Special Conference Edition, June, 2023

http://dx.doi.org/10.4314/bajopas.v14i1.1S

Bayero Journal of Pure and Applied Sciences, 14(1): 185 - 191
ISSN 2006 – 6996

SOIL PHYSICOCHEMICAL ANALYSES AND EFFECT OF SEASONAL VARIATION ON YIELD OF SOME RICE (*Oryza sativa* L.) VARIETIES IN MINJIBIR, KANO - NIGERIA

[1]Rahama Tijjani Babuga, [2]Aminu Ahmad Aliko, [1]Badria Mahmoud Abdussalam and [1]Maryam Musa Karaye
[1]Saadatu Rimi University of Education, Kumbotso.
[2]Department of Plant Biology, Bayero University Kano.
Corresponding author: rahamababuga@gmail.com *08106349050*

ABSTRACT
A Field study was carried out at Minjibir local government of Kano State to determine the effect of seasonal variations on growth and yield of three selected rice varieties. Kano falls within the Sudan savanna agro-ecological zone characterized by two climatic seasons (dry and wet). The experiment consisted of three varieties (FARO 44, FARO61 and YARDAS, local variety) which were grown in the two seasons. Data collected on growth and yield 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 yield of the rice in dry season was significantly higher in dry Season than in wet Season. Correlation analyses of soil and meteorological parameters on yield have indicated that greater radiation during ripening in dry season has contributed to the higher grain yield. Higher grain yield in dry season was partly attributed to the greater number of panicles/m^2, number of filled grains/panicle, 1000 grain weight, grain yield per hectare and reduced sterility, unfilled grains per panicle, days to 50% flowering in dry season trial. Therefore, cultivation of rice during dry season was found to be most effective in terms of better yield and growth characteristics. Thus, outspreading the results of this study on small and medium size farmlands could improve production of rice in Kano State and other places in the Sudan Savannah Agro-ecological zone.
Keywords: Seasons, growth, yield, rice

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).

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 grains 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).

Rainfall characteristics (quantity and duration), relative humidity, solar radiation and temperature constitute weather-related factors that affect rice yield and its variability (Edeh *et al.,* 2011). Some of these factors are likely to have positive effect on the yield while others are 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, an 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). The study added that these changes modify growing seasons which subsequently reduce rice productivity. Furthermore, in another research conducted by Manneh *et al.* (2007), it was stated that the risk of high temperature and water stress present in all rice production systems from uplands to lowlands is one of the most important production constraints in Africa. It was also noted that, the growth pattern, duration and productivity of rice crop is greatly influenced by temperature while severe moisture stress especially during rice reproductive stage may lead to complete crop failure, because rice when compared to other crops is very sensitive to drought which can reduce stand establishment, tillering, plant height, spikelet fertility and also delay flowering. Nguyen (2004) finally stressed that, the degree of impact of the drought is dependent on the stage of growth of the crop.

Previous studies showed that, environmental factors strongly affect rice quality in the filling stage where the head rice ratio was observed to decrease when the temperature increased from 20°C to 30°C (Ha *et al.*, 1994). Recent studies both in Nigeria and other countries attributed low production of rice to impacts of climate change (Auffhammer, 2011).

This research is therefore, aimed at determining the yield and the yield attributing characteristics of rice as influenced by seasonal variation in Minjibir, Kano-Nigeria.

MATERIALS AND METHODS

Experimental Site

The experiment was conducted at Wasai town of Minjibir local government area located at latitude 12^0 11' 32.81"N and longitude 8^0 37' 42.37"E in the northern part of Kano state.

Wasai town of Minjibir local government area has a reservoir, popularly called Jakara reservoir. It is an important reservoir in Kano that contributes 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 26^0C (Magaji and Rabiu, 2020).

Treatments and Experimental Design

The treatments consisted of dry and wet seasons for determination of seasonal response in FARO44, FARO61 and YARDAS (control) rice varieties. The plots were laid in a Randomized Complete Design (RCD) with three replications.

