Nile Valley University Publications
Nile Journal for Agricultural Sciences (NJAS)
(ISSN: 1585 – 5507)
Volume 10, NO. 01, 2025
https://nilevalley.edu.sd

Research paper

Effect of Different Rates of NPK Fertilizer on Growth and Hardening of Banana Plantlets

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Abstract

The experiment was carried out to improve the quality of banana cv. Grand Nain plantlets produced by tissue culture in greenhouse during January to April of 2022 and 2023. Five doses of NPK (20:20:20) viz: 0, 2, 4, 6 and 8 g/plant were applied. The treatments were replicated 3 times in randomized complete design (RCD) and each plot encompassed 4 plants. The results showed that the different rates of NPK affected growth parameters, roots length and number of roots per plant of banana plantlets. The highest values of plant height, plant girth, number of leaves per plant, roots length, root girth and number of roots per plant were obtained with 6 g/plant compared to control for the two seasons. Using of NPK fertilizer at rate of 6 g/plant was the most stable and economically feasible treatment.

Keywords*: plantlets, banana, hardening, grand nain.*

اثر جرعات مختلفة من السماد المركب NPK علي نمو وتاقلم نبتات الموز

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المستخلص

نفذت التجربة لتحسين نوعية نبتات الموز صنف القراند نين المنتجة نسيجيا بزراعة في البيوت المحمية خلال الفترة من يناير إلى أبريل من عام 2022 و 2023. تم تطبيق خمس جرعات من سماد NPK (20:20:20) وهي: 0، 2، 4، 6 و 8 جم / نبته. تم تكرار المعاملات 3 مرات في التصميم العشوائي الكامل وتضمنت كل قطعة 4 نبتات. أظهرت النتائج أن الجرعات المختلفة من سماد NPK أثرت على مؤشرات النمو وطول الجذور وعدد الجذور لكل نبته من نبتات الموز. تم الحصول على أعلى قيم لطول النبتات، سمك النبتات، عدد الأوراق لكل نبته، طول الجذور، سمك الجذر وعدد الجذور لكل نبته عند 6 جم/نبته مقارنة بالشاهد في الموسمين. كان استخدام سماد NPK بمعدل 6 جم/نبته هو العلاج الأكثر استقرارًا والأكثر جدوى اقتصاديًا.

كلمات مفتاحية: *نبتات, الموز, الاقلمة, قراند نين.*

Introduction

Banana is classified economically as the fifth most important agricultural crop in global trade which is significant fruit crop cultivated in the tropical and sub-tropical regions (Tarek, *et al*., 2022). Banana fruits have excellent nutritional value due to their high content of carbohydrates, minerals, and vitamins.

In Sudan banana is a popular fruit and is an important commercial fruit crop. It is the cheapest and plentiful fruit throughout the year (Ehassan *et al*., 2005).

Banana need high requirement of NPK-fertilizers for maximum yield production. Meanwhile, fertilization aims to provide nutrients for optimal plantlet productivity through the application on the leaves or the soil (Rina, 2021).

Integrated nutrient applications not only ensure the supply of essential nutrients to plants but also have some positive interactions to increase nutrient use efficiency and reduce environmental hazards (Bewuket *et al*., 2017). The application of all needed nutrients through fertilizers is known to have deleterious effect on soil fertility leading to unsustainable yields, while integration of fertilizers is able to maintain the health, productivity and fertility of the soil (Yadav *et al*., 2017).

Acclimatization of banana plantlets it very important step and there is need to study the effect of different rates of NPK fertilizer on the quality of the banana plantlets. Therefore, the objective of this study was to evaluate the effects of different rates of NPK on growth of banana plantlets under greenhouse.

Material and Methods

The objective of this study was to determine the effect of different rates of NPK on growth of banana plantlets under greenhouse during January to April of 2022 and 2023. The sources of plant material employed in the study were *in vitro* plantlets of 'Grand Naine' banana cultivar produced in the Tissue Culture Laboratory of Kassala and Gash Research Station. The plantlets were uniform in size and raised in 18×20cm black polyethylene bags. Five doses of NPK (20:20:20) *viz*: 0, 2, 4, 6 and 8 g/ plant were applied to the plantlets at 2 weeks after transplanting in the greenhouse. The treatments were replicated 3 times in randomized complete design (RCD) and each plot encompassed 4 plants.

