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Response of Some Rice Varieties (*Oryza Sativa L*) to Seasonal Variations on Growth Parameters in Sudan Savannah Agro-Ecological Zone of Nigeria

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Abstract

Field studies were carried out at Kura (Kano South) and Minjibir (Kano North) local governments of Kano State to determine the effect of seasonal variations of some rice varieties on growth parameters. Kano falls within the Sudan savanna agro-ecological zone characterized by two climatic seasons (dry and wet). The experiment consisted of FARO 44, FARO61 and YARDAS (local variety) which were grown at the two locations in the two seasons. Data collected on growth as affected by seasonal variations were subjected to analysis of variance and Fishers least significant difference was used to separate the means. Results obtained revealed that, growth of the rice in dry season were significantly achieved than in wet season. Mean daily radiation was higher in dry Season than in wet Season. The greater radiation in dry season contributed to the higher growth performance in dry season trial which was partly the result of greater plant height, number of tillers per hill, leaf area index and reduced leaf chlorophyll content (high chlorophyll content of the leaves in wet season does not increase the rate of photosynthesis due to unfavorable light intensities obtained in the period). Therefore, cultivation of rice during dry season in Minjibir (Kano North) was found to be most effective for better growth. Thus, extending the results of this study on small and medium size farmlands could improve production of rice in Kano State.

Keywords: FARO 44, FARO61, YARDAS, Dry Season and Wet Season.

Introduction

Rice as a staple food and one of the most important grain in the world is a semi-aquatic annual grass which belongs to the genus *Oryza*, with about twenty three species out of which only two species have been known of their commercial value and are being used for cultivation, *Oryza sativa* (Asian rice) and *Oryza glaberrina* (African rice*). Oryza sativa* is the most commonly grown specie throughout the world today while *Oryza glaberrina* is grown only in South Africa (Vaughan *et al.*, 2008).

It has a life cycle of 80 days to more than 200 days from germination to maturity depending on the variety and the environmental conditions of the area where the variety is grown. The varieties are categorized into two groups; the short-duration varieties which mature in 105-120 days and the long duration varieties which mature in 150 days (or more).

Rice plant completes three agronomic stages of development which include vegetative stage (germination to panicle initiation), reproductive stage (panicle initiation (PI) to heading) and grain filling/ripening or maturation stage (heading to maturity).

Rice farming is highly dependent on environmental factors which are the most important among many other factors that affect agricultural production (Onyegbula, 2017). Rice production which is one of the world's most important grain depends on the combination effect of genetic characteristics of the variety and environmental conditions of the area where the variety is grown (Ghadirnezhad and Fallah, 2014).

Rice farming depends on optimum combination of production inputs in order to obtain incredible yield. These inputs are not limited to the production inputs that are known already but also include the different environmental factors that nature provides. Rainfall characteristics (quantity and duration), relative humidity, solar radiation and temperature constitute these weather-related factors that affect rice yield and its variability (Edeh *et al.*, 2011). Some of these factors are expected to have positive effect on the yield while others are to have negative effect. Rice production is largely affected by these weather-related factors (Islam *et al.,* 2011), and it is very important to have a good understanding of these environmental factors, that is why local farmers are seriously concerned about them due to their impact on food security, availability, stability, accessibility and utilization. For instance, increased rice production was reported under favorable conditions of the environment (Kuta, 2011). However, drastic changes in rainfall patterns and rise in temperatures also introduce unfavorable growing conditions into the cropping calendars (Ajetumobi *et al.,* 2010). However, few studies showed that solar radiation, temperature and humidity have effect on rice milling quality, appearance quality, nutritional quality and cooking quality (Rathnayake *et al.,* 2016). Recent studies both in Nigeria and other countries attributed low production of rice to impacts of climate change (Auffhammer, 2011).

Research Problem

Rice as one of the major staple foods in Nigeria, is consumed across all geo-political zones and socio-economic classes in Nigeria (KPMG, 2019).

A continuous increase in population across the Nation has contributed to a more demand in food material with rice been one of the lead major food substance. Study in growth pattern as well as innovative production methods is becoming more vital than ever.

Despite the fact that rice is cultivated almost in all the ecological zones of Nigeria, yet its sustainability to mankind still remains low. The recorded increase in rice production over the years and the various policy measures taken to increase rice production have not significantly mad the domestic rice production increased enough to meet the rising population of the country "NIGERIA" as the average rice yield is still low 2-3 tons/ha when compared to 6-8 tons/ha (Akinniran et al, 2019).

More-over, the economical inflation of food prices in the Nation has never been higher, making the daily demand and supply trajectory to be in a destabilize state, hence, the need for more study on growth pattern of the rice to be of great use. Which in return could help in production.

Research Aim & Objectives

The aim of the research is to evaluate the response of some rice varieties to seasonal variations in Sudan-Savannah agro-ecological zone of Nigeria.

