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Research Article

Productivity of Finger Millet (*Eleusine coracana* L.) as Influenced by Intra-row Spacing and Application of NPK Fertilizer Rates in Sudan Savanna, Nigeria

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ABSTRACT

Two field experiments were conducted concurrently during the 2024 rainy season at Gerki and Salahawa villages of Batagarawa Local Government Area, Katsina State, Nigeria, to determine the influence of three intra-row spacings and three NPK fertilizer application rates on the growth and yield of the finger millet variety. The trial was carried out with three intra row spacing (75 x 15cm, 75 x 20cm and 75 x 25cm) and three different rates of NPK fertilizer application (N30 P15 K15, N60 P30 K30 and N90 P45 K45) the treatments were factorize and laid under randomize complete block deign (RCBD) with three replications. Data on growth and yield-related components were recorded during the experiment. From the result obtained it is confirmed that intra-row spacing of 75 x 25cm significantly ($P<0.05$) recorded the highest growth and yield values on number of panicle per plant, number of stem per stand, panicle weight per plant, number of stand at harvest and dry matter weight while 75 x 15cm recorded the highest yield per net plot at Salahawa village. Similarly, the three levels of NPK fertilizer application were measured, the result indicated that application of NPK fertilizer at the rate of N90 P45 K45 significantly ($P<0.05$) performed better than application of fertilizer at N60 P30 K30 and N30 P15 K15 rates in all the growth and yield parameters tested. In conclusion, planting finger millet with an intra-row spacing of 75 x 25cm and applying NPK fertilizer at N90 P45 K45 is recommended in the study area.

Keywords: Fertilizer application; Finger millet; Growth; Intra-row spacing; NPK fertilizer; Yield

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INTRODUCTION

Finger millet also known as Tamba and Gero in the northern Nigeria while in India is called *Ragi* it's one of the most important cereal (grain) crop generally cultivated in Africa and Asia particularly Nigeria and India. Finger millet is an annual herbaceous plant widely grown in the semi-arid and arid zones in Africa and Asia. It is a tetraploid and self-polinating species the crop was originated from Ethiopian and Ugandan highlands. It is usually grown as a rain-fed crop in the dry tropics; it is an erect and tall cereal crop with determinate growth habit also a mono cot plant. It has a fibrous root system with strong lateral roots. It has the ability to withstand stress and thrive in hot region, with wide range of soil, which has made it quite popular in hot region and especially across many African countries (Ibrahim and Kerau, 2024). Anonymous, (2010) reported that Finger millet and Pearl millet are similar and almost the same in natural growth but differ in chemical composition. Generally millet is the 6th most important grain in the globe after rice, maize, wheat, sorghum and barley (Akinsuyi, 2011). Over 5 million hectares of land are put under cultivation in Nigeria with annual production of 3.5 million metric tonnes (FAOSTAT, 2019). In West Africa, where the crop is considered of major importance the crop contain vital nutrients. Ibrahim and Kerau, (2024) reported that millet variety could do well and provide a substantial growth and yield related

component in a sandy soils and sandy loamy environment when proper agronomic practices are made available couple with plant nutrition. However, another explanation for the notable impact of fertilizer application on millet output may be related to the crucial roles played by key nutrients such as proteins, amino acids, nucleic acids, enzymes, phytohormones, and enzyme abundance (Ibrahim and Kerau, 2024). However, the estimated global production of millet was 24.2 million hectare with approximately 45% of the global production (FAO, 2015). The grain contains substantial amount of protein, calcium, iron, dietary fibre, carbohydrate, iron, antioxidants and vitamins with slightly superior amino acid substance, it also contains reasonable amount of carotene, riboflavin (Vitamin B2) and niacin (Vitamin B4) (Harsh and Arvadiya 2023). Regrettably some of the factors responsible for low yield in finger millet productions are varietal effect, pest, diseases, fertilizer and agronomic practice. Fertilizer application rate and variety alone contributes about 75% of low yield production in Nigeria (FAO, 2014). However intra-row spacing as a factor affecting low yield production in Nigeria many farmers fail to understand the appropriate plant spacing suitable for millet so as to optimize their yield (FAO, 2014:Ismail, 2012). It was generally observed that finger millet fail to grow better and produce good grains in plots without adequate spacing and nutrients, to achieve optimum grain production, appropriate fertilizer is essential (Miller, 2020). The aim of this research work was to determine the influence of intra- row spacing and NPK fertilizer application rate on Growth and yield of finger millet in the study area.

