Annals of West University of Timişoara, ser. Biology, 2012, vol XV (2), pp.167-176

RESPONSE OF UPLAND RICE (*ORYZA SATIVA L*) CULTIVARS TO SPLIT APPLICATION OF COMPOST ON HIGHLY WEATHERED SOIL OF DERIVED SAVANNAH AGRO-ECOLOGY

Oyeyemi Adigun DADA[1], Ayodele Samuel THOMAS[2], Oyetola Olusola OWORU[2]
[1]Botany Department, University of Ibadan, Nigeria
[2]Crop Production Department, Olabisi Onabanjo University, Ayetoro Campus, Nigeria
C*orresponding author e-mail: oadada247@yahoo.com*

ABSTRACT
Compost application in form of pre-planting incorporation limits nutrient use efficiency in upland rice propagation. Supplying nutrients to crop as required enforces realization of yield potential of field crop. Field study was carried out between 2009 and 2010 planting seasons to investigate the response of upland rice cultivars to split application of compost at varying growth phases in derived savannah agro-zone. Cattle dung + maize stover compost was applied in two splits of different growth phases (Pre-planting, tillering and panicle exertion, tillering and booting, panicle exertion and booting) to three upland rice cultivars - NERICAI, NERICA II and Ofada. The study was laid out in randomized complete block design with three replicates. Data were collected on growth, dry matter, nutrient uptake concentrations and grain yield. Data were analyzed using Analysis of Variance (ANOVA) and the significant means were compared with Least Significant Difference (LSD) at p = 0.05. The results showed that compost application at active vegetative periods (Tillering to booting) promoted better LAI (1027.89), number of leaves (23.94) and tillers (5.11). The response of the three upland rice cultivars to varying time of compost application revealed that split application of compost had significant effect on yield components of upland rice cultivars. Uptake concentration of N (11.49mg/kg) and P (8.65mg/kg) were significantly highest in rice field fertilized at panicle exertion and booting growth
KEY WORDS: *compost, split application, NERICA, nutrient uptake concentration*

INTRODUCTION

Nutrient use efficiency in crop plant is a function of timely release of applied nutrients for crop use. One of the major constraints to rice production in Nigeria is inadequate supply of nutrients by soils (Nottidge *et al.* 2005; Ayeni, 2011). The use of fertilizer to improve soil fertility has assumed wide range of criticisms from environment and availability view points. Utilization of compost, however have been shown as an alternative replacement for mineral fertilizer. According to (Myint *et al.,* 2010) compost is known to synchronized nutrient release with plant demand and minimized the amount of inorganic fertilizer needed to sustain high crop yield. This is important to boost yield in short cycle crops such as rice, maize, water melon, and grain amaranths, all of which have high nutrient demand (Lathwell, 1990). Compost also maintains the level of organic matter in the soil (Witt *et al*., 2002; Dobermann *et al*., 2003; Buresh and Witt, 2008; Dada and Togun, 2012).

Nutrient availability in composted material is one thing, releasing the nutrients for crop use is another. In order to promote healthy growth and maximize yield, nutrients must be available not only in the right quantity, but in a usable form at the right time (Sanchez, 2002). Improper use of organic fertilizers is detrimental to both soil and plant (Hartemink, 2003). The usual practice of heaping or spreading compost in the field during off season months long before sowing time is shown not be the appropriate way to apply compost. Such practice leads to wastage of nutrients due to leaching, loss in gaseous form due to high volatility (Bundy, *et al*., 2001) and competition from weeds (Dada and Fayinminnu, 2010). Method of compost application are generalised for all arable crops whereas, crops differs in their utilization efficiency of nutrient available in a given organic fertilizer. This generalized recommended method may not enforce better mineralization and nutrient uptake by upland rice being a shallow feeder. It is however not clear if applying compost at varying growth phases as split application would enhance better nutrient uptake and improve grain yield of upland rice. This study therefore seeks to evaluate the effect of split application of compost at different rice growth stages on growth, biomass production, nutrient uptake concentration and grain yield.

MATERIALS AND METHODS

The study was carried out between 2009 to 2010 planting seasons at the Teaching and Research Farm of College of Agricultural Sciences, Olabisi Onabanjo University, Yewa Campus, Ayetoro, Ogun State.

