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Effects of Irrigation Intervals and Nitrogen Levels on Growth Parameters of Rice (*Oryza sativa* L.) Varieties in Dadin Kowa, Northern Nigeria

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Abstract: Adequate nitrogen and irrigation management practices can reduce the probability of nitrate leaching into underground and maintain profitable yields. Field experiment was conducted during the dry seasons of 2014/2015, 2015/2016 and 2016/2017 at the Teaching and Research farm of the Federal College of Horticulture, Dadin Kowa, Northern, Nigeria (Lat. 11° 30', Long. 10° 20' and 240 m above sea level) to evaluate the effect of irrigation intervals and nitrogen levels on the growth parameters of rice varieties. The experiment was designed as a 3 x 4 x 3 factorial experiment laid out in split-split plot arrangement replicated three times. The main plot consisted of three irrigation intervals (3, 6 and 9 days). The subplots were made up of four nitrogen levels (0, 60, 120 and 180 kg N/ha) while, the sub-sub plot comprised of three rice varieties (Faro 44, Faro 60 and Faro 61). Data collected in various parameters were subjected to analysis of variance (ANOVA) using Genstat Discovery Edition 2013 Statistical package. Means were separated using least significant difference at 5% probability level ($LSD_{0.05}$). Results showed that irrigation at every 3 days resulted in significantly better growth though not significantly different from those of 6 days but were better than 9 days irrigation intervals. Nitrogen significantly, improved all the growth parameters. High nitrogen level (120 and 180 kg N/ha) resulted in better performance than the control (0 kg N/ha).Varietal differences were also significant in most of the measured parameters. Faro 61 excelled in virtually all the growth parameters while Faro 44 was the least. In conclusion, Faro 61 applied 180kgN/ha and irrigated every 6 days performed optimally in growth parameters and are hereby recommended for the farmers in Dadin Kowa, Northern Nigeria.

Key words: Irrigation · Nitrogen · Rice · Growth · Varieties

INTRODUCTION

Rice is the world's important staple food crop, more than four-fifth of the world's rice is produced and consumed by small scale farmers in low income and developing countries such as Nigeria FAO [1]. More than half of the country's population relies on rice as the major daily source of calories. Nigeria is the largest producer of rice in West Africa and second largest producer in Africa after Egypt, with a total production of 4.833 million metric tonnes from 2.6 million hectares of land in 2013 Danmaigoro [2]. According to FAO [1] demand for rice has increased in Nigeria at a faster rate than in any other West Africa countries since the mid of 1970s. Apart from maize, rice ranks second in energy content out of the four most staple foods in Nigeria with energy potential of 334 calories per 100 g Bifarin *et al*. [3]. Rice is both a food and a cash crop for farmers, contributing to smallholders' revenues in the country.

Most studies on constraints to high rice yield shows that water is the main factor for yield gaps and yield variability from experimental stations to farms Papademetriou [4] and Akinbile [5]. Irrigated agriculture is the dominant use of water, accounting for about 80% of developing countries water consumption Rosegrant *et al*. [6]. By 2025, global population will likely increase to 7.9

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billion, more than 80% of whom will live in developing countries and 58% in rapidly growing urban areas Akinbile [5]. The majority of intensive rice production systems are based on maintaining permanent standing water in rice plots in order to suppress weeds and ensure good rice growth. However, such systems lead to an increase in ground water level, which may rise to near the soil surface and cause waterlogging. Availability of water in the crop root zone is very essential for transpiration and tissue formation. Various studies have reported inconsistent (New Africa rice (NERICA)growth and yield under various soil water condition Matsumoto *et al*. [7]. Longer irrigation interval resulted in reduced tissue formation due to decrease in nutrients and water uptake Husseini *et al*. [8].

Nitrogen is the most limiting nutrient for rice growth and yield in almost all environments Roy and Mishra [9]. One major consequence of inadequate N is reduced leaf area, thereby limiting light interception, photosynthesis and finally biomass growth, grain yield and water productivity Sinclair [10]. Application of appropriate quantity of N at the right time using the right irrigation interval will increase yield and N use efficiency Rezaei *et al.* [11] and Bagayoko *et al*. [12]. This will not only save the environment but also reduces the production cost thereby increasing farmers' income. This study therefore evaluated the effects of irrigation intervals and nitrogen levels on growth parameters of rice varieties in Dadin Kowa, Northern Nigeria.

