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EFFECT OF SOWING METHOD ON GROWTH AND YIELD OF IRRIGATED LOWLAND RICE (*Oryza Sativa* L.) IN ALTERNATE WETTING AND DRYING (AWD)

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ABSTRACT
The study investigated the effect of different sowing methods on the growth and yield of irrigated lowland rice in Alternate Wetting and Drying. Field experiment was conducted during the dry season of 2015 and 2016 at Goria farms in Zigau, Shira Local Government Area of Bauchi State Nigeria (Latitude11˚25'N and Longitude 9˚57'E and at an altitude of 410m above sea level). Four different sowing methods (Transplanting, Dibbling, Drilling and Broadcasting) were used. The treatments were laid out in a Randomized Complete Block Design (RCBD), replicated four times. Parameters assessed were plant height, tiller count, number of spikelets per spike, spikes per hill, spike length, 1000 grain weight, grain weight per hill and grain yield per hectare. The data collected were subjected to Analysis of Variance (ANOVA) to test for variation of means among the treatments. Duncan Multiple Range Test (DMRT) was used to separate the means. The result indicated that transplanting produced significantly ($P \leq 0.01$) taller plant (66.82 ± 1.88), higher tiller counts (26.5 ± 0.42), number of spikelets per spike (12.50 ± 2.00), 1000 grain weight (29.49 ± 1.17) and grain yield (6.84 ± 0.16) than all other sowing methods. Drilling and broadcasting were the least in terms of spike length and grain weight per hill compared to other methods of sowing. In this study, transplanted rice performed better than rice planted using other methods of sowing and is therefore, recommended for the production of the crop for higher yield.

Keywords: Sowing method, Lowland rice, Alternate Wetting and Drying, Tiller, Spike

INTRODUCTION

In Nigeria, the demand for rice has been on the increase and at a faster rate than any other West African countries since the mid-1970s (NBS, 2007), which may be attributed to the geometric progression in population growth and the low level of domestic production of the crop. Estimated annual rice demand and production in Nigeria is said to be 5 and 2.21 million tonnes respectively. The national rice supply-demand gap of 2.79 million tonnes had to be bridged by importation which has constituted serious drain on the nation's foreign exchange (NRDS, 2009).

Rice production in Nigeria is constrained by a number of factors which may include among others, the use of poor agronomic practices (such as planting pattern or seeding method), drought and use of local varieties. Even though rice production has been expanding at the rate of 6% per annum in Nigeria, but far from bridging the supply-demand gap (Falusi, 1997; Fagade, 2000; WARDA, 2007; Okoruwa *et. al.*, 2007). Similarly, much of the expansion has been in the rain-fed systems, with little expansion in the irrigation system, which is noted to have best performance in terms of yield (Dingkuhn *et al.*, 1997).

With proper awareness, sensitization and training on rice production under irrigation during dry season particularly on improved planting techniques and water management like Alternate Wetting and Drying (ADW), the quantum leap in the production level may be achieve. The use of strategic water management like Alternate wetting and drying (AWD) as a substitute to the conventional continuous flooding does not only minimized the irrigation input but also plays significant role in the reduction of methane emission one of the major greenhouse gases contributing to Global Warming. The conventional rice production which keeps the soil flooded and anaerobic almost throughout the cropping season could have detrimental effect on the environment through the emission of significant amount of methane. According to the earlier report by Mosier *et al*. (1998), wetland rice system emits large quantity of methane (CH_4) and account for 8.7-28% of total anthropogenic emission.

Different methods of sowing rice can be classified into direct seeding and transplanting. Rice can be directly sown in the field instead of the seedlings being first raised as seedlings in the nursery and later transplanted into the main field. Direct sowing can be achieved through broadcasting, dibbling and drilling. Rice production in Nigeria is predominantly practiced in direct seeding method which involves the use of higher seeding rates and this might have accounted for the lower yield of the crop in the country. Improper sowing techniques usually affects plant population one of the most important factors limiting yield potential of the crop. Increase in yield may be ensured by maintaining appropriate plant population through different sowing patterns such as transplanting and dibbling methods which involve sowing the crop at specific distance. Sowing improved varieties using appropriate methods of seeding could produce a fast growing and uniform crop with higher yields which could compete with weeds effectively. There has been a

disparity among researches as whether or not transplanted rice outperforms direct seeded rice. Though transplanting method seems to be more laborious from raising nursery, uprooting and transporting the seedlings, however, it has been shown to be a better practice than direct method of seeding (Padney *et al*., 2002 and Javaid *et a*l., 2012). According to Hayat *et al*. (2003) and Ali *et al*. (2007) direct seeded rice when managed properly can yield as high as the transplanted one. Therefore, this research intended to study the effect of sowing methods on the growth and yield of irrigated lowland rice in alternate wetting and drying to determine the best method of sowing for higher yield in rice production.

