EVALUATION OF THE PERFORMANCE OF UPLAND RICE CULTIVARS AS AFFECTED BY FERTILIZER LEVELS IN A CLAY LOAM ULTISOL.

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ABSTRACT
A field experiment was conducted under rain-fed condition during the 2006 and 2007 planting seasons in Nara, Enugu (06^0 52'N and 07^0 15'E) in the Derived Savanna of Southeast agro-ecological zone of Nigeria, to evaluate the growth and yield performance of different upland rice cultivars under various fertilizer levels. The cultivars were NERICA – I, WAB – 189, NERICA – II, ITA – 150, and the fertilizer levels were 100kg ha^{-1} NPK 15 – 15 – 15 + 100kg ha^{-1} urea, 200kg ha^{-1} NPK 15 – 15 – 15 + 100kg ha^{-1} urea and 300kg $ha^{-1,}$ NPK 15 – 15 – 15 + 100kg ha^{-1} urea. A 4 x 3 factorial was laid out in a Randomized Complete Block Design with three replications. Results obtained show that the effects of cultivars and fertilizer rates on days to 50% heading, days to maturity, number of tillers and productive tillers, panicle count, and grain yield were highly significant. The interaction effects of cultivar and fertilizer were also significant for days to maturity, number of tillers and productive tillers, and panicle count. It was observed comparatively that WAB – 189 significantly (p = 0.05) performed better in the study area in terms of panicle and grain yield when NPK 15 – 15 – 15 at 300kg ha^{-1} + 100kg ha^{-1} urea fertilizer was applied, followed by NERICA – I

Key words: Upland rice, fertilizer levels, Productivity

INTRODUCTION

FAO (2004) estimated rice production in Nigeria between 2001 and 2003 at 2.03 million mega grams while consumption was 3.96 million mega grams. Large quantities of rice are still being imported to fill the production gap and this has a heavy import burden on Government. The potential land area for rice production in Nigeria is between 4.6 – 4.9 million hectares (Nwilene *et al*; 2009). The main production ecologies are rain-fed lowland, rain-fed upland, irrigated lowland, deep water/floating, and mangrove swamp. The land area for rice under rain-fed upland is 25%, rain-fed lowland 50%, irrigated lowland 16%, deep water and mangroves 9%. The share of production is 17%, 35%, 27% and 3% for rain-fed upland, rein-fed lowland, irrigated lowland, and deep water mangrove respectively.

Most rice varieties grown in the Derived Savanna zone of Southeastern Nigeria are hydromorphic or Swamp type with low yield and short to medium grain length. With recent crave by consumers for long and shinny rice grains over short grains of some of the already adapted varieties, Scientists at the West Africa Rice Development Association (WARDA) developed some upland rice cultivars known as New Rice for Africa (NERICA) among others. NERICA rice varieties were developed from the hybridization between Oryza Sativa and Oryza glaberrima (Chang, 1988). They have long grains and yield potentials of 4.0 – 5.0 t ha^{-1} (Africa Rice Centre, 2006).
Previous studies by Okhievbie (2001) indicated that among the various agronomic practices, transplanting date, plant spacing, and fertilizer levels are the interrelated factors to step up the yield of rice. He stated that for achieving high yield, adoption of improved varieties and proper agronomic practices are of considerable importance. Strangel (1978) in his studies reported that IR 8 rice variety requires 150-170kg N ha^{-1} for maximum yield during the dry season but less than 100kg N ha^{-1} during the wet season. Alkinson and Kunkel (1976) also reported that N requirement for modern varieties were about 130kg N ha^{-1} for dry season and about 80kg N ha^{-1} for wet season. Adigbo (2008) reported improved yield on application of 40kg ha^{-1} NPK 20 – 20 -20 at 4 weeks after planting and 40kg ha^{-1} inform of Urea top-dressed at 10 weeks after planting in his studies at University of Agriculture, Alabata, Abeokuta. Ogah *et al* (2008) reported a grain yield increase with increasing levels of nitrogen up to 80kg N ha^{-1} irrespective of transplanting dates and plant spacing at Abakaliki, Southeast, Nigeria. Nwilene *et al* (2009) identified low soil fertility, nutrient deficiency, birds, and weeds as the major constraints in rain-fed upland rice production in Nigeria.

