



## Performance of Sorghum (*Sorghum bicolor* (L.) Moench) as Affected by Organic and Inorganic Sources of Fertilizer in Kaura-Namoda Zamfara State, Nigeria

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### ABSTRACT

The field experiment was conducted at the Federal Polytechnic Kaura-Namoda Teaching and Research farm during the rainy season of 2019 Zamfara state belongs to savannah agro-ecological zone and geographically located between latitude 12°35' N and 6°35' E and 391 meters above the sea level. The experiment was conducted to determine the effect of organic and inorganic fertilizer on the growth and yield of sorghum. The design used for the experiment was randomized complete block design (RCBD) and replicated three times. The treatment consisted of four levels of cow manure (0, 1 and 2 ton/ha) and four levels of NPK 15:15:15 (0, 15, 30 and 45 kg/ha), these were factorially combined to give 12 treatment combinations. The result of the experiment indicated that, there is a significant ( $P < 0.05$ ) difference among the treatment used. It was further revealed that, application of NPK fertilizer at the rate of 45 kg/ha and 2 ton/ha cow manure was found to be significantly ( $P < 0.05$ ) better than the three levels of (NPK 15:15:15) (0, 15, 30 and 45 kg/ha) and all the treatment were better than control. It was observed that the combination of 45 kg NPK/ha and 2 ton cow manure/ha was found to be significantly better than other treatment. Based on the finding of this study, it was recommended that Stakeholders in crop production should advice the sorghum farmers that use of 45 kg/ha NPK with 2 ton/ha cow dungs can give optimally the plant height, number of leaves, leaf area, Panicle length, Number of spikes per panicle, and Grain Yield of sorghum in the study area.

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### INTRODUCTION

The major constrain to productivity of crops in the semi-arid region is inadequate, unreliable and poorly distributed rainfall and low soil fertility especially (N and P). The limited use of minerals and organic fertilizers on crop is due to limited resources by the farmers and the risk associated with in the environment of low and uncertain rainfall. The importance of integrated use of organic and inorganic nutrient sources in the semi -arid tropics have been reported (Aduayi and Okra, 2012). Organic sources such animal manure is an effective source of major nutrients (N, P, and K) when applied at optimum rates and can influence the temporal dynamics of nutrients availability (Ano and Agwu, 2016.), increase water

use efficiency of crops (Carter *et al.*, 2018), decrease phosphorous fixation and enhance its availability in the soils through its effects on physical and chemical properties of the soil (Lyamuremye and Dick, 1996). Despite all these, a complementary application of mineral fertilizer is usually required for a good nutrient balance.

Intensive farming with fertilizer responsive crop rely on high application of inorganic fertilizer, this is very expensive and pose a serious threat to soil health and ground water. Entire dependence on organic sources of nutrient may not be adequate for good productivity. Soil fertility decline is caused by the interaction of natural and managerial factors, usually through leaching, soil erosion and crop removal. The



steady decline in food production observed over the years has been attributed to the decline in some factors such as soil fertility (Denova and Casey, 2017). Unless the nutrients are replenished through the use of organic or mineral fertilizers or through traditional fallow system that allows restoration of nutrient and reconstitution of soil organic matter, the food security in the semi-arid region will not be achieved. Majority of the farmers in the study area are subsistence and cannot afford the required amount of inorganic fertilizer, due to cost associated with transporting huge amount of organic fertilizer and lack of information on the inappropriate combining ratio of organic and inorganic fertilizer in sorghum production. This lead to significant low yield in sorghum production due to poor soil fertility which is the limiting factor for optimum yield of sorghum. Soil degradation which is brought about by loss of organic matter as a result of continuous cropping become aggravated when inorganic fertilizers are solely applied repeatedly (FAO 2011).

