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EFFECT OF SPACING AND NUTRIENT SOURCES ON THE GROWTH AND YIELD OF MILLET (Panicum milliaceum) IN BIDIR, KATAGUM LGA, BAUCHI STATE, NIGERIA

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Abstract

The field experiment was conducted to study the effect of spacing and nutrient sources on the growth and yield of millet in Bidir village, Katagum local government area of Bauchi state during the rainy season of 2023. The Bidir village is located at 110 50'08" N 100 10'02" E. The treatments consisted of three spacing (50x75, 75x75 and 100x75cm), three nutrient sources (NPK, Poultry manure and Cow dung) and a control. These were factorially combined to give twelve treatments and laid out in a randomized complete block design (RCBD) with three replications. The result of the experiment indicated that, there was a significant (P<0.05) difference among the treatments used throughout the study period. The result further revealed that, growing millet at wider spacing (75x75 and 100x75) with the application of poultry manure and NPK was found to be significantly (P<0.05) better than the other treatments and all the treatments were better than control in all the parameters observed. Based on the finding of this study, planting millet at a spacing of 75x75 cm with application of poultry manure stimulates the growth and yield of millet. Growing millet at a spacing of 75 x 75 cm intra and inter row spacing with application of poultry manure at a rate of 5 t/ha is recommended for farmers in the study area for sustainable millet production.

Keywords: *cowdung, millet, nutrients, poultry manure, spacing*

INTRODUCTION

Millet (*panicum milliaceum)* originated from the highlands of Ethiopia and is presently grown in eastern and southern Africa (Mengistu and Yamoah, 2012). It is an important crop in eastern and southern Africa where small-scale farmers grow it in low input farming systems (Alkass *et al*., 2010). The crop has food security, nutritional, cultural, medicinal, and economic value with high industrial potential (Basavaraj *at al*., 2011). It was found to adapt better on poor soils, erratic rain and droughts than main food grains like maize and wheat (Chakraborty and Newton, 2011). While its production has been declining, there is still a significant demand for the crop and millet price has been much higher than other cereals in the past few years (Firoz *et al*., 2010). Interestingly, new food products made from millet are also becoming popular among

younger people, including noodles, pasta, vermicelli, snacks, and different bakery products (Titonell *et al*., 2003). The crop is of higher nutritional value especially to pregnant women and weaning children and its seeds can be stored for more than five years due to low vulnerability to insect damage. It provides food security for poor farmers (Rincon *et al*., 2008).

The crop is cultivated by peasant farmers in most part of Africa including Nigeria and average yield of the crop remains as low as 1 t/ha which is far below its potential compared to the yield of 5-6 t/ha obtained in other parts of the world like Kenya and India (Poar Marvi,2009). These low yields are largely explained in terms of droughts and depleted nutrients in soils such as phosphorus, among other reasons. Significant increase in soil nitrogen, phosphorus, potassium and pH has been reported in combined application of the inorganic fertilizers, farm yard manure (FYM) and lime over control (Donald, 2013). Furthermore, the rate of application of NPK fertilizer on millet has not been clearly established. Phosphorus (P) is among the major essential nutrients required by the plants for their normal growth, development and yield (Doumbia *et al*., 2008). Increased Nitrogen phosphate (NP2O5) application rate has been found to hasten the number of days to 50% flowering and number of days to physiological maturity respectively, increased plant height and number of fingers (Doumbia *et al*., 2008). Despite such positive results; it is yet to be established whether application of an NPK fertilizer will give similar results when used under millet in acidic soils. Nutrients deficiency symptoms in plants include severe stunting, thin stems, erect and dark green leaves. Its deficiency reduces seedling height, tiller number, stem diameter, leaf size, and leaf duration (Moral *et al*., 2012). Application of NPK + FYM increased millet yield compared to NPK alone. It also increased the number of tillers, ear length, ear weight, grain weight, threshing percent, and number of fingers per ear head (Titonell *et al*., 2003). The study is therefore carried out to determine the most effective inter and intra raw spacing and the best nutrient source for the production of millet in the study area.

