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Effect of Inorganic Fertilizers on the Growth and Yield of Finger Millet (Eleusine coracana L. Gaertn)

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Abstract

In this study on fertilizer needed for finger millet (Eleusine coracana L. Gaertn) production aimed at identifying the quantity of inorganic fertilizer for optimum production. Results obtained revealed that nitrogen fertilizer in the form of urea can be apply to finger millet but at a higher dosage up to 600kg/ha for optimum production of the crop. 600kg/ha was found to produce significantly (P≤0.05) taller plants (102.25cm), largest leaf area (110.67cm^2), more number of tillers per plant (5.00) and 2.01t/ha grain yield which were significantly (P≤0.05) higher than the control and other treatments applied. NPK 20 10 10 applied at 150kg/ha gave the tallest plants of 48.60cm and 47.17cm at 8 weeks after transplanting and at physiological maturity respectively, the number of tillers per plant and yield at harvest were statistically similar with the used of 300kg/ha, thus indicating that an increase in fertilizer rate above 150kg/ha was detrimental to the crop. Similarly, NPK was also discovered to have significant (P≤0.05) effect on finger millet when apply at the rate of 100kgN, 50kgP_2O_5 and 50kgK_2O per hectare, this is because it was found to have higher number of seeds and grain yield than the other treatments (poultry droppings, cow dung, horse manure and the control). These are supported by a report indicating blended fertilizer applied at the rate of 75kg/ha gave significantly (P≤0.05) more productive tillers and grain yield. Based on results obtained from this study, it was recommended that NPK fertilizer can be applied at the rate of 100kgN, 50kgP_2O_5 and 50kgK_2O or NPK 20 10 10 applied at the rate of 150kg/ha for optimum production of finger millet (Eleusine coracana L. Gaertn).

Keywords: Finger Millet; Inorganic; Fertilizer

Introduction

Finger millet (Eleusine coracana L. Gaertn) is an important cereal that can be cultivated as rainfed crop due to its drought tolerance or has the ability to under moderate moisture conditions with a rainfall requirement between 500mm to 1000mm [1,18] reported that finger millet is the third most important cereal crop in India, while in Nigeria, it is grown only in the northern parts of the country where it is gradually being replaced by other cereal crops that seems to have more economic return to the farmers, thus rending the crop to its present status at subsistence and gradually becoming a lost crop [2].

The crop has high nutritional value compared to other cereals as reported by many researchers [3,4] reported that finger millet contains calcium, magnesium, manganese, protein, carbohydrate, fat and crude fibre in varying proportion which makes it a nutritious food for both young and aged people. The straws are source of animal feeds [5].

The Nigerian savannah covers more than half of the total land area [6]. Low soil fertility had been identified as the major constraint for crop production; therefore, high crop yield can only be obtained through the use of fertilizers. Inorganic fertilizers have high concentration of nutrients that are readily available for plant uptake [7]. In tropical countries, optimum yield of crops is obtained by the use of fertilizers (organic or inorganic), however, research has shown that organic fertilizer alone cannot give optimum yield, therefore, it needs to be supplemented with chemical fertilizer [8].

Fertilizer application for finger millet has been based on mere assertions as no empirical data on different synthetic fertilizer brand have been made available for finger millet production. Therefore, there is the need to identify the quantity of different inorganic fertilizer needed for the production of finger millet for optimum yield in order to enhance its production by peasant farmers; hence the need for this review in order to put together research results on different inorganic fertilizers to ease accessibility on recommendations for whichever fertilizer is available to farmers.

Materials and Methods

Recent literatures were gathered from the internet and hard copies from library were consulted in order to meet the objectives stated in this work.

