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Rice For A Sustainable Future: Exploring The Synergistic Effects Of Nitrogen And Variety On Productivity Under Irrigation And Rainfed

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Abstract
Rice is considered to be the major source of calories and staple food worldwide. The aim of the study was to investigate the productivity of rice as influence by Nitrogen and variety under irrigation and Rainfed. The research was conducted at Fadama near Matawalle bridge Argungu, Kebbi State. Two varieties of rice are used for this experiment 'FARO' 44 and 'Dan boto'. Physical and chemical Parameters of the soil were determined. Rice varieties were sown at different nursery beds. Data collected from the experiments both in the laboratory and in the field were subjected to Analysis of Variance (ANOVA). The effect of nitrogen on plant height at 2, 4, 10 and 12 WAP, however nitrogen has significant effect on plant height at 6 and 8 WAP. The results indicated no significant (P<0.05) effect of nitrogen on number of tillers at 2, 8, 10 and 12 WAP, however nitrogen has significant effect on number of tillers at 4 and 6 WAP. It can be concluded that vegetative parameters (plant height, panicle length and number of tillers) were better established in 'Dan Boto' than in 'FARO 44'. Considering the good performance of Dan 'Boto' local variety under irrigation and Rainfed, its cultivation by local farmers should be given a boost through provision of agricultural facilities and better funding by the government.

Keywords: Rice Productivity, Nitrogen, FARO 44 and Dan Boto, variety, Parameters

I. INTRODUCTION

Rice is considered to be the major source of calories and staple food worldwide and the most important among all the cereal crops (Jumare, 2014). It is the world's largest food crop providing the caloric needs of millions of people daily (Kamai *et al.*, 2020). Rice is an important staple food crop for more than 60 percent of humans in the world. In 2008, more than 430 million metric tons of rice was consumed worldwide (Simbo *et al.*,2019). Being one of the oldest cultivated cereal crops throughout the world, rice is staple food crop in Nigeria that is adapted to both flooded and non-flooded soil conditions in all the agro-ecological zones. Over 90% of the world production was done under irrigation (Hussain *et al.*, 2013). According to FAOSTAT (2012), rice production in Nigeria has increased from 5.5 million tons in 2015 to 5.8 million tons 2017.

According to Umar *et al.*(2013), the potential land area for rice production in Nigeria is estimated to be between 4.6 and 4.9 million hectares that are shared among the upland, rainfed and irrigated lowlands, deep water and mangrove swamp ecologies. Rice provides 8.0%of the calories consumed in the continent and occupies 4.4% of the cropped area. Rice production as at 2007 was 23.5million tons (3.6% of global rice production) (International Rice Research Institute,2013). It is important to note that Africa still import more than one fourth of her present rice requirement.

Rice is very important in Nigeria based on the various ways it can be used. The capability to produce more rice has aided in development of numerous communities, while its failure has led to the spread of starvation, death and political uncertainty in many countries including Nigeria (Adiyaya and Yasa, 2017; Kamai *et al.*,2020). On the other hand, consumer acceptability and the marketability of the rice grain broadly relies upon its quality; hence, it influences the economy of rice producers (Sharma and Singhvi, 2017). In Nigeria rice has consumption per capita of 32kg indicating 4.7% increase in the past decade, making the total consumption to be 6.4 million tonnes in 2017 as against 3.7 million tonnes produced per year in the past decades (Kamai *et al.*, 2020). Thus, report on nitrogen requirements of rice, results from different levels of nitrogen application to soil and

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recommended doses for different regions and seasons.

The genus *Oryza* is classified under the tribe Oryzeae, subfamily Oryzoideae, of the grass family Poaceae (Gramineae). This genus has two cultivated species (*O. sativa* L. and *O. glaberrima* Steud.) and more than 20 wild species distributed throughout the tropics and subtropics (Mader *et al*., 2012) The Asian cultivated rice (*O. sativa*) is an economically important crop that is the staple food for more than one-half of the world's population.

Crop development and flowering dates are altered by N fertilizer levels, even though was not limiting to plants, which is important for farmer that do use fertilizers, because a long peak tillering for N fertilizer. Nitrogen (N) management in addition to water management, differs considerably across rice cropping systems (Saito *et al.*, 2005).In Africa, low N application rates are predominant in upland rice because of uneven rainfall distribution during the growing season (Saito *et al*., 2005, Kondo *et al*., 2005).

II. OBJECTIVES OF THE STUDY

This research is aimed at:

i. Examine the physical and chemical properties of the soil in the study area.
ii. To determine the seed germination percentage and seedling growth of the rice varieties.
iii. To examine the effect of nitrogen levels on the growth performance of the rice varieties.
iv. To examine the effect of nitrogen levels on grain yields and yield component of the two rice varieties.

Taxonomy and Origin of Cultivated Rice

The African grown rice *Oryza glaberrima* is planted on a limited scale in West Africa. It belongs to the grass family Gramineae. The genus Oryza, to which grown rice belongs, may have originated at least 130 million years ago and dispersed as a wild grass in Gondwanaland, the super continent that eventually broke up and drifted apart to become Asia, Africa, Australia, and Antarctica (Kirk, 2018). This shows the distribution of Oryza species all over the world except Antarctica. There are 22 wild species of genus *Oryza*, nine of the wild species are tetraploid and the remaining wild species and the two cultivated species are diploid.

The universal rice, Oryza sativa, and the African rice, *Oryza glaberrima*, are thought to be examples of directional evolution in crop plants (Joen, 2019). The wild progenitor of *O. sativa* is the Asian universal wild rice, *O. rufipogon*, which shows a range of difference from perennial to yearly types. Yearly types, also given the specific name of *O.nivara* were tamed to become *O. sativa*. In a parallel origin path, *O. glaberrima* was tamed from annual *O. breviligulata*, which in turn arise from perennial *O. longistaminata*.

Domestication of wild rice probably started about 9,000 years ago. Development of annuals at different elevations in East India, northern Southeast Asia, and western China was enhanced by alternating periods of drought and variations in temperature during the Neothermal Age about 10,000 to 15,000 years ago (Kirk, 2017). Domestication in Asia could have occurred independently and concurrently at several sites within or bordering a broad belt that extends from the plains below the eastern foothills of the Himalayas in India through upper Myanmar, northern Thailand, Laos, and Vietnam to south western or southern China. The African cultivar *O. glaberrima* originated in the Niger River delta. The primary point of diversity for *O. glaberrima* is the swampy basin of the upper Niger River and two secondary points to the south west near the Guinean coast. The primary point was probably established around 1500BC while the secondary points were formed 500 years later (Atlin, 2016).

Distribution of Cultivated Rice

From the Himalayan foot hills rice spread to Western and Northern India, to Afghanistan and Iran and to SouthSri Lanka. The data of 2500 BC has already been mentioned for Mohenjodarao, while in Sri Lanka rice was a major crop as early as 1000 BC (Fageria and Baligar, 2013). The rice crop may well have been introduced to Greece and neighboring countries of Mediterranean by returning members of Alexander the Great's expedition to India in 324 BC.

However, in all probability rice did not become an established crop in Europe much later perhaps in 15th or 16th century. Rice grown in the Mediterranean region is japonicas while the rice grown in the Indian subcontinent is indicas (Olsen and Parugganan, 2012). Rice also travelled from India to Madagascar and East Africa and then to countries of West Africa. Indica rice also spread eastward to Southeast Asia and north to China. The japonica rice was most likely domesticated somewhere in northern parts of South East Asia or South China. It moved north to become a temperate japonica. From China, temperate Japonicas were introduced in Korea and from Korea to Japan around the beginning of 1st century. In the hilly areas of Southeast Asia Japonica rice were grown under upland culture as a component of shifting cultivation before the upland tribes moved into the

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lowlands and introduced the Japonicas into lowland culture (DingKuhn, 2019). From mainland Southeast Asia, both Indica and Japonica rice were introduced to Malaysia, Philippines, and Indonesia and from Philippines to Taiwan. Migrating Malays from Indonesia introduced tropical Japonicas into Madagascar in 5th or 6th century. Portuguese priests introduced the tropical Japonicas from Indonesia into Guinea Bissau from where they spread to other West African countries (Dingkuhn, 2019). Thus, most of upland rice varieties grown in West Africa are tropical Japonicas. The Portuguese also introduced tropical japonicas and lowland Indicas to Brazil and Spanish people brought them to other Latin American countries. Thus, in Brazil today, most of the upland varieties are tropical Japonicas and lowland varieties that belong to Indian group. The first record of rice for U.S.A. dates from 1685, and was probably introduced to Madagascar with slave trade (Garrity and Toole, 2013).