MATERIAL AND METHODS

Description of the Experimental Site

Field experiment were conducted during the wet season of 2024 at Gerki and Salahawa villages of Batagarawa local government area situated at 12^0 59'34 N, 8^0 16'58 E, and 549 meters above sea level in Katsina State, Nigeria. The region has an estimated rainfall between 500 and 650mm of rain and 15^0 and 43^0C of average temperature yearly. The soil at the experimental sites was sandy loam.

Treatments and Experimental Design

The treatment comprise of three intra-row Spacing 75 x 15cm, 75 x 20cm and 75 x 25cm and three different rates of NPK fertilizer application (N30 P15 K15, N60 P30 K30 and N90 P45 K45) and arranged in a 3x3 factorial combination with three replicates using randomize complete block design (RCBD). The field were cleared, harrowed and ridged. The ridges were then separated into plots of six ridges each, measuring 3m by 4.5m (13.5m). The net plot was made up of two inner rows spaced out by 75cm by 3m long a pass-way of one 1m was created. Prior to setting of the trial, soil samples were randomly taken from the experimental site at diagonal soil depths of 0-30 cm across the field by using standard method as outlined by (Black, 1968), the composite sample was examined for physical and chemical characteristics. The finger millet seeds (Tamba) variety was sourced from the Katsina State Agricultural and Rural Development Authority (KTARDA). The seeds were also treated with apron star @5g per 2.5kg of seeds to guard against soil infections and pests. Seeds were planted manually and space as per treatment at a depth of 5 cm. The seeds were sowed on 12thJune 2024 and 13th June 2024 for Gerki and Salahawa respectively. At 3WAS 1st weeding ware conducted and the plant was thinned to three plant per stand. However NPK fertilizer was applied as per treatment.

Data Collection

Data collected for each year on plant growth was recorded at 3, 6, and 9WAS from five tagged plants per plot while data on yield were also gathered immediately after harvesting. The data collected were subjected to statistical analysis of variance using General linear model (GLM), using SAS package 2002 version 9.0. Differences between treatment means were compared using Duncan Multiple Range Test (DMRT) Duncan (Duncan, 1955). At the 5% level of probability ($P < 0.05$).

RESULTS

The results of Number of stem per stand, number of panicles per stand and dry matter weight (g) are presented in table 1. The result indicated that both Number of stem per stand, number of panicles per stand and dry matter weight (g) were significantly influence ($P<0.05$) by varying intra-row spacing and 75 x 25cm intra-row spacing recorded the highest value which was followed by 75 x 15cm and 75 x 20cm respectively at Salahawa location. Similarly, application of NPK fertilizer at the rate of N90 P45 K45 significantly outperformed better than application of the same fertilizer at the rate of N60 P30 K30 and N30 P15 K15 in that order at Gerko village. The interaction between intra-row spacing and application of varying NPK fertilizer rates was not significant at both two locations. The results on Panicle weight per plant (g), number of stand at harvest and Number of reproductive tillers at harvest are presented in table 2. The result indicated that panicle weight per plant (g) and number of stand at harvest per plot was significantly affected ($P<0.05$) by intra-row spacing at the two location. However, 75 x 25cm intra-row spacing recorded the highest value

which was followed by intra-row spacing of 75 x 20cm and 75 x 15cm respectively. However, application of NPK fertilizer at different rate was not significant at both locations. Similarly all the interactions were not significant

The results on 1000 grain weight (g), yield per net plot (g) and yield per hectare (Kg) at harvest are presented in table 3. The result indicated that 1000 grain weight (g) and yield per net plot (g) were significantly affected ($P<0.05$) by varying intra-row spacing at Salahawa village. Consequently, intra-row spacing of 75 x 25cm recorded the highest weight and yield per net plot with 3.44g and 114.84g for 1000 grain weight and yield per net plot when compared to the other varying intra-row spacing tested. Furthermore, application of NPK fertilizer at different rate was not significant at both locations. All the interaction between the two factors were not significant at both years.

