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RESPONSE OF SESAME (*Sesamum indicum L*.) TO MOISTURE REGIME AND NITROGEN FERTILIZER IN ILORIN, NIGERIA

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ABSTRACT

A potted experiment was conducted at the Faculty of Agriculture screen house, University of Ilorin, Nigeria in 2018 and 2019 planting seasons to evaluate the performance of sesame to different moisture regimes and nitrogen fertilizer application. The experiment was a factorial fitted into a randomized complete block design and replicated four times. The treatments consisted of four nitrogen levels (0, 30, 60 and 90 kg N/ha) and four moisture regimes (every day, every five days, every ten days, and fifteen days). Data were collected on growth parameters (plant height, number of leaves per plant as well as yield component (seed yield per plant) Data were analyzed by the analysis of variance, using the GenStat 17th edition and significant means were separated by the least significant difference at 5% probability level. The result of the study revealed that increasing nitrogen levels from 0 to 90kgN/ha and moisture regimes from 15 days to every day resulted in a significant ($p<0.05$) increase in plant height, number of leaves and yield per plant and farmers are therefore encouraged to cultivate sesame crop using these rates for maximum yield. From the result of the study, using Nitrogen fertilizer at the rate 60 $kgha^{-1}$ increased the growth and yield attribute of sesame and therefore should be encourage among farmers.

Keywords: Sesame; N fertilizer; moisture regime; growth; yield

INTRODUCTION

Agriculture is the predominant occupation of the inhabitants of the southern Guinea savannah zone of Nigeria (Foli, 2012). These farmers cultivate crops such as yam, cassava, soya beans, sesame, rice, vegetables and Guinea corn at subsistence level relying on low level of inputs. Of these crops, sesame is the preferred economic crop because of the short gestation period (Eifediyi *et al*., 2022), which can give the farmers financial security. Traditionally, these farmers use the bush fallowing method for nutrient replenishment in order to obtain high yields. However, in recent years, this method is no longer sustainable due to reduction in the fallow period from ten years to two years, due to an increase in population and infrastructural development (Kamara et al., 2016). In addition, the soil orders of the zone are Alfisols and Entisols which are characterized by poor nutrient and low water retention capacities thereby exacerbating the problem. Several factors responsible for the low yield of sesame are poor nutrients status of soils in area of cultivation (Kalaiselvana *et al.,* 2001), use of local varieties, erratic rainfall and poor agronomic practices. Among agronomic inputs, (such irrigation conditions and nitrogenous fertilizer) are the most important inputs for increasing its yield. Although the crop is tolerant to drought, optimum moisture in the soil will improve its growth and yield; thus irrigation scheduling can play an important role in yield improvement. Besides, nitrogen is important for vegetative growth, dry matter production, and yield (Malik *et al.,* 2003; Kalpana *et al.,* 2017; Adenuga *et al.,* 2012); it is also an essential component in structural constituent of plant cell. To obtain optimum yield, it is necessary to supply enough moisture for nutrient absorption and translocation of assimilates (Jouyban *et al.,* 2011). In Nigeria, research on the sesame crop water relation is relatively scanty in comparison with other oil crops, mainly because it is cultivated in areas of erratic rainfall which may be the reason for low yield of 367 kg/ha compared to Egypt's 1323 kg/ha, Ethiopia`s 825 kg/ha and Uganda's 609 kg/ha (FAO, 2009) and seldom grown commercially under irrigation (El Mahdi and Abdel Rahman, 2008). However, the crop is grown under irrigation conditions in arid and semi-arid parts of the world, which are characterized by high temperatures, solar radiation and evaporation rate (Witcombe *et al.,* 2008; Hassanzadeh *et al.,* 2009). The study was carried out to assess the growth and yield of sesame under different nitrogen rates and moisture regimes.