Botanical Description of Rice

The rice plant is a member of Poaceae (old Gramineae) family. The common cultivated rice plant is an annual which usually grows to a height of a half meter or two meters, but there are certain varieties that grow much taller (6-9 metres). Some deepwater rice varieties grow with the gradual rise of the flood water level (Second, 2019). Rice plant can be divided intotwomain parts namely root system and shoot system:

Root System

When a rice grain germinates in a well-drained, upland soil the sheath (coleorhizae) emerges. If it germinates in submerged low lands, coleoptile emerges ahead of the coleorhizae. The primary, embryonic roots (radicle) comes out through the coleorhiza shortly after it appears. This is followed by two or more secondary roots, all of which develop lateral roots. The embryonic roots later die and are replaced by secondary adventitious roots produced from the underground nodes of the culm (Second, 2019).

Shoot System

Shoot system, collectively applies to all plant part visible above the ground level. It is mainly composed of culms, leaves and inflorescence (panicle).

1. **Culm:** The culm or stem is made up of a series of nodes and internodes. The rice culms are usually hollows except at the nodes. Each node bears a leaf and a bud. Under favorable conditions buds near ground level grow into tillers. The primary tillers give rise to secondary tillers which give rise to tertiary tillers.
2. **ii. Leaves**: The leaves of rice are sessile in nature. They are borne at an angle, on the culm in two ranks along the stem, one at each node. The leaf blade is attached to the node by the leaf sheath (Guo *et al*., 2013). The rice leaf is similar to that of wheat, but is usually distinguished from it by the length of the ligule. In the rice, ligule is very prominent, usually more than one centimeter. The leaf number is more on a primary tiller than on the secondary and tertiary tillers**.**
3. **Panicle:** The rice inflorescence known as panicle is a group of spikelets borne on the uppermost node of the culm. The primary panicle branch is divided into secondary and sometimes tertiary branches. These bear the spikelet.
4. **Spikelet:** The individual spikelet consists of two outer glumes. All the parts found above the outer glumes are collectively called floret. It consists of a hard covering the two sections of which are known as lemma and palea (the glumes) and the complete flower is between them. The lemma and palea together are known as the "hull". The rice flower contains six functioning stamens (male organ) and a pistil (female organ). At the base of the flower are two transparent structures known as 'lodicules'. Rice is a self-pollinated crop. When rice flower becomes ready to bloom, the lodicules become turgid and push the lemma and palea apart, thus allowing the stamens to emerge outside the open floret. Rupturing of the anthers then leads to the shedding of pollen grains. After the pollen grains are shed on stigma the lemma and palea close (Guo *et al*., 2013).

Grain (Caryopsis)

Rice grain develops after pollination and fertilization are completed. The grain is tightly enclosed by the lemma and palea. The dehulled rice grain is known as brown rice as brownish pericarp covers it. The pericarp is the outermost layer which envelopes the caryopsis and is removed when rice is milled and polished. The embryo lies at the ventral side of the spikelet next to the lemma. Adjacent to the embryo is a dot like structure the hilum. The embryo contains the plumule and radicle. The plumule is enclosed by a sheath known as coleoptile and the radicle by the coleorhizae (Sohrahi *et al*., 2012)

Rice cultivation

Rice is grown under various ecological environments. Four major environments are generally recognized as follows: Irrigated, Rainfed lowland, Upland, and lastly Flood prone. Approximately, 55% of the world rice area planted to rice, is irrigated and is the most productive rice growing system (Sohrahi *et al*., 2012. Perhaps 75% of the world rice production comes from irrigated areas and Asian mega cities are fed from irrigated rice (Sohrahi *et al*., 2012). Irrigation water is provided by human intervention through a variety of works including river diversions, reservoirs and wells. The area of irrigated rice has expanded markedly in the last 3 decades. Modern rice varieties and improved cultivation techniques have had their greatest impact on increasing the productivity of irrigated lands. Most of the irrigated areas are planted to improved varieties and more fertilizer and other inputs are used than in other ecologies (Wang, 2016). Rice yields in irrigated areas have more than doubled to five tons per hecter in the past 30myears and there is considerable scope for further yield improvement. Irrigated areas are further divided into irrigated wet season when rainfall is supplemental with irrigation water and irrigated dry season when rainfall is very low and irrigation is the primary source of water supply. Yields during the dry season are higher than during the wet season due to higher incoming solar radiation (Wang, 2016).

Rainfed lowland Rice

About one fourth $\frac{1}{4}$of the world rice area is rainfed lowland (Zhong *et al*., 2019). Yields average about two tons per hectare. Rainfed lowlands have a great diversity of growing conditions that vary by amount of rainfall and duration of rainfall, depth of standing water, duration of standing water, flooding frequency, and time of flooding, soil type and topography. Rainfed lowland fields are bunded and water is impounded, when available, just like irrigated fields. Rainfed lowlands are further subdivided into five categories (Wang *et al*., 2013). Rainfed shallow favorable, where rain falls is adequate. Short periods of moisture stress may occur. Improved varieties developed for irrigated conditions are grown in such area and yields average around three tons. Where rainy period is short and periods of mild to severe drought stress occur during the growing season, photoperiod insensitive varieties with short duration and degree of drought tolerance are most suitable. Where rice crop is submerged during periods of heavy rain falls for up to 10 days, raining period is generally long and crop is harvested after the raining season is over (Tsuji *et al*., 2015). Photoperiod sensitive varieties are generally grown, under rainfed condition where water accumulates in the fields in low lying areas and stagnates for 2 to 5 months because of impeded drainage. Photoperiod sensitive varieties with tolerance to stagnant water are grown under rainfed, naturally well drained soils in bunded or un bunded fields without surface water accumulation. Some of the upland rice areas are on sloping mountain sides. Rice is planted under dry conditions just as wheat or maize. Rice varieties are photoperiod insensitive, have deep roots and some level of drought tolerance. Many of the upland soils have low pH and are deficient in nutrients. Yields average about 1.2 tons per hectare. About 16 million hectares of world rice land is classified as upland (Tsuji *et al*., 2015).

Flood-prone rice

Flood prone rice is grown in low lying lands in river deltas of South and Southeast Asia. Standing water depth may vary from50 cm to more than 3m.However, flooding occurs only during part of the growing season. Fields are un bunded and rice is broadcast sown. Tall varieties with photoperiod sensitivity are grown. Varieties grown in deeper areas (100 cm) have elongation ability. About 9 million hectares are planted to flood prone rice of which 3 million falls in the category of deepwater rice. Average yields are around 1.6 tons per hectare (Tsuji *et al*., 2015).

Rice production in Nigeria

Rice is important in Nigeria for several reasons. It is a major contributor to internal and sub-regional trade. Rice is also the staple for most of the people in the Niger-Benue trough which divides Nigeria into three parts, Sokoto-Rima Basin in the north-west, Chad Depression in the north-east, Hadejia-Jamaare trough in the extreme north, and Cross River trough in the south (Reddy *et al*., 2017). Farmers find rice more adaptable than a high input staple like maize when there is declining soil fertility because of the huge array of varieties they can switch over to every few years. Since it is becoming a staple crop, farmers seem to be willing to grow it all the time no matter the constraints they are facing (Andriesse and Fresco, 2017). Nigeria is currently the largest rice producing country in Africa. This is as the result of conscientious efforts by the current administration to place more emphasis on agrarian production. With the available literature, annual rice production in Nigeria has increased from 5.5 million tons in 2015 to 5.8 million tons in 2017. In 2015, Nigerians spent not less than N1bn on rice consumption, adding that while spending had drastically reduced, consumption had increased because of increased local production of the commodity. The consumption rate now is 5.8 million tones and the production rate has increased to 7.9 tons per annum (Adijaya and Yasa, 2014). The increase was as a result of the Central Bank of Nigeria (CBN)'s Anchor Borrowers Program with a total of 12 million rice producers and four million hectares of FADAMA rice land. The move was aimed at reducing the nation's over reliance on oil which has in the past year proved economically devastating as oil prices plummeted on the global market (Udemezue, 2018).

