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INVESTIGATING THE INFLUENCE OF SOWING METHODS AND TIMING OF HERBICIDE APPLICATION ON GROWTH AND YIELD OF FARO 44 RICE VARIETY IN BADEGGI, NIGER STATE, NIGERIA

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ABSTRACT: *The field experiment was conducted at the National Cereals Research Institute during the 2021 and 2022 wet seasons, this study aims to investigate the influence of sowing methods and timing of herbicide application on the growth and yield of FARO-44 rice variety in Badeggi, Niger State, Nigeria. The treatments consisted of five sowing methods (broadcasting dry, broadcasting wet, dibbling wet, dibbling dry, and transplanting) and two herbicide application timings (2 and 3 weeks after sowing) arranged in a factorial experiment laid out in a randomized complete block design (RCBD) with three replications. Data collected included plant height, number of tillers, days to 50% flowering, days to maturity, number of seeds per panicle, seed yield per panicle, 1000-grain weight, and grain yield per hectare. Data were subjected to analysis of variance (ANOVA), and treatment means were separated using the Least Significant Difference (LSD) test at 5% probability level. Results showed that transplanting significantly produced the highest values for growth and yield parameters, followed by dibbling wet and dibbling dry methods, while broadcasting methods recorded the lowest performance. Herbicide application at 2 weeks after sowing significantly enhanced crop performance compared to application at 3 weeks after sowing. The study concluded that transplanting combined with herbicide application at 2 weeks after sowing is the most effective strategy for improving the productivity of FARO 44 rice variety at Badeggi, Niger State, Nigeria.*

KEYWORDS: *FARO-44, Sowing, Herbicide, Broadcasting, Dibbling, Transplanting and Hectare*

Introduction

Rice (Oryza sativa) is a member of the Poaceae family and serves as a staple food for more than 60% of the world's population, contributing about 20% of global dietary energy supply (FAO, 2022). It is an important source of calories, carbohydrates, protein, and fats for millions of people worldwide (ICAR, 2006). In Nigeria, rice is one of the most widely consumed cereal crops and constitutes a major component of the daily diet, providing a substantial proportion of caloric and protein intake among the population. The increasing demand for rice due to rapid population growth has intensified the need to increase production. According to CGIAR (2023), global rice production must rise from about 520 million tonnes to approximately 880 million tonnes by 2025 to meet future food demand. Achieving this target requires the adoption of improved agronomic practices, high-yielding varieties, and sustainable production technologies. However, rice production is constrained by challenges such as water scarcity, increasing fertilizer costs, labor shortages, and weed infestation, which necessitate efficient crop management strategies for sustainable productivity.

Africa, despite accounting for only 2.6% of global rice cultivation area and 4.6% of the population, produces an average of 14.6 million tonnes of rice annually on 7.3 million hectares, as reported by AfricaRice (2022). West Africa dominates the continent's rice production, covering 56.5% of the land area, approximately 3.7 million hectares. In Nigeria, rice has become a staple food across all social classes, with demand surpassing other staples. The country's annual rice consumption is 5.4 million metric tons, worth over $9.2 billion. However, domestic production only reaches 2.3 million metric tons, resulting in a significant import deficit of 3.1 million metric tons (Federal Ministry of Agriculture and Rural Development) FMARD. (2021). Nigerian farmers face substantial challenges in boosting productivity, including optimizing establishment methods, effective weed control, and fertilizer application, all of which significantly impact rice yields, as noted by Arouna *et al.* (2017).

Faro 44, has lately become one of the most widely spread rice varieties. In comparison to most local cultivars, Faro 44 rice paddy is one of the most desirable cultivars available to farmers since it is of higher quality, with much higher productivity and production success (National Bureau of Statistics and Presidential Initiative on Rice) NSPI. (2024).

It has a reasonable amount of starch and has a good malting quality and germination capacity. Faro 44 can be cultivated twice or more in a year under irrigation farming, depending on the temperature and soil fertility. Under ideal conditions, the production of Faro 44 can vary from 7 to 10 tonnes per hectare NSPI (2024).

It is known for its superior milling qualities, which promote a better end product during milling. It has a minimal chance of breaking during processing due to its mild water absorption and rupturing tendency around 60-65°C NSPI (2024).

