Effect of Nutrients Supply Time for Optimum Productivity in Rice (*Oryza Sativa* L.) Production

Ikuli J. M. & Akonye L. A.
Department of Plant Science and Biotechnology,
University of Port Harcourt
PMB 5323 Choba, Port Harcourt,
Rivers State, Nigeria
E-mail: Ikulijosiah@yahoo.com.

Abstract
The study investigated the effect of time of nutrients supply on rice productivity. Four cultivars of lowland rice were used. Namely; FARO 44, UPIA 3, FARO 52 and IWA 4.To the first unit, fertilizer was applied thrice (basal, juvenile and last split). To the second unit, fertilizer was applied twice (basal and last split). To the third unit, it was applied twice also (juvenile and last split). To the fourth unit, higher quantity of fertilizer was applied only at last split and in the last unit, no fertilizer was applied. From the observed mean, there was a significant difference at 0.05 level of probability. The study showed that supplying nutrients at the basal, juvenile and last split had the best yield. The study also revealed that if the critical point of nutrients requirement is missed there is no amount of fertilizer or nutrients supplied thereafter, that will revive the yielding potential of the plant. Farmers must therefore imbibe the habit of conducting soil test before planting and acquire knowledge of the time of fertilizer application and the type of fertilizer to be used at a particular time and soil.

Key words: *Basal, Juvenile, Last split, nutrients and rice.*

INTRODUCTION

Food security is the ability to supply adequate food for human beings in order to attain productive and healthy life. Rice (*Oryza sativa* L.) is a staple food crop in Nigeria (Maziya-Dixon *et al;* 2006, Ojogho and Erhabor, 2011) but because of inadequate production importation is necessitated. Nigeria and Philippines ties as the world largest rice importing countries (FAQ rice monitor cited inward, 2007).

Since a large portion of maize crops are grown for purposes other than human consumption, rice is the most important grain with regard to human nutrition and calorie intake, providing more than one fifth of the calories consumed worldwide by humans.

As a cereal grain, it is the most widely consumed staple food for a large part of the world's human population, especially in Asia and West indies. It is the grain with the second-highest worldwide production after *maize* according to data for 2010. (Harvest plus, 2011).

For optimum and maximum productivity in rice, proper knowledge of its nutritional requirements must be understood. This is necessary because if the critical time of nutritional requirement is missed no amount of nutrients (fertilizer) added thereafter that can revive its yield potentials; Hence, the need for farmers to be enlightened about the nutritional requirements and time of application.

The objectives are to enlighten farmers on the use of fertilizers for high productivity and to improve food security.

MATERIALS AND METHODS

The research was carried out at Fortune Estate, Omuchiolu-Aluu in Ikwerre Local Government Area, Port Harcourt Rivers State. (Lat. 4^0 65^1N; Long. 7^0 05^1 E). With a temperature range from 23^0C to 35^0C and total Rainfall range of 2000-3000mm per anum. The research was conducted for a period of eleven months.

PLANTING MATERIALS AND PLANTING

Rice (*Oryza sativa* L.) cultivars were obtained from AGRA-Germplasm, University of Port Harcourt in Port Harcourt, (UPIA 3, IWA 4, FARO 44 and FARO 52).

PLOT LAYOUT FOR EXPERIMENT

Soils were collected from about five year old fallowed land. They were thoroughly mixed. Pots made of plastic buckets were filled with 15kg soil each. These pots were arranged 4 by 3 making a total of 12 pots per unit for a cultivar. Twenty units were laid out in a Randomized complete Block Design.

TRANSPLANTING

Seedlings were transplanted 8 days after germination into the arranged pots at a density of two seedlings per pot.

TREATMENTS

To the first unit, fertilizer was applied three times (basal, juvenile and last split).
To the second unit, fertilizer was applied twice (basal and last split).
To the third unit, it was applied two times also (juvenile and last split).
To the fourth unit, fertilizer was applied only at last split and
In the last unit, no fertilizer was applied.