The statistic of rice production in Nigeria shows a 5% increase every year. For the first half of year, 2016, it has already risen by 2.67%. The import rates have also increased by 5,850 from 4,800 during the same period of time. For today, Nigeria is only able to supply 49% of domestic demand (Sahrawat, 2013). Out of the thirty-six States in Nigeria, only eight States can produce rice in a large scale. These states include: Anambra, Nassarawa, Ebonyi, Kaduna, Niger, Kano Kaduna and Benue. However, Anambra State is one of the engine houses of rice production in Nigeria. The industrial rice farms have already pushed the rice production of the State from 90,000 metric tons to 210, 00 metric tons and with this, capacity of production will soon reach 320,000 metric tons in the next one year (Udemezue, 2014). Therefore, it will reach and then surpass the rates of consumption of rice in Adamawa State and when this number is reached, it will show a clear victory over consumption rates. According to the Nigeria rice production statistics, Nigerian rice importations have made up 50% of the local consumption rates. Currently, Nasarawa State is the leader when it comes to rice production in Nigeria. It has over 10,000 fully irrigated rice hectares. However, the global rice production statistics show that the top five importers of Nigeria are the USA, Vietnam, India, Thailand, and Brazil (Peng *et al*., 2018) These countries help Nigeria to overcome the shortfall of over 4.3 million metric tons. This shortfall is valued over N365 billion. In Nigeria, rice consumption has risen tremendously at about 10% per annum due to changing consumer preferences. However, research has shown that most Nigerians prefer to consume imported rice brands as compared to local rice varieties. The reason is that most Nigerian rice processors lack adequate technology of rice processing to meet international standard (Imolehin and Wada, 2015).

Effect of N application on growth and yield of Rice

Application of appropriate level of nitrogen fertilization is a major objective to increase nitrogen use by rice varieties. Nitrogen is essential nutrient element for rice growth and metabolic processes (Salem, 2006). Before making recommendations for the nitrogen fertilizer dose for any crop, one should evaluate the efficiency and optimum rate for different application levels for better growth and yield performance of released rice variety (Noor, 2017). Generally, N fertilizer recommendations in many rice-growing regions of the world follow a prescriptive approach based on generic models, without considering site-specific differences for crop N requirements (Noor, 2017). Efficient use of N chemical fertilizers can be attained through cultural and agronomic practices. Most importantly by breading varieties having maximum NUE, thereby reducing risk of environmental and soil water pollution with low nitrogen inputs (Noor 2017; Fageria *et al.* 2008; Sachiko *et al.* 2009) found that applying optimum dose of nitrogen can save money while maintaining a safe environment. Excessive use of nitrogen fertilizer has impacts on soil and environment through residual effect. Salem (2006) reported that by maximizing nitrogen, all grain specimens significantly increased in weight and protein content. Ebaid and Ghanem (2000) also revealed in their study that increasing nitrogen dose up to 144 kg N ha^{1}significantly improved plant growth, yield and yield components. El-Batal *et al.* (2004) recorded that nitrogen application increase from 120 to 190 kg N ha^{-1} improved plant height panicle length, number of filled grains / panicle and grain yields significantly. Similarly, Yoseftabar (2013) found increase in plant growth parameters, yield traits and grain yield at the rate of 100, 200 and 300 kg N ha^{-1}. The optimum N application rates for newly released Egyptian rice yield was significantly increased when N was applied at 150-225 kg / ha. As the N rate increased up to 225 kg / ha decreased. Whereas the number of grains per panicle and number of effective panicle increased.

Nitrogen is essential nutrient element for rice growth and metabolic processes (Sharma and singhvi 2017; Savant and Deddata 2019). Before making recommendations for the nitrogen fertilizer dose for any crop, one should evaluate the efficiency and optimum rate for different application levels for better growth and yield performance of each released rice variety (Noor 2017). Generally N fertilizer recommendations in many rice growing regions of the world follow a prescriptive approach based on generic models, without considering site-specific differences for crop N requirements (Saito *et al.*, 2005). Applying optimum dose of nitrogen can save money while maintaining a safe environment. Excessive use of nitrogen fertilizer has impacts on soil and environment through residual effect Wada, (2015). Tuner and Jund, (2017) reported that by maximizing nitrogen, all grain specimens significantly increased in weight and protein content. Reddy *et al.*(2017) also revealed in their study that increasing nitrogen dose up to 144 kg N ha^{-1} significantly improved plant growth, yield and yield components. Husain *et al.*(2013) recorded that nitrogen application increased from 120 to 190 kg N ha^{-1} improved plant height, panicle length, number of filled grains / panicle and grain yield significantly. Similarly, Abidiani(2019) found significant increase in plant growth parameters, yield traits and grain.

Effect of variety on growth and yield of Rice

To evaluate different varieties of rice for the growth and yield characteristics, an experiment was conducted in Pakistan with four variety IR-28, NERICA-4, Koshihikari and Nipponbare. Increase plant height recorded by the cultivars may be due to increase internode length or due to varietal attributes (Hussain *et al.*,2014) and Mohammad *et al.* (2002) also reported increased plant height due to inter node elongation of genetic potential of the plant respectively number of tillers at 60 DAS was found to be significantly higher for jopanica compared to be the rest of the cultivars, which made be due to availability of growth resources as well as genetic potential of the cultivar. Production rate and number of tillers per plant depends on variety, availability of water, mineral nutrients and photosynthates (Reddy *et al.*, 2017). Hussain et al. (2014) also reported that higher numbers of tiller production of (790) by Nipponbare and NERICA-4 produced lower numbers of (403) as compared to other varieties. Koshihikari was the leading variety in panicles production followed by Nipponbare and IR-28 and NERICA-4 have less number of panicles. NERICA produced the highest number of spikelets than japonica varieties (Hussain *et al*, 2014). Data on various growth and yield parameters revealed that Koshihikari was the tallest (117 cm) and Nipporibare the shortest (102 cm) Singh *et al.* (2000).

III. MATERIALS AND METHODS

Study Area

A year experiment was conducted at Fadama near matawalle bridge in Argungu, Kebbi State, Nigeria, during the 2023 and 2024 growing seasons. Argungu is situated in the Sudan savanna at latitude 13^0 N and longitude 5.I5^0 E and altitude of approximately 350m above sea level. The climate of the area is characterized by annual rainfall ranging from 700-900 mm, average temperature 14-300 c during the dry season and relative humidity varying between 21-47% in the dry season and 51-79% during the raining season KARDA,(2023). Research objectives are to recommend the appropriate nitrogen doses and appropriate variety for optimum yield in Argungu kebbi state. The project is expected to last for one year.

Germplasm Collection

Two varieties of rice used for this experiment (FARO 44 and Dan boto). FARO 44 was collected from MASLAHA SEEDS LTD Gusau Zamfara State and Dan boto was collected from local farmers in Argungu Town of Kebbi State. Approximately 2 kg of seeds of each variety were obtained.

Experimental Design

The treatments consisted of factorial combination of five N rates (N_0, N_{50}, N_{100}, N_{150}, N_{200}) and two varieties of Rice (Faro 44 and Dan boto) laid out in randomized Complete Block Design (CRBD) and replicated 3 times.

