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Full length Research paper

Interactive effects of organic and inorganic fertilizers on the performance of Upland Rice (O*ryza sativa* l.) Cultivars

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Field experiments were conducted at the research field of the National Cereals Research Institute, Badeggi, Niger State, Nigeria (Lat. 9° 45' N, Long.06° 07' E). The experiments were designed as 5 x 4 factorial in Randomized Complete Block and laid out in split-plots arrangement, replicated three times. Results showed that the application of different combinations of organic manure and inorganic fertilizer resulted in significantly better growth and grain yield (2.51 t/ha for 1 t/ha + 20 kg N/ha urea and 2.26 t/ha for 0.5 t/ha + 40 kg N/ha urea), compared to the none application of any form of soil amendment (control) (1.38 t/ha), with the parameters also varying significantly among the soil amendments. The use of combined organic manure and inorganic fertilizer, more importantly, 1 t/ha PM + 20 kg N/ha and the cultivation of the NERICA 1 rice variety, are hereby recommended for the farmers in the experimental area.

Key words: Poultry manure, inorganic fertilizer (urea), plant height, tiller count, number of panicles, 100grain weight, grain yield.

INTRODUCTION

In Nigeria, rice (*O. sativa* L.) was ranked as the sixth major crop in cultivated area after sorghum *(Sorghum bicolor*, L), millet (*Haena sativa* L), cowpea (*Vigna unguiculata* (L) Walp), cassava (*Manihot esculentum*, L) and yam (*Dioscorea spp.*, L) (Olaleye *et al.,* 2004; Dauda and Dzivama, 2004). It is the only crop grown nationwide in all agro-ecological zones from Sahel to the coastal swamps. It remains an important diet in Nigeria and due to this, demand for rice rose far above its supply. Olaleye *et al.,* (2004) remarked that an estimated 2.1 million tons of rice are consumed annually. FAO (2006) reported that rice is the second highest worldwide produced crop after maize. The importance of the cereal in the evolution of humanity cannot be overlooked (FAO, 2006). Cereal grains are unique among our foods prominent among which is rice (*O. sativa* L.). Rice constitutes one of the most important staple foods of over half of the world's population (Normal and Otoo, 2006). Rice is of significant importance to food security in many African countries and while the per capita rice consumption in some Asian nations is declining, it is growing rapidly in most countries in sub Sahara African (Mohapatra, 2006). Annual demand for rice in sub Sahara Africa is increasing by 6% per year, fueled by the rapid population growth and changes in consumption preferences (FAO, 2000).

Nitrogen and phosphorus fertilizers are major essential plant nutrients and key input for increasing crop yield (Alam *et al.,* 2009; Alinajoati and Mirshekari 2011; Dastan *et al.,* 2012). Nitrogen deficiency generally results in stunted growth and chlorotic leaves due to poor assimilate formation that leads to premature flowering and shortening of the growth cycle. Several field research reports have indicated that high and sustainable crops yields are only possible with integrated use of mineral fertilizer with organic manure (Satyanarayana *et al.,* 2002). Complementary application of organic and inorganic fertilizers increase nutrient synchrony and reduces losses by converting inorganic nitrogen to organic forms (Kramer et al., 2002). Synthesis of chemical fertilizers consumes a large amount of energy and money. However, an organic farming with or without chemical fertilizers seems to be possible solution for these situations (Prabu *et al.,* 2003). The integration of organic

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sources and synthetic sources of nutrients not only supply essential nutrients but also have some positive interaction with chemical fertilizers to increase their efficiency and thereby reduce environmental hazards.

There are two broad categories of soil amendments: organic and inorganic. Organic amendments come from something that is or was alive. Inorganic amendments, on the other hand, are either mined or man-made (Davis and Wilson, 2008). Organic matter improves soil aeration and water infiltration, and it also improves both water and nutrient-holding capacity of soils. They increase water retention by the soil and are important in maintaining soil tilth (Sarka and Siegh 2002). Ball *et al.,* (2005) noted that organic fertilizers are also responsible for the formation of soil aggregates. Livestock manure supplies all major nutrients (N, P, K, Ca, Mg, S,) necessary for plant growth, as well as micronutrients (trace elements), hence it acts as a mix fertilizer (Tremblay *et al.,* 2011). Manure application in a given year will influence not only crops grown that year, but also crops in the succeeding years, because decomposition of the organic matter is not completed within one year (Bayu *et al.,* 2006). Application of organic materials as fertilizers provides growth regulating substances and improve the physical, chemical and microbial properties of the soil (Belay *et al.,* 2001).

MATERIALS AND METHODS

Experiments were conducted at the National Cereals

Research Institute (NCRI) upland rice field, Badeggi (Lat. 9^o 45' N, Long.06^o 07' E), 705 metres above sea level in the southern Guinea savanna ecological zone of Nigeria. The average annual rainfall of Bida is in the range of 1000 – 1500mm. Rainfall starts in April and ends at mid October of every year.

