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Preliminary Response of Some Rice Varieties to Soil Ph and Texture in Parts Kano State, Nigeria

Mohammed, U. A.*[1], Hayatu, M.[2] & Ibrahim, S[3].

[1]Department of Biological Sciences,
Bauchi State University
P.M.B. 65,
Gadau, Bauchi State, Nigeria.
Email: farukamohammed@gmail.com

[2]Department of Plant Biology,
Bayero University,
Kano, Nigeria

[3]Department of Biological Sciences
Bayero University,
Kano, Nigeria.

Abstract

Drought is one of the adverse effects of climate change. It is a repetitive meteorological event and a very complex phenomenon occurring naturally which influences environmental factors, vegetation, agriculture, humans and wildlife plus the local economies. Most rice farmers in the developing countries are faced with the challenge of climate change which affects rice production. Rice yield is affected by soil physicochemical properties like soil textural class and pH and other meteorological factors. This study's objective was to determine the effect of standardized precipitation index (SPI), meteorological data and soil physicochemical properties on 1000 grain weight, days to maturity and grain yield in kg/ha of some rice varieties. A field experiment was conducted in Bayero University Kano experimental plots, Kano State Nigeria simultaneously on six rice varieties (Dan China, Faro 44, Jamila, Nerica 1, Nerica 2 and YarDass) in the form of RCBD (Randomise complete block design). The soil textures of the two units used in this study differ in the two locations. Unit one was classified as loamy sand with the pH value of 5.4while unit two was sandy loam with the pH value 5.6. A significant increase ($p<0.05$) in grain weight (1000 grain) and grain yield (kg/ha) was observe in loamy sand soil which recorded 27.2g and 5030kg/ha respectively compared to sandy loam soil with the values 23.8g and 3830kg/ha. The rice varieties also matured early on loamy sand which was contrary to what was observed on a sandy loam soil. The rice variety Dan China had the best grain quality on both loamy sand and sandy loam soil. Jamila had the best yield in kg/ha on loamy sand soil while Nerica 1 had the best on sandy loam soil. In terms of the ability to mature early it was Nerica 2 that recorded the lowest number of days compared to the other varieties in both loamy sand and sandy loam. Nerica 1 was the most consistent rice variety in this study when all the varieties were compared.

Keywords: Soil texture, Rice, Soil pH, Varieties and Yield.

INTRODUCTION

Rice is becoming important staple foodin both Africa and Latin America. Despite the recent increase in rice production since the start of the Green Revolution, rice remains one of the most protected food commodities in world trade (Muthayya *et al.*, 2014).

*Author for Correspondence

One of the most important natural resources limiting agricultural production is water (Dou *et al.*, 2016). The production of food has been affected in several countries by drought (Singh, 2002; Okpara and Tarhule, 2015). As a result, water has to be efficiently utilized in order to avoid the aggravation of drought due to climate change. Usually the efficiency in water management is mostly evaluated by water productivity (WP), which is defined as the ratio of the marketable crop yield over actual evapotranspiration (Zwart and Bastiaanssen, 2004; Dou *et al.*, 2016). Soil can also play significant roles in the production of rice in terms of water holding capacity. Soil textures have a strong potential of affecting soil available water capacity (AWC). Usually, soil with more clay content contains more organic matter than those with less due to the fact that a greater physical protection are attributed to clay(Dou *et al.*, 2016; Six *et al.*,2000)

The fertility of a soil and the level of acidity or alkalinity play an important role in determining the yield of the crops, which can be affected by intensive farming, hence the reason why proper soil quality management is required to sustain high yield in rice production (Talpur *et al.*, 2013).

MATERIALS AND METHODS

Experimental Site

The research was conducted at the new site of Bayero University, Kano, Faculty of Agriculture experimental plots coordinate 12°02′44″N 8°29′08″.

Seed Collection

Seeds of improved varieties of rice were purchased from the Bauchi State Agricultural and Rural Development Program (BSADP), and local varieties were collected from local farmers in Bauchi State.

Soil Sampling and Analysis

Soil samples were randomly taken at 0 to 30cm depth using auger for soil analysis. Sieved samples < 2 mm soil fraction were bagged for routine analysis. The fraction of sand, silt and clay was determined using hydrometer method(Gee and Or, 2002)with NaOH as dispersant. The soil pH was determined using a pH meter (Buchanan, 1983).

Experimental Design

A field experiment was conducted on six rice varieties namely Dan China, Faro 44, Jamila, Nerica 1, Nerica 2 and YarDassusing Randomise complete block design (RCBD).