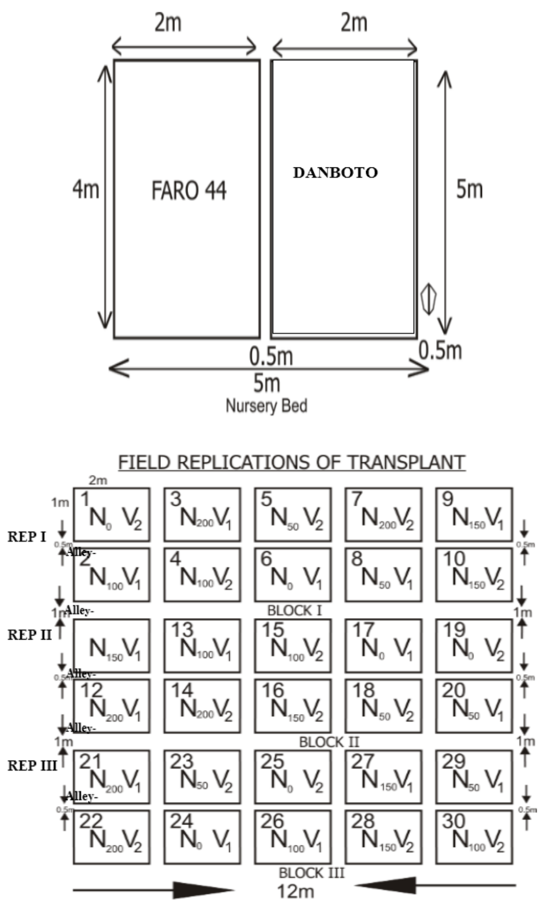

Fig I: Nursery Seed Beds of the two rice varieties

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Key

1. N 0 V1
2. N 0 V2
3. N 50 V1
4. N 50 V2
5. N 100 V1
6. N 100 V2
7. N 150 V1
8. N 150 V2
9. N 200 V1
10. N 200 V2

10 X 3 REPLICATES

= 30 PLOTS (Treatment combinations)

N: Nitrogen level

V_1: FARO44

V_2: DANBOTO

Fig II: Field Layout of Transplanted rice varieties

Determination of Physical and chemical Parameters of the Soil

Soil Sample Collection

Top soil samples from the experimental site was collected at a depth of 0–20 cm using soil auger. From the experimental site at Fadama near matawalle bridge Argungu,Kebbi State Nigeria. Soil samples collected were transferred in to polyethylene bags labelled accordingly and transported to Agric chemical laboratory for physical and chemical analysis, so as to determine the soil condition and nutrient status prior to the experiment.

Soil Sample Preparation

The soil samples were air dried for a period of one week and then grounded with a clean porcelain mortar and pestle and passed through a 2.0 mm sieve. The soil samples were kept in polythene bag for further analysis. Soil samples were analyzed for the following parameters: particle size analysis, density, porosity, moisture content, pH, electrical conductivity, organic carbon, organic matter and cation exchange capacity test were also conducted.

Soil particle size analysis

Particle size analysis of the soil sample was carried out using hydrometer method as outlined in Adepetu *et al.* (2000) as follows One hundred 100 ml was mixed of with 5% dispersing solution and 880 ml of deionized water in a 1000 ml cylinder. This mixture is the blank. (Note: 100 ml + 880 ml = 980 ml). This blank was not diluted to 1000 ml; the other 20 ml was the volume occupied by 50 g of soil. Soil 25-50 g was weighed and transferred to a dispersing cup. The weight will be approximated to ± 0.01g. Exactly 100ml of 5% dispersing solution was added. Dispersing cup was attached to mixer and proceed to mix the sample for 30 – 60 sec. The suspension was transferred quantitatively from the dispersing cup to a 1000 ml cylinder. Distilled water was added to the 900 ml mark equilibrated to room temperature, and allowed to stand overnight. The cylinders with the content was inverted 3times to agitate the samples. Hydrometer was dropped immediately into the cylinders and allowed to float for 40 seconds. The sand had settled to the bottom of the cylinder. The first reading (H1) had been taken from the hydrometer and recorded. The first temperature reading (T1) was conducted by dipping thermometer into the solution. The solution which was allowed to stay undisturbed up to the next level of reading. The second hydrometer reading was taken after 6 hrs 52 minutes (silt in the sample had settled to the bottom of the cylinder at that time). The reading was also taken by dipping hydrometer into the solution without disturbance and allowed to float for 40 seconds. The second temperature reading was also be taken by dipping thermometer into the solution. Readings obtained from the experiment has been used to calculate the percentages of clay, silt and sand from the soil samples as follows

Calculations

Percent clay: % clay = corrected hydrometer reading at 6 hrs, 52 min. x 100/ wt. of sample.
Percent silt: % silt = corrected hydrometer reading at 40 sec. x 100/ wt. of sample - % clay
Percent sand: % sand = 100% - % silt - % clay

Determination of Soil Density

The core method described by Lal and Shukla (2004) was adopted for this study. Mass and volume of wet soil was also obtained for each treatment by using a core sampler. The cylinder (sampler) with the soil core was weighed, oven dried and re-weighted again. Values obtained for the different parameters has been used to calculate the soil densities using the following expressions: -

Mean particle density (P_s) $= \frac{Ms}{Vs}$

where: M_s = Mass of solids
V_s = Volume of solids

a. Dry (specific) bulk density (Pb) = $\frac{Ms}{Vt} = \frac{Ms}{Vs + Va}$

Where Vt = total volume of soil
Va = volume of air

b. Wet (total) bulk density (Pt) = $\frac{Ms}{Vs} = \frac{Ms}{Vs + Va + Vw}$

Where Vw = volume

Determination of Soil Porosity

Total porosity determination was determined by the expression in Lal and Shukla (2004), as follows: -

$$E_p = 100\% - \frac{bulk\ density}{particle\ density} \times 100$$

Soil Moisture Content

Soil moisture content was determined by oven drying method (Jackson, 2017). 10 g of composite soil sample had been taken. The samples will be oven dried at 105°C for 24 hrs. Dry weight of the sample will be taken till it showed its constant weight. The loss in weight corresponds to the amount of water present in the soil sample. The formula below was used to calculate the percentage of moisture content in each of the soil samples (Joel and Amajuoyi, 2019). Moisture content (MC) (%) = Loss in weight on drying (g) Initial sample weight (g) x 100 The corresponding moisture correction factor (mcf) for analytical results or the multiplication factor for the amount of sample to be weighed in for analysis will be calculated as follows:

$$\text{Moisture content (MC) (\%)} = \frac{Loss\ in\ weight\ on\ dryimg\ (g)}{Initial\ sample\ weight\ (g)} \times 100$$

pH

The pH of the soil samples was measured in water suspension (1:2.5) as described by (Jackson, 2017). Air dried soil of 20 g had been taken in a beaker and to this 50 ml of water will be added. The mixture will be stirred with glass rod for 10 min and will be allowed to stand for 30 min. The pH meter (ELMETRON, CPI-501, Poland) will be calibrated using standard buffer solution of pH 4.0, 7.0 and 10.0. Then electrode of the pH meter will be inserted in to the supernatant solution and the pH reading will be taken.

Electrical Conductivity (EC)

The electrical conductivity (EC) of the soil samples were determined as described by (Jackson, 2017). Air dried soil of 20 g was taken in a beaker and to this 50 ml of water will be added. The mixture was stirred with glass rod for 10 min and was allowed to stand for 30 minutes without any disturbances. The soil was allowed to settle down and the EC value was measured by inserting electrical conductivity meter (SCHOTT handylab LF11, Germany) in to the supernatant solution.

Organic Carbon and Organic Matter

The organic carbon content of the soil samples was determined by the method of Walkey and Black (2015). Exactly 10g finely ground soil sample was passed through 0.5 mm sieve without loss into 500 ml conical flask, to which 10 ml of 1 N potassium dichromate solution at 0.06 mol L^{-1} and 20 ml conc. H_2SO_4 was added with measuring cylinder. The contents were shaken for 1 minute and allowed to stand for 30 min. Then 200 ml distilled water, 10 ml orthophosphoric acid and 1 ml diphenylamine indicator was added. The solution will be titrated against 0.5 N ferrous ammonium sulfate till the colour flashes from blue-violet to green. The blank titration was carried out at the beginning without soil.

Organic content was calculated by the following formula C (gkg^{-1})= [40-(titrating volume x f)] x 0.6

Where f is a factor for the blank test

Percentage organic matter was obtained from percentage organic carbon as follows:

Organic carbon % = C(gkg^{-1}) x 100

Organic matter % = Organic carbon % x 1.725

Cation Exchange Capacity (CEC)

Cation exchange capacity (CEC) was determined by the method described by Raman and Sathiyanarayanan (2019). Exactly 1.3 g of soil had been taken in the centrifuge tube. 11 ml of 1 N sodium acetate solution was added into the centrifuge tube. It was shaken well and centrifuged. The supernatant liquid was decanted. Exactly 11 ml of isopropyl alcohol will be added into the centrifuge tube. The centrifuge tube was shaken well and centrifuged. The supernatant liquid was decanted. Exactly 11 ml of 1 N ammonium acetate solution will be added into the centrifuge tube. The centrifuge tube was shaken well and centrifuged. The supernatant liquid was poured into the 100 ml flask. The solution in the 100 ml standard measuring flask was made up to 100 ml. The flame photometer had been calibrated with standard sodium solution. The prepared solution was injected into the instrument and the reading will be taken.

