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EFFECTS OF FERTILIZERS ON THE GROWTH AND YIELD OF UPLAND RICE *(Oryza sativa*L.) VARIETY IN SOUTHERN NIGERIA.

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ABSTRACT

The experiment was conducted at the University of Port Harcourt Teaching and Research farm, Port Harcourt in 2019 on the effect of fertilizers on the growth and yield of upland rice (Oryza sativa) variety in Port Harcourt, Rivers State. There were 4 treatments which included control, NPK 15:15:15, spent mushroom substrate and poultry manure. The experiment was done in a Randomized Complete Block Design with 4 replications and 4 treatments. The growth and yield contributing characters that were measured include: plant height, leave number, tiller number, leaf area, leaf area index, panicle length, panicle weight, grain yield, 1000 grain weight, fresh and dry weight of straw. The result showed that the fertilizers applied (organic and inorganic fertilizers) positively affected the growth and yield of the rice variety when compared with the control. The highest growth and yield were recorded in the plot treated with poultry manure, followed by spent mushroom substrate and NPK while the lowest was obtained in control. The experiment indicates that organic manure (poultry manure and spent mushroom substrate) gave better and higher yield than the inorganic fertilizer (NPK 15:15:15). Thus, the use of organic manures especially poultry manure was recommended for the cultivation of rice in the study area.

Key words: Fertilizers, growth, yield, upland rice.

INTRODUCTION

Rice (*Oryza sativa*) is a staple food in the country and the most widely consumed according to FAOSTAT data (2012). It is the second most cultivated cereal crop worldwide and is central to the lives of billions of people around the world (Nguyen and Ferrero, 2006). Rice provides 23% of calories out of the 49% calories consumed by human population where wheat and maize provide 17% and 9% respectively (Subudhi*et al.*, 2006), thus almost one-fourth of the calories consumed by the entire world population comes from rice. Rice is one of the main sources of carbohydrate and also contains considerable amount of protein, minerals and vitamins (Naorem, 2018). Eighty-five percent of rice that is produced in the world is used for direct consumption. Rice is the only cereal crop that grow for a long period of time in standing water. Furthermore, 57% of rice is grown on irrigated land, 25% on rain fed lowland, 10% on uplands, 6% in deep water and 2% in tidal wet lands (Chopra, 2002).

Today, global agriculture is at a crossroad as a consequence of increased population, climate change and detrimental environmental effect. The increasing population imposes the need for more food and more pressure on crop production from available cultivable land with limited available resources. Application of suitable fertilizers is one of the ways to attain maximum crop yield. Chemical fertilizer has been the major supplier of nutrients besides organic manure and its use has been the headpin of modern agriculture. This undoubtedly boosted the food production but at the same time showed detrimental effects on physiochemical properties of soil, nitrogen transformation, micro and macro nutrient uptake and nutritional composition (Mahesh and Hosmani, 2004). However, the simultaneous use of chemical fertilizer and organic manure has revealed diverse result relative to the plant types and soil characteristics. Chad *et al., (*2016), reported that mixed use of

nitrogen, phosphorus and potassium (chemical fertilizer) and organic manure increases the mean growth of Mints.

Organic materials are the safer sources of plant nutrient without detrimental effect to crop and soil. Examples of organic materials include poultry droppings, cattle dung, farm yard manure, green as well as major and secondary plant nutrients (Peters, 2004). Organic manures leave behind sufficient residual effect for the sequence crops (Singh *et al.*,1996). The use of various sources of organic material has been promoted as one of the principal sustainable management options for improving soil quality and productivity (Wagner *et al.*, 2002). Energy crises, higher fertilization cost, sustainability in agricultural production system and ecological stability are the important issues which triggers the interest of researchers and farmers to the use of non-chemical fertilizers such as farm yard manure (FYM), compost, poultry manure, bio fertilizers, etc. and the balanced use of nutrients through organic materials are pre-requisite to sustain soil fertility, produce maximum crop yield with optimum input level (Dahiphale*et al.*, 2003).

