The Future of Horticulture

FSA

Article

Enhancement of 'Williams' Banana Productivity by Using Plant Compost as Partial Replacement of Mineral Nitrogen Fertilization

Hamdy I.M. Ibrahim[1,*]; Mohamed E.M. Eyssa[2] and Hassan E.M. Ibrahim[1]

[1]Depart. of Hort., Fac. of Agric., Minia University, Egypt.

[2]Depart. of Hort., Fac. of Agric., Fayoum University, Egypt.

[*]**Corresponding author:** hamdy_france@yahoo.com

Abstract: The response of 'Williams' banana ratoons, grown in loamy clay soil, to partial replacement of mineral nitrogen fertilizer with plant compost was studied. A field experiment was conducted at El- Gendia village, Beni-Mazar District El-Minia Governorate. The obtained results confirmed that replaced the mineral nitrogen fertilizers by using compost (as an organic fertilizer) at different percentages (25%, 50% and 75%) was lead to improving the Williams banana mineral statues, yield (kg/plant) and fruit physical and chemical properties of 'Williams' banana fruit. However, replaced 50% of mineral nitrogen fertilizer by using 50% compost produced the best mineral nutrients status, yield (kg), and fruit physical properties. While, fruit physical properties, and using 75% mineral + 25 % compost present the best chemical properties of 'Williams' banana cultivar.

Key words: Williams banana, compost, organic fertilizer, yield, fruit quality, nutritional status.

Future Science Association

Available online free at www.futurejournals.org

Print ISSN: 2692-5826

Online ISSN: 2692-5834

DOI: 10.37229/fsa.fjh.2024.10.04

Received: 25 August 2024
Accepted: 26 September 2024
Published: 4 October 2024

Publisher's Note: FA stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

1. Introduction

Banana plant (*Musa spp.* L.) is widely grown under hot and humid countries, it native to tropical and subtropical zones. It is widespread in all African countries. Banana plant is one of the largest herbal plants on world. Banana is monocotyledonous plant; botanically it belongs to Family *Musaceae* (**Rao, 1984** and **Pereira & Maraschin, 2015**). Some highly yielding cultivars were introduced and expanded in Egypt, including 'Williams' cultivar, subject of the current study. In Egypt, Banana considered as one of the most important commercial and favorite fruits. 'Williams' fruiting area reached 64382 fed., produced 995446 tons (Agric. Economic Bull. 2020, Ministry of Agric. and Reclamation, Cairo, Egypt). Williams banana cultivar is a hybrid belongs of *Cavendish*, it characterized by early season maturity and shortest vegetative growth cycle (**Rao, 1984**). It considered as one of the main banana cultivars in terms of widespread and economically. Williams cultivar characterized by: hardy pseudostem, which has a good

resistance to wind, heavy weight of bunch and large heads, good size of fruit and fruit sweet (**Maldonado *et al.*, 1998** and **Barakat *et al.*, 2011**). Currently, it considered as one of the major banana cultivars in El-Minia Governorate and other Egyptian rejoins. Banana plant classified as one of the voracity to fertilization (especially nitrogen fertilization). In the other side, increasing the mineral fertilization has very dangerous effects on human health and environment. Then reducing the mineral fertilization of banana becomes necessary. In this respect the link between organic fertilization (Eco-friendly fertilizers) and human health is one of the major concerns of consumers. However, natural sources of nitrogen fertilization such as organic fertilization (plant compost) can play an important role in this regard (**Xu *et al.*, 2000; Song *et al.*, 2012; Eissa 2016; Rajput *et al.*, 2017; Rinaldi *et al.*, 2007** and **Riahi *et al.*, 2009**).

The present investigation aimed to study the effect of partial replacing of mineral nitrogen fertilizers by using plant compost at different doses (25%, 50% and 75%) on nutritional status, yield and fruit quality of 'Williams' banana grown under El-Minia Governorate conditions.

2. Material and Methods

The present trail was conducted during 2021 and 2022 seasons on the second and third ratoons of 'Williams' banana plants grown in El- Gendia village, Beni-Mazar District El-Minia Governorate. Twelve stools, each one contains 3 plants uniforms in vigor of 'Williams' banana was chosen for achieving this trail. Whereas, the soil texture is loamy clay and well drained water. The chosen stools are planted at 3 X 3 meters apart.

