THE EFFECTS OF ROW SPACING ON THE GROWTH AND YIELD OF RICE (o. sativa and o. glaberrima) IN MUBI ADAMAWA STATE

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Abstract

This study is aimed at determining the performance and yielding capacity of two distinct rice varieties under different levels of spacing in Nigeria. Two field experiments were conducted during the rainy seasons of 2008 and 2009 to study the effects of row spacing on the growth and yield of two varieties of rice in Mubi, Adamawa State. The experiments were carried out at the research farm of Agricultural Technology department, Federal Polytechnic, Mubi. Two varieties of rice, E-425 (which is upland) and NERICA-2 (which is an improved rice and also upland); and four row spacings (i.e. 15, 20, 25 and broadcast as control) were used during the study. The treatments were factorially combined and laid in a split plot design with three replications. The varieties were laid in the main plot while the row spacing was laid in the sub plot. E-425 was observed to produce significantly (P=≤ 0.05) higher numbers of tillers per plant and spikes per hill than NERICA 2. However, NERICA 2, was observed to produce significantly (P ≤ 0.05) higher number of seeds and spikelets per spike, seed weight per spike, 1000 grain weight and grain yield (kg ha-1) over E-425. The use of 15, 20 and 25cm row spacings were observed to be significant (P ≤ 0.05) over the broadcast method of planting in all the characters studied. Based on the results obtained, NERICA 2 though a low tillering variety is discovered to be superior in yield than E-425. The paper concludes that at the row spacings, irrespective of the method used; hole planting of rice could be more appropriate for optimum grain yield.

Key Words: NERICA, row spacing, varieties, replications.

Introduction

Rice is a member of the grass family poaceae and it belongs to the genus oryza under the tribe oryzae. The genus oryza includes twenty wild species and two cultivated species. The wild species are widely distributed in the humid tropics and subtropics of Africa, Asia, Central and South America and Australia (Chang & Liu, 1995). Out of the two cultivated species, African rice (o. glaberrima steud) is confined to West Africa, whereas the common or Asian rice (o. sativa L;) is now commercially grown in about twelve countries, covering all the continent (Futakuchi, 2006)

Rice is a staple food for nearly one half of the world’s population. In Africa, the crop is meant to be a luxurious food that was only used by the rich, and the average earning families. It is food that was only consumed during festivities. Although 240 millions of people in West Africa rely on rice as the primary source of energy and protein in their diet, (Sarla and Mallikaruna, 2005), the majority of this rice is imported at a cost of 1 billion USD, (Watanabe Futakuchi and Jones, 2006). Self sufficiency in rice production, according to Kijima, Serunkuma & Otsuka, (2006) would improve food security and aid economic development in West Africa.

Over the past decades in Nigeria, the crop has moved from being luxurious to a staple food due to increase in production by the teeming subsistence farmers. Nigeria according to the 2006 census is the most populous country in Africa with over 140 million people. The struggle for food is expected to have increased with the increase in its inhabitants, and the demand for rice has since been rising steadily at about 14% annually (Erenstien, Lacon, Osiname and Kebbeh, 2003). With the exception of a few countries that have attained self-sufficiency in rice, the demand for rice in many countries especially Nigeria has exceeded its production; as such, large quantities are imported to meet the demand at a huge cost (Fagade, 2000).

The country's inability to attain self-sufficiency in rice production was a result of several major factors that require urgent redress. Some of these constraints may include local stresses, lack of new improved varieties and lack of awareness of the new technologies and methods of production of the crop. The recent ban on the importation of rice by the Federal Government of Nigeria has resulted into a significant increase in the price of imported rice with no significant increase in the production and quality of the local rice. This situation has made Nigerian consumers suffer more than ever before. The use of poor or low yielding varieties by farmers in the country was earlier identified as a serious constraint to increase in rice production (Harper, 2003). Most farmers are not aware of the existence of the new improved varieties which are ecology and location specific like NERICA (New rice for Africa) varieties. Other farmers on the other hand ignorantly and randomly use the improved varieties without consideration to the type of ecology and other purposes for which such varieties were bred for.

