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THE EFFECTS OF THREE LEVELS OF UREA FERTILIZER AND THREE IRRIGATION SCHEDULES ON THE GROWTH AND YIELD OF GUINEA CORN (*Sorghum bicolour* (L) MOENCH) IN LAFIA, NIGERIA

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ABSTRACT
Field experiment was conducted between February and April during the dry season of 2019, at the Research and Teaching Farm of College of Agriculture Lafia, Nasarawa state to "Asses the growth and yield response of an early sorghum variety using three levels of urea fertilizer and three irrigation schedule" The Red seeds of sorghum were sourced from Nasarawa Agricultural Development Programme, Lafia. (NADP).The treatments consisted of factorial combination of urea fertilizer at 3 levels (0 kg N, 40 kg N, 80 kg N), and three irrigation schedule,(1,2, and 3 days intervals). The treatments were laid out in split plot and were replicated two times. This was randomly arranged with each replication consisting of nine (9) plots. Each plot measured 1.5m^2. A space of 0.85cm was constructed between plots, with 1m inter plot boundary. Two seeds were planted per hole and were thinned to one plant per stand. Observations on growth and yield characters were taken and analyzed using Gemstat 12th edition, and means were separated using DMRT. The result of the experiment revealed that the application of 40kg (1.2g) N (Urea) fertilizer alongside daily watering of the plants gave the best physiological growth, biomass weight, and seed yield. Higher interactions effect were found when 80kg (2.4g) N (urea) fertilizer was applied alongside daily application of water at vegetative growing stage
Keywords: *Sorghum bicolor*, Urea, Plant stand, irrigation schedule

INTRODUCTION

Sorghum bicolor (L) Moench is an annual crop or grass. It is a genus of the flowering plant in the grass family poecea.(Sharma,1993) Sorghum in English is commonly called Guinea corn, broom corn, chicken corn, common wild sorghum,

durra, great millet, sweet sorghum.(USDA ARS,2012). Commercial sorghum species are native to tropical and subtropical regions of Africa and 'Asia. (FAO, 1995, Sally et al.,2016). Sorghum cultivation extends back to about 3000 Bc in Northern and Eastern Africa (Harlan and De Wet, 1972; Shewale and Pandit 2011). In Nigeria, most cultivation is done in the northern states, in the arid and southern guinea savanna. Most varieties are drought and heat tolerant. (Tove, 2015). Sorghum is grown in hot and arid regions due to its resistance to drought and heat. The leading producers of sorghum bicolor in Africa are Nigeria, accounting for about 71%. (Mohammed et al 2011). The leading producers in the world are India, Nigeria, Sudan, Mexico, Ethiopia and U.S.A (FAOSTAT, 2009).

Sorghum has been for centuries, an important staple food for millions of poor rural farmers in the Semi-arid, Asia and Africa regions.(Dillon et al.,2007) Sorghum cultivation extends back to about 3000 BC in Northern and Eastern Africa.(Paterson, et al.,2009) Sorghum remains a principal source of energy, vitamins and minerals. Sorghum grow in harsh environment where other crops cannot thrive well.(FAO,2004) Soil pH of 5.5-6.8 favor sorghum production, while a soil pH of 6.5 is optimum for sorghum growth, and nutrient use efficiency deteriote outside this pH range and lime could be added to raise the pH to 6.0 or above to make it effective (Agropedia,2009). Sorghum stalks and leaves are coated with white wax. The leaves are about 5cm broad and 75cm long. The root system is very fibrous and can extend to a depth of 1 .2m. The tiny flowers are produced in panicles. The seeds vary widely among different varieties in color, shape, and size. Each flower cluster bears 800-3000 kernels. (Mask et al.; 1988). Sorghum is high in carbohydrates, contains about 70% starch

with 10% protein, 3.4% fat, and contains calcium and small amount of iron, vitamin B 1, and niacin. The grain is used in making edible oil, starch, dextrose and alcoholic beverages.(Mutegi, et al;2010). The last wild relatives of commercial sorghum are currently confined to Africa South of the Sahara. (Kumar, et al; 2011) Most cultivated varieties of sorghum can be traced back to Africa where they grow on savanna lands (Kumar, et al; 2009)

MATERIALS AND METHODS

The experiment was carried out at the Teaching and Research site of College of Agriculture Lafia, Nasarawa State in the dry season period between February and April of 2018; under irrigated condition to investigate the "Optimum growth and yield of guinea (Sorghum bicolor) using different levels of Urea fertilizer under different irrigation intervals"

