IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)
e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 17, Issue 7 Ser. 2 (July. 2024), PP 35-39
www.iosrjournals.org

Grain Yield And Economic Returns Of Rice (Oryza Sativa L.) As Influenced By Sowing Techniques, Timing Of Herbicide Application And Npk Fertilizer Rates At Bacita And Badeggi, Southern Guinea Savannah Of Nigeria.

Audu S. D.[1], I. M. Haruna[2], Ibrahim A. J.[3], And Ibrahim S. O.[4] S. O. Bakare[1]
National Cereal Research Institute Headquarters P.M.B 08 Bida, Niger State, Nigeria.
Department Of Agronomy, Faculty Of Agriculture P.M.B 135 Shabu-Lafia Campus, Nasarawa State University, Keffi, Nigeria.
Department Of Agronomy, Faculty Of Agriculture, Federal University Of Lafia P.M.B 146, Nasarawa State, Nigeria.
Department Of Crop Production Technology, School Of Agronomy And Environmental Management, College Of Agriculture, Science And Technology P.M.B 33 Lafia, Nasarawa State, Nigeria.

Abstract
The experiment was conducted in 2021 and 2022 wet season at National Cereals Research Institute headquarters, Badeggi, Niger state (latitude 9o041 02.05"N, longitude 0.6o011 3.31"E) and Bacita sub-station, Kwara state (latitude 9o1 16'N, longitude 5o59'E). Both locations are in the Southern Guinea Savannah Agro-Ecological Zone of Nigeria. The research aims to evaluate the economic benefits of various sowing techniques, herbicide application timings and NPK fertilizer rates on lowland rice production. The experiment was laid out in a factorial experiment. The treatment consists of five sowing methods (broadcasting dry, broadcasting wet, dibbling wet, dibbling dry and transplanting) with two different timing of herbicide application and three NPK rates (0, 60 and 120kgha-$_1$). The thirty treatments combinations were laid out in a split-plot design with NPK fertilizer rates and timing of herbicides application assigned to the main plot and sowing methods assigned to the sub-plot. Data were collected on grain yield per hectare. The result indicated that overall, the transplanting method of planting resulted in the significantly highest grain yield per hectare compared to other methods of sowing. Applying herbicide at 2 WAS resulted in higher grain yield compared to 3 WAS in both years and location. The NPK fertilizer rate of 120kg/ha-^{1} significantly produced highest grain yield per hectare compared to other rate and the control. The transplanting method with herbicide application at 2 WAS and NPK fertilizer rate of 120kg/ha-^{1} resulted in the significantly highest grain yield, gross returns, and gross margin, making it the most profitable option and is therefore recommended.

Keyword: *planting, transplanting, dibbling, herbicide, gross, margin.*

Date of Submission: 14-07-2024 Date of Acceptance: 24-07-2024

I. Introduction

Rice (Oryza sativa L.), a member of the Poaceae family, is a staple food for over 60% of the global population (ICAR, 2006). In Nigeria, it plays a vital role in agriculture and is a daily staple for millions, providing approximately 20% of the world's dietary energy. Rice is an excellent source of calories, protein, fat, and carbohydrates, accounting for two-thirds of the total caloric intake and half of the total protein intake of the average Nigerian.

Rice production faces numerous challenges, with weed growth being the most significant obstacle. Research shows that weed presence can reduce potential rice yields by 75% to 100% (Akobundu, 2011; Imeokparia, 2011; Lavabre, 2011). In no-tillage rice, weed competition has a more severe impact on yield compared to transplanted rice. The use of dwarf varieties, early-maturing varieties, and heavy reliance on fertilizers has led to weed problems in no-till farming. Poor weed control can result in up to 40% production losses Africarice (2022).

In Nigeria, rice planting techniques vary, including broadcasting, dibbling on ridges, random transplanting, and row transplanting (Fukagawa and Ziska, 2019). While row transplanting is promoted for boosting yields in lowland areas, it requires significant water and labor resources. To address these challenges, direct seeding is now recommended as a labor-saving and water-efficient alternative (Kamai *et al.,* 2020).

