IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Effect Of Planting Density On The Growth And Yield Of Lowland NERICA-L-19 Rice (*Oryza Sativa* L.) In Suakoko, Liberia

Junior S. Kamara[1,2], Joseph Ndebeh[1]

[1]Cuttington University, XCR9+2C9, Suakoko, Bong County, Liberia

[2]Pan African University Life and Earth Sciences Institute, FW73+7JJ, University of Ibadan-Ajibode Road, Ibadan, Oyo State, Nigeria

Authorship contribution

Junior S. Kamara: Data curation, Methodology, Investigation, Formal analysis, Software, Resources Writing - original draft,

Joseph Ndebeh: Conceptualization, Methodology, Visualization, Writing - review & editing, Proofreading Validation

Abstract

Planting density plays a major role in adjusting rice population structure, increasing yield and reducing cost. It has the potential to reduce labor costs, protect the environment, and increase rice quality, resulting in a major regulatory effect on rice growth and population structure, as well as altering basic seeding per unit area. An experiment on the effect of planting density on the growth and yield of Nerica-L-19 was conducted from August to December 2021 in Suakoko, Liberia. The experiment was performed using a randomized complete Block design with three treatments and three replications. Total field size was 56.4 m^2 with each plot in the trial field segmented into 1 m x 2 m plots. Results revealed no significant differences observed for the parameters except the total number of panicles which showed significant differences from the means across different spacing. The plant height was highly correlated to grain weight and number of panicles. Thus, lowland farmers in Suakoko should adopt the 20 cm x 20 cm spacing for optimal yields in NERICA-L-19 leading to lower seed rated to occupy large hectares with the best output.

Keywords Panicle yield, Seed, Vegetative stage, Reproductive growth

Introduction

Rice (*Oryza sativa* L.) is grown on every continent except Antarctica and is the world's most extensively consumed cereal grain, with a unique role in alleviating global famine (Chen et al., 2020). It is the world's most widely consumed food, and it was initially planted some 10,000 years ago in China's middle Yangtze and upper Huai rivers (FAO, 2014). Over a period of 2,000 years, the crop spread along rivers at Non NokTha in Thailand's Korat province. Because of the increase in population, agriculturists and rice specialists worldwide have developed many varieties such as Nerica-L-19 (Matsunami 2015).

Nerica (New Rice for Africa) is a cross-species hybrid rice variety with parents from the high-yielding Asian rice (*Oryza sativa*) and African rice (*Oryza glaberrima*) that possess resistance to main production constraints such as insects, pests, and pathogens across ecologies in Sub-Saharan Africa (SSA) (Peralta et al., 2018). It was developed by the West African Rice Development Association (WARDA), which later became the Africa Rice Centre, with the aim of increasing food security for small-scale farmers who produce rain-fed upland rice (Matsunami, 2015). However, planting density plays an important role in modifying rice population structure, boosting yield, and lowering costs (Saju, 2019).

Adequate planting densities can not only maximize the yield potential of a rice population, resulting in the highest grain output per unit area, but it can also save labor, and high cost, protect the environment, and improve rice quality (Profile, 2018). Planting density can also have a considerable impact on rice growth and population structure, as well as basic seeding per unit area (Ngouajio, 2011). Low seeding density cultivation can give rice an individual advantage in terms of tilling and growth, although less productive ears can have an impact on population structure and yield (Profile, 2018). Furthermore, high seeding density culture increases the number of ears per unit area while increasing individual conflict, resulting in structural instability of ears such as extra spikes, size degradation, and low yield (Saju 2019). Thus, only rational closed planting can fully utilize land capacity while ensuring maximum yield development in terms of spike number, sizes, and weights. Rice, particularly NERICA19, can efficiently utilize light energy, resulting in increased rice yield (Saju 2019).

Liberia is a tropical country with excellent soil in practically every area, yet local rice farmers in the country are unaware of the impact of planting density on rice growth and output (Huang et al., 2017). As a result, these farmers use large farming resources and gain minimum yield. Additionally, there has been little research on the influence of planting density on rice growth and yield, resulting in low rice production and an increase in the price of imported rice within the country. This research attempts to provide information on the effect of planting density on the growth and yield of rice and determine the maximum yield of rice caused by optimum planting density. The obtained results offer valuable information for further investigations aiming to improve rice production and yield.

