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Growth Responses of Direct Seeded Upland Rice (Oryza species) Varieties to Seed Rates at Different Sampling Stages

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Abstract
Field trials were conducted at Samaru and Maigana during the 2011 and 2012 wet seasons on the experimental farm of the Institute for Agricultural Research, Ahmadu Bello University Samaru, Zaria and on the Research Farm of the Kaduna State Agricultural Development Programme, Maigana both in the Northern Guinea Savannah agro-ecological zone of Nigeria to determine the growth responses of direct seeded upland rice varieties to seed rates. The treatments consisted of three upland rice varieties (NERICA 4, 8 and JAMILA), three sowing methods (broadcasting, drilling and dibbling) and three seed rates (40, 80 and 120 kg ha^{-1}). The treatments were laid out in a split plot design and were replicated three times with factorial combinations of sowing methods and seed rates in the main plot and three rice varieties in the sub plots. Results revealed that an increase in seed rates resulted in decrease in plant height at 6WAS in both locations. At Maigana significant reduction was observed on number of tillers at all the sampling periods and at 9WAS, number of leaves as well as leaf area index also decreases as seed rates increased. At Samaru, no significant effect was recorded on number of tillers, number of leaves and leaf area index.) Theree was no significant influence of sowing methods on plant height, number of leaves, tillers and leaf area index throughout the study at both locations. However, there were significant variation and similarity among the varieties used in this study. It was observed that at Samaru, JAMILA produced the tallest plant, more number of leaves and tiller number at all the growth periods while NERICA 8 had the tallest plants, more number of leaves, tiller number and leaf area index. However, NERICA 4 and 8 displayed similarities in number of tillers and number of leaves at one growth stage to another. Based on the result obtained from the study, it can be inferred that JAMILA had better growth performance in Samaru while NERICA 8 Perform better in Maigana. Consequently broadcast or drilled rice performed better at 40 kg ha^{-1} seed rate.
Keywords: Growth, direct seeded, rice varieties and seed rates.

I INTRODUCTION

Rice is the World's most important crop and it is a staple food for more than half of the world population. It provides 30-70% of the calories to more than three billion people (Khush, 2004). Worldwide, rice is grown on 161 million hectares, with annual production of about 678.7 million tons of paddy (FAO 2009). The current production as reported by FAO (2014) was at a global harvest of 741.4 million tonnes. However, the productivity and sustainability of rice based systems are threatened because of insufficient use of inputs such as fertilizers, improved varieties, changing climate, sowing methods and seed rates (Ladha *et al*., 2009). The possibility of expanding the area under rice cultivation and increase yield has to come from a productivity gain through good agronomic management practices such as selection of improved varieties that can adapt to a region, optimum seed rates and sowing method with less labour and water thereby ensuring long-term sustainability. The production factors such as selection of variety plays an important role in enhance the productivity of rice in any location as yields differed significantly among varieties (Das, 2003). In Nigeria, rice is mostly cultivated by transplanting method. The use of transplanting method, though advantageous in terms of economising seeds is very laborious and time consuming. Also the time, energy and money spent in raising the nursery are risky enterprises, as the failure of the nursery may result in failure of the entire transplanted crops.

Transplanting shock is another setback for growth due to uprooting and replanting of seedlings as well as late nursery transplanting which reduces growing period of the crop and resulted in decrease in yield and lower the kernel quality (Ghosh and Singh, 1994). Transplanting also decreases rice seedlings ability to withstand moisture stress and the required plant population (250,000 plants ha^{-1}) cannot be easily maintained through transplanting from the nursery due to scarcity of skilled labour and high cost of this operation (Baloch *et al* 2000). Direct seeding of rice instead of transplanting into puddled soil, offers the potential for water savings, reduced labour demand and improve soil structure. Direct sowing in rice reduces production inputs and with potential benefits of soil structure. To overcome this problem, direct seedling of rice seems only to be the viable alternative in rescuing farmers Santhi *et al*., 1998. Therefore, the objective of this study is to determine growth responses of direct seeded upland rice varieties at different sampling stages to seed rates.

II MATERIALS AND METHODS

The field trials were conducted on the experimental farm of the Institute for Agricultural Research, Ahmadu Bello University Samaru, Zaria and on the Research Farm of the Kaduna State Agricultural Development Programme, Maigana in 2011 and 2012 cropping seasons. Samaru is on the Latitude 11°11[1] N and Longitude 7 °38[1] E and is 686 m above sea level while Maigana is located on Latitude 11°11.06[1] N and Longitude 7.54° 7.58[1] E both in the Northern Guinea Savannah Agro ecological zone of Nigeria. Random samples of soils were taken at depth of 0-30cm from the experimental sites using an auger of 10 cm diameter before land preparation and were analysed for physical and chemical properties.

