



## EFFECT OF NITROGEN FERTILIZER AND SOWING METHODS ON PERFORMANCE OF SESAME (*Sesamum indicum* L.) VARIETIES IN BAUCHI STATE, NIGERIA

<sup>1</sup>Waziri, A., <sup>2</sup>Fagam, A. S., <sup>2</sup>Garba, A. A. and <sup>2</sup>Aliyu, M.

<sup>1</sup>Department of Horticultural Technology,  
Federal College of Horticulture Dadinkowa, Gombe, Nigeria

<sup>2</sup>Department of Crop Production,  
Abubakar Tafawa Balewa University, Bauchi, Nigeria

**Corresponding Author's E-mail:** awaziri76@gmail.com **Tel.:** 08068164106

### ABSTRACT

Field experiment was conducted at the Abubakar Tafawa Balewa University Teaching and Research farm, Bauchi in 2018, 2019 and 2020 rainy seasons to study effect of nitrogen fertilizer and sowing methods on performance of sesame (*Sesamum indicum* L.) varieties. The treatments consisted of four levels of nitrogen fertilizer rates (0, 30, 60 and 90 kg N/ha), three sowing methods (dibbling, drilling and broadcasting) and two varieties of sesame (Ex – Sudan 1 and NCRI BEN 01M). The experiment was factorially combined and laid out in to a Randomized Complete Block Design and replicated three times. The result of the experiment revealed that, nitrogen fertilizer had significant ( $P \leq 0.05$ ) effect on growth characters of sesame plant. The application of nitrogen fertilizer at 60kg/ha significantly ( $P \leq 0.05$ ) increased plant height, number of leaves, leaf area, stem girth, number of branches, leaf area index, leaf area ratio, crop growth rate, relative growth rate and net assimilation rate in the 3 years of study. It was also observed that sowing method had significant ( $P \leq 0.05$ ) influence on the performance of the crop. Dibbling method of sowing significantly ( $P \leq 0.05$ ) produced higher plant height, number of leaves, leaf area, leaf area index, stem girth, number of branches than the other two sowing methods. Studies carried out during the 3-year indicated that 2020 rainy season produced significantly ( $P \leq 0.05$ ) higher plant height, number of leaves, leaf area, leaf area index, stem girth, number of branches than 2018 and 2019 seasons. Based on the results obtained, it can be concluded that the application of 60 kg N/ha and dibbling method of sowing can be adopted by farmers in the study area for optimum production.

**Keywords:** Effect, Nitrogen fertilizer, Performance, sowing methods, Sesame.

### INTRODUCTION

Sesame (*Sesamum indicum* L.) belongs to the family Pedaliaceae, and is one of the most ancient crops and oilseeds known and used by mankind. It is also known as *benniseed*, *gingerly*, *simsim*, *ajonjoli*, sesame and til. It was a major oilseed crop in the ancient world due to its easiness of extraction, great stability and resistance to drought. Sesame was cultivated and domesticated on the Indian subcontinent during Harrapan and Anatolian eras (Bedigian and Van der Maesen, 2003). This is evidenced by the presence of archaeological remnants of crop dating back to 5500 BC in the Harappa Valley in the Indian subcontinents (Weiss, 2000; Ashri, 2007).

Sesame is considered to have both nutritional and medicinal values. The seeds are used either decorticated or whole in sweets such as sesame bars and halva, in baked products, or milled to get high-grade edible oil or tahini, an oil paste (Bedigian, 2004). Sesame seed contains two lignans, sesamin and *sesamol*. After roasting sesame seeds, *seasmolin* is converted to *seasamol*. *Sesamol* has been found to have anti-oxidative effects to induce growth arrest and apoptosis in cancer cells.



Nitrogen is a basic constituent of many other compounds of primary physiological importance to plant metabolism, such as chlorophyll, nucleotides, proteins, alkaloids, enzymes, hormones and vitamins (Marschner, 2005). Nitrogen is a nutrient required by plants in comparatively larger amounts than are other soil borne elements; endogenous application to crops often results in yield improvement. Nitrogen is obtained from the soil through mineralization of soil organic matter and from external sources, both organic and inorganic. For an optimal yield, the N supply must be available according to the needs of the plant, matching its pattern and total amount. One of the veritable tools that could be used to boost the production of sesame by farmers in the tropics is to develop high yielding varieties that can produce very well in a wide range of agro-ecological zones. Hence, the choice of these varieties; Ex-Sudan, an exotic variety from Sudan which was evaluated for its high yield performance and National Cereal Research Institute Badagry Nigeria (NCRI BEN) developed new varieties (NCRI BEN-01M and NCRI BEN-02M) which were released in 2002. The objective of the study was to determine the effect of nitrogen fertilizer and sowing methods on growth characters of sesame varieties.

