Journal of Plant Production

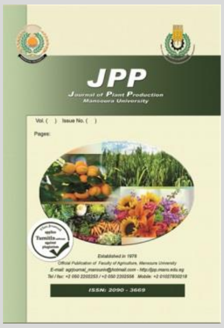
Journal homepage: www.jpp.mans.edu.eg
Available online at: www.jpp.journals.ekb.eg

Effect of Soil Potassium Fertilization and Foliar Spray of Different Potassium Sources on Growth, Yield and Fruit Quality of William Banana Plants

Cross Mark

Hussein, M. A.* and M. R. Gad El- Kareem

Hort. Dept. Fac. of Agric. Sohag Univ. sohag, 82524, Egypt.



ABSTRACT

This study was conducted during the 2018/2019 and 2019/2020 seasons in a private orchard located at Sohag governorate. To investigate the impact of soil potassium fertilization at 40, 60 and 80 % from recommended rates and foliar spray with Nano-Chitosan-K at 500, 1000 and 1500 ppm, potassium chelate at 0.5, 1 and 1.5 % and potassium Sulphate at (0.5, 1 and 1.5 %) on growth, yield and fruit quality of William banana. Results showed that treatments with soil potassium fertilization plus foliar spray with Nano-Chitosan-K or potassium chelate significantly increased vegetative growth, nutritional status, yield and fruit quality in William banana than other treatments. Application of soil potassium fertilization combined with foliar application of potassium was preferable to using soil potassium to improve yield. Application of soil potassium fertilization combined with foliar application with Nano-Chitosan-K was more effective than potassium chelate and potassium sulfate. The best results for fruit chemical qualities were measured using 60% mineral k plus 1000 ppm Nano-Chitosan-K.

Keywords: Potassium, Chitosan, Foliar fertilization, William banana.

INTRODUCTION

Banana is an important world crop. It is grown over 10 million hectares worldwide globally, estimated at 81.2 million metric tons per year, representing 40 % by weight of all world trade in fruits.

In Egypt, the Banana is considered one of the most important and popular fruit crops. The total fruiting area is 84205 feddans, with a total production of about 2105125-ton fruits. Sohag governorate occupied the seventh position in Egypt concerning the cultivated area of Banana. Also, the fruiting area is 3000 feddans produced 52657 metric ton fruits (according to Annual Reports of Statistics, 2020).

Potassium is an activator of many enzymes essential for photosynthesis and respiration and enzymes that produce starch and proteins (Bhandal and Malik, 1988). Potassium is also involved in the osmotic potential of cells and the turgor of guard cells that open and close stomata (Salisbury and Ross, 1992). It has been noted that around 50–90 % of applied fertilizer's potassium content is lost in the environment and unabsorbed by plants, which cause great economic losses (Solanki *et al*., 2015). Moreover, chemical fertilizers have low use efficiency, which increases production costs and results in pollution of the environment (Wilson *et al*., 2008). Therefore, it could help use and test other fertilizer methods to supply essential elements for banana plant growth and productivity, keeping the soil structure in good shape and the surrounding environment clean. Nanotechnology has become a new method for the development and application of new types of fertilizers. The nano-term is from the Greek word meaning many small. The word Nano equals the one-billionth part of a meter. Particles with at least one dimension less than a hundred nm are known as nanoparticles (Thakkar *et al*., 2010). Nano-fertilizers are nutrient carriers of Nano-dimensions ranging from 30 to 40 nm and hold bountiful of nutrient ions according to its high surface area and release it steadily and slowly that proportional to tree needs (Subramanian *et al*., 2015). Nano-fertilizers were classified into three groups according to Kah *et al*. (2018): nanomaterials made of micronutrients; nanomaterials made of macronutrients; and nanomaterials used as carriers for macronutrients. Nanoparticles of chitosan were recently used to bear ions of nutrient elements and introduce them to plants. Recently, Chitosan-based materials have been used to produce nanoparticles able to efficiently supply plants with chemicals and nutrients (Kah *et al*., 2013).