MATERIALS AND METHODS

Experimental Site

The experiment was conducted at the Faculty of Agriculture, University of Ilorin, Nigeria (8°29^1 N 04°35^1 E, 307 m above sea level), during the 2018 and 2019 cropping seasons. The site is located in the southern Guinea savannah zone of Nigeria on an Alfisol belonging to the Bolodunro Series (Ogunwale *et al*., 2002). The rainfall pattern of the location is bimodal, starting in late March to July with the first peak in late July followed by a break in August. The second part of the rainy season usually starts in late August with a peak in late September and ends in late October. The annual rainfall for the location was 991 mm in 2018 and 1432.92 mm in 2019. The mean annual temperature of the study area was 29 °C while the average annual relative humidity is about 85 %.

Soil physical and Chemical Analyses

Soil samples for the experimental pots were collected at a depth of 0–30 cm and then used in filling 20 litres capacity pots. Then a composite was taken for physical and chemical analyses. The soil samples collected were air-dried, ground, and passed through a 2 mm sieve. The sieved soil samples were analyzed for chemical properties as described by Carter and Gregorich (2007). Soil organic carbon (C) was determined according to Walkley and Black using the dichromate wet oxidation method (Nelson and Sommers, 1996). Organic matter was estimated by multiplying organic carbon by 1.724. Total N was determined by micro-Kjeldahl digestion and distillation techniques (Bremner, 1996), and available phosphorus (Bray-P) was determined in a 1N NH4F + 0.5N HCl extractant by the vanadomolybdophosphoric acid method (Kuo, 1996). Soil pH was measured in a soil: water ratio of 1:2 using a glass electrode method. Particle-size analysis was done using the hydrometer method (Gee and Or, 2002) and the textural class was determined with a textural triangle (Hunt and Gilkes, 1992; Brady and Weil, 2008). Extraction of exchangeable bases was done by 1N ammonium acetate and exchangeable potassium (K) were determined by flame photometry while calcium (Ca) and magnesium (Mg) were analyzed by atomic absorption spectrophotometry.

Experimental Design and Treatment Layout

The experiment was a factorial fitted into a randomized complete block design (RCBD) with four nitrogen levels (0, 30, 60 and 90kgN/ha) and four irrigation intervals (every day, every five days, every ten days, and fifteen days). The treatments were replicated four times.

Data Collection

Vegetative Traits

At 4, 6, 8 and 10 weeks after sowing (WAS), plant height was assessed as the distance from the soil level to the terminal point of the stem using a measuring tape. At the same time, the number of leaves was determined by visual assessment of the green leaves.

Yield Components

Yield per Plant

This was obtained by weighing the harvested capsules from the sampled plants in each treatment after sun drying and the mean was calculated and recorded.

Data Analysis

All data collected was subjected to analysis of variance (ANOVA) using General Statistical Package (GenStat 17th Edition) and significant treatment effects of the means were determined using least significant difference (LSD) at 5% level of probability.

RESULTS

The results of some physical and chemical properties of the soil of the experimental site are presented in Table 1. The results showed that, the soils were sandy loam in texture, slightly acidic, low organic carbon, low total nitrogen (0.05 and 0.04), low exchangeable acidity (0.28 and 0.40) and available phosphorus of (3.65 and 4.05) in 2018 and 2019 respectively. This indicated that there is need for soil amendment to meet the crop requirements based on the work of Horneck *et al.* (2011).

Table 1. Physical and Chemical Properties of Experimental Soil

Physical Properties	Analytical Values	
	2018	**2019**
Sand (%)	84.96	92.96
Silt (%)	8.00	2.00
Clay (%)	7.04	5.04
Textural class	Sandy-loam	Sandy-loam
Chemical Properties		
pH (H_2o)	7.31	7.22
Available P (mg/kg)	3.65	4.05
Total N (%)	0.05	0.04
Organic Carbon (%)	0.53	0.64
Organic matter (%)	0.87	0.73
Exchangeable Basesm)		
Calcium (cmol/kg)	0.30	0.29
Magnesium (cmol/kg)	1.05	0.97
Potassium (cmol/kg)	0.27	0.26

Table 2. Effect of Nitrogen Rate and Moisture Regime on the Plant Height (cm) of Sesame at 2 weeks Interval

