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INFLUENCE OF NUTRIENT SOURCES AND VARIETY ON GROWTH AND YIELD OF SORGHUM (*Sorghum bicolor* L. Moench)

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ABSTRACT

A experiment was conducted at Federal Polytechnic, Bauchi (10°22'N and 9°47'E), in the northern guinea savannah zone of Nigeria, during the rainy season of 2018 to study the influence of nutrient sources and variety on the growth and yield of sorghum. The treatment

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

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 laid out in Randomized Complete Block Design (RCBD) and 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≤0.05) difference observed throughout the study period with regards to the varieties used, but there is a significant (P≤0.05) difference among the nutrient sources. The result further revealed that application of 30kg/ha NPK was found to be significantly (P≤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: *Influence, variety, nutrient, growth, yield.*

is widely distributed throughout the continent (Staggenborg and Vanderlip, 1996). 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 (de Wet and Price, 1996). Grain sorghum entered the US as "Guinea corn" (Bennet *et al*., 1990).

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 unfavourable to other cereal crops like rice, wheat and barley (Dowens,1992).

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).

Global sorghum production is estimated at about 64.6 million tons on a cultivated area of 43.8 million hectares in 2017 (FAO,2018). 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).

In terms of production, Bauchi State is among the leading states following Kaduna and Borno states with a total production of 453,000 metric tonnes in 2015 (FMOA & RD, 2017).

Statement of the Problem

In West African savannah, the intensification of agricultural system has resulted in declining nutrient availability, soil acidification and build-up of pests and diseases leading to decline in crop yield. Declining soil fertility due to nutrient mining, erosion and desertification are the major threat to food production in Nigeria. The problem of soil fertility in the Northern States of Nigeria like most of sub-Saharan African countries is driven by a wide range of factors. The rapid increase in population growth impose more pressure on the land leading to cutting down of trees for shelter, fuel and farmland. This exposes the soil to adverse climatic factors and increases the rate of nutrient depletion with little or no commensurate increase in the amount of fertilizing elements in form of organic or inorganic fertilizers being added to the soil. Under continuous crop cultivation common in the savannah zone, the drain in soil nutrients is very high and the occurrence of nutrient deficiency becomes widespread. The high cost of inorganic fertilizers coupled with its poor distribution system and

the low incomes of our peasant farmers who constitute about 75% of the population has made its widespread use difficult.

Despite lack of staple food supply and the importance of cereal crops notably sorghum as a source of carbohydrate, farmers in this region do not use enough nutrient in sorghum production. Savannah soils on the other hand are low in fertility and therefore cannot satisfactorily support crops like sorghum without addition of fertilizers. Organic fertilizers are simple to apply and available locally while inorganic fertilizers are generally costly and not readily available to small scale farmers. This necessitates the use various sources of fertilization as a means of soil fertility restoration in order to determine the best combination that gives optimum growth and yield of sorghum in the study area.

Objectives of the Study

The objectives of the study are:

1. To study the best among the different nutrient sources on the growth and yield of sorghum.
2. To determine the interaction of nutrient source on variety on the growth and yield of sorghum.
3. To investigate the effect of variety on the growth and yield of sorghum in the study area.

MATERIALS AND METHODS

Experimental Site

The experiment was conducted at the Federal Polytechnic, Bauchi Demonstration 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

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(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 and Knabe, 1972). According to Lombin (1983), the soil of the experimental site is sandy loam with p^H range of 6.30-6.78.

Experimental Materials and their Sources.

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

Experiments and Experimental Design

The treatments consisted of two variety of sorghum (SK-5912 and CSR-01) and four nutrient sources (poultry manure, municipal waste, mineral fertilizer, chicken feather) and 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 m^2 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

Data was collected from ten randomly tagged plants from the net plot at bi-weekly interval on the following parameter: Plant height (cm), Number of leaves, Leaf area(cm^2), Panicle length(cm), 1000 grain weight(g) and grain yield (kg/ha)

Data Analysis

All data collected during the experiment were subjected to Analysis of Variance (ANOVA) to determine the significant difference between treatments and the mean performance of each treatment. However, the treatment means were separated using Duncan Multiple Range Test (DMRT) as described by Duncan, (1955).