Plots measuring 4.5m^2, with 3m length and 1.5m breadth were used which were 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). The plots were kept weed free throughout the growing period by manual weeding (Sangita *et al.*, 2018).

Planting and Management

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).

Data Collection and Analyses

The following parameters on yield of rice were collected, days to 50% flowering**,** number of panicles per square meter**,** number of grains/panicle, 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 DISCCUSSION

In the experimental site, the results (Table 1) has indicated that the soil was loamy sand both in wet and dry seasons with a slightly acidic soil of pH 6.38 in dry season and 6.25 in wet season before planting. The organic carbon, Phosphorous and total Nitrogen content were recorded to be moderately available in the soil in both seasons. The Ca present in the soil in both seasons was determined to be moderate. However, the amount of Mg, K and Na were found to be high. Furthermore, the ECEC available in the soil was in moderate content.

For the results after planting, the soil was also loamy sand both in wet and dry seasons with also a slightly acidic soil of pH 6.21 in dry season and 6.12 in wet season. A moderate content of organic carbon, P, Ca and Na, in both seasons were found. Very low nitrogen was recorded in the soil in both seasons while Mg and K were detected to be high.

The textural class of the soil reported by the study is suitable for rice production as prescribed by Aondoakaa and Agbakwuru, (2012), who also reported that the standard soil pH requirement for rice cultivation is between 6.1 and 6.5. The report also supported the findings of this study that, other physicochemical properties of the soil are all within the range to support rice cultivation. The organic Carbon content and the total Nitrogen of Minjibir (Kano North) were low, but good enough for most crops including rice (FMAWRRD, 1989; FMANR, 1990). The alteration in some physicochemical parameters at postharvest is an indication that the rice plants have absorbed certain amount. This finding was supported by Sultana *et al.,* (2016). Xu *et al.*, (2008) also observed a decrease in soil P content of postharvest soil analysis for rice cultivation.

Table 1: Soil properties of the experimental site Minjibir (Kano North)

Properties	Dry Season Before planting	After planting	Wet Season before planting	after planting
Physical (%)				
Clay	13.32	11.77	14.81	12.81
Silt	24.36	22.46	19.79	18.45
Sand	62.32	65.77	65.68	68.74
Textural class	Loamy sand	Loamy sand	Loamy sand	Loamy sand
Chemical				
pH	6.38	6.21	6.25	6.12
EC (Us/cm)	144.02	138.23	141.67	137.09
ECEC (cmol/kg)	5.94	4.43	6.08	4.58
EA (cmol/kg)	0.19	0.13	0.18	0.11
Organic Carbon (%)	1.21	1.31	1.32	1.40
Total nitrogen (%)	0.12	0.05	0.14	0.07
Phosphorous (mg/kg)	13.11	10.34	13.83	9.42
Water soluble ions (cmol/kg)				
Calcium Ca	2.75	2.19	3.07	2.11
Magnesium Mg	1.98	1.35	2.12	1.21
Potassium K	0.32	0.20	0.31	0.17
Sodium Na	0.31	0.18	0.33	0.11

Key: EC=Electrical conductivity, ECEC=Effective Cation Exchange Capacity, EA=Exchangeable Acidity of the soil

Table 2 showed the result of the response of some rice varieties to seasonal variations on yield and yield components. Means compared were significantly different among the varieties and across the seasons.

The results have indicated that, days to 50% flowering were attained within shortest time in dry season when compared to the number of days taken to attain 50% in wet season. Number of unfilled grains per panicle and percentage sterility was also observed to be less in dry season while other yield parameters are significant in dry season.

The three selected varieties have not shown difference statistically with regards to days to 50% flowering, panicle length and 1000 grain weight. However, number of panicle(s)/m^2, filled grains per panicle and yield per hectare were significant in FARO 44 and FARO 61 when compared to what was observed in Yardas variety (although statistically similar to FARO 61). Unfilled grains per panicle and percentage sterility on another hand were observed to be greater in Yardas variety even though statistically similar to was recorded in FARO 61.