Experimental Procedure

Land Preparation

The land was cleared using hand hoes, before ploughing, harrowing and leveled properly in the two locations (Toungos, 2016).

Plot size

16 blocks were prepared to contain 8 experimental units each, and each unit contained a single rice variety. 30cm X 30cmwasthe size of each experimental unit making total of 128. The size of the experimental plot was 24.57m^2 including the spacing between the blocks.

Sowing

Eight rice seeds were sown per hole at a depth of 2 - 3cm with a spacing of 30 X 30cm, and were thinned to five at two weeks after germination in the two locations.

Weed control
Weeding of the experimental plot was done manually using hands and hoes after planting. This activity was carried out six times before harvest.

Harvesting
Harvesting was done when rice panicles ripened into a golden brown colour, the rice panicle was not be allowed to dry completely (80 -85% straw colour) to avoid shattering. It was be harvested manually by using sickle.

Data Collection
Days to maturity
Days to seed maturity was recorded from the time of planting till the panicles are dry completely and ready for harvest.

1000 seed weight
The weight (g) of the one thousand grains of rice was determined, by counting 100 seeds and weighing them on a weighing balance with an electronic compact scale (ATOM – A122). The values obtained were converted to 1000 seeds weight by multiplying by 10.

Yield in kg/ha
The yield of the rice varieties was also determined using weighing balance with an electronic compact scale (ATOM – A122).

Statistical Analysis
All data collected were subjected to Analyses of Variance (ANOVA) General Linear MODEL, t-test of independent variables and Pearson correlation. Where there was significant difference, means was separated by Tukey Method Using MINITAB computer Software (Version 16).

RESULTS
The soil pH in water and $CaCl_2$ with textural classes and soil acidity classification of the location (Kano)was recorded in Table 1. The pH (H_2O) for both the two units in the plot were acidic likewise that of the pH ($CaCl_2$).

Table 1: Some Physical Parameters if the Soil

pH (H_2O)		Classification	pH ($CaCl_2$)	Classification	Textural Class
Units					
1	5.4*	Ac	5.1*	Ac	Loamy sand
2	5.6*	Ac	5.3*	Ac	Sandy loam

Ac: Acidic. * = not significantly different at p>0.05

Soil textural class and percentage of clay, silt and sand for the two units are presented in figure 1. The first unit recorded 81% sand, 11% silt and 7% clay which has a loamy sand textural class. 77% sand, 13% silt 9% clay and a sandy loam textural class was observed in the second unit.

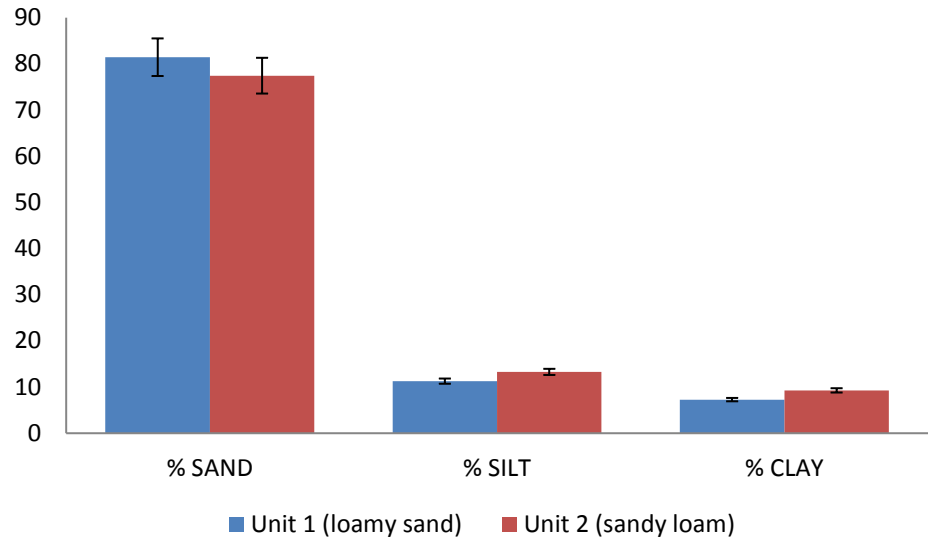

Fig 1: Soil textural class and percentage of clay, silt and sand

Table 2: Mean1000 grain Weight, Days to Maturity and Kg/ha for Loamy Sand and Sandy Loam Units interactions with rice varieties