Spent mushroom substrate (SMS) is the leftover of wastes after different flushes of mushroom have been harvested. This growing substrate may be composed of different waste materials such as sawdust, rice straw, bedded horse manure, paper waste, cocoa shells, cotton wastes, wheat straw, maize husk and other various waste (Jonathan *et al.*,2011). After the cultivated mushroom have exhausted the nutrients within the substrates and there are no more fruit bodies to harvest, the so called remains regarded as useless material is known as spent mushroom substrate (Fasidi*et al*., 2008). Spent mushroom substrate is believed to be a source of humus formation and humus is known to provide plants with micro nutrients which improve soil aeration, soil water holding capacity and also helps to maintain soil structure (Chang and Yau, 1981). It has been reported that spent mushroom substrate contains nutrients which could be used for the growth of plants and these materials are generally non-toxic to cultivated plants and spent mushroom have also been reported to contain cellulose and lignin which is important for soil improvement and safe for human consumption (Orluchukwu and Ugwu, 2018b).

Poultry manure also known as chicken manure provides nutrient for cultivated plant and it is an excellent material for soil amendment that improves soil quality because of its high organic matter content and available nutrients for plant growth (Van Ryssen*et al.*, 1993). Poultry manure has been reported to contain more plant nutrient than other organic materials or manure (Ali, 2005). Poultry manure is an excellent organic fertilizer as it contains high NPK and other essential plant nutrients (Boateng*et al*., 2006). Nitrogen-Phosphorus-Potassium (NPK) fertilizer is a complex fertilizer comprised primarily of three (3) primary nutrients required for plant growth. The agricultural industry relies heavily on the use of NPK fertilizer to meet global food supply and ensure healthy crops (Carrie and Shane, 2019). Rice production is facing rate in growth and yields, depletion of natural resources such as soil and the high cost of inorganic fertilizers are beyond the reach of local farmer in developing countries like Nigeria.The hazardous environmental effect makes inorganic fertilizer undesirable and also uneconomical. Hence, the alternative source of organic manures which would enhance the growth and production of rice by farmers and is environmentally friendly. This experiment is to determine the effect of organic manure (poultry dropping and spent mushroom substrate) and inorganic fertilizer (NPK) that would increase the yield and growth of upland rice variety.

MATERIALS AND METHOD

Experimental site

The experiment was carried out at the University of Port Harcourt, Faculty of Agriculture Teaching and Research Farm. University of Port Harcourt lies on latitude 4^0 54'N and longitude 6^0 55'E, with an average temperature of 27^0 C, relative humidity of 78% and average rainfall that ranges from 2500-4000mm (Nwankwo and Ehirim, 2010). The experimental land area of 10m x 17m ($170m^2$) was marked out. The land was cleared using simple farm tools such as cutlass, shovels. The land was cleared to remove excess vegetation. The land was mapped using pegs and twine to avoid or reduce experimental error. Tillage and bed preparation of 2m x 3m was done using simple farm tools such as hoes and shovels.The area was marked into blocks and plots and each plot had a dimension of 2m x 3m ($6m^2$) and 0.5m alleyway for easy movement. The statistical design was a simple Randomized Complete Block Design (RCBD) of four (4) treatments with four (4) replications. The treatments include spent mushroom substrate, poultry manure, and inorganic (NPK) fertilizer and control. The spent mushroom substrate and poultry manure was applied at the rate of 10,000kg per hectarerandomly and was incorporated into the soil before planting using shovel.Soil samples were collected before planting at the depth of 15cm which was analyzed for the presence and percentage of Nitrogen (N), Phosphorus (P) and Potassium (K), Calcium (Ca), Magnesium (Mg), organic matter in the soil and soil pH.The treatments, poultry manure and spent mushroom substrate were also analyzed for the afore mentioned parameters except for organic matter content.Spent mushroom substrate and poultry manure were added to the designated experimental unit randomly at the rate of 10,000kg per hectare

before planting and the inorganic fertilizer (NPK) was added at the rate of 108kg per hectaretwo weeks after planting.