Year	Weeks After Sowing			
	4	**6**	**8**	**10**
2018	64.23	90.02	103.30	113.70
2019	65.42	90.31	102.20	112.20
LSD	Ns	Ns	Ns	Ns
Nitrogen Rate (kg/ha)				
0	66.17	89.96	99.70	104.60
30	68.46	91.67	103.00	109.20
60	69.08	89.67	96.50	103.30
90	73.58	103.38	111.80	114.70
LSD	3.91	4.75	5.86	6.38
Moisture Regime				
Everyday	71.42	100.42	111.00	115.40
Every 5 days	71.08	98.42	109.80	117.00
Every 10 days	71.00	93.17	100.60	105.40
Every 15 days	63.79	82.67	89.50	94.00
LSD	3.91	4.75	5.86	6.38
Interaction				
Year x NR	5.53	Ns	8.29	Ns
Year x MR	Ns	6.71	8.29	9.02
NR x MR	Ns	Ns	Ns	Ns
Year x NR x MR	Ns	Ns	Ns	Ns

(*) Denotes effects significant at 5 percent probability level. NS denotes effects not significant (p>0.05); Nitrogen Rate (NR); Moisture Regime (MR).

The mean average of the two growing season shows no significant difference in plant height at 4, 6, 8 and 10th WAS. All rates of Nitrogen applied level shows significant difference across 4,6,8 and 10 WAS with the best result gotten when Nitrogen was applied at the rate of 90Kg^{-ha} in the 10th WAS. On moisture regime, the best result was gotten when water was applied every day at all the WAS except at 10WAS while the lowest results were gotten when water was supplied at every 15days. As for the interaction between Nitrogen rate of application and moisture regime, no significant difference is observed across all WAS.

Table 3. Effect of Nitrogen Rate and Moisture Regime on the Number of Leaves of Sesame at 2 weeks interval.