This study objective was to examine the impact of soil potassium fertilization at 40, 60 and 80 % from recommended rates in William banana plants and foliar spray with Nano Chitosan-K at 500, 1000 and 1500 ppm, potassium chelate at 0.5, 1 and 1.5 % and Potassium Sulphate at 0.5, 1 and 1.5 % on growth, yield and fruit quality of William banana.

MATERIALS AND METHODS

This research was performed during 2018/ 2019 (third ratoons) and 2019/ 2020 (fourth ratoons) on Williams banana plants (*Musa cavendishii*) grown in a private banana orchard situated at Awlad Salim village, Dar EI-Salaam district, Sohag Governorate. Soil is clay loam in texture and well-drained with a water table (1) depth not less than two meters. Williams banana plants are planted at 3.5 × 3.5 meters apart.

* Corresponding author.
E-mail address: kkk9932001@yahoo.co.uk
DOI: 10.21608/jpp.2021.102326.1071

To study the effect of using different rates of soil potassium fertilization and foliar spray (Nano-Chitosan-K, potassium chelate at and potassium Sulph ate) on growth, nutritional status, yield, and fruit quality in Williams banana plants. Thirty stools have nearly similar vigor chosen to do this research. All selected plants got the same agricultural practices like irrigation, fertilization, pest and disease control programs are usually done in this location. Plants were subjected to ten treatments; Each treatment was replicated three times, one stool per each. Each stool contained three plants for fruiting in the current season plus three suckers for fruiting in the following one.

Table 1. Some physical and chemical properties of the soil of the experimental site.

Soil property	Value	Soil property	Value
Sand (%)	29.2	Total N (%)	0.08
Silt (%)	: 29.7	P (ppm, Olsen method)	7.0
Clay (%)	: 41.1	K (ppm, ammonium acetate)	460.0
Texture	Clay loam	Soluble Mg (meq/ L.)	: 0.83
Organic matter (%)	1.51	Available Zn (EDTA extractable) (ppm):	: 1.6
$CaCO_3$ (%)	1.15	Available Fe (EDTA extractable) (ppm):	: 1.5
pH (1:1 suspension)	7.75	Available Mn (EDTA extractable) (ppm):	: 2.3
ECe (dS/m^{-1})	0.80	Available Cu (EDTA extractable) (ppm):	: 1.1

This experiment included ten treatments:

T1= 100 % of potassium sulphate recommended dose. (Control).

T2= 80 % of potassium sulphate recommended dose + 500 ppm Nano-Chitosan-K.

T3= 80 % of potassium sulphate recommended dose + 0.5% potassium chelate.

T4= 80 % of potassium sulphate recommended dose + 0.5% potassium sulphate.

T5= 60 % of potassium sulphate recommended dose +1000 ppm Nano-Chitosan-K.

T6= 60 % of potassium sulphate recommended dose + 1% potassium chelate.

T7= 60 % of potassium sulphate recommended dose + 1% potassium sulphate.

T8= 40 % of potassium sulphate recommended dose +1500 ppm Nano-Chitosan-K.

T9= 40 % of potassium sulphate recommended dose + 1.5% potassium chelate.

T10= 40 % of potassium sulphate recommended dose + 1.5% potassium sulphate.

Potassium sulphate (48 % K2O) was applied as a soil application at the rate of 100% (1166 g/stool), 80% (932.8 g/stool), 60% (699.6 g/stool) and 40% (466.4 g/stool) at two equal batches before bunch emergence and at bunch development (middle of Sept.). while Nano-chitosan–K fertilizer, potassium chelate and potassium sulphate was applied as a foliar application at three equal doses. These treatments were used at three stages, at the last week of March, before bunch emergence and bunch development (middle of Sept.). Nano-chitosan–K fertilizer was from the Genetic engineer department, Ain Shams University

Experimental design:

Experiments were performed using a randomized complete block design (RCBD) with three replications, one stool per each.

Various measurements:

Measurements of vegetative growth:

After the emergence of inflorescences at the beginning of July for third and fourth ratoons, the following growth characteristics were determined.

(1) Pseudostem height in (cm)was measured from the soil surface up to the last emerged leaf petiole.

(2) Girth of pseudostem (cm) in the base, middle and top of pseudostem was recorded then the average was calculated.

