Journal of Agriculture and Agricultural Technology

(JAAT)

Journal of Agriculture and Agricultural Technology 14 (3), 2025

GROWTH AND YIELD OF RICE (*Oryza sativa* L.) AS INFLUENCED BY PLANTING METHODS AND WEED MANAGEMENTIN BADEGGI AND LAFIA, NIGERIA

*** [1]Lawal, A.O., [2]Ibrahim, A.J., Amana, S.M., [1]Mangwa, I.J., Mohammed, A.B., Dogo, A.S.**

* [1] Department of Agronomy, Nasarawa State University Keffi, Nasarawa State, Nigeria.

[2] Department of Agronomy, Federal University Lafia, Nasarawa State, Nigeria.

[3]Department of Horticulture, Federal University of Technology Minna, Niger State, Nigeria.

[4] National Cereals Research Institite Badeggi, Niger State, Nigeria.

Lawalabdulafeesolasupo@gmail.com

*Corresponding Author: Phone: 07087474496

ABSTRACT

A multi-locational field experiment was conducted during the rainy seasons of 2022 at the Teaching and Research Farm of the Faculty of Agriculture, Nasarawa State University, Keffi Shabu-Lafia Campus, and at the National Cereals Research Institute, Baddegi, Niger State, Kusotachi experimental site to study the influence of planting method, weed management on growth and yield of lowland rice in Baddegi and Lafia. The treatment was a factorial combination of two planting methods (dibbling and transplanting), six methods of weed control (weedy check, hoe weeding at 3 and 6 WAS, Cyhalofop-butyl + MCPA, Metsulfuron methyl, MCPA 2–methyl–4–chlorophenoxyacetic acid, Pretilachlor + Pyribenzoxium), and two locations (Lafia and Badeggi) laid in a split-split plot design in three replications. Location *was assigned to the main plot, planting method to the sub-plot, and weed management to the sub-sub-plot. The results showed that rice grown at Badeggi recorded taller plants and higher grain yield. In contrast, Lafia produced shorter plants but higher tiller number, crop resistance index, and weed control efficiency in both years. The transplanting method significantly enhanced plant height, tillering ability, crop resistance index, weed control efficiency, and grain yield compared with dibbling across locations. Weed management practices also influenced growth and yield. Late applications of Pretilachlor + Pyribenzoxim produced the tallest plants, while both early and late applications of MCPA consistently resulted in higher grain yield, crop resistance index, and weed control efficiency. The weedy check performed the worst across all parameters. These findings suggest that Badeggi provides a more favourable environment for rice production, while the transplanting method combined with the timely application of MCPA enhances competitiveness against weeds and improves grain yield across locations*.

Key words: Rice, location, planting method, weed management, grain yield.

INTRODUCTION

Rice (Oryza sativa L.) is a primary food crop cultivated widely over 161 million hectares in more than 100 countries across the globe (FAOSTAT, 2020). Globally, rice ranks third in production after wheat and maize (Ejebe, 2013). It is cultivated on almost 11% of the earth's cultivated land and across a wide range of ecosystems (Oluwaseyi *et al*., 2016). China and India account for 28% and 22% of global rice production, respectively (Bandumula, 2018).

Rice is a major staple food in many parts of the world. It supplies more carbohydrates, proteins, fats, and also minerals needed for survival and a healthy life (Ejebe, 2013). Rice supplies about 50% of the total daily calories in the human diet and is a source of income for more than 100 million households worldwide (Muthayya *et al*., 2014). It stands out as the major food crop for about half of the human race, and consumption of rice is growing faster than that of any other staple in Africa and worldwide, simply because it has become a convenient food for the growing world population (Oluwaseyi *et al*., 2016). All over the world, increases of 26% and 50% are demanded in rice production to meet the needs of the growing human population by 2035 and 2050, respectively (Rao *et al*., 2017).

In Nigeria, demand for rice has increased steadily over the past decades, while demand for sorghum and millet fluctuates annually. Rice demand in Nigeria was estimated at 5 million metric tons, while local production was around 2.21 million metric tons, and about 2.79 million metric tons were imported to bridge the gap (Udah *et al*., 2021). However, rice production is affected by weeds. Weeds are among the major pests in agriculture, competing with crops for nutrients through rapid growth and development.

In a paddy field, weeds compete with rice plants for available nutrients, water, light, and space. Under adverse conditions, weeds negatively affect leaf architecture, plant developmental patterns, plant growth cycles, tillering ability, and yield and yield attributes of rice (Materu *et al*., 2018). Transplanting is the most common method of planting rice, while dibbling and broadcasting are reported to be gaining ground (Gill *et al*., 2014). Akhgari and Kaviani (2011) defined dibbling (direct seeding) of rice as the process of establishing a rice crop from seeds sown in the field rather than by transplanting rice seedlings from the nursery. It helps rice farmers reduce production costs. Poor weed management is also responsible for reductions in rice yield, depending on weed type and infestation level (Neog *et al*., 2015). A good weed management program is essential throughout crop growth to overcome various weed challenges. Manual weed control is not a quick method; thus, it requires a lot of time and labour. Herbicides provide effective, economical, and rapid weed control when applied at a proper dose and at the appropriate stage of crop growth (Bhullar *et al*., 2018). Among all measures taken in rice weed control, chemical weed control is commonly used to overcome weed infestation. It is reliable, easy, quick, time-saving, and cost-effective. Rice growers in Nigeria give little attention to the use of metsulfuron-methyl, cyhalofop-butyl + MCPA, quinclorac, pyrazosulfuron-ethyl, MCPA (2-chloro-4-diphenoic acid), and pretilachlor + Pyribenzoxim herbicides for weed control in rice production due to a paucity of information about these herbicides. However, this study aims to evaluate the effects of these herbicide applications under two locations and two planting methods (dibbling and transplanting) on rice production. The objective of this study, therefore, is to determine the effects of planting methods and weed management on weed control, growth, and yield of lowland rice in two locations in Nigeria.