The objectives of the study are:

- To determine the physic chemical parameers of the soil in rice fields
- To determine the effect of seasonal variations on growth and nature of some rice varieties

Material and Methods

Field experiments were conducted at Bauren Tanko town, Kura local government area in the southern part of Kano state which is located between latitude 11° 46' 20.35"N and longitude 8° 25' 34.72" E and Wasai town of Minjibir local government area located at latitude 12° 11' 32.81"N and longitude 8° 37' 42.37"E in the northern part of Kano state.

Kura local government area is an agricultural town becoming the most extensively irrigated local government area in the state due to the introduction of irrigation system in the area where about 80% of the people in the area are farmers who are engaged in mixed farming in both seasons. Some of the crops produced are rice, wheat, maize, millet, guinea-corn, beans, tomatoes etc. The area has a mean annual rainfall of 1300mm with the mean annual temperature of 34°C, average wind speed of 7.7 miles per hour and a relative humidity of 31% during dry season and 62% during wet season (Olofin *et al.*, 2008).

Wasai town of Minjibir local government area lies at 12° 53′ North and 8° 32′ East. Wasai reservoir, also known as Jakara reservoir is an important reservoir in Kano that contribute immensely towards agricultural development in the area. The people living in the nearby settlements\villages primarily depend on the reservoir as a source for irrigational activities (Magaji and Rabiu, 2020). Over 90% of the inhabitants of the area are farmers in both dry and wet seasons, crops grown in the area include onion, rice, sweet-potatoes, maize, okra etc. The area has a mean annual rainfall of 800mm with relative humidity of 75% during the rainy season and 36% during dry season, average wind speed of 7.3 miles per hour and a mean annual temperature of 26°C (Magaji and Rabiu, 2020).

The treatments consisted of dry and wet seasons for determination of seasonal response and FARO44, FARO61 and YARDAS (control) for the determination of varietal response on the season. The plots were laid in a Randomized Complete Block Design (RCBD) with three replications.

The experimental fields were ploughed twice by hand and major weeds were removed seven days before transplanting. The soil was leveled to reduce the amount of water wasted by uneven pockets of too-deep water, to allow the seedlings to be planted at the right depth, to help with the weed control and also to expose the rhizomes of perennial weeds to scorching action of the sun. The plots were kept weed free throughout the growing period by manual weeding (Sangita *et al*., 2018).

Plots measuring $4.5m^2$, with 3m length and 1.5m breadth were used which were separated by separated by 0.50m. The plant spacing between and within rows was 0.2m, maintaining 15 rows with 8 hills per row in each plot, following the recommendation of National Cereal Research Institute (2003).

21-days old nursery seedlings were transplanted to the experimental field by uprooting the seedlings and

planted at the rate of 2–3 seedlings per hill to a depth of 3–4 cm with a space of 20cm between rows and 20cm between plants. Gap fillings were done four days after transplanting to maintain the desired plant population in the experimental plots (IRR, 2007).

The transplanted seedlings were fertilized at the rate of 200kg/ha of NPK 15:15:15 fourteen (14) days after transplanting. Second application was at the rate of 100 kg/ha of urea at four weeks interval. The amount of fertilizer applied on each plot was 90g of NPK 15:15:15 and 45g of urea using the relation of plot size per hectare (IRRI, 2007).

Water level was maintained in the field up to 5cm from one week after transplanting up to grain maturity during dry season. Bund of 0.5m height was made between individual plots to stagnate rain water. The water was drained a week before harvesting (Sangita *et al*., 2018).

The following parameters on yield of rice were collected, days to 50% flowering**,** number of panicles per square meter**,** number of grains/panicles, length of panicle**,** grain sterility percentage, weight of one thousand (1000) grains and grain yield per hectare.

Meteorological parameters recorded were rainfall, wind speed, relative humidity, solar radiation and temperature using standard procedures.

Data collected were analyzed using analysis of variance (ANOVA) and means were separated using Fishers least significant different at 0.05 probability level. Using Microsoft Excel version 2019.

Results and Discussion

Results on plant height as affected by seasonal variation and varietal responses in both locations (Kura and Minjibir) were presented on Table I, means compared have revealed significant difference among varieties and seasons. Plants cultivated in wet season were observed to be significantly taller than those cultivated in dry season in both locations.

For the varietal variation at Kura (Kano South), at 2WAT, FARO 44 has significantly recorded higher values for plant height in comparison to FARO 61 and those treated as control (Yardas variety), where the Yardas variety recorded the least value and was found to be significantly lower than what was recorded by FARO 61. Similar trend was observed at 4, 8, 10 and 12 weeks after transplanting (WAT). However, at 6WAT significant difference ($P \leq 0.05$) was not detected. Moreover, at 14WAT FARO 61 and the Yardas, have recorded similar but lower values.

At Minjibir (Kano North) for the varietal variation, at 2WAT, FARO 44 recorded the highest values for plant height when compared to FARO 61 and Yardas variety, where the Yardas variety recorded the least value. Similar trend was recorded at 8, 10, 12 and 14 weeks after transplanting (WAT).

However, at 4WAT, FARO 44 recorded significantly higher values of plant height while FARO 61 was recorded to produce the least value on plant height which was significantly lower than what was produced by the Yardas variety. Moreover, significant difference ($P \leq 0.05$) was not observed between the varieties at 6WAT.

