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Enhancing Williams Banana Cropping by Using Some Organic Fertilization Treatments

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Abstract: This investigation was carried out at a private orchard in El-Bostan district, Cairo Alexandria desert road, Behera Governorate on Williams banana plants (*Musa cavendishii* L.) during the two successive seasons 2008 and 2009. The experimental site represents newly reclaimed sandy soil irrigated by drip irrigation system. The investigation aimed to estimate the response of Williams banana to organic fertilizers at three doses *i.e.* low, medium and high rates versus mineral recommended dose. The three doses used alone or with effective microorganisms (EM). The obtained results cleared that organic fertilization with medium or high dose 1.0 fold (400 N + 250 P + 900 K g /plant) or 1.5 fold (600 N + 375 P + 1350 K g /plant) of recommended mineral dose enhanced the most studied characters, even EM added or not. Using organic fertilizers at 1.5 fold of recommended chemical dose improved the banana bunch weight and the most of fruit quality. Moreover, continuous addition of organic fertilizers (accumulation effect) was superior to that fertilized once. Also, Williams banana fruit chemical properties were affected by organic fertilization treatments comparing with control. On the other hand, results of control plants (that received the recommended mineral dose) were better than plants received half strength of organic matter. Whereas the lowest values of nitrate residues were gained from compost treatments and it decreased with continuous adding of organic fertilizers.

Key words: Banana · Biofertilizers · EM · Fertilization · Fruit properties · Organic · Williams

INTRODUCTION

Banana and plantains (*Musa cavendishii* Lamb.) are today grown in many regions and constitute the 4th largest fruit crop of the world, following grapes, citrus and apple. In Egypt, the total area of banana increased to 55000 feddan in 2009 season produced 1,100,000 tons with average of 20 tons/feddan according to the latest statistics of FAO [1].

Williams banana is cultivated successfully in newly reclaimed soils because of its excellent performance, the large bunch with longer fingers, the excellent taste and high tolerance to transportation. Musa plants require range of plant nutrients in high amounts to maintain high production of good quality fruits [2].

A combination of mineral and organic fertilizers is necessary to sustain and improve crop production on depleted soils [3,4]. Because the organic fertilizer is usually generated internally within a farming system, the total amount of soil nutrients does not increase unless external resources are brought in [5]. Chemical fertilization and irrigation practices carry substantial environmental risk. Nitrate pollution and there also concern that high nitrate contents poses health risk to consumers [6]. Consequently, it has drawn the attention of researchers and banana growers to use the organic and bio fertilizers as well as would safe for human, animals and environment. Thus, it's using avoided this pollution and induced the costs of fertilization [7,8].

Microbial fertilizer is one way of organic farmers and it is able to increase yield and quality of crops without a large investment of money and labor [9]. EM is microbial fertilizers, created in Japan over 25 years ago in University of Ryukyus in Okinawa and marketed by EMRO (EM Research Organization). The basic purpose of EM is the restoration of 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*, *Lactobacillus casei*, *Lactobacillus fermentum*, *Lactobacillus delbrueckii*, *Saccharomyces cerevisiae* and *Rhodopseudomonas palustris* [10].

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Organic N with mineral source was greatly responsible for enhancing fruit finger and pulp weight and yield of banana [11-19]. Also, it increased banana yield and fruit physical and chemical characters [20]. The application of FYM with mineral NPK gave highest bunch and fruit chemical properties (TSS and total sugar) of banana compared to using mineral source only [18, 21-23]. Fruit physical parameters (hand and finger weight, finger number/bunch and pulp/peel ratio) and yield also improved effectively in banana plants treated with compost [24-26]. Moreover, bunch weight of organic fertilized banana was increased in plants which inoculated by *Azospirillium* as compared with the unfertilized one [27-31]. Nitrate is easily formed from mineral nitrogen fertilization but it is slowly formed from organic fertilizers [32].

The purpose of this study is to determine the efficiency and optimal dose of organic fertilizers and natural rocks providing nutrient requirements of banana plants. Also, is to enhancing banana fruit quality by using biofertilizers treatments. Finally, is to increase Williams banana organic fruits for safety using and exporting.