## MATERIALS AND METHODS

### Experimental Design

Field trial was conducted during the 2018, 2019 and 2020 rainy seasons at the Abubakar Tafawa Balewa University, Teaching and Research Farm, Bauchi. The experiment was laid out in a Randomized Complete Block Design (RCBD) in three replications with net plot size of 3m x 4m with a border row of 0.5m between plots and 1m between replications. The treatments consisted of four levels of nitrogen; 0, 30, 60, and 90kgN/hectare applied as urea (46%N), three sowing methods (dibbling, drilling and broadcasting) and two varieties of sesame; Ex-Sudan 1 and NCRI BEN 01M. Nitrogen fertilizer was applied as a single dose at four weeks after emergence. Growth characters such as plant height, number of leaves, number of branches, stem girth, leaf area, leaf area index, leaf area ration, crop growth rate, relative growth rate and net assimilation rate were recorded. The data collected were subjected to analysis of variance (ANOVA) treatments means were compared by using Duncans Multiple Range Test (DMRT) as stated by Fasino (2003).

## RESULTS AND DISCUSSION

### Plant height (cm)

The result in Table 1 showed the effect of nitrogen fertilizer and sowing methods on plant height of two sesame varieties grown during the 2018, 2019 and 2020 rainy seasons. The effect of nitrogen fertilizer consistently and significantly ( $P \leq 0.05$ ) affected plant height at all the growth stages. The result revealed that the application of 60kg N/ha significantly ( $P \leq 0.05$ ) produced taller plants than the other treatments in both seasons. However, the control had the least plant height among all the treatments considered. This result is in conformity with the findings Umar *et al.* (2012) who reported that application of up to 60 kg N/ha resulted in significant increase in plant height of sesame. The present study also supported the earlier reports of Fagam *et al.* (2009) who reported that increasing nitrogen fertilizer increases plant growth of maize.

**Table 1:** Effect of nitrogen fertilizer, sowing methods and year on plant height of sesame varieties in 2018, 2019 and 2020 rainy seasons

Treatment	Weeks After Sowing			
	6	8	10	12
<b>N fertilizer (kg/ha)</b>				
0	46.41 <sup>d</sup>	69.22 <sup>d</sup>	99.48 <sup>c</sup>	140.50 <sup>d</sup>
30	49.13 <sup>c</sup>	71.26 <sup>c</sup>	100.04 <sup>c</sup>	144.28 <sup>c</sup>
60	56.09 <sup>a</sup>	74.19 <sup>a</sup>	114.07 <sup>a</sup>	161.67 <sup>a</sup>
90	52.89 <sup>b</sup>	72.44 <sup>b</sup>	106.74 <sup>b</sup>	153.83 <sup>b</sup>
LS	**	**	**	**
SE±	0.59	0.80	1.27	1.26
<b>Sowing method (SM)</b>				
Dibbling	51.03	75.18 <sup>a</sup>	114.17 <sup>a</sup>	155.25 <sup>a</sup>
Drilling	50.92	72.39 <sup>b</sup>	105.07 <sup>b</sup>	150.03 <sup>b</sup>
Broadcasting	50.54	67.76 <sup>c</sup>	96.01 <sup>c</sup>	144.96 <sup>c</sup>
LS	NS	**	**	**
SE±	0.51	0.69	1.10	1.09
<b>Variety (V)</b>				
Ex-Sudan	51.18	72.14	105.50	150.45
01M	50.88	71.72	104.67	149.70
LS	NS	NS	NS	NS
SE±	0.42	0.57	0.90	0.89
<b>Years (Y)</b>				
2018	42.33 <sup>c</sup>	56.18 <sup>c</sup>	101.40 <sup>b</sup>	150.53 <sup>b</sup>
2019	50.64 <sup>b</sup>	73.63 <sup>b</sup>	93.13 <sup>c</sup>	139.71 <sup>c</sup>
2020	60.42 <sup>a</sup>	85.53 <sup>a</sup>	118.72 <sup>a</sup>	160.00 <sup>a</sup>
LS	**	**	**	**
SE±	0.51	0.69	1.10	1.09
<b>Interaction</b>				
N x P	**	**	**	**
N x V	NS	NS	NS	NS
P x V	NS	NS	NS	NS
Y x N	**	NS	**	**
Y x P	NS	*	**	**
Y x V	NS	NS	NS	NS
Y x N x P x V	NS	NS	NS	NS

\*\* and \* = significant at 1 and 5 percent level of probability respectively. NS = Not Significant. Means followed by the same letter(s) within a treatment group are not significantly different at 5% level of probability (Duncan's New Multiple Range Test)

As presented in Table 1, sowing method significantly ( $P \leq 0.05$ ) affected plant height at 8, 10 and 12 weeks after sowing (WAS). Dibbling method generally had taller plants which was significantly ( $P \leq 0.05$ ) taller than the other two sowing methods. However, drilling method on the other hand, significantly ( $P \leq 0.05$ ) gave taller plants than broadcasting method. This behavioral pattern of response in plant height could be due to the fact that agricultural practices (such as sowing method, plant population, plant density and sowing date) are one of the most important factors that affects the productivity of sesame plants. This agreed with the findings of (Ozturk and Saman, 2012; Fromme *et al.*, 2019) who reported that suitable Plant population density has important impacts on plant growth. Yearly variation significantly ( $P \leq 0.05$ ) affected plant height at all growth stages. Plants grown in 2020 rainy season were significantly taller than those sown in 2018 and 2019 seasons. This could be attributed to variation in climatic conditions especially temperature, rainfall and relative humidity.