The introduction and adaptation of upland rice cultivars with improved yield under optimum fertilizer application are envisaged to supplement swamp rice production and increase the total rice production in Nigeria, thereby closing the gap between production and consumption. The objective of the study is to evaluate the growth and yield of different upland rice cultivars under various fertilizer levels and identify the most

MATERIALS AND METHODS

The materials used in the study were four upland rice cultivars – NERICA-I, WAB-189, NERICA-II, and ITA-150 from National seed service, Nigeria, and NPK 15 – 15 – 15 and urea fertilizers. The field experiments were conducted under rain-fed condition during the 2006 and 2007 planting seasons in Nara, Enugu (Latitude 06^0 52' N and Longitude 07^0 15' E; altitude 450 m) in the Derived Savanna of southeast agro-ecological zone of Nigeria. The average annual rainfall varies from 1,700 to 2010mm with bimodal distribution. The rainfall usually lasts between April and October with peak in July and September. The dominant soil type in the experimental area is clay loam, classed as an ultisol (Ezeaku and Anikwe, 2006)

The experiment was a 4 x 3 factorial laid out in a Randomized Complete Block Design (RCBD) and replicated three times. Factor A represents the four upland rice cultivars; NERICA-I, WAB-189 NERICA-II, ITA-150, while factor B represent the three level of fertilizer, viz: 100kg NPK 15-15-15 fertilizer + 100 kg urea, 200kg NPK 15-15-15 fertilizer + 100kg urea, 300kg NPK 15-15-15 fertilizer + 100kg urea. In choosing the fertilizer levels, the recommendation of the Federal Fertilizer Department (2002) on different soil fertility status was taken into consideration.

The treatments were randomly applied to plots measuring 4 x 4m (16m^2) The NPK fertilizer was applied at 4 weeks after planting while the urea was applied at 10 weeks after planting. Seeds were planted in lines with a spacing of 20cm x 20cm. Adequate field maintenance was carried out to ensure that crops perform well. Weeding was done manually at three weeks interval
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Table 1: Treatment Combinations

Treatment:	Treatment Combinations
T1	NERICA – 1 x 100 kg NPK 15-15-15 + 100kg Urea fertilizer
T2	NERICA – 1 x 200 kg NPK 15-15-15 + 100kg Urea fertilizer
T3	NERICA – 1 x 300 kg NPK 15-15-15 + 100kg Urea fertilizer
T4	WAB – 189 x 100 kg NPK 15-15-15 + 100kg Urea fertilizer
T5	WAB – 189 x 200 kg NPK 15-15-15 + 100kg Urea fertilizer
T6	WAB – 189 x 300 kg NPK 15-15-15 + 100kg Urea fertilizer
T7	NERICA – II x 100 kg NPK 15-15-15 + 100kg Urea fertilizer
T8	NERICA – II x 200 kg NPK 15-15-15 + 100kg Urea fertilizer
T9	NERICA – II x 300 kg NPK 15-15-15 + 100kg Urea fertilizer
T10	ITA – 150 x 100 kg NPK 15-15-15 + 100kg Urea fertilizer
T11	ITA – 150 x 200 kg NPK 15-15-15 + 100kg Urea fertilizer
T12	ITA – 150 x 300 kg NPK 15-15-15 + 100kg Urea fertilizer

Data were collected on number of tillers per plant, number of productive tillers per plant, number of days to 50% heading, number of days to maturity, panicle count per 1m^2, and yield. The pooled data for two years were subjected to statistical analysis according to the procedure outlined by Steel and Torrie (1980) for a Randomized Complete Block Design, while mean separation was done using F-LSD at 50% level of probability as described by Obi (2002).

RESULTS

Details of the soil physical and chemical characteristics are shown in Table 2. The level of acidity according to the rating by USDASCS (1974) shows that the soil of study area is extremely acidic. The observed increments in most of the physiochemical properties of the soil in 2007 could be due to the improvement of the soil nutrients as a result of the fertilizer treatments on the experimental soil in 2006.

Table 2: Result of soil physical – Chemical properties of the study location

Soil Properties		**2006**	**2007**
Textural class		Clay loam soil	Clay loan soil
Clay %		32.26	31.76
Sand %		25.28	29.28
Fine sand %		31.46	27.94
Coarse sand %		11.80	11.02
pH – H_2O		4.4	4.8
pH – KCL		3.7	4.6
C %		1.01	1.17
OM %		1.71	2.00
N %		0.053	0.096
Na	Cmol kg^{-1}	0.45	0.48
Ca	Cmol kg^{-1}	2.1	1.4
Mg	Cmol kg^{-1}	0.6	1.6
CEC	Cmol kg^{-1}	17.2	16.6
P	Cmol kg^{-1}	4.38	20.48
K	Cmol kg^{-1}	0.16	0.25

Results in Table 3 showed that the effects of cultivars and fertilizer rates on days to 50% heading, days to maturity, number of tillers, number of productive tillers, panicle count, and grain yield were highly significant. The interaction effects of cultivars and fertilizer were also significant for days to maturity, number of tillers and productive tillers, and panicle count, while interaction effects for days to 50% heading and yield were not significant.