The treatments consisted of three seeding methods (broadcasting, drilling and dibbling), three seed rates (40, 80 and 120 kg ha^{-1}) and three upland rice varieties (NERICA 4, 8 and JAMILA). The treatments were laid out in a split plot design with the combination of sowing methods and seed rates in the main plots and three rice varieties in the sub plots measuring 3 m x 3 m with a net plot of 2 m x 2 m and were replicated three times. The main plots were separated by a distance of 1 m and the sub plots by 0.5 m. Pre-planting herbicides, glyphosate (round up) was applied to the experimental sites at the rate 2 kg active ingredents ha^{-1} two weeks before land preparation in each year of the study in order to control the prevalent weeds on the field. Thereafter, the field was harrowed twice to ensure fine tilth of the soil and the soil levelled manually.

Seeds of each variety were treated with Apron star as seed dressing chemical at the rate of 1.0 g of metalaxy to 3.0 kg seed to prevent pest attack and the three rice varieties were planted on 13th July 2011 and 9th June 2012 at Samaru while at Maigana, the varieties were planted on 30th July 2011 and 12th June 2012 when the rains were fully stablized using direct seeding such as broadcasting, drilling and dibbling methods. Also hand pulling methods of weed control was used to control the weeds that later emerged at four and eight weeks after sowing. Fertilizers were applied at the recommended rate of 100 kg N ha^{-1}, 50 kg P_2O_5 ha^{-1} and 50 kg K_2O ha^{-1}. The nitrogen fertilizer were applied as split, half of the nitrogen fertilizer together with 50 kg P_2O_5 and 50 kg K_2O ha^{-1} were applied once at two weeks after planting using NPK (15:15:15) while the second half of the nitrogen were applied at panicle initiation stage using urea (46% N). Data were collected on the following parameters; plant height, number of leaves, tiller numbers and leaf area index were analysed using a General Linear Model in SAS and Duncan Multiple Range Test was used to separate the treatment means (Duncan, 1995).

III RESULTS

The response of plant height of three upland rice varieties to seed rates and sowing methods at 3, 6, 9 and 12WAS in 2011 and 2012 wet seasons and the combined at Samaru are presented in Tables 1. At Samaru, seed rates significantly influenced plant height only at 6WAS in 2011 and the combined and at 12WAS in 2012 cropping seasons (Table 1). Sowing rice at 40 kg ha^{-1} seed rate produced taller plants than 80 and 120 kg ha^{-1} while the shortest plants were observed with 120 kg ha^{-1} seed rate though statistically similar with 80 kg ha-^{1}. However, heights of rice obtained with 40 kg ha^{-1} seed rate were in turn at par with that of 80 kg ha^{-1} for the combined at 6WAS in 2011 and at 12WAS in 2012. Sowing methods did not significantly influenced plant height throughout the sampling stages of both years.

There was a significant variation in plant height among the three varieties of upland rice tested at all the sampling periods in both years of the study except at 3WAS in 2012 and the combined. At 3WAS in 2011, JAMILA had taller plants than NERICA 4 and was statistically similar with NERICA 8. However, NERICA 8 in turn was at par with NERICA 4. But at 6WAS in 2011, NERICA 4 significantly recorded tallest plants, followed by NERICA 8 while JAMILA recorded the shortest plants. At 9 and 12WAS in 2011, the height of NERICA 8 was statistically similar with that of JAMILA though shorter than that of NERICA 4. But at 6WAS in 2012 and the combined, NERICA 8 and JAMILA had statistically similar plant height that was taller than that of NERICA 4. During the 9th and 12th WAS in 2012 and the combined, NERICA 4 and 8 recorded shorter plants than JAMILA. The combined for the last sampling period of 12WAS had shown JAMILIA as the tallest, followed by NERICA 4 while the shortest plant was produced by NERICA 8.

Table 1: Effect of seed rates and sowing methods on the height (cm) of three upland rice varieties at Samaru in 2011 and 2012 wet seasons.

