Nigerian Journal of Scientific Research (NJSR)
ISSN-0794-0378

EFFECT OF ORGANIC NITROGEN RATE AND PLANT DENSITY ON SWEET SORGHUM (*SORGHUM BICOLOR* (L.) MOENCH) IN THE NORTHERN GUINEA SAVANNAH OF NIGERIA

ADEBISI, I.A.[1], SHABAYAN, J.A.Y.[1] AND MUHAMMAD, U.L.[2]
[1]Department of Agronomy, Ahmadu Bello University, Zaria, Nigeria
[2]Department of Agronomy, Federal University of Kashere, Gombe, Nigeria

ABSTRACT

A field trial was conducted during the wet season of 2021 at Samaru in the northern guinea savannah to study the effect of organic nitrogen and plant density on sweet sorghum (*Sorghum bicolor* (L.) Moench). Treatments were (four levels of poultry manure (0, 50, 100 and 150 kg N ha^{-1}) sourced poultry manure at (0, 3, 6, and 9 tons ha^{-1}), and three plant densities 2, 3 and 4 plants/stand) were factorially combined and laid out in a randomized complete block design (RCBD) with three replications. The variables measured were plant height, shoot dry weight, number of grains per panicle, grains yield ha^{-1}, brix yield and 1000 – grains weight. Data collected on the growth and yield parameters were subjected to analysis of variance (ANOVA) and the means were separated using Duncan's Multiple Range Test (DMRT) at 5% level of probability. Result obtained shows positive interaction between organic nitrogen level and plant density which significantly increases plant height, yield and yield components of the sweet sorghum. Similarly, 3 plants/stand recorded higher growth and yield characters than other plant densities evaluated. Based on these findings, it can be concluded that application of 100 kg organic nitrogen sourced from poultry manure applied at 150 N kg ha^{-1} and plant density of 3 plants/stand were optimum for sweet sorghum production in the Sudan savannah agronomical zone of Nigeria.

Keywords: Growth rate, organic nitrogen, plant density, Sweet Sorghum
***Correspondence:** adeishaq24@gmail.com**,** 08037701575

INTRODUCTION

Sweet sorghum (*Sorghum bicolor* (L.) Moench) is a sub- species of saccharum a tropical perennial plant that belong to the same species of as grain sorghum. It is a member of genus of flowering plants in the grass family Poaceae. It is similar to grain sorghum in all standards but contain high sugar content of about 40-50% rich stalk [3]. The crop originated from East Africa, where its production now extends to other regions of the world [2]. Sweet sorghum is cultivated in warm climates worldwide. Sweet sorghum is a drought tolerant feed stock with potential to produce more ethanol per acre than maize. The name sweet sorghum is used to identify varieties of *sorghum bicolor* that have sweet and juicy stalks [1]. Sweet sorghum requires medium to heavy soil, having good drainage for better yield quality of grains, green cane yield or fodder. Sweet sorghum requires an annual rainfall of 600-1000mm; sandy loam and slit soils that contains adequate organic matter and soil pH range of 5.5-7.0 for good growth, sweet sorghum requires a lot of sunshine hour of 6 and temperature of 32^{o}C for good growth. It has potential to be a good substitute for ethanol production. Sweet sorghum ranked 5th behind other cereal crops like: rice, maize, wheat, maize and barley in term of importance as staple crops [9]. Sweet sorghum is less economically important for refined sugar production than other sugar crops, e.g., sugar beet and sugarcane, but can produce more raw fermentable sugar under marginal conditions than those crops. The whole sweet sorghum stalk, and its bagasse, has been subjected to studies of a wide array of pretreatment, enzymatic hydrolysis, and fermentation processes in order to explore additional values [7]. The potential fermentation products of sweet sorghum are wide ranging; those demonstrated, by Vetmerris *et al.* [10]. Include ethanol, acetone, butanol, various lipids, lactic acid, hydrogen, and methane. Many potential native products of sweet sorghum, in addition to cellulose for paper production, have also being identified, which includes waxes, proteins, and allelopathic compounds, such as sorgoleone. In Africa, stems of sweet sorghum are chewed like sugar cane and the seed extract are used for traditional medicine for the treatment of hepatitis, and decoctions of twigs with lemon to treat jaundice, leaves and the panicles of sweet sorghum are used with other herbal mixture against pneumonia [8]. The production of biofuel from sweet sorghum in Nigeria has not being well developed like the Western world. Also, grains from sweet sorghum can be process into sugar, syrup and wine. Fibers from sweet sorghum are good source of pulp for the production of quality papers, which encourage farmers to cultivate sweet sorghum in large quantity because of urge economical returns.