Sorghum is an important crop worldwide used for food (as grain and in sorghum syrup), fodder, alcoholic beverages and bio-fuels. Sorghum is adapted to a wide range of environmental condition but is particularly adapted to drought. Most research work show that the use of several organic materials especially Cow dung, poultry manure and farmyard manure as soil amendment for increasing crop production particularly among subsistence farmers with inorganic fertilizer. However the benefit derivable from the use of organic materials has not been utilized fully in the northern guinea savannah mainly due to large amount of organic materials required in order to satisfy the nutritional need of the crops (Lopez, *et al.*, 2008).

The aims of this study was to determine the response of sorghum to combined organic and inorganic fertilizer base on some growth performance indicators. Specifically to test the effects of cow dung and NPK (15: 15: 15) on the growth parameters of sorghum at the end of ten weeks after planting.

## MATERIAL AND METHODS

Material and methods Inadequate material and methods: enrich with plants stand population from each block, plant spacing, amount of rainfall per annum in the study year (2019), nature of cultural practices offered, interval of data collection method like, number of research assistants employed for all farming activates as well as different parameters measured as performance indicators used in this research process are: plant height, number of leaves, leaf area, Panicle length, Number of spikes per panicle, and Grain Yield of sorghum

The experiment was conducted during the rainy season of 2019 at Federal Polytechnic Kauran Namoda and research farm Zamfara, to determine the response of sorghum to organic and inorganic fertilizer. The treatment consisted of four levels of cow manure (0, 1 and 2 ton/ha) and four levels of NPK 15:15:15 (0, 15, 30 and 45 kg/ha), these were factorially combined to give 12 treatment combinations. The design used for the experiment was randomized complete block design (RCBD) and replicated three times. The data collected for the experiment were on the following parameter plant height, number of leaves, leaf area, panicle length, number of spike per panicle, grain weight (1000 seed) and grain yield. The middle six plants of each plot were selected for data collection and analysis, thirteen Weeks after Planting (13 WAP).

Analysis of variance (ANOVA) was used in data analysis to compare the variability in the selected parameters while Duncan's multiple range test (DMRT) was used to separate the means.

## RESULT AND DISCUSSION

### ***Effect of Organic and Inorganic Fertilizer on Performance Characters of Sorghum***

*Effects of NPK fertilizer and cow dung on plant height of sorghum*

**Table 1** Effect of organic and inorganic fertilizer on plant height of sorghum

Treatments	WAS				
	2	4	6	8	10
NPK (kg/ha)					
0	10.94d	33.01d	59.48d	85.01d	136.92d
15	12.72c	41.92c	79.56c	143.13c	189.69c
30	13.17b	47.30b	83.90b	140.13b	215.57b

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45	14.23a	53.12a	96.13a	181.35a	280.83a
LS	**	**	**	**	**
SE±	0.14	1.30	1.12	0.78	8.32
Cow Dung (ton/ha)					
0	12.29c	40.04c	73.76c	137.84	203.18
1	12.80b	44.02b	80.84b	136.09	207.96
2	13.22a	47.44a	84.69a	138.27	206.12
LS	**	**	**	NS	NS
SE±	0.12	1.12	0.97	0.68	7.2
Interaction					
CD X NPK	**	**	**	**	**

Means followed by the same letter in a column are not significantly different following DMRT. SE= standard error, \*\* = (P<0.01), LS= level of significance, WAS = Weeks after sowing, NS = Not significant.

Table 1, showed the effect of organic and inorganic fertilizer on plant height of sorghum. The result revealed that, 45 kg/ha NPK and 2 ton/ha cow dung was significantly (P<0.05) observed to be better in terms of plant height throughout the study period. The result further revealed a significant (P<0.05) difference between levels of organic and inorganic fertilizers, however all the treatments were found to be better than the control. The significant (P<0.05) difference observed throughout the study period on plant height of sorghum in which the rate of 45 kg/ha NPK proved to be better than all the rates used, indicated that, increased in rate of NPK fertilizer increased growth of sorghum. It further indicated that, the application of 2 ton/ha cow dung was found to be better than other rate. The increase in plant height could be as a result of increase in optimal efficiency of fertilizer used. This is in line with the result of Aduayi and Okra, (2012), who reported that application of cow manure alone or in combination with nitrogen significantly increased the plant height of sorghum. The result also lend its support to the findings of Elghball (2012), who reported that there is a significant effect of nitrogen on growth of sorghum. The interaction of cow dung and NPK showed that 45 kg/ha NPK combined with 2 ton/ha cow dung significantly produced tallest plants than the other treatments used. This conform with the report of Feisal *et al.*, (2012) who reported that, the quantity of soil organic matter in the soil has been found to depend on the quantity of organic material which can be introduce in to the soil either by natural return through roots, stubble, root nodules and roots exudate or by artificial application in form of organic manure.