Table 1: Nigerian Seed Portal Initiative on FARO-44 (SIPI-692033)

FARO-44 (SIPI-692033)	
Crop Name	Rice
National Code	NGOS-91-44
Variety Name	FARO-44
Original Name	SIPI-692033
Outstanding Characteristics	Long grain, optimum production under low management.
Agroecological Zones	Forest Transition/Derived Savanna, Humid Forest
Origin/Source	Taiwan
Developing Institute	WARDA/ IITA/ NCRI
Breeder(s)/Collaborators	T.M. Masajo, B.N. Singh, O.A. Oladimeji
Potential Yield (t/ha)	6-8 (t/ha)
Year of Release:	1990
Year of Registration	1991

Source: Nigerian Seed Portal Initiative (2024)

Rice production faces numerous challenges, with weed growth being the most significant obstacle. Weeds can reduce rice yields by 75-100% due to competition for resources like water, nutrients, and light. (Akobundu, 2011; Imeokparia, 2011; Lavabre, 2011). No-tillage rice is more vulnerable to weed competition than transplanted rice, especially when using dwarf varieties and fertilizers. Poor weed control can lead to 40% production losses. Early weed control is crucial in direct sowing, where rice seeds and weeds germinate simultaneously. Farmers have various weed control methods, including chemical treatments, traditional practices, and manual weeding (Street and Lanham, 2016). Effective weed management requires precise timing and method selection, with herbicide efficacy being critical. Researchers have identified effective herbicides for different growth stages, including pre-plant, burn-down, pre-emergence, and post-emergence treatments. (Mahajan and Chauhan, 2022; Allen, 2012). Specific herbicides like thiobencarb, pendimethalin, and ethoxysulfuron have proven effective in controlling weeds in direct-seeded rice systems (Kumar *et al*., 2018; Mahajan and Chauhan, 2022).

In Nigeria, rice farmers employ various planting techniques, including broadcasting, dibbling on ridges, and random or row transplanting (Fukagawa and Ziska, 2019). While row transplanting is touted as a means to increase rice yields in lowland areas, it demands substantial water and labor resources. To address these challenges, direct seeding is now being advocated as a more efficient and labor-saving approach that conserves water (Kamai *et al.,* 2020). Manual weeding is the traditional method, but it's no longer viable due to labor shortages and increasing costs. Moreover, distinguishing between rice seedlings and weeds, particularly grasses, is difficult during the early growth stage,

making manual weeding ineffective. (Kamai *et al*., 2020). Therefore, herbicides are considered the most effective solution for weed control in direct-seeded rice (DSR) (Sanjoy *et al.,* 2019). Pre-emergence herbicide application is crucial for efficient weed management in DSR. However, selecting the right herbicide is essential for cost-effective weed suppression. Environmental factors, such as soil moisture, can impact herbicide efficacy and crop safety by affecting absorption, translocation, or metabolism. To boost rice production and meet the growing population's demands, it's essential to optimize rice planting methods, nitrogen rates, and herbicide application timing based on prevailing conditions (Sanjoy *et al.,* 2019).

Despite the importance of optimizing rice production, there is a lack of knowledge on the best planting method and herbicide application timing for achieving high yields in this agro-ecological zone (Adeosun *et al.,* 2019; Kamara *et al.,* 2021). This study aims to fill this knowledge gap by investigating the effects of different planting methods and herbicide application timings on rice productivity, with the goal of identifying the most effective practices for improving yields.

Problem Statement

Rice (Oryza sativa) is one of the most important staple food crops consumed in Nigeria and across the world. Despite increased demand for rice due to rapid population growth, rice productivity in Nigeria remains relatively low compared to its production potential. One of the major constraints to rice production is poor crop establishment resulting from inappropriate sowing methods and ineffective weed management practices. Different sowing methods influence plant population, nutrient utilization, weed competition, and ultimately grain yield.

Weed infestation is another major factor limiting rice productivity in Nigeria. Weeds compete with rice plants for nutrients, water, light, and space, especially during the critical growth stages. Herbicides are commonly used for weed control; however, improper timing of herbicide application may reduce weed control efficiency and negatively affect crop growth and yield. Although several studies have been conducted on rice production, limited information exists on the combined effects of sowing methods and timing of herbicide application on the performance of FARO-44 rice variety under the ecological conditions of Badeggi, Niger State. Therefore, there is a need to determine the most suitable sowing method and optimum herbicide application timing for improved growth and yield of FARO-44 rice variety.