The land was mechanically ploughed and harrowed using tractor-mounted disc plough and harrow. Thereafter, field layout was done to mark out the appropriate number of treatment plots, each measuring 4m × 4m prepared manually. Sowing of the rice seeds was done at a rate of four seeds per hill and spaced at 20cm × 20cm. The experiments were designed as 4 × 5 factorial in Randomized Complete Block and laid out in split-plots arrangement. The main plots consisted of five rice varieties (NERICA 1, FARO 48, FARO 49 FARO 55 and SOR–2) obtained from the seed unit of the NCRI, Badegi, while the sub plots were made up of four soil amendments (1.5 t/ha poultry manure (PM), 1 t/ha PM + 20 kg N/ha inorganic fertilizer, 0.5 t/ha PM + 40 kg N/ha inorganic fertilizer and 0 kg N/ha (control). All factorial combinations were replicated three times. The poultry manure at the appropriate rates mentioned above was incorporated into the soil prior to sowing of rice, while inorganic fertilizer in form of urea was split- applied at the rates mentioned above by broadcasting method on the plots that were to receive inorganic fertilizer urea, at 30 DAS and at booting stage. Weed control in each experimental plot was carried out by manual weeds removal using the traditional hoe, done twice at 3 and 6 weeks after sowing. One 1m × 1m quadrant was marked out from each of the plots and all the plants therein were used for data collection.

Data on plant growth parameters including plant height (cm), tiller counts, length of panicle (cm) and number of panicles per plant at maximum booting and grain yield (t/ha) at harvest, were collected from the designated 1 m^2 quadrant in each plot. The heights of rice plants from the 1m^2 quadrant in each plot were measured from the base of each plant to the tip of its newly emerged leaf. This was taken with the aid of a measuring tape and was done at 30, 60, and 90 days after sowing (DAS). The average values were taken to represent the height per rice plant at each assessment period. The number of tillers from the same1m^2 quadrant was counted at 30, 60, and 90 (DAS) in each plot. The average values were later taken to represent the number of rice tillers per plant. The length of panicle was measured from plants in the 1m^2 quadrant. This was measured with the use of a measuring tape. The average values of the measured panicles from each quadrant were recorded per plot. The number of rice panicles was counted from the 1m^2quadrant. This was carried by manual counting. The average values of the rice plants in each quadrant were determined and recorded per plot. The harvesting of the rice was done at maturity by cutting all plants from the 1 m^2 quadrant in each plot. The harvested rice plants were sun dried, threshed, winnowed to obtain the paddy rice which was thereafter weighed using a metric balance. Thereafter 1000 grains of rice was counted and weighed using an electronic weighing balance. The rice grain yield per hectare was finally estimated from the grain yield per plot using the following expression:

Given: Yield per plot (1 m^2) = x kg; 1ha = 10,000m^2

Grain yield/ha= (x)*10000 (kg); Grain yield (t/ha) = (x)* (10000/1000)

= 10x (t/ha)

Data collected on various parameters were subjected to the statistical analysis of variance (ANOVA) using SAS (2002). Means were separated using the Least Significant Difference at 5% probability levels ($LSD_{0.05}$). (Steel and Torie, 1980)

RESULTS

The results of the significant variety × soil amendment interactive effects observed at the three periods of measurement on plant height, presented on Table 1, show that at 30 DAP, the application of 1 t/ha PM + 20 kg N/ha NPK resulted in the tallest plants with NERICA 1, FARO 55 and SOR-2 rice varieties, while the highest values of the parameter were obtained with the application of 1.5 t/ha with FARO 48 and FARO 49 rice

Table 1. Interactive effects of variety and soil amendment on plant height of rice.

