Annals of Agric. Sci., Moshtohor ISSN 1110-0419
Vol. 59(3) (2021), 803 – 814 https://assjm.journals.ekb.eg

The Influence of Potassen-N and Em on Some Phonological Measurements, Productivity, and Fruit Quality of Williams Banana Plants

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Abstract

The current study was carried out on an experimental farm at the El-Kanater Horticultural Research Station in Qayubeia Governorate, Egypt, and lasted two seasons in 2018 and 2019. Banana plants of the "Williams" cultivar were grown in clay loamy soil with the mates (plantation holes) 3x4 meters apart under the flood irrigation system. The purpose of this investigation was to study the effect of Potassen-N and EM on some phonological measurements, productivity, and fruit quality in "Williams" Banana plants. In any case, an experiment included the following nine treatments: (1) T1 stands for control (100 percent minerals NPK or RD), (2)T2-RD + Potassen-N at1 L/Fed (3) T3-RD + Potassen-N at 1 L/Fed + EM at 10 L/Fed (4) T4-RD + Potassen-N at 2 L/Fed(5) T5-RD + Potassen-N at 2 L/Fed + EM at 10 L/Fed (6) T6- RD + Potassen-N at 3 L/ Fed (7) T7- RD + Potassen-N at 3 L/Fed + EM at 10 L/Fed, (8) T8- RD + Potassen-N at 4 L/Fed + EM at 10 L/Fed and (9) T9- RD + Potassen-N at 4 L/Fed + EM at 10 L/Fed The obtained results revealed a positive correlation between the values of the studied parameters (Vegetative growth, productivity, fruit quality, and nutritional status) and the treatments under consideration. T9: T9-RD + Potassen-N at 4 L/Fed + EM at 10 L/Fed were statistically superior in this case. T1: 100 percent minerals NPK or RD and T2-RD + Potassen-N at 1 L/Fed, on the other hand, achieved the lowest values of these parameters. Furthermore, in both seasons of research, the remaining treatments occupied a position in the middle of the treatments mentioned above. Finally, based on the results obtained, it can be concluded that the use of RD + Potassen-N at 4 L/Fed + EM at 10 L/Fed and/or RD + Potassen-N at 3L/Fed + EM at 10 L/Fed could be safely recommended under similar environmental and horticultural practices as those used in this experiment.

Keywords: Banana, Williams, Potassen-N, EM, phonological measurements, productivity, and fruit quality.

Introduction

Banana (*Musa sp*.) is a major crop in tropical and subtropical regions of the world. In Egypt, it represents the most important fruit crop after citrus and grapes. It covers an area of 28667 hectares with a production of 1228458 tons in **2017** (**FAO STAT**). Among crop management practices, plant nutrition, in particular, represents one of the major factors influencing banana yield. Moreover, all soils are deficient in N, P and K (**Akhtar *et al.*, 2003**), besides, soil organic matter contents are low (**Abbas *et al.*, 2012**) and this is true in newly reclaimed lands in Egypt. Fertilization is very important not only to meet the crop requirements but also to improve soil fertility. Moreover, banana is the world's fourth-largest fruit crop, trailing only grapes, citrus, and apple. It is important in tropical economics as a cash export as well as a complementary food in local sets. Bananas have a high economic value as one of the most popular fruits in Egypt due to their high nutritive value, cheap source of energy (high starch content, vitamins, other minerals and traces of fat (**Abdel-Moniem *et al.*, 2008**).

Williams banana is an excellent performer due to its large bunch, longer fingers, and excellent taste. It requires a relatively large amount of nutrients to maintain the high production with high fruits quality due to its large size and rapid growth rate (**Saleh, 1996**). As a result, the major issues confronting banana growers are the high costs of excessive manufactured fertilizer requirements. Furthermore, during their production and use, these chemical fertilizers are considered polluters of the air, soil, and water. (**Abdel- Moniem *et al.*, 2008**).

Potassium is required for essential physiological functions such as sugar and starch formation, protein synthesis, and cell division and growth (**Obreza, 2003; Abbas and Fares, 2008**). It is also necessary for the formation and function of proteins, fats, carbohydrates, chlorophyll, and the maintenance of salt and water balance in plant cells. Potassium is required for four physiological biochemical functions: enzyme activation, membrane transport, anion neutralization, and osmotic potential.

Effective microorganisms (EM1) is a biofertilizer, the basic purpose of EM is the restoration of a healthy ecosystem in both soil and water by using three major genera of microorganisms which are found in nature: phototrophic bacteria (*Rhodopseudomonas*), lactic acid bacteria (Lactobacillus) and yeast (*Saccharomyces*). EM contains *Lactobacillus plantarum,* L. *casei,* L. *fermentum, L. delbrueckii, Saccharomyces cerevisiae and Rhodopseudomonas palustris* (**Abd-Rabou, 2006** and **Higa, 2010)**. Higher yield in the EM treatments can be correlated with improved soil chemical and physical conditions, as determined by the use of effective microorganisms during the citrus plants' bloom and fruit formation in late winter. Effective microorganisms (EM) are used to improve soil fertility, fertilizer efficiency, and fruit tree productivity. (**Higa and Wididana, 1991; El-Haddad *et al.*, 1993; Kannaiyan, 2002 and El-Salhy *et al.*, 2006**).