2.1. Soil characters

The orchard soil was loamy clay (table 1). A composite sample was collected and subjected to physicochemical analysis in laboratory according to the procedures outlined by **Wilde *et al.* (1985**). Then, the data are shown in Table (1).

Table (1). Physical and chemical analysis of banana orchard soils

Constituents	**Values**
Sand %	9.40
Silt %	18.82
Clay %	71.78
Texture **EC mmhos / cm (1 : 2.5 Extract)**	Loamy Clay 1.05
Organic matter %	1.92
pH (1 : 2.5 extract)	7.6
Total CaCO3 %	1.88
N %	0.21
Available P (Olsen, ppm)	8.11
Exch. K^+ (mg/100g)	482.12
Exch. Ca $^{++}$ (mg/100g)	22.6

2.2. Experimental work

In order to study the effect of partial replacement of conventional mineral nitrogen fertilizer with organic fertilization (in form of plant compost) of 'Williams' banana productivity and fruit physic-chemical characteristics. Three replaced doses of mineral nitrogen fertilizer namely; 25%, 50%, and

75% from recommended dose (in form of Ammonium Nitrate 33.5% N), were replaced by using 25%, 50% and 75% plant compost (equal 10, 20 and 30 kg / stool).

2.3. Chemical analysis of compost

The plant compost used in this investigation was obtained from El-Nile Company for organic fertilizers. A compost sample was taken and chemical analyzed. The chemical analysis of compost was illustrated in Table 2.

Table (2). Chemical analysis of compost used in the investigation

Constituents	Values
pH	6.48
EC (mS/cm)	1.93
Density (g/cm^3)	2.45
Organic mater	53% (from dry weight)
N %	0.51 %
P %	0.049
K %	0.15
Ca %	1.49
Mg %	1.08
Fe (ppm)	451.2
Zn (ppm)	7.8
Mn (ppm)	13.2

2.4. Experimental design and statistical analyses

The present investigation was designed by using randomized complete Block design (RCBD) according to **Gomaz and Gomaz (1990**). Each treatment was replicated three times, one stool (three ratoons per each one). The obtained data were subjected to the proper statistical analysis of variance (ANOVA), using statistical package (MSTATC Program). Comparisons between means were made by using least significant differences (L.S.D) at p= 0.05 (according to **Snedecore and Cochran, 1990**).

2.5. The following parameters were determining

2.5.1. Leaf mineral analysis

Leaf samples were taken from the third upper leaf after bunch shooting during the two experimental seasons. A simple of 10 cm from the middle part of the leaf blades of the third leaf from the top as recommended by **Martin-Préval *et al.* (1984)** and **Ibrahim (2010)** was taken, washed with tap water and distilled water after, air dried and oven dried at 60 C^o overnight until a constant weight. Then, ground by using an electric mill. 0.5 gram of the ground powder material digested by using a mixture of H_2O_2 : H_2SO_4 (1 : 10 v/v) (according to **Chapman and Pratt, 1965**). The clear digestion transferred to 100 ml volumetric flask. Then the following mineral nutrients were determined: Nitrogen, by using the micro-Kjeldahl method as described by **(Wilde *et al.*, 1985)**. Phosphorus was determined colormetrically, by using Olsen method **(Wilde *et al.*, 1985)**. Potassium was determined by using Flame photometric methods, according to **Martin-Préval *et al.* (1984)**. Magnesium determined by using versene method (**Martin-Préval *et al.* (1984)**.

2.5.2. Yield and fruit quality

The punches picking: when the fingers reached three quarter, bunches were picked during the end of November during 2021and 2022 seasons. Average bunch weight in kg (before artificial ripening), average hand weight (kg) and the number of fingers per hand were measured and recoded. Sample of two hands were taken from the middle of part of bunch, as a sample, for achieving the physical and chemical properties. After the ripening of fingers, the following physical and chemical parameters were determined:

2.5.3. Physical and chemical parameters of fingers

Included finger weight (g) by using an accurate digital balance, Fingers dimensions (length and diameter in cm), Pulp to finger ratio (weight / weight) by weighting the pulp and peel. The percentage of each one was calculated and Pulp to fruit ratio was calculated. Fresh sample was taken from the pulp of five fingers taken and mixed by using electric blender, and the following chemical parameters were determined: TSS% (Percentage of total soluble solids) by using handy refractometer **(Rangana, 2000)**. Reducing, non-reducing and total sugars percentages as well as starch percentage were done by using Lane and Eynon (1965) volumetric method, outlined in **(Rangana, 2000)**. Percentage of titratable acidity (in term of malic acid grams / 100 g fruit pulp) were achieved by using titration against 0.1 N NaOH in presence of phenol-phthalein as an indicator **(AOAC, 200)**.