Results and Discussion

Effect of Nitrogen Fertilizer on Growth and Yield of Finger Millet

Researchers have discovered that nitrogen influence the yield of finger millet but is highly mobile and can easily be leach through excessive rainfall or irrigation, therefore it needs to be added in sufficient quantity throughout the growing season for optimum growth and yield of crops (Kogbe and Adediran, 2003). In a study to determine the growth and yield of finger millet using various nitrogen levels at the teaching and research farm of Adamawa State College of Agriculture, Mubi, Nigeria in 2004 and 2005 cropping seasons (Table 1). Result obtained on plant height indicated that nitrogen fertilizer applied at 600kg/Nha increased plant height significantly ($P \leq 0.05$) compared to the control. The tallest plants (102.5cm) were obtained when 600kg/Nha was used while the control had the least mean plant height (52.50cm). Similar result was observed for leaf area; this was because the highest fertilizer level (600kg/Nha) applied gave the largest leaf area of 110.67cm while the least leaf area (52.99cm) was found in the control plot as presented in Table 1. Furthermore, Result obtained on number of tillers per plant followed the same trend as the application of 600kg/Nha gave 5.00 tillers per plant and was significantly ($P \leq 0.05$) higher than the control which had 1.76 tillers per plant (Table 1). The increase in growth attributes of finger millet with increasing level of nitrogen fertilizer was attributed to the nitrogen supplied in soil solution for plant growth throughout the growth period. Similar result was also reported by Ahmad et al (2018) on maize cultivars where an increase in nitrogen level showed a corresponding increase in the growth and yield of maize.

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

Nitrogen level	Plant height (cm) 12WAS	Leaf area (cm^2) 12WAS	No. of tillers / plant 12WAS	No. of fingers /head 12WAS	Grain yield (tones/ha^{-1})
0	52.50	52.99[a]	1.76[a]	5.25	0.75[a]
100	62.00[a]	61.45[a]	2.75[ab]	7.00[a]	1.00[a]
200	68.00[a]	70.40[a]	3.25[b]	7.00[a]	1.29
400	79.25	97.91[b]	3.75[b]	10.75	1.75[b]
600	102.25	110.67[b]	5.00	12.75	2.01[b]
$LSD_{P\leq0.05}$	7.40	18.50	1.13	1.53	0.29
C.V. (%)	12.49	30.18	8.99	7.52	0.95

Source: [16]

Means with the same letters under the column do not differ Significatly (P≤0.05)

Results obtained on yield from the study indicated that the number of fingers increased as the nitrogen level increased and reaches a peak at the highest rate of fertilizer applied (600kg/Nha) and was significantly (P≤0.05) higher than the control which had the least number of fingers per plant. The application of 600kg/Nha gave 12.75 fingers per plant while the control gave 5.25 fingers per plant and this seems to in turn enhanced finger millet grain yield significantly (P≤0.05). The highest grain yield of 2.01t/ha was obtained when 600kg/Nha was used while the least yield value of 0.75t/ha was found in the control plot (Table 1). Increase in Nitrogen level that might have translated the plant to get larger leaf area discovered in this study is in conformity with the work of Bekele et al (2016) who reported that larger leaf area could be responsible for utilization of solar energy for photosynthesis which enhances growth and yield of crops.

Effect of NPK 20:10:10 Fertilizer on Growth and Yield of Finger Millet

The response of finger millet to different rate of NPK 20 10 10 fertilizer was studied by [9] at different spacing. Results of the study at 8 weeks after transplanting (WAT) and at physiological maturity (PM) indicated that NPK 20 10 10 had significant (P≤0.05) effect on the growth of this crop. This was because, at 150kg/ha application rate, plant height increase significantly (P≤0.05) at single row spacing than double and triple row spacing while the control plot had the least value of plant height (Table 2). The tallest plants at 8WAT and at PM were obtained when 150kg/ha NPK 20 10 10 fertilizer was applied and under single row spacing and was significantly (P≤0.05) taller than the control (Table 2). This significant increase in height was attributed to the nutrient content in fertilizer used for this study which promotes growth of the crop and this was found to agree with the work of [10]. An increase in fertilizer rate from 150kg/ha to 300kg/ha reduces plant growth as presented in Table 2 is an indication that these fertilizer elements when apply in excess is detrimental to the growth of finger millet. This result was found to be in conformity with the work of [11] who recommended basal application of 100kg/ha DAP and later top dress with 100kg/ha urea.

