



EFFECTS OF NUTRIENT SOURCES AND VARIETY ON THE GROWTH AND YIELD OF SORGHUM (*Sorghum bicolor* L. Moench) IN BAUCHI STATE NIGERIA

Shuaibu, Y. M., Nayaya, J. A., Bala, R. A., Sabo M. U., Abdu, A. I. and Abdulkadir S. U.

Department of Crop Production, Faculty of Agriculture and Agricultural Technology
Abubakar Tafawa Balewa University Bauchi.

Corresponding Author's Email: anayaya@atbu.edu.ng, **GSM:** 08069565979

ABSTRACT

The experiment was conducted at Bauchi State College of Agriculture (10°22'N and 9°47'E), in the northern guinea savannah zone of Nigeria, during the rainy season of 2018 to study the effect of nutrient sources and variety on the growth and yield of sorghum. The treatment consisted of four nutrient sources (chicken feather, mineral fertilizer, municipal waste, poultry manure) and control and two varieties of sorghum which are (CSR-01 and SK-5912), these were factorially combined to give 10 treatment combinations and laid out in Randomized Complete Block Design (RCBD) replicated three times. All data collected were subjected to analysis of variance (ANOVA) and Duncan Multiple Range Test (DMRT) was adopted in separating the means. The result of the experiment indicated that no significant ($P \leq 0.05$) difference observed throughout the study period with regards to the varieties used, but there is a significant ($P \leq 0.05$) difference among the nutrient sources used. The result further revealed that application of 30kg/ha NPK was found to be significantly ($P \leq 0.05$) better than other nutrient sources. Based on the finding of this experiment, nutrient source can be used as a means of improving soil condition for sustainable sorghum production.

Keywords: Nutrient, Sources, Variety, Growth, Yield, Sorghum

INTRODUCTION

Sorghum [*Sorghum bicolor* (L.) Moench] belongs to the family *poaceae*, sub-family *panicoideae* and tribe *andropogoneae*. It is the 5th most important cereal crop in the world after rice (*Oryza sativa* L.) wheat (*Triticum aestivum* L.), maize (*Zea mays* L.) and barley (*Hordeum vulgare* L.) (Musa, 2012). It is used for food in Africa and many parts of Asia, cattle feed, bio-energy, thatch making, roofing of houses, brewing beer and for the manufacture of starch (Reda *et al.*, 2005). Cultivated sorghum is believed to have originated near Lake Chad in Africa 3000-5000 years ago and is widely distributed throughout the continent. Even though the migration of sorghum out of Africa is not clear, it is believed that human activity may be responsible for this process; from Africa it was carried to Asia and spread in India, Indonesia, China and Pakistan (Boateng *et al.*, 2006). Grain sorghum entered the US as "Guinea corn" (Eaton and Hilhorst 2003). It is adapted to the hot, semi-arid tropical and dry temperate areas of the world (Blum, 2004). Sorghum is better suited to high temperature and moisture stress conditions bio-chemically and physiologically than rice, wheat and barley. It can give useful yields in areas unfavorable to other cereal crops like rice, wheat and barley (Daniel *et al.*, 2010). Sorghum is adapted to a wide range of environmental and ecological conditions, having the ability to thrive in the hot, semi-arid, tropical and dry temperate areas of the world (Blum, 2004). Sorghum germinates in 3-5 days and emerges above ground in about 5-10 days after sowing under optimal soil moisture and temperatures (Salem, 2006). Sorghum is a determinate, short day plant and it completes vegetative growth in about 30-40 days after sowing. The sorghum seed has 3-6 days to produce a leaf under optimum temperatures. A sorghum plant typically produces about 12-18 leaves arranged in alternate fashion on the culm. The top most leaf also known as flag leaf or boot leaf, is generally short and broad. Most commercial varieties of sorghum cultivated in the world show a unimodal distribution of leaf area, where leaf area increases with leaf number, reaches a maximum and then starts to decline, but tropical varieties under stress exhibit bimodal distribution of leaf area (Musa *et al.*, 2011). Grain development in sorghum is composed of three stages-milk, early (soft) dough, and late (hard) dough. Physiological maturity can be visually identified by the dark brown callus tissue formed at the hilar region. At this stage, seed moisture percentage will be 25-30% and



seed will be fully viable. Sorghum seed, which is caryopsis, varies in shape colour and size depending upon the cultivar. Plant population, tillering, panicle size, number of seeds/unit length of primary branch, seed size and seed weight have major influence on yield formation in sorghum. Cultivated sorghum is a ratoon (perennial) crop by nature though only the seed is capable of surviving freeze conditions.