Materials and methods

Experimental site and design

The study was conducted at the experimental site of Cuttington University, Liberia. The experimental station had latosols soil type with a PH of 5.5 and the temperature ranges from 65°F to 85°F. It was laid out in a randomized complete block design (RCBD) with three blocks and three replications. The total area of the experiment was 56.4 m^2 with the length, width, and walkway of 7.8 m, 7.2 m, and 0.6 m respectively. Three planting densities (15 cm x 15 cm, 15 cm x 20 cm, and 20 cm x 20 cm) were used in rows and columns. The number of plants in each plot depended on the planting densities.

Seed treatment and seeding nursery

Seeds were collected from the Central Agriculture Research Institute of Liberia. The selected seeds were rinsed and disinfected with sodium hypochlorite (bleach) in four (4) times dilution (2ml in 100ml of H2O) for 15 minutes each time. The selected and disinfected seeds were oven-dried by placing the seeds on a baking sheet and drying them in the oven at a low temperature of 60 ^{0}c for 4 hours. The seeds were placed on a wet paper towel for pre-germination. The pre-germinated seeds were sown in seeding boxes 40 cm x 40 cm) at the rate of 80 gm per box. The seeding boxes were brooded for 48 hours for uniform germination. Then, the seedings were raised at the Central Agriculture Research Institute's nursery for about 21 days before transplanting.

Fertilizer application

Prior to planting, all plots were fertilized with NPK 15-15-15. The NPK 15-15-15 fertilizer was applied at the rate of 0.3557 kg per block 15 days after planting with additional NPK at 0.025 kg per block 4 weeks after planting. All agronomy practices were performed according to standard procedures.

Field management

The experimental site was manually prepared and hand weeding was done when necessary to control weeds during the growing period. Water management, disease, and insect control, and other agronomy management recommendations were applied based on Central Agriculture and Research Institute of Liberia standards.

Data collection and statistical analysis

Data were obtained on the following parameters prior to harvesting: plant heights, number of panicles, number of spikelets, number of tillers, and grain weights. These data were analyzed using SAS software at α 0.05 to determine the analysis of the variance, recognize the significance value between the treatment means, and determine the coefficient variance percentages (CV%). The sample selection of the experiment was done randomly from each of the nine plots within the experimental field.

Results

The results of plant height, number of panicles, spikelets, tillers, and grain weight could be presented as follows:

The analysis of the variance presented in Table 2 illustrates that there were no significant differences amongst the growth and yield parameters except the panicle which had significant ($P<0.05$) differences among treatment. Based on the ANOVA table below (T_1), the replication was not significant in this experiment. The highest (15.44) panicle were observed in Density three (3) (20 by 20) while the least panicle were observed in density two (2) (15 x 20).

Table1.0

Sum of squares of the analysis of variance for the height, number of tillers, spikelets, panicles grain weight, and 1000 grain weight.

Source of Variation	DF	Height	Tillers	Spikelets	Panicles	Grain weight	1000 g Weight
Treatments	2	338.29	12.44	0.78	15.44*	8282.47	1.27
Replications	2	142.24	2.11	1.44	2.11	2532.17	2.27
Error	6	144.88	3.11	2.28	2.11	13764.15	1.10
R^{-} Square		0.62	0.70	0.33	0.81	0.28	0.62

**= significant at 1% level of probability. NS= Not significant;

Table 2

The table (T_2) below shows the means separation for the growth and yield parameters of this research. However, from the analysis, the treatment were not significant for the growth and yield parameters but the highest mean for Height (80.17), Tillers (12.00), Spikelets (11.33), Panicles (10.33), Grain weight (333.63) and 1000g weight (32.33) were observed in density three (20 by 20).

In a column, figures with same letter do not differ significantly whereas figures with dissimilar letters differ significantly as (DMRT)

Table 2

Mean separation for growth and yield Parameters.