Table 1: Productivity of finger millet as influenced by intra-row spacing and NPK fertilizer rate on number of stem per stand, number of panicles per stand and dry matter weight (g) at Gerki and Salahawa during the 2024 rain fed season

Treatments	Number of stem per stand		Number of panicles per stand		Dry matter weight (g)	
	Gerki	Salahawa	Gerki	Salahawa	Gerki	Salahawa
Intra-row spacing (cm)						
75 X 15	14.22	12.00^{b}	28.11	23.78^{b}	310.56	232.56^{b}
75 X 20	14.56	11.33^{b}	31.00	22.56^{b}	328.78	210.44^{b}
75 X 25	13.11	21.11^{a}	30.67	42.89^{a}	288.78	338.00^{a}
S.E(±)	0.97	2.90	2.50	6.05	25.87	50.84
Significance	NS	*	NS	*	NS	*
NPK Fertilizer rate (kg/ha)						
N30 P15 K15	14.22^{b}	14.22	28.67^{b}	27.44	303.56^{b}	237.78
N60 P30 K30	11.56^{b}	14.89	23.67^{b}	31.44	261.11^{b}	268.89
N90 P45 K45	16.31^{a}	15.33	37.44^{a}	30.33	363.44^{a}	274.33
S.E(±)	0.97	2.90	2.50	6.05	25.87	50.84
Significance	*	NS	*	NS	*	NS
Interactions						
S x F	NS	NS	NS	NS	NS	NS

Note: Means followed by the same letter(s) in each column, under each variety are not significantly different 5% level of significance ($P < 0.05$), using DMRT. *= Significant, NS= Not Significant at 5% level of probability

Table 2: - Productivity of finger millet as influenced by intra-row spacing and NPK fertilizer rate on panicle weight per plant (g), number of stands at harvest and Number of reproductive tillers at harvest at Gerki and Salahawa during the 2024 rain fed season

Treatments	Panicle weight per plant (g)		No. of stand at harvest		No. of reproductive tillers	
	Gerki	Salahawa	Gerki	alahawa	Gerki	Salahawa
Intra-row spacing (cm)						
75 X 15	21.67^{b}	26.33^{b}	20.33	19.06^{b}	33.78	32.22
75 X 20	23.07^{b}	25.56^{b}	20.33	19.06^{b}	33.44	30.78
75 X 25	26.78^{a}	31.56^{a}	19.22	20.89^{a}	31.22	33.78
S.E(±)	1.79	1.02	1.60	0.90	2.21	1.64
Significance	*	*	NS	*	NS	NS
NPK Fertilizer rate (kg/ha)						
N30 P15 K15	25.00	27.44	20.56	20.00	33.67	33.33
N60 P30 K30	22.56	28.00	20.00	20.67	31.67	31.89
N90 P45 K45	24.56	28.00	19.33	19.33	33.11	31.56
S.E(±)	1.79	1.02	1.60	0.90	2.21	1.64
Significance	NS	NS	NS	NS	NS	NS
Interactions						
S x F	NS	NS	NS	NS	NS	NS

Note: Means followed by the same letter(s) in each column, under each variety are not significantly different 5% level of significance ($P < 0.05$), using DMRT. *= Significant, NS= Not Significant at 5% level of probability

Table 3: - Productivity of finger millet as influenced by intra-row spacing and NPK fertilizer rate on 1000 grain weight (g), yield per net plot (g) and yield per hectare (Kg) at harvest at Gerki and Salahawa during the 2024 rainfed season