Aim of the Study

This study aims to investigate the influence of sowing methods and timing of herbicide application on the growth and yield of FARO-44 rice variety in Badeggi, Niger State, Nigeria.

Specific Objectives

The specific objectives of the study are to:

1. evaluate the effect of different sowing methods on the growth and yield of FARO-44 rice variety;
2. determine the influence of herbicide application timing on the growth and yield of FARO-44 rice variety;
3. assess the interaction effects of sowing methods and herbicide application timing on yield components and grain yield of FARO-44 rice variety;
4. identify the most effective sowing method and herbicide application timing combination for optimum rice productivity in Badeggi, Niger State.

Materials and Method

Description of the Experimental Site

The experiment was conducted at the research field of National Cereals Research Institute headquarters, Badeggi, Niger state. National Cereals Research Institutes Badeggi experimental field is located at (latitude 9o041 02.05''N and longitude 0.6o011 3.31''E), in the southern Guinea Savannah Agro Ecological Zone of Nigeria. The experiment was carried out during the wet season of 2021 and 2022.

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) and two levels of timing of herbicides application (2 and 3 weeks after sowing). The (15) 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 9m2 (3m x 3m) and net plot size was 4m2 (2m x 2m).

Agronomic Practices

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.

Growth and Yield Parameters

In each plot, five hills were randomly selected and tagged for data collection throughout the experimental period. The following growth and yield parameters were recorded:

Growth Parameters

Plant Height (cm)

Plant height was measured at 10 weeks after sowing (WAS) and at harvest using a meter rule. Measurements were taken from ground level to the apical bud of the tagged plants, and the mean height was recorded.

Number of Tillers

The number of tillers was counted from the tagged plants at 10 WAS, and the average number of tillers per plant was recorded.

Days to 50% Flowering

Days to 50% flowering were determined by counting the number of days from sowing to the stage when approximately 50% of the plants in each plot had flowered.

Days to Maturity

Days to maturity were recorded as the number of days from sowing to the harvesting date for each treatment.

Yield Parameters

Number of Seeds per Panicle

The number of seeds per panicle were determined by threshing the selected tagged panicles, counting the seeds obtained, and recording the average value.

Seed Yield per Panicle (g)

Seeds obtained from the selected panicles after threshing were weighed using a sensitive weighing balance, and the mean seed weight per panicle was recorded.

Grain Yield (t ha^{-1})

Total grain yield at harvest was determined by weighing grains obtained from each net plot using a Mettler Scale Model 1210. The values obtained were converted to tonnes per hectare (t ha^{-1}).

Statistical Analysis

Data collected from the experiment were subjected to Analysis of Variance (ANOVA) using the General Linear Model (GLM) procedure in GENSTAT statistical software (2008 edition). The experiment consisted of a factorial combination of five sowing methods and two herbicide application timings arranged in a Randomized Complete Block Design (RCBD) with three replications.

The statistical model adopted for the analysis was:

$$Y_{ijk} = \mu + B_i + S_j + H_k + (SH)\,jk + \sum_{ijk}$$

Where:

- Y_{ijk} = observed value of the dependent variable;
- μ= overall experimental mean;
- B_i = effect of the i^{th} block (replication);
- S_j = effect of the j^{th} sowing method;
- H_k = effect of the k^{th} herbicide application timing;
- $(SH)_{jk}$ = interaction effect between sowing method and herbicide application timing; and
- $\sum_{ijk}$ = random experimental error associated with each observation.

Whenever significant differences were detected among treatment means, separation of means was carried out using the Least Significant Difference (LSD) test at the 5% probability level ($P \leq 0.05$).