Trt	Height (cm)	Tillers	Spiklets	Panicles	Grain weight (g)	1000 g Weight
Density1	63.50[a]	9.33[a]	11.67 [a]	7.00[ab]	247.33 [a]	32.97 [a]
Density2	60.43[a]	8.00[a]	12.33 [a]	6.00 [b]	245.93 [a]	31.67 [a]
Density3	80.17 [a]	12.00[a]	11.33 [a]	10.33 [a]	337.63 [a]	32.33 [a]

Table3

The table below is showing the Pearson Correlation Coefficients of the growth and yield parameters, N = 9 Prob > |r| under H0: Rho=0

The correlation analysis reviled that there was a strong positive correlation between plant height and number of tillers (0.72**), number of tiller and panicles (0.67**), and between tillers and the grain weight (0.69**). As for the other variables, there was no significant correlation between the variables.

**= significant at 1% level of probability. NS= Not significant;

Pearson Correlation Coefficients of the growth and yield parameters, N = 9 Prob > |r| under H0: Rho=0

	Height	Tillers	Spikelets	Panicles	Grain weight
Tillers	**0.72****				
Spikelets	-0.18	-0.23			
Panicles	0.59	**0.67****	-0.31		
G. weight	0.30	**0.69****	-0.33	0.35	
1000gweight	0.48	0.62	0.13	0.12	0.45

Discussion

Even though the significance levels were modest, it was obvious from the analysis that density three (20cmx20cm) had the best results. The height of the plants differed from one spacing to the next. However, the best height was observed at density three, showing that if rice is allowed ample planting space, it will be free of competition for nutrients, water, and sunlight, allowing farmers to achieve the best height in their fields. Individual tilling is encouraged by good spacing, which increases panicle rate and the quantity of productive tillers. Furthermore, planting density has an impact on the length of each rice growth period. The lower the planting density, the longer the spike differentiation, blooming time, and overall growth period. Blade counts per plant, blade length, and leaf falling angle all increase as planting density decreases. Additionally, the maximum number of panicle was found in density three, implying that farmers can get the best yield in their fields if proper spacing is observed in their farms, as panicle number is a crucial component of rice output. This experiment concluded that a planting density of 20cm x 20cm performed better than density levels of 15cm x 15cm and 15cm x 20cm during this study. As a result, the standard density three (20 cm x 20 cm) is required for the best yield. It allows the rice to be free of competition for nutrients, water, and sunlight, among other things.

Statements and Declarations

Conflict of interest: The authors declare that they have no conflicts of interest.

Acknowledgments

The authors thank Kollie Topkah of Manchester University, Manchester, England for his assistance in the study. The support of the Cuttington University and the Pan African University Life and Earth Sciences Institute (including Health and Agriculture), Ibadan, Nigeria is appreciated.

References

Gumma M, N. (n.d.). *Rice Almance*.

Kinyumu, D. M. (n.d.). *Comparative Study on the Growth and Yield of NERICA Cultivated with Organic and Inorganic Fertilizers : Participatory On-Farm Research at Marakwet District in Kenya*. *1*.

Matsunami, M., Matsunami, T., & Kokubun, M. (2015). *Growth and Yield of New Rice for Africa (NERICAs) under Different Ecosystems and Nitrogen Levels Growth and Yield of New Rice for Africa (NERICAs) under Different Ecosystems and Nitrogen Levels*. *1008*. https://doi.org/10.1626/pps.12.381

Meertens, H. C. C., Ndege, L. J., & Lupeja, P. M. (1999). The cultivation of rainfed, lowland rice in Sukumaland, Tanzania. *Agriculture, Ecosystems and Environment*, *76*(1), 31–45. https://doi.org/10.1016/S0167-8809(99)00073-0

Nakamura, T. (2010), & Sokei, Y., A. (2010). *GUIDE for NERICA*.

Profile, S. E. E. (2018). *Effect of planting density on yield and yield attributes of local aromatic rice varieties*. *September*. https://doi.org/10.3329/bjar.v43i3.38395

Rice Almanac. (n.d.).

Saju, S. M., Thavaprakaash, N., Sakthivel, N., & Malathi, P. (2019). *Influence of high density planting on growth and yield of rice (Oryza sativa L .) under modified system of rice intensification*. *8*(3), 3376–3380.

Singbo, A. G., & Lansink, A. O. (2010). Lowland farming system inefficiency in Benin (West Africa): Directional distance function and truncated bootstrap approach. *Food Security*, *2*(4), 367–382. https://doi.org/10.1007/s12571-010-0086-z

Veluw, K. Van. (2018). *Master Thesis Productivity of different rice production systems in plot and field scales ; an economic approach . Farming Systems Ecology*. *February*.