For instance, majority of the farmers in Northern Nigeria are not aware of the improved cultural practices in rice production. Owing to ease in planting, labour cost and timeliness in application, most farmers prefer to broadcast the crop instead of drilling or hole planting. During the growth and development of the crop, too close spacing as characterised by broadcasting results in mutual shading among the plants where fewer or no tillers are produced coupled with smaller panicles and tall but weak plants that are susceptible to lodging. National Cereal Research Institute (NCRI, 2005) suggests the use of 20cm x 20cm inter and intra row spacing for optimum rice production. However, no clear specification regarding spacing was shown for the two ecology dependent species and these are the low tillering upland types and the high tillering lowland types. Upland varieties are genetically low in tillering production than the lowland types, hence the need for different spacings for the two different ecology, (Klosterboer & Turner, 2001).

For rice production to increase in quantity; there is an urgent need to create awareness among farmers on the existence of new improved varieties like FARO 54 and FARO 55 (NERICA-2) that have shown increased yield with reduction in production cost. Unlike the more adapted varieties like FARO 44, these new varieties are resistant to local stresses like blast and non toxicity. Therefore, they are characterised with high yielding, early maturing and high protein content. The objective of this study is to determine the performance of two distinct rice varieties under different levels of spacing.

Materials and Methods

Field experiments were conducted during the 2008 and 2009 rainy seasons at the Teaching and Research Farm of Agricultural Technology Department, Federal Polytechnic Mubi, Adamawa State. The treatments consisted of two varieties of rice (E-425 and NERICA-2), three row spacing (15, 20, and 25cm) and broadcast as control. The treatments were laid out in a split plot design with three replications. The varieties were laid in the main plot while row spacing was laid as sub plot.

The land was ploughed and harrowed twice to obtain a fine tilt. Basal application of cow dung was applied to each plot, and then, two weeks after the application, five to seven seeds were sown per hole. Manual weeding was carried out twice. NPK fertilizer was applied three weeks after sowing, then at six and nine weeks after sowing; urea fertilizer was applied as top dress in two split doses.

Data collected include the plant height, number of tillers per plant, number of spikes per hill, number of spike lets per spike, number of seeds per spike, weight of seeds per plot, 1000 grain weight (g) and total grain yield (kg/ha). Data collected were subjected to analysis of variance. Significant differences among the treatment were evaluated using the Duncan Multiple Range Test

(DMRT).

Results and Discussion

Table 1: Effect of variety and row spacing on plant height at harvest of rice grown during the rainy seasons of 2008 and 2009 in Mubi.

	Plant height (cm)		
Treatment	2008	2009	combined
VARIETY			
E-425	60.68[b]	60.74[b]	60.71[a]
NERICA 2	81.52[a]	81.26[b]	81.39[b]
SE ±	2.16	2.13	1.92
ROW SPACING (cm)			
15	85.96	85.60	85.78
20	84.01	83.73	83.87
25	83.74	83.43	83.59
Control	82.01	81.74	81.88
SE ±	3.02	3.01	2.76
INTERACTIONS			
V X R	NS	NS	NS

Means within a column of treatment followed by unlike letter (s) are significantly different using DMRT at 5% level of significance.

Table 1 shows the effect of variety and row spacing on plant height of rice. At harvest, the two varieties differed significantly ($P \leq 0.05$) on plant height. NERICA 2 was observed to be consistently taller than E-425 in the two years of study and combined. Plant height may be an inherent genetic character observed between the two varieties. Similar results on the genetic differences among crops producing characters like plant height were also observed as advanced earlier in groundnut (Seaton, Coffelt & Scoyoc, 1992).

During the period of study, all the row spacings considered did not show any significant difference on plant height. This research contradicts earlier result of Mahmud, Chiezey, Ahmed and Rufai, (1996) and Zitta (2004) in mungbean in green gram, that the closer the spacing of any crop plant, the higher the population per unit area and vice versa. With very high populations, the tendency is that plants may enter into keen competition for available resources and a continuous competition may also eventually lead to plants growing taller to shade one another in competition.

Treatment	2008	2009	combined
VARIETY			
E-425	13.62[a]	12.43[a]	
NERICA 2	11.87[b]	9.83[b]	
SE(±)	0.63	0.65	0.69
ROW SPACING (cm)			
15	14.54[a]	13.64[a]	
20	16.02[a]	14.57[a]	
25	19.46[a]	15.63[a]	
Control	0.00[b]	0.00[b]	0.00
SE (±)	0.91	0.93	0.95
INTERACTIONS			
V X R	NS	NS	NS

Table 2: The effects of variety and row spacing on number of tillers per plant of rice at harvest grown during the rainy seasons of 2008 and 2009 in Mubi.

Means within a column of treatment followed by unlike letter (s) are significantly different using DMRT at 5% level of significance.