MATERIALS AND METHODS

The field experiment was conducted at two locations during the 2022 cropping season at the Teaching and Research Farm (of the Faculty of Agriculture, Shabu-Lafia Campus, Nasarawa State University Keffi, Nasarawa State, Latitude 08.330N, Longitude 08.330E) and at the National Cereals Research Institute (NCRI), Badeggi, Niger State, at experimental site Kusotachi, latitude 9°3'24.58 "N, Longitude 6°08′36.31″ E). The treatment was a factorial combination of two locations (Lafia and Badeggi), two planting methods (dibbling and transplanting) and six methods of weed control (Weedy check, Hoe weeding at 3 and 6 WAS, cyhalofop-butyl + MCPA at the rate of 3 L a.i/ha, Metsulfuron methyl at the rate of 250 g a.i/ha, MCPA (2 chloro 4 diphenoic acid), at the rate of 1 kg a.i/ha and Pretilachlor + Pyribenzoxim at the rate of 1.25 L a.i/ha at 0 and 6 WAS thus all the herbicide applied base on the treatment combination were carried out as early and late timing of application and were laid in a split-split plot design in three replications. Location was assigned to the main plot; planting method to the sub plot; and weed management to the sub-sub plot. Treatment was laid out in a split-split plot design and replicated three times. The gross plot size was 3 m x 4 m (12 m^2) while the net plot size was 1.5 m x 4m (6 m^2). Before field establishment, the experimental site was cleared using a pre-planting herbicide (Glyphosate 1.08kg a.i/ha), applied with a 15 L knapsack sprayer. The soil was ploughed manually, and the site was marked into plots. A one-meter unplanted border was maintained between plots, while a 0.5 m unplanted border was maintained between each replication. Rice seed (FARO 44) was pre-soaked for 1 day for both dibbling (80kg/ha) and transplanting (40kg/ha), then removed and placed in a jute bag. After 2 days of sprouting, the pre-germinated seeds were sown (dibbling) on the same day the nursery bed was prepared for transplanted seedlings. The nursery was ready in dry soil conditions on a 3 by 4 m wide seed bed, with the topmost soil filled to a 10 cm level before the pre-germinated seeds were broadcast and later covered with a layer of half-burned paddy husk to facilitate uprooting. A 21-day-old seedling was later transplanted from the nursery bed to the permanent field, with one seedling sown per hole. A spacing of 20 cm by 20 cm between and within the plants was maintained for both planting methods. Broadcasting methods of fertilizer application were used at 3 WAS, with NPK fertilizer applied at 20 kg N/ha, 10 kg P2O5/ha, and 10 kg K2O/ha. After 6 WAS, N in the form of UREA was applied at 46 kg N/ha.

Five randomly selected tagged plants from each plot were used for periodic observation during the crop growth periods at 4, 6, 8, 10, and 12 WAS. The net plot was harvested manually, grain collected, dried to 13.5% moisture content, and the weight was recorded. This was determined by weighing grains from the net plot, dividing by net area, and multiplying by 10,000. Grain yield × 10,000 (Bukar and Lassa, 2021). The data were subjected to analysis of variance (ANOVA) using Statistica software, while the Least Significant Difference (LSD) was used to separate treatment means at the 5% level of probability.

RESULTS AND DISCUSSION

The results of the physical and chemical soil analyses before land preparation in Lafia and Badeggi revealed that the soil was sandy clay and sandy loam, respectively, with slightly acidic pH (Table 1). The results also indicated that organic carbon, total nitrogen, and available phosphorus were low in both locations. However, there is a moderate amount of calcium, sodium, and potassium in both locations, whereas potassium and sodium were high. Conversely, the cation exchange capacity (CEC) was high at Lafia and low at Baddegi.

The results of the meteorological distribution obtained from Lafia showed that the average annual relative humidity was 786.65%, average solar radiation was 117.4 MJ/m2/day, average sunshine was 76.46 hours, average minimum temperature was 278.2 °C, and average maximum temperature was 419.6 °C. Total annual rainfall was 2499 mm. At the Badeggi location, the average yearly relative humidity was 71.61%, the annual average solar radiation was 180.54 MJ/m2/day, and the average yearly sunshine was 63.11 hours. Annual minimum temperature was 279.4 °C, average yearly maximum temperature was 407.57 °C, and the annual total rainfall was 1458 mm in the year 2022 (Figure II - VII).

Plant height differed significantly at 4, 6, 8, 10, and 12 weeks after sowing (WAS) for rice across locations, planting methods, and weed management (Table 2). Generally, the Badeggi location consistently produced taller plants than the Lafia location, which consistently recorded shorter plants throughout the sampling periods in this study. The planting method had a significant effect on plant height at 10 and 12 WAS in this study. The transplanting method consistently produced significantly taller plants than the dibbling method, which consistently produced shorter plants.

Weed management had a significant effect on rice plant height across the study's sampling periods. The weedy check and early and late applications of Cyhalofop + MCPA produced taller plants than the other weed controls, which recorded shorter plants at 4 WAS. At 6 WAS, early application of Metsulforun methyl produced significantly taller plants, not statistically different from the weedy check, early application of Cyhalofop + MCPA, and early application of Pretilachlor + Pyribenzoxium, compared with late application of MCPA, which produced the shortest plants. At 8 WAS, weedy check recorded the tallest plants, which were statistically similar to 2 HW at (3 + 6 WAS), early and late applications of Metsulforun methyl, early and late applications of Cyhalofop butyl + MCPA, early application of Pretilachlor + Pyribenzoxium, and late application of Pretilachlor + Pyribenzoxium recorded shorter plants. At 10 WAS, the use of 2 HW at (3 + 6 WAS), early applications of Metsulforun methyl, and late application of Pretilachlor + Pyribenzoxium produced taller plants than all other weed controls, whereas early and late applications of MCPA produced shorter plants that were statistically similar. At 12 WAS, late applications of Pretilachlor + Pyribenzoxim produced significantly taller plants than all other weed controls, whereas late applications of Cyhalofop butyl + MCPA produced the shortest plants.