The planting method significantly influences the yield performance of lowland rice varieties. Historically, transplanted rice was considered to outyield direct-seeded rice. However, inconsistent grain yields reported in the literature may also be attributed to intervening factors such as nitrogen fertilizer and weed management, which can impact crop performance under different rice establishment methods (Kamai *et al.,* 2020).

In Nigeria, manual weeding is commonly practiced, but the increasing cost and scarcity of labor necessitate alternative methods. Manual weeding is also challenging due to the similar morphology of early rice seedlings and certain weeds, particularly grasses (Rahman et al., 2012). Herbicides are the most effective method for managing weeds, but selecting the appropriate herbicide is crucial for cost-effective weed suppression from the existing seed bank.

Environmental factors, such as soil water content during application, can impact herbicide efficacy and crop phytotoxicity by modifying herbicide absorption, translocation, or metabolism (Sanjoy *et al.,* 2019). Optimizing the timing of herbicide application and soil moisture levels is critical to minimize crop phytotoxicity while maximizing herbicide effectiveness in weed control.

There is a lack of knowledge on the optimal planting method and timing of herbicide application that can lead to higher rice yields in this agro-ecological zone. This study aims to investigate how different planting methods and herbicide application timings impact rice productivity, in order to identify the best practices for improving rice yields in this region.

II. Materials And Methods

Description of the Experimental Site

The experiment was conducted at the research field of National Cereals Research Institute headquarters, Badeggi, Niger state and Bacita out station in Kwara state. National Cereals Research Institutes Badeggi experimental field is located at (latitude $9^{o}04^{1}$ 02.05''N and longitude $0.6^{o}01^{1}$ 3.31''E), Bacita is located at (latitude 9^{o1} 16'N and longitude 5^{o}59'E) both in the southern Guinea Savannah Agro Ecological Zone of Nigeria. The experiment was carried out during the wet season of 2021 and 2022 in the two locations.

Treatments and Experimental Design: The trials were carried out in two years in the raining season. The experiment consisted of factorial combinations of five planting methods (dry-seeding broadcasting, wet-seeding broadcasting, dry-seeding dibbling, wet-seeding dibbling and row transplanting methods), two levels of timing of herbicides application (2 and 3 weeks after sowing) and three level of NPK fertilizer rates. The (30) treatments combinations with three replications were laid down factorial in a split-plot design with timing of herbicide application and NPK fertilizer rate allocated to the main plot while sowing methods were designated to the sub-plot. The gross plot size was $9m^2$ (3m x 3m) and net plot size was $4m^2$ (2m x 2m).

Land Preparation: The experimental field was prepared according to standard procedures, involving ploughing, harrowing, leveling, and manual bounding. In both locations, nursery beds were created for sowing seeds and raising seedlings, which were later transplanted to the field.

Seed/Seedling: Direct seeding and broadcasting were done using both dry and pre-germinated seeds. A nursery was established for the seedlings, which were later transplanted at 14 days after establishment at a rate of 2 seedlings per hole. Both transplanting and direct seeding were done with a spacing of 20 x 20 cm. The FARO 44 rice seed variety was used, with the following seeding rates: 25 kg/ha for transplanting, 50 kg/ha for direct seeding, and 60 kg/ha for broadcasting.

Fertilizer Application: A basal application of NPK 15:15:15 fertilizer was applied on the day of sowing or transplanting, prior to sowing or transplanting. The first topdressing with Urea was applied 3-4 weeks after sowing or transplanting, followed by a second topdressing with Urea 6-8 weeks after sowing or transplanting, according to the specified fertilizer rates for each treatment.

Disease and Pest control: Throughout the experimental period, there were no occurrences of pest or disease outbreaks. As a result, no pesticides were applied during the experiment.

Harvesting: The rice field was harvested when 80-85% of the panicles had turned yellow or brown, which occurred around 14-16 weeks after sowing (WAS). Harvesting was done using a rice sickle.

