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Growth and yield of finger millet (*Eleusine coracana* L.) (Garten) as affected by varying nitrogen levels at Mubi, Adamawa State, Nigeria

Hussaini, I. Danjuma[1*], Mohammed, Aminu[2], Bassi, A. Nuhu[2], Hassan, Ismaila[2] and Aliyu, M. Abubakar[2]

[1]Department of Agricultural and Bioenvironmental Engineering Technology, Adamawa State College of Agriculture, P.M.B. 2088 Ganye, Nigeria.
[2]Department of Agricultural Technology, Adamawa State College of Agriculture, P.M.B. 2088 Ganye, Nigeria.

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A field experiment was conducted at the Teaching and Research Farm of the Adamawa State College of Agriculture at Mubi, Nigeria to determine effect of Nitrogen fertilization on the growth and yield of Finger Millet (*Eleusine coracana* L. (Garten). Results indicated that all the growth and yield components were significantly ($p \leq 0.05$) influenced by increasing nitrogen fertilizer application rates. The highest performances for all the parameters were recorded at the application rate of 600 kg Nha^{-1}. Growth and yield components were found to be positive and linearly related to increasing nitrogen rates. It is therefore recommended that Finger millet be fertilized with 600 kg Nha^{-1}, at Mubi.

Key words: Finger millet, nitrogen fertilization, savanna ecological zone, nutritious, semi-arid.

INTRODUCTION

Finger millet (*Eleusine corocana* L. Garten) called “tamba” in Hausa language, a staple food crop in the semi-arid tropics of South Asia and Africa (Malinda et al., 2015), is said to be the third most important cereal crop in India (Saraswathi et al., 2017) and is a minor cereal crop that belongs to the Orchideccae subfamily. The crop has been highly valued by traditional farmers for its nutritious values, drought resistance, early maturing and ability to survive under low chemical input requirement (Malinda et al., 2015; Bhomte et al., 2006; Wekha et al., 2016). In addition, it has low pest problems and hence low storage problems.

The crop has a total production of five million tons over a land area of 4.0 to 4.5 million hectares with India as the World-leading producer of 5 million tons followed by Africa with about two million tons (Mathew and Luigi, 2011; Tsado et al., 2016). Finger millet is cultivated in the northern part of Nigeria with a production capacity rated as 44% on the African continent (Tsado et al., 2016).

The grain is more nutritious than other cereals and hence called nutrition millet in India (Sandhya et al., 2017; Bekele et al., 2016; Tsado et al., 2016). It provides sustaining diet for diet related patients, nourishing for infants and its straw is a valuable fodder for animals (Sandhya et al., 2017; Bekele et al., 2016).

Finger millet has the ability to survive very well in different agro-climatic conditions where there is as low as 400 mm of rainfall and temperature above 15°C and

*Corresponding author. E-mail: hussainidanjuma@gmail.com.

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can be grown throughout the year (Malinda et al., 2015). It can be grown for weed control and can be grown on poor soil (Ibrahim et al., 2018).

Despite the importance of the crop to the farmer nutritiously and for its low input requirements (Bekele et al., 2016), the crop suffers from low yield due to the poor fertility status of the soils in sub-Saharan Africa (Malinda et al., 2015) and paucity of information on how to improve its productivity. It is important therefore, to optimize the nutrient management practices and other related factors affecting finger millet cultivation in order to attain better yields under the comparatively marginal local growing conditions. Unfortunately, compared to the major cereal crops the recommendations available for nutrient management of finger millet in the study area are scarce, limiting the ability of agricultural extension officers to assist subsistence farmers.

It is in line with the above, that the study was carried out to determine the effect of varying levels of nitrogen fertilizer on the growth and yield of finger millet in the study area.

MATERIALS AND METHODS

The study was conducted in the 2004 and 2005 rainy seasons on the Teaching and Research Farm of the Adamawa State College of Agriculture at Mubi, Adamawa State, Nigeria.