Treatments	3WAS			6WAS			9WAS			12WAS		
	2011	2012	Combined	2011	2012	Combined	2011	2012	Combined	2011	2012	Combined
Seed Rates (R) Kg ha^{-1}												
40	4.2	3.7	3.9	33.2a	52.2	42.7a	62.2	71.7	66.9	86.8	97.9a	92.4
80	3.7	3.7	3.7	30.0b	53.2	41.6ab	61.8	73.4	67.6	86.9	96.4ab	91.7
120	3.9	3.6	3.7	28.1b	50.2	39.1b	60.1	70.4	65.2	86.9	93.0b	89.9
SE ±	0.14	0.11	0.09	2.07	1.20	1.03	1.47	1.51	0.90	1.69	1.38	0.95
Sowing Method (S)												
Broadcasting	4.0	3.7	3.9	31.0	52.7	41.8	61.2	74.3	67.7	88.4	96.2	92.3
Drilling	3.8	3.7	3.7	30.2	50.7	40.4	62.1	71.3	66.7	85.4	95.4	90.4
Dibbling	4.0	3.6	3.8	30.1	52.3	41.2	60.9	69.8	65.4	86.8	95.7	91.2
SE ±	0.14	0.11	0.09	2.07	1.20	1.03	1.47	1.51	0.90	1.69	1.38	0.95
Variety (V)												
NERICA 4	3.7b	3.7	3.7	33.7a	43.6b	38.7b	67.1a	67.1b	67.1ab	92.2a	89.9b	91.1b
NERICA 8	3.9ab	3.7	3.8	30.7b	54.6a	42.7a	58.9b	70.0b	64.5b	82.8b	92.6b	87.7c
JAMILA	4.1a	3.6	3.9	26.8c	57.4a	42.1a	58.0b	78.2a	68.1a	85.6b	104.8a	95.2a
SE ±	0.12	0.08	0.07	0.94	1.11	0.87	1.15	1.57	1.02	1.23	1.54	1.03

Means followed by the same letter (s) within same column and treatment group are not statistically different at 5% level of probabilityusing Duncan Multiple Range Test (DMRT).
WAS= weeks after sowing

At Maigana, it was only in 2011 wet season that seed rate significantly influenced the plant height at all the sampling periods and the combined (Table 2). The use of 40 kg ha^{-1} consistently recorded the tallest plants at all the sampling stages and the combined, followed by 80 kg ha^{-1} while 120 kg ha^{-1} produced the shortest plants but plants height at 80 kg ha^{-1} seed rate was statistically similar with that of 120 kg ha^{-1} only at 3WAS in 2011and the combined. Seed rate did not significantly affect plant height in 2012.

The heights of the rice varieties were significantly affected by sowing method only at 9 and 12WAS in 2011. At 9WAS, broadcasting and dibbling methods had rice with similar heights that were taller than for drilling method, whereas at 12WAS, drilling and dibbling methods had rice with similar heights that were shorter than for the broadcasting method. At other sampling periods in 2011 and all the sampling periods in 2012, height was not significantly affected by sowing methods.

There was significant variation in the height of three upland rice varieties tested at all the sampling stages except at 3WAS in each of the year of the study. At the later stages, JAMILA produced the shortest plants which were at par with NERICA 4 only at 6WAS in 2011. The combined analysis at 6WAS and 9WAS in 2011 showed NERICA 8 as the tallest, followed by NERICA 4 while JAMILA recorded the shortest plants. At 6 and 9 WAS in 2012, NERICA 4 and 8 had similar heights which was taller than JAMILA. At 12WAS in both years and the combined, the result further revealed NERICA 4 as the tallest plants followed by NERICA 8 while JAMILA was the shortest.

Table 2: Effect of seed rates and sowing methods on the height of three upland rice varieties at Maigana during 2011-2012 wet seasons. (cm)

Treatments				Weeks after Sowing								
	2011	2012		2011	2012		2011	2012		2011	2012	
	3WAS	3WAS	Combined	6WAS	6WAS	Combined	9WAS	9WAS	Combined	12WAS	12WAS	Combined
Seed Rate (R) (Kg ha^{-1})												
40	3.5a	3.2	3.3a	35.9a	49.9	42.9a	63.1a	71.0	67.0a	87.4a	83.2	85.3a
80	3.3ab	3.0	3.2ab	30.3b	48.4	39.4b	57.3b	68.8	63.1b	82.7b	80.7	81.7b
120	3.1b	3.1	3.1b	23.7c	48.5	36.1c	47.2c	69.1	58.1c	70.9c	82.6	76.8c
SE ±	0.06	0.08	0.06	0.87	2.05	0.99	0.38	1.22	0.69	0.62	1.27	0.58
Sowing Method (S)												
Broadcasting	3.3	3.1	3.2	29.6	48.9	39.3	57.2a	69.4	63.3	82.2a	82.8	82.5
Drilling	3.2	3.1	3.2	29.2	48.4	38.8	54.0b	70.1	62.0	80.3b	81.8	81.1
Dibbling	3.4	3.1	3.2	31.1	49.5	40.3	56.4a	69.4	62.9	78.6b	81.9	80.0
SE ±	0.06	0.08	0.06	0.87	2.05	0.99	0.38	1.22	0.69	0.62	1.27	0.58
Variety (V)												
NERICA 4	3.1	3.1	3.1	27.3b	45.0a	38.6b	52.9b	74.0a	63.5b	84.2a	91.6a	87.9a
NERICA 8	3.4	3.0	3.2	34.7a	54.9a	44.8a	64.4a	71.4a	67.9a	80.3b	80.5b	80.4b
JAMILA	3.4	3.1	3.3	27.9b	42.0b	35.0c	50.2c	63.5b	56.9c	76.6c	74.5c	75.5c
SE ±	0.10	0.33	0.06	0.76	1.79	1.02	0.57	1.07	0.60	0.76	1.20	0.73