The basic goal of EM is to use natural microorganisms to restore a balanced environment in both soil and water. In general, EM technology has been widely adopted around the world and is recognized as a versatile and effective method in agriculture and horticulture for crop and animal production systems (**Chamberlain *et al.*, 1997**). EM is used to boost soil fertility and organic farming practices. (**Higa and Wididana, 1991**).

Following that, this study was designed to look at the effects of foliar spraying Williams banana plants with Potassen-N as well as soil application of an EM compound on yield and fruit quality.

Materials and Methods

This study was conducted on 1st and 2nd Williams banana ratoons grown in clay loamy soil of a banana orchard belonging to the Horticultural Research Station at Al-Kanater Al-Khairia, Qaliubia Governorate, Egypt, during the 2018 and 2019 experimental seasons-Mats (plantation holes) were 3x4 meters apart. Before experiments had been conducted in 1st season, mechanical and chemical analyses of orchard soil surface (0–30 cm depth) were determined according to methods described by **Piper, (1950)** and **Jackson, (1967)** as shown in Table (1).

Table A. Mechanical and chemical analyses of experimental orchard soil 0- 30 cm depth in the 2019 season.

A- Physical analysis						
Sand (%)	**Silt (%)**	**Clay (%)**	**Soil texture**	**F.C. (%)**	**W.P. (%)**	**A.W. (%)**
17.7	**29.1**	**53.2**	**Clay loamy**	**42.5**	**21.2**	**20.1**

B- Chemical analysis										
	Available nutrients (mg/kg)							**E.C. ds/m**	**pH (1: 25)**	**$CaCO_3$**
	N	**P**	**K**	**Fe**	**Zn**	**Mn**	**Cu**			
Total	677	340	452.5	3156	113	146	47	3.71	7.8	3.6
Avail.	63	13.7	61.2	21.1	5.7	16.6	2.6			

Chemical NPK Fertilizers (RD):

One rate of chemical fertilizers NPK was employed in this study: 100 % of chemical NPK from ammonium nitrate 33.5% N, superphosphate 15.5 % P_2O_5 and potassium sulphate 48% (K_2O) equal (2.68; 0.7 and 2.0 kg/plant), respectively. **Ibrahim (2003)**. They applied at four equal batches in the first week of March; May; July and September.

Rate and application method of bio-fertilizers :

Bio-fertilizers treatments: Effective Microorganisms (EM) preparation was added as soil drench three times at the rate of 10 liters per fedden (10 cm^3 per plant) at the one-month interval, starting in March 1st, which was supplied by the Department of Microbiology, Agric. Res. Inst., Giza was used in this study as the biological activator.

Rate and application method of Potassen-N :

Potassen-N contains 30% K_2O and 5% NO_3 foliar spray six times a year starts in March and after one-month interval.

The experiment consisted of nine treatments as follows:

1- T1- Control (100 %Minerals NPK) (RD).
2- T 2- RD + Potassen-N at 1 L/Fed
3- T3- RD + Potassen-N at 1 L/Fed + EM at 10 L/Fed
4- T4- RD + Potassen-N at 2 L/Fed
5- T5- RD + Potassen-N at 2 L/Fed + EM at 10 L/Fed
6- T6- RD + Potassen-N at 3 L/ Fed
7- T7- RD + Potassen-N at 3 L/ Fed + EM at 10 L/Fed
8- T8- RD + Potassen-N at 4 L/Fed
9- T9- RD + Potassen-N at 4 L/ Fed + EM at 10 L/Fed

Experimental layout:

The complete randomized block design with three replications was used for arranging the differential investigated treatments. Every replicate was represented by four stools with 3 similar plants (ratoons) left per each for cropping in the current season and following one. The selected stools (mats) required for each experiment were equally classified according to their vigor into 3 categories, whereas plants of the category were subjected to their own investigated treatments.

1. Some phonological measurements:

1.1. Time to flowering:

Duration extended from sucker emergence till shooting of inflorescences in days was estimated.

2.1. Time from bunch shooting to harvesting:

Duration needed from bunch shooting till harvesting (maturation) in days was also calculated.

3.1. Life cycle:

Duration extended from sucker emergence till harvesting (maturation) in days was also calculated.

2. Yield parameters:

Bunch length; bunch circumference (cm); bunch weight (kg) after cutting; the number of hands per bunch; the number of fingers per bunch and bunch length (cm.) were determined as yield parameters. As well, the yield was calculated according to the following equations for both seasons:

Yield (ton/Fed) = bunch weight (kg) x number of plant (1050 plants)/ Fed /1000

3. Fruit quality:

Samples each of two hands from the middle portion of every bunch were ripened by wrapping with the newspaper in closed polyethylene bags and kept at room temperature until reaching the ripe stage of yellow flecked with brown. After ripening, the following fruit physical and chemical characteristics were determined:

3.1. Fruit physical characteristics:

3.1.1. Finger length in (cm): By measuring the length of the finger with the pedicel.

3.1.2. Finger diameter in (cm): By measuring the middle part of the finger using a vernier caliper.

3.1.3. Finger weight: It was done by weighing all fingers of each hand then the average weight of each finger/fruit in (g) was calculated.