#### *Effects of NPK fertilizer and cow dung on number of leaves of sorghum*

The result in table 2 showed the effect of organic and inorganic fertilizer on number of leaves of sorghum, the result revealed a significant (P<0.05) difference among the treatments used on number of leaves of sorghum. The result further revealed that, application of 45 kg NPK/ha was found to be statistically (P<0.05) better than the other rates and all the rates were better than the control. Cow dung on the other hand, application of 2 ton/ha proved to be significantly (P<0.05) better than the other rates used and all the rates were better than the control. The result of the interaction showed that application of 45 kg NPK/ha combined with 2 tons cowdung/ha significantly (P<0.05) produced highest number of leaves of sorghum throughout the study period.

The significant (P ≤0.05) difference observed throughout the study period on number of leaves of sorghum in which the rate of 45 kg/ha NPK proved to be better than all the rates used, this indicate that increased in rate of NPK fertilizer increased growth of sorghum. It further indicated that the application of 2 ton/ha cow dung was found be superior to other rate. This collaborate with the finding of Conley *et al.*, (2005) who reported that difference in NPK use efficiency were related to increase in number of leaves of sorghum. The importance of organic matter was reported by many scientists. Beckwith (2002), indicated that the soil organic matter play an essential role in maintaining the stability of soil aggregates. Bendfeldt (2002), stated that the main constituent of soil organic matter are humus substance, which together with polysaccharides, are active ingredient for aggregation. The interaction of cow dung and NPK in which 45 k/ha

NPK plus 2 ton/ha cowdung significantly produced highest number of leaf than other treatment used.

**Table 2** Effect of organic and inorganic fertilizer on number of leaves of sorghum

Treatments	WAS				
	2	4	6	8	10
NPK (kg/ha)					
0	4.78d	7.33c	8.88d	8.88d	11.78d
15	5.67c	8.22b	9.89c	10.78c	12.67c
30	6.22b	8.56b	10.56b	11.57b	13.56b
45	7.00a	10.22a	12.22a	13.33a	15.89a
LS	**	**	**	**	**
SE±	0.12	0.24	0.17	0.54	0.11
Cow Dung (ton/ha)					
0	5.58b	8.08b	10.00b	10.35c	13.33
1	6.22a	8.50b	10.50a	11.57b	13.32
2	6.08a	9.17a	10.67a	13.33a	13.67
LS	**	**	*	**	NS
SE±	0.11	0.21	0.15	0.13	0.09
Interaction					
CD X NPK	NS	*	**	**	**

Means followed by the same letter within the same column are not significantly different following DMRT. SE= standard error, \* = ( $P \leq 0.05$ ) and \*\* = ( $P \leq 0.01$ ), LS= level of significance, WAS = Weeks after sowing, NS = Not significant.

*Effects of NPK fertilizer and cow dung on leaf area of sorghum*

The result as presented in table 3 revealed the effect of organic and inorganic fertilizer on leaf area of sorghum. The result showed that, application of 45 kg NPK/ha significantly ( $P \leq 0.05$ ) produced highest leaf area throughout the study period. Similarly, the application of 2ton cow dung/ha significantly ( $P \leq 0.05$ ) produced higher leaf area than the other rates and all the rates were better than the control. The result of the interaction revealed that, combination of 45 kg NPK /ha and 2 tons cow dung/ha was found to be significantly ( $P \leq 0.05$ ) better than other treatments used. The significant ( $P \leq 0.05$ ) difference observed throughout the