Mubi is situated at latitude 11°E and Longitude 13°N in the Southern Sudan Savanna Zone of Nigeria. The area has a mean annual rainfall of 1000 mm with temperature ranging between 18 and 27°C, that is,favourable for the cultivation of the crop.

The field was laid in Randomized Complete Block Design. The treatments were varying levels of Nitrogen; T1 (0 kg N/ha), T2 (100 kg N/ha), T3 (200 kg N/ha), T4 (400 kg N/ha) and T5 (600 kg N/ha), these were replicated four (4) times. A total of 20 experimental units each size 4m x 3m with 0.5 m path between them giving a total area of 297 m^2. Each plot was ploughed manually with hoe. The seeds sourced from Jos, Plateau State Nigeria, were planted in rows 75 cm apart and 20 cm between stands at the rate of five seeds per hole and after germination thinned to two per hole. Prior to planting, phosphorus and phosphate fertilizer were applied to the plots to allow for adequate solublization and subsequent availability to the plants. Weeding was first done immediately after germination and subsequently whenever necessary.

Nitrogen fertilizer in the form of urea was applied in accordance with the treatments four weeks after germination.Data collected were those of plant height, leaf area, leaf length, leaf width, number of fingers per plant, dry matter yield, root dry weight and the grain yield. The data collected were analyzed using Analysis of Variance (ANOVA) appropriate for the experimental design at 5% significance level and means were separated using Fisher's LSD at 5% probability. Regression analysis was also carried out to estimate the relationship between the parameters measured and the applied Nitrogen fertilizer.

RESULTS AND DISCUSSION

Plant height

The results from Table 1 shows that application of nitrogen fertilizer has resulted into significant ($p \leq 0.05$) increase in the plant height compared to the control. The result shows that treatment T5 gives the highest plant height of 102.5 cm while the control gives the lowest plant height value of 52.50 cm. However, plant height at 100 (T2) and 200 (T3) kg/Nha do not differ significantly ($p \leq 0.05$). Increase in plant height with respect to increase in Nitrogen rate was also found to be positively related ($r = 0.99^{**}$). This relationship has accounted for 98% ($r^2 = 0.98$) of the variability in height.

Leaf area

The leaf area of finger millet was significantly ($p \leq 0.05$) influenced by Nitrogen application rates with treatment T5 and T1 yielding the largest area of 110.67 cm^2 and the smallest area of 52.99 cm^2 respectively. However, the result also reveals that, leaf are at T1 and T2 were statistically similar but with T2 having higher leaf area than T1. In a similar manner, T4 and T5 were also statistically similar with T5 having larger area than T4. The result also reveals that there was a significant and positive linear relationship ($r = 0.99^{**}$) between increasing rate of Nitrogen fertilizer application and the leaf area of finger millet.

Leaf length

The results from Table 1 also reveals that, increase in Nitrogen fertilizer application rate has significantly ($p \leq 0.05$) influenced the leaf length of finger millet in the study area. The results shows that, treatment T5 (600 kg N/ha) yielded the longest leaf length of 62.83 cm and treatment T1 (control) yielded the shortest leaf length of 49.62 cm. However, the result also indicated that, leaf length at T1 and T2 were not significantly different ($p \leq 0.05$) but with T2 yielding longer leaf length of 53.32 cm than T1 (49.62 cm). In a similar manner, leaf length at T3, T4 and T5 were also statistically similar, but with T5 yielding longest among the three treatments of 62.83 cm, followed by T4 (62.40 cm) and T3 (59.70 cm). The leaf lengths were also found to be positively related ($r = 0.90^{**}$) to the increase in Nitrogen levels.