There were interactions between time of planting (season) and the rice varieties, where FARO44 in wet season resulted in the highest of plant height across the weeks in the two locations.

The results obtained on plant height indicated that, the response of the rice varieties to seasonal variation differs significantly between the varieties and across the seasons. The maximum plant height was obtained at 14WAT, during milky stage at the ripening stage when the height was stable and less variable. In general, rice plants performed significantly better in wet season than in dry season. This corroborates the findings of Ali *et al.* (2000) who found out that, plant height was significantly influenced by water depth and further stated that rice plant height increased with increase in water depth resulting to taller plants. Xiaoyu *et al.* (2014) also stated that, height in rice plants varies ranging from approximately 0.4m to over 5m in certain deep water varieties with rise in water level.

The superiority of the FARO 44 in wet season could be due genetic differences. Genetically, FARO 44 has higher potential average plant height (100-115cm) than FARO 61 (90-100cm) and the Yardas variety (Kamai *et al.*, 2020).

Table I: Response of some rice varieties (*Oryza sativa* L) to seasonal variations in Sudan Savannah Agro-ecological zone of Nigeria on plant height (cm)

Means ± = Standard error, means for a pair of season and varieties with different superscript along column are significantly different at 5% level of probability using Fisher's LSD. NS = Not Significant, WAT = weeks after transplanting, ***= Significant at 99% level, **= Significant at 95% level, * = Significant at 90% level.

Source	2WAT	4WAT	6WAT	8WAT	10WAT	12WAT	14WAT
Kura (Kano South)							
Season							
Dry	24.51±1.24[b]	40.05±0.53[b]	52.81±1.66[b]	69.56±2.31[b]	75.22±1.74[b]	77.42±1.98[b]	81.83±1.42[b]
Wet	30.96±0.48[a]	45.56±1.03[a]	56.14±5.89[a]	89.14±.6.5[a]	91.40±1.37[a]	98.20±1.57[a]	101.46±1.36[a]
Varieties							
FARO44	30.35±1.15[a]	44.62±1.27[a]	59.63±1.14[a]	83.81±2.95[a]	96.56±4.54[a]	94.13±4.50[a]	96.95±4.40[a]
FARO61	27.8±1.10[b]	40.92±0.53[b]	49.52±8.11[a]	79.90±4.49[b]	83.77±4.15[b]	86.58±4.05[b]	89.32±4.04[b]
YARDAS	25.05±2.26[c]	42.90±2.13[c]	54.27±3.51[a]	74.35±1.24[c]	82.10±5.56[c]	82.75±5.48[c]	88.67±4.77[b]
LSD 5%	0.76	0.69	NS	1.11	1.21	1.05	0.83
Interaction							
Seasons x varieties	***	***	NS	***	***	***	NS
Minjibir (Kano North)							
Seasons							
Dry	25.73±1.49[b]	42.39±1.08[b]	55.10±1.60[b]	77.38±2.26[b]	81.20±2.30[b]	84.90±2.65[b]	87.11±2.35[b]
Wet	30.96±0.48[a]	45.57±1.03[a]	56.14±5.83[a]	89.14±0.64[a]	96.40±1.37[a]	98.20±1.57[a]	101.46±1.36[a]
Varieties							
FARO44	31.13±0.82[a]	46.88±0.29[a]	60.50±1.81	87.23±1.61[a]	94.67±3.20[a]	98.23±2.69[a]	100.22±2.94[a]
FARO61	28.85±0.64[b]	41.75±0.42[c]	50.91±8.32	84.35±2.51[b]	88.23±2.16[b]	91.32±2.21[b]	93.73±2.23[b]
YARDAS	25.05±2.26[c]	43.30±1.95[b]	55.45±2.95	78.20±4.08[c]	83.50±4.93[c]	85.10±4.46[c]	88.9±4.66[c]
LSD 5%	0.66	0.72	NS	1.38	0.98	1.70	1.34
Interaction							
Seasons x Varieties	***	***	NS	***	***	***	***

The results of average number of tillers per hill as affected by seasonal variation and varietal responses in both locations (Kura and Minjibir) were presented on Table II, means compared have revealed significant difference among varieties and seasons, were values recorded for average number of tillers per hill were significantly higher in dry season when compared to wet season trial in both Kura and Minjibir.

For the varietal variation at Kura (Kano South), at 2WAT, FARO 44 recorded the highest number of tillers per hill in comparison to other varieties. On the other hand, Yardas variety recorded significantly the least value for average number of tillers per hill. Similar trend was observed at 6WAT.

At 4WAT, FARO 44 also recorded greater number of tillers per hill which was significantly higher than in the two other varieties which recorded similar statistical effect. Similar trend was observed at 8WAT.

For the result of Minjibir (Kano North) on the varietal variation, FARO 44 has recorded the highest number of tillers per hill when compared to other two varieties at 2WAT and this stands to be significantly higher and no significant difference was observed between FARO 61 and Yardas variety.