Table 2: Mean effects of NPK 20 10 10 fertilizer rates on plant height of finger millet at 8 WAT and PMS under SRP, DRP and TRP in 2012 and 2013 cropping seasons

Row Spacing	Fertilizer rates			
	0.0kg/ha	150kg/ha	300kg/ha	mean
	Plant height (cm) at 8 WAT			
SRP (50,000 plants/ha	40.57	48.60	43.47	44.21
DRP (100,000 plants/ha	23.30	40.13	40.17	34.68

TRP (150,000 plants/ha	24.13	40.13	40.17	34.81
Mean	29.33	43.01	411.36	37.90
	Plant height (cm) at PMS			
SRP (50,000 plants/ha	42.83	47.17	43.50	36.98
DRP (100,000 plants/ha	24.63	43.23	43.50	37.12
TRP (150,000 plants/ha	24.63	43.23	43.50	37.12
Mean	30.58	44.63	44.59	39.93
	Plant height at 8 WAT		Plant height at PMS	
LSD 0.05 for fertilizer dose	1.647		0.592	
LSD 0.05 for row spacing	1.647		0.592	
LSD 0.05 for fertilizer dose x spacing	2.853		1.025	

Source: [9] WAT= weeks after transplanting; SRP = single row planting; DRP = double row planting; TRP = triple row planting, PMS = physiological maturity stage

The significant increase in height due to spacing at 8WAT and at PM under single row spacing than double or triple row spacing (Table 2) was an indication that there was less competition for soil nutrients. This was found to be in agreement with the recommendation made by [11] who recommended that finger millet should be planted at a spacing of 75cm by 25cm for optimum growth and yield.

The trend for plant height in Table 2 was similarly observed for number of tillers and yield in Table 3. Therefore, the reasons advanced for plant height earlier could be responsible for number of tillers and yield of the crop in Table 3. The highest yield of 831.33kf/ha under single row spacing and double row spacing over the triple row spacing which yielded 826.33kg/ha when 150kg/ha NPK 20 10 was used is an indication that overpopulation of finger millet reduces yield, although, they were statistically similar (Table 3).

Table 3: Mean effects of NPK 20 10 10 fertilizer rates on number of tillers and grain yield of finger millet at 8 WAT and PMS under SRP, DRP and TRP in 2012 and 2013 cropping seasons

Row Spacing			**Fertilizer rates**		
	0.0kg/ha	**150kg/ha**		**300kg/ha**	**Mean**
			Number of tillers at 8 WAT		
SRP (50,000 plants/ha	2.66	3.00		3.00	2.88
DRP (100,000 plants/ha	3.00	4.00		4.00	2.77
TRP (150,000 plants/ha	3.00	4.00		4.00	3.66
Mean	2.66	3.33		3.33	3.11
			Number of tillers at PMS		
SRP (50,000 plants/ha	3.00	5.66		6.00	4.88
DRP (100,000 plants/ha	2.33	8.33		9.00	6.55
TRP (150,000 plants/ha	3.00	8.33		8.66	6.66
Mean	2.77	7.44		7.88	6.03
	Grain Yield kg/ha				
SRP (50,000 plants/ha	743.33	818.33		831.33	797.67
DRP (100,000 plants/ha	746.67	831.33		815.33	797.78
TRP (150,000 plants/ha	739.67	818.00		826.33	794.67

Mean	743.22	822.56		824.33	796.70
	No.of tillers 8WAT		Plant height at PMS	Grain Yield kg/ha	
LSD 0.05 for fertilizer dose	0.263		0.366	2.633	
LSD 0.05 for row spacing	0.263		0.366	2.633	
LSD 0.05 for dose x spacing	0.456		0.634	4.560	

Source: [9]