Means followed by the same letter (s) within same column and treatment group are not statistically different at 5% level of probability using Duncan Multiple Range Test (DMRT).
WAS=weeks after sowing

Effect of seed rates and sowing methods at various sampling periods in 2011 and 2012 wet seasons and the combined on number of leaves of three upland rice varieties at Samaru are presented in Table 3. Seed rates did not significantly influence number of leaves throughout the sampling stages in both years of the study. Number of leaves significantly responded to sowing methods only at 6WAS in 2012. At this stage, broadcasting significantly recorded higher number of leaves than drilling which was statistically similar with dibbling method.

There was a significant variation in number of leaves among the three varieties of upland rice tested in 2012 and 2011 at Samaru. At 6, 9 and 12WAS and combined in both years of the study, NERICA 4 though

statistically similar with NERICA 8 significantly recorded lesser number of leaves than JAMILA except at 6WAS in 2012 where there was significant differences among the varieties with JAMILIA recording the highest number of leaves, followed by NERICA 8 while NERICA 4 produced the least number of leaves.

Table 3: Effect of seed rates and sowing methods on Number of leaves of three upland rice varieties at Samaru during 2011-2012 wet seasons.

	Weeks after Sowing											
Treatments	2011	2012		2011	2012		2011	2012		2011	2012	
	3WAS	3WAS	Combined	6WAS	6WAS	Combined	9WAS	9WAS	Combined	12WAS	12WAS	Combined
Seed Rate (R) kg/ha												
40	3.7	3.6	3.7	15.3	13.2	14.2	30.5	22.9	26.7	39.9	29.7	34.8
80	3.7	3.6	3.7	16.1	13.7	14.9	30.6	21.4	26.0	40.0	30.1	35.1
120	3.9	3.6	3.7	15.3	13.7	14.5	30.8	21.3	26.1	39.4	29.8	34.6
SE ±	0.09	0.02	0.05	0.64	0.80	0.49	1.05	1.44	1.00	1.14	1.47	0.99
Sowing Method (S)												
Broadcasting	3.9	3.6	3.8	15.7	14.2a	15.0	30.6	22.8	26.7	40.3	28.6	34.4
Drilling	3.7	3.6	3.7	15.7	12.3b	14.0	31.5	20.6	26.1	39.4	29.3	34.4
Dibbling	3.7	3.6	3.6	15.3	14.0a	14.6	29.9	22.2	26.0	39.5	31.8	35.6
SE ±	0.09	0.02	0.05	0.64	0.80	0.49	1.05	1.44	1.00	1.14	1.47	0.99
Variety (V)												
NERICA 4	3.8	3.6	3.7	14.9b	11.5c	13.2b	29.4b	16.8b	23.1b	38.5b	24.8b	31.7b
NERICA 8	3.8	3.6	3.7	14.7b	13.7b	14.2b	29.1b	17.7b	23.4b	38.0b	25.1b	31.5b
JAMILA	3.8	3.6	3.7	17.2a	15.3a	16.2a	33.4a	31.1a	32.2a	42.7a	39.7a	41.2a
SE ±	0.10	0.03	0.05	0.35	0.50	0.36	0.59	1.08	0.65	0.65	1.25	0.74

Means followed by the same letter (s) within same column and treatment group are not statistically different at 5% level of probabilityusing Duncan Multiple Range Test (DMRT).
WAS= Weeks after sowing

Effect of seed rates and sowing methods at various sampling periods in 2011 and 2012 wet seasons and the combined on number of leaves of three upland rice varieties at Maigana are presented in Table 4.Seed rates significantly influenced number of leaves at all the sampling periods except 6WAS in 2011.but was significant only at 6WAS in 2012.Higher number of leaves was recorded at 40 kg ha^{-1} than 80 kg ha^{-1} which was statistically similar with 120 kg ha^{-1} at 3WAS. At 6WAS in 2012, 40 kg ha^{-1} of seed rate though statistically similar with 120 kg ha^{-1} recorded lesser number of leaves than 80 kg ha^{-1}.There was significantly different among the seed rates at 9WAS and combined with 40 kg ha^{-1} recording the highest number of leaves, followed by 80 kg ha^{-1} while 120 kg ha^{-1} recorded the least number of leaves. At 12 WAS and combined, 40 Kg ha^{-1} of seed rate recorded higher number of leaves than 120 kg ha^{-1} but was statistically similar with 80 kg ha^{-1}. In 2011, number of leaves significantly responded to sowing methods at 3, 6 and 9WAS. Result revealed that at these three sampling periods, broadcasting significantly increased number of leaves over dibbling which was statistically similar with drilling method at 3WAS but drilling in turn was similar with dibbling at 6WAS whereas similarity was recorded between drilling and dibbling at 9WAS.