At 4WAT, FARO 44 has also recorded a value which was found to be significantly higher than the remaining two varieties while significant difference was observed between the values recorded by FARO 61 and Yardas variety for average number of tillers per hill. Similar trend was recorded at 6 and 8WAT.

Interactions between time of planting (season) and the rice varieties were observed, were FARO 44 in dry season recorded the highest number of tillers per hill and this was found to be significantly higher than the tillers produced by the two other varieties in both seasons.

Number of tillers is one of the determinants of yield when assumed that every tiller bears a panicle (Jean *et al.*, 2019). The response of some rice varieties to seasonal variation on average number of tillers per hill as observed in the present findings differs significantly between the varieties and across the seasons. Generally, dry seasons had maximum number of tillers than wet seasons, the result was in consistent with the findings of Kawure (2021) who reported that, rice production in dry season had significantly higher number of tillers per hill than wet season rice production due to higher solar radiation which favors the tilling capacity. This was also in line with the findings of Santosa and Suryanto (2015) who reported that, high rainfall during the growth of paddy decreased the number of leaves, leaf area and LAI, which subsequently decreased the number of tillers per hill. However, Tadesse *et al.* (2013) highlighted that, continuous and prolong rainfall resulted in lower productive tillers, but report by Shi *et al.* (2016) stated that, low temperature (associated with wet season) reduce tillering capacity in rice plants.

Concerning the varieties, maximum tillering capacity of the varieties was reached at 8WAT. The superiority of FARO 44 could be due to genetic factors (since variation in tillering potential among varieties is controlled genetically by hereditary traits and environmental factors) as well as their ability to utilize the environmental resources such as water, nutrient and light most effectively. Garba and Fushison (2007) studied Performance of ten varieties of rice (*Oryza sativa L*) grown under irrigation during dry season in Bauchi State, who found out that FARO 44 produced significantly higher number of tillers per hill than all other varieties tested. However, this was an indication that, the variety responded positively to the environmental resources (water, nutrient and light) and the agronomic practices than other varieties.

Table II: Response of some rice varieties (*Oryza sativa* L) to seasonal variations in Sudan Savannah Agro-ecological zone of Nigeria on number of tillers per hill.

Source	2WAT	4WAT	6WAT	8WAT
Kura (Kano South)				
Season				
Dry	2.36±0.24[a]	5.72±0.35[a]	9.59±0.56[a]	16.01±0.87[a]
Wet	1.76±0.14[b]	4.57±0.19[b]	7.91±0.43[b]	10.44±0.75[b]
Varieties				
FARO44	2.57±076[a]	6.00±0.42[a]	10.43±0.53[a]	16.22±1.38[a]
FARO61	2.05±0.22[b]	4.58±0.25[b]	8.23±0.17[b]	11.93±1.13[b]
YARDAS	1.55±0.14[c]	4.85±0.35[b]	7.58±0.64[c]	11.53±1.40[b]
LSD 5%	0.32	0.44	0.47	0.81
Interaction				
Seasons x varieties	NS	NS	***	NS
Minjibir (Kano North)				
Season				
Dry	2.34±0.14[a]	8.60±0.15[a]	16.51±0.68[a]	21.13±0.94[a]
Wet	1.93±0.22[b]	8.01±0.68[b]	12.04±1.02[b]	14.15±0.64[b]
Varieties				
FARO44	2.77±0.19[a]	9.97±0.49[a]	16.98±1.27[a]	20.13±2.68[a]
FARO61	1.80±0.15[b]	8.07±0.70[b]	13.6±1.27[b]	17.30±1.08[b]
YARDAS	1.85±0.23[b]	6.88±0.31[c]	12.25±1.00[c]	15.50±1.65[c]
LSD 5%	0.29	0.70	1.26	0.80
Interaction				
Seasons x varieties	NS	***	NS	**

Means ±Standard error, means for a pair of season and varieties with different superscript along column are significantly different at 5% level using Fisher's LSD. NS = Not Significant, WAT = weeks after transplanting, ***= Significant at 99% level, **= Significant at 95% level, * = Significant at 90% level.

Table III showed the result of the response of some rice varieties to seasonal variations on leaf area index. Means compared were significantly different across the varieties and seasons.

In Kura (Kano South) rice plants in dry season have recorded significant value of leaf area index than wet season across the weeks. Similar trend was observed Minjibir (Kano North).

For the varietal variation in Kura (Kano South), significant difference (P≤0.05) observed has indicated that, at 2WAT, FARO 61 recorded the highest value and was found to be significantly higher than the values recorded by other two varieties, but it was observed to be statistically similar to Yardas variety. The least value was recorded by FARO 44 which was also recorded to be statistically similar to Yardas variety.

At 4WAT, FARO 44 has recorded the highest value which stands to be significantly higher than other two varieties but statistically similar to Yardas variety. FARO 61 was observed to record least value which was statistically similar to Yardas variety.

No significant difference (P≤0.05) was observed between the varieties at 6WAT, 8WAT, 10WAT and 12WAT.

For the varietal variation at Minjibir (Kano North), significant difference (P≤0.05) was only observed at 6WAT where FARO 44 recorded the highest value which was found to be significantly higher than in FARO 61 and Yardas variety.

