EFFECTS OF SPACING ON GROWTH, YIELD AND WEED SUPPRESSION OF RICE VARIETY IN SOUTH-SOUTH, NIGERIA.

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Abstract: This study on the effects of spacing on growth, yield and weed suppression of rice variety in Port Harcourt was conducted at the Faculty of Agriculture Teaching and Research Farm, University of Port Harcourt. Experimental design used was Randomized complete block design (RCBD) with four treatments (15cm x 15cm, 20cm x 20cm, 25cm x 25cm and 30cm x 30cm) and replicated four times. Data were collected on growth parameters such as plant height, leaf area, numbers of leaves, numbers of tillers, while yield parameters were on weight of grains, weight of panicles, weight of fresh tillers, weight of dry tillers and number of panicles at harvest. Weed parameters were also taken. The result of the study showed that a spacing of 25cm x 25cm had a higher growth rate of 114.70cm and yield of 302.70kg/ha compared to narrow row spacing of 15cm x 15cm which had 102.70cm and 220.33kg/ha respectively. The result also showed that significant differences were observed on weight of panicles, weight of fresh tillers, weight of dry tillers and weight of grains. Therefore, farmers are advised to use spacing of 25cm x 25cm for optimum yield and growth of the rice variety; and weed suppression was better in narrow spacing of 15cm x 15cm in the study area.

Keywords: Spacing, Growth, Yield, Weed suppression, Rice variety.

INTRODUCTION

Rice *(Oryza sativa* L.) is an annual cereal grain belonging to the family of Poaceae. It is one of the three major food crops of the world and forms the staple food for over half of the world's population and it is the most important food crops for the world's population, especially in South Africa, Asia, Middle East, Latin America and West India (Zhao *et al*., 2011). The total area of the world rice production coverage is estimated for 161.53 million hectares and an annual average yield was 481.14 million metric tons (Food and Agricultural Organization - FAO, 2016)

Nigeria is the largest rice producer in the West African region with a relatively higher comparative advantage than other countries of the region (Nwanze *et al,* 2006). About 83% of domestic rice output is produced in the northern part of the country while the south accounts for the remaining 17% (National Bureau of Statistics [NBS], 2007). Nigeria's rice consumption has increased over the last decade (6 – 7% per annum) and is now estimated at 6 million metric tonnes annually and the total retail market value for rice in Nigeria is $3.6bn (Federal Ministry of Agriculture and Rural Development [FMARD], 2012). The growing demand for rice consumption in Nigeria concurrently presents a food security challenge and an economic opportunity for the country. Currently, one third (2 million MT) of Nigeria's rice demand is being met by importation, mainly due to low productivity as a result of pest such as weed.

Weeds are a major constraint to increased rice production and farmers spend many hours' hoe-weeding (Akobundu, 1987); and this puts more strain on labour which is scarce as reported by Tollens (2006). Weeds interfere with rice growth and development by reducing the light intensity, nutrient, water, CO_2 and compete with crop for space; secrete toxic exudates into the soil that depress growth and development of rice (Tollens, 2006).

Oerke and Dehne (2004), affirmed that weeds are estimated to account for 32% of potential and 9% of actual yield losses in rice. Rodenburg *et al.* (2009) pointed out that uncontrolled weed growth is reported to cause yield losses in the range of 28–74% in transplanted lowland rice. Throughout Africa, weeds are cited among the main production constraints in any of the rice producing agro-ecosystems (Adesina *et al.,* 1994; Diallo and Johnson, 1997).

The limited increase in production of rice is due to ineffective weed control for which it is imperative that an effective weed control mechanism and its effective adoption result in better productivity and leading to increase of net rice production (Pender *et al.,* 2004). The occurrence of weeds as constant component of the ecosystem compared to the epidemic nature of other agricultural pests makes farmers unaware of the significant losses, they incur from weed infestation. Weed according to Pender *et al.* (2004) is one of the greatest bottle necks to increased yields and quality of rice.