MATERIALS AND METHODS

This study was carried out during the two successive seasons 2008 and 2009 on Williams banana plants that newly planted in a private orchard in El-Bostan district, Cairo Alexandria desert road, Behera Governorate, Egypt. The plants were grown in sandy soil (Table 1) and irrigated by drip irrigation system. The trees were spaced at 2.5 x 3 meters apart. All plants were similar in age, growth and received the recommended agricultural practices. 63 vigorously and healthy plants were arranged in 7 treatments and statistically analyzed as one factor factorial in complete block design.

Each treatment was represented by 9 plants, each three of them treated as one replicate. The treatments in this study were as follow:

T_1 : 0.5 fold of organic: 13.65 Kg Compost + 199 g rock phosphate + 3.74 Kg feldspar vs. 200N + 125P + 450K unit /plant / year.

T_2 : 1.0 fold of organic: 27.3 Kg Compost + 399 g rock phosphate +7.48 Kg feldspar vs. 400N + 250P + 900K unit/plant / year.

T_3 : 1.5 fold of organic: 40.95 Kg Compost + 598 g rock phosphate + 11.21 Kg feldspar vs. 600N + 375P + 1350K unit/plant/year.

T_4 : 0.5 fold of organic mentioned above + 360 ml EM /plant / year.

T_5 : 1.0 fold of organic mentioned above + 360 ml EM /plant / year.

T_6 : 1.5 fold of organic mentioned above + 360 ml EM /plant / year.

T_7 : Control treatment: 400N + 250P + 900K unit (1.2 Kg ammonium nitrate + 555 ml phosphoric acid +1.8 Kg potassium sulphate)/plant / year.

All treatments were done during January in each season of study. During the first and second season, treatments were applied on virgin soil. Also, in the second season, all treatments were applied on soil fertilized by organic for one year before, to study the accumulation effect of organic fertilization. The used organic fertilizers were spread on soil surface at the two sides of the plants and covered with 10 cm soil.

The chemical analysis of compost (Table 2) was used to calculate the required amounts to supply the three studied rates of NPK based on the dry weight of the compost. In addition, Feldspar rocks that used in this study contained 8.29% K_2O. Also, phosphate natural rock

Table 1: Physical and chemical analysis of soil characteristics.

Physical characteristics %		Chemical characteristics	
Field capacity	11	$CaCO_3$ %	12.1
Available water	1.5	Organic matter %	0.31
Wilting point	4.22	pH	8.82
Coarse sand	46.2	EC(ds/m)	3.25
Fine sand	38.4	Ca(mg/100g)	0.15
Silt	11.8	Na (mg/100g)	0.29
Clay	3.6	K (mg/100g)	0.21
Texture class	Sandy	Cl (mg/100g)	0.47

Table 2: Chemical characteristics of the one cubic meter of compost.

Parameter		Parameter	
Dry weight	550 kg	Total P %	0.8
Moisture %	23	Total K %	1.26
Organic matter %	33.65	Total Ca %	1.95
Organic Carbon%	31.75	Total Mg %	0.96
pH	8.5	Total Fe (ppm)	331
EC(ds/m)	6.33	Total Mn (ppm)	115
C/N ratio	15.78	Total Zn (ppm)	28
Total N %	1.8	Total Cu (ppm)	180

contained 18.14% P_2O_5. Biofertilizers used in this study were obtained from Ministry of Agriculture produced by the General Organization for Agriculture Equalization Found (GOAEF).

One type of biofertilizer was used in this study namely EM solution (0.001%) (a multi-strain bio-fertilizer) the bio-fertilizer was added to the wetted compost as soil application in mid-February at 10 cm soil depth 30 ml/plant/week for three months (10). The chemical fertilizers doses were added as soil applications from mid February until mid October through drip irrigation system. Ammonium nitrate (NH_4NO_3, 33.5 % N) was used as a source of nitrogen, phosphoric acid (45 % P_2O_5) was used as a source of phosphorus and potassium sulphate (high dissolve, 50% K_2O) was used as a source of potassium.

The Following Characters Were Estimated: Bunches were harvested at the green maturity stage. After that, Bunches were artificially ripped [33], then three hands were taken randomly (without any thing from bunch pedicel part) from bunches of each replicate of all treatments to estimate fruit physical characteristics, *i.e.* bunch weight (kg), hand number/bunch, hand weight (kg), finger weight (g), number of fingers/bunch, finger pulp weight, finger peel weight and finger pulp/ peel weight ratio.