### Number of Leaves per Plant

Effect of nitrogen, sowing method, variety and year on number of leaves per plant at all sampling periods is presented in Table 2.

**Table 2:** Effect of nitrogen fertilizer, sowing method and year on number of leaves of sesame varieties in 2018, 2019 and 2020 rainy seasons

Treatment	Weeks After Sowing			
	6	8	10	12
<b>N fertilizer (kg/ha)</b>				
0	27.15 <sup>d</sup>	45.59 <sup>d</sup>	60.37 <sup>c</sup>	75.11 <sup>c</sup>
30	27.89 <sup>c</sup>	48.08 <sup>c</sup>	62.26 <sup>b</sup>	80.82 <sup>b</sup>
60	34.41 <sup>a</sup>	51.80 <sup>a</sup>	64.30 <sup>a</sup>	84.00 <sup>a</sup>
90	31.17 <sup>b</sup>	49.19 <sup>b</sup>	63.74 <sup>a</sup>	81.24 <sup>b</sup>
LS	**	**	**	**
SE±	0.51	0.64	0.58	1.08
<b>Sowing method (SM)</b>				
Dibbling	31.57 <sup>a</sup>	51.40 <sup>a</sup>	63.15	82.50 <sup>a</sup>
Drilling	31.14 <sup>b</sup>	49.68 <sup>b</sup>	62.98	81.35 <sup>b</sup>
Broadcasting	27.76 <sup>b</sup>	44.90 <sup>c</sup>	62.75	77.03 <sup>c</sup>
LS	**	**	NS	**
SE±	0.44	0.55	0.50	0.94
<b>Variety (V)</b>				
Ex-Sudan	30.21	48.77	62.95	80.54
01M	29.90	48.56	62.38	80.05
LS	NS	NS	NS	NS
SE±	0.36	0.45	0.61	0.76
<b>Years (Y)</b>				
2018	23.42 <sup>c</sup>	47.79 <sup>b</sup>	60.22 <sup>b</sup>	78.44 <sup>b</sup>
2019	33.13 <sup>b</sup>	47.32 <sup>b</sup>	58.90 <sup>c</sup>	78.65 <sup>b</sup>
2020	33.92 <sup>a</sup>	50.86 <sup>a</sup>	68.88 <sup>a</sup>	85.78 <sup>a</sup>
LS	**	**	**	**
SE±	0.44	0.55	0.50	0.94
<b>Interaction</b>				
N x P	**	**	**	**
N x V	NS	NS	NS	NS
P x V	NS	NS	NS	NS
Y x N	**	**	**	NS
Y x P	NS	NS	*	NS
Y x V	NS	NS	NS	NS
Y x N x P x V	NS	NS	*	NS

\*\* and \* = significant at 1 and 5 percent level of probability respectively. NS = Not Significant. Means followed by the same letter(s) within a treatment group are not significantly different at 5% level of probability (Duncan's New Multiple Range Test)

As presented in Table 2, nitrogen significantly ( $P \leq 0.05$ ) affected number of leaves per plant at all growth stages. The result revealed that the application of 60 kgN/ha consistently and significantly ( $P \leq 0.05$ ) produced higher number of leaves per plant except at 10 WAS where 90 kgN/ha was at par with 60 kgN/ha. This could be due to the fact that nitrogen is one of the limiting nutrients in savannah soils and plays an important role in rapid vegetative growth. This report is in line with the findings of (Anon, 2006; Malik 2003) who reported that there is great growth and yield improvement with fertilized sesame than unfertilized ones.

The different sowing methods also significantly ( $P \leq 0.05$ ) affected number of leaves per plant at 6, 8 and 12 WAS. The result indicated that dibbling method significantly ( $P \leq 0.05$ ) gave higher number of leaves per plant than drilling and broadcasting methods of sowing except at 6 WAS where drilling method produced similar number of leaves per plant with dibbling

method. Widely spaced crops produced larger plants as a result of reduced competition for growth factors. Due to proper space, plant can gain sufficient sunlight, water and nutrient from soil which can influence healthy yield of plant. Miah *et al.* (1990).

### Leaf Area (cm<sup>2</sup>)

The result of nitrogen, sowing method, variety and year on leaf area is presented in Table 3. Nitrogen significantly ( $P \leq 0.05$ ) affected leaf area at different growth stages. The result (Table 3) revealed that the application of 60 kgN/ha at 6, 10 and 12 WAS significantly ( $P \leq 0.05$ ) produced larger leaf area of sesame plant however, it was not significant at 8 WAS.