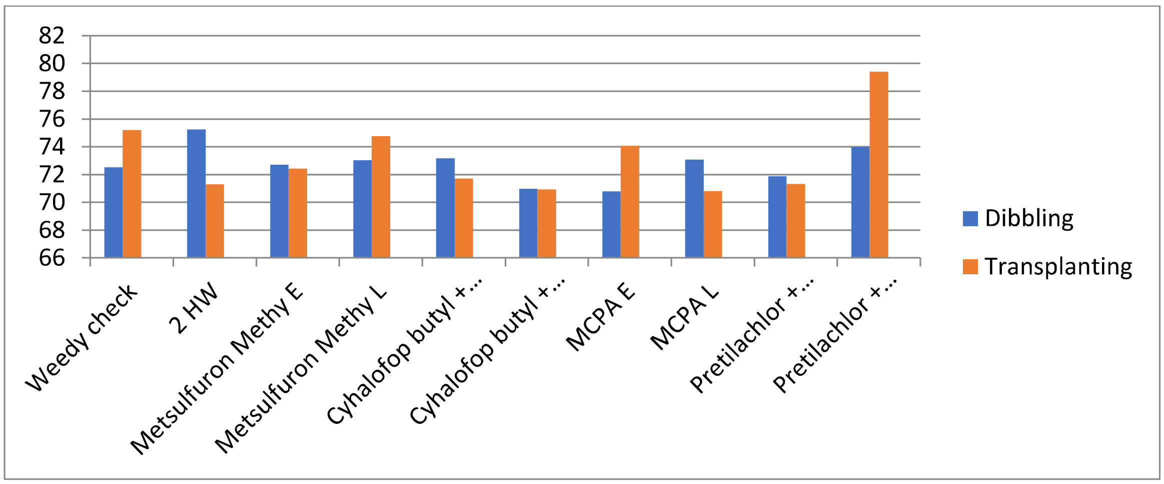
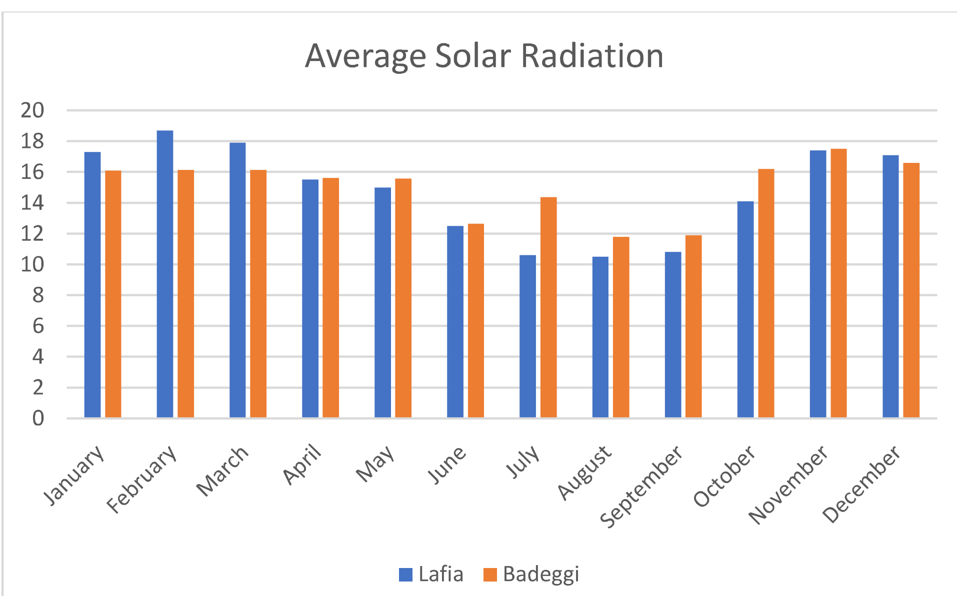


Figure I: Theinteraction between planting method and weed control on plant height



.

Figure II: Average solar radiation of Lafia and Badeggi.

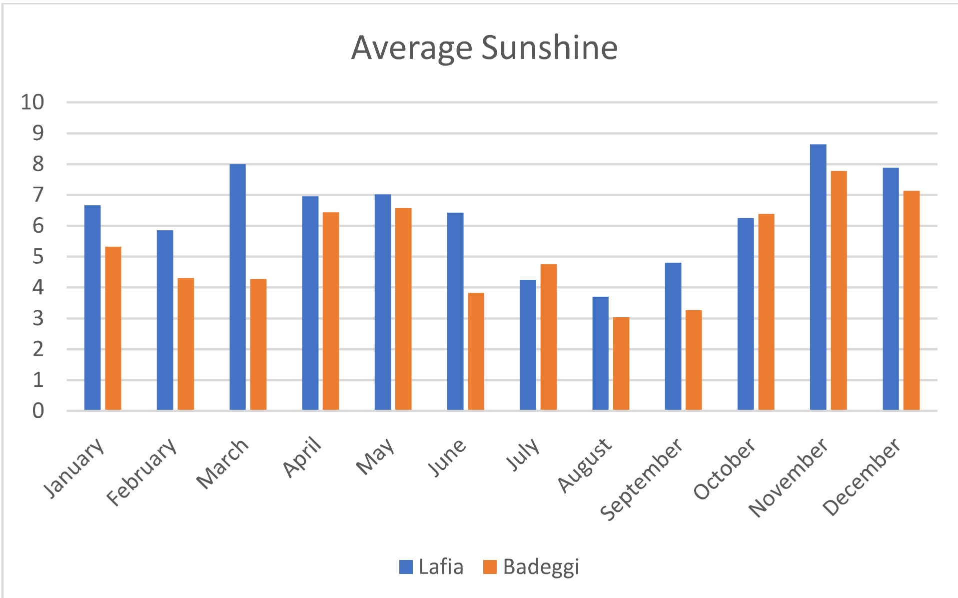


Figure III: Average sunshine hours of Lafia and Badeggi.