The seeds were sown directly by seed dibbling in holes less than 2cm depth with a planting space of 30cm within rows and 30cm between rows. Two seeds were planted per hole. Proper weeding was employed to control weed infestation and pest that

Data Collection

The initial fertility status of the soil was collected and recorded. Data collection was done at an interval of two weeks. Data was collected on growth parameters such as plant height, number of leaves, number of tillers, leaf area, leaf area index, and the yield parameter collected were on grains and the 1000 grain weight (dry matter weight), weight of panicles, length of panicles, fresh and dry weight of straw which was obtained after harvesting manually, in which the tillers was weighed and recorded and the dry weight after sun drying. Data was obtained from 3 plants using random selection in each experimental unit and the mean was collected from the representative sample of the population. The parameters taken were analyzed statistically using analysis of variance (ANOVA)and the means were separated using least significance difference (LSD) at 5% level of probability using statistical GenStat release, version 12.1 package.

RESULTS

Chemical analysis of soil and organic materials

The result of the chemical analysis of the soil taken before planting and those of the organic materials which are poultry manure and spent mushroom are shown in Table 1. The result indicates that total nitrogen of the soil recorded 0.08%, available Phosphorus recorded 18.6mg/kg, potassium recorded 0.08 cmol/kg, Magnesium recorded 2.21 cmol/kg, Calcium 1.72 cmol/kg and Organic matter recorded 3.5% with pH of 5.2 which is acidic. For organic manure used, poultry manure and spent mushroom after analysis, the result indicates that poultry manure and spent mushroom substrate has a pH of 7.1 and 6.4 respectively and total nitrogen was 4.8% and 1.74% respectively, available Phosphorushad 9.7 mg/kg and 1.73 mg/kg respectively, Potassium was 1.8 Cmol/kg and 2.26 Cmol/kg respectively, Magnesium was 2.01 cmol/kgand 1.94 cmol/kg respectively while Calciumwas 2.31 cmol/kg and 1.95 cmol/kg respectively.

GROWTH PARAMETERS

The effects of poultry manure, spent mushroom substrate and NPK I5:15:15 on plant height, number of leaves and number of tillers, leaf area are represented in the Tables below.

Effect of fertilizers on Plant height (cm) of rice

The effects of fertilizers on plant height at 4 weeks and 14 weeks after planting, is statistically significant($P< 0.05$)but at 6weeks to 12weeks after planting, there were no Significant ($P>0.05$)difference between treatment means. However, from observations using the raw data collected from the plot, the highest plant height was obtained from the plot treated with poultry manure at 4-14weeks after planting with a mean range of 36.02 - 79.36cm, followed by spent mushroom substrate (31.19 - 75.89cm), and by NPK 15:15:15 (30.11-70.32cm) and then control which has the mean range (28.78 - 64.39cm).

Effect of fertilizers on Number of leaves of rice

The number of leaves from 4weeks to 14weeks after planting in Table 3 is not statistically affected for all treatment means at 0.05 probability level of significance. However, from observations using the raw data collected from the plot, the highest number of leaves was obtained from the plot treated with poultry manure at 4 -10weeks after planting with a mean range of 9.33 - 45.92, followed by spent mushroom substrate (8.58 - 44.42), and NPK 15:15:15 (8.25 - 41.4) while control had mean range value of 8.08 -32.92 but at 12 weeks and 14 weeks after planting, spent mushroom substrate increased with the highest mean number of leaves followed by poultry manure, NPK 15:15:15 and then control.

