This resulted in higher yield of rice. These results clearly indicated that the foliar application of N minimizes the loss of N that results in higher N use efficiency and increased grain yield of rice as compared to broadcast application of N in the form of urea. It is therefore recommended that basal (NPK) + 2 splits urea (Foliar method) (T3) be adopted in the experimental area and other areas of similar ecological conditions for maximum utilization of nutrients for optimum yield of rice productivity.

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