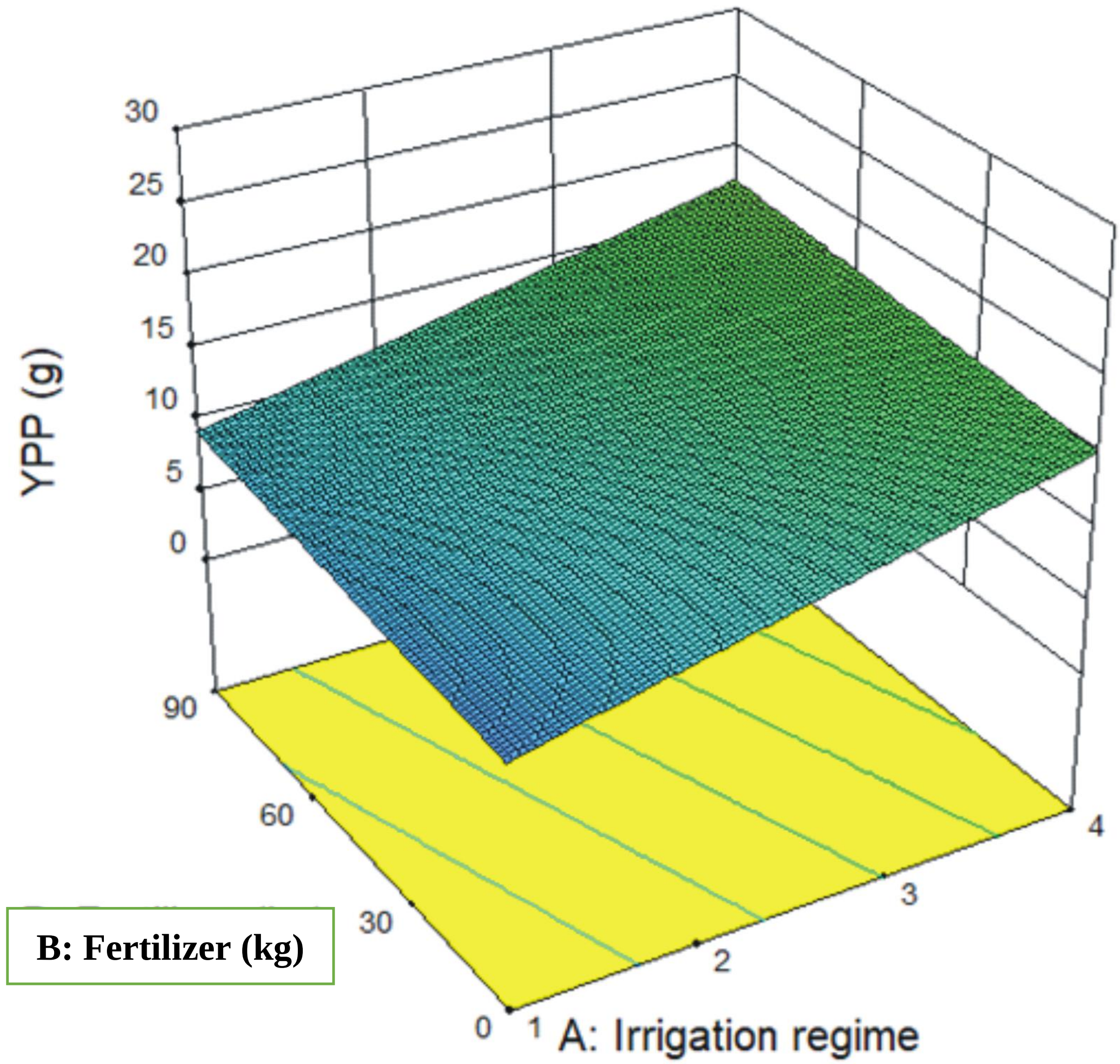
YEAR	Weeks After Sowing			
	4	6	8	10
2018	38.50	44.44	51.60	45.98
2019	38.92	45.27	52.10	45.81
LSD	Ns	Ns	Ns	Ns
Nitrogen Rate (kg/ha)				
0	34.17	48.42	56.33	56.29
30	35.17	54.04	67.83	68.54
60	37.71	62.67	79.71	82.29
90	35.00	58.29	71.54	72.46
LSD	Ns	3.72	3.70	3.61
Moisture Regime				
Everyday	36.46	60.33	75.54	77.33
5 days	34.83	52.17	65.17	66.50
10 days	37.38	58.92	70.21	70.96
15 days	33.38	52.00	64.50	64.79
LSD	ns	3.72	3.70	3.61
Interaction				
YEAR x NR	5.08	5.27	5.24	5.11
YEAR x MR	5.08	5.27	5.24	5.11
NR x MR	ns	7.44	7.40	7.23
Year x NR x MR	ns	10.53	10.47	10.22

(*) Denotes effects significant at 5 percent probability level. NS denoted effects not significant (p>0.05); Nitrogen Rate (NR); Moisture Regime (MR)

In the two growing season, no significant difference was seen across all WAS, with the highest result coming from 2018 at 10th WAS. Significant difference was observed when Nitrogen was applied at different rate except at all the WAS except at 4 WAS where Nitrogen application has no significant difference on the number of leaves. The best result was obtained when Nitrogen was applied at 60kg^{-ha} across all the WAS. No significant difference was observed at 4 weeks after sowing across all the rate of moisture regime while at 6, 8 and 10th WAS, they are all significantly different. The best result was gotten when water was applied everyday across all level except at 4 WAS where 10days interval has the best result. The interaction between Nitrogen rate and moisture regime, as well as the interaction between the year, Nitrogen rate and moisture regime showed no significant differences at 4 WAS while there are significant differences across every other level of interactions.

Yield and Yield components

Figure 1 shows the response surface plot of the effect of fertilizer rate and irrigation regime on seed weight. It can be observed that fertilizer application has very little effect on the yield per pot. Though a very slight positive effect is observed, the ANOVA informs that this effect is statistically insignificant. On the other hand, higher irrigation regime can be observed to increase the yield per pot and this holds over the entire domain of fertilizer rate. From the result, the optimal factor combination for the yield per hectare is 90 kg fertilizer and every day irrigation regime.