Land Preparation

Prior to the land preparation sample of soil in the experimental area was collected and subjected to physical and chemical analysis in the laboratory. Here the land was prepared tilled, harrowed and demarcated. First, 36 m^2 of land area was ploughed, harrowed for the purpose of the experiment. The area will be divided into plots and blocks. Two meter squared ($2m^2$) of the land was used for each individual treatment and between the 1 m^2 area lead way between plots of 0.5 m was allowed. Each plot consists of 12 m^2 and there are 3 blocks had been earmarked for the experiment representing the 3 replicates. The total experimental area comprising of the 3 blocks each having 10 plots give the net area for the experiment as 168.75m (Sahrawat, 2014). The experimental design to be used is randomized complete block design (RCBD).

Nursery Preparation and Practices

Method of Wang, (2016) had been adopted. Rice cultivars were sown at different nursery beds. 2m by 4m field was secured using thorn fence and the seeds were sown by broadcasting method. The seeds were allowed to germinate to seedlings and grow for 3 weeks to ensure they are ready for transplanting. The soil had been watered based on moisture requirement after mixing. The seedlings were transplanted according to treatments and spacing (Sahrawat, 2014).Each seedling was transplanted in dug hole on soil 3cm depth and about 5cm spacing between seedling transplants will be allowed.

Transplanting of Rice Seedlings

Method of Peng *et al*. (2016) was adopted. After germination, the rice seeding was transported according to the treatments and spacing method. Each seedling was planted at 20 cm both inter and intra row spacing. This was done for each of the treatments and blocks for the 3 replicates. Transplanting will be done 3 weeks after germination.

Cultural Practices

Irrigation

Irrigation is a factor of intensified agricultural production and increased production volume by means of creating favorable conditions for the growth of crops; thus the use of irrigation increases the average yield and production volume of high value crops (Fageria and Baligar, 2013).Critical to any irrigation management approach is an accurate estimate of the amount of water applied to a field. Too little water causes unnecessary water stress and can result in yield reductions. Too much water can cause logging, leaching and also result in loss of yield (Jeon 2019). The field of these experiment were watered using surface channel irrigation after 2 days' interval.

Weed control

Hand weeding technique was used to control weeds in the rice fields as follows: -

Hand weeding

Rice fields were weeded regularly, especially during the early stages of growth. Weeding problem was minimal as the rice field was well prepared before transplanting. Weeding was done twice: first at 2-3 weeks after transplanting and then at 5-6 weeks after transplanting in line with the recommendations of IRRI (2013).

Fertilizer Application

N was applied as per treatment, while all P and K were applied basal. The treatments are N_0 as check, N_{50}, N_{100}, N_{120}, N_{200}.

Harvesting and processing

Harvesting of the rice commenced as soon as the grains turned yellow/brown and 80-85 % of the grains are straw coloured 45 days after flowering. Harvesting was done using sickle at about 10-15 an above the ground. After cutting, the panicles were tied in bundles. Drying was done slowly under shade for 1 week to avoid breaking. During the drying, cane was taken to avoid placing the rice panicles on bare floor to minimize introduction of the sand and pebbles. The tied-up bundles of harvested rice were kept in an upright position for drying in line with the method of Kamai *et al*.(2020).

Rice paddy intend for storage was properly dried. Clean the storage container, such as a number, before pouring in your paddy. To protect against insect pests, use $1\frac{1}{2}$matchboxes full of coopex 2.5 to dust about 25 kg of paddy. Store in cool, dry rodentproof conditions. Infested paddy should be fumigated with phostoxin in air-tight container / rooms at the rate of tablet / jute bag (100 kg paddy) or 10-15 tablets / ton of paddy (Kamai *et al.*, 2020).

Sampling and Data Collection

The following growth and yield parameters was evaluated adopting the Standard Evaluation System for rice (SES, 2012) of International Rice Research Institute (IRRI).Five randomly selected plants were tagged in each plot. Data on plant height, number of titters/plant, number of leaves/plant (LAI), number of panicle/plant, Length of the panicle, Thousand grain weight, Seed yield/plant. were monitored and collected at 1-12 weeks after transplanting.

Statistical Data Analysis

Data collected from the experiments both in the laboratory and in the field were subjected to Analysis of Variance (ANOVA) where the treatment are significant, Duncan's New Multiple Range Test (DMRT) was used to separate the mean at $P<0.05$.

IV. RESULTS

The investigation of the effect of nitrogen levels on growth and yield of two varieties of rice due under irrigation in Argungu sudan savanna, Nigeria were presented in this chapter (Tables 1-8).

Physical and Chemical Properties of the Soil before Planting

The results of the analysis of the soil used for the experiment are presented in Table 1, in which the particle size distribution has the following results: P^H6.67, EC (dc/cm)187.6, Ca (cmol/kg)1.1,Mg (cmol/kg)2.9,Na (cmol/kg)0.9,K (cmol/kg)0.7,CEC (cmol/kg)7.6,Organic carbon (%)0.60,Total nitrogen (%) 0.06,Sand (%) 27.8, Silt (%) 38.7,Clay (%) 33.5, PO_4 (mg/kg)0.64 and the texture of the soil was sand loamy as shown in Table 1.

Table 1: Physical and Chemical Properties of the Soil before Planting

	Irrigation		Rainfed	
S/N	Soil Parameters	Values	Soil Parameters	Values
1	PH	6.67	PH	6.8
2	EC (dc/cm)	187.6	EC (dc/cm)	188.4
3	Ca2+ (cmol/kg)	1.1	Ca+ (cmol/kg)	1.4
4	Mg+ (cmol/kg)	2.9	Mg+ (cmol/kg)	2.6
5	Na+ (cmol/kg)	0.9	Na+ (cmol/kg)	0.7
6	K+ (cmol/kg)	0.7	K+ (cmol/kg)	0.9
7	CEC (cmol/kg)	7.6	CEC (cmol/kg)	6.9
8	Organic carbon (%)	0.60	Organic carbon (%)	0.80
9	Total nitrogen (%)	0.06	Total nitrogen (%)	0.08
10	Sand (%)	27.8	Sand (%)	28.3
11	Silt (%)	38.7	Silt (%)	35.5
12	Clay (%)	33.5	Clay (%)	31.2
13	PO_4 (mg/kg)	0.64	PO_4 (mg/kg)	0.73
14	Textural class	Sand loamy	Textural class	Sand loamy

Effect of N Application on Plant Height at 2, 4, 6, 8, 10 and 12 weeks after planting

The effects of nitrogen and variety on plant height is presented in Table 2. The results indicated no significant (P>0.05) effect of nitrogen on plant height at 2, 4, 10 and 12 WAP, however nitrogen has significant effect on plant height at 6 and 8 WAP. At 6 WAP application of nitrogen at 200 kg/ha differed significantly (P<0.05) with tallest plant, which is statistically similar with application of N 150, 100 and control and the shortest plant was from 50 kg/ha. At 8 WAP application of N at 100 kg/ha differed significantly with tallest plant, followed by 200 kg/ha which is statistically similar with control and the shortest plant was from 50 and 150 kg/ha. At 2wap application of N at 50 kg/ha was not differed significantly with tallest plant while the shortest plant was from control, at 4 WAP application of N at 200 kg/ha has the tallest plant while the shortest plant was from control, at 10 WAP application of N at 150 kg/ha has the tallest plant while the shortest plant was from control and at 12 wap the application of N at 150 kg/ha has the tallest plant while the shortest plant was from control. The tallest plant were observed with application of N because N in plants is important in plant growing. The results on effect of variety indicated that there is no significant (P>0.05) difference on plant height at 4, 6 and 12 WAP, however there is significant (P<0.05) difference on plant height at 2, 8 and 10 WAP. The results on the interaction of treatment and varieties indicated that there is significant (P<0.05) difference on plant height at 6, 8 and 10 WAP however there is no significant difference on plant height at 2, 4 and 12 WAP as shown in Table 2.

