EFFECT OF DIFFERENT LEVELS OF SODIUM CHLORIDE (NaCl) SALT ON GERMINATION AND SEEDLING GROWTH OF SESAME (*Sesamum indicum L.)*

[1]Adamu Muhammad, Isa Mohammed Auyo[2], Ahmed Abubakar[3], Yusif Shehu[4] and **Ahmad Abubakar[5].**

[1,3]Sule Lamido University, Jigawa State, Nigeria.
[2]Federal University, Dutse, Jigawa State, Nigeria.
[4] Aminu Saleh College of Education, Azare, Bauchi State, Nigeria.
[5]Federal University, Dutse, Jigawa State, Nigeria.
muhammadgy43@gmail.com
+2348065723232

ABSTRACT

Salinity is the accumulation of salt often dominated by sodium chloride in soil and water to the level that has negative impact on plant. Sesame (Sesamum indicum L.) is an annual crop with height ranging from 50 to 100cm tall. It is one of the important oil crops and ranked 9th among the top thirteen oil seed crop. A field trail was conducted at Botanical Garden, Federal University, Dutse from 25th march 2017 to 8th June 2017 to assess the effect of different level of sodium chloride salt on germination and seedling growth of two cultivar of sesame namely E-8 and Ex-Sudan under four salinity levels (0.0, 3.0, 6.0 and 9.0dsm^{-1}); the salinity was induced before sowing. The experiment was laid out at completely randomize design (CRD) with three replication. Percentage of germination, plant height, and number of leaves, shoot fresh and dry weight decrease with increasing level of salinity and none of the sesame cultivar was resistant to salinity. Germination was negatively affected most at 9.00dsm^{-1} in which germination did not take place; germination is low at 6.00dsm^{-1} and highest at 0.00dsm^{-1}. Growth was poorest at 9.00dsm^{-} and best at 0.00dsm^{-1}. Ex-Sudan differ with E-8 in term of number of leaves at 5WAS but the two cultivars respond in other growth character similarly. Salinity is a problem that affects germination and seedling growth of plant and such need to be tackled in a collective term to meet global food demand.

Keyword: Salinity, Sesame, Cultivar, E-8, Ex-Sudan

INTRODUCTION

Sesame (*Sesamum indicum L.*) is an annual crop with height ranging from 50 to 100 cm tall. It is one of the important oil crops and ranked 9th among the top thirteen oil seed crops, which make up to 90% of the world edible oil production (Kafiriti and Deckers, 2001). The production of high quality seed is prerequisite to successful sesame cultivation. Apart from being the principal method of reproduction, the seed is largely the material from which the edible oil is extracted.

The world hectare exceeds 6 million and world output stood at 2.4 million tonnes (Phillips 1997; Dudley *et al*., 2000). In Africa, Nigeria is the second largest producer after Sudan. Sesame oil is of good quality. According to Dudley *et al*., (2000), the oil is used for cooking, baking, candy making, soaps, lubricant, hair treatment, food manufacturing, industrial uses and alternative medicine (blood pressure, stress and tension). Also, Irvine (1970) reported that the leaves are used in vegetable soup while the seeds are consumed when fried and mixed with sugar in most African countries and the stems are used in making paper, fuel wood and source of potash after burning. Sesame has the potential of producing high percent of blossoms, better pod set and pod yield with good agronomic practices (Alam *et al*., 2007), in which proper weeding and appropriate planting date are inclusive and indispensable.

The current global climatic changes is affecting all agricultural and other human activities, flooding and drought resulting from the changes, fertilizer application in our farmlands and irrigation technique employed today are gradually deflating our soil nutrient and dangerously making it more saline thereby decreasing our soil and crop productivity of any plant, hence challenging food security. Productivity of any plant depends on its ability to manufacture organic natural matter using available inorganic resources while enduring and adapting to the challenging of the environment.

Salinity is a serious challenge affecting our food production today. While some plants can tolerate salts some cannot. To what extent salinity affects growth and yield of plants sesame needs to be investigated.

MATERIALS AND METHODS

Experimental Site

The experiment was conducted at Botanical Garden, Federal University, Dutse, Jigawa state found in Sudan savannah ecological zone and lie between latitude 11.00° N to 13.00° N and longitude 8.00° E to 10.15° E from 25th march 2017 to 8th June 2017 using polythene bags and soil was collected from Agricultural Farm, Federal University, Dutse, Jigawa state.