**Table 3:** Effect of nitrogen fertilizer, sowing method and year on leaf area of sesame varieties in 2018, 2019 and 2020 rainy seasons

Treatment	Weeks After Sowing			
	6	8	10	12
<b>N fertilizer (kg/ha)</b>				
0	40.86 <sup>c</sup>	60.12	62.70 <sup>c</sup>	59.88 <sup>c</sup>
30	43.38 <sup>b</sup>	62.01	63.73 <sup>b</sup>	64.74 <sup>b</sup>
60	45.28 <sup>a</sup>	65.39	67.46 <sup>a</sup>	66.92 <sup>a</sup>
90	45.23 <sup>a</sup>	63.82	63.87 <sup>b</sup>	65.17 <sup>b</sup>
LS	**	**	**	**
SE±	0.65	5.83	0.77	0.56
<b>Sowing method (SM)</b>				
Dibbling	47.78 <sup>a</sup>	75.60 <sup>a</sup>	68.19 <sup>a</sup>	66.30 <sup>a</sup>
Drilling	42.20 <sup>b</sup>	67.71 <sup>b</sup>	65.09 <sup>b</sup>	63.86 <sup>b</sup>
Broadcasting	41.09 <sup>c</sup>	54.45 <sup>c</sup>	60.05 <sup>c</sup>	62.38 <sup>c</sup>
LS	**	**	**	**
SE±	0.57	5.05	0.67	0.48
<b>Variety (V)</b>				
Ex-Sudan	44.68	65.14	64.56	64.28
01M	43.98	62.03	64.33	64.08
LS	NS	NS	NS	NS
SE±	0.46	4.12	0.55	0.39
<b>Years (Y)</b>				
2018	41.42 <sup>c</sup>	59.43	57.34 <sup>c</sup>	63.48 <sup>c</sup>
2019	42.52 <sup>b</sup>	62.83	67.26 <sup>b</sup>	63.40 <sup>b</sup>
2020	45.13 <sup>a</sup>	64.29	68.73 <sup>a</sup>	65.66 <sup>a</sup>
LS	**	NS	**	**
SE±	0.57	5.05	0.67	0.48
<b>Interaction</b>				
N x P	**	*	**	**
N x V	NS	NS	NS	NS
P x V	NS	NS	NS	NS
Y x N	NS	NS	**	NS
Y x P	NS	NS	**	NS
Y x V	NS	NS	NS	NS
Y x N x P x V	NS	NS	NS	NS

\*\* and \* = significant at 1 and 5 percent level of probability respectively. NS = Not Significant. Means followed by the same letter(s) within a treatment group are not significantly different at 5% level of probability (Duncan's New Multiple Range Test)

As presented in Table 3, the significant response of leaf area index (LAI) to nitrogen at all stages of growth could be ascribed to the role of nitrogen in vegetative development for enhanced absorption of nutrients and subsequent utilization in cell multiplication, amino acids synthesis and energy formation that acts as structural compound of the chloroplast which carries out photosynthesis. This result is in conformity with the findings of Olowe and Busari



(2000) and Malik *et al.* (2003) who opined that sesame responded strongly to nitrogen fertilizer in the range of 60 – 90 kg N/ha.

The different sowing method also significantly ( $P \leq 0.05$ ) affected leaf area of sesame plant throughout the study period (Table 3). The result indicated that dibbling method significantly ( $P \leq 0.05$ ) produced larger leaf area of sesame plant than the other sowing methods. Sowing method determines the canopy structure which affect the crop in two important ways: first through light interception and distribution' secondly, through correlated physiological development and morphological changes (Evans *et al.*, 1978).

### Leaf Area Index (LAI)

The result in Table 4 showed the effect of nitrogen fertilizer and sowing method on plant height of two sesame varieties during the 2018, 2019 and 2020 rainy seasons. Nitrogen significantly ( $P \leq 0.05$ ) affected leaf area index at all growth stages. The result revealed that the application of 60 kgN/ha significantly ( $P \leq 0.05$ ) produced better leaf area index however, 90 kgN/ha was statistically at par with 60 kgN/ha at 10 and 12 WAS. The significant response of leaf area index (LAI) to nitrogen at all stages of growth could be ascribed to the role of nitrogen in vegetative development for enhanced absorption of nutrients and subsequent utilization in cell multiplication, amino acids synthesis and energy formation that acts as structural compound of the chloroplast which carries out photosynthesis. This result is in conformity with the findings of Olowe and Busari (2000) and Malik *et al.* (2003) who opined that sesame responded strongly to nitrogen fertilizer in the range of 60 – 90kg N/ha.

As presented in Table 4, the different sowing method also significantly ( $P \leq 0.05$ ) affected leaf area index throughout the study period. The result indicated that dibbling method of sowing significantly ( $P \leq 0.05$ ) gave better leaf area index than the other sowing methods. Yearly variation consistently and significantly ( $P \leq 0.05$ ) affected leaf area index at all growth stages. 2020 season significantly ( $P \leq 0.05$ ) produced better leaf area index than 2018 and 2019. This could be due to the fact that sowing method determines the canopy structure which affect the crop in two important ways: first through light interception and distribution' secondly, through correlated physiological development and morphological changes. (Evans *et al.*, 1978). Widely spaced crops produced larger plants as a result of reduced competition for growth factors. Due to proper space, plant can gain sufficient sunlight, water and nutrient from soil which can influence healthy yield of plant as said by Miah *et al.* (1990).