study period on leaf area of sorghum in which the rate of 45 kg/ha NPK proved to be better than all the rates used, indicated the importance of inorganic fertilizer in promoting leaf area of sorghum. This further proved that increased in rate of NPK fertilizer increased growth of sorghum. It further indicated that the, application of 2 ton/ha cow dung was found be superior to other rate. This revealed the importance of combine application of organic and inorganic fertilizer. The increase in leaves area as observed in this study could be as a result of increase in application of organic and inorganic fertilizer. This agreed with the findings of Afiakpul *et al.*, (2005), who reported that manure alone or mixed with N.P.K result in an increase in growth and yield of sorghum.

**Table 3** Effect of organic and inorganic fertilizer on leaf area of sorghum

Treatments	WAS		
	4	6	8
NPK (kg/ha)			
0	54.47d	179.14b	218.23d
15	81.42c	285.83a	297.53c
30	100.91b	285.51a	340.22b
45	120.80a	248.16a	415.12a
LS	**	**	**

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SE±	3.15	19.55	5.10	
0	85.02c	220.64	286.99b	
1	187.34b	258.30	329.04a	
2	195.85a	267.65	337.34a	
LS	*	NS	**	
SE±	2.73	16.85	4.42	
CD X NPK	NS	NS	**	

Means followed by the same letter within a column are not significantly different following DMRT. SE= standard error,\* = (P≤0.05) and \*\* = (P≤0.01), LS= level of significance, WAS = Weeks after sowing, NS = Not significant.

### Effect of Organic and Inorganic Fertilizer on Yield and Yield Components of Sorghum

#### Panicle length (cm)

Table 4 showed the effect of organic and inorganic fertilizer on panicle length of sorghum. The result revealed that the application of 45 kg/ha NPK and 2ton/ha was observed to produce significantly (P≤0.05) longer head than the other treatment used. With control having the shortest head among the treatments used. This indicates the importance of NPK fertilizer as a basic component of plant physiological activities. The interaction of cowdung and NPK fertilizer indicated that, combine application of 45 kg NPK/ha and 2tons cowdung/ha gave significantly (P≤0.05) highest panicle length. This revealed the importance of combine application of organic and inorganic fertilizer in sorghum production. This corroborate with the findings of Gambara *et al.*, (2002) who reported that cow mature gave taller plant height, number of leave per plant and increasing the yield and yield component of sorghum.

#### Number of spikes per panicle

The result as presented in table 4 showed the effect of organic and inorganic fertilizer on number of spike per panicle of sorghum. The result revealed that, application of 45 kg NPK/ha and 2 ton/ha cowdung significantly (P ≤0.05) had a highest number of spikes per panicle than other treatment and all the treatments were better than the control. The significant (P≤0.05) difference observed in this experiment indicated the significance of inorganic fertilizer on number of spikes of sorghum. This further revealed the effects of combine application of NPK and cowdung on yield of sorghum. The result of this study is in line with the report of Conley SP *et al.*, (2005), who found that the grain sorghum yield responds to organic and inorganic fertilizer combination. It is also in conformity with the report

Mullins and Benefeldt (2002) who reported that little organic manure combined with inorganic fertilizer contain considerable amount of organic matter, hence has an effect in soil pH.

#### Grain weight (1000 seeds)

Table 4 showed the effect of organic and inorganic fertilizer on grain weight (1000 seeds) of sorghum. The result showed that application of 45 kg NPK and 2 ton/ha cowdung was observed to had a significantly (P≤0.05) highest 1000 grain weight than other treatments. The result of this study revealed that, application of inorganic and organic fertilizer has an effect on 1000-grain weight of sorghum. This supported the finding of Mafongoya *et al.*, (2006), who observed a significant increase in 1000-grain weight due to the addition of 45 kg/ha NPK. It is also in agreement with that of Chaudhary *et al.*, (2003), who found significant increase in grain-weight with increase in inorganic fertilizer rates.