	1000 grain weight(g)	Days to maturity	Kg/ha
Soil texture vs Varieties	**Mean**	**Mean**	**Mean**
Loamy sand *Dan China	30.3^{a}± 0.85	105.7^{b}± 0.53	5070^{b}± 7.6
Loamy sand * Faro 44	24.3^{b}± 0.85	114.7^{a}± 0.53	3660^{c}± 7.6
Loamy sand * Nerica 1	26.7^{ab}± 0.85	94.3^{c}± 0.53	5730^{ab}± 7.6
Loamy sand * Nerica 2	24.7^{b}± 0.85	93.3^{c}± 0.53	3770^{c}± 7.6
Loamy sand * YarDass	29.3^{a}± 0.85	106.7^{b}± 0.53	5430^{ab}± 7.6
Loamy sand * Jamila	27.7^{ab}± 0.85	114.3^{a}± 0.53	6490^{a}± 7.6
Sandy loam *Dan China	25.3^{a}± 0.7	108.3^{d}± 0.27	3210^{b}± 4.47
Sandy loam * Faro 44	23.3^{a}± 0.7	116.7^{b}± 0.27	2910^{b}± 4.47
Sandy loam * Nerica 1	23.73^{a}± 0.7	95.3^{e}± 0.27	5630^{a}± 4.47
Sandy loam * Nerica 2	23.74^{a}± 0.7	94^{a}± 0.27	3710^{ab}± 4.47
Sandy loam* YarDass	23.33^{a}± 0.7	114.3^{c}± 0.27	3670^{ab}± 4.47
Sandy loam* Jamila	23.7^{a}± 0.7	118^{a}± 0.27	3870^{ab}± 4.47

The values refer to means and ±represent standard error. Means followed by the same letter within a column(superscripts) are not significantly different at P > 0.05 level by general linear model Tukey method

Analysis of variance was also carried out for the two units (loamy sand and sandy loam) and the means were separated using general linear model Tukey method as presented in table 2. The rice varieties differ significantly in terms of 1000 grain weight, days to maturity and kg/ha. In the loamy sand unit the rice variety Dan China came on top in the with the value 30.3, followed by YarDass (29.3), Jamila (27.7) and Nerica 1 (26.7) while Nerica 2 and Faro 44 recorded the least with the values 24.7 and 24.3 respectively. The mean days to maturity observed were as follow; Faro 44 recorded (114.7), Jamila (114.3), YarDass (106.7), Dan China (105.7) and Nerica 1 had 94.3 while Nerica 2 recorded the least which was 93.3.the rice variety with the highest yield in terms of kg/ha was Jamila (6490) followed by Nerica 1 (5770) while Faro 44 (3660) also had the least.

In sandy loam unit, the rice varieties did not differ significantly at 95% confidence level when 1000 grain weight were compared but they differ significantly, when days to maturity and kg/ha were compared. Dan China had a mean 1000 grain weight of 25.3, Nerica 2 recorded 23.74, Nerica 1 had 23.73, followed by Jamila with 23.7 while YarDass and Faro 44 had 23.33

and 23.3 respectively. Jamila (118) came highest the second season when days to maturity were compared followed by Faro 44 (116.7) after which YarDass (114.3) preceded Dan China (108.3), Nerica 1 (95.3) and Nerica 2 (94).The rice varieties with the highest values for yield in kg/ha were Nerica 1 (5630) and Jamila (3870) and Faro 44 (2910) recorded the least.

Table3:Mean1000 grain Weight, Days to Maturity and Kg/ha for Combined Analysis of Loamy Sand and Sandy Loam

	1000 grain weight(g)	Days to maturity	Kg/ha
Soil texture	**Mean**	**Mean**	**Mean(±) S.E**
Loamy sand	27.2^{a}± 0.39	107.8^{a}± 0.34	5030^{a}± 2.63
Sandy loam	23.8^{b}± 0.39	104.8^{b}± 0.34	3830^{b}± 2.63
Varieties			
Dan China	27.8^{a}± 0.67	107^{c}± 0.6	4140^{ab}± 4.6
Faro 44	23.8^{b}± 0.67	115.7^{a}± 0.6	3290^{b}± 4.6
Nerica 1	25.2^{ab}± 0.67	94.8^{d}± 0.6	5680^{a}± 4.6
Nerica 2	24.2^{b}± 0.67	93.7^{d}± 0.6	3740^{ab}± 4.6
YarDass	26.3^{ab}± 0.67	110.5^{b}± 0.6	4550^{ab}± 4.6
Jamila	25.7^{ab}± 0.67	116.2^{a}± 0.6	5180^{ab}± 4.6

The values refer to means and ±represent standard error. Means followed by the same letter within a column(superscripts) are not significantly different at P > 0.05 level by general linear model Tukey method

A combined analysis of variance carried out for loamy sand and sandy loam units and presented in table 3. The two units (loamy sand and sandy loam) differ significantly at 95% confidence level when 1000 grain weight, days to maturity and kg/ha of the rice varieties were compared. The same was observed when all the varieties were compared.
The loamy sand unit had a higher value (27.2) as against the sandy loam unit which recorded (23.8). The sandy loam had 107.8 mean value for days to maturity as against a lesser value of loamy sand which had 104.8. In terms of kg/ha the loamy sand and the sandy loam had these values 5030 and 3830 respectively.