In view of the high rising population of humans and increase in animal farming which rice husk can serve as a vital source of nutrient to them in South-south part of Nigeria, the demand of rice which is a staple food and consumed largely by the population has increased. Again, the close of the Nigeria border which has led to decrease in rice quantity thereby, causing a decline in the rate of supply and consumption of rice which led to an increased cost and demand of rice in the study area are not exempted. Climatic condition of the South – south (high rainfall) also encourages the growth of weeds which tends to compete with crops grown in farms in the area especially in Port Harcourt, Rivers State. This has led to the quest for the effects of spacing of rice variety on growth, yield and weed suppression in the study area. Therefore, the objective of the study is to ascertain the effects of spacing on growth, yield and weed suppression of rice variety in Port Harcourt, Rivers State, South-south area of Nigeria.

MATERIALS AND METHODS

Experimental site

This study was carried out at the Faculty of Agriculture Research and Teaching Farm, University of Port Harcourt, Rivers State Nigeria, 2021. The experimental site is located between latitude 40^{o} 31N to 5^{0} 00N and longitude 6° 45" E to 7°E, with an average temperature of 27°C, relative humidity of 78% and average rainfall that ranges from 2500 - 4000mm (Nwankwo and Ehirim, 2010.

Experimental design and field preparation

On experimental design, a Randomized Complete Block Design (RCBD) was used, covering a total land area of 12m by 30m ($360m^2$ – 0.036ha) with a bed size of 3m by 3m and 4 treatments. The total bed for this experiment was 32 (4 replicates and 4 treatments) and an alley way of 0.5m by 1m. The conventional land preparation method was used which was the manual clearing of the land with the use of hoes, shovels and cutlass. Beds with a height of 30cm and size of 3m by 3m were raised to conserve soil and its nutrients. A rice variety (UPIA 3) was sourced from the Faculty of Agriculture Research and Teaching farm, University of Port Harcourt.

Soil Sample Collection and Treatments

Soil sample were collected from the experimental field using soil auger before clearing of the site for analysis. The following soil parameters, Nitrogen, phosphorus, calcium, Potassium, Sodium, Magnesium, Soil pH, Total Organic Carbon, Total Organic Matter were analyzed in the laboratory.

The treatments used were planting spaces of 30cm by 30cm, 25cm by 25cm, 20cm by 20cm and 15cm by 15cm. Planting was done manually using two seeds per hole at a depth of 3cm with a spacing of 30cm by 30cm with a total of 100 stands and 200 seeds on a 3m × 3m bed size, 25cm by 25cm with a total of 168 stands and 336 seeds on a 3m × 3m bed size, 20cm by 20cm with a total of 240 stands and 480 seeds on a 3m× 3m bed size and 15cm by 15cm with a total of 342 stands and 684 seeds on a 3m × 3m bed size.

Data collection

Data collection started at 4 weeks after planting and thereafter at 2 weeks' intervals in respect to growth, weed and yield parameters. The parameters taken were on Plant height (cm), Leaf area (cm), Number of leaves per plant, Number of tillers, Fresh weight, Dry weight, Weight of tillers, Weight of panicles, Grain yield, and on Weed parameters.

On Plant height**,** the height of the plant from the ground level to the tip of the longest leaf was achieved by measuring with a graduated meter rule, while the leaf area was determined using the formular: LA = a x (L x W), where LA is leaf area (cm^2)**,** L is leaf length (cm)**,** W is the largest leaf blade with (cm)**,** a is the angular coefficient or the slope of the linear regression (Fagundes *et al* 2009, Richter *et al.* 2014, Schwab *et al.* 2014)

The Number of leaves per plant was determined by counting the number of leaves on the plant at two weeks' interval starting from 4WAP, whereas the number of tillers was determined by counting the number of tillers from selected stands at two weeks' interval starting from 4WAP.

The fresh weight of weeds was collected using the quadrat and the weeds collected were weighed using weighing scale before sun drying at a temperature of 30^0C to 35^0C. The dry weight of weeds was also collected after drying.
On yield parameters, the weight of tillers was taken fresh and dried. The fresh weight was gotten by cutting the tillers from the base of the plant and weighed. The tillers were sun dried for two weeks and dry weights were taken. The weight of panicle was taken after threshing. The panicles were sun dried and weighed using the sensitive weighing balance.

