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GROWTH AND YIELD PERFORMANCES OF SOME UPLAND RICE (*Oryza sativa* L.) CULTIVARS AS INFLUENCED BY VARIED RATES OF NPK (15:15:15) FERTILIZER ON AN ULTISOL.

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ABSTRACT
Field studies were conductedin 2005 and 2006 to assess the effects of different NPK (15:15:15) fertilizer rates on the growth and yield of upland rice varieties. The experiment were conducted in a high rain forest ecology of Uyo, Akwa Ibom State, Nigeria. The treatments consisted of factorial combination of five rice varieties (WAB340-8-8-2HI, WAB881-10-37-18-8-2-HI, WAB99-1-1, WAB224-8-HB, WAB189-B-B-B-8-HB) and four rates of NPK (15:15:15) fertilizer (0, 200, 400 and 600kg/ha) laid out in a randomized complete block design and replicated three times. The results showed that 600kg/ha NPK (15:15:15) fertilizer rate significantly (P < 0.05) increased plant height, number of leaves and tillers per plant in both years. The 400kg/ha rate increased the number of panicles per plant, length of central panicle per plant and the overall grain yields over other rates by 4-32% and 2-21% in 2005 and 2006, respectively. Among the varieties, WAB224-8-HB produced the highest grain yield (4.73 and 4.40 t/ha) followed by WAB189-B-B-B-8-HB (4.37 and 4.20 t/ha) for both years. The interaction effects between rice variety and fertilizer rates were generally significant. The mean grain yield for both years showed that WAB224-8-HB variety performed better than other varieties by 6-24% while the grain yield in the 400kg/ha plot superceded other rates by 3-26% and hence have potentials to support upland rice production in Uyo agro-ecology.

Key words: Upland rice, NPK fertilizer, ultisol, *Oryza sativa*.

INTRODUCTION

Rice (*Oryza sativa* L.) originated from Africa as a wild plant (Jordan, 1965). It is however, successfully grown today in regions having the necessary warmth and abundant moisture favourable to its growth. Rice can be classified ecologically into three types, namely upland, lowland and floating/deep water rice. Swamp rice is grown on lands which are either artificially or naturally flooded (Grist, 1986) and can germinate under water. They normally have higher yields than upland rice because fields are less weedy and does not suffer from moisture deficiency (Grist, 1986). Swamp rice can be grown under irrigation and are regarded as most important. The earliest cultivation of *Oryza sativa* L. in Nigeria is 1890, and this led to the introduction of upland rice varieties to the high forest zone in Western Nigeria (Grist, 1986). Upland rice therefore refers to rice grown on both flat and slopping fields that are prepared and seeded under dry land conditions and dependent on rainfall for moisture. Upland rice is grown in Asia, Africa and South America, mostly on small and medium size farms. Grain yields are generally low, ranging from 0.5 to 1.5 tonnes/ha in Asia, about 0.5 metric tonnes/ha in Africa and 1 to 4 metric tonnes/ha in South America (Fageria *et al*., 1982).

Rice is one of the most important cereal crops in the world followed by wheat and maize. It is indispensable in terms of importance as food crop because it provides more calories per hectare than any other crop. Other uses of rice include the manufacture of wines and spirits, cosmetics and textile. The bran is a valuable poultry feed and the oil extracted from it can be used as cooking oil, for soap manufacture, as carrier for insecticides and as anti-corrosive and rust-resistant oil.

In Nigeria, rice is widely grown in swampy areas, which are very limited and as such cannot meet rice demand by the populace. Despite this, less attention is still being given to upland rice production in Nigeria perhaps as a result of low yields following inadequate technology for its production. One of such inadequate technology is that most recommended rates of fertilizers are based on results of studies conducted in different agro-ecologies where soils and climatic conditions are not quite similar. Moreover, the inability of the farmers to know the most adaptable varieties for a given agro-ecology is also a serious factor. Against this background, a study was conducted to evaluate the effects of varied NPK (15:15:15) fertilizer rates on some upland rice in Uyo agro-ecology.