Treatments	1000 grain weight (g)		Yield per net plot (g)		Yield per hectare (Kg)	
	Gerki	Salahawa	Gerki	Salahawa	Gerki	Salahawa
Intra-row spacing (cm)						
75 X 15	3.11	3.00[b]	116.07	103.49[b]	480.51	462.96
75 X 20	3.33	3.44[a]	109.78	114.84[a]	467.77	464.96
75 X 25	3.11	3.00[b]	106.40	105.00[b]	431.77	470.33
S.E(±)	0.17	0.10	7.47	5.65	24.15	19.91
Significance	NS	*	NS	*	NS	NS
NPK Fertilizer rate (kg//ha)						
N30 P15 K15	3.11	3.11	112.11	111.78	456.58	471.43
N60 P30 K30	3.33	3.22	106.96	105.56	454.03	456.03
N90 P45 K45	3.11	3.11	113.18	106.40	469.43	470.78
S.E(±)	0.17	0.10	7.47	5.65	24.15	19.91
Significance	NS	NS	NS	NS	NS	NS
Interactions						
S x F	NS	NS	NS	NS	NS	NS

Note: Means followed by the same letter(s) in each column, under each variety are not significantly different 5% level of significance (P < 0.05), using DMRT. *= Significant, NS= Not Significant at 5% level of probability

DISCUSSION

From the result obtained it was observed that growth and yield related component of finger millet are significantly influenced by varying intra-row spacing and different rate of fertilizer application which could be due to variability of nutrient available and space in relation to photosynthesis which is a key for plant growth and development and crop adaptability to the environment. This result is similar to the report of Ibrahim and Kerau, (2024) that variety of millet are significantly differ in all the growth and yield component at both years due to its adaptability to the environment and genetic make-up. However, growth, yield and yield related components of millet variety could be influenced by a number of factors which include adaptability, genetic make-up, seed quality, crop husbandry, effects of pest and diseases, competition for growth factors such as water, nutrients and light (Sheriff *et al.*, 2019). Similarly, Bassi *et al.*, (2020) also reported that performance of pearl millet varieties was determined more by their inter and intra-row spacing due to their tillering capacity. More so, the significant effects of plant spacing recorded by 75 x 25cm on growth and yield related component could be attributed to the fact that finger millet could do better at a wider plant space (75 x 25cm) in between better than lower space (75 x 20cm and 75 x 15cm). This finding is in consonant with the report of Ibrahim and Kerau, (2024) in an experiment conducted at the two locations during the 2022 and 2023 growing seasons and conclude that medium plant spacing (50cm) has the potentially of producing more yield than lower plant spacing. Nura *et al.* (2023) reported that wider plant spacing of (75cm) produced the highest grain yield, panicle length, yield per hectare and heavier 1000 grains while the closer spacing (25cm) gave out the least yield value as well as lighter 1000 grain across the two locations. Kumawat, (2017) also reported that1000 seeds weight, total yield obtain per hectare, harvest index and panicle weight per plant was significantly affected by intra row spacing.

The significant effect recorded from the application of NPK fertilizer at the rate of N90 P45 K45 on growth and yield component could be due to the potential ability of pearl millet to utilize nutrients for growth and yield However, another reason for obtaining a significant response to fertilizer application on yield in pearl millet could be link to the important role plays by essential nutrient such as proteins, amino acids, nucleic acids, enzymes, phyto-hormones and number of enzymes. The result confirmed Alhassan, *et al*., (2006) report that Fertilizer application is one of the limiting factors to pearl millet production in Sudan savannah Nigeria. Ibrahim and Kerau, (2024) also reported that higher harvest index could be recorded in millet varieties due to increase in fertilizer rate in kg ha^{-1}. According to El-tilib *et al*., (2006) growth, yield and yield related component could be increase when nitrogen rates of the fertilizer is increase leading to significant effect in growth and yield component of pearl millet at the rate of 90 kg N/ha.

CONCLUSION

Conclusively, from the findings of this research it is clearly indicated that, finger millet can be successfully

grown at the two locations. The result also shows that using wider plant space of 75 x 25cm provide higher growth and yield value in all the growth, yield and yield related component measured at both locations while application of fertilizer at the rate of N90 P45 K45 gives the best results compared with other treatments in all the growth, yield and yield related component measured. In view of these findings, therefore, we recommend plant spacing of 75 x 25cm and application of fertilizer at the rate of N90 P45 K45 in the study area in order to obtain higher yield of finger millet.

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