MATERIALS AND METHODS

The experiment was conducted to study the effect of spacing and nutrient sources on the growth and yield of millet in Bidir village, Katagum local government area of Bauchi state during the rainy season of 2023. The Bidir village is located at 11^0 50'08" N 10^0 10'02" E. The treatments consisted of three spacing (50x75, 75x75 and 100x75cm), three nutrient sources (NPK, Poultry manure and Cow dung) and a control. These were factorially combined to give twelve treatments and laid out in a randomized complete block design (RCBD) with three replications. The millet seed (Super SOSAT Variety) was obtained from Bauchi state Agriculture Development program (BSADP) zonal office Azare in order to have a recommended and certified seed variety. Data was collected at bi-weekly interval from five randomly tagged plants on: plant height, number of leaves, stem girth, leaf area, number of tillers, panicle length, 1000 grain weight and grain yield. All data collected were subjected to analysis of variance (ANOVA) and Duncan's Multiple Range Test (DMRT) was adopted in separation of the means.

RESULTS AND DISCUSSION

Plant Height

Table 1 presented result on the effects of spacing and nutrient sources on plant height of millet. The result as presented in table 1 revealed a significant ($P<0.05$) difference among the treatments used throughout the study period. The result further showed that, except at 2 and 4WAS where no significant ($P<0.05$) difference was observed, planting millet at a spacing of 100 x 75cm was found to produced statistically ($P<0.05$) the tallest plants than the other spacing used. The result further indicated that, growing millet with the application of poultry manure was found to significantly ($P<0.05$) produced taller plants than the other nutrients sources and all the nutrient sources were better than the control throughout the study period. Result of the interaction (Table 2) revealed that, growing millet at a spacing of 50 x 75cm and 75 x 75cm with the application of poultry manure produced statistically ($P<0.05$) the tallest plants than the other treatments combination used. The significant difference observed in this study indicated the importance of organic fertilizer in millet production. The increase in plant height as a result of poultry manure application could be due to availability of plant nutrients released by poultry manure. The result of this study is in agreement with the report of Agber *et al*., (2012) who reported that, fertilizer application increases the plant height of crop plants. The result of this findings also lend support from the report of Shuaibu *et al*., (2022) that, difference on plant height might be related to the effect of nitrogen which promotes vegetative growth in plant. On the various spacing used however, the result indicated that, growing millet at a spacing of 75 x 75 cm produced the tallest plants. The significant increase in plant height observed proved the influence of plant density on plant height of millet. The result of this findings corroborates the report of Bationo *et al* (2010) who affirmed that, plant height and stem girth of millet shows a significant response to plant population. It is also in conformity with the result of Roy and Isah *et al*., (2020) who reported a similar trend while studying spacing in Groundnut production.

Table1: Effects of Spacing and Nutrient Sources on Plant height of Millet

	WAS				
Treatments	2	4	6	8	10
Spacing					
50x75cm	9.31	26.17	76.72^{b}	182.39^{C}	202.95^{b}
75x75cm	9.00	27.74	79.12^{ab}	186.39^{b}	204.24^{b}
100x75cm	9.21	26.09	81.85^{a}	190.37^{a}	209.22^{a}
LS	NS	NS	**	**	*
SE ±	0.23	0.85	1.03	1.05	1.68

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Nutrient Sources					
Control	6.33[c]	17.32[c]	55.36[d]	169.27[d]	189.19[c]
NPK	9.08[b]	25.92[b]	73.63[c]	185.50[c]	204.92[b]
PM	11.70[a]	34.94[a]	102.48[a]	200.70[a]	220.94[a]
CD	9.58[b]	28.50[b]	85.48[b]	190.05[b]	206.83[b]
LS	**	**	**	**	**
SE ±	0.26	0.98	1.19	1.21	1.94
INTERACTION					
SxF	**	NS	NS	*	NS

Means followed by different letters(s) within a treatment group are significantly different by DMRT, LS = Level of significance, **Significant at 1% probability level, *Significant at 5% probability level, NS = Not significant.

Table 2: Interaction of Spacing and Nutrient Sources on Plant height of Millet at 2 and 8WAS.

			WAS			
	2			8		
Treatments	50x75	75x75	100x75	50x75	75x75	100x75
Control	5.36[e]	5.28[e]	8.35[d]	168.06[d]	170.05[d]	169.71[d]
NPK	7.99[d]	8.07[d]	11.17[bc]	182.06[c]	182.72[c]	191.71[b]
PM	12.76[a]	12.17[ab]	10.18[c]	191.70[b]	202.06[a]	208.35[a]
CD	11.12[b]	10.49[c]	7.13[d]	187.73[bc]	190.71[b]	191.69[b]
LS		**			**	
		0.46			2.10	

Means followed by different letters(s) within a treatment group are significantly different by DMRT, LS = Level of significance, **Significant at 1% probability level, *Significant at 5% probability level.