FERTILIZER APPLICATION

Three grams (3.0g) of N P K 15:15:15 was applied a week after transplanting (15 days after germination), as a basal application to each pot.
Five weeks after transplanting (43 days after germination), three grams (3.0g) of Urea was also applied to each pot (juvenile application).
Eight weeks after transplanting (64 days after germination), three grams (3.0g) of N P K 15:15:15 and two grams (2.0g) of Urea were applied to each pot (Last split application).Treatments were repeated (Two units get the same treatment each).
To the fourth treatment that fertilizer was applied at the last split only, the rate increased; 5.0g of NPK and 3.0g of urea

RESULTS AND DISCUSSION

CHLOROPHYLL CONTENT

Cultivar	**C**	**BJL**	**BL**	**JL**	**L**
FARO44	22.95	23.28	20.72	25.84	24.95
UPIA 3	24.69	21.42	25.38	19.95	20.70
FARO52	25.18	24.51	20.76	23.38	22.79
IWA 4	18.65	20.77	24.21	23.35	25.21

The total chlorophyll content in all the cultivars and treatments showed that all cultivars had sufficient chlorophyll. It ranged from 18.65mg/L (IWA 4 Control) to 25.84mg/L (FARO 44 Juvenile and split). There was no significant difference in the chlorophyll content. However, in FARO 44, the highest chlorophyll content was recorded in JL treatment and lowest in BL treatment but does not interpret like wise to yield. This is because highest yield was recorded in BJL and lowest yield recorded in control.

In UPIA3, the highest chlorophyll content was recorded in LB and lowest in JL. This also does not reflect in yield result because in UPIA 3, the highest yield was obtained from BJL and lowest in control.

For FARO52, the highest chlorophyll content was recorded in control (25.78mg/L) while the highest yield was obtained from BJL and lowest from control (C). This suggests that insufficient nutrients in the soil caused the plants in ability to make good use of the available chlorophyll or the chlorophyll was used by the plant for growth mostly.

For IWA 4 the highest chlorophyll content was recorded in split treatment (25.21mg/L) and lowest in control (18.65mg/L). This also does not reflect in yield although, the lowest yield was from the control, but the highest yield was not from the split which had the highest chlorophyll content. From the results above it indicates that chlorophyll content do not have significant effect regarding the yield difference.

NUMBER OF TILLERS

Cultivar	C	BJL	BL	JL	L
FARO44	8	12	9	11	20
UPIA 3	10	24	16	20	10
FARO52	6	13	10	12	19
IWA 4	12	23	14	15	11

The number of tiller in all the cultivars and treatments ranged from 8 (FARO 44 control) to 24 (UPIA 3). Basal, juvenile and last split.

In FARO 44 control, only 8 tillers (lowest) were produced and 20 tillers (highest) produced in last split but this does not reflect in yield because about 60% of these tillers from the last spilt shoot out after the fertilizer application and many of the panicles produced by these tillers were unfilled. This showed abnormalities in rice growth and development resulting from wrong time of nutrient supply.

In UPIA 3 the lowest number of tillers was recorded in control and last split (10 tillers) and the highest was recorded in BJL (24 tillers). This reflected in the yield. Because the highest yield was recorded in BJL (9.00ton/ha) and lowest in control (4.48ton/ha) followed by split (4.61ton/ha). This indicates that the cultivar made use of supplied nutrients judiciously and that the nutrients applied helped the plant to express its potential during vegetative stage by producing more tillers and in the reproductive stage, had greater percent of filled grains.

FARO 52 has the lowest number of tillers in control (6) followed by JL (10) and had the highest number of tillers in BL (19) treatment followed by BJL (13). This also does not reflected in yield.

IWA4 has the lowest number of tillers in split treatment (11) and highest in BJL (23). In IWA4 BJL treatment with the highest number of tillers has the highest yield (8.55ton/ha), but the yield from split treatment with the lowest number of tillers 3.40ton/ha was higher than the yield from control (2.94ton/ha) with more tillers.

LEAF AREA

Cultivar	C	BJL	BL	JL	L
FARO44	6.49	6.52	6.51	6.51	6.62
UPIA 3	6.73	6.90	6.84	6.80	6.32
FARO52	2.38	6.42	5.49	5.97	5.47
IWA 4	6.31	6.19	6.58	6.65	6.57

YIELD

The total yields from all the varieties range from 0.94 ton/ha (FARO 52 Unit 5) to 9.00 ton/ha (UPIA 3 Unit 1). The results of the yield of the four cultivars of rice (*Oryza sativa*) in the five units are presented in table 1 to 5.