Compost was prepared from combination of maize stover and cattle dung in ratio 3:1 (Dada and Togun, 2012). The chemical composition of the matured compost was analyzed using standard procedure described by IITA (1990). The experiment was a randomized complete block design (RCBD) with three replications. 12 treatments were derived from a factorial combination of three rice cultivars (NERICAI, NERICAII, and Ofada) and four periods of compost application (Pre-planting, tillering and panicle exertion, tillering and booting, panicle exertion and booting) using side placement method except at the pre-planting when compost was mixed thoroughly with the soil a week before sowing. 8 tons per hectare of compost was applied one week before sowing as pre-sowing application treatment. Compost at the rate of 4t ha^{-1} was applied each at tillering and panicle exertion stages (6 and 9 Weeks After Sowing (WAS)), tillering and at booting phases (6 and 12 WAS) and at panicle exertion and booting phases (9 and 12 WAS). Land was cleared by employing slash and burn method; the debris was cleared, packed and burnt outside the main experimental plot.

Soil samples were randomly collected from each of the plot per replicate within the depth of 15cm-30cm. Samples were mixed to form a composite sample. The composite sample was air dried and crushed to pass through a 2mm sieve to remove plant root and other debris. 2kg of the sample was weighed and was taken to the laboratory for physico-chemical analysis. Representative samples were analyzed for percentage sand, silt and clay (Bouyoucos, 1962), pH was determined electrochemically with a pH meter in distilled water, Organic carbon by Walkey procedure (Walkey – black *et al*., 1966), total nitrogen using Kjeldahl method (Bremmner, 1965). Potassium, Ca, Mg, and Na were extracted using neutral normal NH_4OAC (pH 7). K in the filter extract was determined by flame photometer, while Mg, Na, and Ca were determined with an atomic absorption spectrophotometer (AAS model, Buck 200). Available phosphorus was determined by Bray-1 method (Bray and Kurtz, 1945).

Three rice cultivars: NERICAI (WAB 450-1-B-38-HB) (FARO 55), NERICAII (WAB 450-1-P-28-HB) (FARO 56), and OFADA were obtained from Africa Rice Center (AfricaRice), Ibadan sub-station. 2 to 4 seeds per hole at the depth of 3 – 4 cm were sown directly on the field using drilling method. Seeds were planted at a spacing of 25cm by 30cm to give 133,333 plants per hectare. It was later thinned to two plants per stand. The plot was fenced round with traps to prevent rodents from invading the farm. Scarecrow of human effigy was set up at emergence to heading. Bird scarier was employed at the heading stage till harvesting to scare the birds. The rice field was manually weeded regularly, especially during the early stage of growth.

Data collection

Growth characters were taken on four tagged plants from middle of each plot. Data were collected on plant height (cm), number of leaves and tillers, Leaf Area Index (LAI) calculated by multiplying the value of the leaf area at physiological maturity with 0.69 (Gomez and Gomez, 1984). Data on yield attributes were collected on number of panicles per plant, number of spikelets per panicle, dry weight of grains per panicle (g), filled grains (g), 100 seeds weight (g) and grain yield (t/ha). At physiological maturity (15 WAS), four two tagged plants were harvested, partition into shoots and roots and oven dried at 80^0C to constant weight before determining the dry weight of both parts. The plants were analyzed in the laboratory for uptake concentrations of N, P and K. The N was analyzed using Kjeldahl method, P was determined by Bray-1 method and the K was determined by flame photometer (IITA, 1990).

Statistical analysis

Data collected were subjected to analysis of variance (ANOVA). The differences between the means were determined using Fisher's Least Significant Difference (LSD) at 5% probability level (Gomez and Gomez, 1984).

RESULTS

Growth parameters

Physico - chemical properties of the soil used for this study is presented in Table 1. The soil is low in essential nutrients when compared to nutrients for soil fertility classes in Nigeria (Bada and Umunnakwe, 2011).

Response of upland rice cultivars to time of compost application on growth attributes of three upland rice cultivars is presented in Table 2. The results showed that compost application at varying rice growth stages had no significant (P >0.05) effect on growth performances of the rice cultivars. However, incorporation of compost prior to sowing promoted taller plants (97.51cm) significantly than when compost was applied at tillering and panicle exertion phases. It appeared that compost application at active vegetative periods, covering tillering to booting promoted better LAI (1027.89), leaf (23.94) and tiller (5.11) formation than when compost was applied at the reproductive phase (panicle exertion and booting).