Number of Leaves

The result on the effects of spacing and nutrient sources on number of leaves of millet is presented in Table 3. The result revealed a significant ($P<0.05$) difference among the treatments used except for the different spacing where no significant ($P<0.05$) difference was observed. It also shows that, growing millet with the application of poultry manure significantly ($P<0.05$) produced higher number of leaves than the other nutrient sources and all the nutrient sources were better than the control throughout the study period. The increase in number of leaves at different weeks after sowing than the control could be due to the availability of nutrients that perform vital functions in plant development. The result of this study is in line with the findings of Roy and Shauibu *et al*. (2018) who stated that application of fertilizer gradually increased plant height, stem diameter number of leaves per plant, leaf area per plant and fodder yield. It also lend support from the findings of Moral *et al*. (2012) who reported that nutrient deficiency reduces seedling height, tiller number, stem diameter, leaf size, and leaf duration.

Table 3: Effects of Spacing and Nutrient Sources on Number of Leaves of Millet

			WAS		
Treatments	2	4	6	8	10
Spacing					
50x75cm	5.80	7.33	9.98	10.75	11.30
75x75cm	5.82	7.55	9.93	10.83	11.37
100x75cm	5.82	7.33	9.95	10.73	11.37
LS	NS	NS	NS	NS	NS
SE ±	0.07	0.17	0.10	0.09	0.11
Nurient sources					
Control	4.07[c]	5.73[c]	8.98[d]	9.80[c]	10.56[c]

NPK	5.91[b]	7.56[b]	9.62[c]	9.80[c]	11.38[b]
PM	6.69[a]	8.33[a]	10.80[a]	11.67[a]	11.96[a]
CD	6.60[a]	8.00[ab]	10.16[b]	10.96[b]	11.49[b]
LS	**	**	**	**	**
SE ±	0.08		0.12	0.11	0.13
INTERACTION		0.20			
S*F	NS	NS	NS	NS	NS

Means followed by different letters(s) within a treatment group are significantly different by DMRT, LS = Level of significance, **Significant at 1% probability level, NS= Not significant.

Stem Girth

Table 4 presented result on the effects of spacing and nutrient sources on stem girth of millet. The result shows that, there was no significant (P<0.05) difference among the spacing. The result indicated that plant population had no significant (P<0.05) effect on stem girth of millet. This is not in support of the report of Bationo *et al* (2010) who affirmed that, plant height and stem girth of millet shows a significant response to plant population. The result further revealed that, except at 8 WAS where no significant (P<0.05) difference was observed, a significant (P<0.05) difference exist among the nutrient sources throughout the study period. The significant difference observed in this study in which application of nutrient sources increased stem girth of millet showed the importance of nutrient in millet production. Nutrient sources have significantly influenced the stem girth at every week after sowing than the control on millet crop. This was due to the availability of nutrients that perform vital functions in plant development. Similar result was reported by Shuaibu *et al*. (2022) who stated that application of fertilizer gradually increased plant height, stem diameter, number of leaves per plant, leaf area per plant and fodder yield.

Table 4: Effects of Spacing and Nutrient Sources on Stem Girth of Millet

	WAS				
Treatments	2	4	6	8	10
Spacing					
50x75cm	1.41	4.48	5.05	6.09	7.23
75x75cm	1.46	4.77	5.30	6.24	7.31
100x75cm	1.29	4.37	4.93	9.79	7.36
LS	NS	NS	NS	NS	NS
SE ±	0.07	0.13		2.12	0.11
Nutrient Sources					
Control	1.27[b]	3.45[b]	3.99[d]	9.88	6.15[d]
NPK	1.24[b]	3.85[b]	4.60[c]	5.65	7.18[c]
PM	1.54[a]	5.53[a]	6.13[a]	7.17	8.27[a]
CD	1.50[a]	5.32[a]	5.65[b]	6.79	7.59[b]
LS	*	**	**	**	**
SE ±	0.08	0.15	0.14	2.45	0.13
INTERACTION					
S*F	NS	NS	NS	NS	NS

Means followed by different letters(s) within a treatment group are significantly different by DMRT, LS = Level of significance, **Significant at 1% probability level, *Significant at 5% probability level, NS = Not significant.