Variety	Soil amendment	Plant Height (cm)		
		30	**60**	**90 DAP**
NERICA 1	0 kg N/ha	24.01i	45.59h	54.52g
	1.5 t/ha PM	33.65b-f	44.13h	66.62cde
	1 t/ha PM + 20 kg N/ha NPK	34.97b-e	45.30h	67.99bcde
	0.5 t/ha PM + 40 kg N/ha NPK	26.61hi	58.59d-g	68.45bcd
FARO 48	0 kg N/ha	32.87d-h	59.19c-g	69.82bcd
	1.5 t/ha PM	37.70ab	52.11fgh	60.04efg
	1 t/ha PM + 20 kg N/ha NPK	33.14c-g	64.48a-d	74.51abc
	0.5 t/ha PM + 40 kg N/ha NPK	34.80b-e	68.07abc	74.60abc
FARO 49	0 kg N/ha	35.38bcd	54.50efg	62.88def
	1.5 t/ha PM	40.56a	62.19b-e	69.31bcd
	1 t/ha PM + 20 kg N/ha NPK	37.43abc	71.45a	75.21ab
	0.5 t/ha PM + 40 kg N/ha NPK	35.44bcd	70.55ab	79.66a
FARO 55	0 kg N/ha	30.25fgh	63.06a-e	74.50abc
	1.5 t/ha PM	33.36b-f	50.33gh	57.68fg
	1 t/ha PM + 20 kg N/ha NPK	34.02b-f	61.19cde	69.10bcd
	0.5 t/ha PM + 40 kg N/ha NPK	33.55b-f	60.74c-f	74.38abc
SOR-2	0 kg N/ha	30.82e-h	44.95h	56.87fg
	1.5 t/ha PM	28.88gh	52.26fgh	62.62defg
	1 t/ha PM + 20 kg N/ha NPK	35.23b-e	71.26a	75.32ab
	0.5 t/ha PM + 40 kg N/ha NPK	34.28b-f	58.36d-g	66.86cde
s.e.d		2.234	4.184	3.827
l.s.d		4.450	8.871	8.113

Figures followed by the same letter(s) in each column are not significantly different by the least significant difference at 5% probability level

Table 2. Interactive effects of variety and soil amendment on tiller count of rice.

Variety	Soil amendment	Tiller count (no.)		
		30	**60**	**90 DAP**
NERICA 1	0 kg N/ha	17de	21hij	25gh
	1.5 t/ha PM	16e	20ij	21h
	1 t/ha PM + 20 kg N/ha NPK	25a	26c-f	30cdef
	0.5 t/ha PM + 40 kg N/ha NPK	16e	23f-i	25gh
FARO 48	0 kg N/ha	20b-e	25d-g	28defg
	1.5 t/ha PM	19cde	21hij	24gh
	1 t/ha PM + 20 kg N/ha NPK	19cde	23f-i	26fg
	0.5 t/ha PM + 40 kg N/ha NPK	22abc	31a	31cde
FARO 49	0 kg N/ha	17de	19j	24gh
	1.5 t/ha PM	24ab	25d-g	25gh
	1 t/ha PM + 20 kg N/ha NPK	22abc	29abc	33abc
	0.5 t/ha PM + 40 kg N/ha NPK	21a-d	25d-g	28defg
FARO 55	0 kg N/ha	19cde	24e-h	36ab
	1.5 t/ha PM	19cde	24e-h	27efg
	1 t/ha PM + 20 kg N/ha NPK	23abc	27b-e	33abc
	0.5 t/ha PM + 40 kg N/ha NPK	23abc	28a-d	28defg
SOR-2	0 kg N/ha	19cde	22g-j	24gh
	1.5 t/ha PM	23abc	28a-d	32bcd
	1 t/ha PM + 20 kg N/ha NPK	23abc	30ab	37a
	0.5 t/ha PM + 40 kg N/ha NPK	24ab	28a-d	30cdef
s.e.d		2.05	1.70	2.09
l.s.d		4.12	3.38	4.16

Figures followed by the same letter(s) in each column are not significantly different by the least significant difference at 5% probability level

Table 3. Interactive effects of variety and soil amendment on number of panicles and panicle length of rice.

Variety	Soil amendment	Number of panicles	Panicle length (cm)
NERICA 1	0 kg N/ha	10cde	23.60de
	1.5 t/ha PM	8e	20.22ef
	1 t/ha PM + 20 kg N/ha NPK	11bcde	20.33ef
	0.5 t/ha PM + 40 kg N/ha NPK	11bcde	23.94de
FARO 48	0 kg N/ha	9de	17.57fg
	1.5 t/ha PM	12bcd	23.27de
	1 t/ha PM + 20 kg N/ha NPK	11bcde	32.71bc
	0.5 t/ha PM + 40 kg N/ha NPK	11bcde	35.74b
FARO 49	0 kg N/ha	10cde	15.37g
	1.5 t/ha PM	9de	31.38c
	1 t/ha PM + 20 kg N/ha NPK	18a	32.94bc
	0.5 t/ha PM + 40 kg N/ha NPK	12bcd	40.08a
FARO 55	0 kg N/ha	10cde	22.22de
	1.5 t/ha PM	9de	23.33de
	1 t/ha PM + 20 kg N/ha NPK	20a	26.16d
	0.5 t/ha PM + 40 kg N/ha NPK	14b	23.11de
SOR-2	0 kg N/ha	12bcd	22.71de
	1.5 t/ha PM	13bc	24.22de
	1 t/ha PM + 20 kg N/ha NPK	10cde	23.32de
	0.5 t/ha PM + 40 kg N/ha NPK	10cde	25.12d
s.e.d		1.68	2.110
l.s.d		3.34	4.216