Also, growth response of three upland rice cultivars to time of compost application was not significantly different with respect to number of leaves, tillers formed and LAI. However, Ofada cultivar had significantly tallest (109.78cm) plants than NERICA I. Similarly, Ofada cultivar had significantly highest biomass (26.64g) accumulation than NERICA II.

Split application of compost at different rice growth phases had no significant effect on leaf and tiller formation by the three upland rice cultivars but NERICA I produced most leaves (29.00) and tillers (6.33) on field fertilized during tillering and panicle exertion phases. However, incorporation of compost prior to planting in field where Ofada cultivar was grown promoted significantly tallest plants (120.03cm). Similarly, partitioning of dry matter into shoot (26.83g), root (3.33g) and total biomass (30.68g) was highest in cultivar Ofada plots fertilized with compost at panicle exertion and booting phases.

Yield and yield components

Response of upland rice cultivars to split application of compost on yield parameters is presented in Table 3. The results revealed that split application of compost at different rice growth stages had no significant effects on yield attributes of the three upland rice cultivars. However, compost application to rice plant at panicle exertion and booting stages tends to enhance better panicles formation (4.40), spikelets production (13.72), filled grain weight (8.11g), as well as grain yield (3.16 t/ha). Whereas, weights of panicle (5.56g) and 100 seeds (2.66g) were highest in plots fertilized at tillering and booting phases.

The response of the three upland rice cultivars to varying time of compost application revealed that split application of compost had significant effect on yield components of upland rice cultivars. Ofada cultivar produced significantly highest spikelets (15.54), heaviest panicle (7.39g), grain weight (6.75g) and grain yield (3.70 t/ha) than NERICA cultivars. Although, there was no significant difference among the three upland rice cultivars in terms of number of panicles produced and harvest index but these parameters were highest in cultivar Ofada (Table 3)

The interactions between the three upland rice cultivars and growth stage of compost application had significant effect on yield parameters measured. Application of compost to Ofada cultivar field during tillering and panicle exertion phases significantly influenced weights of panicles (8.45g), grain (8.03g), 100 seeds (2.77g), grain yield (4.32 t/ha) and harvest index (0.56).

Nutrient uptake

Influence of time of compost application on nutrient uptake of upland rice cultivars is presented in Table 4. Time of compost application significantly influenced nutrient uptake concentration of the three upland rice cultivars. Uptake concentration of N (11.49mg/kg) and P (8.65mg/kg) were significantly highest in rice field fertilized at panicle exertion and booting growth phase but not significantly different from plots augmented with compost at both pre-planting as well as tillering and panicle exertion stage. K uptake (20.54mg/kg) was however highest on field where compost was incorporated pre-sowing. Among the three upland rice cultivars, concentration of N (10.54mg/kg) and P (7.42mg/kg) though not significantly different but was highest in Ofada cultivar than the NERICA cultivars. Least concentration of N, P and K was observed in NERICA II cultivar.

The interaction between growth phases of compost application to three upland rice cultivars as it relates to N, P and K uptake concentrations was significantly different. Incorporation of compost prior to sowing enhanced N (18.69mg/kg) and P (37.40mg/kg) uptake concentrations in Ofada cultivar better than NERICA cultivars. However, uptake concentration of P (12.53mg/kg) was significantly highest in Ofada cultivar field fertilized at panicle exertion and booting phases.

TABLE 1. Physicochemical characteristics of soil used for the study

Parameters	**Value**
pH H_2O	7.1
pH KCl	6.4
Organic Carbon (gkg^{-1})	2.6
Organic Matter (gkg^{-1})	4.5
Total Nitrogen (gkg^{-1})	0.3
Available P($mgkg^{-1}$)	42.5
Exchangeable cations (cmol/kg)	
K	0.3
Na	0.5
Ca	0.9
Mg	0.8
C. E. C	2.5
Exchangeable acidity (cmol/kg)	0.02
Clay(gkg^{-1})	21.0
Silt (gkg^{-1})	22.4
Sand (gkg^{-1})	56.6

DISCUSSION

The non significant difference observed among the different growth stages when compost was applied as it relates to rice growth attributes might not be unconnected to the fact that each of the period of application corresponded to critical stages in rice growth cycle when nutrient deficiency might negatively affect rice growth parameters. Better growth performance was observed when the compost was applied between tillering and booting phases; covering the active vegetative phase. Application of compost prior to these phases tends not to meet the nutrient demand up to maturity stage. It thus appears that nutrients released across tillering and booting growth stages were efficiently utilized by the crop. This observation is in agreement with that of Eghball, (2000).