MATERIALS AND METHODS

Field experiment was conducted during the dry season (October to March) of 2014/2015, 2015/2016 and 2016/2017 at the Teaching and Research farm of the Federal College of Horticulture, Dadin Kowa, Gombe State in Northern Nigeria (Latitude 11° 30' N, Longitude 10° 20'E and 240m above sea level) located in the Sudan Savanna Agro-ecological zone of Nigeria. The mean temperature ranges from 30 to 33°C. The rainfall pattern is unimodal, ranging from 700 to 1250 mm and is characterized by distinct dry (October – May) and rainy (June – September) seasons Mustapha *et al.* [13]. Soil samples were collected, using soil auger, from the experimental site at the depth of 0-20 cm prior to crop establishment each season. The samples were air dried, bulked, sieved for physical and chemical characteristics analysis.

The land was ploughed and harrowed using animal drawn-emcot plough and harrow respectively. The seedlings were raised in nursery beds of 1.3 m^2 dimension and transplanted to the main fields four weeks later at a spacing of 20 x 20cm and at two seedlings per hole.

Meanwhile, field layout was done to mark out the plots each sub-sub plots measuring 1.5 x 1.2 m. The study was designed as a 3 x 4 x 3 factorial experiment laid out in split-split plots arrangements with three replications. Irrigation interval constituted the main plots, nitrogen levels sub-plots while rice varieties were in the sub-sub plots.

Surface irrigation method was used in conveying water into each basin. The canals were lined with polyethylene sheets to reduce the rate of seepage and allow free flow. The irrigation water discharging into the basins were computed and the depth of water applied was monitored using a stop watch. The timed volume-container head method (Bucket system) was employed during each irrigation scenario in calculating the amounts of water applied into required depth using Trimmer [14] formula:

$$D = V/T$$

where; D is the discharge rate (Milliliters/seconds), V is the volume of the container (Milliliter), T is the time taken to fill the container (Seconds).

The flow rate and the average time allowed to pond a basin were calculated.

Thereafter, irrigation treatments were applied as the main plot factor as I_1 = 3 day I_2 = 6 day and I_3 = 9 day irrigation intervals. The sub plots were made up of four levels of nitrogen 0, 60, 120 and 180kg N/ha while the sub sub-plots were three rice varieties (FARO 44, FARO 60 and FARO 61) obtained from the seed unit of National Cereal Research Institute Baddeggi, Niger state, Nigeria. Basal application of phosphorus and potassium was carried out at 60 kg/ha using single super phosphate (18% P_2O_5) and muriate of potash (60% K_2O) on all plots. Glyphosate herbicide was applied after land preparation, two weeks before transplanting at the rate of 2.88 kg ha^{-1} (a.i.) at 150 ml in 20 liters of water to control weeds comprising mostly sedges and grasses with rhizomes. Two weeks after transplanting, post-emergence herbicide 2, 4-D amine (2.4 kg/ha a.i.) plus Propan 360 (Propanil 1.5 kg/ha a.i.) were applied at the rate of 250 ml in 20 liters of water. In addition two manual weeding were carried out using traditional hoe at 3 and 6 weeks after transplanting (WAT). Three consecutive rice plants were tagged per plot for data collection. Data collected included plant height (cm), number of tillers per plant, leaf area (cm^2) and total dry matter (DM) at 12 weeks after transplanting (WAT) and at harvest. Plant height was measured using a meter ruler from the plant base to the tip of the newly emerged leaf or flag leaf at harvest and the average value computed to get per plant value. Two plants were harvested randomly at 12 WAT and at maturity by cutting from each plot, prior to which the leaf area had been measured as length and breadth multiply by a constant, K (0.67). Three to six leaves were measured from each plant and mean value per plant was computed. After determining the leaf area, the two rice plants were oven dried at 70°C for 72 hours in the oven to constant weight after which the dry matter per plant was determined using electric weighing balance at 12 WAT and at maturity. All the data collected on various parameters were subjected to statistical analysis of variance using Genstat Discovery Edition 2013 statistical package. Means were separated using Least Significant Difference (LSD) test at $P \leq 0.05$ Steel *et al*. [15]. The results of the main effects were presented and discussed except if there were significant interactive effects.