There was a significant variation in number of leaves among the three varieties of upland rice tested in 2012 and 2011 at Maigana. At all the sampling stages in 2011, NERICA 8 though statistically at par with JAMILA significantly recorded higher number of leaves than NERICA 4 at 12WAS but NERICA 4 in turn was statistically at par with JAMILA at combined of 3WAS. At 3 and 6WAS, significant differences were recorded among the varieties with NERICA 8 recording the highest number of leaves, followed by JAMILA while NERICA 4 recorded the least number of leaves at 3WAS. However, at 6WAS, it was JAMILA that recorded the least number of leaves. At 9WAS and combined of 6, NERICA 4 though statistically similar JAMILA recorded lower number of leaves than NERICA8. At 12WAS, JAMILA recorded higher number of leaves than NERICA 4 which was statistically similar with NERICA 8. At 9, 12WAS and combined in 2012, NERICA 4 which was statistically similar with NERICA 8 significantly recorded lesser number of leaves than JAMILA.

Table 4: Effect of seed rates and sowing methods on the number of leaves of three upland rice varieties at Maigana during 2011-2012 wet season.

Treatments	Weeks after Sowing											
	2011	2012		2011	2012		2011	2012		2011	2012	
	3WAS	3WAS	Combined	6WAS	6WAS	Combined	9WAS	9WAS	Combined	12WAS	12WAS	Combined
Seed Rate (R) Kg/ha												
40	3.6a	3.5	3.5	12.4	8.7b	10.6	26.5a	19.8	23.1a	33.4a	27.3	30.6a
80	3.3b	3.4	3.4	12.6	10.1a	11.3	24.1b	18.5	21.3b	32.5a	26.6	29.5a
120	3.5a	3.4	3.5	12.2	9.8b	11.0	16.9c	17.7	17.3c	30.3b	24.7	27.5b
SE ±	0.06	0.09	0.06	0.26	0.49	0.26	0.42	1.35	0.61	0.45	0.97	0.59
Sowing Method (S)												
Broadcasting	3.6a	3.2	3.4	13.0a	9.8	11.4	23.9a	17.9	20.9	32.6a	26.2	29.4
Drilling	3.6a	3.5	3.5	12.3ab	9.0	10.6	21.6b	17.9	19.8	32.5a	26.6	29.6
Dibbling	3.2b	3.5	3.4	12.0b	9.8	10.9	21.9b	20.2	21.0	31.1b	25.8	28.4
SE ±	0.06	0.09	0.06	0.26	0.49	0.26	0.42	1.35	0.61	0.45	0.97	0.59
Variety (V)												
NERICA 4	3.3c	3.4	3.3b	12.4b	9.1	10.8b	21.5b	15.0b	18.2c	30.4b	24.4b	27.4b
NERICA 8	3.7a	3.4	3.6a	13.9a	9.9	11.9a	24.2a	15.9b	20.1b	33.3a	23.7b	28.5b
JAMILA	3.4b	3.4	3.4ab	11.0c	9.6	10.3b	21.7b	25.1a	23.4a	32.5a	30.5a	31.5a
SE ±	0.05	0.14	0.07	0.24	0.31	0.22	0.52	0.9	0.55	0.48	1.08	0.57

Means followed by the same letter (s) within same column and treatment group are not statistically different at 5% level of probabilityusing Duncan Multiple Range Test (DMRT). WAS= Weeks after sowing.

Effect of seed rate and sowing method at various sampling stages in 2011 and 2012 wet seasons and the combined on number of tillers of three upland rice varieties at Samaru are presented in Tables 5. At Samaru, Apart from effect of variety at 6, 9, and 12 WAS and the combined in 2011 and 2012 wet seasons, all other main effects and their combined did not significantly affect number of tillers (Table 5). During these sampling periods of 6, 9 and 12WAS and the combined, NERICA 4 though statistically similar to NERICA 8 significantly produced lower tillers than JAMILA in both years of the study, except at 12WAS in 2011 where tillers produced by NERICA 8 was also at par with of JAMILA.