The growth performance of Ofada was better than those of NERICA cultivars though comparable. This could be linked to the innate features of cultivar Ofada which confers efficiency utilization of nutrients under seemingly unfavourable conditions unlike the NERICA cultivars which are newly introduced to this environment. Ofada a line from *Oryza glaberimma* showed favourable response to harsh biotic and abiotic conditions typified of humid tropical agro-ecology unlike the tropical japonica lines. This is in line with the report of Saito (2010) that upland WAB56-104 and CG 14 cultivars (*O. glaberimma* lines) showed significantly higher tillering ability, panicle number and grain yield than NERICA cultivars under both fertilized and unfertilized conditions.

Among the cultivars, Ofada maintained higher shoot and root dry weight and hence it produced the highest total dry matter. Higher dry matter production in Ofada can be ascribed to higher leaf area index which is directly linked to efficient utilization of assimilates for metabolic process. Similar increment in dry matter due to high leaf area index was recorded by IRRI (2006).

For treatment combinations, no significant difference was observed. This might be that nutrients was available to these rice plants at each phase of application which in turn favoured the development of plant growth parameters resulting in better biomass accumulation. Hartz *et al*., (1996), have reported that when nutrient is available in the right proportion, photosynthetic activity of the plants will be considerably favoured and this will improve light interceptions, dry matter, accumulation and partitioning.

The non significant difference observed among the different time of compost application as it relates to yield components might be related to timely release of nutrients at each phase or time of application which probably coincided with time when nutrients need is efficiently utilized and partitioned into economic yield. This is in conformity with Baskar and Selvakumari. (2005).

The significant enhancement of grain yield (t/ha) produced by Ofada cultivar corroborate the report of Nyamangara *et al,*(2003). This could be linked to positive effect of availability of adequate amount of essential nutrients as well as favourable physical environment in the soil treated with compost as reported by Kondo *et al*, (2003). This is likely to improve the vegetative growth, synthesis and translocation of photosynthate from the sources to the sink and significant increase in number and weight of grain yield and other yield components.

Uptake of nitrogen was significant at incorporation, panicle exertion and booting. This suggests that application of compost at these phases might have stimulated microbial activity by providing more nitrogen uptake by root and thus, mobilizing the available nitrogen. This might foster vegetative growth resulting in increase in biological yield as well as economic yield which became obvious in the high harvest index recorded for Ofada at these growing phases. The significant macronutrients uptake might be ascribed to their increase availability in the soil treated with compost. Similar results were reported by Baskar and Selvakumari, (2005) and Myint *et al,* (2010).

CONCLUSION

Split application of compost to upland rice cultivars field is beneficial from view points of timely availability and release of nutrient as well as high nutrient use efficiency. This is because the results revealed that nutrients were made available to the plant during the critical period when the native nutrient was probably becoming limiting. Applying compost to upland rice cultivars especially Ofada in splits during tillering up to booting phases; covering active vegetative stages promoted better growth and improve grain yield (t/ha). There is clearly the need to improve the newly released upland NERICA and future breeding efforts with a view to improving their response to nutrient constraints imposed by Nigerian soil.

ACKNOWLEDGEMENTS

We acknowledge AfricaRice Center, Ibadan sub-station for supplying the rice seeds used for the study. Technical supports of Analytical Laboratory of Institute of Agriculture Research and Training (IAR&T) Apata, Ibadan for the soil and plant nutrient analysis is highly acknowledged