Table 3: Summary of ANOVA for growth and yield attributes evaluated after application of three rates of NPK 15-15-15 + urea fertilizer on four upland rice cultivars (Average of two cropping seasons)

Source of variation	**d.f**	**Days to 50% heading**	**Days to maturity**	**Number of tillers/plant**	**Number of productive tillers/plant**	**Panicle count per 1m^2**	**Gram yield (t ha^{-1})**
Block	2	1.17	0.46	4.61	2.04	0.19	2.38
Cultivar	3	1975.44**	1774.48**	62.45**	11.84**	7982.96**	360.95**
Fertilizer	2	16.36**	56.83**	52.52**	19.47**	172.38**	4553.11**
Variety x fertilizer	6	0.38^{ns}	9.32**	2.84*	1.11*	2.17 *	0.41^{ns}
Error	22						

** Significant at 1% probability level. * Significant at 5% probability level. ^{ns} not significant.

In Table 4 and 5, ITA-150 at 100 kg, 200 kg, 300 kg fertilizer rates recorded significantly (p = 0.05) higher number of days to heading and maturity above the other three cultivars, the trend was ITA-150 > NERICA-II, > NERICA-I, > WAB-189. There were significant increases in the three attributes with increase in fertilizer levels up to 200 kg ha^{-1}.

Table 4: Effect of cultivars and fertilizer rates on days to 50% heading

Cultivars	NPK 15-15-15 fertilizer (kg ha $^{-1}$) + 100kg ha^{-1} urea			Mean
	100	200	300	
NERICA-I	63	65	67	65.00
WAB-189	57	60	60	59.00
NERICA-II	67	70	70	69.00
ITA-150	109	113	113	111.67
Mean	74.00	77.00	75.50	

Lsd (p=0.05): Cultivar = 1.585
Fertilizer = 1.373
Cultivar x fertilizer = 2.745

Table 5: Effect of cultivars and fertilizer rates on days to maturity

Cultivars	**NPK 15-15-15 fertilizer (kg ha $^{-1}$) + 100kg ha^{-1} urea**			**Mean**
	100	**200**	**300**	
NERICA-I	95	100	100	98.33
WAB-189	89	90	89	89.33
NERICA-II	101	105	109	105.00
ITA-150	130	140	141	137.00
Mean	103.75	108.75	109.75	

Lsd (p=0.05): Cultivar = 1.444
Fertilizer = 1.251
Cultivar x fertilizer = 2.501

The ITA-150 had significant (p = 0.05) higher number of tillers than the other cultivars, with significant increase as the fertilizer rates increased from 100 kg ha^{-1} to 300 kg ha^{-1} across all the cultivars. The trend in tiller production was WAB – 150 > WAB – 189 > ITA – 150 while productive tillers produced by NERICA-I and NERICA-II were statistically the same.

Table 6: Effect of cultivars and fertilizer rates on number of tillers per plant

Cultivars	NPK 15-15-15 fertilizer (kg ha $^{-1}$) + 100kg ha^{-1} urea			Mean
	100	200	300	
NERICA-I	6	8	9	7.67
WAB-189	7	10	12	9.67
NERICA-II	7	7	9	7.67
ITA-150	10	13	14	12.33
Mean	7.50	9.50	11.00	

Lsd (p=0.05): Cultivar = 0.821
Fertilizer = 0.711
Cultivar x fertilizer = 1.421

Table 7: Effect of cultivars and fertilizer rates on number of productive tillers per plant

Cultivars	NPK 15-15-15 fertilizer (kg ha $^{-1}$) + 100kg ha^{-1} urea			Mean
	100	200	300	
NERICA-I	5.00	6.00	8.33	6.44
WAB-189	6.00	8.00	11.00	8.33
NERICA-II	5.00	6.00	7.00	6.00
ITA-150	4.00	5.00	6.00	5.00
Mean	5.00	6.25	0.08	

Lsd (p=0.05): Cultivar = 1.190
Fertilizer = 1.031
Cultivar x fertilizer = 2.062

With regards to panicle counts and yield (Tables 8 and 9), WAB-189 significantly (p = 0.05) out yielded the other cultivars. It recorded a panicle count and yield of 248.67 and 2.4267 t ha^{-1} respectively. The panicle and yield increased significantly as the fertilizer rate increased from 100 kg ha^{-1} to 300 kg ha^{-1}. Fertilizer rate of 300 kg ha^{-1} produced the highest panicle and yield. NERICA-I significantly (p = 0.05) out yielded NERICA-II and ITA-150. It recorded a panicle and yield of 199.67 and 2.1333 t ha^{-1} respectively.