Table 2 shows the effects of variety and row spacing on the number of tillers per plant of rice. At harvest, significant difference ($P \leq 0.05$) was observed. A higher number of tillers were observed more in E-425 than NERICA 2. The row spacing of 15, 20 and 25cm were observed to produce higher number of tillers per plant than the broadcast method. This could be interpreted that, at a wider inter and intra row spacing, plants do not compete much for light, nutrient and space to grow and develop as against when they are grown in dense population. Imolehin (1991) in an earlier report highlighted that tiller buds are normally formed at each node of rice stems irrespective of the variety and environmental conditions, but that the growth of tiller buds was determined by genetic factors and the growing conditions.

	Number of seed per spike		
Treatment	2008	2009	combined
VARIETY			
E-425	81.42[b]	83.63[b]	82.53[b]
NERICA 2	105.13[a]	101.65[a]	103.39[a]
SE ±	3.59	9.86	3.29
ROW SPACING (cm)			
15	98.15[a]	94.25[b]	96.2[b]
20	101.36[a]	98.51[a]	99.94[a]
25	102.73[a]	99.32[a]	101.03[a]
Control	69.42[b]	74.13[c]	71.78[c]
SE ±	5.43	5.17	4.73
INTERACTIONS			
V X R	**	**	**

Table 3: The effect of variety and row spacing on number of seeds per spike of rice grown during the rainy seasons of 2008 and 2009 in Mubi.

Table 3, shows the effects of variety and row spacing on number of seeds per spike of rice grown during the rainy seasons of 2008 and 2009 in Mubi. A significant variation ($P \leq 0.05$) was observed between the two varieties on the number of seeds per spike. NERICA 2 produced higher number of seeds per spike than E-425. The number of seeds per spike may likely depend on the number of tillers produced per stand and decreases with increase of tillers. This result corroborates with the report of WARDA (2003) that most upland varieties were equally bred for improved yield by utilizing the little amount of inputs like moisture and fertility than the land race varieties (Hossmer & Juo, 1999; CGIAR & WARDA, 2003).

Spacing of 15, 20 and 25cm has significant ($P \leq 0.05$) higher number of seeds per spike than broadcast method. This can be explained that at wider intra row spacing, plants do not compete for light, nutrients and space for growth and development much, as they do when they are compactly sown. The lower number of seeds per spike obtained at closer spacing could be due to intense competition for light, nutrients and space. These results were similar to that of Mahmud, Falaki, Abubakar and Miko (1996) in green gram and Anonymous (1997) in mungbean.

Number of spikelets per spike

Treatment	2008	2009	combined
VARIETY			
E-425	9.23[b]	9.11[b]	9.17[b]
NERICA 2	10.55[a]	11.13[a]	10.84[a]
SE ±	0.31	0.39	0.35
ROW SPACING (cm)			
15	11.67[a]	11.69[a]	11.68[a]
20	11.84[a]	11.76[a]	11.80[a]
25	11.82[a]	11.98[a]	11.90[a]
Control	8.37	9.23[b]	8.80[b]
SE ±	0.43	0.53	0.46
INTERACTIONS			
V X R	NS	NS	NS

Table 4: Effect of variety and row spacing on number of spikelets per spike of rice grown during the rainy seasons of 2008 and 2009 in Mubi.

Table 4 shows the effects of variety and row spacing on number of spikelets per spike. NERICA 2 produced significantly ($P \leq 0.05$) higher number of spikelets (10.84) than E-425 (9.17) in both seasons and the combined. The effects of row spacings however shows that the use of 15, 20 and 25cm row spacing consistently had a higher number of spikelets per spike with each producing 10.84 spikelets; as against the lower number of spikelets recorded when the broadcast method was used.

Production of higher number of spikelets in NERICA 2 was not uncommon since the variety had fewer or lower number of tillers per plant. This translate that the fewer the tillers in rice, the more spikelets are produced (Fagade, 2000). The same trend was observed in WITA – 4 and FARO 44 where it was observed that when more tillers are produced the crop tend to make a compensation on the number of spikelets per spike because potentially, a high tillering rice plant tend to "feed" more than the low tillering one. However, the low tillering ones tend to grow taller in height producing bigger and heavier eyes (Chang & Liu, 1995).