3. Results and Discussion

3.1. Leaves mineral contents

Data presented in Table (3) shows the impacts of partial replacement of mineral fertilizers by using plant compost on leaves mineral contents, during the both experimental seasons (2021 and 2022). It is clear from this table that, treated 'Williams' banana with compost as a partially replacement of mineral nitrogen fertilizers (at 25%, 50% and 75%) significantly improved 'Williams' banana macro-nutrients (N, P, K and Mg), compared to using 100% mineral fertilizers (control), during the two experimental seasons. Except the case of magnesium in the first season, whereas, replaced 25% from mineral fertilizer by 25% of plant compost hadn't any significant effect.

The control ratoons (received 100% RD mineral nitrogen fertilizers) present the lowest percentage of the four macro mineral elements (N, P, K and Mg) in their adult leaves compared to those received 25%, 50% and 75% mineral nitrogen fertilizers, and the remaining percentages was supplemented with compost. Increasing the percentage of replaced mineral nitrogen fertilizers ratio to 50% leads to clear and significant increase of the four macro elements (N, P, K and Mg) in 'Williams' banana leaves and present the best values during the two experimental seasons. However, increasing the percentage of replaced mineral nitrogen to 75% lead to a slight decline in adult leaves N, P, K and Mg of 'Williams' banana during the two experimental seasons compared to those received 50% compost.

Treated the fruit trees with compost can lead to improve mineral status. This increment can be related to stimulating the root growth, increasing the availability of mineral elements, decreasing the soil pH level, increasing the uptake of water and mineral elements (**Barakat *et al.*, 2011; Eissa, 2016; Rajput *et al.*, 2017; Zhanga *et al.*, 2019** and **Abobatta & El-Azazy, 2020).** This practical analysis of previous studies can explain the clear enhancement of macro-nutrients in the leaves of 'Williams' banana plants during the present investigation two seasons.

Table (3). Partial replacement of conventional mineral nitrogen fertilizer with compost and its effect on N, P, K and Mg of 'Williams' banana, during 2021 and 2022 seasons

Treatments	N %		P %		K %		Mg %	
	2021	2022	2021	2022	2021	2022	2021	2022
100% mineral N (control)	2.7	2.8	0.17	0.18	2.4	2.2	0.51	0.50
75% mineral + 25% compost	3.0	3.2	0.21	0.24	2.6	2.8	0.53	0.54
50% mineral + 50% compost	3.3	3.5	0.24	0.28	3.1	3.4	0.57	0.61
25% mineral + 75% compost	3.2	3.3	0.22	0.25	3.1	3.2	0.62	0.67
LSD at 5%	**0.1**	**0.2**	**0.02**	**0.03**	**0.2**	**0.2**	**0.04**	**0.04**

3.2. Yield and its components

Data illustrated in Table (4) pertaining to the average bunch weight (kg) and hand weight (kg) of Williams bananas second and third ratoons as influenced by treated the ratoons with compost as a partial replacing of conventional mineral nitrogen fertilizers at various doses (25%, 50% and 75%), during 2021 and 2022 seasons. The obtained data indicates that 'Williams' banana yield, in terms of bunch weight (kg) and hand weight (kg), significantly enhanced by the different compost treatments during both experimental seasons. The obtained data shows that, all treatments lead to significant improvement in average bunch and hand weight (kg).

It's clear from the same Table that increasing the replaced ratio of mineral nitrogen to 50% played an important role of increasing the bunch and hand weights (kg) compared to using 100% or 75% of mineral nitrogen fertilization. Furthermore, the ratoons received 50% mineral nitrogen plus 50% compost produced the best bunch and hand weight (kg), these findings were true during the two experimental seasons. Contrary, the ratoons received 100% nitrogen recommended dose in form of mineral fertilizer produced the lowest weights of bunch and hand (kg), during 2021 and 2022 seasons respectively. Replacement of mineral fertilizers (25%, 50% and 75%) with compost can lead to improving the yield in kg/plant. This positive effect can be related to increasing the essential nutrients availability and uptake, decreasing the soil pH level, the degradation of compost in soil produced some plant growth regulators, and makes the plants more resistance to extreme environmental condition (**Abd El-Moniem, 2008; Shaheen *et al.*, 2009; Zeid *et al.*, 2009; Eissa, 2016; Rajput *et al.*, 2017 and Zhanga *et al.*, 2019**).