The plant height (cm), plant girth (cm), number of leaves/plant, leaf length (cm) and leaf width (cm) were recorded at 1.5 month and at the end of experiment. Root length (cm), root girth (cm) and number of roots per plant were recorded at the end of experiment.

Marginal rate of return was analyzed according to CIMMYT (1988) and used the field information and data collected for evaluation.

Data was subjected to analysis of variance procedures. Treatment means were separated using Duncans Multiple Range Test at 5% level of significance.

Results and Discussion

Effect of different rates of NPK fertilizer on plant height, plant girth and number of leaves per plant of banana plantlets

Plant height, plant girth and number of leaves per plant of banana plantlets showed highly significant differences in both seasons at 6 and 12 weeks after planting (Table 1 and 2). The highest values of plant height, plant girth and number of leaves per plant were recorded under 6 g/NPK/plant, while the lowest were obtained with control (0 g/NPK/plant) on both seasons at 6 and 12 weeks after planting (Table 1 and 2). The values of plant height, plant girth and number of leaves per plant were increased with NPK rates until 6 g/plant and then decreased. The improvement on plant height, plant girth and number of leaves per plant might be due the effective role of NPK fertilizer in enhancing the growth of banana planets. These results are supported by those of Xiukang and Yingying (2016) who reported that the rates of NPK fertilizer has very significant influence on plant height, stem diameter and number of leaves of tomato. Moreover, Abdallah and Mohammed (2021) found that NPK fertilizer improved plant height, plant girth and number of leaves.

Table 1. Effect of different rates of NPK fertilizer on plant height, plant girth and number of leaves of banana plantlet cv. Grand Nain after 6 weeks from planting

NPK rates (g/plant)	Plant height (cm)		Plant girth (cm)		No. of leaves/plant	
	Season one	Season Two	Season one	Season two	Season one	Season two
0	8.5d	7.4d	0.83c	0.58d	2.3c	2.6e
2	9.0cd	8.3c	0.93c	0.68c	2.5bc	3.9d
4	9.5c	8.7c	1.10b	0.74c	2.6bc	4.4c
6	12.4a	10.5a	1.30a	1.10a	3.10a	5.8a
8	10.5b	9.6b	1.20ab	0.98b	2.8ab	5.3b
Significant level	***	***	***	***	**	***
$SE^{\pm}$	0.26	0.20	0.04	0.02	0.13	0.11
CV%	4.50	3.95	7.26	4.50	8.26	4.37

*** and ***indicate significance at P< 0.01 and P< 0.001, respectively.*

Table 2. Effect of different rates of NPK fertilizer on plant height, plant girth and number of leaves of banana plantlet cv. Grand Nain after 12 weeks from planting

NPK rates (g/plant)	Plant height (cm)		Plant girth (cm)		No. of leaves/plant	
	Season one	Season Two	Season one	Season two	Season one	Season two
0	27.0d	26.0c	3.3d	1.9d	5.0d	5.3d
2	28.0d	27.0c	3.6c	2.8c	8.0c	6.3c
4	30.0c	31.3b	3.9b	3.8b	8.7bc	7.8b
6	34.0a	43.7a	4.5a	4.8a	10.0a	8.5a
8	32.0b	35.0b	4.3a	4.5a	9.3ab	8.3a
Significant level	***	***	***	***	***	***
$SE^{\pm}$	0.58	1.17	0.08	0.09	0.42	0.13
CV%	3.31	3.60	3.73	4.52	8.91	3.01

****indicate significance at P< 0.001.*

Effect of different rates of NPK fertilizer on leaf length and leaf width of banana plantlets

Results obtained showed significant differences in leaf length and leaf width in both seasons at 6 and 12 weeks after planting (Table 3 and 4). The leaf length and leaf width were increased with increased NPK rates and there is no significant differences between 6 g/NPK/plant and 8 g/NPK/plant (Table 3 and 4). This could be attributed to adequate nutrient supply which might improve cell enlargement and cell division. These results are in agreement with Khalid and Rashid, (2009) who reported that leaf parameters of non-fertilized control plants were not significantly different when compared to fertilized banana plants. Khalifa *et al*. (2021) who reported that leaves parameters were increased with NPK doses of cucumber.