A significant difference observed among the seasons with regards to days to 50% flowering may be attributed to the differences in climatic factors (temperature, abundant sunshine, humidity and rainfall) which cut short the periods of vegetative and reproductive stages considerably. Wet season was recorded to have lower temperatures, higher humidity, high rainfall and limited sunshine and according to the findings of Mbah *et al.* (2016), at lower temperature, translocation of photosynthates to grain took place at a slower rate and thus the maturity got delayed. Nguyen (2004) also noted that the growth pattern, duration and productivity of rice crop are greatly influenced by temperature. A report by Shi *et al.* (2016) stated that, low temperature at vegetative stage can cause slow growth and increase the growth period. According to Yan *et al.* (2010) moist humid weather at vegetative stage is most desirable.

The number of panicles per meter square and the panicle length were close to the grain yield more than the number of tillers (Jean *et al.,* 2019). The results of the study showed that, the number of panicles/m^2 were higher in dry season than in wet season in both locations. This might be as a result of higher number of tillers that were recorded in dry season than that of wet season. The result of this finding was in agreement with that of Jean *et al.* (2019) who assumed that every tiller bears a panicle.

Comparatively, FARO 44 in both locations had the highest number of panicles/m^2 than other varieties while the Yardas variety recorded the lowest number of panicles/m^2 in both locations. This could possibly be explained by the variety's high number of tillers which could possibly produce panicles. This was also in line with the findings of Garba and Fushison (2007) where FARO 44 had the highest number of panicles per meter square (due to genetic factor inherent within the variety) and Yardas variety recorded the least number of panicles per meter square among the varieties. However, Donn (2011) stated that, the number of panicles per land unit depends on the average number of tillers per plant as FARO 44 recorded the highest number of tillers per hill

Concerning the panicle length, results obtained from the research indicated that the panicles in wet season were longer than the dry season panicles This findings was in accordance with that of Ma *et al.* (2004) who found out the performance of rice plant with regard to panicle length to be higher in wet season than in dry season. He further stated that cultivars with greater plant height (as in wet season) also had longer panicles.

Substantial differences observed in the number of filled and unfilled grains per panicle in the seasons could be attributed to the effect of low temperature and low radiation associated with wet season.

The result of this study was in agreement with that of Mbah *et al.* (2016) who identified low temperature (due to precipitation) and low solar radiation as a critical factor that negatively affect the grain filling stage of rice plant. The research also found out that, grain filling percentage was generally greater in dry season than in wet season and attributed the differences observed to the differences in weather conditions between the two seasons, as the contribution of the reserved carbohydrates become substantial for grain filling due to low light and low night temperatures. However, Gana *et al* (2013) stated that, a night temperatures in wet season has been reported to decrease grain filling in rice. Number of unfilled grains per panicle in Minjibir (Kano North) was higher in wet season (13.66) than in dry season (12.06). This might be due to the temperature during the grain filling stage might not be at its optimum, thereby affecting the filling of the grains (Garba and Fushison, 2007). In Minjibir (Kano North) the number of unfilled grains per panicle was slightly higher in wet season (15.30) than in dry season (15.10) and this could also be attributed to the low temperature associated with wet season (Gana *et al*., 2013).