The results of yields from all the units were subjected to univariate analysis of variance which showed that there was significant difference at 0.5 level of probability.

TABLE 1: YIELD in ton/ha

	Treatment				
Cultivar	C	BJL	BL	JL	L
FARO 44	1.99 ± 0.37	8.46±0.69	7.19±1.06	6.57±1.76	3.81±0.53
UPIA 3	4.48±0.44	9.00±1.91	8.01±0.95	7.88±0.95	4.61±0.58
FARO 52	0.94±0.20	5.58±0.66	4.25±0.67	4.59±0.44	1.38±0.88
IWA 4	2.94±0.20	8.55±0.67	7.53±1.19	7.08±1.73	3.40±0.59

Control: No Fertilizer Application (C)
Basal, Juvenile and Last split Application (BJL),
Basal, and Last split Application (BL)
Juvenile and Last split Application (JL)
Last split Application only (L)

DISCUSSION

The yield from the unit where fertilizer was applied three times; basal application (a week after transplanting), juvenile application (5 weeks after transplanting) and last split application (7-8 weeks after transplanting) outweighed the yield from all other application rate and time. The percentage (%) of filled grains ranged from 88% to 95%. The plants had large number of tillers. From the observed mean, there was significant difference at 5% level of probability between FARO 52 and all the other cultivars.

The yield range of the unit that fertilizer was applied at basal and last split only had almost the same yield range with the unit that application was done at the juvenile and last split only. However, the grain filled percent was higher in the unit where application was done at the basal and last application only (70- 90%), while those that fertilizer was applied at juvenile and last split had more tillers but lesser grain filled percentage (65- 88). This indicates that vital nutrients necessary for grain fill were not adequate at the beginning of the plant growth. From the observed mean, there was significant difference at 5% level of probability between FARO 52 and all other cultivars. However, in the unit where fertilizer was applied at the juvenile last split, from the observed mean it was learnt that significance existed only between UPIA 3 and FARO 52.

The yield from the unit that fertilizer was applied only at the last split was almost the same as not applying fertilizer. Both had the poorest yield. However, from the observed mean, in the unit where fertilizer was applied at the last split, only FARO 52 was significant to all other cultivars. But in the unit that no fertilizer was applied all the cultivars were significant to each other at 0.05 level of probability. The percentage of filled grain ranged from 20- 50%. After the fertilizer application, the plant changed morphologically (colour and vegetation); many started producing new tillers even at the reproductive phase. They produced large and appreciable panicle size and branches but 50- 80% were unfilled. Indicating that no matter the amount of fertilizer applied at this stage, if the necessary nutrients needed were not available at the early stage of the rice development, the yielding potentials of the rice plant cannot be revived. This reflects the law of equal initial nutritional requirement importance.

This law simply explain that for optimum and maximum productivity, all nutrients that will be needed at any developmental stage in the plant have equal vitality need not minding the quantity at the early developmental stage. In other words, their demand may differ in quantity but equal in importance at that time. However, in a very fertile soil, that is a soil rich in all necessary nutrients required at the early stage can still produce appreciable yield with filled grain percentage ranging from 60- 80% if the fertilizer is applied only at the last split. Though, the numbers of tillers may not be much as that which fertilizers were applied at the basal, juvenile and last split.

The major nutrients required in large quantity to an extent by the rice plant include; Nitrogen (N), Phosphorus (P) and Potassium (K). The rice plant requires 60- 80kg/ha of N for it to do well. Nitrogen (N) is needed for growth/vegetation and in grain filling. Phosphorus (P) is needed mostly in root initiation and establishment. It is also needed in grain filling. The rice plant need about 40- 60kg/ha of P. The rice plant needs potassium (K) just like N. It is essential for its development and productivity. For optimum productivity, the rice plant requires 60- 75kg/ha of K.