MATERIALS AND METHODS

The study was conducted at the Teaching and Research Farm of the University of Uyo, located at Use- Offot, Uyo, Akwa Ibom State, Nigeria, in the first seasons (April – August) of 2005 and 2006. Use-Offot is located in the lowland humid tropics (Latitude 5.17^0 and 5.27^0N; Longitude 7.27^0 and 7.58^0E) and is about 38.1 meters above sea level. The annual rainfall is 2500 mm and has bimodal pattern, with long (March – July) and short (September – November) seasons usually separated by a short dry spell of uncertain length, usually in August. The mean annual temperature varies between 22°C and 32^0C. The mean relative humidity of the area is 78% while the sunshine hours (daylength hours) range between 3 and 8 hours (Slus, 1989). The soil is acidic and belongs to broad soil classification group, *ultisol*, formed from acid plain sands, characterized by low cations exchange capacity and usually suffer from multiple nutrient deficiencies (Enwezor *et al.*, 1990).

Soil at the site was randomly sampled at two depths (0-15cm and 15-30cm) using soil auger before land preparation and after harvesting of rice. The soil samples were analyzed for it physical and chemical characteristics. The soils physico-chemical characteristics are shown on Table 1 for the 2005 and 2006 planting seasons.

The experimental design was a 5 x 4 factorial laid out in a randomized complete block with three replications. Factor A treatments were five upland rice varieties: WAB340-8-8-2HI, WAB881-10-37-18-8-2-HI, WAB99-1-1 WAB224-8-HB and WAB189-B-B-B-8-HB while the factor B treatments were four NPK (15:15:15) fertilizer rates: 0, 200, 400, and 600kg/ha. Each treatment plot measured 2m x 12m with 1m path separating one plot from the other. Planting distance was 25cm within row and 60cm between rows. In both years, four rice seeds were direct seeded per hill in April each year. Fertilizer was split applied by broadcasting method on the plots that were to receive fertilizer at 4 and 8 weeks after sowing (WAS) and at booting stage using $^1/_3$ of each rate at each application time.

The plot was weeded twice (3 and 6 weeks after sowing) using native hoe. Ten stands of rice plant were randomly selected and tagged from each of the plots for data collection. Data collected included plant height at 9 weeks after sowing number of leaves and tillers per plant (at 60 days after planting), number of panicles per plant at 100% booting, length of central panicle (cm) at maximum booting, and grain yield (tonnes/ha). The upland rice was harvested in August each year. Data collected were subjected to analysis of variance based on the factorial experimental design as described by Gomez and Gomez (1984). Least significant different was used to separate treatment means where significance differences were indicated.

RESULTS

Plant height and number of leaves: Plant height differed significantly ($P < 0.05$) among the upland rice varieties (Table 2) and mean across the fertilizer rates ranged from 95.93 cm for WAB 340 – 8 – 8 – 2- HI to 119.30cm for WAB 159 – B – B – HB in the first year and 92.64cm to 114.91cm for the same varieties in the second year. The height of WAB189-B-B-B-8-HB variety was 1 – 20 % higher than other varieties in the first year and 2 – 19 % higher in the second year (Table 2). Among the fertilizer rates, mean across the rice varieties revealed that the 600kg/ha rate produced the tallest plants (115.78 cm and 113.31 cm for both years, respectively). The mean height of rice as affected by the NPK (15:15:15) fertilizer rates ranged from 98.06 cm – 115.78 cm in the first year and from 94.43 cm – 113.31 cm in the second year. This showed that the 600kg/ha rate produced rice plants that were 1-15% and 5 – 17% taller than plants that received other fertilizer rates in 2005 and 2006, respectively. The interactions effect of variety and fertilizer significantly affected rice height in both years. Rice height generally increased with increase in the fertilizer rate.