Results obtained from this research indicated that, thousand grain weight obtained at 14% grain moisture content was recorded to be higher in dry season than in wet season in both locations. This might be due to poor grain filling as a result of the effect of low temperature and limited sunshine associated with wet season. As dry sunny weather during ripening stage is most desirable (Yan *et al.,* 2010).The higher number of filled grains per panicle obtained in this research in dry season might be the reason that had made them to have heavier thousand grain weight. This support the findings of Jean *et al*., (2019) according to whom, one of the negative effect of low temperature as in wet season on crop is a bad grain filling which reduces grain weight. Similar result were also obtained by Garba and Fushison (2007) in their research on the performance of 10 rice varieties in dry season, where FARO 44 had the heaviest thousand grain weight (22.9g). The heaviness of FARO 44 grains could be due to environmental and plant conditions (Donn, 2011). No statistical significant differences were observed between the varieties in Minjibir (Kano North). No significant difference was observed in the interaction between seasons and the varieties in the two locations. This corroborates to the findings of Edeh *et al*., (2011) who reported that 1000- grain weight was not significantly influenced by environmental factors.

From the results obtained, sterility percentage was recorded to be higher in wet season than in dry season in both locations. These findings were in conformity with results of Abeysiriwardena *et al.* (2002) who found out in a research, a higher sterility percentage in wet season than in dry season due to low night temperatures that mostly occurred in wet season, which was the critical low temperature for inducing grain sterility in rice.

Concerning the varieties, Yardas variety had highest percentage of the sterile grains and FARO 44 recorded the least percentage in both locations. This could be due to genetic factors inherent within the varieties coupled with the level of adaptation of the varieties to the environment (Ayinde *et al*., 2013). Other findings by Garba and Fushison, (2007) also reported FARO 44 to recorded least sterility percentage among 10 different rice varieties and the Yardas variety (control) recorded the highest sterility percentage.

The grain yield was found to be generally higher in dry seasons than in wet season in both locations. Previous studies had shown that, higher grain yield obtained in dry seasons are due to higher mean daily radiation and higher temperature in dry season than in wet season (Yang and Jee 2001). Santosa and Suryanto (2015) also reported that, the greater radiation and higher sunshine hours during the grain filling period between flowering and maturity in dry season contributed to the higher grain yield. In another research, it was recorded that, high rainfall decreased the plants photosynthesis and resulted in lower assimilation rate so that the growth of plants was inhibited (Yang and Jee*.* 2001). Zaini *et al.* (2017) reaffirmed that, excessive weather conditions during the rainy season (decreasing daily air temperature, lower solar radiation, cloudy and high rainfall) were considered a serious limiting factors in rice farming.

Table 3 showed the interaction effect between seasons and some rice varieties on yield and yield components.

FARO 44 in dry season was observed to record significant number of panicles/m^2 and was found to be significantly higher than all other combinations. On the other hand, FARO 61 and Yardas variety in wet season trial were observed to produce statistically least number of panicle/m^2.

For the number of filled grains per panicle, FARO 44 in dry season has recorded the highest value and was significantly higher than the rest combinations. Yardas variety in both trials was however, observed to record least number which was observed to statistically be different from what was recorded by FARO 61 in both seasons and FARO 44 in wet season.

Concerning the average number of unfilled grains per panicle, Yardas variety in both seasons and FARO 61 in dry season have recorded greater number and this stands to be significantly different from all other numbers recorded by other combinations. However, FARO 44 in both seasons and FARO 61 in wet season trial were observed to record less number.

Panicles in Yardas variety during wet season trial were observed to be shorter even though statistically the same length with FARO 44 and FARO 61 in both seasons trial. Thus, Yardas variety in wet season was observed to record longer panicles.

For sterility percentage, Yardas variety in both seasons' trials has reported greater sterility even though statistically similar with what was observed in FARO 61 during wet season trial. However, few sterile grains were observed in the other three combinations.

Final grain yield recorded in FARO 44 during dry season trial was observed to be highest and stands to be significantly different ($P \leq 0.05$) from the rest combinations. On the other hand, significant difference ($P \leq 0.05$) was not observed between the values recorded by FARO 61 in both season, FARO 44 in wet season and Yardas variety in both seasons.

Table 2: Response of some rice (*Oryza sativa* L) varieties to seasonal variation on yield and yield components in Minjibir, Kano- Nigeria.