Threshing and Winnowing: Threshing was done manually using a drum on a tarpaulin. The seeds were then separated from the chaff through winnowing, a process that uses air to blow away the lighter chaff, leaving the heavier seeds behind.

Grain Yield: Total grain at harvest was determined by weighing the grains from each net plot with a Mettler scale Model 1210 and the value obtained was converted to per hectare basis.

Economic Analysis: The profitability status of rice production in this study was measured using Gross Margin Analysis by computing the revenue based on the pooled means of yield from different sowing methods, timing of herbicide and rates of NPK fertilizer using farm gate price (₦250.00/kg). Gross Margin Analysis was estimated as Revenue minus the total variable cost. That is: GM=R-TVC, Where GM =Gross margin, R=Revenue and TVC =Total Variable Cost.

Statistical Analysis: Data analysis was performed using GENSTAT software (2008 edition). Analysis of Variance (ANOVA) was conducted using the General Linear Model Procedure. Least Significant Difference (LSD) was used to compare means at a 5% level of probability (P≤0.05).

III. Results And Discusssion

As shown in **Table 1:** the pre-planting physico-chemical properties of the soils at the experimental sites during cropping seasons revealed that the soil texture was sandy clay, with a slightly acidic pH ranging from 5.16 to 5.4 over the two years. The soil organic carbon content was between 2.5 and 2.8%, total nitrogen was moderately low, available phosphorus was moderate, and exchangeable cation contents were low, as described by Peter *et al.* (2006**).**

Table 1: Physical and Chemical Properties of Soil in the Experimental Site for the both wet seasons

Properties	Bacita	Badeggi
PH	7.3	6.9
O.C.%	1.82	1.80
O.M.%	3.12	3.09
N%	0.35	0.28
Avail P (ppm)	12.35	8.43
K	0.34	0.30
Na	0.21	0.19
Ca	3.56	3.21
Mg	2.86	2.15
EA	0.50	0.67
TEB	6.97	5.85
CEC	7.47	6.52
B.S.%	93%	89%
Particle size analysis		
Sand %	78.6	74.6
Silt %	5.4	5.4
Clay %	16	20
Texture	Sandy loam	Sandy loam

Table 2 indicated the result on Grain yield per hectare which revealed that the transplanting method of planting significantly and consistently produced highest yield in both years and locations compared to other methods of sowing. The timing of herbicide application on grain yield per hectare indicated that 2 WAS significantly influenced the production of rice yield per hectare compared in both location and years of investigation compared with 3WAS application of herbicide. NPK fertilizer rate of 120kgha-^{1} significantly increased rice grain year per hectare in both years and locations compared to the control and the other rate of application (Table 2).

Table 3: showed the Economic analysis of rice production on different planting methods and timing of herbicide application and NPK fertilizer rates at Bacita and Badeggi Badeggi (pooled data for 2021 and 2022) on the grain yield (t/ha) indicated that highest yield was obtained with the transplanting method of sowing compared to other methods of sowing. Herbicide application at 2WAS significantly resulted to increased yield compared to 3WAS timing of herbicide application. The Gross returns in naira revealed that the highest gross returns were obtained from transplanting method of sowing, herbicide application at 2WAS and NPK 120kgha-^{1} of application. The Gross Margin (₦) indicated that the highest gross margin was obtained from transplanting method of sowing, 2WAS of herbicide application and application of 120kgha-1 of NPK. Combination of transplanting method with herbicide application at 2WAS and NPK fertilizer of 120kgha-1 would enhance the productivity and profitability of rice in the zone.