Effect of fertilizers on Number of tillers of rice

The number of tillers as shown in Table 4 shows that there is no statistically significant difference for all treatments means at 0.05 probability level of significance at 4weeks, 6 weeks, 8weeks and 10 weeks after planting, but at 12weeks and 14 weeks after planting, there were significant($P<0.05$) difference among treatment means. Nevertheless, from observations using the raw data collected from the plot, the highest number of tillers was obtained from the plot treated with poultry manure at 4-10weeks after planting with a mean range of 2.33 - 11.75, followed by spent mushroom substrate (2.08-10.25), and NPK 15:15:15 (1.92-10.17) but the control had the mean range of 2.00 - 8.17at 12 weeks and 14 weeks afterplanting, but spent mushroom substrate had the highest mean number of tillers followed by NPK 15:15:15, poultry manure and then control.

Effects of fertilizers on the growth and yield of upland rice Variety in southern Nigeria**.** organic

Chemical properties	Materials		
	Soil	poultry manure	Spent mushroom substrate
pH	5.2	7.1	6.4
N(%)	0.08	4.8	1.74
P(mg/kg)	18.6	9.7	1.73
K(cmol/kg)	0.08	1.8	2.26
Mg(mg/dl)	2.21	2.01	1.94
Ca(mmol/l)	1.72	2.31	1.95
Organic matter (%)	3.5		

Effect of fertilizers on Leaf Area (cm^2)

The effects of fertilizers on leaf area are in Table 5 and it showed that the leaf area at 4weeks, 8weeks, 12 weeks and 14weeks after planting, is statistically significant for all treatment means at 0.05 probability level of significancewhile at 6weeks and 10weeks there were no significant difference among treatments. However, from observations using the raw data collected from the plot, the highest leaf area was obtained from the plot treated with poultry manure at 4 - 14weeks after planting with a mean range of 12.74 - 49.65cm^2, followed by spent mushroom substrate (9.73 - 49.08cm^2), and NPK 15:15:15 (8.74 - 36.33cm^2) while control had the mean range of 9.52 - 28.35cm^2.

Table 2: Effect of fertilizers on plant height

TREATMENTS	LEAF AREA (cm^2)				
4WAP	6WAP	8WAP	10WAP	12WAP	14WAP
CONTROL 28.78	40.55	46.20	51.12	53.79	64.39
NPK15:15:15 30.11	42.54	47.67	57.39	60.82	70.32
SMS31.19	45.53	52.01	57.39	67.01	75.89
PM36.02	46.23	53.62	60.4	66.68	79.36
LSD(0.05) 7.03	8.39	10.69	52		

Table 3: Effect of fertilizers on number of leaves

TREATMENTS	NUMBER OF LEAVES				
4WAP	6WA	8WAP	10WAP	12WAP	14WAP
CONTRO 8.08	14.17	22.42	32.92	45.00	54.58
NPK15:15:15 8.25	17.25	26.42	41.4	55.75	65.33
SMS 8.58	15.67	25.75	44.42	73.25	85.6
PM 9.33	17.33	27.92	45.92	64.67	66.25
LSD (0.05) 3.26	7.78	13.35	20.97	39.54	21.02

Table 4: Effect of fertilizers on number of tillers

TREATMENTS	NUMBER OF TILLERS				
4WAP	6WAP	8WAP	10WAP	12WAP	14WAP
CONTROL 2.00	3.50	5.17	8.17	9.33	10.92
NPK15:15:15 1.92	4.50	5.92	10.17	11.67	13.25
SMS2.08	4.17	5.75	10.25	12.25	14.08
PM2.33	4.83	7.00	11.75	11.75	12.42
LSD (0.05)	1.04	2.61			

Effect of fertilizers on Leaf area index (cm^2)

Table 6 showed that the leaf area index at 4weeks, 6 weeks, 8weeks and 10 weeks after planting is not statistically significant for all treatment means at 0.05 probability level of significance but was statistically different at 12weeks and 14 weeks after planting. However, from observations using the raw data collected from the plot, the highest leaf area index was obtained from the plot treated with poultry manure at 4-8weeks after planting with a mean range (0.11-0.67cm^2), followed by spent mushroom substrate (0.08-0.58cm^2), followed by NPK 15:15:15 (0.07-0.56cm^2) and then control which has the mean range (0.07-0.69cm^2) and at 12 weeks and 14 weeks after planting, spent mushroom substrate increased with the highest mean in number of leaves followed by poultry manure, NPK 15:15:15 and then control.