Table (4). Partial replacement of mineral nitrogen fertilizers with compost, and its effect on yield and its components of 'Williams' banana, during 2021 and 2022 seasons

Treatments	Bunch weight (kg)		Hand weight (kg)		Finger weight (g)	
	2021	2022	2021	2022	2021	2022
100% mineral N (control)	21.1	20.5	1.7	1.8	87.3	89.7
75% mineral + 25% compost	27.2	28.3	1.9	2.0	92.2	96.2
50% mineral + 50% compost	30.1	31.7	2.1	2.3	99.2	105.7
25% mineral + 75% compost	29.1	30.7	2.2	2.3	91.5	92.2
LSD at 5%	**1.2**	**1.1**	**0.1**	**0.2**	**4.3**	**5.9**

3.3. Fruit physical properties

The statistical analysis of physical properties data of 'Williams' banana in connection to various partial replacement of mineral nitrogen fertilizer with compost are illustrated in Tables (4 and 5). The obtained data demonstrated that replaced 25% or 50% of mineral nitrogen fertilizers with compost lead to significant enhancement of fruit physical properties of 'Williams' banana plant during the two experimental seasons, in term of fruit weight, fruit length and fruit diameter. However, non-significant differences were observed in the pulp : fruit ratio during the two experimental seasons. Increasing the replacement ratio 75% failed to modify the physical properties of fruit significantly during the two experimental seasons. Except the case of fruit diameter during the second season. It is clearly shown that the ratoons of 'Williams' banana received 50% mineral nitrogen fertilizer + 50% in form of organic fertilizers (compost) produced the best fruit weight and fruit dimensions, in 2021 and 2022 experimental seasons. In the other side, the ratoons received 100% mineral nitrogen produced the lowest values.

This positive effect of replacing mineral nitrogen with compost on improving fruit physical properties of 'Williams' banana was previously conducted by some authors such as: **Baiae and EL-Gioushy (2015)**, on 'Grande Naine' banana ratoons grown under sandy soil conditions; **Abdel-Hafiz *et al.* (2016)** on 'Williams' banana grown under heat stress conditions, in Aswan Governorate – upper Egypt**Adriano *et al.*, 2012** on banana; ; **El-Aidy *et al.* (2012)** on Valencia orange **(2018)**, and **Rahman *et al.* (2021)** under India environmental conditions on 'Amritsagar (AAA)' banana cultivar.

It well known that the compost contents a higher percentage of organic matter, which leads to improve soil physical and chemical properties as well as microbiological population in root rizospher. Furthermore, compost lead to enhancing mineral nutrients solubilizing and uptake, water holding capacity and capacity of cations exchange (**Shiralipour *et al.*, 1992; El-*Aidy et al.*, 2018 and Rahman *et al.* (2021)**. These preferable functions certainly lead to improving the physical properties of 'Williams' banana fruit.

Table (5). Partial replacement of conventional mineral nitrogen fertilizers by using compost, and its effect on fruit physical properties of 'Williams' banana, during 2021 and 2022 seasons

Treatments	Fruit length (cm)		Fruit diameter (cm)		Pulp to fruit ratio	
	2021	2022	2021	2022	2021	2022
100% mineral N (control)	13.7	13.5	5.2	5.3	73.2	73.5
75% mineral + 25% compost	14.4	15.6	5.5	5.9	73.4	73.7
50% mineral + 50% compost	15.1	15.9	6.1	6.3	73.6	73.2
25% mineral + 75% compost	13.9	14.1	5.8	6.2	72.2	72.5
25% mineral + 50% compost + 25%AMF	13.2	13.9	5.2	5.8	73.3	71.3
LSD at 5%	0.7	0.6	0.2	0.2	NS	NS

3.4. Fruit chemical properties

Concerning the chemical properties of 'Williams' banana fruit, the statistical analysis of data in connection to various partial replacement ratio (25%, 50% and 75%) of mineral nitrogen fertilizers with compost are illustrated in Table (6). The obtained data clearly showed that replaced 25% to 75% of mineral nitrogen fertilizers by using compost lead to significant varying in the must fruit chemical properties of 'Williams' banana plant, during the two experimental seasons.