3.1.4. Pulp weight, peel weight (g) and pulp/peel ratio: Fresh pulp and peel weight in (g), as well as pulp/peel ratio of the finger, was determined.

3.1.5. Pulp and peel percentages: pulp and peel percentages of the finger were calculated.

3.2. Fruit chemical properties:

3.2.1. Total soluble solids (TSS):

A Carl Zeiss hand refractometer was used to determine the total soluble solids percentage in the pulp.

3.2.2. Total Titratable acidity:

Total Titratable acidity was determined and calculated as grams of malic acid in 100 grams of fresh pulp by titration with a 0.1 N NaOH solution using phenolphthalein indicator according to the method described by **A.O.A.C (2000).**

3.2.3. Total soluble solids content/acid ratio: TSS/acid ratio was estimated from results recorded of fruit juice TSS and total acidity by dividing TSS% over total acidity.

3.2.4. Total sugars and reducing sugars: Percentage of both total sugars and reducing sugars in the fresh pulp of ripened fruits were determined calorimetrically according to **Smith *et al.*, (1956)**.

3.2.5. Total carbohydrates and starch: Total carbohydrates and starch % of fresh fruit pulp were determined calorimetrically according to **Smith *et al.*, (1956)**.

4. Statistical Analysis:

All data obtained during both seasons of the study were subjected to analysis of variances according to **Snedecor and Cochram, (1980)** and significant differences among means were determined according to Duncan's multiple test range **Duncan, (1955).**

Results and Discussion

Phonological measurements:

Time to flowering (days) Time to harvesting (days).

The period from sucker emergence to bunch shooting (time to flowering), also, the period from bunch shooting to harvesting date (time to harvesting) were affected by increasing the rate of Potassen-N as well as adding of EM. Herein data showed significant decreases in time to both flowering and harvesting compared to the other treatments. Results in **Table (2)** showed that using T9 (RD + Potassen-N at 4L/ Fed + EM at 10L/Fed) Followed by T7 (RD + Potassen-N at 3L/ Fed + EM at 10L/Fed) and T6 (RD + Potassen-N at 3L/ Fed), gradually and significantly shorted the time to flowering. On the contrary, T1 (Control (100 %Minerals NPK) (RD) gave the longest period to flowering during both seasons of study. Other treatments were intermediate to the above-mentioned two extents.

Time to the harvesting of plants was decreased by increasing the rate of Potassen-N during both seasons. In this respect manner, T9 (RD + Potassen-N at 4L/ Fed + EM at 10L/Fed) Followed by T8 (RD + Potassen-N at 4L/ Fed) gave the shortest period to harvesting during both experimental seasons. An opposite trend was true with T1 (RD) which gave the longest period to harvesting during both seasons of study.

Duration cycle:

Application of Potassen-N as mineral sources plus EM reduced the total duration of the crop in two tested seasons as shown in **Table (2)**. Herein applied Potassen-N as mineral sources plus EM exerted its effect on total crop duration mainly by influencing the days to shoot. There was a reduction of (58 and 64 days) in the total crop duration period exhibited by T9 (RD + Potassen-N at 4L/ Fed + EM at10L/Fed) during the first and second season, respectively, Potassen-N as mineral sources of N and K plus EM as a source of bio-fertilizers helping the plant to attain early physiological maturity.

Table 2. Effect of Potassen-N and EM treatments on flowering of Williams Banana plants during 2018 and 2019 experimental seasons.

Parameters / Treatments	Time to flowering (days)		Time to harvesting (days)		Duration cycle (days)	
	2018	2019	2018	2019	2018	2019
T1- Control (100 %Minerals NPK) (RD)	403.67 a	403.00 a	130.33 a	133.33 a	533.33 a	536.33 a
T 2- RD + Potassen-N at **1L/Fed**	401.67 a	396.33 b	129.67 a	133.00 a	532.00 a	529.33 b
T3- RD + Potassen-N at **1L/Fed + EM** at **10L/Fed**	383.67 b	382.67 c	125.67 b	129.67 b	506.67 b	510.00 c
T4- RD + Potassen-N at **2L/Fed**	380.33 bc	378.33 d	125.33 bc	127.33 c	503.67 b	504.33 d
T5- RD + Potassen-N at **2L/Fed + EM** at**10L/Fed**	377.00 bc	378.00 d	123.33 bcd	126.33 cd	502.33 b	503.67 d
T6- RD + Potassen-N at **3L/ Fed**	376.00 bc	374.33 e	123.00 cd	124.67 de	499.67 b	503.00 d
T7- RD + Potassen-N at **3L/ Fed + EM** at **10L/Fed**	374.00 cd	374.00 e	122.67 d	124.00 e	498.67 b	498.33 e
T8- RD + Potassen-N at **4L/Fed**	365.67 de	366.00 f	116.67 e	117.67 f	482.33 c	483.67 f
T9- RD + Potassen-N at **4L/ Fed + EM** at**10L/Fed**	360.00 e	355.67 g	114.67 e	116.67 f	474.67 c	472.33 g

The means of each column followed by the same letter/s during every season are not significantly differed at the 5% level.