YPP= Yield per plant

Figure 1. Effect of Nitrogen fertilizer rate and irrigation regime on yield per plant

DISCUSSION

Soil Analysis

The soils of the experimental site were very low in most of the nutrients evaluated such as organic matter and thus poor fertility. This pH range and texture are well suited for the growth of sesame. This is in agreement with the reports of Kumar and Sharma (2008) who reported that sesame plant can thrive well in soils with a pH range of 6 - 9 and prefers a well-drained soil. Similarly, National Research Council (2006) reported that sesame can be cultivated in soil with a pH of 4.5-9.0 and prefers sandy and alluvial soils. The soil is a reflection of a typical Nigerian savanna soils (Aduayi *et al.,* 2002; Falodun and Adewunmi, 2020) which is prone to drying out quickly unless they are amended with materials high in organic matter (Rajaona, 2011).

Effect of N fertilizer and Moisture Regimes on Growth Parameters

The increase in number of leaves with increase in nitrogen rates and moisture regimes could be attributed to more moisture available for the uptake of the fertilizer nutrients and subsequent assimilate production and partitioning into productive parts of the plant. This is similar to the findings of (Shehu *et al.,*2010) who reported an increase in the number of leaves with increase in nitrogen up to 112.5kgN/ha and El Mahdi & El Amin (2008) who reported that 7 days' irrigation interval gave the highest number of leaves compared to other intervals (14 and 21) days. However, nitrogen rates, moisture regimes and interaction effects were not significant in 2018 while it was significant in 2019 except interaction effect at 4WAS.This could be due to low evapotranspiration rate in 2018. The increase in plant height in both years as a result of increase in nitrogen rates is due to increased rate in assimilate production and partitioning to the vegetative parts of the plant. This is in agreement with the findings of (Roy *et al.,* 1995; Mankar and Santao, 1995) who reported that plant height increased with increase in nitrogen rates up to 90kgN/ha. Increase in moisture regimes also increased plant height significantly. This is in agreement with the findings of El-Mahdi and Ei-Amin (2008), Obalola et al. (2016) who reported that mean plant height was increased by the application of different irrigation regimes. The height of plant is an important growth character directly linked with the productive potential of plant in terms of fodder, grains and yield.

Effect of N fertilizer and Moisture Regimes on Yield Parameters

The increase in the yield and yield components of sesame is due to more nutrients and water available for the crop for photosynthesis and subsequent partitioning of the assimilates into reproductive parts such as capsule and seeds formation. Similar results had earlier been reported by Ahmed *et al*. (2001) that with the application of nitrogen, the yield attributes like number of capsules per plant, number of seeds per capsule increased, which might have increased the overall yield. Higher yield per plant (seed weight) was recorded with increase in nitrogen rates and moisture regimes up to 90kgN/ha and five days interval. This is similar to the findings of Okpara *et al*. (2007) who also reported an increase in seed yield per plant and number of seed per capsules with increase in nitrogen up to 75kgN/ha. Damdar *et al.* (2014) reported that number of capsules per plant, 1000 seeds weight and seed yield per plant and per hectare attributes were significantly higher with 90kgN/ha. In addition, the increase in yield per plant could be associated with maximum plant height, number of seeds per capsule and number of capsules per plant, which enhanced total dry matter of the plant. All the positive effect of nitrogen could be adduced to its function as the principal constituent of proteins, enzymes, hormones and chlorophyll which contributed to improved leaf area index and increased yield.

However, Haruna *et al.* (2009) and Olowe and Busari (2000) reported a non-significant response in sesame grain yield at nitrogen level above 60kgN/ha. The application of nitrogen at 60 kg/ha gave the highest yield due to increased assimilate production which were partitioned to the reproductive parts of the plant resulting in proper capsule filling and subsequent yield (Shehu *et al*., 2010).

CONCLUSION AND RECOMMENDATION

From the result of the study, using Nitrogen fertilizer at the rate 60 $kgha^{-1}$ increased the growth and yield attribute of sesame. Farmers are therefore encouraged to use this nitrogen fertilizer rate and irrigation regime for increased sesame production.

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