Treatment	2008	2009	combined
	Number of spikes per till		
VARIETY			
E-425	13.52[a]	12.56[a]	13.04[a]
NERICA 2	11.19[b]	9.17[b]	10.18[b]
SE ±	0.67	0.66	0.66
ROW SPACING (cm)			
15	12.69[b]	11.81[b]	12.25[b]
20	13.87[b]	12.54[a]	13.23[b]
25	16.94[a]	13.78[a]	15.36[a]
Control	1.02	1.02	1.02
SE ±	0.94	0.54	0.94
INTERACTIONS			
V X R	**	**	**

Table 5: Effects of variety and row spacing on number of spikes per till of rice grown during the rainy seasons of 2008 and 2009 in Mubi.

Means within a column of treatments followed by unlike letter (s) are significantly different using DMTR at 5% level of significance.

The effects of variety and row spacing on number of spikes per till is presented in table 5. Among the two varieties, E-425 was observed to be superior on number of spikes per till in the two years of study and combined. The result of this investigation shows that there was a significant difference between the two varieties studied and also from the different row spacing used. E-425 variety was observed to produce significantly higher number of spikes per till than NERICA 2. The difference observed between the two varieties could be due to hereditary traits inherent within the two varieties used. Another reason could be the environmental factors which affected the crop prior to the jointing stage which is considered as a critical stage in rice production (Yoshida, 1998).

Row spacing of 15, 20 and 25cm were observed to produce significantly higher number of spikes per hill than broadcast. At wider plant spacing and especially with adequate nutrition, vegetative growth could be prolonged thereby elongating the phonological stage (Zitta, 2004). At narrower spacing, the reverse could be the case due to competition.

Seed weight per spike (g)			
Treatment	2008	2009	combined
VARIETY			
E-425	3.43[b]	2.59[b]	3.01[b]
NERICA 2	5.25[a]	5.13[a]	5.21[a]
SE ±	0.43	9.86	0.35
ROW SPACING (cm)			
15	4.32[b]	4.05[b]	4.19[b]
20	4.07[b]	4.21[b]	4.14[b]
25	4.97[a]	4.61[a]	4.79[a]
Control	3.32	3.23[c]	3.28[c]
SE ±	0.35	0.25	0.30
INTERACTIONS			
V X R	NS	NS	NS

Table 6: The Effect of Variety and Row Spacing on Seed Weight per Spike of rice Grown during the Rainy Seasons of 2008 and 2009 in Mubi.

Means within a column of treatment followed by unlike letter (s) are significantly different using DMRT at 5% level of significance.

Table 6 shows the effect of variety and row spacing on seed weight per spike of rice grown during the rainy seasons of 2008 and 2009 in Mubi. NERICA 2 significantly ($P \leq 0.05$) produced higher seed weight than E-425 throughout the study period and combined. At the row spacing however, broadcast plots were observed to significantly ($P \leq 0.05$) produce lower seed weights per spike when crops spacing of 15, 20 and 25cm for both years and combined.

Seed weight per spike varied significantly between the two varieties. Seeds from NERICA 2 were significantly heavier than those from E-425. This was not unexpected since the number of seeds per spike and the numbers of spikelets per spike were higher in NERICA 2 than E-425. In considering the row spacing, the use of 15, 20 and 25cm gave significantly ($P \leq 0.05$) higher seed weights than it did in broadcast method. This might be due to the fact that at wider spacing, each individual plant was provided with enough space for its root system to explore mineral nutrient. Moreover, with wider spacing, there could be less competition for nutrients, moisture and light with probability that more photosynthesis would be produced at the source and in turn translocated to the sink, thus resulting in higher yield. These results confirm the findings of Mahmud, Chiezey, Ahmed and Rufai (1997) that an increase in intra row spacing resulted to an increase of the seed weight in green gram.

Treatment	1000 grain weight (g) 2008	2009	combined
VARIETY			
E-425	24.67[b]	23.46[b]	24.07
NERICA 2	28.65[a]	27.82[a]	28.24
SE ±	0.75	0.94	0.81
ROW SPACING (cm)			
15	26.05	25.87[a]	25.96[a]
20	27.65[a]	25.27[a]	26.46[a]
25	27.35[a]	25.87[a]	26.61[a]
Control	24.89[b]	21.65[b]	23.27[b]
SE ±	1.13	1.39	1.19
INTERACTIONS			
V X R	NS	NS	NS

Table 7: Effects of variety and row spacing on 1000 grain weight of rice grown during the rainy seasons of 2008 and 2009 in Mubi.

Means within a column of treatment followed by unlike letter (s) are significantly different using DMRT at 5% level of significance.