**Table 4:** Effect of nitrogen fertilizer, sowing methods and year on number of branches of sesame varieties in 2018, 2019 and 2020 rainy seasons

Treatment	Weeks After Sowing			
	6	8	10	12
<b>N fertilizer (kg/ha)</b>				
0	13.62 <sup>d</sup>	15.92 <sup>d</sup>	17.21 <sup>c</sup>	18.96 <sup>c</sup>
30	14.36 <sup>c</sup>	16.55 <sup>c</sup>	17.76 <sup>b</sup>	19.94 <sup>b</sup>
60	15.40 <sup>a</sup>	19.15 <sup>a</sup>	19.34 <sup>a</sup>	22.63 <sup>a</sup>
90	15.09 <sup>b</sup>	18.45 <sup>b</sup>	19.25 <sup>a</sup>	22.41 <sup>a</sup>
LS	**	**	**	**
SE±	0.14	0.25	0.18	0.31
<b>Sowing method (SM)</b>				
Dibbling	15.13 <sup>a</sup>	18.37 <sup>a</sup>	18.95 <sup>a</sup>	22.41 <sup>a</sup>
Drilling	14.61 <sup>b</sup>	17.51 <sup>b</sup>	17.78 <sup>c</sup>	20.53 <sup>b</sup>
Broadcasting	14.11 <sup>c</sup>	16.66 <sup>c</sup>	18.45 <sup>b</sup>	20.06 <sup>c</sup>
LS	**	**	**	**
SE±	0.12	0.22	0.15	0.27
<b>Variety (V)</b>				
Ex-Sudan	14.56	17.69	18.42	21.04
01M	14.63	17.54	17.78	20.53
LS	NS	NS	NS	NS
SE±	0.10	0.18	0.12	0.22
<b>Years (Y)</b>				
2018	12.94 <sup>c</sup>	15.55 <sup>c</sup>	17.07 <sup>c</sup>	18.86 <sup>c</sup>
2019	16.74 <sup>b</sup>	16.69 <sup>b</sup>	18.11 <sup>b</sup>	20.76 <sup>b</sup>
2020	18.74 <sup>a</sup>	20.00 <sup>a</sup>	20.31 <sup>a</sup>	23.36 <sup>a</sup>
LS	**	**	**	**
SE±	0.12	0.22	0.15	0.27
<b>Interaction</b>				
N x P	**	**	**	**
N x V	NS	NS	NS	NS
P x V	**	**	**	NS
Y x N	NS	NS	**	NS
Y x P	*	**	*	NS
Y x V	NS	NS	NS	NS
Y x N x S x V	NS	NS	**	NS

\*\* and \* = significant at 1 and 5 percent level of probability respectively. NS = Not Significant. Means followed by the same letter(s) within a treatment group are not significantly different at 5% level of probability (Duncan's New Multiple Range Test).

### Stem Girth

Effect of nitrogen, sowing method, variety and year on stem girth at all sampling periods is presented in Table 5. Nitrogen significantly ( $P \leq 0.05$ ) affected stem girth at all growth stages. The result showed that the application of 60 kgN/ha consistently and significantly ( $P \leq 0.05$ ) produced thicker stem girth except at 6 and 8 WAS where 90kgN/ha was at par with 60kgN/ha. The differences observed in terms of stem girth indicated that fertilized sesame produced thicker and firmer stem than unfertilized sesame which could be as a result of increase in growth rate of the crop due to nitrogen application. It was observed by Sumathi and Jaganadham (1994) that application of nitrogen fertilizer increased stem girth and number of branches of sesame. Fagam *et al.* (2009) also reported that, increase in nitrogen fertilizer increases growth characters of plant. It is also in conformity with the findings of Tiwari *et al.*

(2000) who reported that there is significant increase in sesame growth with increasing level of nitrogen.

**Table 5:** Effect of nitrogen fertilizer, sowing method and year on stem girth of sesame varieties in 2018, 2019 and 2020 rainy seasons

Treatment	Weeks After Sowing			
	6	8	10	12
<b>N fertilizer (kg/ha)</b>				
0	3.70 <sup>c</sup>	5.52 <sup>c</sup>	12.20 <sup>c</sup>	12.46 <sup>d</sup>
30	3.82 <sup>b</sup>	5.68 <sup>b</sup>	12.33 <sup>c</sup>	12.70 <sup>c</sup>
60	4.05 <sup>a</sup>	5.78 <sup>a</sup>	13.13 <sup>a</sup>	13.57 <sup>a</sup>
90	4.02 <sup>a</sup>	5.75 <sup>a</sup>	12.87 <sup>b</sup>	13.23 <sup>b</sup>
LS	**	*	**	**
SE±	0.04	0.08	0.15	0.08
<b>Sowing method (S)</b>				
Dibbling	3.99 <sup>a</sup>	6.03 <sup>a</sup>	13.31 <sup>a</sup>	12.92 <sup>a</sup>
Drilling	3.90 <sup>b</sup>	5.63 <sup>b</sup>	12.68 <sup>b</sup>	12.69 <sup>b</sup>
Broadcasting	3.80 <sup>c</sup>	5.41 <sup>c</sup>	12.53 <sup>c</sup>	12.75 <sup>b</sup>
LS	**	**	**	*
SE±	0.03	0.07	0.13	0.07
<b>Variety (V)</b>				
Ex-Sudan 1	3.89	5.70	12.79	12.85
01M	3.91	5.68	12.78	12.82
LS	NS	NS	NS	NS
SE±	0.03	0.06	0.11	0.06
<b>Year (Y)</b>				
2018	4.13 <sup>b</sup>	5.34 <sup>c</sup>	11.11 <sup>c</sup>	11.57 <sup>c</sup>
2019	3.37 <sup>c</sup>	5.76 <sup>b</sup>	12.23 <sup>b</sup>	13.53 <sup>b</sup>
2020	4.23 <sup>a</sup>	5.99 <sup>a</sup>	13.73 <sup>a</sup>	14.64 <sup>a</sup>
LS	**	**	**	**
SE±	0.03	0.07	0.13	0.07
<b>Interaction</b>				
N x S	*	NS	NS	**
N x V	NS	NS	NS	NS
S x V	NS	NS	NS	NS
Y x N	NS	NS	NS	NS
Y x S	NS	NS	*	NS
Y x V	NS	NS	NS	NS
Y x N x S x V	NS	NS	NS	NS