Key: WAT= weeks after transplanting; SRP = single row planting; DRP = double row planting; TRP = triple row planting, PMS = physiological maturity stage

Effect of NPK Fertilizer on Yield of Finger Millet

A multi-station experiment was conducted using nutrient sources to determine the performance of finger millet at the teaching and research farm of the Federal University of Mina, Nigeria during the 2013 and 2014 cropping seasons by [12]. Result obtained on grain and seed weight is presented in Table 4. Nutrient sources had significant (P≤0.05) effect on yield of finger millet at both locations (Mina and Kaduna). The application of 100kg N, 50kg P2O5 and 50kg K2O/ha gave the highest grain yield of 4530.70 kg/ha in Mina and 4241.30 kg/ha in Kaduna (both locations), then this was followed by poultry dropping, cow dung and horse manure in that order, while the control had the least mean value ((Table 4). This was attributed to the nutrient content in mineral fertilizer which are readily available for plant uptake. The result agreed with the work of [19] who reported significantly (P≤0.05) highest grain yield of finger millet obtained in his study when 100kg/ha N was applied. Nutrient sources had significant (P≤0.05) effect on seed weight of the crop studied and in both locations (Table 4). Interestingly here is that organic fertilizer (poultry droppings) applied at 2t/ha produced the heaviest seeds in the two locations. The heaviest seeds of 2.59g obtained in Minna and 2.48g in Kaduna was obtained when 2t/ha poultry droppings were applied and was significantly (P≤0.05) higher than other treatments applied, this was followed by horse manure, cow dung, inorganic fertilizer in that order while the least was found in the control plot (Table 4). Heavier obtained due to application of poultry droppings at recommended dose of 2t/ha was attributed to slow but steady release of essential nutrients to this crop during the grain filling which might have enhanced seed weight [13]. similarly observed better growth of finger millet due to better use of available nutrients which resulted in heavy seed weight.

Table 4: Influence of nutrient sources on grain yield and seed weight of finger millet in Minna and Kaduna

Nutrient sources	Rate	Grain yield (kg/ha^{-1})		Seed weight (g)	
		Minna	Kaduna	Minna	Kaduna
NPK	100, 50, 50	4530.70a	4241.30a	1.84a	1.64d
Poultry dropping	2t/ha^{-1}	3332.70b	3299.00b	2.59a	2.48c
Cow dung	4.5t/ha^{-1}	3083.30c	3033.30b	1.90bc	1.76c
Horse dung	6t/ha^{-1}	2604.30d	2452.70c	1.95b	1.86b
Control	0t/ha^{-1}	2064.70e	1856.30d	1.46d	1.29c
SE±		71.58	96.31	0.02	0.02

Source: [15]

Effect of NPK Blended Fertilizer on Growth and Yield of Finger Millet

In a study by [14] to determine the effect of NPK blended fertilizer in an on-station experiment at the Kenya Agricultural and Livestock Research Organization (KALRO) revealed that NPK blended fertilizer had significant (P≤0.05) effect on the two varieties tested in both short and long rainy season (Table 5). The highest number of tillers

for Gulu-E Variety at both short and long season was recorded when 100kg/acre fertilizer rate was applied, but this was not significantly (P≤0.05) different with the application of 75kg/acre fertilizer rate whereas the least mean values were obtained in the control plots (Table 5). The increase in productive tillers as shown in Table 5 was attributed to uptake of nutrients supplied by blended fertilizer applied by the plant [17]. reported an increase in growth attributes of wheat due to application of different phosphatic fertilizer. Results on grain yield similarly followed the same trend as that of productive tillers. During the short season, the two varieties produced significantly (P≤0.05) highest grain yield when 75kg/acre fertilizer rate was used. At 75kg/acre treatment level, Gulu-E variety produced the highest grain yield (80.3g/plant) while P-224 produced 78.7g/acre during the short season and were statistically similar but significantly (P≤0.05) higher than the other treatments applied and the control. During the long rain, fertilizer rate at 75kg/acre gave the highest grain yield (155.0kg/plant) for Gulu-E variety and was significantly (P≤0.05) higher than P-224 variety where 75kg/acre produced its highest grain yield of 110.3g/-plant (Table 5). An increase in fertilizer rate above 75kg/acre had no significant (P≤0.05) effect on grain yield of finger millet. The control plots had the lowest values of grain yield in both short and long rain (Table 5). Results presented in Table 5 imply that grain formation and filling were lower in the control where no fertilizer w\as applied. The significant (P≤0.05) increase in grain due to application of blended fertilizer could be due to available nutrients in the blended fertilizer and this agreed with the work of [15].