Yield parameters:

Bunch length and bunch circumference (cm):

It is obvious from **Table (3)** that, the highest bunch length (cm) was obtained from T9 (RD + Potassen-N at 4L/ Fed + EM at 10L/Fed) (139.33 & 125.42 cm) followed by T8 (RD + Potassen-N at 4L/Fed) (138.50 & 128.75 cm) and T7 (RD + Potassen-N at 3L/ Fed + EM at 10L/Fed) (134.75 & 129.08 cm) during 1st and 2nd season, respectively. On the other side, the lowest bunch length was obtained from T1 (RD) (97.08 & 107.42 cm) followed by T2 (RD + Potassen-N at 1L/Fed) (99.08 &109.08 cm), T4 (RD + Potassen-N at 2L/Fed) (113.00 & 108.67 cm) during the first and second season, respectively.

In general, the superiority of bunch circumference in both seasons was exhibited by T9- (RD + Potassen-N at 4L/ Fed + EM at 10L/Fed) which gave the highest values relative to other treatments in most cases during both seasons of study. A similar trend was also obtained concerning the bunch length, as the previously mentioned super treatment also scored the utmost high means all treatments and other used treatments in the two studied seasons (2018 and 2019) giving the highest significant values .

On the contrary, the lowest recorded statistical values were obtained from the T1 (RD) and T2 (RD + Potassen-N at 1L/Fed), respectively, during both seasons of the study. Such trends were true throughout the two seasons of study.

Table 3. Effect of Potassen-N and EM treatments on bunch length and bunch circumference of Williams banana plants during 2018 and 2019 experimental seasons.

Parameters / Treatments	Bunch length (cm)		Bunch circumference (cm)	
	2018	2019	2018	2019
T1- Control (100 %Minerals NPK) (RD)	97.08f	107.42c	100.60 e	102.13 d
T 2- RD + Potassen-N at **1L/Fed**	99.08f	109.08c	104.60 d	103.23 d
T3- RD + Potassen-N at **1L/Fed + EM** at **10L/Fed**	124.42c	109.42c	103.93 d	103.73 d
T4- RD + Potassen-N at **2L/Fed**	113.00e	108.67c	112.60 b	111.93 c
T5- RD + Potassen-N at **2L/Fed + EM** at**10L/Fed**	113.75e	113.92b	108.50 c	96.27 e
T6- RD + Potassen-N at **3L/ Fed**	120.42d	108.42c	112.60 b	116.37 b
T7- RD + Potassen-N at **3L/ Fed + EM** at **10L/Fed**	134.75b	129.08a	119.50 a	117.27 ab
T8- RD + Potassen-N at **4L/Fed**	138.50a	128.75a	119.50 a	113.70 c
T9- RD + Potassen-N at **4L/ Fed + EM** at**10L/Fed**	139.33a	125.42a	118.17a	118.97a

The means of each column followed by the same letter/s during every season are not significantly differed at the 5% level.

Bunch weight (kg) and estimated yield (ton/Fed).

It is clear from **Table (4)** in both seasons of study that, the highest significant values of bunch weight (kg) and estimated yield (ton/fed) were obtained from T9 (RD + Potassen-N at 4L/ Fed + EM at 10L/Fed) followed by T8 (RD + Potassen-N at 4L/Fed). On the contrary, the lowest values for bunch weight and yield were obtained from T1 (RD) followed by T2 (RD + Potassen-N at 1L/Fed) and T3 (RD + Potassen-N at 1L/Fed + EM at 10L/Fed) during both experimental seasons.

Table 4. Effect of Potassen-N and EM treatments on bunch weight and estimated yield of Williams banana plants during 2018 and 2019 experimental seasons.

Treatments / Parameters	Bunch weight (kg)		Estimated yield (ton/Fed)	
	2018	2019	2018	2019
T1- Control (100 %Minerals NPK) (RD)	19.79d	17.49c	20.78d	18.36c
T 2- RD + Potassen-N at **1L/Fed**	23.65cd	20.24c	24.82cd	21.26c
T3- RD + Potassen-N at **1L/Fed + EM** at **10L/Fed**	24.34bcd	20.62c	25.55bcd	21.65c
T4- RD + Potassen-N at **2L/Fed**	24.50bc	21.57abc	25.71bc	22.65c
T5- RD + Potassen-N at **2L/Fed + EM** at**10L/Fed**	24.93bc	21.19bc	26.16bc	22.25c
T6- RD + Potassen-N at **3L/ Fed**	26.26bc	23.36abc	27.57bc	24.52bc
T7- RD + Potassen-N at **3L/ Fed + EM** at **10L/Fed**	28.30ab	23.41abc	29.71ab	24.58bc
T8- RD + Potassen-N at **4L/Fed**	28.78ab	27.84ab	30.22 ab	29.23ab
T9- RD + Potassen-N at **4L/ Fed + EM** at**10L/Fed**	32.15a	28.58a	33.76a	30.01 a

The means of each column followed by the same letter/s during every season are not significantly differed at the 5% level.

Fruit quality.