Material and Methods

The experiment was carried out during the dry season of 2015 and 2016 at Goria farms in Zigau, Shira Local Government Area of Bauchi State Nigeria (Latitude11˚25'N and Longitude 9˚57'E and at an altitude of 410m above sea level) to study the effect of sowing method on growth and yield of irrigated rice in alternate wetting and drying (AWD). Lowland rice variety Federal Agricultural Research Oryza (FARO) 44 (Sippi 692033) was used during the study. The treatments consisted of four different sowing methods (Transplanting, Dibbling, Drilling and Broadcasting), laid in Randomized Complete Block Design (RCBD) with four replicates. The experimental site was first cleared, ploughed and harrowed twice to obtain a good tilth. After land levelling, Bunds of about 0.2m were constructed at edge of each plot to serve as demarcation between plots and means for conserving moisture. For direct method of sowing (dibbling, drilling and broadcasting), the seeds were sown directly on the field. However, in transplanting method of sowing, seedlings were first raised in the nursery before transplanting in the field. The seeds were sown the same day for both direct seeding and nursery. Uniform inter and intra row spacing of 20cm was used for dibbling and transplanting method. In drilling method of seeding, the seeds were sown in a groove of 2-3cm deep spaced at 20cm. In Broadcasting the seeds were manually spread using hand and covered lightly with soil for effective germination. Seed rates used were; Transplanting (50kg/ha), Dibbling (60kg/ha), Drilling (80kg/ha) and Broadcasting (120kg/ha). Weeding was done manually at 3, 8 and 12 weeks after sowing. Compound fertilizer NPK 20:10:10 was first applied as basal using broadcast method at the rate of 60kgN/ha, 30kgP_2O_5 and 30kh/haK_2O. The remaining nitrogen dose was then applied in two split doses as top dress at 7 week after sowing and at booting stage. Surface irrigation method was used to convey water from wash bore through hose pipe to constructed channels between blocks or replicate to each plot. The irrigation water was applied to the treatment plots through bridge that linked each plot to the constructed channels. Intermittent irrigation with alternate wetting and drying of 3 days interval was used (Lourduray & Bayan, 1999; Sa'ad, 2015). However, during the early vegetative growth (one to three weeks after emergence) and flowering, when moisture requirement is highly essential (IRRI, 2007) irrigation water was applied on daily basis. Data were collected on plant height, tiller count per plant, spike number per hill, number of seed per spike, spikelet number per spike, spike length, 1000grain weight, grain weight per hill and total grain yield per hectare. Plant height and number of tillers per plant were taken at two weeks interval from 4 to 14 WAS and at harvest and data on yield characters were recorded at harvest.

Statistical Analysis

The data collected were subjected to Analysis of Variance (ANOVA) for Randomized Complete Block Design (RCBD) using SPSS version 22. Duncan Multiple Range Test (DMRT) was used in separating the treatment means.

Results and Discussion

The effect of sowing method on plant height and tiller count per plant during dry season of 2015 and 2016 is presented on table 2. Transplanting was observed to produce significantly ($P \leq 0.01$) taller plants (66.82cm ± 1.88) and higher tiller counts per plant (26.5 ±0.42) than all others methods. Drilling and broadcasting were the least on plant height and number of tillers per plant. Rice under transplanting in this study, where single seedlings was transplanted at 20×20cm intra and inter row spacing might have provided enough room to be nourished during photosynthesis and assimilates absorption from the soil. This indicated that growth dynamics and partitioning pattern in rice depends on sowing methods. This research corroborates the findings of Maqsood (1998), Hussain *et al*. ,(2013)and Hassan *et al.*(2013)who reported higher plant height under transplanting than other methods of seeding. Lower tiller count observed in sowing methods other than transplanting may be connected to the higher plant density which could exert more pressure on available nutrients, space and sunlight thereby reducing individual plant performance. The present study is in agreement with the early reports of IRRI (2008) that transplanting enables optimal spacing which may probably increase tillers and paddy yield over poor spacing particularly broadcasting and drilling.

The effect of sowing method on yield characters is presented on Table (3 and 4). Transplanting produced significantly ($P \leq 0.01$) higher number of spikelets per spike (12.5 ± 2.00), spike length (29.89cm ±1.03), 1000 grain weight (29.49g ± 1.17) and grain yield (6.84t/ha ± 0.16) when compared with other methods of sowing. Transplanting and dibbling methods were at par with each other and better than drilling and broadcasting on grain weight per hill and number of spikes. In most of the parameters measured transplanted rice had performed better than rice under other sowing methods. The significant performance of transplanting over the other sowing methods could be attributed to optimum plant population by planting the seedlings at specific distance which may allow for more radiation to be intercepted by the canopy due to reduced mutual leaf shading for more efficient photosynthesis, therefore the highest grain yield per hill were significantly ($P \leq 0.01$) higher than those of drilling (4.27 ± 1.73) and broadcasting (4.05 ± 1.73) method of sowing. Reduced plant density at sowing time ensures proper growth and development through efficient utilization of solar radiation and nutrients. Therefore, increase in most of the parameters measured under transplanting might be connected to less competition for growth resource factors between adjacent plants when compared with the other methods of sowing. The result of present findings agrees with the report of Hay and Walker (1989) that increase in plant density by different sowing methods may lead to increase in competition between adjacent plants which may subsequently affect yield and yield components