Table 2: Effects of Sowing Methods, Timing of Herbicides Application and NPK Fertilizer Rates on Grain Yield per Hectare in 2021 and 2022 at Bacita and Badeggi

	Yield (Kg/ha-^{1})			
Treatments	2021		2022	
	Bacita	Badeggi	Bacita	Badeggi
Sowing Methods (S)				
Broadcast dry	3185.31c	2977.54c	2945.69d	3833.33d
Broadcast wet	3270.69d	2638.47d	2988.61c	3930.56cd
Dibbling dry	3194.58c	3152.50c	4507.78b	4333.33c
Dibbling wet	3623.61ab	3495.69b	4813.89a	5277.78b
Transplanting	3940.56a	4882.50a	4912.78a	6073.19a
SE±	90.76	110.10	122.82	83.08
Timing of Herbicide Application (H)				
2 WAS	3487.83	3576.91a	3990.50	4883.33a

3 WAS	3554.07	3201.78b	3787.00	4495.94b
SE±	57.40	69.64	77.67	52.545
NPK Fertilizer Kg ha^{-1} (F)				
0	2759.60c	2893.33b	3056.33c	3583.30c
60	3615.67b	2985.50b	4373.92b	5233.33b
120	4187.58a	4289.19a	4791.00a	5452.25a
SE±	70.30	85.29	95.13	51.22
Interactions				
S x H	**	**	**	*
S x F	**	**	**	**
S x H x F	NS	NS	NS	NS

Means followed by same letter(s) within the same column and treatment group are not significantly different at 5% level of probability. [1]Weeks after sowing; [2]not significant difference at 5% level of probability

Table 4.3: Economic Analysis of Rice Production on Different Sowing Methods and Rates of NPK Fertilizer Application at Bacita in 2021 and 2022 Combined

	Sowing Methods					**Timing of Herbicide Application**		**NPK Fertilizer Rates**		
VARIABLE COST (₦)	BD	BW	DD	DW	TP	2 WAS	3 WAS	0kg	60kg	120kg
Cost of seed	30,000	30,000	25,000	25,000	12,500	24,500	24,500	24,500	24,500	24,500
Cost of NPK	40,000	40,000	40,000	40,000	40,000	40,000	40,000	0	80,000	120,000
Land preparation	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000
Nursery preparation	-	-	-	-	5,000	5,000	5,000	5,000	5,000	5,000
Cost of planting	10,000	10,000	20,000	20,000	30,000	18,000	18,000	18,000	18,000	18,000
Hoe Weeding	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000
Fertilizer application	6,500	6,500	6,500	6,500	6,500	6,500	6,500	0	5,000	8,000
Harvesting	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000
Threshing/ winnowing	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000
TVC	281,500	281,500	286,500	286,500	289,000	289,000	289,000	242,500	327,500	370,000
Revenue	766,375	782,413	1,925,590	2,109,375	2,213,335	1,869,583	1,835,268	1,453,983	1,997,398	2,244,645
Gross margin	484,875	500,913	1,639,090	1,822,875	1,924,335	1,580,583	1,546,268	1,211,483	1,669,898	1,874,645

NB: BD=Broadcasting dry, BW=Broadcasting wet, DD=Dibbling dry, DW=Dibbling wet, TP=Transplanting, WAS =weeks after sowing, TVC =total variable cost

Table 4.4: Economic Analysis of Rice Production on Different Sowing Methods and Rates of NPK Fertilizer Application at Badeggi in 2021 and 2022 Combined.

	Sowing Methods					**Timing of Herbicide Application**		**NPK Fertilizer Rates**		
VARIABLE COST (#)	BD	BW	DD	DW	TP	2WAS	3WAS	0kg	60kg	120kg
Cost of seed	30,000	30,000	25,000	25,000	12,500	24,500	24,500	24,500	24,500	24,500
Cost of NPK	40,000	40,000	40,000	40,000	40,000	40,000	40,000	0	80,000	120,000
Land preparation	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000
Nursery preparation	-	-	-	-	5,000	5,000	5,000	5,000	5,000	5,000
Cost of planting	10,000	10,000	20,000	20,000	30,000	18,000	18,000	18,000	18,000	18,000
Hoe Weeding	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000

Fertilizer application	6,500	6,500	6,500	6,500	6,500	6,500	6,500	0	5,000	8,000
Harvesting	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000
Threshing/ winnowing	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000
TVC	281,500	281,500	286,500	286,500	289,000	289,000	289,000	242,500	327,500	370,000
Revenue	851,358	821,129	935,729	1,096,684	1,369,461	1,057,530	962,215	809,579	1,027,353	1,217,680
Gross margin	569,859	539,629	649,229	810,184	1,079,961	768,030	672,715	567,079	699,854	847,680

