Influence of Different Rates of Urea Fertilizer on Growth, Yield and Yield Components of Banana (*Musa* AAA) Cavendish CV.Grand Nain under Kassala State Conditions, Sudan

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DOI: 10.52981/fajas.v%vi%i.3535

ABSTRACT

An experiment was established in a private farm in Alqurashi village near Atbara River, Aroma locality, Kassala State, Sudan. Where tissue cultured banana suckers cv. "Grand Nain", (3 months old) were transplanted in the field on the first of October 2021, at a spacing of 3×3 meter (1111 mother plants/ha). Six doses of urea *viz*: 0, 300, 600, 900, 1200 and 1500 g/urea/mat/year were applied in two equal doses in December and June. The six treatments were replicated 3 times in a randomized complete block design (RCBD), and each plot included 4 plants. The results revealed that the application of 900, 1200, and 1500g/mat/year showed a highly significant increase in growth parameters, crop duration (days), yield, and yield components compared with the control. The highest value of marginal rate of return was recorded when adding 300g/mat/year of banana.

Keywords: Nitrogen application, Pseudo stem, Yield, and Banana

1. INTRODUCTION

In Sudan, the areas under banana are about 23000 hectares, mainly used for local consumption and export (Bakhiet *et al*., 2011). Banana is a popular fruit in Sudan. It is the cheapest and most plentiful fruit found throughout the year Elhassan *et al*., 2005). Today, bananas are a leading tropical fruit in the world market with a high scale of export potentiality (Gawade*et al*., 2021).

Fertilization is considered as the main factor for improving the production of banana because plants absorb large amounts from the soil. Nitrogen is the most absorbed nutrient in vegetative as well as in the reproductive periods (Fatma, *et al*., 2021). Banana crop needs sufficient fertilizer for higher production. Dhutraj, *et al*. (2018) reported that high fertilization recrops need of banana is mainly due to its rapid and vigorous growth and high fruit yield.Excessive N application could lead to soil acidification as well as worsen the soil environment, thus ultimately has a negative impact on crop growth and yield (Schroder *et al*., 2011). Yield reductions in crops with high N fertilization are primarily caused by physiological disorders associated with excessive uptake of N and soil degradation (Qiao *et al*., 2012). Zhao *et al*. (2014) found that the application of lower N rates sustained high yields compared with higher N rates.

The area around Kassala has traditionally been used for fruit and vegetables production using underground water for irrigation. The high requirements of water in Kassala have been a big problem for drinking and cultivation, with a limited water supply from the groundwater (R.A.U.W.V, 2009). Currently, due to the depletion of under groundwater in Kassala, banana cultivation has moved to the Atbara River, especially after the water flow in the river became regular throughout the year due to the construction of the Atbara River and Setit dams. These new areas need more

research for all crops, especially for important horticultural crops, and banana is one of these crops. Accordingly, the objective of this study was to evaluate the effects of different rates of urea fertilizer on growth, yield, and yield components of banana cv. Grand Nain under Kassala conditions.

2. MATERIALS AND METHODS

The experiment was established in a private farm in Alqurashi village located near Atbara River Aroma locality, Kassala State, Sudan (latitude 15° 13´ N, longitude 35° 93´ E, altitude 421 m above sea level) during the period of October 2021 to March 2023. The climate of the study area is characterized by being dry and hot in summer. The soil type of the experimental site is silty clay loam with high silt content (68%) and low clay content (26.7%).

Three-month-old banana suckers cv. "Grand Nain", propagated by tissue culture, were transplanted in the field on the first of October 2021, at a spacing of 3×3 meter (1111 mother plants/ha) as recommended (Hamid, 1995). Irrigation was applied immediately after transplanting. Three months after planting, two suckers were left, giving 2222 plants/ha. This plant population was maintained thereafter. The special horticultural practices, *viz;* weed control, leaf removal, mulching, desuckering, bunch propping, removal of male bud, wind breaks, etc. were carried out as recommended. Irrigation was applied every 5-7 days according to farmers practice by surface irrigation. Six doses of urea *viz*: 0, 300, 600, 900, 1200 and 1500 g/urea/plant/year, were applied in two equal doses in December and June.

The six treatments were replicated 3 times in a randomized complete block design (RCBD), and each plot included 4 plants. Growth parameters measured included plant height, 5 cm above the soil surface to the point of intersection of the petioles of the two youngest leaves. Plant girth was measured 5 cm above the ground

level. The number of green leaves was counted and recorded at shooting.

Mature bunches were harvested when they reached the full three-quarter shape. Yield and yield components were taken, with 10cm of the stalk left with the bunch to facilitate handling. The second hand of freshly harvested bunch was used to measure the fruit characteristics according to Dadzie and Orchard (1997).

Marginal rate of return analyses, as described by CIMMYT (1988), were used to evaluate the profitability of the urea levels based on the field information and data collected. CropStat statistical program was used for data analysis, and the least significant difference range test was used for mean separation at the probability level of 0.05.