The grains were weighed after threshing. This was done by removing the grains from the panicles and then weighed using a sensitive weighing scale. Weeding was done manually with the use of hole and hand picking at six weeks after planting. The weeding was carried out after taken the weed score, using quadrat of 1m x 1m and after classifying them into broad and narrow weeds.

Statistical Analysis: The data generated from this experiment were subjected to Analysis of variance (ANOVA) using Gen Stat version 12.1 (2009). The Least Significant difference (LSD) of the means was determined at 5% probability.

RESULTS

Physiochemical properties of the experimental site before planting

The physicochemical properties of the experimental site for the study area before planting are presented in Table 1. The result showed that the soil properties of this site for sand were placed at 92.40%, silt (3.15%), and clay (1.10%). The result also shows that the chemical characteristics of this study area site for pH was 4.69, Organic carbon (1.35), organic matter (2.6), total nitrogen (0.08), available Phosphorus (17.50mg/kg), Calcium (2.00), magnesium, (0.20), sodium (0.05) and potassium (0.13).

Table 1: Physiochemical properties of the experimental site before planting

Soil properties	Value
Physical characteristics	
Sand (%)	92.40
Silt (%)	3.15
Clay (%)	1.10
Textural class	Sandy
Chemical characteristics	
pH(H_20)	4.69
Organic carbon	1.35
Organic matter	2.6
Total nitrogen (%)	0.08
Available P (mg/kg)	17.50
Exchangeable Calcium (cmol/kg)	2.00
Exchangeable Magnesium (cmol/kg)	0.20
Exchangeable Sodium (cmol/kg)	0.05
Exchangeable Potassium (cmol/kg)	0.13

Effects of crop spacing on plant heights of rice variety

The Table 2 illustrates the effects of crop spacing on plant height at 4 to 12 weeks after planting for the rice plant. The result showed that there was significant effect at treatment 15cm x 15cm at 4WAP (26.38), 6WAP (42.47), 8 WAP (61.81), 10WAP (89.63) and 12 WAP (102.7).

The table further shows that at 20cm x 20cm there was significant difference at 4WAP compared to other weeks of the treatment spacing. This was also the same trend in other treatment spacing.

Table 2. Effects of crop spacing on plant height (cm) of rice variety

Treatment	4 WAP	6 WAP	8 WAP	10 WAP	12 WAP
15 x 15cm	26.38^{a}	42.47^{b}	61.81^{b}	89.63^{b}	102.7^{b}
20 x 20cm	26.10^{a}	44.75a^{b}	65.31^{ab}	90.31^{b}	102.8^{b}
25 x 25cm	29.71^{a}	51.91^{a}	71.51^{ab}	101.21^{b}	114.7^{b}
30 x 30cm	27.38^{a}	48.22^{ab}	68.05^{b}	85.89^{b}	96.4^{b}
LSD (0.05)	5.307	7.91	7.55	8.38	8.59

Effects of crop spacing on Number of leaves of rice variety

The effect of crop spacing on number of leaves of rice variety is illustrated in Table 3. The result showed that at spacing of 15cm x 15cm, the number of leaves at 4WAP (5.88), 6WAP (19.62), 8WAP (33.62), 10WAP (52.88) and 12WAP (63.6) were all affected significantly. At treatment spacing of 20cm x 20cm, the result showed that 4WAP (5.88) was significantly different compared to other weeks. This was same in other treatment spacing as the weeks showed significant differences.

Table 3: Effects of crop spacing on Number of leaves of rice variety

Treatment	4 WAP	6 WAP	8 WAP	10 WAP	12 WAP
15 x 15cm	5.88a	19.62ab	33.62ab	52.88b	63.62b
20 x 20cm	5.88a	17.25b	37.38b	60.25b	72.88b
25 x 25cm	7.56 a	27.19a	53.56a	84.31 ab	100.12 ab
30 x 30cm	7.25 a	21.19ab	44.81ab	77.00 a	95.19 a
LSD (0.05)	2.105	7.23	12.44	14.59	15.89

Effects of crop spacing on leaf area of rice variety

The Table 4 illustrates effects of crop spacing on leaf area of rice variety. The result at spacing treatment of 15cm x 15cm showed that at 4WAP, the plant leaf area was 12.95cm^2, at 6WAP, it was 30.69cm^2, while at 8WAP, 10 WAP and 12 WAP it was 92.0cm^2, 48.23cm^2 and 115.7cm^2 respectively, and they were significantly affected. This trend followed in other treatment spacing where all the weeks were significantly affected.