(3) Number of green leaves per plant was recorded.

(4) Leaf area (m^2) was recorded according to the following equation.

L. A = 0.67 (L × W) + 107.15 (Ahmed and Morsy, 1999), which

L = Leaf length (cm) and W = Leaf width (cm).

(5) Assimilation area (m^2) was calculated by multiplying the average leaf area by the number of green leaves / plant.

Leaf mineral analysis:

Leaf samples were taken from the third upper leaf in the descending leaves from the top of the plant after bunch shooting in September in the two seasons. A sample of 10 × 10 (cm) area from the middle part of the leaf blades, recommended by Martin- Prevel (1977), was taken for mineral analysis. Leaf samples were washed several times with tap water and distilled water after they dipped in a 0.1 N HCl. Samples were oven-dried at 60 – 70 ̊C until constant weight and then ground using an electric mill. The weight of 0.5 gram of the ground material was digested using a mixture of perchloric acid: sulphuric acid (1: 10) (v/v), according to Chapman& Parker (1961). The clear digestion was quantitatively transferred to 100 ml volumetric flask. In this solution, the following nutrients were determined:

(a) Total nitrogen was determined using the micro-kjeldahl method as described by Black *et al.*, (1965).

(b) Phosphorus was determined by using the method of Chapman and Pratt (1975).

(c) Potassium was determined by using Flame photometer, according to the method of Brown and Lilleland (1946).

(d) Magnesium was determined by versenate method according to Wilde *et al.*, (1985).

Measurements of yield and fruit quality:

The bunches both of third and fourth ratoons were picked in the middle of November in the 2019 and 2020 seasons when the fingers reached the three-quarter stage. Bunch weight in kg (before artificial ripening), and average hand weight (g), were recorded.

Three hands were taken from the base, middle and distal end of the bunch as a composite sample for the physical and chemical determination. Then, the chosen hands were wrapped with newspaper and arrested in closed wooden boxes with a glass surface to achieve artificial ripening. After the fingers ripened, the following physical determination were performed:

1- The weight of the finger (in g.) was weighted by using an analytical balance.

2- Fingers dimensions (width and length) (cm).

3- percentage of pulp weight = the pulp weight/ finger weight x 100.

A fresh composite sample was taken from pulp and mixed using an electric blender, then the following constituents were determined:

1- Percentage of total soluble solids by using a hand refractometer.
2- Percentages of reducing and total sugars using Lane and Eynon (1965) methods.
3- Percentages of total acidity (expressed as g. malic acid per 100 g. pulp) by titration with 0.1 N sodium hydroxide and using phenolphthalein as an indicator AOAC (1995).

Statistical analysis:

The obtained data were statistically analyzed using analysis of variance (Snedecor & Cochran, 1980); treatment means were compared according to New LSD at 0.5 level of probability.

RESULTS AND DISCUSSION

Results

Effect of Nano-chitosan – K, potassium chelate and potassium sulphate fertilizers application on vegetative growth of Williams banana plants.

Data in Table 2 and 3 indicate that all treatments significantly enhanced pseudostem girth, pseudostem height, the number of leaves, leaf length, leaf width, and leaf area expected T9 in both seasons of the study compared to control treatment. The highest values in this respect correspond to T5 (60 % of Potassium Sulphate recommended dose + 1000 ppm Nano-Chitosan-K) during the two seasons of study, respectively. In addition, the T10 (40 % of Potassium Sulphate recommended dose + 1.5% Potassium Sulphate) treatment significantly gave the lowest values in two seasons, respectively.

Effect of Nano chitosan– K, potassium chelate and Potassium Sulphate fertilizers application on bunch weight (kg.) and Hand weight (kg.) of Williams banana plants.

Data in table 3 show that T5 recorded the highest on bunch weight and Hand weight in both seasons, followed by T6. While T10 (40 % of Potassium Sulphate recommended dose + 1.5% potassium Sulphate) treatment tabulated the lowest values in that respect.

Table 2. Effect of Nano-chitosan – K, potassium chelate and potassium sulphate fertilizers application on vegetative growth of Williams banana plants.