Table 7 shows the effects of variety and row spacing on 1000 grain weight of rice grown during the rainy seasons of 2008 and 2009 in Mubi. The two varieties were observed to vary significantly ($P \leq 0.05$) on 1000 grain weight in the two years under study. NERICA 2 was observed to produce higher grain weight (28.24) than E-425 (24.02) throughout the study period. This could be due to the former having more translocation of assimilates to the sink. On the other hand, NERICA 2 may have expanded a lot of its photosynthates to its large vegetative structure which might have competed highly as sink with the reproductive organ.

Under the different row spacing, a significant difference ($P \leq 0.05$) was also observed on 1000 grain weight. Row spacing of 15, 20 and 25cm, consistently had higher 1000 grain weight than broadcast method. This probably explained that, with narrow spaced plant, competition for sunlight, water and nutrients is high; and the result is a production of smaller and lighter grains. Similarly, shading from the sun tends to reduce the action of light which quickens Z-model of photo act, hastening the calvin cycle for dry matter partitioning.

Treatment	Yield (kg/ha^{-1}) 2008	2009	combined
VARIETY			
E-425	2382.8[b]	2413.4[b]	2398.1[b]
NERICA 2	3111.7[a]	3253.5[a]	3182.6[a]
SE ±	278.38	254.7	243.36
ROW SPACING (cm)			
15	4436.3[a]	4237.4[a]	4336.85[a]
20	4082.7[a]	4169.6[a]	4126.20[a]
25	3861.9[a]	3827.5[a]	3844.7[a]
Control	1353. 2[b]	1578.7[b]	1465.9[b]
SE ±	361.13	323.73	327.71
INTERACTIONS			
V X R	NS	NS	NS

Table 8: Effects of variety and row spacing on yield of rice grown during the rainy seasons of 2008 and 2009 in Mubi.

Means within a column of treatment followed by unlike letter (s) are significantly different using DMRT at 5% level of significance.

Table 8 shows the effects of variety and row spacing on grain yield (kg/ha) of rice grown during the rainy seasons of 2008 and 2009 in Mubi. NERICA 2 was observed to be superior in grain yield over E-425 in both seasons. The performance of NERICA 2 in grain production may be due to its ability to produce more photosynthates which were utilized in the production of grains than the other variety during the anthesis and grain filling stages. The present report also lends support from the work of Garba (2006) who reported similar trend during anthesis and grain filling in groundnut.

Proper spacing is discovered to be one of the important factors which facilitates good yield in rice. With wider spacing, more productive tillers and higher grain yield could be expected. At wider spacing, costs are cut tremendously and with recently introduced system in rice intensification (SRI), 80-90% of costs is reduced, (Tanaka & Arima, 1996). With skillful management of the factors of production particularly for planting and weeding, return on labour can be very great. At narrow spacing on the other hand, higher sterility has been reported in rice (Takeda & Hirota 1991). Ying, Peng, Yang, Visperas and Cassaman (1998), report that transplanting at a spacing of 25cm x 25cm and 20cm x 30cm resulted in grain yield of 9.5 and 9.2t/ha respectively. Hasegawa, Takermura and Nakayama (1991) also report that average rice grain yield increased from 5.2t/ha at the lowest density of 100 plants/ha to 6t/ha at the highest density of 250 plants/ha. As droughts are becoming more frequently and serious in Nigeria, weather fluctuations are becoming greater and as such, wide spaced plant induces rice to grow much larger with deeper root systems giving more resistance to impact to drought, (Uphoff, 2005) and (Tanaka and Arima, 1996).

Findings and Conclusion

The major finding in this study is that the improved variety of NERICA 2 had higher grain yield than E-425. It was also discovered that NERICA 2 matures earlier than E-425 with a difference of about one month, even with the harsh weather around Mubi agro ecology. Similarly, it was observed that irrespective of the spacing used, hole planting of rice produces more yield than the traditional farmers' method of broadcasting. From the results obtained in this research, it is concluded that NERICA 2 is most suitable for Mubi's ecological formation. Also, hole planting of rice appeared to be ideal for optimum yield. The paper thus csubmits that NERICA 2 will be more suitable in Mubi and its surrounding environs.

Recommendations

The following recommendations could be made, based on the findings of the study: -

- The ideal variety of rice in terms of high yielding and time of maturity is NERICA 2.
- Farmers can adapt to planting of NERICA 2 rice.
- The best spacing recommended to the farmers in Mubi and its environs is 15, 20 and 25cm row spacing.
- Further research should be conducted on other varieties of NERICA rice with the same row spacing in other environments.

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