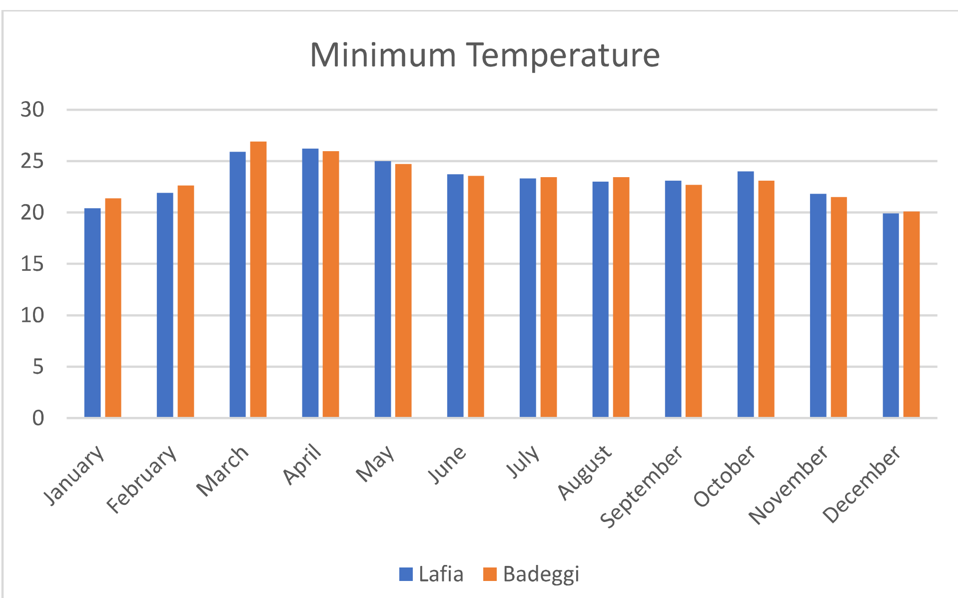


Figure IV: Minimum temperature of Lafia and Badeggi.

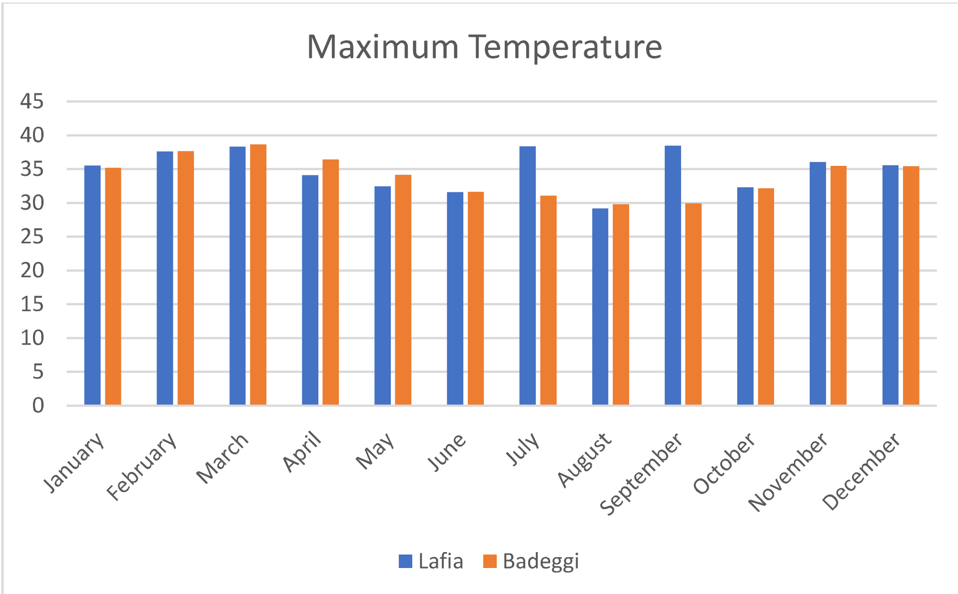


Figure V: Maximum temperature of Lafia and Badeggi.

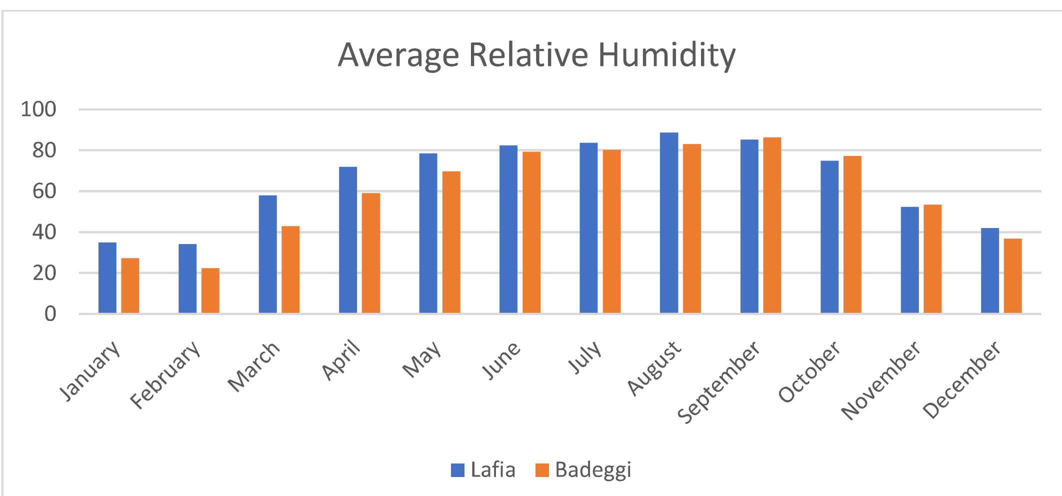


Figure VI: Average relative humidity of Lafia and Badeggi.