Table 3. Effect of different rates of NPK fertilizer on leaf length and leaf width of banana plantlet cv. Grand Nain after 6 weeks month from planting

NPK rates (g/plant)	Leaf length (cm)		Leaf width (cm)	
	Season one	Season two	Season one	Season Two
0	3.6d	6.7c	2.1d	3.3d
2	4.4c	8.0b	2.7c	4.3c
4	4.8c	8.5ab	3.2b	5.0bc
6	6.8a	9.5a	3.8a	6.0a
8	5.8b	9.0ab	3.3b	5.5ab
Significant level	***	***	***	***
$SE^{\pm}$	0.13	0.32	0.12	0.24
CV%	4.35	6.75	6.74	8.79

****indicate significance at P< 0.001.*

Table 4. Effect of different rates of NPK fertilizer on leaf length and leaf width of banana plantlet cv. Grand Nain after 12 weeks from planting

NPK rates (g/plant)	Leaf length (cm)		Leaf width (cm)	
	Season one	Season two	Season one	Season Two
0	12.7c	17.3b	6.3d	7.8d
2	13.0c	18.7b	9.7c	10.3c
4	17.0b	19.0ab	10.8b	11.4b
6	21.0a	22.0a	12.0a	12.5a
8	19.0ab	20.0ab	11.6a	11.6b
Significant level	***	*	***	***
$SE^{\pm}$	0.75	0.95	0.15	0.15
CV%	7.81	8.52	2.57	2.48

*** and ****indicate significance at P< 0.05 and P< 0.001, respectively.*

Effect of different rates of NPK fertilizer on roots length, root girth and number of roots per plant of banana plantlets

Table 5 showed very high significant differences in roots length, root girth and number of roots per plant in both seasons at 12 weeks after planting. The highest values of roots length, root girth and number of roots per plant were recorded under 6 g/NPK/plant compared to control (0 g/NPK/plant) (Table 5 and 6). This finding indicated that using of NPK fertilizer has great effect on root length, root girth and number of roots per plant of banana plantlets. These results are in conformity with the findings of Abdallah and Mohammed (2021). Moreover, Idris *et al*. (2015) reported that, nitrogen combined with sulphur resulted in significantly higher roots length, roots number and root girth compared to control of banana plantlets.

Table 5. Effect of different rates of NPK fertilizer on root length, root girth and number of roots per plant of banana plantlet cv. Grand Nain after 12 weeks from planting

NPK rates (g/plant)	Root length (cm)		Root girth (cm)		Number of roots/plant	
	Season one	Season two	Season one	Season two	Season one	Season two
0	17.0d	15.0e	0.35c	0.20d	9.7d	10.0d
2	18.0d	17.0d	0.45b	0.24d	12.7c	13.0c
4	20.0c	19.0c	0.45b	0.30c	13.7c	14.0c
6	29.3a	26.0a	0.70a	0.53a	21.7a	27.0a
8	25.0b	24.0b	0.65a	0.35b	18.0b	19.7b
Significant level	***	***	***	***	***	***
$SE^{\pm}$	0.49	0.58	0.22	0.01	0.75	0.83
CV%	3.90	4.95	7.42	6.31	8.53	8.59

****indicate significance at P< 0.001.*

Economic evaluation

In determining the most economically acceptable treatment, partial, dominance and marginal analysis were conducted for data of banana cv. Grand Nain plantlets produced by tissue culture in greenhouse using market prices for plantlets and NPK fertilizer. All costs and returns were calculated on per-1000 planets basis in SDG. Results showed treatment of application of NPK at 6 g/plant resulted in the highest return of investment. Return to investment in this treatment was estimated in the form of marginal rate of return (MRR), which came out to be 64.4 for 1000 planets at price 2000 SDG for 1 planets (Tables 6 to 8).

Therefore, the economic evaluation based on partial budget and marginal analysis indicated that using of NPK fertilizer at rate of 6 g/plant was the most stable and economically feasible treatment.