REFERENCES

- Akanbi W.B., Togun A.O., 2002. Productivity and Influence of maize stover on Growth, Yield and Nutrient Uptake of Amaranth. *Sci. Hortic.,* 93:1-8.
- Ayeni I.S. 2011. Integrated plant nutrition management: A panacea for sustainable crop production in Nigeria. *Int. J. Soi. Sc.* 6: (1) 19-24.
- Bada B.S, Umunnakwe C.F. 2011. Phytoremediation potential of Kenaf (*Hibiscus cannabinus* L.) under different soil pH and copper concentrations. *Journal of Science Research* 10 (2) 160 – 166.
- Baskar M., G. Selvakumari, 2005. Influence of flyash on soil properties, nutrient uptake and yield of rice in Inceptisol Alluvium. *Madarias Agric. J.* 92 (7-9): 456 – 463.
- Bundy L.B., Andraski T.W., Powell J.M. 2001. Management practice effects on phosphorus losses in runoff in corn production systems. *J. Environ. Qual*. 30:1822-1828.

- Buresh R. J., Witt C. 2008. Balancing fertilizer use and profit in Asia's irrigated rice systems. *Better Crops*, 92:18-22.
- Bouyoucos J. 1962. Hydrometer method improved for making particle size analysis. *Agro. J*. 54 39 – 45.
- Bray R.H, Kurtz, L.T 1945. Determination of total organic and available forms of phosphorus in soils. *Soil Sci*. 59:39 – 45.
- Breman H. 1998. Soil fertility improvement in Africa, a tool for or a by-product of sustainable production? *African Fertilizer Market* 11 (5), 2 – 10.
- Dada, O.A and Fayinminnu 2010. Period of weed control in okra (*Abelmoschus esculentus* (L.) Moench) as influenced by varying rates of cattle dung and weeding regimes. Not. Bot. Hort. Agrobot. Cluj 38 (1), 149-154.
- Dada O.A., Oworu, 2010. Mineral and Nutrient Leaf Composition of Two Cassava (*Manihot esculenta*, Crantz) Cultivars Defoliated at Varying Phenological Phases *Not Sci Biol* 2 (4) 2010, 44-48
- Dada O.A, Togun, A.O. 2012. Tissue nutrient contents and grain yield of upland rice cultivars as influenced by varying rates of compost on Oxic Paleustalf in derived savannah agro ecosystem. *Global Advanced Research Journal of Agricultural Science Vol. 1(3)* (in press).
- Dobermann A., Witt C., Abdulrachman S., Gines H. C., Nagarajan R., Son T. T., Tan P. S., Wang G. H., Chien N. V., Thoa V. T. K., Phung C. V., Stalin P., Muthukrishnan P., Ravi V., Babu M., Simbahan G. C., Adviento, M. A. A. 2003. Soil Fertility and Indigenous Nutrient Supply in Irrigated Rice Domains of Asia. *Agronomy Journal*, 95:913–923.
- Eghball, B. 2000. Nitrogen mineralization from field-applied beef cattle feedlot manure or compost. *Soil Sci. Soc. Am. J*. 64:2024-2030.
- Gomez A. K, Gomez A. A.. 1984. *Statistical procedure for Agricultural Research.* 2nd Edn. pp: 680.
- Hartemink A.E. *Soil Fertility Decline in the Tropics— With Case Studies on Plantations*; 2003. ISRIC-CABI Publishing: Wallingford, 2003.
- Hartz T.K, Coasta F.J., Schrander W.L., 1996. Suitability of composted green wastes from horticultural uses. *Horts science*, 31(6): 961-964.
- I.I.T.A. 1990. Standard method of analyzing nutrient in the laboratory.
- Imolehin E. D. 1991. Rice improvement and production in Nigeria. *Paper presented at WARDA Upland Breeding Task-Force Workshop, Bouake, Cote d'Ivoire, 4 Oct. 1991.*
- IRRI (International Rice Research Institutes). 2006. world Rice Statistics. *Intl. Rice Res. Inst.* http://www.irri.org/science/wrs. Accessed on November, 2010.
- Kondo, M., Pablico, P. P., Aragones, D. V., et al., 2003. Genotypic and environmental variations in root morphology in rice genotypes under upland field conditions. *Plant soil 255: 189- 200.*
- Lathwell D. J. 1990. Legume green manure: principles of management based on recent research. *Tropsoils Tech. Bulletin 90-01.*
- Myint A. K., Yamakawa T, Kajihara Y, Zenmyo T. 2010. Application of different organic and mineral fertilizers on the growth, yield and nutrient accumulation of rice in a japanese ordinary paddy field. *Science World Journal 5 (2)*: 47-54.
- Nottidge, G.O, Ojeniyi, S.O and Aswalam, D.O. 2005. Effect of plant residue and NPK fertilizer on soil properties in a humid Ultisol. *Soil Sci. Soc. Nig.*, 15: 9-19.
- Nyamangara J., Bergstorm L. F., Piha M. L., Giller K. E.. 2003. Fertilizer use efficiency and Nitrate Leaching in a Tropical Sandy Soil. *J. of Environmental Quality 32: 599-606.*
- Saito K. 2010. Progress in genetic improvement to increase rice yield in West Africa being a paper Presented at the 28th International Rice Research Conference, 8-12 November 2010, Hanoi, Vietnam OP07: Raising the Yield Potential.3p.
- Sanchez, P.A. Soil fertility and hunger in Africa. 2002. *Science*, 295 (5562), 2019–2020.