Figures followed by the same letter(s) in each column are not significantly different by the least significant difference at 5% probability level

varieties. Similar results at 60 DAP show that the application of 0.5 t/ha + 40 kg N/ha resulted in the tallest plant in NERICA 1 with the value significantly better than the value with the application of 1.5 t/ha PM. The application of 1 t/ha PM + 20 kg N/ha resulted in the tallest plant with FARO 49 and the value was significantly better than those of 0 kg n/ha and 1.5 P.M, while the same soil amendment produced the tallest plant with SOR-2, which value was however better than with the application of all other soil amendments including the control. None application of any form of soil amendment resulted in the tallest plant with FARO 55, with the value only significantly better than with the application of 1.5 t/ha P.M. Results of the significant interactive effects of variety and soil amendment observed for the plant height at 90 DAP show that the application of all types of soil amendment resulted in similar plant height values which were significantly better than with the control in NERICA 1 rice variety, while with FARO 48 and FARO 55, the application of 1.5 t/ha P.M. resulted in significantly shorter plant than with the other types of soil amendments including the control. The results further show that while the application of 0.5 t/ha P.M. + 40 kg N/ha resulted in significantly taller plant than with the other types of soil amendment with FARO 49, the application of 1 t/ha P.M. + 20 kg N/ha produced significantly tallest plant with SOR-2.

The results of the significant interactive effects of rice variety and soil amendment presented in Table 2 show that the application of 1 t/ha PM+ 20 kg N/ha urea resulted in significantly more tillers than in all other soil amendments at the three periods of measurements, while the same treatment showed significantly more tillers than those with the application of all other soil amendments, while the same soil amendment produced the tallest plant with FARO 48, which value was however only better than only the control at 30 DAP and better than in all other soil amendments at 60 and 90 DAP in FARO 49. However, the application of 0.5 t/ha + 40 kg N/ha urea resulted in more tillers in FARO 48, with the value not significantly better than in all other soil amendments including the control at 30 DAP, significantly better than all other soil amendments at 60 DAP and 90 DAP, except the control which showed similar value at 90 DAP. The application of 0.5 t/ha PM + 40 kg N/ha urea similarly produced the highest tiller counts at 30 and 60 DAP with significant differences only at 60 DAP in FARO 55. The application of soil amendments resulted in more tillers than in the control in all assessment periods with significant differences at both 60 and 90 DAP when the application of 1 t/ha PM + 20 kg N/ha urea resulted in significantly more tillers than in all other soil amendments.

The results of the significant variety x soil amendment interactive effects on number of panicles per plant, presented of Table 3 revealed that while the number of panicles due to soil amendments were not significantly different for NERICA 1, FARO 48 and SOR-2 rice varieties, the application of 1 t/ha PM + 20 kg N/ha urea resulted in the highest numbers of panicle per plant of FARO 49 and FARO 55. These values in both cases were significantly better than with the application of all other soil amendments. Moreover, with FARO 55, the application of 0.5 t/ha PM + 40 kg N/ha also resulted in number of panicles which value was significantly better than the application of the sole manure at 1.5 t/ha and none application of any form of soil amendment. Similar

Table 4. Interactive effects of variety and soil amendment on grin yield and 1000 grains weight of rice.

Variety	Soil amendment	Grain yield(t/ha)	1000 grains weight(g)
NERICA 1	0 kg N/ha	2.02cde	1.790bcd
	1.5 t/ha PM	1.95cde	1.770bcd
	1 t/ha PM + 20 kg N/ha NPK	3.88a	1.88b
	0.5 t/ha PM + 40 kg N/ha NPK	2.77b	1.753b-e
FARO 48	0 kg N/ha	1.14fg	1.087g
	1.5 t/ha PM	1.63def	1.772bcd
	1 t/ha PM + 20 kg N/ha NPK	2.37bc	1.848bc
	0.5 t/ha PM + 40 kg N/ha NPK	2.12cd	1.805bcd
FARO 49	0 kg N/ha	0.95g	1.180g
	1.5 t/ha PM	1.42efg	1.180g
	1 t/ha PM + 20 kg N/ha NPK	2.39bc	1.827bc
	0.5 t/ha PM + 40 kg N/ha NPK	2.34bc	1.732b-e
FARO 55	0 kg N/ha	1.13fg	1.525ef
	1.5 t/ha PM	1.70def	2.150a
	1 t/ha PM + 20 kg N/ha NPK	1.85cde	1.780bcd
	0.5 t/ha PM + 40 kg N/ha NPK	1.67def	1.540ef
SOR-2	0 kg N/ha	1.67def	1.425f
	1.5 t/ha PM	1.46efg	1.577def
	1 t/ha PM + 20 kg N/ha NPK	2.07cd	1.807bc
	0.5 t/ha PM + 40 kg N/ha NPK	2.41bc	1.822bc
s.e.d		0.297	0.1146
l.s.d		0.592	0.2290