Leaf width

The leaf width of finger millet was found to be significantly ($p \leq 0.05$) influenced with the increasing Nitrogen levels with treatment T4 and T5 giving the largest width of 1.94 cm and treatment T1 giving the smallest width of 1.26 cm. However, the result also reveals that leaf width at T1 and T2 were statistically with T2 giving larger width of 1.46 cm than T1 (1.26 cm). In a similar manner, leaf widths at T3, T4 and T5 were also statistically similar ($p \leq 0.05$) but with T5 giving the largest leaves in descending

Table 1. Growth and yield of finger millet under varying Nitrogen levels at Mubi, Adamawa State, Nigeria.

Nitrogen levels (kg Nha^{-1})	Plant height (cm) 12WAS	Leaf area (cm^2) 12WAS	Leaf length (cm) 12WAS	Leaf width (cm) 12WAS	No. of tillers/plant 12WAS	No. of spikelets (fingers per spike (head) 12WAS	Dry matter of whole plant (g) 12WAS	Root dry weight/plant (g) 12WAS	Grain yield (tones ha^{-1})
0	52.50	52.99^a	49.62^a	1.26^a	1.76^a	5.25	24.55	4.00	0.75^a
100	62.00^a	61.45^a	53.31^a	1.46^a	2.75^{ab}	7.00^a	28.45	5.33	1.00^a
200	68.00^a	70.40^a	59.70^b	1.78^b	3.25^b	7.00^a	35.15	5.88^a	1.29
400	79.25	97.91^b	62.40^b	1.94^b	3.75^b	10.75	48.22	6.17^a	1.75^b
600	102.25	110.67^b	62.83^b	1.94^b	5.00	12.75	58.10	9.22	2.01^b
$LSD_{p\leq0.05}$	7.40	18.50	4.53	0.27	1.13	1.53	2.98	0.54	0.29
C.V. (%)	12.49	30.18	8.62	2.98	8.99	7.52	7.52	6.89	0.95

Means with the same letters under the same column do not differ significantly ($p \leq 0.05$)

order to T3. The result also discovered that a linear positive relation (r = 0.85**) exists between increasing Nitrogen fertilizer application rate and leaf width.

Number of tillers per head

Tiller development in small grain crop is an index of biological yield (Fageria, 2007). In this study, variation in Nitrogen application rates was found to have significantly ($p \leq 0.05$) influenced the increase in the number of tillers. The result reveals that, treatment T5 yielded the highest number of tillers of 5.00, while treatment T1 (control) yielded the number of tillers of 1.76. However, number of tillers at T1 and T2 were found to be statistically similar but with T2 having higher number of tillers than T1. In a similar manner, number of tiller at T2, T3 and T4 were also found to be statistically similar ($p \leq 0.05$) but with T4 having the highest number of tillers among the three in descending order. In addition, a positive linear relation (r = 0.98**) was observed between increasing Nitrogen application rates and tillering ability of the finger millet.

Number of fingers per head

The number of fingers per head just like the number of tillers is a measure of biological yield of a crop (Fageria, 2007). The result from Table 1 shows that, number fingers produced was significantly ($p \leq 0.05$) influenced by the increasing levels of Nitrogen fertilizer. The number of fingers corresponding to the treatment levels are; 5.25, 7.0, 7.0, 10.75 and 12.75 corresponding to T1, T2, T3, T4 and T5 respectively. However, number of fingers at T2 and T3 were not significantly different ($p \leq 0.05$) but were higher than the control (T1). In addition, results from Table 2 shows that, number of fingers were positively related (r = 0.99**) with the increase levels of Nitrogen fertilizer.

Dry matter yield (DMY)

Increase in dry matter yield is an index of growth and development of a crop. The result of this study shows that, DMY is significantly ($p \leq 0.05$) influenced by varying level of Nitrogen fertilizer; with T5 yielding the highest DMY of 58.10 g and T1 yield the lowest DMY of 24.55 g. The result also reveals that there is a linear positive relationship (r = 0.99**) between DMY and increasing rate of Nitrogen fertilizer application.