3. RESULTS AND DISCUSSION

Influence of different rates of urea fertilizer on growth parameters:

The results showed very highly significant differences among treatment on pseudostem height, pseudostem diameter, and number of green leaves for mother plant and first ratoon of banana cv. Grand Nain (Table 1). The highest growth parameters were observed with the higher doses of fertilizer, while the lowest was recorded under the control. Similar results were also observed by Hossain and Haque, (2013), who found that high doses of N increased vegetative growth resulted in the greatest plant height and pseudo-stem girth of banana. Moreover, Chandrakumar *et al*. (2011) found that increase in the N fertilization levels improved the growth parameter of banana. Islam *et al*. (2020) reported that the application of 500g urea/plant showed more significant increase in morpho-physiological characteristics namely pseudo-stem height (m), pseudo-stem girth (cm), and number of functional leaves of banana compared to 300g urea/plant.

Table 1. Influence of different rates of urea fertilizer on pseudostem height (cm),

pseudostem diameter (cm) and number of leaves per plant of banana.

Levels of urea(g/mat/year)	Pseudostem height (cm)		Pseudostem diameter (cm)		Number of green leaves per plant	
	MP	FR	MP	FR	MP	FR
0	188	208	65	67	19	24
300	190	212	68	69	19	25
600	194	216	69	71	19	25
900	197	218	71	72	20	26
1200	199	219	71	73	21	27
1500	200	222	72	74	21	27
Sig. level	***	***	***	***	***	***
$SE^{\pm}$	1.07	1.01	0.33	0.74	0.25	0.30
CV%	0.9	0.8	0.8	1.8	2.2	1.7

MP= Mother plant. FR= First ratoon crops
****: indicated significance at P≤0.001.*

Influence of different rates of urea fertilizer on crop duration:

The number of days from planting to flowering and number of days from flowering to harvest showed very highly significant differences on mother plant and first ratoon (Table 2). Fewer days from planting to flowering and from flowering to harvest were observed with 1200 and 1500g/mat/year compared to control for the mother plant and first ratoon crops (Table 2). These results are in conformity with the findings of Hossain and Haque (2013), who reported that application of an increased level of nitrogen enhanced flowering and shortened crop duration of banana. Moreover, Islam *et al*. (2020) found that application of different levels of nitrogen fertilizer had a significant influence on crop duration, and the maximum crop duration was recorded on 400g urea/plant treatment, while the minimum crop duration was recorded on 500g urea/plant treatment.

Table 2. Influence of different rates of urea fertilizer on number of days from planting to flowering and number of days from flowering to harvest of banana.

Levels of urea(g/mat/year)	Number of days to flowering		Number of days to harvest	
	Mother plant	First ratoon	Mother	First ratoon

			plant	
0	314	465	109	119
300	305	443	107	116
600	304	432	103	113
900	300	425	102	106
1200	295	422	100	101
1500	291	409	92	97
Sig. level	***	***	*	***
$SE^{\pm}$	1.91	1.81	3.23	1.76
CV%	1.1	0.7	5.5	2.8

MP= Mother plant. FR= First ratoon crops
and *: indicated significance at P≤0.05and P≤0.001, respectively.*

Influence of different rates of urea fertilizer on yield:

There were very highly significant differences in yield among the application of different levels of urea for mother plant and first ratoon of banana (Table 3). The maximum bunch weight and total yield were obtained with 1500g urea/mat/year treatment while the minimum yield was obtained with the control (0g urea/mat/year). This indicated that the higher level of urea positively affected yields (Table 3). The increased in yield might be due to the better growth parameters. These results agree with those of Islam *et al*. (2020), who reported that maximum yield was obtained from 500g urea/plant treatment and the minimum yield was obtained from 300g urea/plant treatment. Moreover, Chattopadhayay*et al*. (2018) report that yield of Amrita Sagar banana variety increased with the increase of N levels up to 240 g/plant. Navaneethakrishnan*et al* (2021) finding that the plants with Treatment (200 g N in 5 split doses) had significantly higher mean bunch weight (17.88 kg/plant).

Table 3. Influence of different rates of urea fertilizer on bunch weight (kg) and total yield (t/ha) of banana

Levels of urea(g/mat/year)	Bunch weight (kg)			Total yield (t/ha)
	Mother plant	First ratoon	Combine	

0	16	18	17.2	58
300	19	22	20.3	70
600	22	25	23.5	80
900	24	27	25.5	87
1200	26	28	27.0	91
1500	27	31	28.8	98
Sig. level	***	***	***	***
SE±	0.61	0.70	0.48	1.98
CV%	4.7	4.8	5.0	4.3

MP= Mother plant. FR= First ratoon crops
****: indicated significance at P≤0.001.*

Influence of different rates of urea fertilizer on number of hands and fingers per bunch and fruit weight

The effect of urea rates on the number of hands per bunch, number of fingers per bunch and fruit weight showed very highly significantly differences on the mother plant and first ratoon crops of banana (Table 4). The highest values were recorded with high rates of urea compared to control. Similar results were reported by Islam *et al*. (2020) who found that the application of 500g urea/plant showed more significant increase in total number of fingers per bunch, total number of hands per bunch and fruit weight compared to 200g urea/plant of banana. Moreover, Dawoud *et al*. (1999) reported that the increased in number of hands per bunch, number of fingers per hand and fingers weight of banana were increased with N rates.