Treatments	Pseudostem height(m)		Pseudostem girth (cm)		Number of green leaves		Leaf length(cm)	
	18/19	19/20	18/19	19/20	18/19	19/20	18/19	19/20
T1	2.04	2.14	76.87	77.96	20.03	20.93	217.26	209.36
T2	2.62	2.75	88.40	87.50	22.33	25.50	223.03	222.26
T3	2.39	2.45	83.83	85.46	20.53	23.66	222.33	217.76
T4	2.09	2.22	80.46	79.83	18.73	21.83	219.40	210.53
T5	2.80	2.89	91.53	90.00	24.33	27.66	227.00	226.66
T6	2.25	2.35	83.03	84.10	21.00	22.83	225.50	213.60
T7	2.14	2.35	81.50	80.86	24.33	22.13	220.96	220.16
T8	2.50	2.62	85.96	86.10	21.66	24.40	224.50	224.20
T9	1.97	1.93	73.03	71.23	19.30	20.23	210.86	208.13
T10	1.87	2.07	65.60	64.33	17.80	19.06	207.80	207.00
New L.S.D. at 5%	0.11	0.10	2.80	3.09	0.63	1.05	2.14	2.30

Table 3. Effect of Nano-chitosan – K, potassium chelate and potassium sulphate fertilizers application on some vegetative growth, bunch weight and hand weight of Williams banana plants.

Treatments	Leaf width(cm)		Leaf area (m^2)		Bunch weight (kg.)		Hand weight (kg.)	
	18/19	19/20	18/19	19/20	18/19	19/20	18/19	19/20
T1	68.06	70.60	0.98	1.04	20.36	20.90	1.77	1.77
T2	75.76	73.13	1.10	1.17	26.26	26.56	2.27	2.39
T3	71.36	74.00	1.04	1.15	22.70	22.73	1.96	1.97
T4	68.66	71.50	1.13	1.08	20.83	20.90	1.87	1.87
T5	77.33	78.63	1.19	1.21	28.56	27.90	2.83	2.78
T6	74.50	76.63	1.16	1.16	23.83	24.03	2.03	2.02
T7	66.43	69.53	0.93	1.01	19.93	19.83	1.93	1.92
T8	72.90	75.46	1.07	1.11	25.10	25.16	2.08	2.09
T9	70.40	72.23	1.01	1.08	21.80	21.90	1.83	1.83
T10	63.37	68.56	0.88	0.95	19.40	19.00	1.69	1.70
New L.S.D. at 5%	1.65	1.24	NS	0.001	0.99	1.15	0.14	0.12

Effect of Nano-chitosan – K, potassium chelate and potassium sulphate fertilizers application on N, P, K and Mg (%) content in the leaf of Williams banana plants.

Results in table 4 indicate that N% significantly increased in leaf by application of T5 (60 % of Potassium Sulphate recommended dose + 1000 ppm Nano-Chitosan-K) compared with other treatments in the two seasons of study. While, Control significantly gave the lowest values in two seasons, respectively of N% in leaf. Data also specified that all Nano-K fertilizer, potassium chelate and potassium sulphate treatments significantly increased N leaf compared to control treatment in both seasons of study. As for P%, Table 4 show that T5 (60 % of potassium sulphate recommended dose + 1000 ppm Nano-Chitosan-K) significantly increased P% in leaf compared with the other studied treatments during both seasons of study. The obtained data showed that control treatment had the lowest values during the two seasons. Data in the same table indicate that T5 significantly increased values of K% in the two experimental seasons. On the contrary, the lowest values this respect were detected by T1 (Control) during both seasons.

As for Mg%, Table 4 showed that T5 gave a significant increase of Mg% in leaf compared with the other studied treatments during both seasons of study. Meanwhile, control treatment showed the lowest values during both seasons.

Effect of Nano-chitosan – K, potassium chelate and potassium sulphate fertilizers application on finger physical characteristics of Williams banana plants.