The number of leaves per plant varied among the varieties and fertilizer rates (Table 3). The highest number of leaves per plant was observed on WAB881-10-37-18-8-2-HI variety in both years (6.08 and 5.97) while WAB228-8-HB variety produced the lowest number of leaves per plant in both years (5.85 and 5.83). The number of leaves observed on WAB881-10-37-18-8-2-HI variety was 1-4 % and 2-4 % higher than other varieties for both years, respectively. The application of NPK (15:15:15) fertilizer increased the number of leaves per rice plant over the zero (control) by 2-16% and 2-17 % for the two years, respectively. There was no difference in the number of leaves per plant between the 400 and 600kg/ha rates for both years but their number of leaves were significantly higher than the 200kg/ha rate.

Table 1 . Physico-chemical properties of soil at the experimental site

	2005 planting season				2006 planting season			
Soil properties	Before planting		After harvesting		Before planting		After harvesting	
	0-15cm	15-30cm	0-15cm	15-30	0-15cm	15-30cm	0-15cm	15-30cm
Sand (%)	87.20	81.53	83.69	83.88	84.67	81.60	84.26	83.40
Silt (%)	4.13	6.47	6.31	6.12	5.47	6.53	6.74	6.60
Clay (%)	8.67	12.00	10.00	10.00	10.53	12.20	9.00	10.00
pH (H_2O)	5.63	5.60	6.40	6.13	5.73	5.57	6.50	6.40
EC (ds/m)	0.06	0.06	0.07	0.09	0.07	0.06	0.07	0.09
Organic matter (%)	1.18	1.42	1.21	1.25	1.61	.94	1.57	1.36
Total N (%)	0.07	0.05	0.05	0.05	0.08	0.07	0.06	0.05
Available P (mg/kg)	85.06	84.41	58.90	61.22	91.40	88.03	56.33	60.66
Ca (cmol/kg	4.00	2.80	2.40	2.13	4.07	2.87	2.60	2.40
Mg (cmol/kg)	1.27	1.10	1.20	1.21	1.33	1.18	1.29	1.30
Na (cmol/kg)	0.04	0.07	0.06	0.07	0.06	0.07	0.06	0.07
K (cmol/kg)	0.08	0.12	0.06	0.01	0.10	0.13	0.09	0.13
EA (cmol/kg)	1.59	1.67	2.37	2.51	1.51	1.61	2.70	2.61
ECEC (cmol/kg)	6.97	5.43	6.10	6.01	7.05	6.27	5.91	5.72
B.S (%)	77.35	68.14	61.53	58.23	78.08	72.49	61.50	59.70

Table 2: Effects of NPK (15:15:15) fertilizer rates on rice height (cm) at 9 weeks after sowing

	2005 Planting season					2006 Planting season				
	Fertilizer rates (kg/ha)									
Rice Variety	0	200	400	600	Mean	0	200	400	600	Mean
WAB340-8-8-2-H1	81.10	96.40	93.30	112.90	95.93	77.63	94.33	87.60	111.00	92.64
WAB881-10-37-18-8-2-H1	105.70	116.60	127.40	125.40	118.78	101.77	114.27	112.20	121.53	112.44
WAB99-1-1	97.80	107.30	119.30	109.20	108.40	95.80	105.73	116.33	107.83	106.42
WAB224-8-HB	97.70	111.10	107.30	103.90	105.00	93.77	107.93	101.40	101.10	101.05
WAB189-B-B-B-8-HB	108.00	116.50	125.20	127.50	119.30	103.20	111.97	119.00	125.07	114.81
Mean	**98.06**	**109.58**	**114.50**	**115.78**		**94.43**	**106.85**	**107.31**	**113.31**	
LSD 0.05 fertilizer	2.13					2.10				
LSD 0.05 varieties	1.10					1.30				
LSD 0.05 fertilizer x variety interaction	3.51					3.06				

Table 3: Effects of NPK (15:15:15) fertilizer rates on the number of leaves per plant