The area is located in latitudes 8°29'38.04'N, and Longitude 8°31'55.15' E, located 130.2km ESE of Abuja.Lafia has an elevation of 204.66m.(DMS Cordinates,2020). The dry season begins early November and ends in April or May, while the rainy season begins late April or early May and ends in October. The prevailing winds are from east west. The temperature ranges between a minimum of 23°c, and maximum of 37°c, while Relative humidity is lower at this time. Two treatments were used namely: irrigation schedule, and Urea fertilizer. Three levels of Urea fertilizer application was used-0kg/ha, 40kg/ha (1 .2g), and 80kg/ha (2.4 g), and three irrigation schedules were used: daily (I day) schedule, two (2) days schedule, and three (3) days schedule respectively. The treatments were completely randomized comprising of two replications and nine treatment combinations. Each plot constructed measures

1.5m^2, with a spacing of 90cm apart between plots. Three seeds were planted per hole and were later thinned to one plant per stand. Each plot consists of nine-plant stand. Irrigation schedule was done according to treatments allocation and fertilization was done according to specifications. Weeding was done four weeks after planting using small hoe.

Data were taken and analyzed for the following parameters: Soil physical and chemical properties of the experimental site, average height (2 plants) per plot, biomass and seeds weight/plot (One thousand seeds weight) after harvest. Observations were done on possible pest and disease incidences. Visible signs were seen on quella birds and few incidences of shoot fly. The birds were periodically scared away and the shoot flies were controlled using an insecticide called sharp shooter. Data generated were subjected to analysis of variance (ANOVA), using descriptive statistics. Split plot design in one way ANOVA was used, Equal variances were assumed for the analysis. Means were separated using Fischer's least significant differences (FLSD) at 95% confidence limits

RESULTS AND DISCUSSION

Soil physical and chemical properties of the experimental location (0-15 cm) showed that the soil was loamy sand, slightly acid (Adepetu et al 2014).This pH range falls within the range 5.0--8.5, as the range in which most sorghum plants grow (NRC, 1996).Furthermore, grain sorghum has traditionally been grown on soils with pH above 6.5 (Mask, et al., 1988) The organic carbon is medium(Chude, et al;2012). The medium organic carbon content is an indication that the soil is fertile and well drained and is favorable for the cultivation of sorghum.,

(Adepetu et al.,2014) , The N content, available p (bray- 1) , Mg, K, and Na values are low, both of which values were below the critical levels.(Aune and Lai,1995), meaning that an increase in the nitrogen level from 1.2g to 2.4 g can significantly increase physiological growth of the sorghum plant., while the Ca content was moderate (Metson, 1961).The percent base saturation was high,(USDA-SCS,1974) while CEC was also very low (Adepetu et al.,2014)

Water uptake at vegetative stage increases plant height under1-D irrigation schedule,(table 2) indicating that sorghum requires ample supply of water at the early stage of growth. Fipps and stichler, 2003, further hinted that in the early stages of sorghum growth, small and frequent application of water is needed. Level of urea application at 2.4 g level has significantly increased plant height at maturity stage. This is also an indication that the more the sorghum plant grows it increases in size with numerous vegetative parts that requires much supply of nutrient. Interaction between 1-D x 1.2g and 2-D X 2.4g level of urea increases plant height significantly at vegetative and maturity stage of growth respectively. Stem thickness (table 3) has increased much more with 1-D x 2.4 g level of urea. Interaction between 3-D x 1.2 g and 1-D x2.4g level of urea was significant. Number of leaves at vegetative stage was not significant, but 1-D irrigation schedule significantly increased number of leaves both at the two stages of growth. The significant increase in number of leaves may be attributed to the fact that "moisture availability is a critical element in seed beds which is essential for successful establishment of the crop (Dweyer et al., 1984).

Interaction was significant between the various treatments;1-D X 1.2g,1-D X 2.4 g,1-D X C, and between 2-D x2-4 g, and 3-D x C respectively (table 3).1-D irrigation was significantly higher for both seed + seeds weight, and for 1000 seeds weight per plot respectively.