The presented data Table 5 showed that T5 recorded the highest finger weight in both seasons, respectively followed by T6. While T10 in the first season and control treatment in the second season recorded the lowest values in this respect. Results in the same table pointed to the superiority of T5 in the case of finger length and finger width in both seasons of study. Data also revealed that all Nano-Chitosan-K, potassium chelate and potassium sulphate fertilizer treatments were significantly superior than control treatment in finger physical characteristics expected treatment with T10 (40 % of Potassium Sulphate recommended dose + 1.5% Potassium Sulphate) during both seasons of study.

Table 4. Effect of Nano-chitosan – K, potassium chelate and potassium sulphate fertilizers application on N, P, K and mg (%) content in leaf of Williams banana plants.

Treatments	N %		P %		K%		Mg%	
	18/19	19/20	18/19	19/20	18/19	18/19	19/20	18/19
T1	1.86	1.70	0.17	0.16	1.98	1.96	0.29	0.29
T2	2.39	2.21	0.36	0.35	2.87	2.83	0.52	0.54
T3	2.29	2.06	0.28	0.28	2.23	2.12	0.45	0.47
T4	2.08	1.88	0.24	0.24	2.17	2.09	0.37	0.38
T5	2.46	2.31	0.40	0.36	2.89	2.86	0.63	0.65
T6	2.31	2.18	0.30	0.31	2.03	2.03	0.42	0.44
T7	2.18	1.95	0.22	0.22	1.91	1.85	0.31	0.32
T8	2.33	2.20	0.32	0.34	2.65	2.58	0.48	0.50
T9	2.26	2.02	0.26	0.26	1.67	1.62	0.36	0.35
T10	1.97	1.81	0.20	0.20	1.80	1.74	0.34	0.33
New L.S.D. at 5%	0.06	0.03	0.08	0.01	0.22	0.24	0.04	0.04

Table 5. Effect of Nano-chitosan – K, potassium chelate and potassium sulphate fertilizers application on finger physical characteristics of Williams banana plants.

Treatments	Finger weight (g)		Finger length(cm)		Finger width (cm.)		Percentage of pulp	
	18/19	19/20	18/19	19/20	18/19	19/20	18/19	19/20
T1	95.83	92.56	16.02	16.19	95.83	92.56	16.02	16.19
T2	112.03	111.17	17.56	17.20	112.03	111.17	17.56	17.20
T3	101.43	101.23	16.77	16.79	101.43	101.23	16.77	16.79
T4	98.53	98.06	16.45	16.51	98.53	98.06	16.45	16.51
T5	125.33	125.07	18.02	17.56	125.33	125.07	18.02	17.56
T6	102.56	103.26	16.99	16.96	102.56	103.26	16.99	16.96
T7	99.63	98.96	16.64	16.67	99.63	98.96	16.64	16.67
T8	105.00	106.06	17.23	17.08	105.00	106.06	17.23	17.08
T9	97.10	96.20	16.24	16.38	97.10	96.20	16.24	16.38
T10	94.40	94.96	15.65	15.90	94.40	94.96	15.65	15.90
New L.S.D. at 5%	3.23	3.46	0.21	0.18	3.23	3.46	0.21	0.18

Effect of Nano-chitosan – K, potassium chelate and potassium sulphate fertilizers application on chemical properties of Williams banana plants fingers.

Results in Table 6 show that T5 (60 % of potassium sulphate recommended dose + 1000 ppm Nano-Chitosan-K) recorded the highest increase of Total soluble solids %, Total sugars % and Reducing sugars %. The lowest values for total acidity during the two study seasons when compared with the other treatments. In addition, it was noticed that the effect of treatments of Nano-chitosan – K, potassium chelate and potassium sulphate fertilizers treatments led to a significant increase in TSS %, Total and reducing sugars % and a significant decrease in total acidity compared with control treatment expected treatment with T10(40 % of potassium Sulphate recommended dose + 1.5% potassium sulphate). On the other hand, the control treatment significantly gave the lowest values of Total soluble solids %, Total and reducing sugars %. It gave the highest total acidity values in the 2018/2019 and 2019/2020 seasons.