Global sorghum production is estimated at about 64.6 million tons on a cultivated area of 43.8 million hectares in 2007 (Reda *et al.*, 2005). Now sorghum has reached the second position as feedstock for grain based ethanol after maize (Musa *et al.*, 2011). As the global population and fresh water demand is continuously increasing, dry land farming and sorghum crop are gaining importance. (Bado *et al.*, 2011), while the industrial demand for sorghum in Nigeria alone is estimated at 200,000 metric tonnes (Reda *et al.*, 2005). About 50% of the total area devoted to cereal crops in Nigeria is occupied by sorghum. The area estimated at 6.86 million hectares extends north-ward from latitude 8°N and latitude 14° N (Aba *et al.*, 2004). In 1978, the total sorghum production in Nigeria was estimated at 4.8 million tons (Obilana, 2005). This figure has risen to about 7.0 million tons annually (Obilana, 2005). Consequently, Nigeria became the largest sorghum producer in the West African sub-region accounting for 71% of regional total sorghum output. Globally also, Nigeria leads in sorghum production for human consumption and has risen from its fifth position in 1995 (FAO, 1996) to be third largest sorghum producer in the world after USA and India where more than 90% of their sorghum harvest is used for animal feed (Obilana, 2005). Sorghum is adapted to a wide range of environmental conditions, particularly drought. Hence, it is widely grown in different ecological zones of Nigeria (Showemimo *et al.*, 2000). It has a number of morphological and physiological characteristics that contribute to its adaptation to dry conditions. These include an extensive root system, waxy bloom on the leaves that reduces water loss, ability to stop growth in period of drought and resumes when conditions are favorable and tolerance to water logging (FAO, 1995). The crop also grows on a wide range of soils: sand, loam, sandy-loam, saline and alkaline soils with a p^H range of 4.0-8.5 (Aba *et al.*, 2004).

Consequently, Nigeria became the largest sorghum producer in West African sub-region accounting for 71% of total regional sorghum output. Globally also, Nigeria leads in sorghum production for human consumption and has risen from its fifth position in 1995 (FAO, 1995) to be the third largest producer of sorghum in the world after the United States and India where more than 90% of their sorghum harvest is used for animal feed (Obilana, 2005). This study is therefore carried out to investigate the influence of nutrient sources and variety on the growth and yield of sorghum.

MATERIALS AND METHODS

Experimental Site

A field experiment was conducted at the Bauchi State College of Agriculture School Farm, located at 10°25'N and 9°51'E, during the 2018 rainy season. The research was carried out to study the effect of nutrient sources and variety on growth and yield of sorghum (*Sorghum bicolor* (L) moench) in the northern guinea savanna agro-ecological zone of Nigeria. The climatic condition of the study area (Bauchi) is characterized by two main seasons; the rainy season spanning from April to October and dry season from November to March. The mean annual rainfall was 1000mm with a mean daily maximum temperature of 26°C (Kowal *et al.*, 1972). According to Lombin (1983), the soil of the experimental site is sandy loam with p^H range of 6.30-6.78.

Land Preparation, Soil Sample Collection and Analysis

The land was cleared, ploughed to obtain a fine tilt. The soil sample were randomly taken from three different sampling points at each of the experimental site at the depth of 0 – 30cm using soil auger before and after the trial. The collected soil samples were air dried, ground and passed through 2mm mesh before subjected to laboratory analysis. Physical and chemical properties of the soil samples were determined using standard procedure as described by A.E.S. (1998), at the soil science laboratory of the Abubakar Tafawa Balewa University Bauchi.