Figures followed by the same letter(s) in each column are not significantly different by the least significant difference at 5% probability level.

results on the central panicle length in the same table show no significant variations in panicle length due to soil amendment with NERICA 1, FARO 55 and SOR-2 rice varieties. However, the application of 0.5 t/ha + 40 kg N/ha urea resulted in the longest panicle which value was similar to the application of 1 t/ha + 20 kg N/ha urea, both of which were significantly better than with the application of sole manure (1.5 t/ha PM) and the control (0 kg N/ha) in FARO 48. Similarly, the application of 0.5 t/ha PM resulted in significantly longest panicle and significantly least value was obtained with none application of any form of soil amendment with FARO 49.

The results of the significant variety x soil amendment interactive effects on 1000 grains weight and rice grain yield in Table 4 show that while there were no significant differences in 1000 grains weight due to soil amendment application with NERICA 1 rice variety, the application of all types of soil amendment, including the application of sole manure (1.5 t/ha P.M.), resulted in significantly higher 1000 grains values than the control (0 kg N/ha) with FARO 48. However, with FARO 49, the application of 1 t/ha PM + 20 kg N/ha urea resulted in significantly higher 1000 grains weight value than with the other soil amendments, with the exception of the application of 0.5 t/ha PM + 40 kg N/ha urea which also significantly higher value than those of sole manure (1.5 t/ha PM) and the control (0 kg N/ha), both with similar values. The results with regards to FARO 55 show that the application of sole manure (1.5 t/ha PM) resulted in significantly higher value than with the application of 1 t/ha PM + 20 kg N/ha which in turn showed higher value than with the application of 1.5 t/ha PM and the control (0 kg N/ha). The application of 0.5 t/ha PM + 40 kg N/ha urea resulted in the highest 1000 grains weight value which was however not significantly better than with the application of 1 t/ha PM + 20 kg N/ha, both of which were significantly better than with those of 1.5 t/ha PM and 0 kg N/ha with SOR-2 rice variety.

Similar results for the rice grain yield in the same table revealed that the application of 1t/ha PM + 20 kg N/ha urea resulted in significantly better grain yield than with the application of 0.5 t/ha PM + 40 kg N/ha urea which grain yield value was similarly better than with the application of sole manure (1.5 t/ha PM) and the none application of any form of soil amendment (control) with NERICA 1. However, with FARO 48, the application of 1 t/ha PM + 20 kg N/ha urea similarly resulted in the highest grain yield value which was significantly better than with other soil amendments with the exception of the application of 0.5 t/ha PM + 40 kg N/ha with value significantly better than with the control. The application of 1 t/ha PM+ 20 kg N/ha urea also resulted in the highest grain yield with FARO 49 with the value significantly better than with the application of 1.5 t/ha PM and 0 kg N/ha but not significantly different from that with the application of 0.5 t/ha + 40 kg N/ha which value was also better than with 1.5 t/ha PM and 0 kg N/ha. The application of 1 t/ha + 20 kg N/ha urea similarly produced the highest grain yield, which value was however significantly better than the control which value was statistically similar to those with the application of sole manure and 0.5 t/ha PM + 40 kg N/ha soil amendments. The highest grain yield produced with the application of 0.5 t/ha PM + 40 kg N/ha urea was not significantly better than with the application of 1 t/ha PM + 20 kg N/ha urea with SOR-2 rice variety. Both values were significantly better than with the application of sole manure and none application of any form of soil amendment (0 kg N/ha).

DISCUSSION

The growth and yield parameters of rice were significantly influenced in response to the application of combined use of organic (poultry manure) and inorganic fertilizers (urea). This may be due to beneficial effects of poultry manure on soil fertility (Satyanarayana *et al.,* 2002). Plant height, number of tillers, and yield of rice were significantly increased by the combined use of poultry manure and urea. This observation was in line with the report of Ainika (2010) who reported that poultry manure significantly increased growth characters such as plant height. The use of the combined organic materials with inorganic N fertilizer produced plants that were better than the use of organic manure alone. This indicated that the high dose of organic manure can be reduced by half and mixed with nitrogen fertilizer as reported by Agbede *et al.,* (2008). It has been observed that the application of a mixture of organic and inorganic fertilizers can be used to sustain rice production in the tropics (Satyanarayana *et al.,* 2002). A similar trend of response had earlier been reported for other crops such as maize (Makinde *et al.,* 2001); Sorghum (Bayu *et al.,* 2006).