Table 6. Effect of Nano-chitosan – K, potassium chelate and potassium sulphate fertilizers application on chemical properties of Williams banana plants fingers

Treatments	Total soluble solids %		Total sugars %		Reducing sugars %		Total acidity %	
	18/19	19/20	18/19	19/20	18/19	19/20	18/19	19/20
T1	18.73	19.16	13.61	13.56	5.36	5.13	0.35	0.35
T2	20.33	20.70	17.13	17.03	6.60	6.50	0.25	0.22
T3	19.73	20.23	15.61	15.60	6.33	6.06	0.31	0.32
T4	19.23	19.76	13.98	14.07	6.10	5.86	0.31	0.30
T5	20.86	21.10	17.26	17.16	6.83	6.63	0.20	0.18
T6	19.83	20.33	16.66	16.56	6.40	6.20	0.29	0.28
T7	19.36	19.93	14.13	14.18	6.23	5.96	0.29	0.29
T8	20.10	20.53	16.90	16.80	6.53	6.36	0.20	0.18
T9	19.53	20.03	13.89	13.91	6.00	5.70	0.27	0.25
T10	19.03	19.50	13.78	13.79	5.76	5.53	0.28	0.27
New L.S.D. at 5%	0.27	0.27	0.24	0.29	0.21	0.18	0.001	0.001

Discussion:

The positive effect of potassium application on yield, fruits quality and leaf potassium content of Williams banana plants are in line with those reported by Mengel (1997). Potassium is critical in water relations and transport and accumulation of sugars in the plant. With suitable K, bananas increase in vigor and disease resistance, improve fruit weight and increase the number of fingers per bunch, as well as weight and diameter of the finger (Atim *et al*., 2013 and Silva *et al*., 2013)

The interaction between different potassium levels and Nano chitosan – K, potassium chelate and Potassium Sulphate concentrations increased significantly all chemical characteristics (Total soluble solids %, Total and reducing sugars %) of Williams banana plants as compared to control treatment in both seasons. These results agree with those found by Ibrahim *et al.* (2019). They observed that the foliar spraying treatments with Nano trace elements and/or Nano-chitosan significantly affected TSS, acidity, and TSS/acid ratio of Superior seedless grapevines. In addition, Gill *et al.* (2012) showed the highest TSS with three foliar application of K_2SO_4 at 2% in Patharnakh pear., Similar results were also obtained by (El-Sese *et al*., 1988); they mentioned that TSS/acid ratio of "Thompson seedless" grapevines was improved as K application-level increased. These results are parallel with those reported that K enhances the translocation of sugars and starch (Ramming *et al*., 1995). The increase in TSS might be due to the hydrolyzation of starch into simple sugars with the role of potassium in the translocation of sugar from leaves to fruits (Kumaran *et al*., 2019). In the same line, Chandrakumar *et al*., (2001) reported improvement in the growth characters of Robusta Banana due to increased K levels. Similar results were also obtained by Baruah and Mohan (2001) on Banana. The improvement in fruit weight and length may be attributed to increased cell division and photosynthetic activities (Kumaran *et al*., 2019).

Many researchers have extensively studied the advantages of potassium in plant nutrition. Potassium is considered a vital mineral nutrient for all protein synthesis stages that contribute to all plant growth processes (Arquero *et al*., 2006). In addition, it controls many enzyme activities in plants by modulating the rate of photosynthesis and increasing the rate of translocation from leaves through the phloem to storage tissue, which leads to improve yield and fruit quality (Saykhul *et al*., 2013). Furthermore, Southwick *et al*. (1996) reported that the uptake of potassium absorption from the foliar spray might be more predictable and efficient than uptake from the soil, where soil-cation interactions may delay the process.

REFERENCES

Ahmed, F. F. and Morsy, M. H. (1999): A new method for measuring leaf area in different fruit crops. Minia J. of Agric. Res. & Develop.,19: 97-105.

Annual Reports of Statistical and Agricultural Economics in Arab Republic of Egypt. (A.R.E): (2020).

Arquero, O., Barranco D. and Benlloch M. (2006): Potassium starvation increases stomatal conductance in olive trees. HortScience, 41: 433–436.

Association of Official Agricultural Chemists, (1995): Official Methods of Analysis 14th ed. (AOAC) Benjamin Franklin station, Washington DC. USA, pp. 490 – 510.