Table 5: Effect of seed rates and sowing methods on number of tillers of three upland rice varieties at Samaru in 2011 and 2012 wet seasons

Treatments	3WAS			6WAS			9WAS			12WAS		
	2011	2012	Combined	2011	2012	Combined	2011	2012	Combined	2011	2012	Combined
Seed Rates (R) Kg ha^{-1}												
40	1.7	1.2	1.5	5.7	3.7	4.7	8.2	7.0	7.6	6.7	10.6	8.6
80	1.8	1.2	1.5	6.2	3.8	5.0	8.7	6.4	7.5	6.5	10.0	8.2
120	1.6	1.2	1.4	5.6	4.0	4.8	8.3	6.4	7.3	6.0	10.7	8.4
SE ±	0.14	0.03	0.07	0.25	0.13	0.16	0.31	0.32	0.27	0.35	0.83	0.36
Sowing Method (S)												
Broadcasting	1.8	1.2	1.5	5.8	4.0	4.9	8.3	6.6	7.5	6.7	9.6	8.2
Drilling	1.7	1.2	1.4	5.8	3.6	4.7	8.2	6.4	7.3	6.2	10.1	8.2
Dibbling	1.7	1.2	1.4	5.9	3.9	4.9	8.6	6.8	7.7	6.3	11.6	8.9
SE ±	0.14	0.03	0.07	0.25	0.13	0.16	0.31	0.32	0.27	0.35	0.83	0.36
Variety (V)												
NERICA 4	1.8	1.2	1.5	5.5b	3.4b	4.5b	7.7b	5.2b	6.5b	5.9b	8.2b	7.1b
NERICA 8	1.9	1.2	1.5	5.9ab	3.6b	4.7b	7.8b	5.2b	6.5b	6.3ab	8.8b	7.6b
JAMILA	1.6	1.2	1.4	6.2a	4.4a	5.3a	9.6a	9.3a	9.5a	6.9a	14.3a	10.6a
SE ±	0.11	0.02	0.06	0.13	0.17	0.11	0.23	0.35	0.20	0.25	0.71	0.41

Means followed by the same letter (s) within same column and treatment group are not statistically different at 5% level of probabilityusing Duncan Multiple Range Test (DMRT).
WAS= Weeks after sowing

The number of tillers significantly responded to sowing methods only at 9 and 12WAS in 2011 at Maigana Table 6. Result revealed that at these two stages, drilled rice significantly produced less tillers than dibbling which were statistically similar with that of broadcast rice only at 9WAS. Dibbled rice consistently had the highest number of tillers which was also at par with broadcast rice in 2011.

The use of 40 kg ha^{-1} seed rate consistently recorded the higher number of tillers that was statistically at par with 80 kg ha^{-1} except at 12WAS in 2012 and the combined at 12WAS. Whereas 120 kg ha^{-1} seed rate recorded the leas number of tillers but was at par with 80 kg ha^{-1} at 9WAS in 2011 and 12 WAS in 2012 and the combined at 12WAS.

There was a significant variation in the number of tillers among the three varieties of upland rice tested in both years except at 3 and 6WAS of 2012 at Maigana. NERICA 8 significantly produced more number of tillers except at 9 and 12WAS in 2012 and the combined where it had lower number of tillers than the highest produced by JAMILA. The higher number of tillers produced by NERICA 8 was statistically similar with NERICA 4 at 6WAS and the combined at 6WAS in 2011. NERICA 4 in turn had similar tiller number with JAMILA at 3 and 9WAS in 2011.

Table 6: Effect of seed rates and sowing methods on number of tillers of three upland rice varieties at Maigana in 2011 and 2012 wet seasons.

Treatments	3WAS			6WAS			9WAS			12WAS		
	2011	2012	Combined	2011	2012	Combined	2011	2012	Combined	2011	2012	Combined
Seed Rates (R) Kg ha^{-1}												
40	2.1	1.2	1.6	5.3a	3.5	4.4a	7.0a	7.5a	7.2a	6.8	8.7a	7.8a
80	2.2	1.2	1.7	5.3a	3.5	4.4a	6.7ab	7.0ab	6.9a	6.8	7.5b	7.1b
120	2.0	1.2	1.6	4.7b	3.6	4.2b	6.3b	6.2b	6.2b	6.4	7.8b	7.1b
SE ±	0.09	0.03	0.05	0.13	0.10	0.07	0.16	0.31	0.17	0.12	0.30	0.16
Sowing Method (S)												
Broadcasting	2.1	1.2	1.7	5.1	3.5	4.3	6.5b	7.3	6.9	6.9a	7.6	7.3
Drilling	2.2	1.2	1.7	5.0	3.5	4.3	6.4b	6.5	6.4	6.3b	8.4	7.3
Dibbling	2.0	1.2	1.6	5.3	3.6	4.5	7.0a	6.9	6.9	6.7a	8.1	7.4
SE ±	0.09	0.03	0.05	0.13	0.10	0.07	0.16	0.31	0.17	0.12	0.30	0.16
Variety (V)												
NERICA 4	2.0b	1.2	1.6b	5.3a	3.5	4.4a	6.4b	5.4b	5.9b	6.6	6.7b	6.7b
NERICA 8	2.3a	1.2	1.8a	5.4a	3.6	4.5a	7.0a	5.7b	6.3b	6.7	6.7b	6.7b
JAMILA	2.0b	1.2	1.6b	4.7b	3.5	4.1b	6.5b	9.6a	8.1a	6.7	10.6a	8.7a
SE ±	0.10	0.02	0.05	0.14	0.10	0.09	1.40	0.34	0.18	0.13	0.29	0.16