RESULT AND DISCUSSION

Effect of nutrient sources and variety on Plant height (cm)

Effect of nutrient sources and variety on the plant height of sorghum is presented in table1. The result revealed a significant (P≤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 plant height irrespective of the sampling period. Considering various nutrient sources used, the result indicated that, mineral fertilizer significantly (P≤0.05) produced taller plant than other nutrient used and all nutrient were better than the control throughout the study period.

The increase in plant height could be as a result of increase in optimal efficiency of fertilizer used. This is in line with the findings of Elthir (2008) 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	WAS 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

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SE±	4.64	1.90	3.28	5.42
Nutrient sources				
Control	33.45^{a}	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±	5.18	2.13	3.67	6.06
Interaction				
V*N	NS	NS	NS	NS

LS = Level of significance, NS = Not significant, ** = significant at 0.01
SE± standard error
Means followed by the same letter within the same are not statistically different following DMRT.

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≤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≤0.05) produced higher leaf number than other nutrient used and all nutrient were better than the control throughout the study period.

This corroborates the finding of Daniel *et al*. (2005) who reported that differences in NPK use efficiency were related to increase in number of leaves of sorghum.

Table 2: Effect of nutrient sources and variety on number of leaves of sorghum

Treatment combination	WAS 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	7.65^{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

LS = Level of significance, NS = Not significant, and ** = significant at 0.01 SE± standard error

Means followed by the same letter within the same are not statistically different following DMR

Leaf Area (cm²)

Effect of transplanting age and nutrient sources on the leaf area (cm) of sorghum is presented in table 3. The result revealed a significant (P≤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.

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Considering various nutrient sources used, the result indicated that, mineral fertilizer significantly (P≤0.05) produced higher leaf area than other nutrient used and all nutrient were better than the control throughout the study period

The increase in leaf area as a result of increase in application of fertilizer also indicated the importance of fertilizer in cereal production. Sorghum growth with organic and inorganic fertilizers combination tend to promote larger surface area for sunlight and CO^2 absorption. This proved the result of Fagam et al., (2009) who reported that increase in Nitrogen fertilizer increase growth characters of plant.

Table 3: Effect of nutrient sources and variety on leaf area of sorghum

Treatment combination	WAS 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}

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LS	**	**	**	**
SE±	0.19	11.30	12.06	11.42
Interaction				
V*N	NS	NS	NS	NS

LS = Level of significance, NS = Not significant, * and ** = significant at 0.01 and 0.05

Panicle length (cm)

The result on panicle length (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 observe regarding the varieties. The result of this experiment is in agreement with the findings of Bassai and Zahran, (2002) 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.

Panicle weight (g)

The result revealed that, application of was found to produce significant ($p \leq 0.05$) heavier panicles than the other treatments and all the treatments were better than the control. No significant difference was observed on variety all through.

This may be due to the increase in the supply essential nutrients which are important in the determination of yield components. The result agrees with the findings of Daniel et al., (2010) who stated application of mineral fertilizer alone or in combination with organic fertilizer led to increased yield and yield attributes compared to control.

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Number of grain per panicle

The result indicated that, mineral fertilizer application was found to produce significantly ($p \leq 0.05$) higher number of grains per panicle, where no significance difference was recorded in case of variety.