The treatment consists of four levels of salt (0.00, 3.00, 6.00, and 9.00 dcm^{-1}) and two varieties of sesame namely E8 and Ex-Sudan arranged factorially giving 8 treatment combinations and laid in completely randomized design (CRD) with three (3) replications each. The seed was collected from the Jigawa State Agricultural and Rural Development Agency (JARDA) Kaugama local government substation.

Collection of Soil Sample

The soil was collected up to 0-15 and 15-30cm depth from Federal University, Dutse agricultural farm, the texture of the soil is sandy loam.

Preparation of Polythene Bags and Crop Management

The collected soil sample was air dried under the sun and mixed with cow dung in 3:1 ratio and each of the polythene bags was filled three quarter (3/4) with the soil.

The length of the polythene bags is 48cm and its diameter is 38cm. A total of 24 polythene bags were placed at the Botanical Garden, Federal University, Dutse.

Salinization of Soil

A stock solution of salt which is more than the higher concentration ($12.0dsm^{-1}$) of the treatment was prepared in bucket. The solution was poured in the soil and the electric conductivity meter was used to monitor the EC value until it reached the desired levels accordingly.

Periodic checking of the salinity was done weekly in order to maintain the salt level.

Sowing and Thinning

Sesame of the tested cultivars (E-8 and Ex-Sudan) was sown in polythene bag in the dip of 1/2inch on Saturday 25th march 2017 about twenty seed mix with Apron B plus (for seed dressing) were sown in each polythene but only three were kept at thinning, the extra seedling was uprooted when the plant was fully established. The plant was watered after three days interval.

Collection of Data

The following data was collected during the experiment:

i. Percentage of germinated seed
ii. plant height in (cm)
iii. number of leaves per plant
iv. shoot fresh weight
v. shoot dry weight

The collected data were analysed using Genstat software for windows, 16th edition version: 16.2.0.11713 by two way analysis of variance (Anova) and the mean was compared by fishers protected least significant difference.

RESULT AND DISCUSSION

Effect of Salinity on Germination of Sesame (*Sesamum indicum L.*)

The effect of different level of sodium chloride (Nacl) salt on percentage of germinated seedling and percentage of germination among cultivar of sesame (*Sesamum indicum L.*) is presented in Table 1 below.

Table 1: Effect of Different Levels of Sodium Chloride (Nacl) Salt on Germination of Sesame (*Sesamum indicum L.*)

Treatment	% of germinated seedlings (E-8 and Ex-Sudan)
Salt level in dsm^{-1}	
0.00	91.7a
3.00	35.0b
6.00	20.0b
9.00	0.0c
LSD	19.67
Cultivar	
E-8	36.7a
Ex-Sudan	38.7a
LSD	13.91

Source: Field Survey, 2017

The table 1 shows that percentage of germination were statistically significant at $p \leq 0.05$ at LSD 19.67, control treatment has high percentage of germination and lowest was highest treatment 9.00dsm^{-1} and no single seed germinated, 3.00 and 6.00dsm^{-1} are the same statistically while percentage of cultivar germination are not significant at $p \leq 0.05$at LSD 13.91.

Effect of Salinity on Plant Height sesame (*Sesamum indicum L.*)

The effect of different levels of sodium chloride (Nacl) salt on plant height of selected sesame (*Sesamum indicum L.*) is presented in Table 2 below.

Table 2: Effect of Different Levels of Sodium Chloride (NaCl) Salt on Plant Height of Selected Sesame (*Sesamum indicumL.*)

	Plant height (cm)			
Treatment	2WAS	3WAS	4WAS	5WAS
Salt level in dsm^{-1}				
0.00	2.69a	2.9a	4.9a	7.2a
3.00	1.1b	0.7b	0.5b	0.0b
6.00	0.3c	0.3b	0.4b	0.0b
9.00	0.0d	0.0c	0.0b	0.0b
LSD	0.70	1.09	1.81	2.01
Cultivar				
E-8	1.1a	0.81a	0.9a	1.1b
Ex-Sudan	1.0a	0.9a	2.0a	2.5a
LSD	0.49	0.77	1.24	0.67