Also, the estimated fruit chemical characters were; total soluble solids in the pulp juice (TSS) using a hand refractometer; total sugar according to the method described by Smith *etal.* [34] and total titratable acidity percentage as malic acid in the pulp juice, by titration with a 0.1N of NaOH solution using phenolphethalein as an indicator according to AOAC [35]. Finally, Nitrate concentration in pulp fruit was determined according to Singh [36].

Statistical Analysis: The design of this experiment was randomized complete block design. Each treatment under study contained three replicates and each replicate had three holes with three plants in each hole. The obtained data were tabulated and subjected to analysis of variance (ANOVA) as one way analysis according to Snedecor and Cochran [37], using MSTAT software packaged. Means of results were compared using least significant difference (LSD) at 5% level [38].

RESULTS AND DISSCUTION

Effect of Organic Fertilizer Treatments on Bunch Weight and Fruit Physical Characters:

Bunch Weight (Kg): Data presented in Table 3 indicated that bunch weight was significantly affected by different organic fertilizer treatments during the studied seasons. Plants fertilized using one and half fold of organic matter as a recommended chemical dose was greatly increased bunch weight even EM added or not during studied seasons. Accumulation season also appeared the same trend of results as 1.5 organic matter dose was the best treatment with or without EM. Fertilizing banana plants using organic matter at half fold of recommended chemical dose was not preferred, because it reduced the bunch weight comparing with control plants during the studied seasons. However, it was clearly noticed that results of accumulation season proved that organic fertilization seasonally had increased banana bunch weight.

These results came in line with finding of Zake *et al.* [39]. They reported that organic manure application of 200 Kg of K/ha had increased Williams banana yield more than double. Also, Kamel [24] demonstrated that fertilizing banana plants with farm refuse compost at 75Kg/hole improved effectively bunch weight. In addition, Abd-Elnaby and El-Sonbaty [18] recorded that banana plants supplied with mineral fertilizers combined with organic manure (farm refuse compost) at 25+75% improved bunch weight.

Table 3: Effect of different organic fertilization treatments on banana bunch weight (Kg) during 2008, 2009 and accumulation 2009 seasons.

Organic fertilization treatments vs. mineral dose	Bunch weight (Kg)		
	2008 season	2009 season	2009 accumulation season
Control	26.32	27.16	27.16
0.5 fold	23.37	22.00	27.11
1.0 fold	26.65	27.19	31.91
1.5 fold	29.85	30.46	32.24
0.5 fold + EM	24.33	23.63	28.13
1.0 fold + EM	27.16	28.52	32.16
1.5 fold + EM	31.00	31.45	32.95
LSD at 5 %	1.22	1.13	1.14

Table 4: Effect of different organic fertilization treatments on hands number, hand weight (kg) of Williams banana plants during 2008, 2009 and accumulation 2009 seasons.

Organic fertilization treatments vs. mineral dose	Hand number			Hand weight (kg)		
	2008 season	2009 season	2009 accumulation season	2008 season	2009 season	2009 accumulation season
Control	11.02	11.00	11.00	2.27	2.32	2.32
0.5 fold	10.95	10.98	10.91	1.98	1.85	2.33
1.0 fold	11.09	11.07	10.96	2.23	2.28	2.71
1.5 fold	11.17	11.07	11.14	2.52	2.54	2.67
0.5 fold + EM	10.93	10.99	11.01	2.07	2.00	2.38
1.0 fold + EM	10.97	11.13	11.02	2.30	2.38	2.72
1.5 fold + EM	11.11	11.08	10.98	2.59	2.64	2.79
LSD at 5 %	n.s	n.s	n.s	0.15	0.13	0.14

Hand Number: Table 4 cleared that hand number of banana was the same statistical analysis as affecting by different organic treatments during the studied seasons. Whatever, treating Williams banana by organic fertilizers at 1.5 fold of recommended mineral fertilization dose gave the highest values of hand number comparing with other treatments during the study. Using EM with fertilization treatment did not gave a clear effect on hand number during this study.