Experimental Materials

The materials used for the research consisted of poultry manure, municipal waste, mineral fertilizer (NPK 15:15:15) and chicken feather. The sorghum variety used for the experiment were SK-5912 and CSR-01 obtained from seed multiplication unit, BSADP Bauchi.

Treatments and Experimental Design

The treatments consisted of two varieties of sorghum (SK-5912 and CSR-01) and four nutrient sources (poultry manure, municipal waste, mineral fertilizer, chicken feather) and a control. These were factorially combined to give 10 treatments combination and laid out in a randomized complete block design (RCBD) replicated three times. A plot size of 4 m² was adopted, 0.5m was left as a border row between the plot and 1.0m was left as walk way between replications.

Data Collection and Analysis

Ten sampled plants were selected at random and tagged for data collection from each net plot area at bi-weekly interval. The parameters recorded were plant height, number of leaves, leaf area, panicle length, grain weight and grain yield. All the Data collected were subjected to analysis of variance (ANOVA) to test the treatment effect for significance using SPSS version 23. Means were separated using Duncan Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Plant Height (cm)

Result of the effects of Variety and nutrient sources on plant height of sorghum is presented in Table 1. The result revealed a significant difference among the treatments used throughout the study period. The result further indicated that, the two varieties were statistically similar in terms of plant height throughout the study period. The result also showed that, application of NPK fertilizer proved to be superior in promoting plant height of sorghum followed by poultry products than the other treatments considered. Control plot on the other hand, produced statistically the shortest plants throughout the sampling period. The significant ($P \leq 0.005$) difference observed throughout the study period on plant height of sorghum in which the application of 30kg/ha NPK proved to be better than all the nutrient sources used, indicated that application of NPK fertilizer increased growth of sorghum. The increase in plant height could be as a result of increase in optimal efficiency of fertilizer used. This is in line with the finding of Ebaid and Ghanem (2000) who reported that there is a significant effect of nitrogen on growth of sorghum. Sorghum yield increase with increase in rate of organic and inorganic fertilizer.

Table1: Effect of Nutrient Sources and Variety on Plant Height (cm) of Sorghum

Treatment combination	Weeks After Sowing			
	2	4	6	8
Variety				
CSR-01	57.07	93.86	132.69	174.44
SK-5912	57.47	92.88	130.67	191.80
LS	NS	NS	NS	NS
SE \pm	4.64	1.90	3.28	5.42
Nutrient sources				
Control	33.45 ^c	54.18 ^d	82.82 ^d	123.95 ^c
CF	60.65 ^b	94.80 ^c	132.42 ^c	193.25 ^{ab}
MF	82.27 ^a	115.80 ^a	160.12 ^a	210.57 ^a
MW	61.93 ^b	102.25 ^b	145.00 ^b	201.60 ^{ab}
PM	73.05 ^{ab}	100.13 ^{bc}	138.03 ^{bc}	186.23 ^b
LS	**	**	**	**
SE \pm	5.18	2.13	3.67	6.06
Interaction				
V*N	NS	NS	NS	NS

Means followed by different letters within each column of the treatment are significantly different following Duncan Multiple Range Test (DMRT) ** Significant at 1% level of significance. NS = Not significant

Number of Leaves

Effect of variety and nutrient sources on the leaf number of sorghum is presented in Table 2. The result revealed a significant ($P \leq 0.05$) difference among the various treatments used throughout the study period. The result further indicated, the two varieties were the same in terms of leaf number irrespective of the sampling period. Considering various nutrient sources used, the result indicated that, mineral fertilizer significantly ($P \leq 0.05$) produced higher leaf number than other nutrient used and all nutrient were better than the control throughout the study period. The significant ($P \leq 0.05$) difference observed throughout the study period on number of leaves of sorghum in which the application of 30kg/ha NPK proved to be better than all the rates used, this indicate that increase in rate of NPK fertilizer increased growth of sorghum. This corroborates the finding of Fagam *et al.*, (2009) who reported that differences in NPK use efficiency were related to increase in number of leaves of sorghum.