There were interactions between time of planting (season) and the rice varieties with regards to leaf area index, FARO 44 in dry season was observed to record a value which is significantly higher than in other two varieties across the weeks in the two locations.

The leaves of a plant are normally its main organ of photosynthesis and the total area of leaves per unit ground area, called leaf area index (LAI), has therefore been proposed by Pham *et al.* (2004) as the best measure of the capacity of a crop in producing dry matter and called it as productive capital. The observed result showed that the average leaf area index increased from 2WAT to 8WAT and declined towards maturity mainly due to leaf senescence. It was observed that, the response of the rice varieties on leaf area index (LAI) was recorded to be higher in dry season than in wet season. The highest value was recorded at 8WAT of Minjibir (Kano North) in dry season (3.66), while the least value was recorded in wet season at 2WAT of Kura (0.13). This finding was coherent with that of Santosa and Suryanto (2015) according to whom, high rainfall during the growth of paddy decreased the number of leaves, leaf area and LAI, then followed by decreasing the number of tillers per hill. Similarly, Lin *et al.* (2011) stated that, irrigation promote higher LAI compared to rainfall, while Tadesse *et al.* (2013) highlighted that continuous and prolong rainfall resulted in lower LAI, crop growth rate, net assimilation rate and productive tillers. Furthermore, current findings were also consistent with the findings of Yang and Jee (2001) who found out that, rice plants grown in dry season showed a higher levels of leaf area at the same chlorophyll level than those grown in the wet season.

Lack of significant difference among varieties was observed and where the significant difference was observed, FARO 44 was recorded to have the highest value among the varieties largely due to the higher number of tillers produced by FARO 44 when compared to other varieties. The findings of Faruk *et al.* (2009) who reported that higher number of tillers per plant causes higher number of leaves per unit area and higher number of leaves produces high LAI. Demarez *et al.* (2008) reaffirmed that, it is true that tiller number per unit area was the major factor determining the LAI of rice.

Table III: Response of some rice (*Oryza sativa* L) varieties to seasonal variation in Sudan Savannah Agro-ecological zone of Nigeria on leaf area index

Source	2WAT	4WAT	6WAT	8WAT	10WAT	12WAT
Kura (Kano South)						
Seasons						
Dry	0.14±0.002[a]	1.50±0.02[a]	2.25±0.331[a]	3.06±0.04[a]	2.16±0.04[a]	1.56±0.02[a]
Wet	0.13±0.004[b]	1.44±0.02[b]	2.04±0.021[b]	3.03±0.03[b]	2.08±0.03[b]	1.41±0.02[b]
Varieties						
FARO44	0.13±0.005[b]	1.53±0.02[a]	2.11±0.025[a]	3.11±0.04[a]	2.19±0.03[a]	1.50±0.03[a]
FARO61	0.15±0.002[a]	1.42±0.04[b]	2.13±0.073[a]	2.95±0.03[a]	2.02±0.03[a]	1.48±0.02[a]
YARDAS	0.14±0.002[ab]	1.45±0.01[ab]	2.19±0.063[a]	3.09±0.03[a]	2.15±0.05[a]	1.48±0.02[a]
LSD 5%	0.01	0.10	NS	NS	NS	NS
Interaction						
Seasons x varieties	NS	***	**	**	NS	***
Minjibir (Kano North)						
Seasons						
Dry	0.15±0.00[a]	1.62±0.02[a]	2.25±0.04[a]	3.66±0.03[a]	2.17±0.03[a]	1.51±0.03[a]
Wet	0.14±0.00[b]	1.44±0.01[b]	2.03±0.02[b]	3.07±0.02[b]	2.15±0.04[b]	1.43±0.02[b]
Varieties						
FARO44	0.15±0.00	1.56±0.05[a]	2.22±0.07[a]	3.36±0.11[a]	2.23±0.04[a]	1.50±0.04[a]
FARO61	0.14±0.00	1.52±0.05[a]	2.06±0.05[b]	3.35±0.16[a]	2.12±0.03[a]	1.46±0.04[a]
YARDAS	0.15±0.00	1.52±0.03[a]	2.13±0.05[ab]	3.38±0.13[a]	2.13±0.05[a]	1.45±0.01[a]
LSD 5%	NS	NS	0.14	NS	NS	NS
Interaction						
Seasons x varieties	**	**	NS	NS	NS	***

Means ± = Standard error, means for a pair of season and varieties with different superscript along column are significantly different at 5% level using Fisher's LSD. NS = Not Significant, WAT = weeks after transplanting, ***= Significant at 99% level, **= Significant at 95% level, * = Significant at 90% level.

Results on the measurements of leaf chlorophyll content as affected by seasonal variation were presented on Table IV. At Kura (Kano South) significant difference was observed for both seasonal and varietal responses except at vegetative and ripening phases where the three varieties were not different.

For the seasonal variation, rice plants at vegetative, reproductive and ripening stages recorded higher chlorophyll content in wet season than those in dry season in.