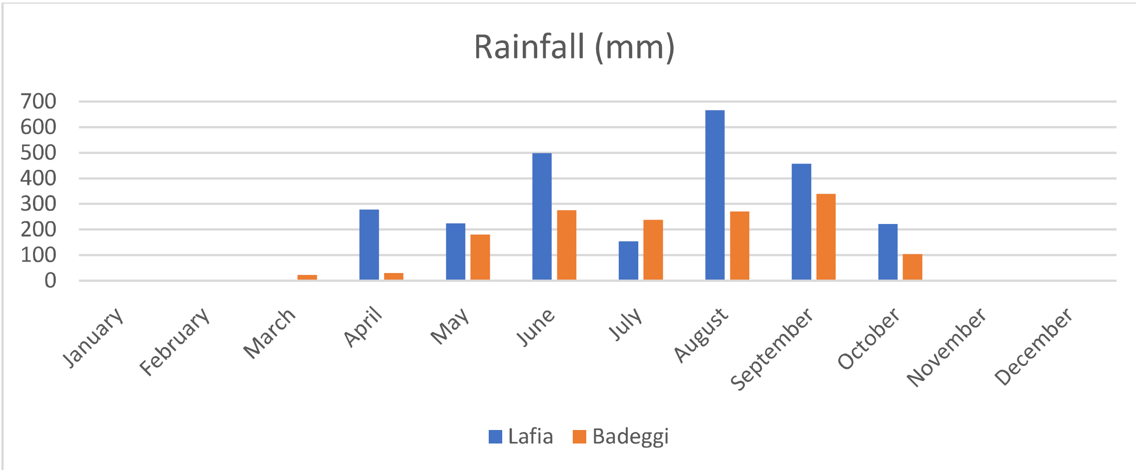


Figure VII: Monthly rainfall of Lafia and Badeggi.

Table 1: Physical and Chemical Properties (0 – 15 cm depth) of the Experimental soil before Planting at Lafia and Badeggi in 2022 Wet Season

Parameters	Lafia	Badeggi
Physical properties (%)		
Clay	21.6	20
Silt	5.4	5.4
Sand	73	74.6
Textural class	Sandy clay	Sandy loam
Chemical properties		
pH (H_2O)	5.7	6.9
pH ($CaCl_2$)		
Organic carbon (%)	1.91	1.80
Total nitrogen (%)	0.21	0.28
Available phosphorus (PPM)	3.20	8.43
Ca^{2+}	2.25	3.21
Mg^{2+}	1.22	2.15
K^+	0.24	0.30
Na^+	0.14	0.19
Exchangeable bases (cmol kg^{-1})	3.85	5.85
Exchangeable acid (cmol kg^{-1})	0.78	0.67
CEC	4.63	6.52

Table 2: Effect of location, planting methods and weed control on plant height at 4 - 12 WAS of rice

	Plant height (cm)				
Treatment	4 WAS	6 WAS	8 WAS	10 WAS	12 WAS
Location (L)					
Lafia	21.92a	28.70b	32.54b	49.92b	66.34b
Badeggi	37.76a	54.91a	59.35a	69.81a	79.48a
LSD (0.05)	0.578	1.954	3.071	0.883	1.304
Planting method (PM)					
Dibbling	29.78a	41.69a	46.28a	59.52b	72.56b
Transplanting	29.89a	41.93a	45.61a	60.21a	73.29a
LSD (0.05)	0.473	0.274	2.159	0.382	0.232
Weed management (WM)					
Weedy check	30.27a	42.87ab	47.55a	59.55bc	73.86b
2 HW (3 + 6 WAS)	29.20b	42.31bc	46.86ab	61.49a	73.28bc
Metsulforun Methyl (E)	29.19b	43.34a	47.28ab	61.33a	72.58de
Metsulforun Methyl (L)	29.64b	41.54de	46.56ab	59.41c	73.90b
Cyhalofopbuthyl + MCPA (E)	30.31a	42.67ab	47.17ab	58.60d	72.44e
Cyhalofopbuthyl + MCPA (L)	30.46a	40.30fg	47.03ab	59.68bc	70.94g
MCPA (E)	29.58b	40.94ef	45.60abc	57.48e	72.44e
MCPA (L)	29.28b	39.98g	43.68bc	57.22e	71.95ef
Pretilachlor + Pyribenzoxium (E)	29.55b	42.63ab	45.74abc	60.24b	71.61f
Pretilachlor + Pyribenzoxium (L)	29.28b	41.80cd	42.02c	61.98a	76.68a
LSD (0.05)	0.585	0.740	3.83	0.706	0.654
Interaction					
L × PM	NS	NS	NS	NS	NS
L × WM	NS	NS	NS	NS	NS
PM × WM	NS	NS	NS	NS	*
L × PM × WM	NS	NS	NS	NS	NS

Means in the same column followed by the same letters are not significantly different according to Fisher's protected LSD test (P <0.05);[1]Weeks after sowing; Early[2]; Late[3]; [4]Significant difference at 5% level of probability; [5]Not significant.

Figure 1 shows the interaction between planting method and weed control on plant height at 12 WAS was significant. The combination of transplanting method with late application of Pretilachlor + Pyribenzoxim produced the tallest plants, whereas the combination of dibbling method with early application of MCPA produced the shortest plants.