Source	Days to50% Flowering	Number of Panicle/m^2	Panicle length (cm)	No. Filled grains/panicle	No. Unfilled grains/panicle	1000grm Weight	Sterility %	Grain Yield/ha
Seasons								
Dry	89.78±0.64^{b}	470.78±19.63^{a}	21.55±0.33^{b}	178.84±8.57^{a}	15.10±1.29^{b}	22.07±0.29^{a}	8.06±0.98^{b}	3.20±0.18^{a}
Wet	104.11±0.45^{a}	393.89±10.24^{b}	22.82±0.33^{a}	158.19±4.65^{b}	15.30±0.82^{a}	21.16±0.52^{b}	8.89±0.62^{a}	2.58±0.39^{b}
Varieties								
FARO44	97.00±3.01^{a}	487.70±25.61^{a}	22.10±0.50^{a}	189.40±8.51^{a}	12.88±0.41^{b}	22.86±0.48^{a}	6.41±0.28^{b}	3.30±0.26^{a}
FARO61	96.00±3.74^{a}	423.17±14.90^{ab}	22.44±0.30^{a}	171.48±3.48^{ab}	14.17±1.09^{ab}	21.09±0.38^{a}	7.67±0.67^{ab}	2.80±0.11^{ab}
YARDAS	97.83±2.98^{a}	386.17±11.44^{b}	22.01±0.64^{a}	144.67±2.23^{b}	18.48±0.89^{a}	20.90±0.35^{a}	11.33±0.45^{a}	2.59±0.06^{b}
LSD 5%	NS	94.20	NS	41.28	5.38	NS	4.70	0.66
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 3: interaction effect between seasons and some rice (*Oryza sativa* L) varieties on yield and yield components, in Minjibir, Kano-Nigeria.

	Seasons	FARO44	FARO61	YARDAS	LSD 5%
Panicle/m^2	Dry	544.70±0.84^{a}	456.33±1.58^{b}	411.33±2.36^{bc}	48.54
	Wet	430.70±3.02^{bc}	390.00±0.88^{cd}	361.00±1.20^{d}	
Filled grain	Dry	208.30±0.91^{a}	179.00±0.88^{b}	149.20±1.06^{bc}	22.28
	Wet	170.50±0.61^{bc}	163.90±0.77^{bc}	140.10±0.57^{c}	
Unfilled grain	Dry	12.50±0.42^{b}	16.40±0.54^{ab}	16.90±0.52^{ab}	5.67
	Wet	13.30±0.23^{b}	12.00±0.25^{b}	20.10±0.47^{a}	
Panicle length (cm)	Dry	21.20±0.24^{ab}	22.70±0.17^{ab}	20.70±0.11^{b}	2.33
	Wet	23.00±0.34^{ab}	22.20±0.32^{ab}	23.30±0.33^{a}	
Sterility %	Dry	5.99±0.12^{c}	6.26±0.12^{bc}	11.92±0.33^{a}	2.91
	Wet	6.83±0.24^{bc}	9.07±0.27^{ab}	10.76±0.34^{a}	
Grain Yield	Dry	3.87±0.03^{a}	3.04±0.02^{b}	2.70±0.04^{b}	0.70
	Wet	2.72±0.02^{b}	2.56±0.02^{b}	2.48±0.01^{b}	

Means ± = Standard error, means with different superscript for a week in both dry and wet seasons are significantly different at 5% level of probability using Fisher's LSD. WAT = weeks after transplanting

CONCLUSION

From the findings of the research, it can be concluded that Minjibir (Kano North) soil is moderately suitable as it satisfied seven (Soil texture, Organic Carbon, available phosphrous, Total Nitrogen, Calcium, Soil PH, Cation Exchange Capacity) out of the ten physicochemical properties tested.