- Walky A., I.A.C Black et al., 1966. An examination of degit jareff method for determining soil organic matter and a proposal modification of the chronic acid titration method. *Soil sci.,* 37: 29 – 28.
- Witt C., Buresh R. J., Balasubramanian V., Dawe D., Dobermann, A. 2002. Improving nutrient management strategies for delivery in irrigated rice in Asia. *Better Crops International*, 16:24-30.

TABLE 2. Effect of split application of compost on growth of upland rice (*Oryza sativa* L.) cultivars (105 DAS)

TIME OF COMPOST APPLICATION		Number of leaves	Plant height (cm)	Number of tillers	Leaf area index	Dry weight (g)/plant		
						Shoot	Root	Total biomass
Incorporation prior to planting.		22.83	97.51	4.44	806.05	18.22	2.20	20.77
Tillering & Panicle exertion		24.39	84.47b	4.83	971.17	19.89	2.59	23.08
Tillering & Booting		23.94	91.59b	5.11	1027.89	18.00	2.37	20.84
Panicle exertion& Booting		23.89	96.63	5.06	940.40	20.68	2.41	23.64
LSD (= 0.05)		**6.22**	**12.04**	**1.56**	**352.58**	**6.58**	**0.83**	**7.33**
RICE CULTIVARS								
NERICA 1		25.33	79.76	5.38	938.92	18.63	2.22	21.42
NERICA 2		22.21	88.11	4.96	789.92	16.37	2.04	18.78
OFADA		23.75	109.78	4.25	1071.28	22.59	2.92	26.04
LSD (= 0.05)		**5.38**	**10.43**	**1.35**	**305.34**	**5.70**	**0.72**	**6.35**
INTERACTIONS								
Time of application	**Cultivars**							
	NERICA I	21.50	83.93	4.50	707.30	17.55	1.97	19.88
Incorporation	NERICA II	22.33	88.57	5.00	719.27	15.82	2.33	18.58
	OFADA	24.67	120.03	3.83	991.57	21.28	2.30	23.83
	NERICA I	29.00	66.65	6.33	1017.49	22.25	3.03	25.88
Tillering & Panicle exertion	NERICA II	19.33	81.17	4.00	629.53	14.00	1.88	16.27
	OFADA	24.83	105.58	4.17	1266.50	23.43	2.85	27.08
	NERICA I	28.00	85.12	6.17	1068.46	16.73	1.88	19.22
Tillering & Booting	NERICA II	22.50	92.27	5.17	961.91	18.45	2.03	20.75
	OFADA	21.33	97.40	4.00	1053.31	18.82	3.18	22.57
	NERICA I	22.83	83.33	4.50	962.45	18.00	2.00	20.70
Panicle exertion & Booting	NERICA II	24.67	90.45	5.67	884.97	17.20	1.90	19.53
	OFADA	24.17	116.10	5.00	973.77	26.83	3.33	30.68
LSD (= 0.05)		**10.22**	**20.12**	**2.53**	**596.56**	**11.36**	**1.53**	**12.72**

Means within the columns followed by the same letter are not significantly different at P> 0.05 using Least Significant Difference (LSD). DAS= Days after sowing.