	2005 Planting season					2006 Planting season				
	Fertilizer rates (kg/ha)									
Rice variety	0	200	400	600	Mean	0	200	400	600	Mean
WAB340-8-8-2H1	5.10	5.70	6.50	6.30	5.90	5.03	5.60	6.40	6.30	5.83
WAB881-10-37-18-8-2-H1	5.40	5.70	6.60	6.60	6.08	5.30	5.87	6.70	6.53	6.10
WAB99-1-1	5.90	5.80	5.50	6.80	6.00	5.70	5.90	5.57	6.67	5.96
WAB224-8-HB	5.10	5.90	6.30	6.10	5.85	5.06	5.90	6.17	6.17	5.83
WAB189-B-B-B-8-HB	5.40	6.00	6.50	6.30	6.05	5.27	5.93	6.47	6.20	5.97
Mean	**5.38**	**5.82**	**6.28**	**6.42**		**5.27**	**5.84**	**6.26**	**6.37**	
LSD 0.05 fertilizer	0.16					0.11				
LSD 0.05 varieties	0.09					0.07				
LSD 0.05 fertilizer x variety interaction	0.10					0.08				

Number of tillers and panicles per plant

The number of tillers per plant was significantly (P < 0.05) influenced by NPK (15:15:15) fertilizer rates (Table 4). The number of tillers per plant across the rice cultivars increased with increased rate of NPK and ranged from 5.12 - 7.42 and 5.12 - 7.19 in 2005 and 2006, respectively. The 600kg/ha rate produced 4-31 % and 2-29 % more tillers than others fertilizer rates for both years, respectively. The WAB99-1-1 produced the highest number of tillers per plant (6.68 and 6.41) and thus superseded other cultivars by 8-25 % and 5-23 % in 2005 and 2006, respectively. The variety x fertilizer interactions effect on number of rice tillers per plant only differed significantly in 2005 planting season with tillers increasing with increased fertilizer rate.

The number of panicles per plant was significantly (P < 0.05) influenced by increase in NPK fertilizer rates (Table 5). The number of panicles per plant across the rice cultivars showed that it ranged from 15.26 - 17.04 in the 600kg/ha plot in 2005 and 15.27 - 16.79 in 2006. Among the varieties, the WAB340-8-8-2-HI variety produced the highest number of panicles per plant in both years (17.13 and 17.20) while WAB99-1-1 produced the lowest number of panicles per plant for both years (15.20 and 15.17). The number of panicles per plant for the WAB340-8-8-2-HI variety was 2-11 % and 1-12 % higher than other varieties in 2005 and 2006, respectively. The variety x fertilizer interactions effect significantly affected the number of leaves of rice. The number of leaves generally increased with increased fertilizer rate. The interactions effect of variety and fertilizer on number of panicles per plant differed significantly. The number of panicles increased with increase in the rate of fertilizer up to 400 kg/ha after which, it either declined or showed no sharp difference between the 400 kg/ha and the 600 kg/ha rates.

Table 4: Effects of NPK (15:15:15) fertilizer rates on the number of tillers per plan

	2005 Planting season					2006 Planting season				
	Fertilizer Rates (kg/ha)									
Rice varieties	0	200	400	600	Mean	0	200	400	600	Mean
WAB340-8-8-2HI	5.10	6.10	6.60	8.10	6.48	4.93	6.00	6.70	7.73	6.34
WAB881-10-37-18-8-2-HI	5.40	5.90	7.50	7.20	6.50	5.33	5.67	7.33	6.97	6.33
WAB99-1-1	4.80	6.70	7.30	7.90	6.68	4.97	5.80	7.17	7.70	6.41
WAB224-8-HB	5.10	5.90	6.80	6.90	6.18	5.00	5.73	6.63	6.70	6.02
WAB189-B-B-B-8-HB	5.20	5.80	7.40	7.00	6.35	5.37	6.00	7.30	6.83	6.38
Mean	5.12	6.08	7.12	7.42		5.12	5.84	7.03	7.19	Mean
LSD 0.05 fertilizer	0.39					0.35				
LSD 0.05 varieties	0.23					0.22				
LSD 0.05 fertilizer x variety interaction	0.11					NS				

NS=Not significant

Table 5: Effects Of Npk (15:15:15) Fertilizer Rates on The Number of Panicles Per Plant At 100% Booting