Table 2: Effect of N Application and variety on Plant Height of Rice under Irrigation and Rainfed at Argungu

	Irrigation						Rainfed					
Treatment	**2WAP**	**4WAP**	**6WAP**	**8WAP**	**10WAP**	**12WAP**	**2WAP**	**4WAP**	**6WAP**	**8WAP**	**10WAP**	**12WAP**
0 kg N/ha	17.00	27.04	46.73^{b}	65.23^{b}	71.39	81.98	16.84^{c}	26.51^{b}	46.61^{c}	67.00^{b}	73.57^{b}	81.67^{b}
50 kg N/ha	19.84	28.23	48.47^{b}	68.22^{b}	74.47	83.77	19.30^{b}	28.14^{a}	48.58^{b}	69.83^{a}	78.70^{a}	83.43^{ab}
100 kg N/ha	18.32	28.27	50.39^{ab}	73.64^{a}	75.35	83.75	19.99^{ab}	28.14^{a}	50.19^{ab}	71.84^{a}	77.94^{a}	84.97^{a}

150 kg N/ha	18.74	29.46	49.92^{ab}	68.34^{b}	76.03	85.22	21.23^{a}	29.10^{a}	50.97^{a}	71.50^{a}	78.24^{a}	84.97^{a}
200 kg N/ha	19.41	29.50	51.25^{a}	71.70^{a}	75.60	83.70	21.00^{a}	29.21^{a}	51.52^{a}	70.82^{a}	79.29^{a}	84.25^{a}
SE±	0.27	0.32	0.52	1.12	0.32	0.51	0.36	0.31	0.50	0.55	0.50	0.43
Significant	Ns	Ns	**	**	Ns	Ns	**	**	**	**	**	**
Varieties												
FARO 44	18.03^{a}	28.81	49.99	70.81^{a}	78.56^{a}	84.26	19.17^{b}	27.33^{b}	48.04^{a}	69.84	77.61	83.74
TOFA	19.29^{b}	28.59	49.51	69.25^{b}	71.78^{b}	83.10	20.17^{a}	29.11^{a}	51.03^{b}	70.57	77.49	83.98
SE±	0.63	0.11	0.24	0.78	3.39	0.58	0.63	0.20	0.32	0.35	0.31	0.27
Significant	**	Ns	Ns	**	**	Ns	**	**	**	Ns	Ns	Ns
Interaction												
T×V	Ns	Ns	S	S	S	Ns	S	S	S	S	S	S

Values are Mean ± SD of biological triplicate, Means with the same letters within column are not significantly different (P<0.05).T= Treatment, V=Variety

Effect of N Application and variety on Number of Tillers of Rice under Irrigation and Rainfed at Argungu

The effects of nitrogen and variety on number of tillers under irrigation and rainfed are presented in Table 3.

Effect of N Application under irrigation on number of tillers

The results under irrigation indicated no significant (P<0.05) effect of nitrogen on number of tillers at 8, 10 and 12 WAP. At 8 WAP application of N at 200 kg/ha had the highest number of tillers while the least number of tillers was from control, at 10 WAP application of N at 100 kg/ha has the highest number of tillers while the least number of tillers was from control and at 12 WAP the application of N at 150 kg/ha has the highest number of tillers while the least number of tillers was from control. The highest number of tillers were observed with application of N because N in plants is important in having more number of tillers per plant as shown in Table 3.

Effect of N Application under rainfed condition on number of tillers

The results under rainfed indicated no significant (P>0.05) effect of nitrogen on number of tillers at 12 WAP, however nitrogen had significant (P<0.05) effect on number of tillers at 8 and 10 WAP. At 2 WAP application of nitrogen at 150 and 200 kg/ha differed significantly (P<0.05) with highest number of tillers, which is statistically similar with application and the shortest plant was from control. At 8 WAP application of N at 100 kg/ha differed significantly (P>0.05) with highest number of tillers while the least number of tillers was from control, at 10 WAP application of N at 100 kg/ha had the highest number of tillers while the least number of tillers was from control. The highest numbers of tillers were observed with application of N because N in plants is important in having more number of tillers per plant as shown in Table 3.

Table 3: Effect of N Application and variety on Number of Tillers of Rice under Irrigation and Rainfed at Argungu

	Irrigation			Rainfed		
Treatment	**8WAP**	**10WAP**	**12WAP**	**8WAP**	**10WAP**	**12WAP**
0 kg N/ha	20.00	26.67	30.33	22.00^{b}	26.00^{b}	30.33
50 kg N/ha	23.00	28.17	32.50	23.83^{ab}	28.50^{a}	33.33
100 kg N/ha	23.33	28.50	31.83	24.50^{a}	27.83^{ab}	33.00
150 kg N/ha	21.83	27.50	33.17	23.67^{ab}	27.67^{ab}	33.17
200 kg N/ha	24.50	28.33	31.50	23.83^{ab}	28.00^{a}	32.67
SE±	0.29	0.17	0.21	0.55	0.45	0.76
Significant	Ns	Ns	Ns	**	**	Ns
Varieties						
FARO 44	22.53	27.73	32.60^{a}	23.07^{a}	27.80^{a}	33.13^{a}
TOFA	22.53	27.93	31.13^{b}	24.07^{a}	27.40^{a}	31.8^{a}
SE±	0.00	0.10	0.74	0.36	0.28	0.48

Significant Interaction	Ns	Ns	**	Ns	Ns	Ns
T×V	Ns	Ns	Ns	Ns	Ns	Ns

Values are Mean ± SD of biological triplicate, Means with the same letters within column are not significantly different (P<0.05).T = Treatment, V = Variety.

Effect of N Application and variety on Number of Leaves of Rice under Irrigation and Rainfed at Argungu

The effects of nitrogen and variety on number of leaves under irrigation and rainfed are presented in Table 4.

Effect of N Application under irrigation on number of leaves

The results under irrigation indicated no significant (P>0.05) effect of nitrogen on number of leaves at 8, 10 and 12 WAP, however nitrogen had significant (P>0.05) effect on number of leaves at 6 WAP application of nitrogen at 150 kg/ha differed significantly (P<0.05) with number of leaves, which is statistically similar with application of N 200 and control and the least number of leaves was from 50 kg/ha. At 8 WAP application of N at 150 kg/ha did not differ significantly (P>0.05) with highest number of leaves while the least number of leaves was obtained from 50 kg/ha. At 10 WAP, the application of N at 100 kg/ha had the highest number of leaves while the least number of leaves was obtained from control. At 12, WAP the application of N at 50 kg/ha had the highest number of leaves while the least number of leaves was obtained from 100 kg/ha. The numbers of leaves due to the application of N to the two varieties of rice under irrigation is shown in Table 4.

Effect of N Application under rainfed condition on number of leaves

The results under rainfed indicated significant (P<0.05) effect of nitrogen on number of leaves at 6, 8, 10 and 12 WAP. At 6 WAP application of nitrogen at 150 kg/ha resulted in significant (P<0.05) variation in the number of leaves between the varieties which is statistically similar with application of N 100. The least number of leaves was obtained from the control. At 8 WAP application of N at 200 kg/ha was differed significantly with highest number of leaves while the least number of leaves was from control, at 10 WAP application of N at 150 kg/ha has the highest number of leaves followed by N 200 kg/ha while the least number of leaves was from control and at 12 WAP the application of N at 50 kg/ha has the highest number of leaves while the least number of leaves was from control. The numbers of leaves were observed with higher application of N as shown in Table 4.

Effect of variety on number of leaves under irrigation

The results under irrigation on effect of variety indicated that there is no significant (P<0.05) differences on number of leaves at 8 and 10 WAP, however there is significant (P<0.05) differences on number of leaves at 6 and 12 WAP as shown in Table 4.

Effect of variety on number of leaves under rainfed

The results under rainfed on effect of variety indicated that there is no significant (P<0.05) differences on number of leaves at 6 and 8 WAP, however there is significant (P<0.05) differences on number of leaves at 10 and 12 WAP as shown in Table 4.