3.4.1. TSS and Sugars contents

It is clear from table (6) that replaced 25% of mineral nitrogen fertilizer by using compost (as an organic fertilizer) lead to significant enhancement of 'Williams' banana fruit TSS%, reducing sugars%, non-reducing sugars and total sugars during the two experimental seasons. On the opposite side, increasing the replaced mineral nitrogen percentage to 50% or 75% with 50% or 75% compost failed to improve the fruit TSS% and sugars contents, neither in the first seasons nor in the second one.

Table (8). Partial replacement of conventional mineral nitrogen fertilizers with compost and AMF, and its effect on fruit TSS% and sugars contents % of 'Williams' banana, during 2021 and 2022 seasons

Treatments	TSS %		Reducing sugars %		Non-reducing sugars %		Total sugars %		Total acidity %		Starch %	
	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022	2021	2022
100% mineral N (control)	18.2	18.7	6.0	6.1	11.2	11.3	17.2	17.5	0.312	0.309	1.04	1.05
75% mineral + 25% compost	19.1	19.6	6.4	6.8	11.7	11.8	18.1	18.6	0.285	0.279	1.10	0.94
50% mineral + 50% compost	18.4	19.3	5.9	6.1	11.1	11.2	17.0	17.4	0.317	0.319	1.04	1.02
25% mineral + 75% compost	17.9	18.3	5.9	5.9	11.5	11.0	17.6	17.8	0.309	0.301	1.14	1.16
LSD at 5%	0.5	0.6	0.4	0.5	0.5	0.4	0.7	0.6	0.021	0.27	NS	0.08

3.4.2. Total acidity and starch percentages

The results presented in Table (6) shows that, replaced 25% of mineral nitrogen with 25% compost significantly decreased the percentage of total acidity and total starch in fruit pulp during the two experimental seasons. The total acidity % and starch % in fruit pulp don't varied significantly as a result of increasing the replaced ratio of mineral nitrogen from 25% to 75% by using compost or/and AMF inoculation, in both experimental seasons. Data in Table (6) indicated that partial replacement of mineral nitrogen with organic manure (compost) failed to improve the percentages of the both examined criteria's (total acidity and starch percentages). Except, the cases of case of total starch percentage during the first season, whereas non- significant differences were obtained. On the opposite side increasing the replacement of mineral nitrogen to 50% and d75% failed to improved total acidity and total starch during the two experimental seasons.

The benefits effect of organic fertilizers (such as compost) on fruit physic-chemical properties depend on the recycling of organic nutrients supplied, which decreases the negative effects of chemical fertilizers. **Weber *et al.* (2010)** found that compost treatments can lead to improving fruit physic chemical properties. **Rahman *et al.*, (2021)** mentioned that treated kiwi trees with compost lead to increase the fruit volume, fruit dry matter, and some fruit chemical properties. **XU *et al.* (2000)** concluded that leaf photosynthesis activities are improved as a result of organic fertilizers application. The use of organic manure as sources of mineral nutrients to improve fruit quality has been established by (**AL-Kharusi *et al.*, 2009**; **Aly & Zagzog 2019**; **Rahman *et al.*, 2021**, and **Muhidin *et al.*, 2022**).

Significant improvement of TSS% and total sugar contents in Zaghloul dates were obtained as a result of treated the palms with organic fertilizer individually or combined with mineral NP K in comparison with 100% mineral fertilization (**Marzouk** and **Kassem, 2011**). Moreover, it is difficult for the fruit trees treated with organic fertilizers to achieve fruit chemical quality properties higher than those achieved with chemical fertilization, such as kiwifruit (**Rahman *et al.*, 2021**).

4. Conclusion

Under loamy clay soil in El-Minia Governorate conditions, partial replacement of mineral nitrogen fertilizers by using compost (as an organic fertilizer) at different percentages (25%, 50% and 75%) lead to improving the Williams banana mineral statues, yield (kg/plant) and fruit physical and chemical properties of 'Williams' banana fruit. However, replaced 50% of mineral nitrogen fertilizer by using 50% compost produced the best mineral nutrients status, yield (kg). While, fruit physical properties, and using 75% mineral + 25 % compost present the best chemical properties of 'Williams' banana cultivar.