Table 4. Influence of different rates of urea fertilizer on number of hands per bunch, number of fingers per hands and fruit weight (g) of banana.

Levels of urea	Number of hands per bunch		Number of fingers per hands		Fruit weight (g)	
(g/mat/year)	MP	FR	MP	FR	MP	FR
0	7	9	15	17	153	158
300	8	10	16	18	158	166
600	9	10	18	19	161	167
900	10	11	19	20	163	171
1200	11	11	20	21	164	173
1500	11	11	20	22	166	174
Sig. level	***	***	***	***	***	***
SE±	0.14	0.24	0.27	0.54	1.30	0.98

CV%	2.5	4.0	2.6	1.5	1.40	1.0

MP= Mother plant. FR= First ratoon crops
****: indicated significance at P≤0.001.*

Economic analysis

In determining the most economically acceptable treatment, partial, dominance, and marginal analysis were conducted for total yield (kg/ha) of banana for Kassala site using market prices for crop and urea fertilizer. All costs and returns were calculated per-hectare basis in SDG (Table 5). Results showed treatment of 300g/mat/year resulted in the highest marginal rate of return (MRR), which came out to be 3.8 (Table 6). Therefore, the economic evaluation based on partial budget and marginal analysis indicated that using urea fertilizer at rate of 300g/mat/year was the most stable and economically feasible treatment.

Table 5. Partial and dominance analysis for yield (t/ha) of banana in Kassala area

Levels of urea(g/mat/year)	Yield (t/ha)	Gross return (SDG/ha)	Variable cost (SDG/ha)	Net return (SDG/ha)
0	58	5800000	0	5800000
300	70	7000000	249975.0	6750025
600	80	8000000	499950.0	7500050
900	87	8700000	749925.0	7950075
1200	91	9100000	999900.0	8100100
1500	98	9800000	1249875.0	8550125

Table 6. Marginal analysis for yield (t/ha) for banana in Kassala area

Levels of urea(g/mat/year)	Variable cost (SDG)	Net return (SDG)	MR	MC	MRR
0	0	5800000	-	-	-
300	249975.0	6750025	950025	249975	3.8
600	499950.0	7500050	750025	249975	3.0
900	749925.0	7950075	450025	249975	1.8
1200	999900.0	8100100	150025	249975	0.6
1500	1249875.0	8550125	450025	249975	1.8

The price of one ton of banana=100000 SDG, the price of one kg of urea =550 SDG and one US=592SDG.

4. CONCLUSIONS

The highest growth parameters, crop duration, yield, and yield components of banana under Kassala conditions were obtained with1500g/mat/year. However, 300g/mat/year recorded the highest marginal rate of return compared with the other treatments.

ACKNOWLEDGEMENT

The authors would like to thank the IAEA Regional Project RAF/5/086 "Enhancing Crop Nutrition and Soil and Water Management and Technology Transfer in Irrigation Systems for Increased Food Production and Income Generation" for supporting this work.

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أثر على النمو والانتاجية ومكونات الانتاجية في الموز صنف قراند نين تحت ظروف ولاية كسلا، السودان

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DOI: 10.52981/fajas.v%vi%i.3535

ملخص البحث:

أقيمت تجربة في مزرعة خاصة بقرية القرشي بالقرب من نهر عطبرة، محلية اروما بولاية كسلا، السودان.حيث تمت زراعة خلفات نسيجية من الموز صنف القراند نين (عمرثلاثة أشهر) بالحقل في الأول من

أكتوبر ٢٠٢٢ ، على مسافة ٣ × ٣ متر (١١١١ نبتة أم / هكتار. تم تطبيق ست جرعات من اليوريا: ٠ ،٣٠٠ ،٦٠٠ ،٩٠٠ ، ١٢٠٠ و ١٥٠٠ جم / يوريا / نبات / سنة على جرعتين متساويتين في ديسمبر ويونيو. تم تكرار المعاملات الست ٣ مرات في تصميم القطاعات العشوائية الكاملة (RCBD) وتضم كل قطعة ٤ شتلات.أظهرت النتائج أن إضافة (٩٠٠ ،١٢٠٠ ، ١٥٠٠ جم/ نبات/ سنة) أدت إلى زيادة معنوية عالية في معايير النمو ومدة المحصول (أيام) وزيادة في الانتاجية ومكوناتها مقارنة مع الشاهد.تم تسجيل أعلى قيمة لمعدل العائد الهامشي عند إضافة ٣٠٠ جم/نبات/سنة للموز.

الكلمات المفتاحية: تطبيق النتروجين، الساق الكاذبة، الانتاجية والموز.