For the varietal variation, at reproductive stage, FARO 44 and FARO 61 were observed to record greater content of chlorophyll when compared to Yardas variety which recorded the least content, although statistically similar to what was recorded by FARO 44.

At Minjibir (Kano North), rice plants at vegetative stage have recorded higher leaf chlorophyll content in wet season than in those cultivated during dry season. Similar trend was also observed at reproductive and ripening stages.

For the varietal variation, significant difference ($P \leq 0.05$) among the varieties was also observed at vegetative stage were Yardas variety and FARO 44 were observed to record highest value and was found to be significantly higher than in FARO 61. However, the least value recorded by FARO 61 was found to be statistically similar to FARO 44.

Interactions effect between seasons and some rice varieties on leaf chlorophyll content were observed, were the results of Kura (Kano South) has indicated that, at reproductive stage, FARO 44 and FARO 61 in wet season observed to be significantly higher ($P \leq 0.05$) than all other combinations. Although FARO 44 in wet season recorded statistically similar value with FARO 61 and Yardas variety in dry and wet season respectively, Yardas variety was observed to record least content.

At ripening stage, the three varieties cultivated in wet season have recorded greater chlorophyll content when compared to what was recorded in all varieties during dry season.

The results of Minjibir (Kano North) have revealed that, at vegetative stage, all the three selected varieties contained significant amount of chlorophyll in wet season when compared to what was recorded in dry season. However, the chlorophyll content in all the varieties during dry season cultivation, were statistically similar to what was recorded by FARO 61 during wet season. Similar trend was also observed at ripening phase but with all varieties cultivated in dry season recording less content of chlorophyll.

Chlorophyll (SPAD) is an important photosynthetic pigment to the plant that largely determined the health status and photosynthetic capacity of a plant. In this study, findings showed that, the plant performed significantly better in wet season than in dry season across all the developmental stages. The results were in agreement with that of Yuxuan *et al.* (2021) who stated that, precipitation affect the photochemical activity of chloroplast, with water (available water present in plants due to wet season are higher than that of dry season) being the medium used for transporting nutrients in plants, mineral salts must dissolved in it to be absorbed by plants. Thus, its availability in the leaves influences the synthesis of chlorophyll, while lack or less availability of it promotes the decomposition of chlorophyll, thereby accelerating leaf yellowing. However, Wang *et al.* (2014) in a research found out that, rice plants grown in wet season showed higher levels of chlorophyll than those grown in dry season. Similarly, current finding agrees with that of Tadesse *et al* (2013) who stated that, in the rainy season, the chlorophyll content of all the type of leaves rises, as the leaves were structurally transformed into shade leaves. Note that, the high chlorophyll content of the leaves in wet season does not increase the rate of photosynthesis due to unfavorable light intensities obtained in the period.

The performance of the varieties in terms leaf chlorophyll content (SPAD) across the 3 developmental stages showed a peculiar trend, where leaf chlorophyll content (SPAD) of a young rice plants began with lower levels (at vegetative stage, about 2WAT-8WAT), which increased as the plants developed (at reproductive stage about 8WAT-12WAT) where the maximum chlorophyll content was recorded at panicle initiation and decreased as the plants aged i.e. when the moisture content of the plants reduced (ripening stage about 12WAT-14WAT) where the minimum chlorophyll level was detected just before or at heading. This finding was inconsistent with that of Yang and Jee (2001).

Moreover, FARO 44 was significantly superior to other varieties in terms of chlorophyll content in both locations. The reason for the higher performance of FARO 44 might be due to its better response to fertilizer application than other varieties. However, it may also be due to among other reasons genetical, physiological and morphological differences in the variety (Edeh *et al.*, 2011), because visibly FARO 44 possessed dark greener leaves than FARO 61 and Yardas variety. This was also in consistence with the results of Gholizadeth *et al.* (2009)) who hypothesized that, the darker is the green color of a leaf, the higher the amount of its chlorophyll content and nitrogen.

In addition, it was observed by Syed *et al*. (2017) that, a darker green color in plants could be an indicative of a higher chlorophyll content.

Table IV Response of some rice (*Oryza sativa* L) varieties to seasonal variation in Sudan Savannah Agro-ecological zone of Nigeria on leaf chlorophyll content (SPAD)

Source	Vegetative phase	Reproductive phase	Ripening phase
Kura (Kano South)			
Seasons			
Dry	30.13±0.14^{b}	38.99±0.48^{b}	30.75±0.20^{b}
Wet	33.56±0.32^{a}	45.32±1.79^{a}	34.04±0.29^{a}
Varieties			
FARO44	31.90±0.66^{a}	42.61±1.37^{ab}	32.63±1.04^{a}
FARO61	31.80±1.00^{a}	45.45±2.51^{a}	32.45±0.59^{a}
YARDAS	31.83±0.78^{a}	38.41±0.63^{b}	32.11±0.68^{a}
LSD 5%	NS	6.49	NS
Interaction			
Seasons x varieties	NS	***	**
Minjibir (Kano North)			
Seasons			
Dry	31.57±0.33^{b}	41.33±0.20^{b}	31.76±0.44^{b}

Wet	37.61±0.65[a]	52.49±0.43[a]	37.78±0.49[a]
Varieties			
FARO44	34.74±1.85[ab]	47.27±4.81[a]	34.73±1.44[a]
FARO61	33.92±0.59[b]	46.10±2.32[a]	34.38±0.98[a]
YARDAS	35.11±1.69[a]	47.36±2.40[a]	35.20±0.18[a]
LSD 5%	1.12	NS	NS
Interaction			
Seasons x varieties	***	NS	***

Means ± = Standard error, means for a pair of season and varieties with different superscript along column are significantly different at 5% level using Fisher's LSD. NS = Not Significant, WAT = weeks after transplanting, ***= Significant at 99% level, **= Significant at 95% level, * = Significant at 90% level.