Table 4: Effects of crop spacing on leaf area (cm^2) of rice variety

Treatment	4 WAP	6 WAP	8 WAP	10 WAP	12 WAP
15 x 15cm	12.95[a]	30.69 [ab]	48.23[b]	92.0[b]	115.7[bc]
20 x 20cm	11.56 [a]	26.35[b]	44.33[b]	123.9 [a]	138.8[ab]
25 x 25cm	16.46 [a]	36.69 [a]	65.15 [a]	117.8 [a]	153.1[a]
30 x 30cm	13.43 [a]	32.49[ab]	56.24[ab]	89.1[b]	109.5[c]
LSD (0.05)	5.137	8.51	13.85	21.85	24.80

Effects of crop spacing on number of tillers of rice variety

In Table 5, the effect of crop spacing on number of tillers of rice variety was shown. The result indicates that at spacing treatment of 15cm x 15cm, at 12 WAP (18.31), there was significant effect on number of tillers compared to that of 4 WAP (0.56), 6 WAP (3.38), 8 WAP (6.88) and 10 WAP (14.56). A similar trend was observed with other weeks across the treatments (20cm x 20cm and 25cm x 25 cm). But no significant difference was observed in treatment spacing of 30cm x 30cm at 4WAP (0.63), 6WAP (4.63), 8WAP (10.13) and 10 WAP (19.06), except at 12 WAP (23.75) which was significantly different.

Table 5: Effects of crop spacing on number of tillers of rice variety

Treatment	4 WAP	6 WAP	8 WAP	10 WAP	12 WAP
15 X 15cm	0.56[ab]	3.38[b]	6.88[b]	14.56[b]	18.31[a]
20 x 20cm	0.31[b]	3.00[b]	8.50[b]	16.50[ab]	20.50[a]
25 x 25cm	1.13 a	5.38a	12.13[a]	20.50[a]	24.88[a]
30 x30cm	0.63 [ab]	4.63[ab]	10.13[ab]	19.06[ab]	23.75[a]
LSD (0.05)	0.616	1.772	3.254	5.285	6.57

Fresh weight of weeds

The results obtained for fresh weight of weeds is indicated in Table 6. From the results there is no significant effect at spacing treatment of 15cm x 15cm and treatment at 20cm x 20cm, while in the results obtained from the plants broad leaf (7.40g) and grasses (2.37g) at treatment 20cm x 20cm, the result showed that there was significant difference (14.01g) compared to that of the plants grasses (2.70g). At spacing treatment 25cm x 25cm, the broad leaf (15.94g) was significantly affected compared to that of the grasses (2.22g). The treatment spacing of 30cm x 30cm for the broad leaf (12.88g) followed the same trend as the spacing treatment of 20cm x 20cm and 25cm x 25cm. On dry weight of weeds, the result showed that no significant effect was observed at spacing treatment of 15cm x 15cm for broad leaf (2.97g) with other spacing treatments, however, grasses for the plant dry weight of weeds show the same no significant effect with all the spacing treatments.

Table 6: Fresh and Dry weight of weeds (g)

Treatment	Fresh weight of weeds		Dry weight of weeds	
	Broad leaves	Grasses	Broad leaves	Grasses
15 x 15cm	7.40	2.37	2.97	1.02
20 x 20cm	14.01	2.70	2.51	0.44
25 x 25cm	15.94	2.22	2.78	0.69
30 x 30cm	12.88	1.34	2.81	0.77
LSD (p = 0.05)	3.281	1.044	0.777	0.369

Effects of treatments on yield parameters of rice plants

In Table 7 the yield parameters on fresh weight of tillers, dry weight of tillers, number of panicles weight of panicles and weight of grains are shown. The result showed that at spacing of 15 x 15cm, the fresh weight of tillers (7250 kg/ha), dry weight of tillers (3194.4 kg/ha), number of panicles (160888.9/ha), weight of panicles (46.28 kg/ha) and weight of grains (220.33 kg/ha) had significant effects on other spacing treatments of 20cm x 20cm, 25cm x 25cm, and 30cm x 30cm.