Dan China had the highest value for 1000 grain weight which was 27.8 followed by YarDass with the value 26.3 which preceded Jamila with the value 25.7 followed by Nerica 1, Nerica 2 and Faro 44 with the values 25.2, 24.2 and 23.8 respectively. The values observed for days to maturity by the rice varieties were 116.2, 115.7, 110.5, 107, 94.8 and 93.7 for Jamila, Faro 44, YarDass, Dan China, Nerica 1 and Nerica 2 respectively. The rice variety with the highest yield in kg/ha was Nerica 1 (5680) and Jamila (5180) that recorded the highest in the second season and Faro 44 also recorded the least with the value 3290.

DISCUSSION

The results of the soil analyses revealed no significant difference in pH (H_2O) and pH ($CaCl_2$) at p > 0.05 between the loamy sand unit and the sandy loam unit. The pH range suitable for arable crops as reported by (Fazekašová, 2012; Krnáčová*et al.*, 1997)is 6 – 7.5 but none of the pH of the two units in this study fall into this category. Both units sandy and loamy sand are acidic.

The soil textures of the two units differ slightly. Unit 1 was classified as loamy sand while unit 2 was sandy loam. The loamy sand have higher potential of holding water than the sandy loam unit due to an increase in the clay content. The clay content affects soil available water capacity (AWC), which can be attributed to the reason why it recorded early average days to maturity and increases in weight of the rice grains (Dou *et al.*, 2016; Zachary and Emily, 2016). The rice varieties with the highest mean 1000 grain weight on a loamy sand were Dan China and YarDass followed by Jamila. It is worthy to note that the performance of all the rice

varieties in terms of quality on a loamy sand soil was encouraging, because of the ability of loamy sand soil to retain more water than sandy loam soil (Dou *et al.*, 2016; Zachary and Emily, 2016). On the contrary the 1000 grain weight recorded by the rice varieties on a sandy loam soil was significantly lower than what was observe on the loamy sand soil at $p < 0.05$. Here Dan China also had the highest mean 1000 grain weight followed by Nerica 2 and Nerica 1.It was observed that all the rice varieties recorded increase in 1000 grain weight when planted on a loamy sand soil compared to sandy loam soil, although Nerica 1 and Nerica 2 indicated that they possess the required attributed to perform better in a sandy loam soil as well as in this study which can be attributed to the fact that they are upland rice varieties as described by the passport data (Africa Rice Center (WARDA)/FAO/SAA, 2008).

Most of the rice varieties used in this study matured after three months, where Nerica 2 (93.7) and Nerica 1 (94.8) recorded the lowest number of days to maturity while Jamila (116.2) and Faro 44 (115.7) recorded the highest number of days. The lowest and the highest number of days to maturity recorded by (Ashrafuzzaman and Ismail, 2008) was 103.7 and 111 respectively. The results obtained by Karunathilaka *et al.* (2013); Chhogyel *et al.*(2016) indicated that some rice varieties can mature in 90 days which is lower than the minimum obtained in this study.

The performance of all rice varieties in terms of yield (kg/ha) in the loamy sand unit was encouraging. Jamila and Nerica 1 recorded 6490kg/ha and 5730kg/ha while lower values were recorded in the sandy loam unit where Nerica 1 was the standout variety with highest yield (5630kg/ha).This is more than what was recorded by some rice varieties in a study by Chhogyel *et al.*(2016) while (Nanda and Bisarya, 2017) reported that organic farming can produce rice yield up to 6069kg/ha.

CONCLUSION

The preliminary findings of this study indicated that the rice variety Dan China had the best grain quality on both loamy sand and sandy loam soil. Jamila had the best yield in kg/ha on loamy sand soil while Nerica 1 had the best on sandy loam soil. In terms of the ability to mature early it was Nerica 2 that recorded the lowest number of days compared to the other varieties in both loamy sand and sandy loam. Nerica 1 was the most consistent rice variety in this study when all compared with others.

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