Means followed by the same letter (s) within same column and treatment group are not statistically different at 5% level of probabilityusing Duncan Multiple Range Test (DMRT).
WAS= weeks after sowing

Effect of seed rate and sowing method at 6, 9 and 12WAS in 2011 and 2012 wet seasons and the combined on the leaf area index of three upland rice varieties at Samaru and Maigana are presented in Table 7. Seed rates did not significantly affect the leaf area index at all the sampling stages throughout the two years of the study at both locations except at 9WAS and the combined in 2011 at Maigana. At this sampling stage and the combined, the highest leaf area index was recorded at 40 kg ha^{-1} of seed rate, followed by 80 kg ha^{-1} while the least leaf area index was recorded at 120 kg ha^{-1}. Leaf area index significantly responded to sowing methods only at 9WAS in 2011 at Maigana. Result revealed that dibbled rice recorded higher leaf area index which was statistically similar with that of drilled rice. However, drilling method in turn was at par with broadcasting method. There was no significant effect at all other sampling periods.

There was significant variation among the three upland rice varieties tested on leaf area index at both locations in the two years of the study. At both locations in the two years, NERICA 8 consistently produced more leaf area index which was statistically similar with NERICA 4 at 6WAS and the combined in Samaru for 2012 wet season. But NERICA 4 in turn was at par with that of JAMILA at 6, 9WAS and the combined at 9 WAS at Maigana in 2011 wet season. There was no significant effect on leaf area index in other sampling periods and the combined in 2012 except at 6WAS in Samaru.

Table 7: Effect of seed rates and sowing methods on leaf area index of three upland rice varieties at Samaru and Maigana in 2011 and 2012 wet seasons.

Treatments	Samaru 6WAS			Samaru 9WAS			Maigana 6WAS			Maigana 9WAS		
	2011	2012	Combined	2011	2012	Combined	2011	2012	Combined	2011	2012	Combined
Seed Rates (R)												
40	2.8	3.0	2.9	10.5	6.7	8.6	7.6	1.8	4.7	5.9a	4.6	5.3a
80	3.1	3.5	3.3	10.7	6.6	8.6	2.0	1.7	1.8	5.7b	4.2	5.0b
120	2.7	3.0	2.9	10.1	6.6	8.3	1.6	2.0	1.8	4.0c	4.6	4.3c
SE ±	0.19	0.27	0.18	0.44	0.33	0.25	3.24	0.12	1.6	0.09	0.19	0.10
Sowing Method (S)												
Broadcasting	3.1	3.3	3.2	11.0	7.0	9.0	1.8	1.8	1.8	5.0b	4.7	4.9
Drilling	2.9	2.8	2.9	10.6	6.0	8.3	1.9	1.7	1.8	5.2ab	4.2	4.7
Dibbling	2.7	3.3	3.0	9.7	6.9	8.3	7.6	2.0	4.8	5.4a	4.5	4.9
SE ±	0.19	0.27	0.18	0.44	0.33	0.25	3.24	0.12	1.6	0.09	0.19	0.10
Variety (V)												
NERICA 4	2.9	3.2ab	3.0ab	10.4	6.6	8.5	1.6	1.7b	1.7	4.9b	4.2	4.5b
NERICA 8	2.9	3.8a	3.3a	10.5	6.4	8.5	2.5	2.1a	2.3	6.0a	4.6	5.3a
JAMILA	2.9	2.5b	2.7b	10.4	6.9	8.7	7.0	1.7b	4.4	4.8b	4.6	4.7b
SE ±	0.11	0.24	0.14	0.25	0.29	0.22	3.23	0.11	1.62	0.08	0.18	0.10

Means followed by the same letter (s) within same column and treatment group are not statistically different at 5% level of probabilityusing Duncan Multiple Range Test (DMRT). WAS= weeks after sowing.

IV DISCUSSION

The differences on growth parameters such as plant height, number of leaves, number of tillers and leaf area index in 2012 than 2011 at both locations was due to the differences in soils types in which the rice crop was sown during the experimental years and also due to the effect of different preceding crops that might have utilized the soil nutrients differently as well as differences in agro-climatic conditions during the growth and development of the rice varieties as manifested by the amount and distribution of rainfall and temperature ranges.