The effect of planting method and weed control on the number of tillers per plant of rice at 5 - 7 WAS is shown in Table 3 below. Location significantly affected the number of tillers: Lafia consistently produced significantly more tillers than Badeggi, which consistently recorded fewer tillers per plant. The number of tillers per plant was significantly different among planting methods at 7 WAS in this study only. The transplanting method produced significantly more tillers per plant than the dibbling method. Weed management had a significant effect on the number of tillers per plant at 5-7 WAS in this study. At 5 WAS, late application of MCPA produced significantly more tillers per plant than all other weed controls, whereas late application of Pretilachlor + Pyribenzoxium produced the lowest number of tillers per plant, which was not statistically different from 2 HW (3+6 WAS) or early application of Pretilachlor + Pyribenzoxium. At 6 WAS, early application of MCPA produced significantly more tillers per plant than all the other weed controls compared with the weedy check and late application of Pretilachlor + Pyribenzoxium, which consistently produced fewer tillers per plant, though similar with 2 HW (3 + 6 WAS), early application of Metsulforun Methyl, late application of Metsulforun Methyl and early application of Pretilachlor + Pyribenzoxium. At 7 WAS, early application of MCPA significantly produced more tillers per plant than all the other weed controls compared with the weedy check, 2 HW (3 + 6 WAS), and early application of Cyhalofop butyl + MCPA, which had the lowest number of tillers, though statistically not different from late application of Cyhalofop butyl + MCPA.

The effects of planting method and weed management on rice grain yield are presented in Table 3. Location differed significantly in grain yield, with Badeggi producing the highest yield and Lafia the lowest. The planting method had a significant effect on rice grain yield. The transplanting method recorded the highest grain yield, while the dibbling method recorded the lowest at Lafia. Weed management also significantly affected rice grain yield, with early and late MCPA applications yielding statistically similar maximum grain yield; these yields were, however, higher than those of all other weed management methods. The weedy check recorded the lowest grain yield.

The effects of planting method and weed control on the crop resistance index and weed control efficiency of rice are presented in Table 4. The Lafia location had a higher crop resistance index than the Badeggi location, which had the lowest. Weed control efficiency was highest at Lafia, compared with Badeggi, which recorded the lowest.

The planting method significantly affected all the parameters. The transplanting method produced the highest crop resistance index and weed control efficiency, while the dibbling method recorded the lowest.

Weed control also had a significant effect on all the parameters. Early application of MCPA produced the highest crop resistance index among all other weed controls. The weedy check gave the lowest crop resistance index. The late application of MCPA achieved the highest weed control efficiency among all other weed controls. The weedy check had the lowest weed control efficiency.

The interaction between planting method and weed control on crop resistance index and weed control efficiency was significant Table 5. The combination of transplanting with early application of MCPA produced the highest crop resistance index, followed by the dibbling-and-transplanting method, and the weedy check recorded the lowest. The combination of transplanting method with late application of MCPA significantly produced the highest weed control efficiency compared to all the other combinations, compared with the combination of dibbling and transplanting methods with weedy check, which produced statistically similar lowest weed control efficiency.

Table 3: Effect of location, planting methods and weed management on number of tillers and grain yield

	Number of tillers			
Treatment	5 WAS	6 WAS	7 WAS	Grain yield kg/ha
Location (L)				
Lafia	4.31a	10.42a	13.09a	4164.6b
Badeggi	4.01b	6.28b	10.18b	4313.8a
LSD (0.05)	0.11	1.51	0.68	124.34
Planting method (PM)				
Dibbling	4.27a	8.26a	10.97b	3891.5b
Transplanting	4.04a	8.43a	12.30a	4586.8a
LSD (0.05)	0.25	0.18	0.28	22.08
Weed management (WC)				
Weedy check	4.15b-e	8.10d	10.74e	1533.7i
2 HW (3 + 6 WAS)	3.91ef	8.13cd	10.82e	3519.6h
Metsulforun Methyl (E)	4.48ab	8.18cd	11.62cd	5457.9b
Metsulforun Methyl (L)	4.23b-e	8.28bcd	11.70c	5268.7c
Cyhalofopbuthyl + MCPA (E)	4.10cde	8.21bcd	10.97e	4519.6e
Cyhalofopbuthyl + MCPA (L)	4.28a-d	8.66ab	11.12de	4615.0d
MCPA (E)	4.12cde	9.02a	14.12a	6089.6a
MCPA (L)	4.61a	8.58abc	13.18b	6056.3a
Pretilachlor + Pyribenzoxium (E)	3.98def	8.19bcd	11.75c	3868.8f
Pretilachlor + Pyribenzoxium (E)	3.67f	8.05d	11.69c	4577.1d
LSD (0.05)	0.34	0.47	0.57	54.47
Interaction				
L × PM	NS	NS	NS	NS
L × WC	NS	NS	NS	NS
PM × WC	NS	NS	NS	NS
L × PM × WC	NS	NS	NS	NS

Means in the same column followed by the same letters are not significantly different according to Fisher's protected LSD test (P <0.05);[1]Weeks after sowing; Early[2]; Late[3]; [4]Significant difference at 5% level of probability; [5]Not significant

Table 4: Effect of location, planting methods and weed control on weed persistence index, crop resistance index, and weed control efficiency of rice

Treatment	Crop resistance index	Weed control efficiency
Location (L)		
Lafia	5.34a	63.82a
Badeggi	5.33b	63.17b
LSD (0.05)	3.64	0.203
Planting method (PM)		
Dibbling	5.13b	59.85b
Transplanting	5.55a	67.14a
LSD (0.05)	0.031	0.243
Weed management (WM)		
Weedy check	1.00f	0.00j
2 HW (3 + 6 WAS[1])	4.32e	67.45i
Metsulforun Methyl (E)[2]	7.56b	81.84c
Metsulforun Methyl (L)[3]	7.84b	80.89d
Cyhalofopbuthyl + MCPA (E)	5.34d	74.09f
Cyhalofopbuthyl + MCPA (L)	6.07c	76.08e
MCPA (E)	8.45a	84.56b
MCPA (L)	7.75b	87.19a
Pretilachlor + Pyribenzoxium (E)	5.42d	69.58h
Pretilachlor + Pyribenzoxium (L)	5.25d	70.94g
LSD (0.05)	0.390	0.613
Interaction		
L × PM	NS	NS
L × WM	NS	NS
PM × WM	*	*
L × PM × WM	NS	NS

Means in the same column followed by the same letters are not significantly different according to Fisher's protected LSD test (P <0.05);[1]Weeks after sowing; Early[2]; Late[3]; [4]Significant difference at 5% level of probability; [5]Not significant.