On the other hand, Mai *et al*. [31], on banana plants, found that number of hands/bunch increased with 50% or 33% recommended dose of N plus *Azospirillum* + phosphat solubilizing bacteria. Also, El-Shenawi and El-Sayed [23] recorded that application of 100Kg farmyard manure plus 3 liters biofertilizers (Pseudomonas bacteria)/plant/year caused significant increases in number of hands/bunch of Grand Nain banana.

Hand Weight: Concerning hand weight, it was significantly increased affecting by fertilization treatment during the study (Table 4). 1.5 organic strength of chemical dose alone or plus EM recorded the highest hand weight during the studied seasons. While the plants which received 0.5 strength of chemical dose with or without EM gave the lowest hand weight. Moreover, treating plants by organic at one fold of recommended chemical dose alone or plus EM did not differ significantly comparing with control plants.

In this respect Kamel [24] stated that hand weight improved effectively in banana plants treated with compost El-Nile at 75 Kg/hole. In addition, Hamam *et al*. [16] found that the best results of weight of hands from the plants receiving 80g N/plant/year in organic form + 370g N/plant/year in mineral source compared to treatment with mineral source only. The effect of organic fertilizers on the weight of hand could be attributed to their role on the availability of elements as a constituent of proteins and other compounds, which produce the new tissues through their role as constituents of the nucleic acid DNA and RNA. In addition, organic manure may be having role in increasing the soil content of IAA and cytokinins and stimulating the growth of plants [40].

Table 5: Effect of different organic fertilization treatments on finger weight (g) and number of fingers /bunch of Williams banana plants during 2008, 2009 and accumulation 2009 seasons.

Organic fertilization treatments vs. mineral dose	Finger weight (g)			Number of fingers / bunch		
	2008 season	2009 season	2009 accumulation season	2008 season	2009 season	2009 accumulation season
Control	126.21	128.24	128.24	194.27	197.33	197.33
0.5 fold	124.32	123.29	128.82	175.28	166.34	196.97
1.0 fold	127.68	126.31	137.64	195.15	200.69	216.62
1.5 fold	136.82	137.57	138.51	211.91	212.99	217.27
0.5 fold+EM	125.22	125.36	129.60	181.02	175.81	202.80
1.0 fold+EM	129.62	127.58	139.44	194.30	202.47	215.17
1.5 fold+EM	138.55	139.54	140.32	208.91	210.42	218.88
LSD at 5 %	3.52	3.31	3.12	8.11	8.16	7.13

Finger Weight (g): Data presented in Table 5 indicated that finger weight was significantly affected by different doses of organic fertilization treatments during the studied seasons. Organic dose as 1.5 strength of chemical dose with EM recorded the highest finger weight (138.55 and 139.54g) in the 1st and 2nd seasons comparing with other treatments in the study.

Regarding to the accumulation of treatments as seasonally effect, the results showed that organic dose at 1.5 fold of chemical dose with EM produced the heaviest finger weight comparing with other treatments. The effect of organic fertilizers on finger weight may be due to the increasing endogenous production and enhancement of nutrient uptake [41]. In addition, it may be due to the role of nitrogen on productivity of banana plants [42].

These results are in harmony with those reported by Abd El-Naby [43] who noted that the best fingers weight in banana plants cv. Magrabi which were applied with banana compost application and with 50 or 25 % chemical fertilizer + sulfur, associated with early maturity stage. Also, Kamel [24] stated that finger weight improved effectively in banana plants treated with farm refuse compost at 75 Kg/hole. However, El-Shenawi and Hassouna [44] found that the best results of finger weight were obtained due to fertilizing Williams banana plants with N at 600g ammonium nitrate/plant plus 5L HALEX bio-fertilizers/plant.

Finger Number/bunch: Finger number/bunch was also significantly affected by organic fertilization treatments during the study (Table 5). Banana plants fertilized by organic fertilizers using 1.5 strength of chemical dose without EM produced the highest finger number/bunch in both seasons. In the accumulation season, the organic fertilization at 1.5 strength of chemical dose with EM had the maximum finger number/bunch (218.88) comparing with the other treatments.

These results are in accordance with those obtained by Abd El-Naby [43] who noted that the best fingers/bunch in banana plants cv. Magrabi which were applied with banana compost application and with 50 or 25 % chemical fertilizer + sulfur, associated with early maturity stage. Moreover, Hamam *et al.* [16] found that the best results of fingers number/hand was obtained from the plants received 80g N/plant/year of organic form + 370g N/plant/year in mineral source compared to treatment with mineral source only.