Tillering is an important trait for grain production and is thereby an important aspect in rice yield. Mirza *et al.,* (2010) reported increase in the number of tillers in rice plants due to the influence of different fertilizer combinations. According to the authors, more number of tillers per square meter might be due to the more availability of nitrogen, which plays a vital role in cell division. Organic sources offer more balanced nutrition to the plants, especially micro nutrients which positively affect number of tillers in plants (Miller, 2007). The yield components of rice crop showed significant differences due to different soil amendments evaluated in the present study. Salem (2006) reported that the application of farm yard manure (FYM) in combination with nitrogen fertilizer significantly increased the number of panicles per square meter, panicle length, panicle weight, number of filled grains/panicle, 1000 -grain weight and grain yield in rice. Increase in grain yield could be due to the increase in plant growth attributes (plant height, number of productive tillers/hill, panicle weight and 1000-grain weight) (Buri *et al.,* 2004). Significant differences in 1000-grain weight of rice as affected by variation in fertilizer packages were also reported by Mirza *et al.,* (2010). These results were also supported by Channabasavanna and Biradar (2001). The increase in grain yield components can be due to the fact that the availability of more water enhanced nutrient availability which improved nitrogen and other macro- and micro-elements absorption as well as enhancing the production and translocation of the dry matter content from source to sink (Akinrinde, 2006). Similar results were also reported by (Awad 2001, El-Refaee *et al.,* 2006).

A similar result for maize has shown that grain yields from the combined application of organic and inorganic fertilizers was higher than yield from sole organic manure application (Makinde *et al.,* 2001). It was also observed from the present study that the sole organic fertilizer (poultry manure) application did not benefit the yield of rice significantly better than the control (0 kg N/ha). The observed lower yield from sole organic fertilizer application from this study supported the earlier suggestion that organic fertilizers are better used for sustaining continuous cropping for 2-3 years than inorganic fertilizers (Agbin, 1985). Chemical fertilizer offers nutrients which are readily soluble in soil solution and thereby instantly available to plants. Nutrient availability from organic sources is due to microbial action and improved physical condition of soil (Sarker *et al.,* 2004). The increase in plant height, number of tillers per hill, 1000-grain weight and grain yield in response to the application of combined organic and chemical fertilizers is probably due to an enhanced availability of nutrients. The variation in plant height due to nutrient sources was considered to be due to variation in the availability of major nutrients. Yadana *et al.,* (2009) reported similar results with the application of organic manure and compost in rice production. The available nutrients might have helped in enhancing leaf area, which resulted in higher photo-assimilates and more dry matter accumulation. These results are supported by the earlier findings of Swarup and Yaduvanshi, (2000) and Yadana *et al.,* (2009).

The variations in plant height of rice varieties may be attributable to differences in the genetic makeup of the varieties and their differences in the utilization ability of the different rates of soil amendments applied. These observations were in consonance with that of Halder et al., (2000) and Hag *et al.,* (2002) who reported that increased rate of the NPK fertilizer favoured the vegetative growth in rice plant. The significant differences 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 of dry matter. The differences in the ability of crop cultivars to utilize available nutrients and optimally partition its photosynthates had been recognized (Ndon and Ndaeyo, 2001). 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 soil amendment application relative to the control treatment. The natural endowments of crop cultivars to optimally utilize available nutrients and subsequently partition its photosynthates for dry matter accumulation and conversion to economic yield vary (Ndon and Ndaeyo, 2001).

The variation in plant height due to nutrient sources was considered to be due to variation in the availability of major nutrients. Chemical fertilizer offers nutrients which are readily soluble in soil solution and thereby instantaneously available to plants. Nutrient availability from organic sources is due to microbial action and improved physical condition of soil. These results were supported by Miller (2007). Tillering is an important trait for grain production and is thereby an important aspect of rice growth improvement. Production of tillers in rice plant was also influenced by different fertilizer combination at all the growth stages.

The productivity of rice plant is greatly dependent on the number of productive tiller (tillers which bears panicle) rather than the total tiller numbers. From this study it was observed that excess application of inorganic fertilizers is not necessary to produce effective tillers if it can be can supplemented with organic manures. However, organic sources offer more balanced nutrition to the plants, especially micro nutrients which has caused better affectivity of tiller in plants grown with poultry manure and vermicompost (Miller, 2007). This result was also supported by Belay *et al.,* (2001). Application of poultry manure combined with N enhances the nutrient availability and suitable soil condition for proper plant growth by reducing the losses of nutrient and hence produced the maximum dry weight. The production of maximum dry matter with proper manuring might be accounted for by the luxuriant growth of plant as well as higher number of tillers (Rahman et al., 2007). The higher growth rate achieved by using poultry manure and urea fertilizer treated plants could be associated with the positive effect of nitrogen, phosphorus and potassium. Singh *et al.,* (2003) reported that crop growth rate, averaged across treatments was highest at 45-60 days after transplanting of rice and significantly influenced by NPK fertilizers.