Root dry weight (RDW)

The root dry weight of finger millet was found to increase significantly ($p \leq 0.05$) under varying Nitrogen application rates. The highest RDW of 9.22 g was obtained at T5 while the Control yielded the lowest RDW of 4.00 g. However, the the RDW at T3 (5.33 g) did not differ significantly ($p \leq 0.05$) with that at T4 (5.88 g). From the result, RDW was also observed to be positively correlated (r = 0.95**) to the increasing Nitrogen levels.

Grain yield

Varying application rates of Nitrogen fertilizer was found to significantly ($p \leq 0.05$) enhance the grain yield with the highest application rate (T5) yielding the highest grain yield of 2.01 tons/ha, while the

Table 2. Relationship between varying Nitrogen levels and growth and yield components of Finger Millet at Mubi, Adamawa State, Nigeria.

Growth and yield components	Coefficient of linear correlation (r)	Coefficient of determination for linear regression (r^2)
Plant height	0.99**	0.98**
Leaf area	0.99**	0.98**
Leaf length	0.90**	0.81**
Leaf width	0.85**	0.72**
No. of tillers per plant	0.98**	0.96**
No. of Fingers per head	0.99**	0.98**
Dry matter for whole plant	0.99**	0.98**
Root dry weight	0.95**	0.90**
Grain yield	0.99**	0.98**

control (T1), yielded the lowest grain yield of 0.75 tons/ha. However, yield at T1 and T2 were found to be statistically similar ($p \leq 0.05$), but with T2 having the higher yield of 1.00 tons/ha. In a similar manner, the yield obtained at T4 and T5 were also statistically similar with T5 having the higher yield of 2.0 ton/ha than T4 (1.75 ton/ha). In addition, the result (Table 2) shows that grain yield is positively and linearly related ($r = 0.99$) to increasing Nitrogen fertilizer.

In general, the results indicated that finger millet responds well to increase in Nitrogen fertilizer levels (Gupta et al., 2012).

DISCUSSION

The positive contribution of increasing Nitrogen Fertilizer levels to the growth and yield components of finger millet could be attributed to its ability to supply Nitrogen in the soil solution throughout the growth period of the crop. A study performed by Ahmad et al. (2018) on response of maize cultivars to Nitrogen levels shows that, grain yield of maize is significantly ($p \leq 0.05$) influenced by increasing levels of Nitrogen application. A similar result was also observed by Malinda et al. (2015).

It was also discovered in studies performed on effect of different amounts of Nitrogen fertilizer on grain yield of forage corn by Leila and Ali (2014) that, Nitrogen have significant ($p \leq 0.05$) effect on the forage grain yield.

This positive influence of increasing Nitrogen on the growth and yield components of finger millet that has translated into longer, wider and larger leaves was also discovered in a similar study by Kumara et al. (2007) and Tsadoet al. (2016). These might have enhanced the utilization of solar energy for higher and better photosynthetic activities (Bekele et al., 2016). In addition, the longer and wider leaves produced could be the reason for enhancing the height of the plants. The significant relationship between the increasing Nitrogen levels and the yield and growth components could also be attributed to the optimum photosynthetic activities in addition to the availability of the Nitrogen in the presence of adequate moisture in the soil. This corroborated the statement made by Gupta et al. (2012) that said, "Finger Millet responds well to Nitrogen application".

In summary, the study discovered that, increasing Nitrogen levels have positive effect on the growth and yield components of finger millet in the study area. This is similar to the results obtained by Tsado et al. (2016) in a study performed on the performance of finger millet as influenced by Nutrient sources in Kaduna and Minna, Nigeria and a study performed by Patil et al. (2015).

CONCLUSION AND RECOMMENDATIONS

From the results obtained in this study, it could be concluded that, finger millet responded well with increasing Nitrogen fertilizer application rate. In addition, application of Nitrogen fertilizer at the rate of 600 kg N/ha could be recommended for Finger millet production in the study area.

The practice of integrated fertility management, where artificial fertilizer and organic manure are used is recommended for further studies.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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