Result and discussions

Assessment of the Physical and Chemical Properties of the Experimental Soil at Badeggi During the 2021 and 2022 Wet Seasons

Table 2 presents the physical and chemical properties of the soil at the experimental site in Badeggi, Niger State during the 2021 and 2022 wet seasons. The result showed that the soil texture was predominantly sandy clay, with a slightly acidic pH range of 5.16 to 5.4 across both years. The soils had a moderate organic carbon content of 2.5-2.8%, relatively low total nitrogen levels, moderate available phosphorus, and low exchangeable cation levels, consistent with the soil characteristics described by Peter *et al.* (2006)

Table 2: Physical and Chemical Properties of Soil at the Experimental Site in Badeggi, Niger State During the 2021 and 2022 Wet Seasons

Properties	Badeggi (2021)	Badeggi (2022)	Combined
PH	7.3	6.9	7.1
O.C.%	1.82	1.80	1.81
O.M.%	3.12	3.09	3.11
N%	0.35	0.28	0.32
Avail P (ppm)	12.35	8.43	10.39
K	0.34	0.30	0.32
Na	0.21	0.19	0.20
Ca	3.56	3.21	3.39
Mg	2.86	2.15	2.51
EA	0.50	0.67	0.59
TEB	6.97	5.85	6.41
CEC	7.47	6.52	7.00
B.S.%	93%	89%	91%
Particle size analysis			
Sand %	78.6	74.6	76.6
Silt %	5.4	5.4	5.4
Clay %	16	20	18
Texture	Sandy loam	Sandy loam	Sandy loam

Source: Laboratory analysis by the Soil Science Department, National Cereals Research Institute, during the 2021 and 2022 cropping seasons.

Effect of Sowing Methods and Herbicide Application Timing on the Growth and Yield of FARO-44 Rice Variety in Badeggi During the 2021 and 2022 Wet Seasons

Table 3 shows the effects of sowing methods and timing of herbicide application on plant height, number of tillers, days to 50% flowering, days to maturity, number of seeds per panicle, seed yield per panicle, 1000-grain weight, and grain yield per hectare of FARO-44 rice variety at Badeggi, Niger State, during the 2021 and 2022 wet seasons.

Plant Height

The result showed that transplanting significantly produced the tallest plants (86.59 and 128.01 cm) in 2021 and 2022, respectively, compared with the other sowing methods. The increased plant height observed under transplanting may be attributed to better plant establishment, reduced competition, and improved nutrient utilization. Herbicide application at 2 weeks after sowing (WAS) significantly resulted in taller plants (85.19 and 104.75 cm) compared with herbicide application at 3 WAS in both years. This may be due to early weed suppression, which reduced crop-weed competition during the critical growth stage of rice. There was no significant interaction between sowing methods and herbicide application timing on plant height, indicating that both factors acted independently. The findings agree with the reports of Adeosun *et al.* (2019), who observed improved rice growth under transplanting methods and early weed control practices.

Number of Tillers

Transplanting significantly produced the highest number of tillers (17.55 and 20.33) in both years compared with other sowing methods. Early herbicide application at 2 WAS also significantly increased the number of tillers compared with application at 3 WAS. The higher tiller production recorded under transplanting could be associated with reduced plant competition and enhanced root establishment. Early weed control possibly improved nutrient availability and moisture utilization, thereby encouraging tiller formation. This finding is consistent with the observations of Kamara *et al.* (2021), who reported that effective weed management and proper crop establishment improved tillering ability in rice.

Days to 50% Flowering

The transplanting method significantly delayed flowering, recording 69.94 and 70.33 days in 2021 and 2022, respectively, compared with other sowing methods. Broadcasting methods attained 50% flowering earlier than transplanting and dibbling methods. However, herbicide application timing had no significant effect on days to 50% flowering. The delayed flowering observed under transplanting may be attributed to prolonged vegetative growth due to better nutrient uptake and crop vigor.

Days to Maturity

The results indicated that transplanting significantly delayed maturity compared with broadcasting and dibbling methods. Although all treatments showed relatively similar maturity periods ranging from 115.94 to 116.50 days, herbicide application at 2 WAS significantly resulted in earlier maturity than application at 3 WAS. The earlier maturity observed under early herbicide application may be

associated with reduced weed competition, which enhanced efficient utilization of growth resources by rice plants.

Number of Seeds per Panicle

Transplanting significantly produced the highest number of seeds per panicle in both years compared with the other sowing methods. Similarly, herbicide application at 2 WAS significantly increased the number of seeds per panicle compared with application at 3 WAS. The superior performance of transplanting may be due to improved crop establishment and reduced intra-specific competition, which enhanced assimilate production and grain formation.