RESULTS

The soil of the experimental site was silty loam, slightly acidic, low in organic carbon, nitrogen and phosphorus (Table 1). Exchangeable bases and micronutrients were moderate. Results of the effects of irrigation intervals, nitrogen fertilizer rates and varietal differences on plant height for 2015, 2016 and 2017 seasons are presented on Table 2. Irrigation intervals significantly ($P<0.01$) affected plant height at harvest in 2015 season while in 2017, irrigation intervals had significant effects on plant height at 12 WAT ($P<0.05$) and at harvest ($P<0.01$). In 2015 season, plants that received irrigation at three days intervals were the tallest (69.91 cm) at 12 WAT while plants that received irrigation at 9 days intervals were the shortest plants (53.52 cm) at the same period. The same trend was observed at 12 WAT and at harvest in 2017.

The effect of nitrogen fertilizer on plant height in all the seasons showed highly significant effect ($P \leq 0.01$) throughout the sampling periods (Table 2). In all the three years trials, nitrogen fertilizer rate of 180 kg N/ha consistently recorded the tallest rice plants at 12 WAT and at harvest while shortest rice plants were observed from the control (0 kg N/ha). Plant heights increased with increased rates of nitrogen fertilizer in all the sampled periods.

There were highly significant effects ($P \leq 0.01$) of irrigation intervals on plant height at 12 WAT and at harvest in all the three years as presented in Table 2. Faro 61 consistently recorded tallest plants followed by Faro 60 while the shortest plants were obtained from Faro 44.

The effects of irrigation intervals, nitrogen levels and varieties on number of tillers per plant for 2015, 2016 and 2017 seasons are presented on Table 3. There were no significant effects ($P \leq 0.05$) of irrigation intervals on number of tillers per plant at the sampled periods in 2015, 2016 and 2017 seasons.

There were highly significant effects ($P \leq 0.01$) of nitrogen fertilizer rates on number of tillers per plant at all the sampled periods in all the three years. In all the trials, nitrogen fertilizer rate of 180 kg N/ha produced highest number of tillers per plant followed by 120 kg N/ha. The lowest number of tillers per plant was recorded from plots that did not received nitrogen fertilization. In 2015 season Faro 61 produced highest number of tillers per plant at 12 WAT and at harvest with 26 and 21 tillers, respectively. Similarly the lowest number of tillers per plant was observed from Faro 44 with 22 and 17 tillers recorded at 12 WAT and harvest. The same trend was observed in 2016 and 2017.

The effects of irrigation intervals, nitrogen levels and varietal differences on leaf area per plant for 2015, 2016 and 2017 seasons are shown on Table 4. Highly significant ($P \leq 0.01$) effects was only recorded at harvest in 2015 where irrigation at every 6 days had highest leaf area per plant (8.76 cm^2) followed by irrigation at 3 (8.04 cm^2). The lowest leaf area was recorded from irrigating the plants at 9 days interval (7.17 cm^2). Results on leaf area for 2016 and 2017 showed no significant effects ($P \leq 0.05$) of irrigation intervals on leaf area throughout the sampled periods.

The effects of nitrogen fertilizer rates on leaf area in 2015, 2016 and 2017 seasons was highly significant ($P \leq 0.01$) at all sampled periods (Table 4). In 2015 season, nitrogen fertilizer rate of 180 kg N/ha produced largest leaf areas of 15.79 cm^2 and 11.43 cm^2 at 12 WAT and at harvest, respectively. The least leaf areas were obtained from plants that received zero nitrogen fertilizer with values of 8.38 cm^2 and 5.24 cm^2 for 12 WAT and at harvest, respectively. The same trend was observed in 2016 and 2017 seasons.