Yield Parameters

The effect of NPK 15:15:15, spent mushroom and poultry manure on panicle weight, panicle yield, fresh and dry weight of tillers, weight of grains and 1000 grain weight is represented in Table 7. From the first week after planting till end of harvest, the P-value is greater than ᾱ (0.05) for panicle length, 1000 grain weight, fresh and dry weight of straw which implies that the test is not statistically significant for all treatment means at 0.05 probability level of significance. However, from observations using the raw data collected from the plot, the highest panicle length (cm), was obtained from the plot treated with poultry manure at 14 weeks after planting, followed by spent mushroom substrate, and NPK 15:15:15 before control. Also, there were significant difference in the treatments means for panicle weight (g), although the highest weight was obtained from the plot treated with poultry manure followed by spent mushroom substrate, and NPK 15:15:15 before control. The 1000 Grain weight from the same Table 7 showed that the P-value is greater than ᾱ (0.05) which implies that the test is not statistically significant for all treatment means at 0.05 probability level of

significance. However, from observations using the raw data collected from the plot, the highest 1000 grain we Orluchukwu J.A. and Kari L.B. ated with pou ting, followed by spent mushroom substrate, followed by substrate, followed by NPK 15:15:15 and then control.

Also, from the same Table 7, the fresh and dry weight of tillers after harvest showed that the P-value is greater than ᾱ (0.05) which implies that the test is not statistically significant for all treatment means at 0.05 probability level of significance. But the raw data collected from the plot, the highest fresh and dry weight of tillers (Kg) was obtained from the plot treated with poultry manure at 4-14 weeks after planting, followed by NPK 15:15:15, spent mushroom substrate and then control. Whereas the grain yield was statistically significant in the treatment means with poultry manure having the highest grain yield when compared to control.

DISCUSSION

The result obtained from the soil analysis indicates that the soil had the pH of 5.2 implying that the soil is acidic and is below the pH range of 5.5-6.5 that is required for maximum availability of nutrient and support optimum plant growth (Stewart, 2006). The total nitrogen in the soil is low which is below the critical level of 0.15% (FDALR, 2004) and this could be attributed to mineralization and leaching effect caused by intensive rainfall in this part of the country. The soil had a high organic matter content of 3.5% as against the critical value of 2% as reported by (Loveland and Webb, 2003) which could be attributed to bush fallowing and crop residues. The available phosphorus was higher with the value of 18.6 compared with the critical value of 15mg/kg reported by Ibedu*et al.,* 1988, thus phosphorus was soluble and available for plant use. The soil had a high calcium content of 1.72cmol/kg when compared to the critical value of 0.5cmol/kg, potassium was low as against the critical value of 0.20cmol/kg and magnesium had a high content of NPK 15:15:15 and then control. Also, there was no significant difference in the treatments
means for panicle weight (g), although the highest weight was obtained from the plot treated with poultry manure followed by spent mushroom
2.21 when compared to the critical value of 0.30cmol/kg according to Ibedu*et al.,*1988. The chemical properties of the organic material before planting shows that pH of poultry manure and spent mushroom substrate were close to neutral and poultry manure had higher content of nitrogen, phosphorus, magnesium, calcium than spent mushroom substrate while spent mushroom substrate was higher in potassium than poultry manure. Addition of different fertilizers (organic and inorganic) significantly increased plant height, number of leaves, number of tillers, leaf area when compared to control. The nutrients available in the various fertilizers used enhanced the plant height and leaf area which resulted in higher assimilates and dry matter accumulation as supported by the earlier findings of Swarup and Yaduvanshi (2000) and Yadana*et al., (*2009).