Seed Yield per Panicle

The transplanting method significantly produced the highest seed yield per panicle compared with the other sowing methods. Herbicide application at 2 WAS also significantly enhanced seed yield per panicle relative to herbicide application at 3 WAS. This result suggests that early weed control improved photosynthetic efficiency and assimilate partitioning towards grain development.

1000-Grain Weight

Transplanting significantly recorded the highest 1000-grain weight compared with the other sowing methods. Herbicide application at 2 WAS significantly improved 1000-grain weight relative to herbicide application at 3 WAS. The increased grain weight may be attributed to better nutrient availability and lower weed interference during grain filling stages.

Grain Yield per Hectare

The result revealed that transplanting significantly produced the highest grain yield per hectare (4882.5 and 6073 kg ha^{-1}) in 2021 and 2022, respectively, compared with the other sowing methods. Herbicide application at 2 WAS significantly enhanced grain yield compared with application at 3 WAS. Significant interaction effects between sowing methods and herbicide application timing were observed on grain yield per hectare. The superior grain yield obtained under transplanting combined with early herbicide application may be attributed to better crop establishment, reduced weed competition, and efficient utilization of nutrients and moisture. This finding agrees with the reports of Chikoye *et al.* (2020), who observed higher rice yield under proper planting methods and timely weed management practices.

Table 3: Effect of Sowing Methods and Timing of Herbicide Application on Plant Height, Number of Tillers, Days to 50% Flowering, Days to Maturity, Number of Seeds per Panicle, Seed Yield per Panicle, 1000-Grain Weight and Grain Yield per Hectare at Badeggi, 2021 and 2022 Wet Seasons

	Plant Height (cm)		Number of tillers		Days to 50% Flowering		Days to Maturity		Number of seeds per panicle		Seed Yield per Panicle (Kg)		1000-Grain Weight (g)		Grain Yield per Hectare (tons)	
Treatments	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022
Sowing Methods (S)																
Broadcast dry	82.82d	89.84b	11.54e	15.17d	67.11c	67.17d	116.00c	116.17b	176.24d	118.83e	84.53d	83.66d	22.79bc	23.87d	2977.54c	3833.33d
Broadcast wet	82.21e	85.33d	11.69d	13.83e	67.28c	67.00e	115.94d	116.17b	177.49c	134.50d	8777.56c	82.50e	22.87bc	24.17c	2638.47d	3930.56cd
Dibbling dry	84.49c	88.38c	13.99b	18.17b	68.39b	68.00b	115.56e	115.67c	179.41b	142.50e	89.38c	86.82c	23.56b	24.11b	3152.50c	4333.33c
Dibbling wet	85.67b	89.12b	12.78c	16.50c	68.33b	67.83c	116.06b	116.11b	179.39b	157.50	92.57b	96.16b	23.92b	24.44a	3495.69b	5277.78b
Transplanting	86.59a	128.01a	17.55a	20.33a	69.94a	70.33a	116.44a	116.50a	182.18a	149.50	105.13a	107.83a	24.71a	24.48a	4882.50a	6073.19a
SE±	0.03	18.82	0.04	0.00	0.29	0.00	0.25	0.02	0.06	0.01	0.07	0.00	0.05	0.05	110.10	83.08
Timing of Herbicide Application (H)																
2 WAS	85.19a	104.75a	13.93a	17.26a	68.47	68.06	116.24a	116.38a	179.65a	142.47a	95.54a	92.39a	23.76a	24.22b	3576.91a	4883.33a
3 WAS	83.52b	87.53b	13.09b	16.33b	68.37	68.06	115.76b	115.87b	178.65b	139.66b	90.92b	90.40b	22.73b	24.16b	3201.78b	4495.94b
SE±	0.02	11.90	0.03	0.00	0.19	0.00	0.16	0.02	0.04	0.00	0.04	0.00	0.03	0.03	69.64	52.54
Interactions																
S x H	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**	**

Source: Field experiment and laboratory analysis conducted at the National Cereals Research Institute during the 2021 and 2022 wet seasons.

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

Interaction Effects of Sowing Methods and Herbicide Application Timing on Grain Yield of FARO-44 Rice Variety

Table 4 shows the interaction effects of sowing methods and herbicide application timing on grain yield per hectare of FARO-44 rice variety during the 2021 and 2022 wet seasons at Badeggi, Niger State.