Table 4: Interaction between planting method and weed control on weed persistence index, treatment efficient index, crop resistance index, weed management index and weed control efficiency of rice

	Weed management									
	Weedy check	2 HW	Metsulforun Methyl (E)	Metsulforun Methyl (L)	Cyhalofopbuthyl + MCPA (E)	Cyhalofopbuthyl + MCPA (L)	MCPA (E)	MCPA (L)	Pretilachlor + Pyribenzoxium (E)	Pretilachlor + Pyribenzoxium (L)
Planting method	**Crop resistance index**									
Dibbling	1.00i	4.57g	7.25d	7.40cd	5.40f	5.59f	7.23d	7.34cd	5.20f	5.22f
Transplanting	1.00i	4.08gh	7.87bc	8.28b	5.28f	6.55e	9.68a	8.15b	5.64f	5.29f
LSD (0.05)					0.560					
	Weed control efficiency									
Dibbling	0.00o	64.88n	74.85f	73.37g	69.83k	70.85ij	77.88e	81.32d	68.32l	70.25jk
Transplanting	0.00o	70.02jk	88.83c	88.42c	78.35e	81.32d	91.23b	93.07a	70.83ij	71.63hi
LSD (0.05)					0.867					

Means in the same column followed by the same letters are not significantly different according to Fisher's protected LSD test (P <0.0

DISCUSSION

The results of this study revealed significant variations in plant height, tiller production, yield, crop resistance index, and weed control efficiency of rice across locations, planting methods, and weed management practices.

Effect of Location

Location significantly influenced rice growth and yield performance. Badeggi consistently produced taller plants and higher grain yield, whereas Lafia recorded shorter plants but higher tiller number, crop resistance index, and weed control efficiency. This suggests that environmental conditions at Badeggi were more favorable for vegetative growth and yield accumulation, whereas those at Lafia favored greater tillering and better crop-weed competition. Similar location-dependent differences in rice performance were reported by Ekeleme *et al*. (2019), who found that rice growth and yield varied significantly across Nigerian agro-ecologies due to differences in soil fertility, rainfall distribution, and weed pressure. Likewise, Adigbo *et al*. (2020) observed that rice yield potential varied across environments, underscoring the strong influence of location-specific factors. Lafia recorded higher values than Badeggi, likely reflecting the stronger weed pressure and crop-weed interaction at Lafia.

Effect of Planting Method

The planting method significantly affected rice growth and yield attributes. Transplanting consistently produced taller plants, more tillers, a higher crop resistance index, greater weed control efficiency, and ultimately higher grain yield than dibbling. The superiority of transplanting could be due to better crop establishment, vigorous early growth, and enhanced canopy cover that suppressed weed emergence. This agrees with the findings of Oloyede *et al*. (2021), who reported that transplanting rice yielded higher yields and better weed suppression than direct seeding methods transplanting consistently enhanced both crop resistance and weed control efficiency, demonstrating its advantage in ensuring a competitive rice stand. Similar findings were reported by Singh *et al*. (2020), who observed that transplanted rice had significantly lower weed biomass and higher weed control efficiency compared with direct-seeded rice under temperate conditions.

Effect of Weed Management

Weed management significantly influenced all measured rice parameters. Plant height response varied across sampling periods, with the weedy check producing taller plants at early growth stages, likely due to competition-induced etiolation, as noted by Rao *et al*. (2019). However, consistent and practical herbicide applications such as Metsulfuron methyl, Cyhalofop + MCPA, and Pretilachlor + Pyribenzosulfuron ensured better growth at later stages.

For tiller production, MCPA application (both early and late) consistently gave the highest number of tillers, while Pretilachlor + Pyribenzosulfuron produced fewer tillers, indicating differential crop-herbicide interactions. These findings align with those of Yusuf *et al*. (2022), who observed that selective herbicides differ in their effects on rice tillering.

Grain yield was highest under early and late MCPA applications, suggesting that MCPA provided the most effective weed suppression, thereby reducing competition and allowing better assimilate partitioning into grain. The weedy check yielded the least, underscoring the yield penalty of weed competition. This aligns with the report of Mamadou *et al*. (2020), who stated that uncontrolled weed infestation in rice fields can cause up to 80% yield losses.

Among weed control treatments, early application of MCPA gave the highest crop resistance index, while late application of MCPA recorded the highest weed control efficiency. This indicates that the timely and strategic application of MCPA is crucial for maximizing both rice competitiveness and weed suppression. Similar results were obtained by Ndiritu *et al*. (2021), who highlighted that proper timing of herbicide use is critical in achieving maximum weed control efficiency in rice systems.

Interaction Effects

The interaction between planting method and weed management was significant for plant height, crop resistance index, and weed control efficiency. The combination of transplanting with late application of Pretilachlor + Pyribenzosulfuron gave the tallest plants. In contrast, transplanting combined with early MCPA produced the highest crop resistance index, and transplanting with late MCPA recorded the highest weed control efficiency. These findings emphasize that optimal integration of planting method and herbicide strategy can greatly enhance rice growth and competitiveness against weeds. This corroborates the report of Johnson *et al*. (2018), who found that integrated weed management, combining an appropriate establishment method and herbicide application, improves rice productivity.

CONCLUSION

The study found that rice performance was significantly influenced by location, planting method, and weed management practices. Rice grown at Badeggi consistently produced taller plants and higher grain yield, whereas rice at Lafia recorded shorter plants but higher tiller number, crop resistance index, and weed control efficiency. These findings demonstrate that site-specific environmental conditions strongly determine rice growth and productivity. The transplanting method proved superior to dibbling across most measured parameters, and transplanting produced taller plants, higher tiller number, greater crop resistance index, higher weed control efficiency, and ultimately higher grain yield. This confirms that transplanting is a more reliable method for achieving better crop establishment, greater weed competitiveness, and enhanced yield performance. Weed management significantly influenced plant height, tillering, yield, and rice competitiveness. At early growth stages, the weedy check produced taller plants due to competition-induced elongation, while late application of Pretilachlor + Pyribenzosulfuron produced the tallest plants at maturity. The application of MCPA consistently enhanced tillering, yield, crop resistance index, and weed control efficiency. The weedy check showed the lowest overall performance, highlighting the severe impact of uncontrolled weeds on rice productivity.