Interaction effect of N Application between treatment and variety on number of leaves

The results on the interaction of treatment and varieties indicated that there is significant (P<0.05) difference on number of leaves at 6, 8 and 10 and 12 WAP for both the seasons except under irrigation at 12 WAP as shown in Table 4.

Table 4: Effect of N Application and variety on Number of Leaves of Rice under Irrigation and Rainfed at Argungu

	Irrigation				**Rainfed**			
Treatment	**6WAP**	**8WAP**	**10WAP**	**12WAP**	**6WAP**	**8WAP**	**10WAP**	**12WAP**
0 kg N/ha	5.00^{a}	13.83	24.17	33.50	4.17^{b}	12.50^{b}	21.67^{c}	32.00^{b}
50 kg N/ha	4.50^{b}	13.17	24.33	33.83	5.50^{ab}	14.83^{a}	23.67^{b}	34.67^{a}
100 kg N/ha	4.83^{b}	14.50	25.67	32.83	6.00^{a}	14.17^{a}	24.17^{ab}	34.00^{ab}
150 kg N/ha	5.50^{a}	14.83	25.17	33.67	6.50^{a}	14.17^{a}	25.17^{a}	33.50^{ab}
200 kg N/ha	5.17^{a}	14.67	25.00	33.50	5.83^{ab}	15.50^{a}	25.00^{ab}	34.33^{a}
SE±	0.17	0.31	0.20	0.17	0.39	0.34	0.35	0.52
Significant	**	Ns	Ns	Ns	**	**	**	**
Varieties								
FARO 44	4.93^{a}	14.20	24.60	32.13^{b}	5.47	14.00	23.47^{b}	32.87^{b}

TOFA	5.07[b]	14.20	24.87	34.80[a]	5.73	14.47	24.40[a]	34.53[a]
SE±	0.07	0.00	0.14	1.34	0.25	0.22	0.22	0.33
Significant	**	Ns	Ns	**	Ns	Ns	**	**
Interaction								
T×V	S	S	S	Ns	S	S	S	S

Values are Mean ± SD of biological triplicate, Means with the same letters within column are not significantly different (P<0.05). T = Treatment ,V = Variety.

Effect of N Application and Variety on Number of Panicle (NP) Panicle Length (PL) Panicle Weight (PW), Number of Grain per Panicle (NGPP) and Grain Yield (GY)

The effect of N Application and Variety on Number of Panicle (NP) Panicle Length (PL) Panicle Weight (PW), Number of Grain per Panicle (NGPP) and Grain Yield (GY)under irrigation and rainfed were presented in Table 5.

The results under irrigation on number of panicle indicated no significant (P>0.05) effect of nitrogen on panicle weight such that 50 kg/ha had the highest number of panicle while the least number of panicle was from control. The results under rainfed on number of panicle indicated significant (P<0.05) effect of nitrogen on panicle weight such that 50 kg/ha has the highest number of panicle while the least number of panicle was from control.

The results under irrigation on panicle length indicated no significant (P>0.05) effect of nitrogen on panicle length such that 150 kg/ha had the highest panicle length while the lowest panicle length was from 50 kg/ha. The results under rainfed on panicle length indicated significant (P<0.05) effect of nitrogen on panicle length such that 150 kg/ha has the highest panicle length while the lowest panicle length was from control.

The results under irrigation on panicle weight indicated no significant (P>0.05) effect of nitrogen on panicle weight such that 200 kg/ha has the highest panicle weight while the least panicle weight was from control. The results under rainfed on panicle weight indicated no significant (P>0.05) effect of nitrogen on panicle weight such that 50 kg/ha had the highest panicle weight while the least panicle weight was from control.

The results under irrigation on grain number per panicle indicated significant (P<0.05) effect of nitrogen on number of grain per panicle such that 150 kg/ha has the highest number of grain per panicle while the least number of grain per panicle was from control. The results under rainfed on grain number per panicle indicated significant (P<0.05) effect of nitrogen on number of grain per panicle such that 50 kg/ha had the highest number of grain per panicle while the least number of grain per panicle was from control.

The results under irrigation on grain yield indicated significant (P<0.05) effect of nitrogen on grain yield such that 150 kg/ha has the highest grain yield while the least grain yield was from 50 kg/ha. The results under rainfed on grain yield indicated significant (P<0.05) effect of nitrogen on grain yield such that 100 kg/ha has the highest grain yield while the least grain yield was from control.

The results on effect of variety indicated that there is significant (P<0.05) difference on number of panicle, panicle weight, number of grain per panicle and grain yield for both the seasons. The results on the interaction of treatment and varieties indicated that there is significant (P<0.05) difference on number of panicle, panicle length, panicle weight and number of grain per panicle, seed length, seed width and grain yield for both the seasons as shown in Table 5.

Table 5: Effect of N Application and Variety on Number of Panicle (NP) Panicle Length (PL) Panicle Weight (PW), Number of Grain per Panicle (NGPP) and Grain Yield (GY)

	Irrigation					Rainfed				
Treatment	**NP**	**PL**	**PW**	**GNPP**	**GY**	**NP**	**PL**	**PW**	**GNPP**	**GY**
0 kg N/ha	20.17	21.37	2.18[b]	148.5[b]	70.59[c]	19.83[b]	20.52[b]	2.43	143.8[b]	68.88[c]
50 kg N/ha	21.50	21.05	2.57[a]	156.7[ab]	69.17[c]	22.50[a]	22.52[ab]	2.71	164.5[a]	72.01[bc]
100 kg N/ha	21.17	22.90	2.47[a]	158.2[ab]	71.66[bc]	22.33[a]	23.32[a]	2.64	157.7[a]	76.95[ab]
150 kg N/ha	20.33	23.65	2.63[a]	160.5[a]	78.02[a]	21.67[ab]	23.71[a]	2.67	162.0[a]	76.49[a]
200 kg N/ha	20.50	22.00	2.67[a]	150.2[ab]	76.64[ab]	21.67[ab]	23.07[a]	2.67	158.7[a]	74.49[a]
SE±	0.26	0.48	0.09	2.33	1.24	0.46	0.53	0.07	2.57	0.98
Significant	Ns	Ns	**	**	**	**	**	Ns	**	**
Varieties										
FARO 44	19.87[b]	22.27	2.24[b]	150.5[b]	69.65[b]	21.67	23.02	2.41[b]	154.3[b]	70.49[b]
TOFA	21.60[a]	22.11	2.77[a]	159.1[a]	76.78[a]	21.53	22.24	2.83[a]	160.3[a]	77.07[a]
SE±	0.55	0.08	0.27	4.30	0.79	0.29	0.34	0.05	1.62	0.62

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Significant Interaction T×V	** S	Ns S	** S	** S	** S	** S	** S	Ns S	Ns S	** S

Values are Mean ± SD of biological triplicate, Means with the same letters within column are not significantly different (P<0.05). T=treatment, V=variety

Effect of N Application and Variety on Seed Length (mm), Seed Width (mm), Length/Width Ratio (mm), One thousand (1,000) Seeds Weight and Days to Fifty Percent 50% Flowering (DF)

The effects of nitrogen and variety on Seed Length (mm), Seed Width (mm), Length/Width Ratio (mm), One thousand (1,000) Seeds Weight and Days to Fifty Percent 50% Flowering (DF) under irrigation and rainfed were presented in Table 6.

The results under irrigation on seed length indicated significant (P<0.05) effect of nitrogen on seed length such that 200 kg/ha had the highest seed length while the least seed length was from control. The results under rainfed on seed length indicated significant (P<0.05) effect of nitrogen on seed length such that 200 kg/ha had the highest seed length while the least seed length was from 50 kg/ha.

The results under irrigation on seed width indicated significant (P<0.05) effect of nitrogen on seed width such that 200 kg/ha has the highest seed width while the least seed width was from control. The results under rainfed on seed width indicated significant (P<0.05) effect of nitrogen on seed width such that 200 kg/ha has the highest seed width while the least seed width was from control.