There were highly significant ($P \leq 0.01$) differences among the varieties in leaf area in 2015, 2016 and 2017 seasons at all 12 WAT and at harvest except at harvest in

Table 1: Physical and Chemical Properties of the Soil at the Experimental Site for 2015, 2016 and 2017 Dry Seasons

Parameters	Values		
	2015	2016	2017
pH water	6.47	6.62	6.80
pH KCl	5.51	5.71	5.61
Organic Carbon (g/kg)	1.18	1.84	1.97
Total Nitrogen (g/kg)	0.16	0.12	0.12
Available P. (mg/kg)	8.87	8.31	9.22
Exchangeable bases (cmol/kg)			
Calcium	3.11	3.64	4.80
Magnesium (Mg)	0.89	0.78	0.74
Potassium (K)	0.29	0.29	0.36
Sodium (Na)	0.20	0.12	0.48
Micro nutrients (mg/kg)			
Zinc	1.54	0.63	1.09
Copper	0.86	0.41	0.64
Iron	6.11	7.36	6.74
Manganese	13.63	18.24	15.94
Soil Texture (%)			
Sand	24.40	24.04	26.00
Silt	51.28	52.34	51.00
Clay	24.32	23.62	23.00
Textural Class	SL	SL	SL

SL = Silty Loam

Table 2: Effects of Irrigation Intervals, Nitrogen Levels and Varietal Differences of Rice Plant Height (cm) in 2015, 2016 and 2017 Dry Seasons

Treatment	2015		2016		2017	
	12WAT	HAV	12WAT	HAV	12WAT	HAV
Irrigation intervals (days) (I)						
3	42.57	69.91	40.64	77.90	40.89	75.47
6	37.44	59.59	37.25	72.00	37.37	66.74
9	41.15	53.52	36.19	68.69	33.94	63.59
P of F	0.290	0.003	0.580	0.250	0.045	0.003
$LSD_{(0.05)}$	7.930	5.480	11.450	13.003	5.010	4.070
Nitrogen levels(kg/ha) (N)						
0	30.50	51.84	25.07	59.21	30.22	60.38
60	36.27	59.05	35.15	69.28	35.57	66.81
120	43.50	63.21	42.33	76.86	39.54	70.32
180	51.27	69.92	49.56	86.10	44.27	76.89
P of F	0.001	0.001	0.001	0.001	0.001	0.001
$LSD_{(0.05)}$	3.540	1.740	3.040	3.430	1.410	2.350
Varieties (V)						
FARO 44	38.53	58.16	35.00	69.54	35.80	65.83
FARO 60	40.24	61.31	37.57	72.91	37.28	68.51
FARO 61	42.38	63.55	41.53	76.15	39.12	71.46
P of F	0.001	0.001	0.001	0.001	0.001	0.001
$LSD_{(0.05)}$	0.730	1.040	1.430	1.140	0.780	1.650
Interactions						
I x N	NS	NS	NS	NS	NS	NS
I x V	NS	NS	NS	NS	NS	NS
N x V	NS	NS	NS	NS	NS	NS
I x N x V	NS	NS	NS	NS	NS	NS

WAT = weeks after transplanting; HAV = harvest

Table 3: Effect of Irrigation Intervals, Nitrogen Levels and Varietal Differences on Number of Tillers per Plant in 2015, 2016 and 2017 Dry Seasons

	2015		2016		2017	
Treatment	12WAT	HAV	12WAT	HAV	12WAT	HAV
Irrigation intervals (days)						
3	24.46	20.54	24.44	20.76	26.31	20.06
6	24.29	20.19	25.40	20.66	27.16	19.60
9	22.40	15.93	23.16	19.17	21.14	19.14
P of F	0.514	0.204	0.664	0.565	0.122	0.892
LSD	5.048	6.469	6.548	4.304	6.629	5.288
Nitrogen levels (kg/ha)						
0	14.98	12.40	15.14	13.42	17.35	14.54
60	21.62	16.91	21.89	18.26	22.23	17.78
120	26.77	20.06	25.75	21.41	27.22	21.16
180	31.51	26.17	34.54	27.69	32.67	24.93
P of F	0.001	0.001	0.001	0.001	0.001	0.001
LSD	1.929	3.092	3.611	1.52	2.298	1.797
Variety (V)						
FARO 44	21.67	16.97	21.77	18.32	22.92	18.35
FARO 60	23.77	18.75	24.16	20.10	24.68	19.64
FARO 61	25.72	20.93	27.06	22.16	27.01	20.81
P of F	0.001	0.001	0.001	0.001	0.001	0.001
LSD	0.656	1.396	1.026	0.539	0.596	0.456
Interactions						
I x N	NS	NS	NS	NS	NS	NS
I x V	NS	NS	NS	NS	NS	NS
N x V	NS	NS	NS	NS	NS	NS
I x N x V	NS	NS	NS	NS	NS	NS