NB: BD=Broadcasting dry, BW=Broadcasting wet, DD=Dibbling dry, DW=Dibbling wet, TP=Transplanting, WAS =weeks after sowing, TVC =total variable cost

IV. Discussion:

Transplanting method of sowing resulted in significantly increased rice grain yield. This could be as a result of taller plants, increased tiller count, higher biomass and dry matter accumulation, more panicles, higher seed yield per hill, and greater photosynthetic capacity. These was consistent with findings by Kawure *et al*. (2023), emphasizing that transplanting and direct seed dibbling methods generally result in higher yields compared to seed drilling and broadcasting methods.

Application of herbicide at 2WAS resulted in higher grain yield per hectare compared to 3WAS of herbicide application.

Application of NPK at 120kgha-^{1} fertilizer resulted in significantly the highest grain yield. This outcome was attributed to the adequate nutrient supply promoting rapid growth, efficient metabolic processes, and enhanced carbohydrate mobilization, which collectively facilitated robust cell division and elongation. These findings align with previous studies by Schnier *et al.* (1990), who reported that higher nitrogen levels (120 and 150 kg/ha-^{1}) resulted in significantly increased yields in both wet-sown and transplanted rice. Similarly, the findings of Peng *et al.* (1996) supported these results, showing comparable yield outputs between transplanted rice provided with nitrogen fertilizer and wet-drilled rice.

The gross margin increased as the grain yield increased, indicating that the higher the yield, the higher the profit. Transplanting method of sowing, 2WAS of herbicide application and NPK fertilizer at 120kgha-1 greatly produced higher grain yield per hectare hence higher gross margin and profitability for rice production. This optimal combination is recommended for rice production to maximize yields and profits

V. Recommendations

1. Transplanting method of planting improved the productivity of rice in the study area and is hereby recommended.
2. Herbicide application at 2 WAS enhanced rice production in the study area and is recommended.
3. Transplanting method of planting with application of herbicide at 2WAS increase in rice growth, development and yield as well maximize their profits.
4. Dibbling wet method of sowing with 2WAS herbicide application is recommended as best alternative to transplanting in the study area and is recommended.
5. Adoptions of this finding would enhance productivity of rice and improved the standard of living of rice farmers in the study area.

References

[1] Africarice (2022). Stress-Tolerant Rice Varieties. Https://Www.Africarice.Org/Stresstolerant-Rice. Accessed On 17–03–2022.
[2] Akobundu, I. O. (2011). Weed Control In Direct-Seeded Lowland Rice Under Poor Water Control Conditions. Weed Research 21:273-278.
[3] Fukagawa, N. K., And Ziska, L. H. (2019). Rice: Importance For Global Nutrition. Journal Nutrition Science Vitaminol (Tokyo); 65 (Supplement): S2-S3. Doi: 10.3177/Jnsv.65. S2. Pmid: 31619630.
[4] Icar (2006). Hand Book Of Agriculture. Http://Www.Icar.Org.
[5] Imeokparia, P. O. (2011). Control Of Cut Grass (Leersia Hexandra) In Direct Seeded Lowland Rice At Badeggi. Agronomy Seminar, Ahmadu Bello University, Zaria.
[6] Kamai, N., Omoigui, L. O., Kamara, A. Y And Ekeleme, F. (2020). Guide To Rice Production In Northern Nigeria. Published By The International Institute Of Tropical Agriculture (Iita) Ibadan, Nigeria. Pp.2-10
[7] Lavabre, E. M. (2011). The Tropical Agriculturist: Weed Control, Pp.86.
[8] Rahman, M., Abdul Shukor, J., Jaya, S. A. S. M., Azmi, B., Man And Parvez, A. (2012). Response Of Weed Flora To Different Herbicides In Aerobic Rice System. Scientific Research And Essays, 7(1), 12-23.