The results under irrigation on Length/Width Ratio indicated significant (P<0.05) effect of nitrogen on Length/Width Ratio such that 150 kg/ha has the highest Length/Width Ratio while the least Length/Width Ratio was from control. The results under rainfed on Length/Width Ratio indicated significant (P<0.05) effect of nitrogen on Length/Width Ratio such that 150 kg/ha had the highest Length/Width Ratio while the least Length/Width Ratio was from control.

The result under irrigation on one thousand (1,000) seeds weight indicated significant (P<0.05) effect of nitrogen on one thousand (1,000) seeds weight such that 150 kg/ha has the heaviest one thousand (1,000) seeds weight while the least one thousand (1,000) seeds weight was from control. The results under rainfed on one thousand (1,000) seeds weight indicated significant (P<0.05) effect of nitrogen on one thousand (1,000) seeds weight such that 200 kg/ha had higher one thousand (1,000) seeds weight while the control had lower one thousand (1,000) seeds weight. The results under irrigation on days to fifty percent 50% flowering indicated no significant (P>0.05) effect of nitrogen on days to fifty percent 50% flowering such that 150 kg/ha had the longest days to fifty percent 50% flowering while the shortest days to fifty percent 50% flowering was from control. The results under rainfed on days to fifty percent 50% flowering indicated no significant (P>0.05) effect of nitrogen on days to fifty percent 50% flowering such that 50 kg/ha has the longest days to fifty percent 50% flowering while the shortest days to fifty percent 50% flowering was from control.

The results on effect of variety indicated that there is significant (P<0.05) differences on seed length, seed width, one thousand (1,000) seeds weight and days to fifty percent 50% flowering for both the seasons. The results on the interaction of treatment and varieties indicated that there is significant (P<0.05) differences seed length, seed width, Length/Width Ratio, one thousand (1,000) seeds weight and days to fifty percent 50% flowering (DF) and one thousand (1,000) seeds weight for both the seasons as shown in Table 6.

Table 6: Effect of N Application and Variety on Seed Length (mm), Seed Width (mm), Length/Width Ratio (mm), One thousand (1,000) Seeds Weight and Days to Fifty Percent 50% Flowering (DF)

	Irrigation					Rainfed				
Treatment	**SDL**	**SDW**	**LWR**	**DYF**	**1000 g/w**	**SDL**	**SDW**	**LWR**	**DYF**	**1000 g/w**
0 kg N/ha	9.40^{c}	2.49^{b}	3.70^{b}	93.33^{b}	28.20^{b}	9.45^{a}	2.47^{b}	3.59^{b}	92.83	27.55^{c}
50 kg N/ha	9.69^{b}	2.56^{a}	3.79^{ab}	101.67^{a}	28.24^{b}	9.93^{b}	2.61^{a}	3.97^{a}	104.67	28.80^{bc}
100 kg N/ha	9.85^{ab}	2.51^{a}	3.83^{ab}	102.83^{a}	28.66^{b}	10.02^{b}	2.59^{a}	4.00^{a}	103.50	29.82^{ab}
150 kg N/ha	9.85^{ab}	2.53^{a}	4.24^{a}	108.33^{a}	31.21^{a}	10.09^{b}	2.54^{ab}	4.12^{a}	108.17	30.60^{a}
200 kg N/ha	9.95^{a}	2.57^{a}	4.00^{ab}	105.67^{a}	30.66^{a}	10.19^{b}	2.62^{a}	4.07^{a}	104.17	30.78^{a}
SE±	0.10	0.02	0.10	2.54	0.64	0.10	0.02	0.15	3.80	0.39
Significant	**	**	**	**	**	**	**	**	Ns	**
Varieties										
FARO 44	9.67^{b}	2.50^{b}	3.87	90.80^{b}	28.07^{b}	9.81^{b}	2.50^{b}	3.99	94.20^{b}	28.19^{b}

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TOFA	9.83[a]	2.57[a]	3.82	113.93[a]	30.71[a]	10.07[a]	2.63[a]	3.91	111.13[a]	30.83[a]
SE±	0.08	0.04	0.03	11.56	1.32	0.06	0.02	0.03	2.40	0.25
Significant	**	**	Ns	**	**	**	**	Ns	**	**
Interaction T×V	S	S	s	S	S	S	S	S	S	S

Values are Mean ± SD of biological triplicate, Means with the same letters within column are not significantly different (P<0.05). T=treatment, Variety

V. DISCUSSION

The effect of nitrogen levels on growth and yield of two cultivars of rice due to seasonal variation revealed that the Analysis of variance for plant height was found to be significantly different (P < 0.05) among the varieties studied. An increase in plant height in response to the recommended dose of nitrogen was due to the improved vegetative growth and the supplementary contribution of nitrogen as opined by Awan *et al.*(2011). Increase in the addition of N on the two varieties resulted in higher values of growth parameters in this study relative to the control and this was also in agreement with the findings of Mohanty *et al.* (2013).

The variation in plant height by the nutrient sources could be attributed to the variation in the level of N application. Nitrogen as one of the major plant nutrients is very essential for growth and yield of rice(Ahmed *et al.,* 2005). It has been observed in this experiment that plant height increased as the rate of nitrogen application increased from 73.92cm at the control plot to 93.02cm at 120 kg N. Similar findings were reported by Lee (1998) that application of nitrogen fertilizer produced more vigorous and taller plants than those that did not receive any nitrogen. The increase in plant height with increased nitrogen application might be primarily due to enhanced vegetative growth with more nitrogen supply to plant. Similar to plant height ,nitrogen has great influence on days to flowering and maturity in rice.

High quantity of N fertilizers applied led to an increase in plant height which improved the rate of translocation of nitrogen from culms to leaves which led to production of photosynthates that enhanced further translocation of nutrients for development of panicles. The tillering stage normally starts with the appearance of the first tiller from the axillary bud in one of the lower most nodes. Paul, (2018) reported that high and early tillering capacity was considered an essential trait for optimum grain yield, thus tillering ability is one of the most important traits of rice because it impacts directly on production of panicles. Low tillering and low tiller productivity are caused by high temperatures during the tillering phase Yan *et al.* (2010).

Sunshine hours during the flowering period enhanced good pollination of rice plants as corroborated with the findings of WARDA (2011). The adoption of integrated nutrient management decreased days to flowering and this assertion in conformity with the reports of Srivastava *et al.* (2018).The weight of grains of rice is a genetic trait and could possibly explain the inconsistent responses of rice varieties to nitrogen fertilizer applications.

Higher N uptake efficiency contributed directly to efficient use of applied nutrients for development of the rice plant. The increase in nutrient uptake coupled with good soil fertility status could be attributed to abundant availability of nutrients, their absorption and transportation to the plant parts from the soil. Nitrogen is the indispensable nutrient in rice production and its uptake is affected by a variety of soil characteristics, split application of nitrogen fertilizers, doses of nitrogen, the timing of application and other environmental factors. Organic fertilizer application enhanced the transfer of nitrogen between the solid phase and soil solution which contributed to higher nitrogen uptakes as a result activities of soil micro-organisms (Yassen *et al.*, 2010).

VI. CONCLUSION

In this study, it can be concluded that vegetative parameters (plant height, panicle length and number of tillers) were better established in Dan boto than in FARO 44. Similarly, higher 1000 grain weight was obtained in Dan boto based on its performance on low level of N application. The relative performance of each of the two rice varieties was glaring, giving each of them the opportunity to perform best at the optimum nitrogen rate throughout the study period. However, this level of Nitrogen application would provide similar or varied grown and vegetative yield under conventional rice production in the Argungu Sudan Savanna. .

VII. RECOMMENDATIONS

These recommendations are made in respect to the results obtained from the experiment.

1. Considering the good performance of Dan boto local variety under irrigation, its cultivation by local farmers should be given a boost through provision of agricultural facilities and better funding by the government.
2. Agronomical evaluation trials at farmer's field should be encouraged to seek more information and farmer's opinions on suitability of the FARO 44 and Dan boto
3. Farmers should be encouraged to grasp the importance of maintaining soil fertility status for sustainable soil productivity and encouraging farmer to split nitrogen fertilizer into two, at tillering and panicle initiation stage.
4. The use of leaf colour chart (LCC) is a novel and promising technology; hence more research needs to be conducted in details especially at varietal level so as to monitor the real time need of N application

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