References

Abd el Moniem, E.A.; Abd-Allah, A.S.E. and Ebeed, S.S. (2008). Effect of some organic and biofertilizer treatments on minimizing mineral nitrogen fertilization of Washington Navel orange trees. Arab Univ. J. Agric. Sci., Ain Shams Univ., 16 (2): 451-457.

Abdel-Hafiz, G.; Abdel-Galil, H.A.; Amin‘, K.I.A. and Ibrahim, R.A. (2016). Using the organic and bio-fertilizers as a partial substitute for mineral-N in 'Williams' banana orchards. Assiut J. Agric. Sci., 47 (3): 34 - 46.

Abobatta, W.F. and El-Azazy A.M. (2020). Role of organic and biofertilizers in citrus orchards. Aswan Univ. J. of Environ. Studies (AUJES), 1(1): 13-27.

Adriano, M. De. L.; Gutierrez, F.; Dendooven, L. and Salvador-Figueroa, M. (2012). Influence of compost and liquid bioferment on the chemical and biological characteristics of soil cultivated with banana *(Musa* spp. L.). J. of Soil Sci. Plant Nutr., 12 (1): 33-43.

AL-Kharusi, L.M.; Elardi, M.O.; Ali, A.; Al-Said, F.; Abdelbast, K.M. and S. AL-Rawahy, S. (2009). Effect of mineral and organic fertilizers on the chemical characteristics and quality of date fruits. Int. J. of Agric. Bio., 11: 290–296.

Aly, A.E. and Zagzog, O. I. (2019): Effect of mineral, organic and bio – fertilizers on growth of zaghloul date palm. J. of Product. & Dev., 24 (4): 727 – 741.

A.O.A.C. (2000). Official Methods of Analysis 16th Ed. A.O.A.C. Benjamin Franklin Station, Washington, D.C., S.A. pp. 490-510

Baiea, M.H.M. and EL-Gioushy, S. F. (2015). Effect of some different sources of organic fertilizers in presence of bio-fertilizer on growth and yield of banana cv. Grande Naine plants. Middle East J. of Agric. Res., 04 (4): 745 -753.

Baiea, M.H.M.; EL-Gioushy, S. F. and El-Sharony, T.F. (2015). Effect of feldspar and bio-fertilization on growth, productivity and fruit quality of banana *cv.* 'Grande Naine'. International J. of Environ., 4(4): 210-218.

Barakat, M.R.; El-Kosary, S. and Abd-Elnafea, M.H. (2011). Enhancing Williams banana cropping by using some organic fertilization treatments. J. of Hort. & Ornamental plants, 3 (1): 29 – 37.

Chapman, H.D. and Pratt P.F. (1978). Method and of analysis of soil, plant and water. Univ. of Calif. Divi. of Agric. Sci. 6th Ed. P: 56-64.

Eissa, M.A. (2016). Influence of compost and chicken manure applications on vegetative growth, nutrient uptake and yield of Balady mandarin trees. Middle East J. of Agric. Res., 5(4): 918-924.

El-Aidy, A.A.; Alam-Eldein, S.M. and Esa, W.M. (2018). Effect of organic and bio-fertilization on vegetative growth, yield, and fruit quality of 'Valencia' orange trees. J. of Product. & Dev., 23 (1): 111-134.

F.A.O (2021). Food and Agriculture Organization. Quarterly Bulletins of Statistics 8 No. (112): 31, Year Book Annuairo production, 45, (154 - 155).

Gomez, K. H. and Gomez, A. A. (1984). Statistical Procedures for Agriculture Research. John Willy and Sons, Inc., New York.

Ibrahim, H.I.M. (2010). Plant samples collection and analysis, Arabic vegan, 1st Ed. Published by Dar El-Fajr – Cairo Egypt.

Maldonado, J.F.M.; Cruzesilva, J.A.D.A.; Fernandes, S.G., Carvalho, S.M.P.D.E., Costa, R.A.; Oliveira, L.A.A., Sarmento, W.R.M.; Cunha, H. And Carvelho, A.C.P.P. (1998). Banana cultivation prospects, Technologies and viability. Hort. Abst. (69) :8.

Martin-Préval, P.; Gagnard, J. and Gautier, P. (1984). L'analyse végétale dans le contrôle de l'alimentation des plantes tempères et tropicales. 2nd Ed., Pp 810. Technique & Documentation – Lavoisier, Paris, France.

Marzouk, H.A. and H.A. Kassem, H.A. (2011). Improving fruit quality, nutritional value and yield of Zaghloul dates by the application of organic and/or mineral fertilizers. Scientia Hort., 127: 249–254.