WAT = weeks after transplanting; HAV = harvest

Table 4: Effect of Irrigation Intervals, Nitrogen Levels and Varietal Differences on Leaf Area (cm²) in 2015, 2016 and 2017 Dry Seasons

	2015		2016		2017	
Treatment	12WAT	HAV	12WAT	HAV	12WAT	HAV
Irrigation intervals (days)						
3	12.87	8.04	11.26	10.32	14.17	11.68
6	11.90	8.76	11.74	10.10	12.08	11.06
9	11.55	7.17	11.65	10.13	11.30	10.97
P of F	0.160	0.004	0.762	0.873	0.177	0.472
LSD	1.550	0.580	1.880	1.250	0.930	7.500
Nitrogen levels (kg/ha)						
0	8.38	5.24	7.51	6.94	8.91	7.50
60	11.01	6.69	9.82	8.93	10.75	9.68
120	13.22	8.59	11.90	10.83	12.38	11.69
180	15.79	11.43	16.97	14.03	19.40	14.71
P of F	0.001	0.001	0.001	0.001	0.001	0.008
LSD	0.570	0.660	1.120	0.840	0.570	6.580
Varieties (V)						
FARO 44	11.01	7.26	10.08	9.28	10.91	9.99
FARO 60	12.16	7.88	11.24	10.03	11.71	11.03
FARO 61	13.13	8.82	13.33	11.24	12.44	15.18
P of F	0.001	0.001	0.001	0.001	0.001	0.115
LSD	0.260	0.290	0.770	0.300	0.200	5.180
Interactions						
I x N	NS	NS	NS	NS	NS	NS
I x V	NS	NS	NS	NS	NS	NS
N x V	NS	NS	NS	NS	NS	NS
I x N x V	NS	NS	NS	NS	NS	NS

WAT = weeks after transplanting; HAV = harvest

Table 5: Effect of Irrigation Intervals, Nitrogen Levels and Varietal Differences on Dry Matter Production (g) in 2015, 2016 and 2017 Dry Seasons

	2015		2016		2017	
Treatment	12WAT	HAV	12WAT	HAV	12WAT	HAV
Irrigation intervals (days) (I)						
3	6.34	42.82	7.37	47.38	6.83	50.66
6	6.54	40.21	8.38	41.12	7.92	43.04
9	6.18	34.75	4.86	35.87	4.46	35.48
P of F	0.272	0.024	0.105	0.067	0.039	0.144
LSD	0.523	4.868	3.476	9.475	2.428	16.473
Nitrogen levels(kg/ha) (N)						
0	4.03	25.97	3.91	38.94	3.29	21.79
60	4.38	31.66	5.55	40.47	5.03	36.71
120	7.87	46.84	7.39	41.93	6.93	47.81
180	9.12	52.56	10.64	44.49	10.35	65.94
P of F	0.001	0.001	0.001	0.013	0.001	0.001
LSD	0.373	1.918	1.150	3.207	0.888	2.918
Variety (V)						
FARO 44	6.02	37.21	5.99	40.88	5.48	37.50
FARO 60	6.27	39.18	6.85	41.40	6.31	42.62
FARO 61	6.76	41.38	7.78	42.09	7.41	49.06
P of F	0.001	0.001	0.001	0.001	0.001	0.001
LSD	0.244	0.817	0.350	0.539	0.341	2.038
Interactions						
I x N	NS	NS	NS	NS	NS	NS
I x V	NS	NS	NS	NS	NS	NS
N x V	NS	NS	NS	NS	NS	NS
I x N x V	NS	NS	NS	NS	NS	NS

WAT = weeks after transplanting; HAV = harvest

2017 season that there were no significant differences among the varieties in leaf area at $P \leq 0.05$ (Table 4). In 2015 Faro 61 produced highest leaf area of 13.13 cm^2 and 8.82 cm^2 at 12 WAT and at harvest, respectively. Faro 44 had the least leaf area of 11.01 cm^2 and 7.26 cm^2 at 12 WAT and harvest, respectively. The same trend was observed in 2016 and 2017 seasons.