RECOMMENDATIONS

Based on the context of this study, the following recommendations are made:

1. Rice cultivation at Badeggi should be prioritized for higher yield potential, while production at Lafia requires more targeted management to optimize crop competitiveness and weed suppression.
2. The transplanting method should be adopted over dibbling for sustainable rice production, as it ensures better crop establishment, stronger weed competition, and higher yield.
3. The timely application of selective herbicides, such as MCPA, should prioritize effective weed control. Early or late applications can be used to maximize both yield and weed control efficiency. Integrated approaches combining transplanting with MCPA are particularly recommended for enhanced rice productivity.

REFERENCES

Adigbo, S.O., Oikeh, S.O.andOkebalama, C. B. (2020). Environmental variation and performance of rice under contrasting agro-ecological zones in Nigeria. *Journal of Agronomy and Crop Science*, 206(3): 412–421.

Akhgari, H. And Kaviani, B. (2011). Assessment of direct seeded and transplanting methods of rice cultivars in the northern part of Iran.*African Journal of Agricultural Research*, 6(31): 6492-6498.

Bandumula, N. (2018). Rice production in Asia: Key to global food security. *Proceedings of the National Academy of Sciences, India Section B: Biological Sciences*, *88*, 1323-1328.

Bhullar, M.S., Singh, S., Kumar, S. and Gill, G. (2018). Agronomic and economic impacts of direct seeded rice in Punjab. *Agricultural Research Journal*, 55(2): 236-242.

Bukar, B.and Lassa, I.A. (2021). Performance of pearl millet (*Pennisetum glaucum* (L.) R. Br.) varieties as influenced by seed priming substances in Sudan Savanna. *Journal of Agricultural Economics, Environment and Social Sciences*, 7(1): 14–17.

Ejebe, C.K. (2013). Parboiling characteristics of selected rice varieties from Nigeria. A thesis submitted to McGill University in partial fulfilment of the requirements of the degree of masters of science. 1 – 73.

Ekeleme, F., Kamara, A.Y., Omoigui, L.O., Tegbaru, A. andAkinwale, R.O. (2019). Influence of environment on weed infestation and rice yield across agro-ecological zones of Nigeria. *Field Crops Research*, 235: 82–91.

Food and Agriculture Organization of the United Nations. (2020). Crops and livestock products [Data set]. FAOSTAT. https://www.fao.org/faostat/en/#data/QCL

Gill, J.S., Walia, S.S. and Gill, R.S. (2014). Direct seeded rice: an alternative rice establishment technique in north-west India: a review. *International Journal of Advanced Research*, 2(3): 375-386.

Johnson, D.E., Dingkuhn, M., Jones, M.P. and Mahamane, M.C. (2018). Integrated weed management strategies for lowland rice in sub-Saharan Africa. *Field Crops Research*, 219(4): 29–39.

Mamadou, A., Bako, M. And Harouna, A. (2020). Yield losses in rice due to uncontrolled weed infestations in West African ecologies. *Weed Research*, 60(5): 339–347.

Materu, S.T., Shukla, S., Sishodia, R.P., Tarimo, A. And Tumbo, S. D. (2018). Water use and rice productivity for irrigation management alternatives in Tanzania. *Water*, 10(8): 10-18.

Muthayya, S., Sugimoto, J.D., Montgomery, S. And Maberly, G.F. (2014). An overview of global rice production, supply, trade, and consumption. *Annals of the New York Academy of Sciences*, 1324(1): 7-14.

Udah, S.C., Ijioma, J.C. and Ani, M. (2021). Analysis of rice marketing in ohaozara local government area of Ebonyi State, Nigeria. *Journal of Agriculture, Research and Advance*, 3: 12-24.

Ndiritu, J., Kamau, J. and Musyoka, M. (2021). Timing of herbicide application and its influence on weed control efficiency in irrigated rice systems of East Africa. *Crop Protection*, 145-150.

Neog, P., Dihingia, P.C., Sarma, P.K., Sankar, G.R., Sarmah, D., Sarmah, M.K. and Mishra, P.K. (2015). Different Levels of Energy Use and Corresponding Output Energy in Paddy Cultivation in North Bank Plain Zone of Assam, India. *Indian Journal of Dryland Agricultural Research and Development*, 30(2): 84-92.

Oloyede, F.M., Salami, A.O. and Lawal, B.O. (2021). Effect of planting methods on weed suppression and productivity of lowland rice. *Journal of Plant Protection Research*, 61(2): 152–161.

Oluwaseyi, A.B., Nehemmiah, D. and Zuluqurineen, S.B. (2016). Genetic improvement of rice in Nigeria for enhanced yield and grain quality: a review. *Asian Research Journal of Agriculture*, 1(3): 1-18.

Rao, A.N., Johnson, D.E., Sivaprasad, B., Ladha, J.K.and Mortimer, A.M. (2017). Weed management in direct-seeded rice. *Advances in Agronomy*, 93: 153-255.

Rao, A.N., Johnson, D.E., Sivaprasad, B., Ladha, J.K.and Mortimer, A.M. (2019). Weed management in direct-seeded rice: Issues and opportunities. *Advances in Agronomy*, 156: 219–263.

Singh, R., Bhullar, M.S. and Gill, G. (2020). Comparative analysis of rice and weeds under transplanting and direct-seeded methods in temperate environments. *Agronomy*, 10(4): 816-820.

Yusuf, A.A., Ibrahim, S. And Bala, A. (2022). Response of rice tillering and yield to selective herbicides under lowland conditions in Nigeria. *Nigerian Journal of Weed Science*, 35(1): 45–55.