Conclusion

Seasonal variation has affected growth of rice by showing greater plant height, number of tillers per hill, leaf area index and reduced leaf chlorophyll content (high chlorophyll content of the leaves in wet season does not increase the rate of photosynthesis due to unfavorable light intensities obtained in the period) in dry season trial. However, varietal responses were also affected, where FARO 44 at both Minjibir (Kano North) and Kura (Kano South) performed significantly better than the two other varieties.

Recommendations

- Dry season cultivation of rice enhances rice plant performance and subsequently yield, which might go a long way in bridging the gap between production and consumption.
- Under the present day constraints of lower production, FARO 44 varieties is recommended to farmers and extending this on small and medium size farmlands could enhance production in the study areas.
- Further studies should be done conducted on effect of seasonal variations on other grain producing crops for comparative analysis and widening of research scope.

References

Ajetumobi, J., Abiodun, A. and Hassan, R. (2010). Economic impacts of climate change on rice agriculture in Nigeria. *Agroecosystem*. 14:613-622.

Ali, M.H., Khatun, M.M. and Mateo, L.G. (2000). Influences of Various Level of Water Depth on Rice Growth in Rice-Fish Culture under Wetland Rice Ecosystems. The *Journal of Geo-Environment*, 4:23-30.

Auffhammer, M., Ramanathan, V. and Vincent, J.R. (2011). Climate Change, the Monsoon, and Rice Yield in India. *Global Journal of Agricultural sciences,* 13:1-6.

Demarez, V., Duthoit, S., Baret, F., Weiss, M. and Dedieu, G. (2008). Estimation of leaf area and clumping indexes of crops with hemispherical photographs. *Agricultural Forest Meteorology,* 148:644–655.

Edeh, H.O, Eboh, E.C. and Mbam, P.N. (2011). Analysis of environmental risk factors affecting rice farming in Ebonyi state, Southeastern Nigeria. *World Journal of Agricultural Science*. 7(1):100-103.

Faruk, M.O., Rahman, M.A. and Hasan, M.A. (2009). Effect of seedling age and number of seedling per hill on the yield and yield contributing characters of BRRI Dhan 33. Department of Agronomy, Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh. *International Journal of Sustainable Crop Production*. 4(1):58-61.

Garba, A. and Fushison, G.G. (2007). Performance of ten varieties of rice (*Oryza sativa L*) grown under irrigation during the dry season in Bauchi State. *Global Journal of Agricultural Science,* 6(2):117-121.

Ghadirnezhad, R. and Fallah, A. (2014). Temperature Effect on Yield and Yield Components of Different Rice Cultivars in Flowering Stage. *International Journal of Agronomy,* 14:1-4.

Gholizadeth, A., Amin, M.S.M., Annur, A.R. and Aimrun, W. (2009). Evaluation of SPAD chlorophyll meter in two different rice growth stages and its temporal variability. *European Journal of Scientific Research*, 37:591-598.

Ha, K.Y., Lee, J.K., Lee, S.Y. and Lee, J.S. (1994). Grain quality characteristics for brewing in rice. *Korean Journal of Crop Science,* 39(1):38–44.

IRRI. International Rice Research Institute (2007). *General Nutrient Management for N, P and K*. Rice Knowledge Bank. Pp.62-65.

Islam, K.M., Backman, Z.S. and Sumelius, J. (2011). Technical, economic and allocative efficiency of microfinance borrowers and non-borrowers: Evidence from peasant farming in Bangladesh. *European Journal of Social Sciences*, 18: 361-377.

Jean, S., Paul, Z., Shiang-Min, C. and Yu-Min W. (2019). Comparison of yields attributes and water productivity under the system of rice intensification (SRI) in Southern Taiwan. Third world Irrigation Form (WIF3). 1st – 7th September 2019. Bhali, Indonesia. Pp.1-8

Kamai, N., Omoigui, L. and Kamara, O.A.Y. (2020). *Guide to Rice Production in Northern Nigeria*. International Institute of Tropical Agriculture, Ibadan, Nigeria. Pp.2-10

Kawure, S. (2021). Productivity of lowland rice (*Oryza sativa*) as influenced by season and sowing method at Zigau, Bauchi State, Nigeria. *African Journal of Agricultural Research,* 6: 167-175.

Kuta, D. A. (2011). Nigeria: Climate change and agriculture in Nigeria. *Global Environmental Change,* 14:273-282.