\*\* and \* = significant at 1 and 5 percent level of probability respectively. NS = Not Significant. Means followed by the same letter(s) within a treatment group are not significantly different at 5% level of probability (Duncan's New Multiple Range Test).

The different sowing method also significantly ( $P \leq 0.05$ ) affected stem girth throughout the study period. The result (Table 5) indicated that dibbling method significantly ( $P \leq 0.05$ ) gave thicker stem girth than drilling and broadcasting methods. This behavioral pattern of response in stem girth could be as a result of the fact that almost in most of the sesame sowing areas, broadcast sowing is the only practiced cultivation because of the ease of broadcasting and lack of proper planting equipment. It is well known that broadcast sowing always resulted in non-uniform plant spacing in the field. Uniform plant stands have mostly yield advantage over non-uniform plant spacing. Significant seed yield reduction due to non-uniform plant spacing were reported in several crop species such as sunflower (Wade, 1990), corn (Pommel and Bonhomme, 1998) and sorghum Larson and Vanderlip (1994). Broadcast sowing also prevents mechanization during further management practices. Stem girth was also found to vary significantly



( $P \leq 0.05$ ) with yearly variation. Among the years, 2020 season produced thicker stem girth than 2018 and 2019 seasons. This could be attributed to variation in climatic conditions especially temperature, rainfall and relative humidity.

### Number of Branches

The result of the effect of nitrogen fertilizer, sowing method, variety and year on number of branches is presented in Table 6. Nitrogen fertilizer levels significantly ( $P \leq 0.05$ ) affected number of branches at 6, 10 and 12 WAS.

**Table 6:** Effect of nitrogen fertilizer, sowing methods and year on number of branches of sesame varieties in 2018, 2019 and 2020 rainy seasons

Treatment	Weeks After Sowing			
	6	8	10	12
<b>N fertilizer (kg/ha)</b>				
0	5.43 <sup>c</sup>	5.92	9.36 <sup>c</sup>	13.09 <sup>c</sup>
30	5.62 <sup>b</sup>	5.93	9.45 <sup>c</sup>	15.17 <sup>b</sup>
60	6.00 <sup>a</sup>	6.57	10.23 <sup>a</sup>	17.19 <sup>a</sup>
90	5.70 <sup>b</sup>	6.47	9.87 <sup>b</sup>	15.33 <sup>b</sup>
LS	**	**	**	**
SE $\pm$	0.09	0.66	0.12	1.46
<b>Sowing method (SM)</b>				
Dibbling	5.91 <sup>a</sup>	7.34 <sup>a</sup>	11.60 <sup>a</sup>	16.11 <sup>a</sup>
Drilling	5.62 <sup>b</sup>	6.23 <sup>b</sup>	9.57 <sup>b</sup>	14.29 <sup>b</sup>
Broadcasting	5.55 <sup>c</sup>	6.01 <sup>c</sup>	8.44 <sup>c</sup>	12.18 <sup>c</sup>
LS	NS	**	**	**
SE $\pm$	0.08	0.57	0.10	1.26
<b>Variety (V)</b>				
Ex-Sudan	5.72	6.82	9.74	14.64
01M	5.66	6.37	9.70	13.74
LS	NS	NS	NS	NS
SE $\pm$	0.06	0.47	0.09	1.03
<b>Years (Y)</b>				
2018	4.29 <sup>c</sup>	5.13 <sup>c</sup>	8.49 <sup>c</sup>	12.14 <sup>b</sup>
2019	5.22 <sup>b</sup>	5.91 <sup>b</sup>	9.41 <sup>b</sup>	13.20 <sup>b</sup>
2020	7.56 <sup>a</sup>	8.13 <sup>a</sup>	11.27 <sup>a</sup>	17.14 <sup>a</sup>
LS	**	**	**	**
SE $\pm$	0.08	0.57	0.10	1.26
<b>Interaction</b>				
N x P	**	NS	**	NS
N x V	NS	NS	NS	NS
P x V	NS	NS	NS	NS
Y x N	NS	NS	*	NS
Y x P	NS	NS	**	NS
Y x V	NS	NS	NS	NS
Y x N x S x V	*	NS	**	NS

\*\* and \* = significant at 1 and 5 percent level of probability respectively. NS = Not Significant. Means followed by the same letter(s) within a treatment group are not significantly different at 5% level of probability (Duncan's New Multiple Range Test).