Table 7: Effects of treatments on Yield parameters of rice plants

Treatments (cm)	Fresh weight of tillers (kg/ha)	Dry weight of tillers (kg/ha)	Number of panicles per ha	Weight of panicles (kg/ha)	Weight of grains (kg/ha)
15 x 15	7250	3194.4	160888.9	46.28	220.33
20 x 20	5138.9	2277.8	119444.4	33.03	148.11
25 x 25	6805.6	3055.6	220222.2	57.42	302.70
30 x 30	5000	2361.1	183555.6	48.25	272.44
LSD (p = 0.05)	3.689	1.683	84.5	21.57	179.5

DISCUSSION

This study revealed that there were significant differences observed on the effects of spacing the rice plant variety on growth, yield and weed Suppression. This finding compared favorably with the result obtained by Adigun *et al.* (2020) where it was observed that high growth and yield was observed with reduction in narrow row spacing compared to wide row spacing in their study which is in line with this present study. The effect of spacing on this crop could be due to a better use of resources (moisture, light and nutrient) for crop growth and yield at narrow spacing compared to wide row spacing as a result of reduced weed competition. Furthermore, the rapid canopy development at narrow row spacing might have resulted in more light interception per unit leaf area index, thereby increasing photosynthetic rates of the leaves and hence, better growth and development (Zhao *et al.,* 2013). Based on the dry weight of weeds, the results showed a reduction of weed dry weight, early suppression of weeds and better crop stand on the other hand thereby reducing weed population and dry weight of weeds. The results are in agreement with the findings of Mohapatra *et al.* (2012). The weight of dry tiller and weight of panicles in this study were significantly affected. This result obtained compared favorably with the result of Ali *et al.* (2019) where it was discovered that row spacing of 15cm affects number of productive tillers per stand and panicles of rice plants significantly. This present study result shows that spacing has effects on number of leaves and the leaf area of the rice plants. This result agreed with what was obtained by Ali *et al.* (2019) where it was deduced that number of leaves of rice plants significantly increases among different row spacing which occurred at narrow row spacing of 15cm as compared with the wider row spacing of 22.5 cm and 30 cm. The result obtained in this present finding agreed with Akobundu and Ahissou (1985) where it was reported that all rice cultivars competed better with weeds when grown at 15cm and 30cm inter row spacing than at wider spacing. Dejen (2019) observed that plant spacing and number of seedlings increase yield of transplanted rice in terms of tiller, plant height (cm), panicle length (cm) and number of kernel per panicle, coupled with grain yield. The result obtained by the aforementioned researcher aligned with the result obtained in this study where suppression of weeds was obtained which brings about increase in yield, number of tillers and number of leaves. However, the result obtained by Dejen (2019) quite disagreed with this present study where it was pinpointed out from their study that spacing 20cm x 20 cm with 3 seedlings appears as the best combination to obtain maximum grain yield of cultivated rice. The result obtained by Murugesan *et al.* (2020) also disagreed with this present study where it was discovered that there was no significant interaction between different weed management practices on plant height at all plant growth stages of rice. The effect of spacing result on number of tillers of rice plants which have been discussed earlier in this study also conformed to what was obtained by Sen *et al.* (2014) where it was observed that spacing has effect on plant height and number of total tiller. In view of the above findings of these studies, plant spacing played a vital role for the growth and yield of rice. At closer spacing (15cm x 15cm) weed population were lower compared to the wider spacing (30cm x 30cm), hence farmers in the study area are advised to use spacing of 25cm by 25cm for optimum growth and yield of the rice variety planted in the study area.

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