The effects of irrigation intervals, nitrogen levels and varieties on rice plant dry matter yield per plant for 2015, 2016 and 2017 seasons are presented on Table 5. The effects of irrigation intervals on dry matter production was significant ($P \leq 0.05$) only at harvest in 2015 season and at 12 WAT in 2016 where plants irrigated at every 3 days intervals produced highest dry matter yield (42.82 g). This was not statistically different from plants that were irrigated at every 6 days (40.21 g).The lowest dry matter yield was obtained from plants that were irrigated at 9 days interval (34.75 g). The same trend was observed at 12 WAT in 2016.

There were highly significant effects ($P \leq 0.01$) of nitrogen fertilizer rates on dry matter production throughout the sampled periods for 2015, 2016 and 2017 seasons (Table 5). In 2015 season nitrogen fertilizer rate of 180 kg N/ha recorded highest dry matter values of 9.12 g and 52.56 g at 12 WAT and at harvest respectively while the lowest values were obtained from plants with 0 kg N/ha with 4.03 g and 25.97 g at12 WAT and at harvest, respectively. A similar trend was observed in 2016 and 2017 seasons.

There were highly significant ($P \leq 0.01$) varietal differences on dry matter production throughout the sampled periods for 2015, 2016 and 2017 seasons (Table 5). At 12 WAT and at harvest, Faro 61 had the highest values of dry matter yield with 6.76g and 41.38g respectively while the least values were obtained from Faro 44 with 6.02g and 37.21g, respectively. The same trend was observed in 2016 and 2017 seasons.

DISCUSSION

The highly significant ($P \leq 0.01$) influence of irrigation regime on plant height is an indication that the frequency of water supply significantly contributed to the growth of rice plants. The short irrigation intervals, the taller plants. Since there were no significant differences between the 3 days and the 6 days irrigation intervals for most of the data collection periods, it shows that 6 days interval can be maintained and an impressive growth can be recorded. This result is in line with that of Rezaei *et al*. [11] and Hussein and Sabbour [16] who reported that, 5 and 7 days interval for irrigated rice produced taller plants than further widening the irrigation regime. This is because sufficient moisture around the root zones enhances nutrient uptake and thus improve plant growth Zumber *et al*. [17]. Furthermore, water stress leads to cessation of cell division and enlargement of different plant tissues which in turn depressed the vegetative growth Hussein *et al.* [8] and Ashraf [18].

The variation in plant height of rice due to nitrogen application is an indication that rice plants responded to the fertilizer rates by increasing their heights. The highest mean plant height that was obtained from 180 kg N/ha is an indication that there was continuous response nitrogen levels up to the highest amount applied. This implies that the plant needed more nitrogen for growth and that there could be more growth if N rates were increased. This might be due to the fact that nitrogen plays a significant role in internodes elongation and greater capacity of metabolites building as a result of enlarged plant leaf area at higher doses during the vegetative growth Hussein and Sabbour [16]. The variations in plant height of rice varieties with Faro 61 being consistently the tallest variety may be attributable to the differences in the genetic makeup of the varieties and their differences in the utilization ability of the different rates of nitrogen fertilizer applied. These observations are in consonance with that of Halder *et al*. [19] and Hag *et al*. [20] who reported that, increased rate of NPK fertilizer favoured the vegetative growth in rice plant. This is also corroborated by the work of Rezaei *et al*. [11] and Fageria [21] that, nitrogen fertilization improved plant height.