Table2: Effect of Nutrient Sources and Variety on Number of Leaves of Sorghum

Treatment combination	Weeks After Sowing			
	2	4	6	8
Variety				
CSR-01	5.92	7.35	9.93	11.02
SK-5912	6.12	7.65	10.33	11.10
LS	NS	NS	NS	NS
SE±	0.17	0.20	0.41	0.23
Nutrient sources				
Control	4.33 ^c	5.62 ^c	6.75 ^c	7.88 ^d
CF	5.95 ^b	7.50 ^b	10.05 ^b	10.93 ^c
MF	7.83 ^a	9.65 ^a	12.37 ^a	13.23 ^a
MW	5.93 ^b	7.35 ^b	10.10 ^b	11.03
PM	76.05 ^b	7.88 ^b	11.38 ^{ab}	12.20 ^b
LS	**	**	**	**
SE±	0.19	0.22	3.67	0.26
Interaction				
V*N	NS	NS	NS	NS

Means followed by different letters within each column of the treatment are significantly different following Duncan Multiple Range Test (DMRT) ** Significant at 1% level of significance. NS = Not significant

Leaf Area (cm²)

Effect of variety and nutrient sources on the leaf area (cm) of sorghum is presented in Table 3. The result revealed a significant ($P \leq 0.05$) difference among the various treatments used throughout the study period. The result further indicated that, the two varieties were statistically in terms of leaf area irrespective of the sampling period. Considering various nutrient sources used, the result indicated that, mineral fertilizer significantly ($P \leq 0.05$) produced wider leaves than other nutrient used and all nutrient were better than the control throughout the study period. The higher leaf area as observed through the application of 30kg/ha NPK could be as a result of the increase in plant growth as influenced by fertilizer application. The increase in leaf area as a result of increase in application of fertilizer also indicated the importance of fertilization in cereal production. Sorghum growth with organic and inorganic fertilizers combination tend to promote larger surface area for sunlight and CO₂ absorption. This proved the result of Shauibu *et al.*, (2018) who reported that increase in Nitrogen fertilizer increase growth characters of plant.

Table 3: Effect of Nutrient Sources and Variety on on Leaf Area of Sorghum

Treatment combination	Weeks After Sowing			
	2	4	6	8
Variety				
CSR-01	274.61	302.43	332.24	364.63b
SK-5912	265.5	297.65	337.87	410.16a
LS	NS	NS	NS	*
SE±	9.22	10.11	10.79	10.22
Nutrient sources				
Control	212.68 ^c	241.77 ^c	289.43 ^d	328.24 ^d
CF	262.75 ^b	281.31 ^b	337.98 ^{bc}	394.64 ^{ab}
MF	307.17 ^a	348.91 ^a	386.79 ^{cd}	442.13 ^a
MW	276.22 ^{ab}	30393 ^{bc}	352.31 ^{ab}	362.36 ^a
PM	291.45 ^{ab}	324.30 ^{ab}	352.31 ^{ab}	409.62 ^{ab}
LS	**	**	**	**
SE±	0.19	11.30	12.06	11.42
Interaction				
V*N	NS	NS	NS	NS

Means followed by different letters within each column of the treatment are significantly different following Duncan Multiple Range Test (DMRT) * = Significant at 5% level of significance Level of significance ** Significant at 1% level of significance. NS = Not significant

Panicle Length (cm)

The result on panicle length as presented in Table 4 showed that, all the nutrient sources were found to be significantly ($P \leq 0.05$) better than the control. No significant difference was observed regarding the varieties. The result of the experiment showed that application of 30kg/ha NPK was found to be better than all the other treatments used. This indicated the importance of fertilizer in crop production. The result revealed that increasing fertilizer levels, increases the panicle length which subsequently increases yield of sorghum. The result of this experiment is in agreement with the findings of Ismaeil *et al.* (2012) who reported significant increase in harvest index of sorghum such as panicle length, number of panicle, 1000 grain weight and grain and straw yield of sorghum crop as a result of application of organic fertilizer in conjunction with inorganic fertilizer under hot and humid condition.