Fruit physical characteristics:

A-Finger weight (g), finger length (cm) and finger diameter (cm):

Data in **Table (5)** showed that the highest significant values for finger weight, length and finger diameter were detected with T9 (RD + Potassen-N at 4L/ Fed + EM at 10L/Fed) followed by T8 (RD + Potassen-N at 4L/Fed) and T7 (RD + Potassen-N at 3L/ Fed + EM at 10L/Fed) during both seasons of study. On the other hand, the lowest values were obtained when the plants were treated with T1 (Control) and T2 (RD + Potassen-N at 6L/Fed) treatments. In addition, the other treatments gave intermediate values during both seasons of study.

Table 5. Effect of Potassen-N and EM treatments on finger length, diameter and finger weight of Williams banana plants during 2018 and 2019 experimental seasons.

Treatments / Parameters	Finger length (cm)		Finger diameter (cm)		Finger weight (g)	
	2018	2019	2018	2018	2019	2018
T1- Control (100 %Minerals NPK) (RD)	21.93d	20.83cde	2.85f	21.93d	20.83cde	2.85f
T 2- RD + Potassen-N at **1L/Fed**	25.18abc	20.58de	2.92ef	25.18abc	20.58de	2.92ef
T3- RD + Potassen-N at **1L/Fed + EM** at **10L/Fed**	23.95bcd	23.30ab	3.05def	23.95bcd	23.30ab	3.05def
T4- RD + Potassen-N at **2L/Fed**	24.28abc	21.33bcde	3.13cde	24.28abc	21.33bcde	3.13cde
T5- RD + Potassen-N at **2L/Fed + EM** at**10L/Fed**	23.82cd	21.58bcde	3.15cd	23.82cd	21.58bcde	3.15cd
T6- RD + Potassen-N at **3L/ Fed**	24.82abc	19.57e	3.30c	24.82abc	19.57e	3.30c
T7- RD + Potassen-N at **3L/ Fed + EM** at **10L/Fed**	24.65abc	22.67abcd	3.32bc	24.65abc	22.67abcd	3.32bc
T8- RD + Potassen-N at **4L/Fed**	26.00ab	22.85abc	3.53ab	26.00ab	22.85abc	3.53ab
T9- RD + Potassen-N at **4L/ Fed + EM** at**10L/Fed**	26.17a	23.73a	3.70a	26.17a	23.73a	3.70a

The means of each column followed by the same letter/s during every season are not significantly differed at the 5% level.

B- Pulp weight (g); peel weight (g):

Concerning the pulp weight, results in **Table (6)** showed that T9 (RD + Potassen-N at 4L/ Fed + EM at 10L/Fed) and T8 (RD + Potassen-N at 4L/Fed) exhibited statistically the highest values of pulp weight as compared to other investigated treatments during both seasons of study. On the other side, the lowest values of pulp weight in the two seasons of the study were recorded by T1 (Control) and T2 (RD + Potassen-N at 1L/Fed)

Data in **Table (6)** mentioned that the highest values of peel weight were obtained from T9 (RD + Potassen-N at 4L/ Fed + EM at 10L/Fed) followed by T8 (RD + Potassen-N at 4L/Fed) but the differences were so slight to reach the level of significance during both seasons of study. On the contrary, the lowest values of peel weight were obtained from both T1 (Control) and T2 (RD + Potassen-N at 1L/Fed) andT2 with insignificant effects between them. In addition to that, other treatments gave intermediate values during both seasons of study.

Table 6. Effect of Potassen-N and EM treatments on some fruit physical properties (pulp and peel weight (g) of Williams banana plants during the 2018 and 2019 experimental seasons.

Parameters / Treatments	Pulp weight (g)		Peel weight (g)	
	2018	2019	2018	2019
T1- Control (100 %Minerals NPK) (RD)	58.147 f	59.320 i	30.887 bc	29.080 c
T 2- RD + Potassen-N at **1L/Fed**	63.220 ef	64.383 h	29.400 c	28.607 c
T3- RD + Potassen-N at **1L/Fed + EM** at **10L/Fed**	65.913 e	67.050 g	29.557 c	28.003 c
T4- RD + Potassen-N at **2L/Fed**	68.163 de	69.097 f	32.053 abc	32.343 b
T5- RD + Potassen-N at **2L/Fed + EM** at**10L/Fed**	72.413 cd	72.150 e	31.303 bc	31.750 b
T6- RD + Potassen-N at **3L/ Fed**	74.667 bc	74.757 d	32.467 abc	33.087 b
T7- RD + Potassen-N at **3L/ Fed + EM** at **10L/Fed**	74.193 bcd	78.080 c	38.710 a	35.610 a
T8- RD + Potassen-N at **4L/Fed**	79.750 ab	81.013 b	37.037 ab	35.487 a
T9- RD + Potassen-N at **4L/ Fed + EM** at**10L/Fed**	81.693 a	83.143 a	36.810 ab	35.633 a

The means of each column followed by the same letter/s during every season are not significantly differed at the 5% level.