The result indicated that transplanting combined with herbicide application at 2 WAS significantly produced the highest grain yield compared with the other treatment combinations. In 2022, transplanting combined with herbicide application at both 2 WAS and 3 WAS produced statistically similar grain yields per hectare.

The enhanced yield performance under transplanting and early herbicide application may be attributed to efficient weed suppression during the critical growth period, improved plant

establishment, and increased nutrient uptake. The interaction effect suggests that the effectiveness of herbicide timing depended on the sowing method adopted.

These findings are consistent with previous studies which reported that appropriate crop establishment methods combined with timely weed management significantly improve rice productivity under lowland conditions.

Table 4: Interaction Effect of Sowing Methods (S) x Timing of Herbicide (H) Application on Rice Grain Yield per Hectare at Badeggi in 2021 and 2022

	Timing of Herbicide Application			
	Badeggi 2021		Badeggi 2022	
Sowing Methods	2WAS	3WAS	2WAS	3WAS
Broadcast dry	2506.19h	2662.78	3444.44h	4222.22e
Broadcast wet	3144.44e	2132.50i	3722.22g	4138.89f
dibbling dry	3221.39d	3083.61f	4333.33d	4333.33d
Dibbling wet	4328.61c	3048.89f	4888.89c	5666.67b
Transplanting	5081.11a	4683.89b	6090.83a	6055.56a
SE (±)	64.6		65.4	

Source: Computed from field experimental data obtained from trials conducted at the National Cereals Research Institute during the 2021 and 2022 wet seasons.

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.

Discussions

Transplanting method of sowing produced significantly better plant growth performance and increased in grain parameters and grain yield compared to other methods of sowing. 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 resulted in higher yields compared to seed drilling and broadcasting methods.

Application of herbicide at 2WAS produced significantly increased grain yield per hectare compared to 3WAS of herbicide application in both years.

Table 4 result in 2021 indicated the interaction on the grain yield revealed that, the transplanting method of sowing with herbicide application at 2weeks after sowing (2WAS) produced significantly higher grain yields compared to other sowing methods and herbicide application timings. In 2022 however, transplanting method of sowing with herbicide application at 2WAS produced significantly higher grain yield per hectare but statistically at par with transplanting method of sowing with herbicide application at 3WAS.

This indicates that the superiority of transplanting sowing method for increasing rice grain yield per hectare in the study area. Herbicide application at 2WAS is the most effective timing for enhancing grain yield when using the transplanting method.

Conclusion

The results of this study demonstrated that both sowing methods and timing of herbicide application significantly influenced the growth and yield performance of FARO-44 rice variety at Badeggi during the 2021 and 2022 wet seasons. Among the sowing methods evaluated, transplanting consistently produced superior agronomic performance in terms of plant height, number of tillers, yield components, and grain yield per hectare compared with broadcasting and dibbling methods. This indicates that transplanting provides better crop establishment, improved resource utilization, and reduced early weed competition.

Similarly, herbicide application at 2 weeks after sowing (WAS) was more effective than application at 3 WAS, resulting in improved growth parameters and higher grain yield. Early herbicide application enhanced weed control during the critical growth stages of rice, thereby reducing competition for nutrients, water, and light.

The interaction effects revealed that the combination of transplanting and herbicide application at 2 WAS produced the highest grain yield across both years, although interaction was significant only for grain yield per hectare. This suggests that optimal rice productivity is achieved when appropriate planting methods are integrated with timely weed management practices.

Overall, the study concludes that transplanting combined with herbicide application at 2 WAS is the most effective agronomic practice for maximizing growth and grain yield of FARO-44 rice variety under the conditions of Badeggi, Niger State, Nigeria.

Recommendations

Based on the study's findings, the following recommendations are made:

1. Transplanting is the recommended planting method for improved rice productivity in the study area.
2. Applying herbicides at 2 weeks after sowing (2 WAS) is recommended to enhance rice production.
3. For optimal results, combine transplanting with herbicide application at 2 WAS to boost rice growth, development, and yield, and maximize profits.

4. As a suitable alternative to transplanting, dibbling wet sowing with 2 WAS herbicide application is recommended for the study area.

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