1000 Grain Weight (g)

Table 4 presented result of the effect of nutrient sources and variety on 1000 grain weight of sorghum. The result showed that, application of 30kg/ha NPK was observed to produced significantly ($P \leq 0.05$) heavier grains than the other treatments considered. This indicated the effect of fertilizer on 1000 grain weight of sorghum. This may be due to the increase in supply of essential nutrients which are important in the determination of yield components. The result of this study agrees with the findings of Daniel *et al.* (2010) who stated that application of mineral fertilizer alone or in combination with organic fertilizer led to increase in yield and yield attributes compared to control.

Grain Yield (kg/ha)

The result of the effects of variety and nutrient sources on yield of sorghum is presented in Table 4. The result showed a significant ($P \leq 0.05$) difference among the treatments used with application of 30kg/ha NPK given higher yield than the other sources considered. This indicated that, yield increases with increase in fertilizer application. This clearly indicates the importance of fertilizer in the performance of sorghum. Lilemo (2005), further confirms this and reported that fertilizers affect plant growth and yield by improving the physical and chemical properties of the soil which in turn influences growth and yield of sorghum. The higher yield recorded could also be attributed to the other yield components such as better adaptation to environmental condition and nutrient use efficiency. This conforms with the report of López-Masquera *et al.* (2008), who stated that grain yield is a product of yield components, including number of plants per unit area, number of panicle per plant, panicle length and 1000 grain weight.



Table 4: Effect of Nutrient Sources and Variety on Yield Parameters of Sorghum

Treatment combination	PL	1000GW	GYH(kg/ha)
Variety			
CSR-01	27.10	29.68	1540.73
SK-5912	23.30	29.29	1543.83
LS	NS	NS	NS
SE±	1.14	0.74	122.05
Nutrient sources			
Control	16.50 ^b	20.98 ^d	326.38 ^d
CF	27.83 ^a	28.36 ^c	1176.19 ^c
MF	27.83 ^a	37.12 ^a	2732.78 ^a
MW	27.50 ^a	31.20 ^b	1669.89 ^b
PM	26.33 ^a	29.78 ^{bc}	1806.16 ^b
LS	**	**	**
SE±	1.27	0.83	136.45
Interaction			
V*N	NS	NS	NS

Means followed by different letters within each column of the treatment are significantly different following Duncan Multiple Range Test (DMRT) ** Significant at 1% level of significance. NS = Not significant.

CONCLUSION AND RECOMENDATION

Application of nutrient sources improved soil conditions which also reflected on the growth and yield of sorghum (*sorghum bicolor*). However, the application of mineral (NPK) fertilizer at the rate of 30kg/ha produced the best result in both growth and yield characters of sorghum. Application of mineral fertilizer and or poultry products is recommended for sorghum production in the study area.

REFERENCES

- Aba, D. A., idenu, N. U., Marley, P. S. and Maigida, D. N. (2004). **Sorghum production guide**, Idenu N. U. A. and showemimo F. A. (eds) cereal crop of Nigeria: principle of production and utilization. Zaria: Ade commercial press. 38-78p.
- Bado, V., Sawodogo, A., Thio, B., Bationo, A., Traore, K. and Cescas, M. (2011). Nematode Infestation and nitrogen effect of legumes on soil and crop yield in legume-cereal mixed. *Agricultural sciences*, **2**(2): 49-55.
- Blum, A. (2004). Sorghum Physiology. In: Nguyen, H. T. and Blum, A. (ed) Physiology and Biotechnology integration for plant breeding. Marcel Dekker, New York.
- Boateng, S.A., Zichermann, J. and Kornahrens, M. (2006). Poultry manure effect on growth and yield of maize. *West Africa Journal of Applied Ecology*, **9**: 1-11.
- Daniel, M., Monicah, M., Pieter, P., Jayne, M., James, K., Bernard, V. and Roel, M. (2010). *Maize productivity as influenced by organic inputs and mineral fertilizer in a Nitisol soil in Meru South District*. 19th World Congress of Soil Science, Soil Solutions for a Changing World, 1 – 6 August 2010, Brisbane, Australia. Pp 82-85
- Eaton, D., & Hilhorst, T. (2003). Opportunities for managing solid waste flows in the peri-urban interface of Bamako and Ouagadougou. *Environment and Urbanization*, **15**: 53-61.
- Ebaid, R. A. and Ghanem, S. A. (2000). Productivity of Giza 177 wheat Variety grown after different winter crops and fertilized with different nitrogen levels. *Journal of Agricultural Research*, **78**: 717-731.
- Fagam, A. S., Buba, U.M., Yahaya, I.M. and Olakanle, F.I. (2009). Effect of variety and nitrogen Level on growth, yield and yield component of maize (*Zea mays L.*) in Bauchi Nigeria. Proceedings of 23rd annual national conference of farm management association of Nigeria 14-17th December 2009.
- FAO (2005). *Fertilizer Use by Crops in Ghana*. Land and plant nutrition management service: Land and water development division. Food and Agricultural Organisation of the United Nations, Rome. Pp40.