The application of organic fertilizers increases plant height, number of tillers, number of leaves, leaf area. As indicated, poultry manure increased plant height, number of tillers in comparison with other fertilizers which may be attributed to greater availability of nutrients as stated by Sivakumar*et al.,* (2007) and Nguyen *et al.,* (2004). Availability of nutrient from organic sources is due to microbial action and improves soil physical condition as stated by Sarkar *et al.,* (2004). The variation in number of leaves is attributed to the variation in the availability of major nutrients as Yadana*et al.,* (2009) reported similar results with the application of organic manure and compost in rice. Rice panicle weight and grain yield was also significantly different among the various treatments. These observations obviously are due to the availability of more nutrients following the application of soil amendment treatment relative to the control treatment.

Table 5: Effect of fertilizers on leaf area

TREATMENTS	LEAF AREA (cm^2)					
4WAP	6WAP	8WAP	10WAP	12WAP	14WAP	
CONTROL9.52	14.09	18.92	22.90	22.29	28.35	
NPK15:15:158.74	17.10	21.32	26. 95	26.76	36.33	
SMS 9.73	17.85	24.76	33.91	33.63	49.08	
PM 12.74	19.30	26.26	32.21	33.80	49.65	
LSD (0.05)4.03	4.94	7.81	10.53	8.97	5.73	

Table 6: Effect of fertilizers on leaf areaIndex

TREATMENTS		LEAF AREA INDEX (cm^2)				
4WAP	6WAP	8WAP	10WAP	12WAP	14WAP	
CONTROL0.07	0.19	0.39	0.69	1.40	1.39	
NPK15:15:150.07	0.28	0.56	1.09	1.40	2.21	
SMS 0.08	0.25	0.58	1.39	2.64	3.38	
PM 0.11	0.30	0.67	1.34	1.97	2.96	
LSD (0.05) 0.05	0.17	0.41	0.85	1.38	1.49	

Dhanasekaran and Govindasamy (2002) reported that the availability of nutrients during reproductive stage resulted in better grain filling and as a result grain weight is increased hence the significant increase in 1000 grain weight by the addition of fertilizers compared to control, and with poultry manure as the highest in 1000 grain weight followed by spent mushroom substrate and NPK. The plot treated with poultry manure had a higher growth and yield when compared to spent mushroom substrate which is probably due to poultry manure which was richer in nutrient (Umanah*et al.,* 2009). The best growth and yield characteristics were obtained from the plots treated with poultry manure which is in accordance with similar result findings of Orluchukwu and Adedokun (2014) who reported higher growth and yield in pineapples treated with poultry manure over those treated with spent mushroom substrate. Also, Orluchukwu and Okosa (2018a) reported higher growth and yield in okra treated with poultry manure over those treated with spent mushroom substrate. In conclusion, the result of the study shows that the rice variety responded positively to the various treatment applications. The highest plant height, number of tillers, leaf area, grain and 100 grain yield, panicle length and weight and also the fresh and dry weight of straws were found in poultry manure, while the Spent mushroom had the highest number of leaves, and the lowest values were obtained from control treatment**.**

Table 7: Effect of fertilizers on Yield parameters

TREATMENTS	Panicle length(cm)	Panicle weight(g)	Grain weight(g)	1000 Grain weight(g)	Fresh weight ofstraw(Kg)	Dry weight ofstraw(kg)
CONTROL	21.73	25.52	33.38	6.75	1.38	0.78
NPK15:15:15	22.41	32.38	54.70	6.75	1.63	1.05
SMS	22.47	34.42	62.20	7.500	1.38	1.00
PM	23.72	50.02	90.90	8.500	2.25	1.43
LSD (0.05)	2.82	23.13	40.52	2.33	1.09	0.91

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