For crops like rice that need more chlorophyll to have sufficient photosynthete for grain filling, micronutrient like Iron (Fe) is very important. Iron (Fe) plays a vital role in its productivity. Iron (Fe) deficiency in rice developmental growth causes chlorosis. The transfer of electrons between Fe and organic molecules transform enzymes that are involved in the synthesis of chlorophyll. Iron (Fe) is a structural component of the porphyrin. It is part of substances that are involved the oxidation-reduction in respiration and photosynthesis (Baley, 2015). Sulphur (S) is also involved in the synthesis of protein and photosynthesis process. This is a reason for ensuring Fe availability at the initial growth stage and a week before or the first week of the reproductive phase in rice production.

TIME OF APPLICATION AND NUTRIENT TYPES

There are three stages of critical nutritional requirements for optimum development and productivity in rice plant. Hence the nutrients supply times include:

Basal Application

Basal application is done either before planting or a week after transplanting.

This is applied to fulfil or satisfy the law of equal initial nutritional requirement importance. This law explains how every nutrient that is to be used by the plant in all developmental stages of the plant are necessary to be available at the initial development stage of the plant. That is why compound fertilizers like NPK 16: 9: 14 + 6 S +0.05 B +0.05 Fe + 0.1 Mn 0.05 Zn, NPK 8: 20: 30 +2 S +0.05 B +0.05 Fe +0.1 Mn +0.02 or NPK 15: 15: 15 are recommended in basal application. To know the very type of fertilizer to be used, it is better, that a soil test is conducted to have the knowledge of the available nutrients in the soil and their quantities.

Juvenile Application

In rice production, the juvenile state is from the active tillering stage to maximum tillering stage. For judicious utilization of resources, it is advisable to apply at the fourth (4^{th}) and fifth (5^{th}) week after transplanting. Urea is more preferred because nitrogen is more required for vegetative development. However, it all depends on the nutritional status of the soil.

Last Spilt Application

The most critical point with regard to highest water and nutritional requirements in rice plant is a week before booting to flowering stage. In other words, the booting and heading stage in rice development is when the highest water and nutrients are required. At this stage more of Nitrogen (N) and Potassium (K) are required. Phosphorus is required most for root initiation and as such, during the booting and heading stage in rice development, less P is required compared to N and K. As a result, fertilizer to be applied can be NPK 20:8:8 and supplement K with muriate of potash or NPK 15:15:15 and supplement N and K with Urea and muriate of potash or NPK 16: 9: 14 + 6 S +0.05 B +0.05 Fe + 0.1 Mn 0.05 Zn.

Conclusion

Unfortunately, farmers have never shown concern of carrying out soil test before planting in rice cultivation. They apply fertilizers indiscriminately without the knowledge of the nutrients status of the soil and time of application. Farmers must now imbibe the habit of conducting soil test before planting and acquire knowledge of the time of fertilizer application and the type of fertilizer to be used at a particular time and soil. This is necessary because in rice farming, if the time of nutrients requirement is missed, no amount of nutrients supplied/applied thereafter can revive the yielding potentials of the plant.

REFERENCES

Acquaah, G. (2001).*Principles of Crop production theory, techniques and technology* Prentice Hall.ISBN-13.pg 4,908.

Baley, A. (2015). *Iron for Plants: Why Do Plants Need Iron?* Gardening writers. Gardening App Media.

Ojogho, O. and Erhabor, P. O. I (2011).*Effect of quality on the demand for Rice in Nigeria.* Agricultural Journal 6: 207-212.

Harvest plus, 2011.China website.

Havlin, J.L., J. D. Beaton, S. L. Tisdale and W. L Nelson (2006).*Soil fertility and fertilizers* 7th ed. Prentice-Hall of India private limited, new Delhi-110001 pg 245-254.

Maziya-Dixon, B. B., I. O. Akinyele, R. A. Sanusi, T. E. Oguntona, S. K. Nokoe and E. W. Harris (2006). *Vitamin A deficiency is prevalent in children less than 5 years of age in Nigeria.* J. Nutr.2006 Aug.136(8) : 2255- 61

Reddy, G. R (2008).*Principles of crop production*. 3rded Kalyani Publishers, New Dehi-110002 pg 43-47.

Stewarte, A., H. Max Grim Shaw, John, A. Parkinson and Christopher, Q., (1974). *Chemical Analysis of Ecological Materials.* Blackwell Scientific Publications. Oxford London Edinburgh Melbourne