Table 6 Effect of different rates of NPK fertilizer on economic analysis of banana plantlets

No	Particulars	NPK rates (g/plant)				
		0	2	4	6	8
1	Variable cost (SDG/1000plantlets)					
	Total fertilizer (kg) for 1000plantlets	0	2	4	6	8
	Fertilizer	0	6400	12800	19200	25600
	Fertilizer application	0	1250	2500	3750	5000
2	Total Cost (SDG/1000plantlets)	0	7650	15300	22950	30600
	Plantlets height (cm)	27	28	31	39	34
	Plantlets price (SDG)	1000	1000	1500	2000	1500
3	Gross return (SDG/1000 plantlets)	1000000	1000000	1500000	2000000	1500000
4	Net return (SDG/1000 plantlets)	1000000	992350	1484700	1977050	1469400

Table 7 Partial and dominance analysis for banana plantlets produced in greenhouse

Total fertilizer (kg) for 1000plantlets	Gross return (SDG/1000 plantlets)	Total variable Cost (SDG/1000 plantlets)	Net return (SDG/1000 plantlets)	Dominated
0	1000000	0	1000000	
2	1000000	7650	992350	D
4	1500000	15300	1484700	
6	2000000	22950	1977050	
8	1500000	30600	1469400	D

Table 8. Marginal analysis for banana plantlets produced in greenhouse

Total fertilizer (kg) for 1000plantlets	Gross return (SDG/1000 plantlets)	Total Cost variable (SDG/1000 plantlets)	Net return (SDG/1000 plantlets)	MC	MR	MRR
0	1000000	0	1000000			
4	1500000	15300	1484700	15300	484700	31.7
6	2000000	22950	1977050	7650	492350	64.4

Conclusion

The highest growth parameters, roots length, root girth, number of root per plant and highest marginal rate of return of banana plantlets were obtained under 6 g/NPK/plant.

References

Abdallah, Hala, M.; Mohamed, A. Ali. (2021). Effect of container size, urea and NPK fertilizers on quality and hardening time of banana cv. Grand Nain plantlets produced by tissue culture. The 60th Meeting of the National Crop Husbandry Committee, Agricultural Research Corporation. Wad Medani. Sudan.

Bewuket, G; Kebede, W.; Ketema, B. (2017). Effects of organic and inorganic NP fertilizers on the performance of garlic (*Allium sativum* L.) varieties at Koga, Northwestern Ethiopia. Journal of Biology, Agriculture and Healthcare 7(7):2224-3208.

CIMMYT. (1988). From agronomic data to farmer recommendations. An EconomicTraining Manual. Completely Revised Edition Mexico, D.F.

Ehassan, A.A.M; Abu-Sara, Asim, F; Elsir, A.; Eldin, S. M. (2005). Response of dwarf cavendish banana to potassium sulfate in sennar area. 40th Meetings of the National Crops Husbandry Committee. (ARC), Wad Medani, Sudan.

Idris, T. I. M; Salih, S. E.; Eltahir, F. H. (2015). Impact of fertilization on growth attributes of tissue culture derived banana (*Musa* spp.). Sudanese Journal of Agricultural Sciences, 2: 56-60.

Khalid, H; Rashid Al-Yahya. (2009). Effect of NPK fertilizer on growth and yield of banana in Northern Oman. Journal of Horticulture and Forestry, 1(8): 160-167.

Khalifa, A. B. A; Saeed, A.B.; Eljali, M.A.; Ali, I. A. (2021). Effect of NPK fertigation on yield and yield components of cucumber (*Cucumis sativus* L.) under greenhouse conditions. The 60th Meeting of the National Crop Husbandry Committee, Agricultural Research Corporation. Wad Medani. Sudan.

Rina, S. S. (2021). Plantlet Acclimatization at Various Concentrations of Foliar Fertilizer and Length of Containment. RSF Conference Series: Engineering and Technology, 1 (1): 244-247. https://proceeding.researchsynergypress.com/index.php/cset/index

Tarek, A. S; Said, M. El-Bialy; Mohammed, E. El-Mahrouk; Alaa, El-Dein Omara; Hossam, S. El-Beltagi and Hassan,El-Ramady.(2022). Acclimatization of In Vitro Banana Seedlings Using Root-Applied Bio-Nanofertilizer of Copper and Selenium Agronomy 12 (539):2-13.

Xiukang, W.; Yingying, X. (2016). Evaluation of the effect of irrigation and fertilization by drip fertigation on tomato yield and water use efficiency in greenhouse. International JournalofAgronomy. 2016, Article ID 3961903. http://dx.doi.org/10.1155/2016/3961903.

Yadav RN; Bairwa, H.; Gurjar, M. (2017). Response of garlic (*Allium sativum* L.) to organic manures and fertilizers. International Journal of Current Microbiology and Applied Sciences 6(10):4860-4867.