MATERIALS AND METHODS

Field experiments was conducted during the wet season of the year 2020 at the research farms of the Institute for Agricultural Research, Ahmadu Bello University, Zaria, Samaru ($11^0$11'N; $7^0$38'E, and 686 m above the sea level) in the Northern Guinea savannah of Nigeria. The treatments consisted of four levels of organic nitrogen using poultry manure as source 0 kg N h^{-1}, 50 kg N ha^{-1}, 100 kg N ha^{-1} an d 150kg N ha^{-1}, and three planting densities of 2, 3 and 4 plants per stand which were factorially combined and laid out in a randomized complete block design (RCBD) with three replications. Each plot size was 3.0 x 5 m (15.0 m^2) consisting of 4 rows of 0.75 m apart and 5m in length, while the net plot size was 1.5m x 5m (7.5 m^2) with alleyway of 0.75 m between plots and 1.5 m between replicates. The land was cleared, harrowed twice and ridged at 0.75 m apart before laying out the experiment as per the treatments. The seeds of sweet sorghum cultivar for the experiments were obtained from the sorghum breeding section in the Department of Plant Science Institute for Agricultural Research (IAR), Ahmadu Bello University, Zaria. Five seeds per stand were sowed and later thinned 2, 3 and 4 plants per stand according to treatments at spacing of 75cm x 25cm inter and intra rows respectively. The seeds were treated with insecticide (Apron star) to control any incidence of pest and disease such as stem borer. Cypermethrin at 0.75 kg a.i. ha^{-1} was sprayed, using a knapsack sprayer to controlled insects. Poultry manure was weighed and applied as per the treatments a day before sowing by drilling into the ridges. Hoe weeding was done at 3, 6 and 9 weeks after sowing to control weeds. Harvesting was done manually when the seed was physiologically mature (soft dough stage). The stalk was cut as close as possible to the ground using cutlass. The grain was harvested by cutting the panicle just near the top node. The Panicle was sun dried, threshed and winnowed in open air to remove chaff and obtain clean grain. The following parameters were collected: plant height, and shoot dry weight. While the yield parameters are: 1000- grains weight, brix yield, number of grains per panicle and grains yield ha^{-1}. Plant height (cm) was measured from the base of the plant to the top of fully opened leaves of at 3, 6 and 9 (WAS) from five randomly tagged plants using a graduated meter rule and the mean recorded. Shoot dry weight per plant was determined by sampling five plants per plot at 3, 6 WAS, the plants were cut at the base cleaned and oven dried at 70ºC to constant weight. The means of the weight was determined and recorded. A randomly selected 1000 dried grains were counted and recorded. The harvested panicles from each net plot were threshed, winnowed, weighed and expressed in kilogram per hectare by extrapolation. The amount of sugar that is contained in the extracted juice of sweet sorghum stalk was determined using a refractor meter which was taken to the laboratory where the polarity of the sugar was determined using Polari meter and expressed in percentage. General linear model procedure (GLM) of the statistical analysis system (SAS) package was used for statistical analysis of all the data collected and differences between the treatments means was compared using Duncan's Multiple Range test as described by Duncan *et al*. [4].

RESULTS AND DISCUSSION

Table 1 shows the effect of organic nitrogen rate and plant density on sweet sorghum (*Sorghum bicolor* (L.) Moench) in the Nigerian savanna on plant height and shoot dry weights. There was no significant difference in plant height, except at 6 WAS in which 150 kg N ha^{-1} gave the highest plant height, while the lowest plant height was recorded with 0 kg N ha^{-1}. Similar trend was observed with the dry shoot matter. There was no significant difference on plant height due to plant density but shoot dry weight increased significantly throughout the sampling period.

The effect of organic nitrogen on 1000 grains weight (g), brix yield (%) and number of grains per panicle were not significant throughout the trial (Table 2). However, the levels of organic nitrogen application are significantly higher on the yield per hectare as the highest yield was recorded from the plots that had 150 kg N ha^{-1} of organic nitrogen (Table 2). These results were in conformity with the findings of Jibril [6], who reported that the growth and the yield of plants are well stimulated when there are fewer competitions for growth factors during critical stage of development. El-Wafa & Abo El-Hamd [5] also found that increase in poultry manure application significantly increased yield and yield parameters of cereals crops.

CONCLUSION

This study revealed that the application of 150 kg N ha^{-1} of organic nitrogen helps to improve the growth and the yield of sweet sorghum when planted at a plant density of 4 plants per stand which is equivalent to 266,666 plants ha^{-1}. Based on the findings from this research work, we can comfortably recommend that organic nitrogen sourced from poultry manure applied at 150 kg N ha^{-1} and the plants density of 4 plants per stand to give a population of 266, 66 plants ha^{-1} should be used in planting sweet sorghum in the Sudan Northern Guinea savannah agroecological zone of Nigeria.