C. Pulp and peel percentages:

It is quite clear as shown from tabulated data in **Table (7)** that the total pulp and peel percentages were slightly influenced by the differential investigated treatments. Such response was relatively higher and reached the level of significance in the second season only. Whereas, in the first season (2018) the response was completely absent from the standpoint of statistics between all treatments. However, in the second one (2019) the highest values of pulp and peel percentages were recorded from (T3&T1) and (T9&T4), respectively. On the opposite, the least values were recorded in the second season from T1 and T3, respectively. The rest of the treatments were intermediate between the highest and lowest limited during the second season.

Table 7. Effect of Potassen-N and EM treatments on some fruit physical properties (pulp and peel %) of Williams banana plants during the 2018 and 2019 experimental seasons.

Parameters / Treatments	Pulp (%)		Peel (%)	
	2018	2019	2018	2019
T1- Control (100 %Minerals NPK) (RD)	65.326 a	67.105 d	34.674 a	32.895 a
T 2- RD + Potassen-N at **1L/Fed**	68.265 a	69.241 abc	31.735 a	30.759 bcd
T3- RD + Potassen-N at **1L/Fed + EM** at **10L/Fed**	69.037 a	70.536 a	30.963 a	29.464 d
T4- RD + Potassen-N at **2L/Fed**	68.008 a	68.114 cd	31.992 a	31.886 ab
T5- RD + Potassen-N at **2L/Fed + EM** at**10L/Fed**	69.798 a	69.444 abc	30.202 a	30.556 bcd
T6- RD + Potassen-N at **3L/ Fed**	69.679 a	69.305 abc	30.321 a	30.695 bcd
T7- RD + Potassen-N at **3L/ Fed + EM** at **10L/Fed**	65.768 a	68.674 bcd	34.232 a	31.326 abc
T8- RD + Potassen-N at **4L/Fed**	68.282 a	69.537 abc	31.718 a	30.463 bcd
T9- RD + Potassen-N at **4L/ Fed + EM** at**10L/Fed**	68.933 a	69.993 ab	31.067 a	30.007 cd

The means of each column followed by the same letter/s during every season are not significantly differed at the 5% level.

Fruit chemical characteristics:

A. TSS and total acidity (%) and TSS/acid ratio:

It is obvious from **Table (8)** that the highest values of TSS (%) and TSS/acid ratio were obtained from T9 (RD + Potassen-N at 4L/ Fed + EM at 10L/Fed) and followed by T8 (RD + Potassen-N at 4L/Fed) and T7 (RD + Potassen-N at 3L/ Fed + EM at 10L/Fed) during both experimental seasons. Concerning total acidity, the highest values were obtained by T1; T2 and T3 with slightly significant differences between them. On the other hand, the lowest values of TSS % and TSS/acid ratio were obtained from T1 (Control) followed by T2 (100% RD + Potassen-N at 1L/Fed) during two experimental seasons. However, the lowest values for total acidity were obtained from T9 and T8, respectively, during both seasons of study.

Table 8. Effect of Potassen-N and EM treatments on TSS (%), total acidity (%) and TSS/acid ratio of Williams banana plants during 2018 and 2019 experimental seasons.

Parameters	**TSS (%)**		**Total acidity (%)**		**TSS/acid ratio**	
Treatments	**2018**	**2019**	**2018**	**2019**	**2018**	**2019**
T1- Control (100 %Minerals NPK) (RD)	17.49c	18.51c	0.393a	0.394a	44.72e	46.91e
T 2- RD + Potassen-N at **1L/Fed**	18.87b	18.87c	0.381ab	0.381ab	54.76d	54.74de
T3- RD + Potassen-N at **1L/Fed + EM** at **10L/Fed**	20.33a	19.73bc	0.362b	0.359abc	58.70cd	60.80cd
T4- RD + Potassen-N at **2L/Fed**	20.85a	20.61ab	0.333c	0.335bc	60.43cd	59.72cd
T5- RD + Potassen-N at **2L/Fed + EM** at**10L/Fed**	20.87a	20.84ab	0.312cd	0.327cd	61.09c	62.52bcd
T6- RD + Potassen-N at **3L/ Fed**	20.97a	21.13ab	0.301d	0.316cd	69.33b	65.40bc
T7- RD + Potassen-N at **3L/ Fed + EM** at **10L/Fed**	21.12a	21.13ab	0.290de	0.315cd	72.23b	65.49bc
T8- RD + Potassen-N at **4L/Fed**	21.20a	20.94ab	0.270ef	0.275de	79.31a	71.75ab
T9- RD + Potassen-N at **4L/ Fed + EM** at**10L/Fed**	21.40a	21.84a	0.267f	0.261e	79.40a	80.92a

The Means of each column followed by the same letter/s during every season are not significantly differed at the 5% level.

b. Total sugars and reducing sugars percentages:

It is clear from **Table (9)** that the highest values of total sugars (%) and reducing sugars (%) were obtained from T9 (RD + Potassen-N at 4L/ Fed + EM at 10L/Fed) and followed by T8 (RD + Potassen-N at 4L/Fed) and T7 (T7- RD + Potassen-N at 3L/ Fed + EM at 10L/Fed) during both experimental seasons. On the contrary, the lowest values of total sugars and reducing sugars (%) were obtained from T1 (Control) during both experimental seasons of study.