TABLE 3. Effect of split application of compost on yield parameters of upland rice (*Oryza sativa* L.) cultivars

TIME OF COMPOST PPLICATION		Number of panicles	Number of spikelets	Weight (g)/plant				Grain yield (t/ha)	Harvest index
				Panicle	Filled grain	Grain	100 Seeds		
Incorporation prior to planting.		4.06	12.50	5.08	7.61	4.79	2.51	2.83	0.51
Tillering & Panicle exertion		4.39	12.83	5.39	7.63	5.11	2.55	2.92	0.48
Tillering & Booting		4.22	13.28	5.56	7.54	4.78	2.66	2.86	0.49
Panicle exertion & Booting		4.40	13.72	5.52	8.11	5.23	2.61	3.16	0.47
LSD (= 0.05)		**1.38**	**1.72**	**0.94**	**3.75**	**0.91**	**0.17**	**1.23**	**0.08**
RICE CULTIVARS									
NERICA I		4.46	11.83b	4.38b	6.86	4.11b	2.67	2.55b	0.47
NERICA II		4.46	11.88b	4.39b	6.85	4.08b	2.52	2.58b	0.49
OFADA		3.88	15.54	7.39	9.46	6.75	2.55	3.70	0.50
LSD (= 0.05)		**1.19**	**1.49**	**0.81**	**3.24**	**0.79**	**0.15**	**1.06**	**0.07**
INTERACTIONS									
Time of application	**Cultivars**								
Incorporation	NERICA 1	3.17	11.00	4.37	7.27	4.18	2.68	2.04	0.45
	NERICA 2	4.83	11.67	4.28	6.90	4.12	2.47	3.05	0.54
	OFADA	4.17	14.83	6.58	8.65	6.08	2.37	3.39	0.53
Tillering &	NERICA 1	4.83	11.00	3.73	5.95	3.57	2.55	2.30	0.40
Panicle exertion	NERICA 2	4.17	11.50	4.00	6.60	3.72	2.38	2.14	0.49
1	OFADA	4.17	16.00	8.45	10.35	8.03	2.72	4.32	0.56
Tillering &	NERICA 1	5.83	12.50	4.45	6.90	4.28	2.67	3.56	0.54
Booting	NERICA 2	4.00	12.67	4.87	6.90	4.00	2.72	2,16	0.43
	OFADA	2.83	14.67	7.35	8.83	6.05	2.58	2.85	0.47
Panicle exertion	NERICA 1	4.00	12.83	4.97	7.32	4.42	2.77	2.30	0.44
& Booting	NERICA 2	4.83	11.67	4.42	7.02	4.47	2.52	4,24	0.43
	OFADA	4.33	16.67	7.17	10.00	6.82	2.53	2.94	0.46
LSD (= 0.05)		**2.23**	**2.91**	**1.67**	**5.82**	**1.68**	**0.33**	**2.12**	**0.13**

TABLE 4. Effect of split application of compost application on nutrient uptake of upland rice cultivars

TIME OF COMPOST APPLICATION		N	P	K
			(mg/kg)	
Incorporation prior to planting.		10.47	6.65	20.54
Tillering & Panicle exertion		8.77	6.38	17.60
Tillering & Booting		5.23	4.58	10.21
Panicle exertion & Booting		11.49	8.65	16.72
LSD (= 0.05)		**4.29**	**3.24**	**7.57**
RICE CULTIVARS				
NERICA I		9.25	6.64	18.58
NERICA II		7.12	5.65	14.43
OFADA		10.54	7.42	18.56
LSD (= 0.05)		**3.71**	**2.81**	**6.56**
INTERACTIONS				
Time of application	Cultivars			
	NERICA I	7.05	5.59	15.40
	NERICA II	5.67	3.29	8.80
Incorporation	OFADA	18.69	11.30	37.40
	NERICA I	11.08	7.37	21.86
	NERICA II	6.34	5.95	15.66
Tillering & Panicle exertion	OFADA	8.88	5.81	15.29
	NERICA I	8.80	8.17	17.39
	NERICA II	6.75	5.47	12.96
Tillering & Booting	OFADA	0.11	0.09	0.28
	NERICA I	10.05	5.43	19.65
	NERICA II	9.93	7.99	20.30
Panicle exertion & Booting	OFADA	14.50	12.53	10.22
LSD (= 0.05)		**7.42**	**5.61**	**13.11**

Means within the columns followed by the same letter are not significantly different at P> 0.05 using Least Significant Difference (LSD).