This clearly indicates the importance of fertilizer in the performance of sorghum. Sanchez (1979), further confirms this when he 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 the yield recorded could also be attributed to the other yield components. This conforms with the report of Nagy, (1997), who stated that grain yield is a product of the 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	PW	NGP
Variety			
CSR-01	27.10	44.96	2368.23
SK-5912	23.30	47.36	2365.63
LS	NS	NS	NS
SE±	1.14	0.99	84.47
Nutrient sources			
Control	16.50^{b}	31.07^{c}	1889.00^{c}
CF	27.83^{a}	46.97^{b}	2213.33^{b}
MF	27.83^{a}	58.00^{a}	2893.67^{a}
MW	27.50^{a}	47.83^{b}	2347.83^{b}
PM	26.33a	46.95^{b}	2490.83^{b}
LS	**	**	**

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SE±	1.27		
Interaction			
V*N	NS	NS	NS

LS = Level of significance, NS = Not significant, and ** = significant at 0.05 SE± standard error
Means followed by the same letter within the same are not statistically different following DMRT

Number of Prop root at harvest

Table 5 present the effect of nutrient source and variety on number of prop root at harvest. The result showed that no significant difference on variety of sorghum, with respect to nutrient sources, the result showed that 30kg/ha NPK was observed to gave the highest number of prop roots than the other nutrient sources collectively.

1000 Grain Weight (g)

Table 5 showed the effect of nutrient sources and variety on 1000 seed weight of sorghum. The result indicated that application of 30kg/ha NPK was observed to had a significantly ($p \leq 0.05$) highest grain weight than the other treatments used.

Grain Yield per Hectare (kg/ha)

The result showed that, the application of 30kg/ha NPK was found to be significantly ($p \leq 0.05$) better than all the nutrient source used. No significant different was observed with regards to variety.

Table 5: Effect of nutrient sources and variety on Yield Parameters of sorghum

Treatment combination	NPRH	GW1000	GYH(kg/ha)
Variety			
CSR-01	7.17	29.68	1540.73
SK-5912	7.17	29.29	1543.83
LS	NS	NS	NS
SE±	0.24	0.74	122.05
Nutrient sources			
Control	0.83^{d}	20.98^{d}	326.38^{d}
CF	4.67^{c}	28.36^{c}	1176.19^{c}
MF	12.50^{a}	37.12^{a}	2732.78^{a}
MW	8.83^{c}	31.20^{b}	1669.89^{b}
PM	9.00^{b}	29.78^{bc}	1806.16^{b}
LS	**	**	**
SE±	0.27	0.83	136.45
Interaction			
V*N	NS	NS	NS

LS = Level of significance, NS = Not significant, and ** = significant at 0.05 SE± standard error

Means followed by the same letter within the same are not statistically different following DMRT.

SUMMARY, CONCLUSION AND RECOMMENDATIONS

Summary

A field experiment was conducted at the Federal Polytechnic Bauchi Demonstration Farm, located at 10°25'N and 9°51'E, during the 2018 rainy season, to study the effect of nutrient sources and variety on growth and yield of sorghum (sorghum bicolor (L) moench). The

treatments consisted of four nutrient sources (chicken feather 2tons/ha, mineral fertilizer, municipal waste, poultry manure and control), and two sorghum varieties (SK-5912 and CSR-01). These were factorially combined to give 10 treatments, and laid out in a randomized complete block design (RCBD) replicated three times. All Data collected were subjected to analysis of variance (ANOVA) and Ducan's Multiple Range Test (DMRT) was used to separate the means. The result of the experiment indicated that growing sorghum using fertilizer had a significant ($p \leq 0.05$) effect on all the characters measured. 30kg/ha NPK significantly ($p \leq 0.05$) gave higher result in all the characters observed. The result further revealed that, no interaction was observed between the two varieties of sorghum used and nutrient sources.

Conclusion

In general application of nutrient sources improved soil conditions which have been reflected in growth and yield increase of sorghum (sorghum bicolor). Irrespective of the varieties used. However, the application of 60kg/ha NPK produces the best result in both growth and yield characters of sorghum.

Recommendation

Based on the result of this study, the following recommendations were made;

1. Growing sorghum with the application of 60kg/ha NPK should be adopted by farmers in the study area.
2. Where mineral fertilizer is in short supply, alternative nutrient source can be utilized and will adequately improve the soil condition.

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3. Further research on this study is also recommended since only 2 varieties were used in the research. This is with a view to finding the variety that best suit specific nutrient source.

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