Table 9. Effect of Potassen-N and EM treatments on total sugars (%) and reducing sugars (%) of Williams banana plants during 2018 and 2019 experimental seasons.

Parameters	**Total sugars (%)**		**Reducing sugars (%)**	
Treatments	**2018**	**2019**	**2018**	**2019**
T1- Control (100 %Minerals NPK) (RD)	15.48d	15.53e	5.90i	5.76g
T 2- RD + Potassen-N at **1L/Fed**	16.30c	16.48d	6.93h	7.11f
T3- RD + Potassen-N at **1L/Fed + EM** at **10L/Fed**	16.78bc	16.70d	7.15g	7.14f
T4- RD + Potassen-N at **2L/Fed**	16.92bc	16.80d	7.43f	7.42e
T5- RD + Potassen-N at **2L/Fed + EM** at**10L/Fed**	17.25b	17.35c	7.65e	7.67d
T6- RD + Potassen-N at **3L/ Fed**	17.27b	17.24c	7.92d	7.89c
T7- RD + Potassen-N at **3L/ Fed + EM** at **10L/Fed**	18.36a	18.44b	8.22c	8.22b
T8- RD + Potassen-N at **4L/Fed**	18.48a	18.51b	8.533b	8.54a
T9- RD + Potassen-N at **4L/ Fed + EM** at**10L/Fed**	18.77a	18.91a	8.717a	8.66a

The means of each column followed by the same letter/s during every season are not significantly differed at the 5% level.

C. Total carbohydrates and starch (%):

It is quite evident data presented in **Table (10)** that, total carbohydrates and starch were significantly affected by all studied treatments, where the highest significant values of total carbohydrates were obtained from T9 (RD + Potassen-N at 4L/ Fed + EM at 10L/Fed) followed statistically by T8 (RD + Potassen-N at 4L/Fed) and T7 (RD + Potassen-N at 3L/ Fed + EM at 10L/Fed) during both seasons of study. On the contrary, the lowest significant values of total carbohydrates % were obtained from T1 (Control), followed by T2 (RD + Potassen-N at

1L/Fed) and T3 (RD + Potassen-N at 1L/Fed + EM at 10L/Fed) during two experimental seasons. Concerning starch % it is quite clear that an opposite trend to that previously found with total carbohydrates % was detected in this respect. On the other side, all investigated nutritive fertilizers treatments resulted significantly in reducing starch % as compared to control. The most effective treatment for reducing starch % was in closed relationship to the Williams banana plants subjected to the RD + Potassen-N at 4L/ Fed + EM at 10L/Fed (9th treatment) during both 2018 & 2019 experimental seasons. Whereas the highest reduction in starch % was exhibited. On the contrary, RD + Potassen-N at 1L/Fed (2nd treatment) was significantly inferior, whereas the least reduction in starch % below control was observed during both seasons.

Table 10. Effect of Potassen-N and EM treatments on Total carbohydrates (%) and reducing starch (%) of Williams banana plants during 2018 and 2019 experimental seasons.

Parameters / Treatments	Total carbohydrates (%)		Starch (%)	
	2018	2019	2018	2019
T1- Control (100 %Minerals NPK) (RD)	14.517 h	14.860 g	2.0833 a	2.0200 a
T 2- RD + Potassen-N at **1L/Fed**	15.337 g	15.533 f	1.9733 b	1.9533 b
T3- RD + Potassen-N at **1L/Fed + EM** at **10L/Fed**	15.957 f	16.030 e	1.9367 c	1.9200 c
T4- RD + Potassen-N at **2L/Fed**	16.860 e	16.883 d	1.8500 d	1.8400 d
T5- RD + Potassen-N at **2L/Fed + EM** at **10L/Fed**	17.257 d	17.073 d	1.8033 e	1.7633 e
T6- RD + Potassen-N at **3L/ Fed**	17.597 c	17.450 c	1.7433 f	1.7267 f
T7- RD + Potassen-N at **3L/ Fed + EM** at **10L/Fed**	17.950 b	17.917 b	1.7067 g	1.6833 g
T8- RD + Potassen-N at **4L/Fed**	18.103 b	18.003 b	1.6867 h	1.6733 g
T9- RD + Potassen-N at **4L/ Fed + EM** at **10L/Fed**	18.693 a	18.587 a	1.6333 i	1.6233 h

The means of each column followed by the same letter/s during every season are not significantly differed at the 5% level.

Discussion and Conclusion

Continuous application of bio-fertilizers is promising in the long run of banana, as sources of organic matter, essential nutrients, amino acids, natural hormones, antibiotics and vitamins. Also, improving both physical and chemical characters of soil. Bio-fertilization has an important role on biological, physical and chemical soil properties, as well as, on facilitating the fixation of atmospheric N, activating the availability and uptake of the nutrients and reducing the incidence of soil born diseases, and then improving soil fertility (**Subba Rao, 1984; Kannaiyan, 2002; El- Salhy *et al*., 2006**).