Atim, M., F. Beed, Tusiime G., Tripathi L. and van Asten P. (2013): High potassium, calcium, and nitrogen application reduce susceptibility to banana Xanthomonas wilt caused by *Xanthomonas campestris* cv. musacearum. Plant Dis., 97:123-130.

Baruah, P.J. and Mohan, N.K. (2001): Effect of Potassium on yield attributing character of Banana. Haryana, J. Hort. Sci., 30(3/4): 205-206.

Bhandal, J.S. and Malik C.P. (1988): Potassium estimation, uptake, and its role in the physiology and metabolism of flowering plants. International Review of Cytology, 110: 205-254.

Black, G. A., Evans, D. D., Ersminger, L. E., White, J. L. and Clark, F. E. (1965): Methods of Soil Analysis. An Soc. Agron. Inc. Bull. Madison Wisconsin, U.S.A. pp. 891-911.

Brown, J.D. and Lilleland, O. (1946): Rapid determination of potassium and sodium in plant material and soil extract by flame photometry. Proc. Amer. Hort. Sci., 48, 341-346.

Chandrakumar, S.S., Thimmegouda, S., Srinivas, K. and Reddy, B.M.C. (2001): Performance of Robusta Banana under Nitrogen and Potassium Fertilization. South Indian Hort., 49: 92-94.

Chapman, H. D. and Parker, F. (1961): Determination of NPK Method of Analysis for Soil, Plant and Water. Put. Div. Agric. Univ. California, USA.

Chapman, H. D. and Pratt P. F. (1975): Methods of Analysis for Soil, Plant and Water. Univ. of California. Division of Agric., Sci. pp. 172-173.

El-Sese, A.M, El-Gamy S.Z. and Hussein M.A. (1988): Effect of potassium application on the yield and fruit quality of table Banati grapes (*Vitis vinifera* L.). Assiut J. Agric. Sci., 19: 247-258.

Gill, P.P.S., Ganaie M.Y., Dhillon W.S. and Singh N.P. (2012): Effect of foliar sprays of Potassium on fruit size and quality of „Patharnakh‟ pear. Indian Journal of Horticulture, 69(4): 512-516.

Ibrahim M.M., Ali A.A. and Serry N.K.H. (2019): Effect of Nano trace elements and Nano chitosan foliar application on productivity and fruits quality of grapevine CV. 'Superior seedless' .Hort. Sci. & Ornamen. Plants, 11 (1): 07-13.

Kah, M., Tiede K., Beulke S. and Hofmann T. (2013): Nano-pesticides: State of knowledge, environmental fate, and exposure modeling. Crit. Rev. Environ. Sci. Technol., 43: 1823–1867.

Kah, M., Kookana R.S., Gogos A. and Bucheli T.D. (2018): A critical evaluation of nano pesticides and nano fertilizers against their conventional analogs. Nat Nanotechnol., https://doi.org/10.1038/s41565-018-0131-1.

Kumaran P.B., Venkatesan K., Subbiah A. and Chandrasekhar C.N. (2019): Effect of pre-harvest foliar spray of potassium schoenite and chitosan oligosaccharide on yield and quality of grapes var. Muscat Hamburg. International Journal of Chemical Studies, 7(3):3998-4001.

Lane, J. H. and Eynon, L. (1965): Determination of reducing sugars of means of Fehlings solutions with methylene blue as indicator. A. O. A. C. Washington D. C., U.S.A.

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 Carvalho, A. C. P. P. (1998): Banana Cultivation Prospects, Technologies and Viability. Hort. Abst., 69: 8.

Martin- Prevel, P (1977): Echantillonnage du bananier pour l`analyse foliaire: consequences des differences de techniques. Fruits, 32: 151 – 166.

Mengel, K. (1997): Food security in the WANA region, the essential need for balanced fertilization. pp.157-174. In: Johnston, A.E. (ed.) Proceedings of the Regional Workshop of the International Potash Institute held at Bomova, Izmir, Turkey, 26-30 May 1997, IPI, Bern, Switzerland.

Ramming, D.W., Roland T. and Badr S.A. (1995): 'Crimson Seedless': a new late-maturing, red seedless grape. HortScience, 30:1473-1474.