Leaf Area (cm)

Table 5 presented result on the effects of spacing and nutrient sources on leaf area of millet. The result revealed a significant (P<0.05) difference among the treatments used throughout the study period. The result further showed that, no significant (P<0.05) difference over planting millet at different spacing except at 2WAS were significant (P<0.05) difference was observed. The result further indicated that, growing millet with the application of poultry manure was found to significantly (P<0.05) produced wider leaves than the other nutrients sources and all the nutrient sources were better than the control throughout the study period. Result of the interaction (Table 6) revealed that, growing millet at a spacing of 75x75cm with the application of poultry manure produced statistically(P<0.05) the higher leaf area than the other treatments combinations used. The significant difference observed could be due to plants competition to absorb sunlight and the availability of nutrients. The result of this study

is in conformity with the report of Debiase *et al*, (2016) who reported that adequate soil nutrient enhances many aspects of plant physiology like fundamental process of photosynthesis, flowering, seed formation and maturation. It is also in support of the findings of Firoz *et al.*, (2010) who found that phosphorus plays an important part in many physiological processes that occur within a developing and maturing plant, it is involved in enzymatic reactions in the plant and it also hastens the ripening of fruits.

Table 5: Effects of Spacing and Nutrient Sources on Leaf Area (cm^2) of Millet

WAS					
Treatments	2	4	6	8	10
Spacing					
50x75cm	10.56^{b}	125.03	156.82	208.25	233.09
75x75cm	11.62^{a}	131.87	165.04	214.07	263.05
100x75cm	10.86^{b}	127.37	167.86	209.63	257.10
LS	*	NS	NS	NS	NS
SE ±	0.24	22.71	6.07	5.51	11.74
Nutrient Sources					
Control	6.45^{d}	79.78^{b}	107.32^{c}	175.11^{c}	218.19^{b}
NPK	9.88^{c}	89.02^{b}	166.83^{b}	207.60^{b}	254.63^{b}
PM	15.56^{a}	184.38^{a}	206.95^{a}	247.03^{a}	296.80^{a}
CD	12.16^{b}	159.19^{ab}	174.53^{b}	212.86^{b}	235.85^{b}
LS	**	*	**	**	*
SE ±	0.28	26.23	7.01	6.37	13.55
INTERACTION					
S*F	*	NS	NS	NS	NS

Means followed by different letters(s) within a treatment group are significantly different by DMRT, LS = Level of significance, **Significant at 1% probability level, *Significant at 5% probability level, NS = Not significant.

Table 6: Interaction of Spacing and Nutrient Sources on Leaf Area (cm^2) of Millet at 2WAS.

	Spacing		
Treatments	50x75cm	75x75cm	100x75cm
Nutrient Sources			
Control	5.93^{f}	6.30^{f}	7.11^{f}
NPK	10.47^{d}	9.91^{d}	9.27^{e}
PM	14.88^{b}	16.87^{a}	14.91^{b}
CD	10.98^{d}	13.39^{c}	12.13^{cd}
LS		*	
SE ±		0.48	

Means followed by different letters(s) within a treatment group are significantly different DMRT, LS = Level of significance, *Significant at 5% probability level.

Panicle Length

Table 8 shows the result on the effects of spacing and nutrient sources on panicle length of millet. The result revealed a significant ($P<0.05$) difference among the treatments used throughout the study period. The result further showed that, planting millet at a spacing of 75x75cm was found to produced statistically ($P<0.05$) the higher panicle length than the other spacing used. It also shows that, growing millet with the application of poultry manure and NPK was found to significantly ($P<0.05$) produced taller panicles than the use of cow dung which was better than the control throughout the study period. The significant difference observed indicated the importance of plant population on panicle of millet. The result of this study lend support from the findings of Blanchet *et al*. (2016) who affirmed that spacing has a significant influence on panicle of millet. The increase in panicle length with the application of poultry manure revealed the influence of organic fertilizer on the performance of millet. This corroborate the findings of Thilakarathna and Titonell *et al*. (2003) that application of NPK + FYM increased millet

yield compared to NPK alone. It also increased the number of tillers, ear length, ear weight, grain weight, threshing percentage and number of fingers per ear head.

Panicle Girth

Table 8 also presented the result on the effects of spacing and nutrient sources on panicle girth of millet. The result revealed a significant (P<0.05) difference among the treatments used throughout the study period. The result further showed that, spacing had no significant (P<0.05) effect on panicle girth of millet. The result of this findings is not in support of the findings of Donald (2013) who affirmed that spacing has a significant influence on panicle of millet. The result also shows that, growing millet with the application of poultry manure followed by NPK was found to significantly (P<0.05) produced thicker panicles than the use of cow dung which was better than the control throughout the study period. The result of this findings lend support from the findings of Basavaraj *et al.* (2010) who reported that panicle girth correlated positively and significantly with fertilizer application in millet production.