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Table 1: Total Rainfall, Mean Temperature and Relative Humidity of the Zigau, Bauchi State, Nigeria for 2015 and 2016

	Rainfall (mm)		Mean Temperature (C)		Relative Humidity (%)	
Months	2015	2016	2015	2016	2015	2016
January	Nill	Nill	27.5	27.0	71.0	71.0
February	Nill	Nill	27.5	26.5	69.0	72.0
March	Nill	Nill	30.0	31.5	72.0	75.0
April	Nill	Nill	34.0	35.0	73.0	76.0
May	Nill	44.3	34.0	35.0	75.0	77.0
June	57.3	99.2	32.0	34.0	73.0	76.1
July	133.7	217.9	30.5	28.5	72.0	73.0
August	282.6	281.6	29.5	27.0	70.0	72.0
September	56.0	134.4	28.5	27.5	69.0	73.0
October	19.6	11.2	30.0	32.0	70.0	74.0
November	Nill	Nill	30.0	27.5	71.0	70.0
December	Nill	Nill	27.5	25.5	74.0	68.0

Source: Bauchi State Agricultural Development Programme (BSADP), Azare Meteorological Station, (2016)

Table 2: Effect of Planting Method on Plant Height (cm) and Number of Tillers Per Plant at harvest of Irrigated Rice in Alternate Wetting and Drying during 2015 and 2016 at Zigau, Bauchi State Nigeria

	Plant height (cm)		Number of tillers per plant		
Planting method	2015	2016	2015	2016	
Transplanting	63.60[a]	70.51[a]	26.38[a]	27.10[a]	
Dibbling	57.55[b]	65.50[a]	13.13[b]	14.00[b]	
Drilling	49.55[c]	50.60[b]	1.00[c]	0.90[c]	
Broadcasting	48.58[c]	51.52[b]	0.80[c]	0.85[c]	
LS	**	**	**		**
SE (±)	1.655	2.100	0.322	0.510	

Means followed by unlike letter (s) within each column are significantly different using Duncan Multiple Range Test (DMRT), ** = Significant at P≤0.01
LS = Level of significance

Table 3: Effect of Planting Method on Number of Spikelets per Spike, Number of Spikes per hillspike length of Irrigated Rice in Alternate Wetting and Drying during 2015 and 2016 at Zigau, Bauchi State Nigeria

	Spikelets/spike		Number of spikes/hill		Spike length (cm)	
Planting method	2015	2016	2015	2016	2015	2016
Transplanting	11.13	12.50[a]	18.88[a]	21.00[b]	29.78[a]	30.00[a]
Dibbling	10.00	10.50[b]	22.25[a]	30.00[a]	27.43[ab]	29.00[ab]
Drilling	9.88	9.00[c]	1.00[b]	1.00[c]	25.78[b]	26.70[b]
Broadcasting	9.63	9.10[c]	1.00[b]	1.00[c]	25.35[b]	27.00[b]
LS	NS	**	NS	*	**	*
SE (±)	1.216	2.000	0.458	0.125	1.084	0.980

Means followed by unlike letter (s) within each column are significantly different using Duncan Multiple Range Test (DMRT), * = Significant at P≤0.05, ** = Significant at P≤0.01
LS = Level of significance

Table 4: Effect of Sowing Method on Yield Characters of Irrigated Rice in Alternate Wetting and Drying during 2015 and 2016 at Zigau, Bauchi State Nigeria.

Planting Method	1000grain weight (g)		Grain weight per hill (g)		Total grain yield (t/ha)	
	2015	2016	2015	2016	2015	2016
Transplanting	28.98[a]	30.00[a]	40.70[a]	41.00[a]	6.62[a]	7.05[a]
Dibbling	25.80[ab]	27.56[b]	39.93[a]	42.00[a]	6.03[b]	6.25[b]
Drilling	22.73[b]	23.80[c]	4.23[b]	4.30[b]	3.86[c]	3.90[c]
Broadcasting	22.20[b]	24.00[c]	4.00[b]	4.10[b]	3.62[c]	3.84[c]
LS	**	*	**	**	**	**
SE (±)	1.139	1.200	1.325	2.130	0.105	0.212

Means followed by unlike letter (s) within each columnare significantly different using Duncan Multiple Range Test (DMRT)WAS = LS = Level of significance ** = Significant at P≤0.01

CONCLUSION AND RECOMMENDATION

This study indicated that transplanted rice performed better than rice under dibbling, drilling and broadcasting and is recommended for the production of rice.

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