The increased grain yield was mainly due to adequate soil moisture availability to the growth of the crop, as lack of adequate soil moisture can result in low grain yield, (Singh, et al., 2006).Furthermore, Stichler, et al,.2003 reported that after seedling establishment, water use by plant increases sharply and water stress can significantly affect grain sorghum yield potential especially during critical water use periods. The grain sorghum responds to irrigation more at certain growth stages (boot, flower, and grain fill) when water use is greater at other stages. Water used increases when more vegetative parts like leaves, flowers, and branches are produced. This assertion agrees with the report by Leon,2004, Stichler et al.,2003 , that the most critical period to avoid water stress is from about one week prior to the emergence of the grain head from boot exertion through two weeks past flowering. During this time plants suffering from severe drought may not be able to push the grain head out of the boot. Furthermore, Stichler and Fipps (2003), reported that, additional application of water after maturity will not add weight to the seeds.

Adequate soil moisture is most important during the booting, heading, flowering and grain filling stages of plant growth.(Leon,2004). Biomass weight (table 5) was higher in 2-d irrigation schedule. Krantz et al. 2008 reported that the most critical period to avoid water stress is from about one week prior to the emergence of the grain head from boot

exertion to two weeks past flowering. However, total water usages can vary based on variety, maturity, planting date, environmental conditions and final yield. Fertilizer rate of 1.2 g has significantly increased biomass and 1000 seeds weight which was significant at p>0.05.Interactions on biomass was higher between 2-D x 1.2g ,and lower between 3-D x 2.4 g. The highest interaction on seed weight occurred between 2-D x1.2g, while the lowest interaction occurred between 3-D x2.4g. The decrease in the height through biomass interaction was because plant growth increases at this level and more water is needed. Highest interaction on 1000 seeds weight per plot occurred on 1-Dx 1.2 g, while the lowest was found in 1-D X C. Stichler and Fipps, 2003, reported that additional water after maturity will not add weight to the seeds but may help with stalk growth. Interaction on 1000 seeds weight was significant statistically at p>0.05.

CONCLUSION AND RECOMMENDATIONS

The application of 2.4g level of urea fertilizer and 1-D (Daily) irrigation schedule was found to be significantly effective on Physiological functioning of sorghum at all stages of growth . The application of 1.2g urea fertilizer and 1-D (Daily) irrigation schedule has significantly increased the growth and yield of sorghum. Interactions effect between 1-D (Daily) irrigation schedule and application of 1.2 g urea fertilizer rate has also significantly increased sorghum growth. Farmers within the study area can cultivate this Sorghum variety during the dry season period for sustainable economic development.

Table.1 Physical and Chemical properties of the soil in the experimental location in 2019.

Soil Properties	Sample code (0-15cm)
Sand	85.0
Silt	3.8
Clay (%)	11.2
Texture	LS
pH H_2O	6.09
Total N (%)	0.14
Organic carbon (%)	1.60
Bray-1 P(Mg L^{-1})	2.81
K (C mol Kg^{-1})	0.29
Na (C mol Kg^{-1})	0.18
Ca (C mol Kg^{-1})	2.51
Mg (C mol Kg^{-1})	1.92
Exchangeable acidity.	0.33
Effective CEC	5.23
TEB (C mol Kg^{-1})	4.90
B.S (%)	94

Table 2: Effects of three Urea fertilizer rate and three irrigation intervals on Sorghum height.

Parameters	Plant Height (cm)	
	Vegetative Stage	Maturity Stage
Irrigation Schedule		
Daily (1-D)	135.00±30.60	320.67±15.67
2 – Days Interval (2-D)	105.40±29.10	327.33±17.65
3 – Days Interval (3-D)	111.00±33.00	308.67±22.34
LSD	46.46	29.78
Fertilizer Rate		
Control (C)	101.90±26.90	314.50±6.44
1.2g (40kg)	124.10±41.50	319.67±23.94
2.4g (80kg)	125.40±24.60	322.50±25.00
LSD	46.46	29.78
Interactions		
1-D X C	112.90	314.50
1-D X 40kg	153.20	325.50
1-D X 80kg	138.80	322.00

2-D X C	91.80	316.00
2-D X 40kg	101.70	329.00
2-D X 80kg	122.80	337.00
3-D X C	101.00	313.00
3-D X 40kg	117.40	304.50
3-D X 80kg	114.60	308.50
LSD	80.47	51.59

Means on the same column (for each section) with differences greater than LSD are statistically significant (p<0