The result (Table 6) revealed that the application of 60kg N/ha produced higher number of branches per plant which were significantly ( $P \leq 0.05$ ) higher than the other treatments. This



could be due to the role of nitrogen in cell division and proliferation of tissues. More so, nitrogen being a major component of chlorophyll may have aided the interception of more solar radiation for the production of photo-assimilates which in turn resulted in the production of more leaves. This result is in conformity with the findings of Sanginga *et al.* (2002) and Bado *et al.* (2006) who reported that nitrogen has a significant contribution to vegetative growth of plants.

Lateral growth development or branches were significantly ( $P \leq 0.05$ ) affected by sowing method at all growth stages (Table 6), dibbling method produced higher number of branches per plant which was significantly ( $P \leq 0.05$ ) higher than the other two sowing methods. Variation in years significantly affected number of branches per plant. A cross examination among the years indicated that plants grown in 2020 significantly ( $P \leq 0.05$ ) gave higher number of branches per plant irrespective of the growth stages. It is a well-known fact that broadcast planting always resulted in non-uniform plant spacing in the field. Uniform plant stands have mostly yield advantage over non-uniform plant spacing. Significant seed yield reduction due to non-uniform plant spacing were reported in several crop species such as sunflower (Wade, 1990), corn (Pommel and Bonhomme, 1998) and sorghum Larson and Vanderlip (1994). Miah *et al.* (1990) reported that spaced plants can gain sufficient sunlight, water and nutrient from soil.

#### **Crop Growth Rate, Leaf Area Ratio, Net Assimilation Ratio and Relative Growth Rate**

The result of the effect of nitrogen fertilizer, sowing method, variety and year on crop growth rate, leaf area ratio, net assimilation rate and relative growth rate is presented in Table 7. Result showed that nitrogen fertilizer significantly ( $P \leq 0.05$ ) influenced crop growth rate (CGR), leaf area ratio (LAR), net assimilation rate (NAR) and relative growth rate (RGR). The result indicated that nitrogen applied at 60 and 90 kgN/ha produced higher CGR, LAR and NAR which were statistically at par. The least were recorded in the control treatment. However, application of 60 kgN/ha significantly ( $P \leq 0.05$ ) recorded higher RGR than the other levels. This may be attributed to constant supply of nutrients to promote vegetative growth as nitrogen played important roles on synthesis of chlorophyll, enzymes and proteins as well as enhanced division and enlargement of cells and photosynthetic processes as opined by Fawzy *et al.* (2012).

**Table 7:** Effect of nitrogen fertilizer, sowing method and year on total ash, crude fiber crude protein and ether extract of sesame varieties in 2018, 2019 and 2020 rainy seasons

Treatment	Weeks After Sowing			
	CGR	RGR	LAR	NAR
<b>N fertilizer (kg/ha)</b>				
0	22.18 <sup>c</sup>	18.32 <sup>c</sup>	10.26 <sup>c</sup>	17.78 <sup>c</sup>
30	23.37 <sup>b</sup>	19.65 <sup>b</sup>	12.83 <sup>b</sup>	21.06 <sup>b</sup>
60	24.46 <sup>a</sup>	20.98 <sup>a</sup>	13.81 <sup>a</sup>	23.44 <sup>a</sup>
90	23.69 <sup>ab</sup>	19.87 <sup>b</sup>	13.76 <sup>a</sup>	22.18 <sup>ab</sup>
LS	**	**	**	**
SE±	0.78	0.83	0.64	1.38
<b>Sowing Method (S)</b>				
Dibbling	24.17	19.79	14.23	25.44
Drilling	23.85	18.92	13.94	23.92
Broadcasting	22.90	18.58	13.88	24.43
LS	NS	NS	NS	NS
SE±	1.76	1.86	0.84	1.68
<b>Variety (V)</b>				
Ex-Sudan	23.77	19.71	12.75	21.20
01M	23.45	19.16	12.58	20.78
LS	NS	NS	NS	NS
SE±	0.70	0.74	0.64	1.28
<b>Years (Y)</b>				
2018	24.38	19.59	14.06	23.45
2019	23.07	18.48	13.86	22.27
2020	23.99	19.13	13.41	22.86
LS	NS	NS	NS	NS
SE±	1.62	1.70	1.50	1.92
<b>Interaction</b>				
N x P	NS	NS	NS	NS
N x V	NS	NS	NS	NS
P x V	NS	NS	NS	NS
Y x N	NS	NS	NS	NS
Y x P	NS	NS	NS	NS
Y x V	NS	NS	NS	NS
Y x N x S x V	NS	NS	NS	NS

\*\* = significant at 1 percent level of probability respectively. NS = Not Significant. Means followed by the same letter(s) within a treatment group are not significantly different at 5% level of probability (Duncan's New Multiple Range Test).

## CONCLUSION AND RECOMMENDATIONS

The study concluded that, application of nitrogen fertilizer had a significant effect on growth of sesame varieties. Application of 60kg N/ha and dibbling method of sowing can be recommended for the study area. Any of the two varieties can be recommended for the study area. Further study can be carried out to include additional varieties of sesame to determine the best variety for the study area.