CONCLUSION

The results from this study show that growth and yield parameters of rice were significantly increased in response to the application of poultry manure combined with inorganic fertilizer. Plant height, number of tillers, and grain yield of rice were significantly increased by the combined use of poultry manure and urea fertilizer. Better rice grain yield from both the combined application of organic and inorganic fertilizer than those from the sole organic fertilizer is a further indication that the nutrients supplied from the combined application were more effective than those supplied with sole organic fertilizer. It was also observed from this study that the sole organic fertilizer (poultry manure) application did not benefit the grain yield of rice significantly better than the control (0 kg N/ha). In conclusion, the use of combined organic manure and inorganic fertilizer (1 t/ha PM + 20 kg N/ha urea and 0.5 t/ha PM + 40 kg N/ha urea) produced significantly better results than the use of the sole organic manure (1.5 t/ha PM), while NERICA 1 was the most outstanding rice variety.

From the foregoing results and discussion of the present study, the use of combined organic manure and inorganic fertilizer, particularly 1 t/ha PM + 20 kg N/ha urea and the cultivation of the NERICA 1 rice variety, are hereby recommended for the farmers in the experimental area.

Further studies may continue along the lines of investigating the optimum application levels of organic and inorganic fertilizers which gives the best results.

REFERENCES

Agbede TM, Ojeniyi SO, Adeyemo AJ (2008).Effect of poultry manure on soil physical and chemical properties, growth and grain yield of sorghum in Southwest Nigeria. American-Euroasian J. Soil Sci. 2(1): 72-77.

Agbin NN (1985). Potentials of peel as soil amendment.11. Field evaluation, J. of Environmental Quality 14: 411-415.

Ainika JI (2010). Response of grain amaranth (Amaranthus cruentus .L.) to Nitrogen and FYM rates in northern Guinea and Sudan savanna ecological zones of Nigeria. Msc thesis. Bayero University, Kano. pp 24-29.

Akinrinde EA (2006). Issue of optimum nutrients supply for sustainable crop production in the tropical developing countries. Pakistan J. Nutri. 5 (4): 387-391.

Alam MM, Hassanuzzaman M, Nahar K (2009).Tiller dynamics of three irrigated rice varieties alfisol. Nigeria J.Soil. Res. 2:15-20.

Alinajati S, Mirshekari B (2011).Effect of phosphorus fertilization and seed biofertilization on harvest index and phosphorus use efficiency of wheat cultivars. J. Food Agric. Environ. l9 (2):388-397.

Awad HA (2001). Rice production at the North of Delta Region in Egypt as affected by irrigation intervals and nitrogen fertilizer levels. J. Agric. Sci. Mansoura University. 26:1151-1159.

Ball BC, Bingham I, Rees RM, Watson C, Litterick A (2005). The role of crop rotation in determining soil