Lin, X., Zhu, D., and Lin X. (2011). Effects of water management and organic fertilization with SRI crop practices on hybrid rice performance and rhizosphere dynamics. *Paddy Water Environment*, 9: 33–39.

Magaji, A.S. and Rabiu, S. (2020). Birds of Wasai Reservoir, Minjibir, Kano-Nigeria. *Science World Journal*, Published by faculty of science, Kaduna State University. 15(2):19-20.

National Cereal Research Institute (NCRI) 2003. Production Technologies for lowland rice in Nigeria. Badeggi, Niger State, Nigeria. Pp4.

Nguyen, V.N. (2004*).* FAO programme on hybrid rice development and use for food security and livelihood improvement. Paper presented at the concluding workshop of the IRRI- ADB funded project. *'Sustaining food security in Asia through the development of hybrid rice technology'*. IRRI, Los Banos, Philippines, 7-9 Dec. Pp24-28

Olofin, E.A., Nabegu, A.B. and Danbazau, A.M. (2008). *The physical setting within Kano region, a geographical synthesis Kano city*: Ademujoji publisher. Pp. 5-34

Onyegbula, C.B. (2017). Rice farmer's perception of effects of climate change on rice development stages in Niger State. *Journal of Agricultural Extension and Rural Development*, 9:14-19.

Pham, Q.D., Mitsu, H., Satoru, S. and Eiki, K. (2004). Analysis of the dry matter production process related to yield and yield components of rice plants grown under the practice of nitrogen-free basal dressing accompanied with sparse planting density. *Plant Production Science,* 7(2):155-164.

Rathnayake, W.M.U.K., De Silva, R.P. and Dayawansa, N.D.K. (2016). Assessment of the Suitability of Temperature and Relative Humidity for Rice Cultivation in Rainfed Lowland Paddy Fields in Kurunegala District. Postgraduate Institute of Agriculture University of Peradeniya Sri Lanka. *Tropical Agricultural Research,* Vol. 27(4):370-388.

Sangita, K., Nabin, S., Poudel, G.B., Suresh, S., Bishma, R.R., Bhuwan, A. and Sanjok, P. (2018). Growth Parameters and Yield Attributes of Rice (*Oryza Sativa*) as Influenced by different Combination of Nitrogen Sources. *World Journal of Agricultural Research*, 6(2):58-64.

Santosa, M. and Suryanto, A. (2015). The Growth and Yield of Paddy Ciherang Planted in Dry and Wet Season and Fertillized with Organic and Inorganic Fertilizers. Faculty of Agriculture, University of Brawijaya, Jl. Veteran Malang 65145, East Java, Indonesia. *Agrivita,* 37(1):25-28.

Shi, W., Yin, X., Struik, P.C., Xie, F., Schmidt, R.C. and Jagadish, K.S.V. (2016). Grain yield and quality responses of tropical hybrid rice to high night-time temperature. *Field Crops Research*, 16:18–25.

Syed, H., Shah, R.H. and Mathew, F.M. (2017). Response of chlorophyll, Carotenoid and SPAD-502 Measurement to Salinity and Nutrient Stress in Wheat (*Triticum aestivum L*). *Agronomy*, 7:61-64

Tadesse, T., Dechassa, N., Bayu, W. and Gebeyehu, S. (2013). Impact of rainwater management on growth and yield of rainfed lowland rice. *Wudpecker Journal of Agricultural Research,* 2:108–114.

Vaughan, D.A., Ge, S., Kaga, A. and Tamooka, N. (2008). Rice Biology in the Genomic era. *Biotechnology in Agriculture and Forestry*, 62:29-32.

Wang, Y., Wang, D., Shi, P. and Omasa, K. (2014). Estimating rice chlorophyll content and leaf nitrogen concentration with a digital still color camera under natural light. *Plant Methods*, 10:1–11.

Xiaoyu, W., Lei, W., Jia, W., Yong, H., Hao, D., Caiguo, X., Yongzhong, X., Xianghua, L., Jinghua, X., and Qifa, Z., (2014*). Grain Number, Plant Height, and Heading Date as Central Regulator of Growth, Development, and Stress Response*. National Key Laboratory of Crop Genetic Improvement, National Center of Plant Gene Research (Wuhan), Huazhong Agricultural University, Wuhan 430070, China. 164:735-747.

Yang, C.M. and Jee, J.Y. (2001). *Seasonal Changes of Chlorophyll Content in Field-Grown Rice Crops and Their Relationships with Growth*. Proceedings of the Natural Science Council, Republic of China. *ROC (B),* 25(4):233-238.

Yuxuan, M., Yao, C., Hao, W. and Dan, W. (2021). Diurnal and Seasonal Variation in the Photosynthetic Characteristics and the Gas Exchange Simulations of Two Rice cultivars Grown at Ambient and Elevated CO_2. Department of Ecology, College of Applied Meteorology, Nanjing University of information science and technology, Nanjing, China. Original Research. Doi: 10.3389/fpls. 2021. 61606. Agricultural research institute, China. Pp. 67-84.