Source: Field Survey, 2017

Table 2 indicates that plant height was statistically significant at $p \leq 0.05$ LSD 0.70 at 2WAS control treatment produced the highest plant height followed by 3.00 than 6.00dsm^{-1} and 9.00dsm-1 produced lowest plant height, also at 3WAS LSD 1.09 control treatment produced highest plant height than 3.00 and 6.00 are similar statistically while 9.00dsm^{-1} produced lowest plant height while at 4 and 5WAS LSD 1.81 2.01 control treatment has highest plant height while at 3.00 6.00 and 9.00 dsm^{-1} are the same statistically, also plant height between cultivar are the same statistically at 2 3 and 4WAS LSD 0.49 0.77 and 1.24 but at 5WAS LSD 0.67 Ex-Sudan cultivar produced highest plant height.

Effect of Salinity on Number of Leaves of sesame (*Sesamum indicum L.*)

The effect of different level of sodium chloride (NaCl) salt on number of leaves among cultivar of the selected sesame (*Sesamum indicum L.*) is presented in Table 3 below.

Table 3: Effect of Different Levels of Sodium Chloride (NaCl) Salt on Number of Leaves of the Selected Sesame (*Sesamum indicum L.*)

Treatment	number of Leaves			
	2WAS	3WAS	4WAS	5WAS
Salt level in dsm^{-1}				
0.00	4.2a	4.8a	5.7a	6.5a
3.00	2.6b	1.3b	0.3b	0.0b
6.00	0.7c	0.3b	0.0b	0.0b
9.00	0.0c	0.0b	0.0b	0.0b
LSD	1.25	1.92	1.75	1.10
Cultivar				
E-8	1.8a	1.4a	1.1a	1.1a
Ex-Sudan	1.7a	1.9a	2.2a	2.2a
LSD	0.88	1.39	1.24	1.25

Source: Field Survey, 2017

Table 3 shows that number of leaves were statistically significant at $p \leq 0.05$ LSD 1.25 at 2WAS control treatment produced the highest number of leaves followed by 3.00 than 6.00dsm^{-1} and 9.00dsm-1 produced lowest number of leaves and are similar statistically, also at 3 4 and 5WAS LSD 1.92 1.75 and 1.10 respectively control treatment produced highest number of leaves while 3.00 6.00 and 9.00dsm^{-1} are similar statistically. Also plant heights between cultivar are the same statistically at $p \leq 0.05$.

Effect of Different Level of NaCl Salt on Shoot Fresh and Dry Weight and Shoot Fresh and Dry Weight among Cultivar of Sesame (*Sesamum indicum L.)* at 6 and 7WAS respectively at FUD Botanical Garden, 2017.

The effect of different level of NaCl salt on shoot fresh and dry weight and shoot fresh and dry weight among cultivar of sesame (*Sesamum indicum L.)* at 6 and 7WAS respectively is presented in Table 4 below.

Table 4: Effect of different levels of NaCl salt on shoot fresh and dry weight and shoot fresh and dry weight among cultivar of sesame (*Sesamum indicum L.)* at 6 and 7WAS respectively.

Treatment	Fresh Weight 6WAS	Dry Weight 7WAS
Salt level in dsm^{-1}		
0.00	2.7a	0.5a
3.00	0.0b	0.0b
6.00	0.0b	0.0b
9.00	0.0b	0.0b
LSD	1.12	0.17
Cultivar		
E-8	0.5a	0.1a
Ex-Sudan	0.9a	0.2a
LSD	0.83	0.12

Source: Field Survey, 2017

Table 4 indicates that shoot fresh and dry weight were statistically significant at $p \leq 0.05$ with control treatment having the high fresh and dry weight while the rest treatment are the same.

DISCUSSION

Response to Salinity Level

The highest salinity level of $9.00dsm^{-1}$ affects percentage of germination most because no single cultivar of sesame germinate at the concentration, this may be due to high concentration of salt that inhibit water uptake by seed for germination because before germination water must be absorbed by seed for hydrolysis of seed endosperm which provide nutrient for embryo leading to emergence of radicle and establishment of plumule as seedling.

Germination decrease with increasing salinity level with $6.00dsm^{-1}$ of salt has lower of germination percentage compared to $3.00dsm^{-1}$ salinity level, also control treatment has the highest percentage of germination.

This is in line with the work of Ragiba (2000); conducted petridish experiment on two sesame cultivar germinated at four level of salinity, salinity and early seedling growth decreased with increasing salinity.