structure and crop growth conditions: Canadian J. Soil. Sci. 85 (50): 557-578.
Bayu W, Rethman NFG, Hammes PS, Alamu G(2006). Effects of farmyard manure and Inorganic Fertilizers on sorghum Growth, Yield and Nitrogen use in a semi- arid area of Ethiopia. J. Plant Nutri. 29(2):391-407.
Belay, A, Classens, AS, Wehner, FC, De Beer JM (2001). Influence of residual manure on selected nutrient elements and microbial composition of soil under long-term crop rotation. South African J. of Plant and Soil, 18:1-6.
Buri MM, Issaka RN, Wakatsuki T, Otoo E(2004). Soil organic amendments and mineral fertilizers: options for sustainable lowland rice production in the forest agro – ecology of Ghana. J. Agric. food. Sci. 3: 237 – 248.
Channabasavanna AS, Biradar PD (2001). Yield and yield attributes of transplanted summer rice as influenced by organic manures and zinc levels. J. Maharashtra. Agric.University.26:170-172.
Dastan S, Siavoshi M, Zakavi D, Ghanbaria-malidarreh A, Yadi R, Ghorbannia DE, Nasiri AR (2012). Application of nitrogen and silicon rates on morphological and chemical lodging related characteristics in rice (*O. sativa* L.) North of Iran. J. of Agric. Sci., 4, (6): 34-37.
Dauda SM, Dzivama AU (2004). Comparative performance of a locally Developed Rice thrasher with a imported vortex Rice Fan, proceedings of the 5th International Conference of the Nigerian Institute of Agricultural Engineers, Ilorin, 26; 29-32.
Davis JG, Wilson CR (2008) choosing a soil amendment. Colorado State University, Extension bulletin. No.7.235.
El-Refaee IS, Ebaid RA, El-Rewiny IM (2006). Performance of rice (*O. sativa* L.) plant under different water regimes and methods of planting. Alex J. Agric. Resources.51 (2):47-55.
F.A.O. (2000) Agricultural Development in Nigeria. Rome: Food and Agricultural Organization.
F.A.O. (2006). Agriculture towards 2015/30 Technical Interim report, Rome.
Hag MT, Sattar MA, Hossain MM, Hasan MM (2002). Effects of fertilizers and pesticides on growth and yield of rice. Online J. of Biol. Sci. 2(2): 84-88.
Halder KP, Chowdhury MJU, Ahmed N(2000). Effect of planting methods and nitrogen rates on the yield and yield components of Aus rice grown under rain fed condition at the coastal area of Bangladesh. Bangladesh J. Agric. Sci.27:59-64.
Kramer AW, Doane TA, Horwath WR, Kessel CV (2002).Combining fertilizer and inorganic inputs to synchronize N supply in alternative cropping systems in California. J. Agric. Econ. Environ.91:233-243.
Makinde EA, Agboola A, Oluwatoyinbo FI (2001). Effects of fertilizer Type on performance of melon in a maize–melon Intercrop. ASSET series. A (2): 151- 158.
Miller HB (2007). Poultry litter induces tillering in rice. J. of Sustainable Agric. 31:1-12.
Mirza Hasanuzzaman KU, Ahamed NM, Rahmatullah N, Akhter KN (2010) Modified rice cultivation methods with irrigation. Paddy Water Environment. 9: 25-32.
Mohapatara, S (2006).Putting Rice on the African Agenda, Rice Today, Publication of the International Rice Research Institute, Manila, Philippines, 5:50.
Ndon BA, Ndaeyo NU (2001).Evaluation of some cowpea (Vigna unquiculata (L.) Walp) cultivars adaptable to acid soils of Uyo, Southeastern Nigeria. Global J. of Pure and Applied Sci, 7 (3): 437-441.
Normal JC, Otoo E (2006).Sustainable rice production for food security. Preceding of the 20th session of the International Rice Commission Bangkok, Thailand, 23 – 26 July 2002.
Olaleye AO, Osiname OA, Cofie O (2004). Soil and water Management for Rice Production, West African International Conference on Hunger without Frontiers proceeding (WASAE), Kumasi Ghana. 256-269.
Prabu T, Sanindranth Ak, Rafi M (2003). Effect of integrated nutrient management on growth and yield of okra. Parbhani kranti. Orissa. J. Hort. 31(1): 17-21.
Rahman MH, Ali MH, Ali MM, Khatun MM (2007).Effect of Different Level of Nitrogen on Growth and Yield of Transplant Aman Rice Cultivar BRRI dhan 32. Int. J. Sustainable Crop Prod. 2 (1): 28-34.
Salem AKM (2006). Effect of nitrogen levels, plant spacing and time of farmyard manure application on the productivity of rice. J. Applied Sci. Res. 2(11):980-987.
Sarka, AK, Siegh RP (2002). Importance of Long Term Fertilizers Use for Sustainable Agriculture In Jharkhand. The Second International Congress on Balancing Food and Environmental Security–A Continue Challenge, New Delhi. India, 26-30 November 2002.Fertilizer News 2002; 47:107-117.
Sarker, MAR, Pramanik MYA, Faruk GM, Ali MY (2004). Effect of green manures and levels of nitrogen on some growth attributes of transplanted rice. Pakistan J. Bio. Sci.7:739-742.
SAS(2002).The SAS System for windows, Version 9.0.SAS Institute Inc., Cary, NC,USA.
Satynarayana VM, Vera PV, Murphy VRK, Boots KJ (2002). Influence of Integrated use of farmyard manure and inorganic fertilizer on yield and yield components of irrigated lowland rice. J. Plant Nutri. 25 (10): 281-2090.
Singh VK, Dwivedi BS, Shukla, AK, Yadav, RL (2003). Effects of nitrogen and phosphorus fertilization on the growth and yield of rice (O. sativa) and wheat (Triticum aestivum) as influenced by the inclusion of forage cowpea (Vigna unguiculata) in rice-wheat system.Indian J. Agric. Sci.73 (9): 482-489.
Swarup A, Yaduvanshi NPS (2000).Effect of Integrated nutrient management on soil System and Management for Plant hopper in East Asia. 13-15 November 2002. Guilin telluric microflora. Ph.D Thesis University, Paris. XII Val de Marne.
Tremblay N, Bouroubi MY, Vigneault P, Bélec C (2011).

Guidelines for in-season nitrogen application for maize (Zea mays L.) based on soil and terrain properties. Field Crops Res.122:273–283. doi:10.1016/j. fcr.2011.04.008.

Yadana K L, Aung K M, Takeo Y, Kazuo O (2009). The Effects of Green Manure (Sesbania rostrata) on the Growth and Yield of Rice. J. of Faculty of Agric. Kyushu University.54 (2): 313 – 319.