The significant differences in plant height, number of tillers and leaf area index in 2011 at Maigana could be attributed to high competition for growth factors such as nutrient and moisture. The non-significant effect of seed rate on height recorded in some years at both locations could be due to the fact that the height advantage at low population was not enough to cause any significant variation in height with that recorded at higher population caused by competition for light, moisture and nutrients. This result agreed with that earlier report by Sulieman, (2010) who reported that increase in the seeding rate resulted in a slight increment in the height of the plants.

The general lack of significant response of tillering, leave area index and number of leaves to seed rates indicate these parameters to be genetically controlled. This shows that irrespective of the stress caused by high population due to high seed rate the varieties were able to express their maximum potentials in terms of tiller and leave production. The higher tillering and leaf production at seed rate of 40 and 80 kg ha^{-1} as well as significant reduction in these parameters at higher seed rate of 120 kg ha^{-1} could be attributed to low and high competition for growth resources at low and high population respectively. While the significant decrease in leaf area index as a result of increased seed rate could be due to stiff competition at higher seed rates. This is in agreement with Heri *et al*. (1997) who reported that there was a significant decrease in leaf area index and dry matter production with the increase in seedling density from the sowing rate of 20 to 60g m^2.

In the two years of this study at Samaru and Maigana, The non-significant influence of sowing methods on plant height, number of tillers, number of leaves and leaf area index was due to reduced competition for available resources such as space, water and nutrients but in 2011 at Maigana as the population build up, competition for the limited resource was able cause significant variation among the sowing methods. Secondly, the non-significant differences in these parameters by direct seeded rice could be due to the fact that the crops did not experience transplanting shock which lead to early establishment of the rice varieties in all the three sowing methods. Also the difference in plant height was due to the fact that plants were at specific distance leading to reduced competition. This conform with Vijayakumar *et al*. (2006) who reported that plants got sufficient space to grow and increased light transmission in the canopy led to increased plant height. The higher number of tillers in dibbling method when compared to other methods of direct seeding could be attributed to deeper placement of seeds and better establishment of the root which ensured water and nutrients availability only to crop root zone at tillering initiation stages (Aslam 2008). While the less robust plant observed was due to low availability of nutrients and moisture in direct seeding due to the presence of more number of weeds and shallow plant root growth (Tanaka and Arima, 1996, Kega and Maingu, 2006). The higher leave area index noted for dibbling and drilling was due to the fact that the crops were fixed firmly on the soil and which developed vigorously and resulted in higher leave length and width. This was owing to the fact that plants at proper spacing enhanced the root growth which facilitated increased cell division and cell enlargement and more number of tillers with more leaves and subsequently higher photosynthetic rate for increased leave area index (Shrirame *et al.* 2000).

The variation in growth and development among the three tested varieties of rice could be attributed to the genetic characteristics or environmental factors such as temperature, photoperiods, light intensity, soil factors and cultural manipulation such as plant density, planting methods and moisture supply (Baset Mia and Shamsuddin, 2011, Mercado and Garity, 1993). Height of the crop is mainly controlled by the genetic makeup of the variety and can also be affected by the environmental factors. Shahzad *et al*. (2007) reported that plant height differed significantly by planting time and location. The greater vegatativeness of JAMILIA varieties in terms of height, number of tillers and leave number could be attributed larger LAI that might have resulted greater assimilate production while the less robust growth of NERICA 4 variety in terms of such vegetative characters as , number of leaves, tiller number, and LAI had indicated that varieties are genetically controlled. Such genetically controlled differences among rice varieties have been reported by Baset Mia and Shamsuddin (2011) that physio-morphological attributes, yield and yield contributing characters varied among varieties.

The similarity in their genetic make-up of three varieties was displayed by growth parameters in some years of growth and development at both locations which indicated that less robust varieties was able to make equal utilization of the environmental resources. This is in agreement with Robert and John (2012) who reported that varieties exhibit high similarity for response to input levels and the overall effect depend mainly on interaction with the environment. Tillering ability of a crop is varietal characteristics, plant environmental conditions, especially soil moisture and mineral nutrition which play a significant role. The higher tillering produced by JAMILA than NERICA 4 and 8 at Samaru and Maigana respectively is an evident that tillering of a crop is both genetic make-up and environmental condition.

V CONCLUSION

Based on the results obtained in this study, it can be concluded that use of 40 kg ha^{-1}, seed rates, broadcasting method and JAMILA had resulted in the growth and development of the rice varieties. However, the most suitable variety that should be used in this area depends on the prevailing weather conditions under which the

varieties were tried. In the years of short duration and poor distribution of rainfall like 2011, NERICA 8 should be sown whereas in years of higher rainfall with fairly better distribution like in 2012, JAMILA variety should be sown.

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