Table 3: Effects of three urea fertilizer rate and three irrigation interval on sorghum Stem Thickness

Irrigation Schedule/Fertilizer Rate/Interactions	Stem Thickness (cm)	
	Vegetative Stage	Maturity Stage
Irrigation Schedule		
Daily (1-D)	16.70±1.91	25.72±2.58
2 – Days Interval (2-D)	15.43±1.34	22.78±3.36
3 – Days Interval (3-D)	14.70±2.47	21.07±3.95
LSD	2.73	4.39
Fertilizer Rate		
Control (C)	15.00±1.76	21.68±2.69
1.2g (40kg)	15.76±1.80	23.90±3.93
2.4g (80kg)	16.07±2.64	23.98±4.41
LSD	2.73	4.39
Interactions		
1-D X C	15.25	23.40
1-D X 40kg	16.50	26.60
1-D X 80kg	18.35	27.15
2-D X C	14.75	20.25
2-D X 40kg	15.10	22.30
2-D X 80kg	16.45	25.80
3-D X C	15.00	21.40
3-D X 40kg	13.40	19.00
3-D X 80kg	15.70	22.80
LSD	4.73	7.60

Means on the same column (for each section) with differences greater than LSD are statistically significant (p<0.05)

Table 4: Effects of three urea fertilizer rate and three irrigation interval on sorghum Leaf numbers

Irrigation Schedule/Fertilizer Rate/Interactions	Number of Leaves at: Vegetative Stage	Maturity Stage
Irrigation Schedule		
Daily (1-D)	25.16±1.72	34.33±3.27
2 – Days Interval (2-D)	24.50±1.97	34.17±4.17
3 – Days Interval (3-D)	24.83±1.32	29.83±5.27
LSD	1.82	4.82
Fertilizer Rate		
Control (C)	23.33±1.50	29.00±2.68
1.2g (40kg)	25.33±1.21	33.50±4.32
2.4g (80kg)	25.83±0.98	35.83±4.07
LSD	1.82	4.82
Interactions		
1-D X C	23.00	30.50
1-D X 40kg	26.00	35.00
1-D X 80kg	26.50	37.50
2-D X C	23.00	29.50
2-D X 40kg	24.50	34.50
2-D X 80kg	23.00	38.50
3-D X C	24.00	27.00
3-D X 40kg	25.50	31.00
3-D X 80kg	25.00	31.00
LSD	3.15	8.36

Means on the same column (for each section) with differences greater than LSD are statistically significant ($p<0.05$

Table 5: Effects of three urea fertilizer rates and three irrigation intervals on sorghum Plant Biomass and Seed Weight

Irrigation Schedule/Fertilizer Rate/Interactions	Plant Biomass and Seed Weight (g) Biomass	Seed Weight	1000 Seed Weight
Irrigation Schedule			
Daily (1-D)	525.30±86.50	487.90±74.70	18400.00±64.67
2 –Day Interval (2-D)	658.60±21.00	475.00±64.10	17533.00±36.83
3 – Day Interval (3-D)	376.60±20.10	314.10±56.80	15267.00±46.61
LSD	251.90	168.40	5015.80
Fertilizer Rate			
Control (C)	430.70±12.30	413.10±8.74	14250.00±36.57

1.2g (40kg)	601.00±27.90	450.60±16.98	20117.00±45.39
2.4g (80kg)	528.80±18.87	413.30±13.85	16833.00±53.55
LSD	251.90	168.40	5015.80
Interactions			
1-D X *C*	433.00	437.00	10500
1-D X 40kg	555.00	516.00	22600
1-D X 80kg	588.00	511.00	22100
2-D X *C*	511.00	450.00	17000
2-D X 40kg	799.00	529.00	21750
2-D X 80kg	666.00	446.00	13850
3-D X *C*	348.00	353.00	15250
3-D X 40kg	449.00	307.00	16000
3-D X 80kg	332.00	282.00	14550
LSD	436.30	291.80	8687.60

Means on the same column (for each section) with differences greater than LSD are statistically significant ($p<0.05$)

MAJOR CONTRIBUTION TO KNOWLEDGE

The cultivation of this (Red) sorghum variety has led to a significant interest by many farmers and researchers. Further investigation on this Sorghum variety using 1.2 g and 2.4 g urea fertilizer application, under 1-D (daily) irrigation schedule has been found to INCREASED the physiological growth and Yield of sorghum respectively.

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