Salisbury F.B. and C.W. Ross (1992). Plant Physiology. 4th Edition. Wadsworth Publishing Company, USA.

Saykhul, A., Chatzistathis T., Chatzissavvidis C., Koundouras S., Therios I. and Dimassi K. (2013): Potassium utilization efficiency of three olive cultivars grown in a hydroponic system. Sci. Hortic., 162: 55–62.

Silva, I.P., Silva J.T.A., Pinho P.J., Rodas A.L., and Carvalho J.G. (2013): Vegetative development and yield of the banana cv. 'Prata Anã' as a function of magnesium and potassium fertilization. Idesia (Chile), 31:83-88.

Snedecor, G.W. and Cochran W.G. (1980): Statistical Methods. Oxford State Univ., Press, Iowa USA. 6th edition.

Solanki P., Bhargava A., Chhipa H., Jain N. and Panwar J. (2015): Nano-fertilizers and their smart delivery system. In: Rai M, Ribeiro C, Mattoso L, Duran N (eds) Nanotechnologies in Food and Agriculture. Springer, Switzerland, pp 81–101.

Southwick, S.M., Olson W. and Yeager J. (1996). Optimum timing of potassium nitrate spray application to' French' prune trees. J. Am. Soc. Hortic. Sci., 121: 326-333.

Subramanian, K.S., Manikandan A., Thirunavukkarasu M. and Rahale C.S. (2015): Nano-fertilizers for balanced crop nutrition. In: Rai M, Ribeiro C, Mattoso L, Duran N (eds) Nanotechnologies in Food and Agriculture. Springer, Switzerland, pp 69–80.

Thakkar, M.N., Mhatre S. and Parikh R.Y. (2010): Biological synthesis of metallic nanoparticles. Nanotechol. Biol. Med., 6:257–262.

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, pp. 96-106.

Wilson M.A., Tran N.H., Milev A.S., Kannangara G., Volk H. and Lu G. (2008): Nanomaterials in soils. Geoderma, 146(1):291–302.

تأثير التسميد الارضى والورقي بمصادر مختلفة من البوتاسيوم على النمو والمحصول وصفات ثمار الموز الوليامز

محمد احمد حسين و محمود رياض جاد الكريم

قسم البساتين –كلية زراعة سوهاج– جامعة سوهاج – مصر.

أجريت هذه الدراسة خلال موسمى2019/2018 و 2020/2019 فى مزرعة خاصة تابعة لمحافظة سوهاج على الموز الويليام المنزرعة فى تربة طمييه ويروى بنظام الرى بالغمر ومنزرع على مسافة 3.5 × 3.5 م وذلك بهدف دراسة تأثير الرش الورقى بسماد البوتاسيوم النانو المحمل على الشيتوسان بثلاث تركيزات (500 ، 1000 و 1500جزء فى المليون) وشيلات البوتاسيوم بثلاث تركيزات (0.5 ،1و 1.5 %) وسلفات البوتاسيوم بثلاث تركيزات (0.5 ،1و 1.5 %) مع التسميد الأرضى بسلفات البوتاسيوم بمعدل (80 ، 60 ، 40 %) من الجرعة الموصى بها على النمو الخضرى والمحصول وجودة االثمار . أظهرت نتائج الدراسة أن جميع معاملات التسميد بالبوتاسيوم النانو وشيلات البوتاسيوم كانت ذات تأثير ايجابى فى زياد النمو ومحتوى الأوراق من العناصر والمحصول وجودة ثمار الموز ويليام. كان استخدام سماد البوتاسيوم نانو مع التسميد الارضى بسلفات البوتاسيوم افضل من الرش الورقى بشيلات البوتاسيوم وكبريتات البوتاسيوم مع التسميد الارضى بسلفات البوتاسيوم. وكان واضحا من النتائج أن المعاملة (60 % معدنى + 1000 جزء فى المليون نانو بوتاسيوم) تفوقت على باقى المعاملات بالنسبة لتحسين النمو الخضرى والمحصول و صفات الجودة في الثمار حيث سجلت أعلى قيم للمواد