Table 8: Effects of Spacing and Nutrient Sources on Pannicle Length and Pannicle Girth of Millet

Parameters		
Treatments	Pannicle Length	Pannicle Girth
Spacing		
50x75cm	37.15^{ab}	9.60
75x75cm	37.86^{a}	9.67
100x75cm	35.91^{b}	9.66
LS	*	NS
SE ±	0.46	0.16
Nutrient Sources		
Control	29.15^{d}	7.87^{d}
NPK	39.70^{b}	10.26^{b}
PM	43.07^{a}	11.25^{a}
CD	35.97^{c}	9.19^{c}
LS	**	**
SE ±	0.53	0.18
INTERACTION		
S*F	NS	NS

Means followed by different letters(s) within a treatment group are significantly different using Duncan Multiple Range Test (DMRT), LS=Level of significance, **Significant at 1% probability level, *Significant at 5% probability level, NS= Not significant.

1000 Grain Weight

Table 9 presented the results on the effects of spacing and nutrient sources on 1000 grain weight of millet. The result revealed a significant (P<0.05) difference among the treatments used throughout the study period. The result indicated that, spacing had no significant (P<0.05) effect on grain weight of millet. The result of this study is not in conformity with the findings of Debiase *et al.* (2016) who said that optimum plant density promotes grain weight. The result further indicated that, growing millet with the application of poultry manure and NPK was found to significantly (P<0.05) produced higher 1000 grain weight than the use of cow dung which was better than the control. This indicated the importance balanced nutrition to grain weight of millet. The result of this findings lend support from the report of Blanchet *et al*. (2016) who stated that application of fertilizer gradually increased plant height, stem diameter, number of leaves per plant, leaf area per plant and grain weight.

Grain Yield (kg/ha)

Table 9 also presented the results on the effects of spacing and nutrient sources on grain yield of millet. The result revealed a significant (P<0.05) difference among the treatments. The result further indicated that, planting millet at a spacing of 75x75cm was found to produced statistically (P<0.05) the higher yield than the other spacing used. The significant difference observed could be due optimum population leading adequate nutrient absorption and adequate sunlight for photosynthesis. This corroborates the findings of Agber *et al*, (2012) that plant population had a significant influence on grain yield of millet. The result also revealed that growing millet with the application of poultry manure and NPK fertilizer was found to significantly (P<0.05) produced higher grain yield than the use of cow dung which was better than the control throughout the study period. This proves the significance of poultry manure in millet production. The result of this study corroborates the findings of Shuaibu *et al.* (2018) who reported an increase in yield of sorghum due to application of poultry manure. It is also in line with the result of Shuaibu, *et al.* (2022) who stated that, poultry manure application increased fertility status of soil which in turn translated to increase in grain yield.

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Table 9: Effects of Spacing and Nutrient Sources on 1000 Grain Weight and Grain Yield of Millet

Parameters		
Treatments	1000 Grain Weight (g)	Grain Yield (kg/ha)
Spacing		
50x75cm	17.73	543.10[b]
75x75cm	18.18	596.72[a]
100x75cm	18.04	567.56[ab]
LS	NS	*
SE ±	0.15	16.01
Nutrient Sources		
Control	15.50[c]	16.01
NPK	18.80[ab]	635.27[ab]
PM	19.20[a]	668.55[a]
CD	18.44[b]	605.46[b]
LS	**	**
SE ±	0.18	18.49
INTERACTION		
S*F	NS	NS

Means followed by different letters(s) within a treatment group are significantly different by DMRT, LS = Level of significance, **Significant at 1% probability level, * significant at 5% probability level, NS = Not significant.

CONCLUSION AND RECOMMENDATION

Conclusively, it is evident that planting millet at a spacing of 75x75cm with the application of poultry manure at the rate of 5 t/ha have more effect on the growth and yield of millet than the other treatments. Based on the result of this experiment, planting millet at a spacing of 75 x 75cm with the application of poultry manure gives the highest value in all the parameters observed and is therefore recommended for millet production. However, farmers who grow millet should adopt the use of 75x75cm intra and inter raw spacing with application of poultry manure at the rate of 5 t/ha for millet production in the study area.

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