In this concern, **Mai *et al.*, (2005)** observed that the number of hands/bunch increased with 50% or 33% recommended dose of N plus Azospirillum phosphate solubilizing bacteria. **Dave *et al.*, (1991), Zake *et al.*, (2000), and Abd El Moniem *et al.*, (2008)** found that bio-fertilization with algae extract significantly improved yield, bunch and hand weight. Moreover, **Attia *et al.*, (2009)** on banana observed that bio-fertilization increased TSS and decreased acidity.

Bio-fertilizers are one of the most important factors for plant development and productivity because they influence the vegetative growth, yield, and fruit quality of citrus trees. **(Abdelaal *et al.*, 2013, El-Khawaga and Maklad, 2013 and El-Khayat and Abdel Rehiem, 2013).** However, bio-fertilizers are simple and effective to manage on-the-ground applications and are very safe for humans, livestock and the atmosphere to increase their productivity by raising crop yields and lowering the costs of certain farming activities. It does not substitute mineral fertilizers but greatly reduces their application rate. **(Ishac, 1989 and Saber, 1993).**

The best results concerning yield and fruit quality of Williams banana due to using EM1 were attributed to the positive action of EM1 on enhancing soil fertility, the availability of nutrients, organic matter, root development, the activity of organisms and N fixation (**Higa, 1989 and Formowitz *et al.*, 2007**). These results about the promoting effect of EM1 on fruiting of Williams banana are in harmony with those obtained by **Badran and Mohamed (2009); Roshdy *et al.*, (2011); Refaai *et al.*, (2012); Ibrahim (2012); Ahmed *et al.*, (2014a and b) and Saied (2015)**.

Anyhow, our findings are supported by the results obtained **by Mansour and Shaaban (2007)** and **Sharaf *et al.*, (2011)** on Washington Navel Orange Trees, **Osman, *et al.*, (2011)** on Bartamuda date, palm, **Barakat *et al.*, (2012)** on Newhall naval orange, **Zaghloul and Knany, (2012)** on Navel orange**, Peralta-Antonio *et al*., (2014)** on mango, **Salama *et al.*, (2014)** on **"**Hayany" Date Palm**, Baiea, *et al.*, (2015)** on banana cv. Grande Naine, **Baiea and EL-Gioushy (2015)** on banana cv. Grande Naine, **EL-Gioushy and Baiea (2015)** on apricot, **El-Badawy (2017)** on Valencia orange trees, **Baiea, *et al.*, (2017)** on Wonderful pomegranate trees, **El-Gioushy *et al.*, (2018)** on Fagri Kalan Mango trees**, El-Gioushy and**

Eissa (2019) on Washington Navel Orange and **Fikry *et al.*, (2020)** on Murcott Tangerine Trees. Anyhow, the fertilization of banana crops with N and K has been the main step to increase the yield and the quality of the banana fruit (**Moreira *et al.*, 2009; Ratke 2008**).

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تأثير أستخدام Potassen–N و EM علي بعض القياسات الفينولوجينه و الانتاجية وصفات الجودة في الموز الويليامز

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أجريت هذه الدراسة على الخلفة الأولى والثانية لنباتات الموز صنف ويليامز والمزروعة في أرض طينية خفيفة وتروي بالغمر في مزرعة محطة بحوث القناطر الخيرية بالقليوبية والتابعة لمركز البحوث الزراعية خلال موسمين متتاليين 2018 و2019 وكانت مسافات الزراعة 3 × 4 م وذلك بغرض التبكير في الوصول الي الاثمار وتحسين الانتاجية وصفات الجوده من خلال الرش بمركب Potassen –N بمعدل 1و2و 3 و 4 لتر للفدان في كل مرة وذلك ست مرات خلال كل موسم بداية من شهر مارس وبمعدل مرة كل شهر و المعاملة الارضية بمركب EM ثلاثة مرات بداية من شهر مارس وبمعدل مرة كل شهر وبمعدل واحد 10 لتر للفدان في كل مرة . وكان معدل محلول الرش المستخدم 1 لتر للنبات. وتم دراسة مدى استجابة نباتات الموز صنف ويليامز للمعاملات المختلفة من خلال التغيرات في بعض القياسات الفينولوجية والانتاجية وكذلك الصفات الطبيعية والصفات الكيماوية للثمار. أوضحت النتائج المتحصل عليها تفوق جميع معاملات الرش المستخدمة خاصة مع المعاملة الارضية مقارنة بالكنترول (الكميات الموصي بها فقط) ومقارنة بمعاملات الرش منفرده دون استخدام المعاملة الارضية في حين كانت أفضل المعاملات في هذا الصدد هي المعاملة التاسعة (الرش بمركب Potassen–N بمعدل 4 لتر للفدان + المعاملة الارضية بمركب EM بمعدل 10 لتر للفدان) والتي ادي أستخدامها إلى التبكير في الحصاد وقصر دورة حياة النبات وزيادة الانتاجية وتحسين صفات الجودة وذلك خلال موسمي الدراسة وبالتالي يمكن التوصية بها أو كل من المعاملتين الثامنة(الرش بمركب Potassen–N بمعدل 4 لتر للفدان)أو السابعة(الرش بمركب Potassen–N بمعدل 3 لتر للفدان+ المعاملة الارضية بمركب EM بمعدل 10 لتر للفدان) وذلك تحت نفس ظروف الدراسة.