## REFERENCES

Anonymous (2006). *Sesame: Past and future*. SPORE. (CTA). Netherland, **125**: 5-6.



- Ashri, A. (2007). Sesame (*Sesamum indicum* L.). In: Singh, R. J. (ed). Generic Resources, Chromosomes Engineering and Crop Improvement. Vol. 4: *Oil Seeds Crop*. CRC. Press. Boca Raton. FL. USA. Pp. 231-289.
- Bado, B. V., Bationo, A. and Cescas, M. P. (2006). Assessment of cowpea and groundnut contributions to soil fertility and succeeding sorghum yields in the Guinea savannah zone of Burkina Faso (West Africa). *Biology and Fertility Soils*, **43**: 171-176.
- Bedigian, D. and Van der Maesen, L. J. G. (2003). *Slimy leaves and oily seeds: Distribution and use of sesame spp. and Ceratotheca sesamoides (Pedaliaceae) in Africa*. In: Schmelzer, G. H. and Omino, B. A. (eds): Proceedings of first PROTA (Plant Resources of Tropical Africa) International Workshop, Nairobi, Prota Foundation. Wageningen. The Netherlands, 271-274.
- Bedigian, D. (2004). History and Lore of Sesame in Southwest Asia. *Economic Botany*, **58** (3): 329- 353.
- Evans, I. T. and Wardlaw, I. F. (1976). Aspects of the comparative physiology of grain yield and cereals. *Advanced Agronomy*, **28**: 302-359.
- Fagam, A. S., Buba, U. M., Yahaya, I. M. and Olakanle, F. I. (2009). *Effect of variety and nitrogen levels on growth, yield and yield components of maize (Zea mays L.) in Bauchi of Nigeria*. Proceedings of 23<sup>rd</sup> annual national conference of farm management association of Nigeria, 14-17<sup>th</sup> December 2009.
- Fasino, A. S. (2003). Top soil; variation of soil properties in some mapping units in a farm in Southern Nigeria. *Journal of Sustainable Agriculture Environment*, **5**(1): 137-146.
- Fawzy, Z. F., El-Bassiony, A. M., Yunsheng, A. and Zhu, O. (2012). Effect of mineral, organic and Bio-N fertilizers on growth, yield and fruit quality of sweet pepper. *Journal of Applied Sciences Research*, **8**(8): 3921-3933
- Fromme, D. D., Spivey, T. A. and Grichar, W. J. (2019). Agronomic response of corn (*Zea mays* L.) hybrids to plant population. *Institutional Journal of Agronomy*. Volume 2019, Article ID 3589768, 8pages.
- Larson, E. J. and Vanderlip, R. I. (1994). Grain sorghum yield response to non-uniform stand reductions. *Agronomy Journal*, **86**(4): 475-477
- Malik, A. M., Salem, M. F., Cheema, M. A. and Ahmed, S. (2003). Influence of Nitrogen Levels on Productivity of Sesame (*Sesamum indicum* L.) under Varying Planting Patters. *International Journal of Agriculture and Biology*, **4**: 490-492.
- Marschner, H. (2005). *Mineral Nutrition of Higher Plants*, Academic Press, London 3432Pp.
- Miah, M. N. H., Karim, M. A., Rahman, M. S. and Islam, M. S. (1990). Performance of Nazersail mutants under different row spacing. *Bangladesh Journal of Training and Development*, **3**: 31-34.
- Olowe, V. I. O. and Busari, L. D. (2000). Evolving Optimum Rates of Nitrogen and Phosphorous Application for Sesame in Southern Guinea Savanna of Nigeria. *Tropical Oilseed Journal*, **4**: 75-85.
- Ozturk, O. and Saman, O. (2012). Effects of different plant densities on the yield and quality of second crop sesame. World Academy of Science, Engineering and Technology, International. *Journal of Biological, Bimolecular, Agricultural, Food and Biotechnological Engineering*, **6**(9): 644-649.
- Pommel, B. and Bonhomme, R. (1998). Variations in the vegetative and reproductive systems in individual plants of a heterogeneous maize crop. *European Journal of Agronomy*, **8**: 39-49.
- Sanginga, N., Okogun, J., Vanlauwe, B. and Dashiell, K. (2002). The contribution of nitrogen by promiscuous soybean to maize best cropping in the moist savanna of Nigeria. *Plant and Soil*, **241**: 223-231.



- Sumathi, V. and Jaganadham, A. (1994). Effect of nitrogen levels on yield, dry matter and nitrogen uptake by sesame (*Sesamum indicum* L.) varieties, *Journal of Research and Agronomy*, **27**: 63-66.
- Tiwari, R. K., Numdeo, K. N., Girish, J. A. and Jha, G. (2000). Effect of nitrogen and sulphur on growth, yield and quality of sesame (*Sesamum indicum* L.) varieties. *Research Crops*, **1**: 163-167.
- Wade, L. J. (1990). Estimating loss in grain yield due to suboptimal plant density and nonuniformity in plant spacing. *Australian Journal of Experimental Agriculture*, **30**(2) 251 – 255.
- Weiss, E. A. (2000). *Oilseed crops*. 2nd edition. Oxford: Blackwell Science. Oxford, United Kingdom.