Muhidin, S.; Nuraida, W.; Florista, D.A.; Nurmas, A.; Yusuf, D.N.; Alam, S. and Samai, S. (2022). The effect of organic manure on the growth of dwarf banana (*Musa paradisiaca L.*) under the natural shade. 5th Inter. Conf. on Agric., Environ. & Food Security, IOP Conf. Series: Earth & Environ. Sci. 977.

Pereira, A. and Maraschin, M. (2015). Banana (*Musa* spp) from peel to pulp: Ethnopharmacology, source of bioactive compounds and its relevance for human health. J. of Ethnopharmacology, 160 (3): 149-163.

Rahman, J.I.; Hazarika, D.N.; Borah, B. and Dhiraj Bhattacharjee, D. (2021). Effect of organic manures and inorganic fertilizer on the fruit quality of banana. Biological Forum An. Intern. J., 13 (4): 908-912. (2021).

Rajput, A.; Memon, M.; Memon, K.S; Tunio, S.; Sial, T.A. and Khan, M.A. (2017). Nutrient composition of banana fruit as affected by farm manure, composted pressumd and mineral fertilizers. Pak. J. of Bot., 49(1): 101-108.

Ranganna, S. (2000). Manual analysis of fruit and vegetable products. Edition Tata Mc Grow-Hill Publishing Company, New Delhi India, 634 P.

Rao, V.N.M. (1984). Banana New Delhi, India. Council of Agricultural Research, 99, 61.

Riahi, A.; Hdider, C.; Sanaa, M.; Tarchoun, N.; Kheder, M.B. and Guezal,I. (2009). The Influence of different organic fertilizers on yield and physico-chemical properties of organically grown Tomato. J. Sust. Agri. 33, 658–673.

Rinaldi, M.; Convertini, G. and Elia, A. (2007). Organic and mineral nitrogen fertilization for processing tomato in Southern Italy. Acta Hort. 758, 241–248.

Shaheen, M. A.; Eissa, M.A.; M. M. Saad, M.M. and Mahmoud, S.M. (2009). Influence of organic and biofertilization on growth, yield and fruit quality of Williams banana. J. Agric. Sci. Mansoura Univ., 34 (7): 8013 – 8025.

Shiralipour, A.; McConnell, D. and Smith, W. (1992). Physical and chemical properties of soils as affected by municipal solid waste compost application. Biomass and Bioenergy, 3: 261 – 266.

Snedecor, G.W. and Cochran, W.G. (1990): Statistical Methods, 7th Ed. The Iowa State Univ. Press Ames. pp 80-100.

Song, X.H.; Xie, K.; Zhao, H.B.; Li, Y.L.; Dong, C.X.; Xu, Y.C. and Shen, Q.R. (2012). Effects of Different Organic Fertilizers on Tree Growth, Yield, Fruit Quality, and Soil Microorganisms in a Pear Orchard. Europ. J. of Hort. Sci., 77 (5): 204-210.

Weber, O.B.; Lima, R.N.; Crisostomo, L.A.; Freitas, J.; Carvalho, J.A. and Maia, A. (2010). Effect of diazotrophic bacterium inoculation and organic fertilization on yield of Champaka' pineapple intercropped with irrigated sapota. J of Plant soil., 327: 355–364.

Wilde, S. A.; Corey, R. B.; Layer, J. G. and Voigt, G. K. (1985). Soils and Plant Analysis for Tree Culture. Oxford and IBH publishing Co., New Delhi, India.

Xu, H.L.; Ran, W. and Mridha, M.A.U. (2000): Effects of organic fertilizers and a microbial inoculant on leaf photosynthesis and fruit yield and quality of tomato plants. J. Crop Prod., 3, 173–182.

Zeid, F.A.; Nesiem, M.R.A.; Abd Elkader, A.M.M. and Hosny, S.S.A. (2009). Effect of mineral and bio-organic fertilization on growth, yield and chemical composition of banana plants. J. Agric. Sci. Mansiura Univ., 34 (7): 7953-7966.

Zhanga, J.; Bei, S.; Li, B.; Zhang, J.; Christie, P. and Xiaolin, L. (2019). Organic fertilizer, but not heavy liming, enhances banana biomass, increases soil organic carbon and modifies soil microbiota. Applied Soil Ecology, 136: 67–79.