Tillering is an important trait for grain production and is an important aspect in rice yield. The 3 days irrigation interval plant appeared to produce more tillers but not significantly different from those of 6 and 9 days irrigation regimes. This may be due to the slower growth under drought with long irrigation interval than growth in moist conditions particularly during the vegetative stage due to shortage of irrigation water, which reduce the physiological process in rice plant especially cell division, thus reducing tillering. Earlier, Nour *et al*. [22], Abou El-Hassan [23], Ghanem and Ebaid [24], Islam [25] and El-Dali [26] reported that prolong drought in rice reduced number of tillers per plant. The result is also in line with those of Abu El-Ezz [27] who found that irrigation at every 4 days gave the highest number of productive tillers/m^2 followed by irrigation at every 6 days but not significantly different from those of 4 days while irrigation at every 8 days gave the least. The increased in the number of tillers as more nitrogen fertilizers were added in this study is an indication that with more nitrogen added to rice plants, there will be more tillers. Mirza *et al*. [28] reported that increase in the number of tillers in rice plants might be due to the more availability of nitrogen, which plays a vital role in cell division. Furthermore, nitrogen application is known to increase the levels of cytokinin which affects cell wall extensibility Arnold *et al.* [29]. It is therefore logical that nitrogen was directly or indirectly involved in the enlargement and division of new cells and production of tissues which in turn were responsible for increase in growth characteristics particularly tiller numbers Haque and Haque [30]. The productivity of rice plant is greatly dependent on the number of productive tiller (Tillers which bear panicle) rather than the total number of tillers.

The significant differences observed in the number of tillers per plant among the varieties with Faro 61 having the highest number of tillers can be ascribed to the differences in the ability of varieties to utilize nitrogen fertilizer as well as partition their photosynthates and accumulate of dry matter differently. The differences in the ability of crop cultivars to utilize available nutrients and optimally partition its photosynthates had been recognized Ndon and Ndaeyo [31].

The non-significant differences among the irrigation intervals in leaf area might be due to the ability plants resist drought at the early growth stages. The higher LA recorded with shorter irrigation interval is indication that the higher available moisture might have helped in enhancing leaf area. Furthermore, the significantly higher LA due to higher rates of nitrogen may be an indication that nitrogen was taken up by the plant and subsequently utilized in cell multiplication, amino acids synthesis and energy formation that acts as structural compound of the chloroplast which carries out the photosynthesis Haque and Haque [30]. Nitrogen had been reported to be a constituent of chlorophyll Lawlow [32]. However, nitrogen insufficiency has been reported to reduce LA resulting in reduced surface light interception for photosynthesis Jing *et al.* [33]. The consistently highest LA recorded from Faro 61 is an indication that varieties differ in their response to moisture and nitrogen rates. The significantly higher dry matter produced from irrigation interval of 3 days at harvest in 2015 and at 12 WAT in 2017 is an indication that high moisture enhances solubility and uptake of nutrients which encouraged high dry matter yield. The consistent increase in dry matter production at increased nitrogen rates shows that elevated nitrogen supply can boost dry matter content through production of photo-assimilates via leaves which is the center of plant growth during vegetative stage and later distribution of assimilates to the reproductive organs Dordas and Sioulas [34] and Azarpour *et al*. [35]. Furthermore dry matter production in rice is significantly related to intercept photosynthetically active radiation Kiniry *et al*. [36]. Low nitrogen concentrations in plant leaves have been described as a limiting factor for reducing radiation use efficiency and biomass productivity Sinclair and Sheehy [37] resulting in lower dry matter production of rice. The significant differences in dry matter production among the tested varieties with Faro 61 having the highest dry matter production at all the sampled periods show that the variety responds to adequate moisture and high nitrogen rates. Plants with large leaf area is expected to absorb sufficient sunlight and so likely to produce large quantities of dry matter through photosynthesis and as a result high grain yield. Muchow [38] had earlier attributed higher dry matter at higher nitrogen to increased leaf area development, longer maintenance of functional leaf area due available moisture in the root zone and the photosynthetic efficiency of the leaf area. Similar responses of dry matter to nitrogen application have been reported by other workers Lucas [39], Yunusa and Gworgwor [40] Akintoye [41] who reported that adequate nitrogen application in rice enhance dry matter production.

CONCLUSION AND RECOMMENDATION

Irrigation interval of 3 days performed better in many growth parameters of rice, but was not significantly different from those irrigated at every 6 days. Good rice growth in the study area could be obtained from irrigation interval of 6 days.

Nitrogen significantly increased growth and some yield parameters with increasing levels up to 180 kg N/ha. A linear response was recorded indicating that with more fertilizer applied, there will higher response in all the growth parameters measured.

Faro 61 consistently performed best in virtually all the growth parameters in the study area. Thus 6 days irrigation interval, 180 kg N/ha and Faro 61 is recommended.

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