Table 1: Effect of organic nitrogen, plant density and weed management on plant height and shoot dry weight in sweet sorghum during the wet season of 2021 at Samaru

Treatment	**Plant height (cm)**		**Shoot dry weight (g)**	
	8 WAS	**12 WAS**	**8 WAS**	**12 WAS**
Nitrogen (kg/ha) (N)				
0	85.04b	144.96c	5.62b	17.34 ab
50	84.04b	123.63d	6.59a	19.09a
100	128.67a	183.26a	6.83a	17.64ab
150	128.82a	179.67b	6.87a	18.67b
SE	1.160	0.921	0.260	0.740
Plant density (plants stand^{-1}) D				
2	105.83b	147.31c	6.03b	17.56
3	101.94c	159.25b	6.88a	18.42
4	112.14a	167.08a	6.53ab	18.56
SE±	1.001	0.790	0.231	0.640
Weed Control (kg a.i ha^{-1}), W				
Prextra Gold	116.67a	173.56a	6.65	18.36
Hoe weeding	95.36c	140.33c	6.43	17.72
Weedy check	107.89b	159.75b	6.36	18.47
SE±	0.690	0.980	0.200	0.610
Interactions				
N x W	NS	NS	NS	NS
N x D	NS	NS	NS	NS
W x D	NS	NS	NS	NS
N x W x D	NS	NS	NS	NS

Means followed by the same letter (s) in the same column within the same treatment group are statistically similar at 5% level of probability using DMRT, S-metolachlor (290g/l) + atrazine (370g/l) sourced from Primextra Gold 660 SC, WAS = Weeks after sowing, NS = Not significant at 5% level of probability

Table 2: Effect of organic nitrogen and plant density on 1000 grain weight, grains yield ha^{-1} number of grains ha^{-1} and brix yield of sweet sorghum during the wet season of 2021 at Samaru

Treatment	**2021**			
	1000 – grains weight (g)	**Grain yield (kg ha^{-1})**	**Number of grains/panicles**	**Brix yield (%)**
Organic Nitrogen (kg/ha) (N)				
0	21.56d	745.93d	796c	9.02a
50	42.74c	1106.67c	739c	8.67ab
100	44.63b	1497.91b	1018b	7.79b
150	48.41a	1747.94a	1347a	9.20a
SE±	5.620	54.023	39.33	0.370
Plant density (plants stand^{-1}) D				
2	50.36a	1076.75c	1042a	7.21b
3	47.69b	1587.44b	889b	9.37a
4	46.19b	1666.32a	996a	9.44a

SE±	4.530	43.010	35.29	0.420
Interactions				
N x W	NS	NS	NS	N0S
N x D	NS	NS	NS	NS
W x D	NS	NS	NS	NS
N x W x D	NS	NS	NS	NS

Means followed by the same letter(s) in the same column within the same treatment group are statistically similar at 5% level of probability using DMRT WAP = Weeks after Planting, NS = Not significant at 5% level of level of probability.

REFERENCES

1. ANIKWE, L.S., ATTHOR, F.M. & SAKAV, T. (2000). Effect of different planting pattern, weed control and manure rates on growth, yields and yield components of Maize. *Indian Agronomy Journal*, **42**: 265-268.
2. CLARK, J.W., MILLER, F.R. & CREEIMAN, R. (1980). Utilization of sorghum biomass for energy. *Sorghum Newsletter*, **23**:44-45
3. DOGGET, H. (1988). Sorghum. 1st Edition Longman, Green and co. Ltd London 118 pp.
4. DUNCAN, R.R., BOCHOLT, A.J. & MILLER, F.R. (1984). Descriptive Comparism of Senescent and Non-senescent sorghum genotypes. *Agronomy Journal*, ***73**: 849-853.*
5. EL-WAFA, A.M. & ABO EL-HAMD, A.S. (2001). Evaluation of some sweet sorghum varieties under different plant population in Upper Egypt, Minia. *Journal of Agricultural Research and Development*, **21**(3): 475-492
6. JIBRIL, H.J. (2017). Influence of weed control treatments and plant density on the growth and yield of sweet sorghum *Sorghum bicolor* (L) Moench Sub species *saccharatum* varieties in the Sudan savannah. Unpublished thesis submitted to the Department of Agronomy, Faculty of Agriculture, Ahmadu Bello University, Zaria, Nigeria, 126 pp.
7. POPESCU, A. & CONDEI, R. (2014). Some consideration on the prospects of sorghum crop scientific paper series Management Economic Engineering in Agriculture and Rural Development Vol.14. (3). Present situation. Forest Kyoto. 70: 69-76 CCAB Abstracts production at Soba Research Station, Sudan, *Annual Report Quality*, **28**(2): 623-632.
8. RAJVANSHI, A.K. & NIMBKAR, N. (2001). Sweet sorghum R & Dat the Nimbkar Online, http://www.icrisat.org/media/2004/media13.htm.
9. KAMRUN, N. (2011). Sweet sorghum, an alternative feedstock for bioethanol. *Iranian Journal of Energy and Environment*, **2**(1): 58 -61
10. VETMERRIS, W., RAINBOLT, C., WRIGHT, D. & NEWMAN, Y. (2007). Production of Biofuel crop in Florida: Sweet Sorghum. University of Florida. IFAS Extension. SS AGR 293 http/edis.ifas.ufl.edu/pdffiles/AG/AG29800.pdf.