#### Grain Yield (ton/ha)

The result in table 4 showed the effect of organic and inorganic fertilizer on grain yield of sorghum. The result revealed that application of 45 kg NPK was found to produced significantly (P≤0.05) higher yield than other treatments used. Control on the other hand having the lowest yield among the treatment considered. It further revealed that application of 2 ton/ha cowdung was observed to significantly (P≤0.05) produced higher yield than the other rates. The yield of sorghum increase with the increase in level of fertilizer application. This revealed the importance of organic and inorganic fertilizer application in sorghum production. This indicates the effect of nitrogen as a basic compound of much physiological process in plants. This supported the finding of Ibrahim *et al.*, (2012) who reported that higher application of manure will positively affect soil fertility in sorghum production, reported that



application of FYM and urea to the soil significantly increased total nitrogen content of the top 30 cm of the soil. This indicated that, combine application of organic and inorganic fertilizer is a best way of reducing negative effect of solely use of inorganic fertilizer as sources of nutrients to crop production. The higher grain yield obtained could be due to balance in the proportion of nutrients in adequate amount. It can also be due to improvement in soil fertility, temperature and the amount of spread rainfall received during the

study. This is in conformity with the report of Conley *et al.*, (2005) who indicated that the grain sorghum responded to organic and inorganic fertilizer by increase in yield. High nitrogen increases sorghum yield as reported by (Conley *et al.*, 2005; Lafarge *et al.*, 2002). The result of this study also lend its support from the report of Ogbonna (2007), reported that the difference in NPK use efficiency were related to grain yield of sorghum to applied NPK.

**Table 4** Effect of organic and inorganic fertilizer on yield components of sorghum

Treatments	Parameters			
	No: of spike/ panicle	Panicle length (cm)	Grain weight (g)	Yield (ton/ha)
<b>NPK (kg/ha)</b>				
0	104.58b	34.15c	24.33c	1.38c
15	120.01a	39.58b	29.78ab	2.17b
30	117.45a	39.80b	29.57b	2.17b
45	122.78a	42.92a	32.11a	3.36a
LS	**	**	**	**
SE±	2.69	0.85	0.82	0.13
<b>Cow dung (ton/ha)</b>				
0	114.43	37.60b	27.50c	2.21
1	117.18	39.78a	30.00a	3.30
2	117.01	40.37a	29.33b	2.30
LS	NS	*	*	NS
SE±	2.33	0.84	0.71	0.11
<b>Interaction</b>				
CD X NPK	*	*	*	**

Means followed by the same letter within the same column are not significantly different following DMRT. SE= standard error, \* = (P≤0.05) and \*\* = (P≤0.01), LS= level of significance, WAP = Weeks after planting, NS = Not significant

**Table 5** Interaction of NPK fertilizer and cow manure on grain yield and 1000 seed weight of sorghum

Treatments	Cowdung (ton/ha)					
	0	1	2	0	1	2
	Grain Yield (ton/ha)			Grain weight (1000 seeds)		
NPK (kg/ha)						
0	0.70f	1.69e	1.73e	20.33g	25.00f	27.67e
15	3.06b	1.74e	1.71e	31.33b	28.67d	29.33c
30	2.39d	2.41d	1.72e	28.67d	32.33b	27.67e
45	2.68c	3.36b	4.04a	29.67c	34.00a	32.67a
LS		*			**	
SE±		0.24			0.89	

Means followed by the same letter within the same column are not significantly different following DMRT. SE= standard error, \* = (P≤0.05) and \*\* = (P≤0.01), LS= level of significance, WAP = Weeks after planting, NS = Not significant.

## CONCLUSION

In conclusion, the application of 45 kg/ha NPK and 2 ton cow dung/ha produced the

best result of performance characters in sorghum production in the study area. Based on the



findings of this study, the following recommendations were made:

Stakeholders in crop production should advise the sorghum farmers that use of 45 kg/ha NPK with 2 ton/ha cow dugs can give optimally the plant height, number of leaves, leaf area, Panicle length, Number of spikes per panicle, and Grain Yield of sorghum in the study area.

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