	2005 Planting season					2006 Planting season				
	Fertilizer Rates (kg/ha)									
Rice variety	0	200	400	600	Mean	0	200	400	600	Mean
WAB 340 – 8 – 8– 2 – HI	16.30	17.10	17.10	18.00	17.13	16.37	17.23	17.53	17.67	17.20
WAB 881 – 10 – 37 – 18 – 8- P_2 – HB	16.00	16.50	18.80	17.10	17.10	15.87	16.70	18.50	17.00	17.02
WAB 99 – 1 – 1	15.00	14.60	15.60	15.60	15.20	15.00	14.63	15.87	15.17	15.17
WAB 224 – 8 – HB	16.10	16.80	16.70	16.70	16.58	15.97	16.30	16.77	16.40	16.36
WAB 189 – B – B –B- 8 – HB	12.90	15.80	18.10	17.80	16.15	13.13	16.07	17.80	17.70	16.18
Mean	15.26	16.16	17.26	17.04		15.27	16.19	17.29	16.79	
LSD 0.05 fertilizer	0.86					0.73				
LSD 0.05 varieties	0.55					0.46				
LSD 0.05 fertilizer x variety interaction	0.35					0.26				

Central panicle length and grain yield:

The central panicle lengths of the rice varieties were significantly influenced by the different rates of NPK fertilizer (Table 6). The central panicle lengths varied from 110.55cm in the control plot to 122.94cm in the 400 kg/ha plot in 2005; and from 107.55cm to 121.62cm in 2006. This indicates that the central panicle length in the 400 kg/ha plot was 1-10 % and 1-12 % longer than those of other fertilizer rates. Among the rice varieties, the WAB881-10-37 – 18 – 8 – P_2 – HB produced the longest central panicles (110.55cm and 107.30cm for 2005 and 2006, respectively). The WAB99-1-1 variety had the shortest central panicle (110.55cm and 107.30cm for both years, respectively). The variety x fertilizer rate interaction effect on rice central panicle length was significant but no clear trend was maintained.

The grain yield was significantly affected by the different fertilizer rates (Table 7). The grain yields varied from 3.07 t/ha in the control plot to 4.51 t/ha in the 400 kg/ha plots in 2005 and; from 3.37 t/ha in the control plot to 4.24 t/ha in 400 kg/ha plot in 2006. Among the rice varieties, the WAB244-8-HB variety produced the highest grain yields in both years (4.73 t/ha and 4.40 t/ha) while the lowest grain yields were obtained from WAB340-8-8 variety for both years (3.53 t/ha and 3.40 t/ha). The grain yields of WAB244-8-HB variety was 8-25 % and 5-23 % higher than other varieties in 2005 and 2006, respectively.

Table 6. Effects of NPK (15:15:15) fertilizer rates on the central panicle length (cm) per plant

	2005 Planting season					2006 Planting season				
	Fertilizer Rates (kg/ha)									
Rice variety	0	200	400	600	Mean	0	200	400	600	Mean
WAB 881 – 10 – 37 – 18 – 8- P_2 – HB	115.50	133.50	132.80	130.80	128.15	108.10	131.57	133.13	128.63	125.30
WAB 99 – 1 – 1	104.80	115.40	112.40	109.60	110.55	102.33	111.83	110.53	106.83	107.88
WAB 224 – 8 – HB	113.10	111.30	116.80	115.50	114.18	110.30	110.97	115.15	113.43	112.40
WAB 189 – B – B –B - 8 – HB	105.70	123.60	128.90	124.90	120.78	104.00	123.27	125.00	124.03	119.08
Mean	110.72	121.76	122.94	121.30		107.55	120.07	121.62	119.62	
LSD 0.05 fertilizer	2.82					2.71				
LSD 0.05 varieties	1.30					1.14				
LSD 0.05 fertilizer x variety interaction	2.62					2.11				

Table 7: Effects of NPK (15:15:15) fertilizer rates on grain yield (t/ha)