Table 5: Effect of NPK blended fertilizer rates on Gulu-E and P-224 varieties at Kakamega

Variety	Fertilizer rate	Short rains		Long rains	
		No. of productive	Grain yield	No. of productive	Grain yield
		Tillers/plot	(g)/plant	Tillers/plot	(g)/plant
Gulu-E	0	25.3b	34.7d	21.9c	69.0d
	25	25.0b	52.7c	24.4c	107.0b
	50	27.7b	67.7b	29.2b	89.7c
	75	36.7a	80.3a	42.3a	155.0a
	100	42.7a	70.3	42.4a	140.0a
P-224	0	26.3b	44.7d	22.9c	65.3d
	25	40.0a	55.0c	32.3b	71.3d
	50	28.3b	64.3b	32.4b	101.3b
	75	41.3a	78.7a	40.1a	110.3b
	100	34.3a	58.3c	41.9a	93.0c
P-value		0.047	0.005	0.043	0.017
SE		1.841	4.512	3.854	8.658
CV%		11.2	10.5	8.9	11.3

Source: [14]

Values in each column followed by the same letter do not differ significantly at P≤0.05

Conclusion and Recommendations

Inorganic fertilizers have high concentration of nutrients that are readily available for plant uptake but the high costs have reduced its accessibility to most peasant farmers. These empirical data aimed at identifying the quantity of fertilizer needed for optimum production of finger millet will encourage farmers in the production of this crop as the application will no longer be on mere assertion that resulted in waste of fertilizer inputs. Single fertilizer (urea) can also be use. The aim could be achieving when the high dosage (600kg/ha) urea is applied because at this treatment level, significantly (P≤0.05) higher number of fingers (12.75) and 2.01t/ha grain yield was obtained with the least

mean values in the control plots.

Results obtained from this study indicated that optimum growth and yield of finger millet can be obtained when 100kgN, 50kgP_2O_5 and 50kgK_2O fertilizer rate is used, this is because the result obtained in this study revealed that at this fertilizer rate, highest grain yield of 4530.70kg/ha and 4790.00kg/ha was obtained at Minna and Kaduna respectively and were significantly (P≤0.05) higher than other treatments applied (poultry droppings, cow dung and horse manure) while the control had the least mean value.

NPK 20 10 10 was also discovered to have significant (P≤0.05) effect on growth and yield of finger millet. The application of 150kh/ha NPK 20 10 10 produced significantly (P≤0.05) taller plants (48.60cm) at 8 weeks after transplanting and 47.17cm at physiological maturity, similarly, the same trend for growth was observed on number of tillers and grain yield as the application of 300kg/ha gave statistically the same number of tillers and grain yield as the used of 150kg/ha. Blended fertilizers also gave significantly (P≤0.05) higher number of tillers and highest yield of (80.3g/plant) for Gulu-E variety while P-224 produced 78.7g/acre during the short season and were statistically similar but significantly (P≤0.05) higher than the control.

Recommendations

Based on information gathered from this study, the followings are recommended for optimum production of finger millet:

i. Urea can be applying at 600kg/ha.

ii. NPK 20 10 10 can be apply at the rate of 150kg/ha

iii. NPK fertilizer can be apply at the rate of 100kgN, 50kgP_2O_5 and 50kgK_2O

iv. NPK blended fertilizer can be used at the rate of 75kg/acre

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