- FAO (2006). *Improving plant nutrient for better farmer livelihood, food security and environmental sustainability*. Proceeding of a Regional Workshop, Beijing, China, 12 – 16 December 2005. Food and Agricultural Organisation of the United Nations, Regional office for Asia and Pacific, Bangkok. Pp125.
- FAO (2011). *Current world fertilizer trends and outlook to 2015*. Food and Agricultural Organisation of the United Nations, Rome. Pp 19.
- FAO. (2004). “Fertilizer Development in support of the Comprehensive Africa Agriculture Development programme (CAADP). “Paper presented at the Twenty third regional Conference for Africa, Johannesburg, South Africa, 1-5 March, 2004.
- Federal Ministry of Agriculture and Rural Development Abuja, Annual Bulletin
- Ismaeil, A. O., Abusuwar, A. and Ahmed, E. (2012). Influence of Chicken Manure on Growth and Yield of Forage Sorghum (*Sorghum bicolor* L. Moench). *International Journal of Agriculture and Forestry* **2**: 56-60.
- Lilemo, M. M., Ginkel, V., Tretowan, R. M., Hernandez, E. and Crossa, J. (2005). Differential Adaptation of bread wheat to global high temperature environments. *Crop Science*. **45**: 2443-2453.
- López- Masquera ME, Cabaleiro F, Sainz MS, López- Fabal A, Carral E (2008). Fertilizing value of broiler litter: Effects of drying and pelletizing. *Bioresource Technol.* **99**: 5626-5633.
- Muchovej, R. M. and Obreza, O. (2001). Utilization of Organic wastes in Florida Agriculture. University of Florida IFAS Extension, SS. AGR-166.
- Musa, E. M., Elsheit, E. F., Mohammed, I. A. and Babiker, E. E. (2011). Intercropping sorghum and cowpea: effect of bradyrhizobium inoculation and fertilization on mineral composition of cowpea seeds. *International Journal of Agricultural Research and Review*, **1**(3): 138 – 146.
- Oagile D and Namasiku M (2010). Chicken manure-enhanced soil fertility and productivity: Effects of application rates. *Journal of Soil Science and Environmental Management*, **1**(3): 46-54.
- Obilana, A. T. (2005). Lagos state polytechnic public lecture series 2: 1-27. Lagos, Nigeria.
- Reda, F., Verkleij, J. A. C. and Ernst, W.H.O. (2005). Intercropping for the improvement of sorghum yield, soil fertility and *Striga* control in the subsistence agriculture region of Tigray (northern Ethiopia). *Journal of Agronomy and Crop Science*, **191**:10–19.
- Salem, A. K. M. (2006). Effect of Nitrogen Level, Plant Spacing and Time of Farmyard Manure Application on the Productivity of Rice. *Journal of Applied Science Research*, **2**(11): 980-987.
- Showemimo, F. A., Echekwu, C. A. and Yeye, M. Y. (2000). Instrument for indirect measurement of canopy architecture. *The Plant Scientist journal*. **1**: 24-31.
- Shuaibu, Y. M., Fagam, A. S. and Kawure, S. (2018). Effects of poultry manure based compost and NPK fertilizer on the growth and yield of sorghum (*Sorghum bicolor* L. moench) in Bauchi state Nigeria. *GSC Biological and pharmaceutical sciences*, **2**(1): 16 – 24. Available at <https://www.gsconlinepress.com/journals/gscbps//node//236>