2005 Planting season						2006 Planting season				
	Fertilizer Rates (kg/ha)									
Rice variety	0	200	400	600	Mean	0	200	400	600	Mean
WAB 340 – 8 – 8 – 2 – H1	3.01	3.01	3.89	4.20	3.53	2.59	2.88	3.89	4.22	3.40
WAB 881 – 10 – 37 – 18 – 8- P_2 – HB	3.84	4.00	4.20	4.17	4.05	3.37	3.82	4.60	3.70	3.75
WAB 99 – 1 – 1	3.13	3.85	4.61	4.30	3.97	2.78	3.53	3.88	4.13	3.58
WAB 224 – 8 – HB	4.40	4.65	4.76	5.12	4.73	4.06	4.04	4.51	4.97	4.40
WAB 189 – B – B –B- 8 – HB	4.16	4.32	5.07	3.91	4.37	4.04	4.17	4.82	3.75	4.20
MEAN	3.07	3.97	4.51	4.34		3.37	3.69	4.24	4.15	
LSD 0.05 fertilizer	0.26					0.14				
LSD 0.05 varieties	0.16					0.09				
LSD 0.05 fertilizer x variety interaction	0.07					0.08				

DISCUSSION

The variations in rice height are attributed to the differences in the genetic make up of the varieties and their differences in the utilization ability of the different rates of fertilizer applied. These observations are in consonance with that of Dixit and Patro (1994) and Awan *et al.* (1984) who reported that increased rate of the NPK fertilizer favoured the vegetative growth in rice plant. The increase in the number of rice leaves per plant as fertilizer rate increased had earlier been observed in other studies (Chen *et al.*, 1984; Ahmad, 1988; Gurmani *et al.*, 1996).

The significant difference observed in the number of tillers and panicles per plant can be ascribed to differences in the ability of the cultivars to utilize the fertilizer as well as partition their photosynthates and accumulation dry matter. The differences in the ability of crop cultivars to utilize available nutrients and optimally partition its photosynthates had been recognized (Squire, 1990; Ndon and Ndaeyo, 2001). Findings from this study also confirm that of Munegowda *et al.* (1972) and Ahmad and Hussain (1974) who reported that increase in NPK fertilizer rates significantly increased tiller number per plant. The result showed that number of panicles was positively correlated with increase in the NPK rates. Das-Gupta (1969), Halder *et al.* (2000) and Hag *et al.* (2002) reported that the number of panicles increased with increase in the nitrogen rates and that number of panicles per plant increased with increase in NPK rates.

Rice panicle length and grain yield were also significantly different among the rice varieties. These observations are apparently due to the availability of more nutrients to the rice plant following the fertilizer application relative to the control treatment. As stated earlier, the natural endowments of crop cultivars to optimally utilize available nutrients and subsequently partition its photosynthates for dry matter accumulation and/or conversion to economic yield vary (Squire, 1990; Ndon and Ndaeyo, 2001). The variety x fertilizer interaction effects on rice grain yield was significant in both years with yield increasing with increased fertilizer rates. The differences in genetic make up, amount of nutrient and utilization potential and photosynthates/dry matter partitioning could also be responsible for the observed differences. Specifically, Miah and Eunus (1978) reported that the application of increased doses of N, P and K tended to increase rice grain yield. Similarly, Khalid *et al* (2003) who studied the effect of different levels of NPK fertilizer on the yield and quality of rice CV.IR-6 reported that different rates of NPK fertilizer significantly influenced rice height. The findings are also in consonance with that of Azad *et al.* (1995) and Hag *et al.* (2002) who reported increase in grain yield of rice as the rates of NPK increased.

Conclusion: The findings from this study revealed that the different rice varieties responded differently to the application of different rates of NPK fertilizer. Increase in the rates of NPK (15:15:15) fertilizer significantly enhanced growth characteristics and increased yields of the upland rice varieties. The study indicated that 400kg/ha of NPK (15:15:15) could support the growth and yield of upland rice in Uyo agro-ecology particularly when the WAB224-8-HB and WAB189-B-B varieties are planted.

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