Plant height of sesame cultivar was found decreased with increasing salinity at different weeks after sowing, plant height varies significantly due to increasing salinity, control treatment produced the highest plant height while in treatment plant height decreased with increasing salt level, this means that salinity has direct effect on plant height. Gradual decrease in plant may be is due to inhibition of cell division cell enlargement and reducing of water uptake by salinity which results in wilting loosing of turgor by plant which leads to stunted growth and death of sesame plant due to blocking of vascular tissue by the salt.

This research is similar with the work of Babu and Thiramuugun (2001) who reported that plant height of sesame cultivar was decreased by high salinity of 35,701nd 140mMNaCl.

Number of leaves, fresh and dry weight of sesame cultivar was decreased with increasing salinity level; this is due to inhibition of cell expansion and lateral bud development by salt and ionic stress that develop when toxic ions (e.g. Na^{+}) accumulate in cell causing increasing in leaf mortality, chlorosis, necrosis and decrease in cellular metabolism leading to biomass production (Munns and tester 2008).

This research is similar in one way with the work of Lyra *et al.*, (1992) who conducted pot experiment on sesame cultivar in soil with six salinity levels; he found that there were significant differences among cultivar with regard to dry matter production at 0, 10, 20, 30, 40 and 50mMNaCl.

Response of Cultivar

The result showed that the two cultivars did not differ in terms of percentage of germinated seedling, number of leaves, plant height at 2 3 and 4WAS. The non-significant difference between the two cultivars may be attributed to the slow growth of sesame plants between emergence up to 5WAS (Anonnymous. 2009). However, Ex-Sudan cultivar has plant height more than E-8 at 5WAS. Fresh and dry weights between cultivar at 6 and7WAS are the same statistically.

Conclusion

Based on this research work, it can be concluded as:

i. Salinity affects negatively germination of sesame with 9.00dsm^{-1} having lower in germination and control treatment having the highest.
ii. Salinity affects negatively seedling growth of sesame in growth parameters (plant height number of leaves shoot fresh and dry weight) decrease with increase in salinity level.
iii. The different cultivar of sesame respond similarly except at 5WAS where Ex-Sudan cultivar produced high number of leaves compared to E-8.

Salt stress is of growing concern in agriculture as it affects germination and seedling growth of plant, by inducing a water deficit and ionic toxicity in plants causing major plant processes like photosynthesis and metabolism to halt.

Finally the null hypothesis is rejected because salinity affects germination and seedling and there is significant relation between level of soil salinity on germination and seedling growth of sesame.

Reference

Alam S.M.N., M. Salim, N. Islam and M.M. Rahman (2007). Effect of sowing date and time of harvesting on the yield and yield contributing characters of sesame (*Sesame indicum* L) seed. *International Journal of Sustainable Crop Production.***2**(6): 31-35

Anonymous (2009). Small seed provides large income. USAID/MARKETS. Nigeria harvest Markets. Agribusiness update. October 21, 2009.

Babu, S. and Thirumugun, T.2001.Effect of NaCl priming for increased salt tolerance in sesame (*Sesamum indicum L.*). *Journal of Ecobiology*.(13):**4**,309-311.

Dudley, T.S., W. James and A. Mc callum(2000). Texas Agricultural Experimental Station, College Station and Yankum. Prepared April 12, 2000.P125

Irvine J. (1970). West African Crops 3rd edition, Oxford University Press, Pp 71-74.

Kafiriti E.M. and J. Deckers (2001). Sesame in: Raemnekers, Rlt (ed.) Crop Production in Tropical Africa DGIC, Brussels, Belgium,P345

Munns, R.,Testa,M.,2008.mechanism of salinity tolerance: *Annual review of plant Biology.* **59**:65-688

Phillips, T.A. (1997). Agricultural Note Book Series, Longman publishers, London. Pp61-62.

Ragiba,M.2001 Germination and early seedling growth of sesame (*Sesamum indicum L.*) as affected by salinity .*Annual Agricultural Reserch*.**21**:2,303-34.

Lyra,J.RM., Araujo, E., Dantus,J.P., Queroga-V-de-p- and Bruno-R-de-LA.(1992).Quality of sesame (*Sesamum indicum L.*) seed produced under condition of salt stress .*Reusta-Brasilera-desementes,*Brazil.**14**:,201-206.