Table 8: Effect of cultivars and fertilizer rates on panicle count per 1m²

Cultivars	NPK 15-15-15 fertilizer (kg ha $^{-1}$) + 100kg ha^{-1} urea			Mean
	100	200	300	
NERICA-I	189	200	210	199.67
WAB-189	240	250	256	248.67
NERICA-II	116	126	135	125.67
ITA-150	95	100	108	101.00
Mean	160.00	169.00	177.25	

Lsd (p=0.05): Cultivar = 2.225
Fertilizer = 1.927
Cultivar x fertilizer = 3.855

Table 9: Effect of cultivars and fertilizer rates on grain yield (t ha^{-1})

Cultivars	NPK 15-15-15 fertilizer (kg ha $^{-1}$) + 100kg ha^{-1} urea			Mean
	100	200	300	
NERICA-I	1.4900	2.4100	2.5000	2.1333
WAB-189	1.8000	2.7000	2.7800	2.4267
NERICA-II	1.4200	2.3200	2.4233	2.0544
ITA-150	1.4100	2.300	2.4200	2.0433
Mean	1.5300	2.4325	2.5308	

Lsd (p=0.05): Cultivar = 0.02769
Fertilizer = 0.02398
Cultivar x fertilizer = 0.04795

DISCUSSIONS

The significant effects of cultivars and fertilizer rates on the growth and yield attributes indicated differences among the different cultivars and in the effectiveness of the fertilizer rates. The differences among the cultivars could be as a result of variation in the genetic constitution, while that of fertilizer could be due to the nutrient composition and quantity of nutrient involved. Increased nitrogen and phosphorus increase vegetative growth and yield as a result of the increase in cell division in the plant tissue and subsequent production of more photosynthetic surface and accumulation of photosynthates. The positive response of the cultivars to increased fertilizer application indicated the inherent low fertility level of the soils of the study area as could be seen from the result of the soil analysis (Table 2). The significant interaction effects of cultivars and fertilizer indicated that the two factors influenced one another to exert effect on the two growth attributes.

ITA-150 had more tillers and matured later than NERICA-I, WAB-189, and NERICA-II; but had the least number of productive tillers. WAB-189, NERICA-I, and NERICA-II, matured early. This implies that for short season cropping, the three cultivars will be more adaptable than ITA-150. At harvest, WAB-189 and NERICA-I had the highest grain yield of 2.78 t ha^{-1} and 2.50 t ha^{-1} respectively at NPK fertilizer rate of 300 kg ha^{-1}. The panicle count followed the same trend, with WAB-189 performing best at the NPK fertilizer rate of 300 kg ha^{-1}, followed by NERICA-I.

This result is in accordance with the result obtained by Alkinson and kunkel (1976) which reported that nitrogen requirements for modern varieties were about 130 kg N ha^{-1} for dry season and 80 kg N ha^{-1} for wet season. It is also in support of the previous studies by Okhievbie (2001) which indicated that for achieving high grain yields, adoption of improved varieties, planting dates, planting spacing, and fertilizer levels are the interrelated factors to step up the yield of rice, Utoh (1999) which reported that improved variety accounted for up to 40% of the productivity gains in crop production. Ogah *et al* (2008 reported a grain yield increase with increasing level of nitrogen up to 80 kg N ha^{-1} at Abakaliki, Southeast, Nigeria. The result is also in agreement with Usman (1999) report, that vital factor for yield and productivity of other inputs such as fertilizer, pesticides etc; and Nwilene *et al* (2009 which indicated that growth and yield attributes of rice such as plant height, tillering capacity, maturity, yield are highly influenced by cultivar.

CONCLUSION

From the results of the study, it was shown that the effects of cultivars and fertilizer rates on days to 50% heading, days to maturity, number of tillers and productive tillers, panicle count, and grain yield were highly significant. The interaction effects of cultivars and fertilizer were also significant for days to maturity and number of tillers WAB-189, NERICA-I, NREICA-II were shown to have matured early at different fertilizer rates, while ITA-150 matured late. It was observed comparatively that WAB-189 significantly (p=0.05) performed better in terms of panicle and grain yield when NPK 15 – 15 – 15 at 300 kg ha^{-1} + 100 kg ha^{-1} urea fertilizer was applied, followed by NERICA-I. From the results of this study, WAB-189 and NERICA-I cultivars with the application of 300 kg ha^{-1} of NPK 15 – 15 – 15 + 100 kg ha^{-1} urea are recommended for a clay loam Ultisol in the South-eastern agro ecological zone of Nigeria.

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