Seasonal variation has affected growth of rice by showing greater number of panicles/m^2, number of filled grains/panicle, 1000 grain weight, grain yield per hectare and reduced sterility, unfilled grains per panicle, days to 50% flowering in dry season trial. However, yield was also affected where in dry season is greater. Varietal responses also affects grain yield because the overall grain yield was significant in FARO 44.

REFRENCES

Abeysiriwardena, D.S.D.Z., Ohba, K. and Maruyama, A. (2002). Influence of temperature and relative humidity on grain sterility in rice. *Journal of the National Science Foundation of Sri Lanka,* **30**(1-2):33-41.

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

Aondoakaa, S.C. and Agbakwuru, P.C. (2012). An Assessment of Land Suitability for Rice Cultivation in Dobi, Gwagwalada Area Council, FCT – Nigeria. *Ethiopian Journal of Environmental Studies and Management (EJESM)*, **5**(4):444-450.

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.

Ayinde, O.E., Ojehomon, V.E.T., Daramola, F.S. and Falaki, A.A. (2013). Evaluation of the Effects of Climate Change on Rice Production in Niger State, Nigeria. *Ethiopian Journal of Environmental Studies and Management*. **6:**763-773.

Donn, B.H. (2011). *Growth and Production of Rice.* Soils, plant growth and crop production. Southeast Missouri State University, Malden, Missouri, USA. **II**:68-69.

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.

FMANR (1990). *Literature review on soil fertility investigations in Nigeria (in five volumes).* Federal Ministry of Agriculture and Natural Resources. Abuja, Nigeria. Pp. 97-99

FMAWRRD (1989). *Fertilizer use and management practices for crops in Nigeria*. Federal Ministry of Agriculture, Water resources and Rural Development. Bobma Publishers, Ibadan. Pp. 163.

Gana, A.S., Shaba, S.Z. and Tsado, E.K. (2013). Principal component analysis of morphological traits in thirty-nine accessions of rice (*Oryza sativa L.*) grown in raifed lowland ecology of Nigeria. *Journal of Plant Breeding and Crop Sciences,* **5:**120-126.

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.

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

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

Ma, R., Laza, C., Shaobing, P., Shigemi, A. and Hitoshi, S. (2004). Effect of Panicle Size on Grain Yield of IRRI-Released Indica Rice Cultivars in the Wet Season. *Plant Production Science*, **7 (3)**:271-276.

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.

Manneh, B., Kiepe, P., Sie, M., Drame, N.K. and Traore, K. (2007). Exploiting partnerships in research and development to help African rice farmers cope with climate variability. *Journal of SAT Agricultural Research,* **4**(1):2-6.

Mbah, E.N., Ezeano, C.I. and Saror, S.F. (2016). Analysis of climate change effects among rice farmers in Benue state, Nigeria. *Current Research in Agricultural Sciences*, **3**(1):7-15.

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

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.

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.

Sultana, T., Rahman M.H., Rahman, M.S., and Paul, A.K. (2016). Postharvest soil fertility status of rice (Hybrid Dhan Hira 2) as influenced by vermicompost, pressmud and urea. *International Journal of Scientific and Research Publications*, **6**:335-338.

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.

Xu, M.G., Li, D.C., Li, J.M., Qin, D.Z. and Hosen, Y. (2008). Effects of organic manure application with chemical fertilizers or Nutrient Absorption and yield of Rice in Hunan of Southern China. *Agricultural Sciences in China*. **7**(10):1245-1252.

Yan, C., Ding, Y., Wang, Q., Liy, Z., Li, G., Muhammad, I. and Wang, S. (2010). The impact of relative humidity, genotypes and fertilizer application rates on panicle, leaf temperature, fertility and seed setting of rice. *Journal of Agricultural Science. Cambridge,* **148**:329 – 339.

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.

Zaini, A.H., Hariyono, D. and Wicaksono, K.P. (2017). Performance of rice (*Oryza sativa* L.) varieties in rainy season and interaction with plant spacing. *Bioscience Research*, **14**: 662-667.