Pulp Weight (g): Data in Table 6 revealed that pulp weight was significantly affected by different fertilization treatments. Organic fertilizer at 1.5 strength plus EM gave the heaviest pulp weight comparing with other treatments during the 1st and 2nd seasons. In addition, there is no significant differences in pulp weight were obtained between three doses, i.e. 1.0, 1.5 and 1.5 with EM during the accumulation season.

In this regard, Kamel [24] stated that pulp% improved effectively in banana plants treated with compost El-Nile. The similar results were also recorded with Abd El-Aziz [17] as he found that yield and yield components were increased by increasing bio-fertilizers application rate from 25 to 100 g/stool/year with the organic treatment (75 Kg/hole).

Peel Weight (g): Illustrated results in Table 6 showed that, the control treatment gave the highest peel weight in both studied seasons and the accumulation season effect. While, all organic treatments recorded lightest peel weight comparing with control. Also, there is no significant effect was recorded between organic treatments that used during the study.

Table 6: Effect of different organic fertilization treatments on pulp and peel weights (g) of Williams banana fruits during 2008, 2009 and accumulation 2009 seasons.

Organic fertilization treatments vs. mineral dose	Pulp weight(g)			Peel weight(g)		
	2008 season	2009 season	2009 accumulation season	2008 season	2009 season	2009 accumulation season
Control	78.35	80.22	80.22	47.86	47.47	47.47
0.5 fold	81.02	81.30	87.17	43.30	41.99	41.65
1.0 fold	85.33	85.42	95.75	42.28	40.89	41.89
1.5 fold	95.27	96.50	96.57	42.55	42.07	41.94
0.5 fold+EM	83.65	85.75	89.72	41.57	39.61	39.88
1.0 fold+EM	89.94	87.90	98.61	40.68	43.53	40.83
1.5 fold+EM	96.99	97.38	98.92	41.57	42.16	41.40
LSD at 5 %	4.62	4.88	4.41	4.61	4.98	4.22

Table 7: Effect of different organic fertilization treatments on Pulp/peel ratio of Williams banana fruits during 2008, 2009 and accumulation 2009 seasons.

Organic fertilization treatments vs. mineral dose	Pulp/ peel ratio		
	2008 season	2009 season	2009 accumulation season
Control	1.64	1.69	1.69
0.5 fold	1.87	1.94	2.09
1.0 fold	2.02	2.09	2.29
1.5 fold	2.24	2.29	2.30
0.5 fold + EM	2.01	2.16	2.25
1.0 fold + EM	2.21	2.02	2.42
1.5 fold + EM	2.33	2.31	2.39
LSD at 5 %	1.08	1.11	1.09

Table 8: Effect of different organic fertilization treatments on Williams banana fruit TSS and total sugar % during 2008, 2009 and accumulation 2009 seasons.

Organic fertilization treatments vs. mineral dose	TSS (%)			Total sugar %		
	2008 season	2009 season	2009 accumulation season	2008 season	2009 season	2009 accumulation season
Control	22.24	22.92	22.92	16.98	18.80	17.06
0.5 fold	17.43	19.12	21.93	11.48	15.62	17.93
1.0 fold	20.62	21.44	25.67	16.34	17.45	21.76
1.5 fold	24.91	25.02	26.92	20.32	21.20	21.92
0.5 fold + EM	17.55	20.56	21.42	13.26	16.25	18.65
1.0 fold + EM	21.64	22.43	24.72	17.24	17.12	21.84
1.5 fold + EM	25.59	25.61	25.24	21.04	21.51	21.92
LSD at 5 %	2.61	2.81	3.01	2.21	2.58	2.17

Pulp/ Peel Ratio: Data in Table 7 indicated that pulp/peel ratio was significantly affected by different fertilizers treatments during the studied seasons. Fertilizing plants using one fold and half of organic matter, calculated as recommended chemical dose, with EM was greatly increased pulp/peel ratio (2.33 and 2.31) in both seasons, respectively. Moreover, accumulation season effect appeared that the best pulp/peel ratio was gained when Williams banana plants treated by 1.0 fold of organic matter with EM.

These observations are in accordance with those obtained by Abd El-Moniem and Radwan [30] who demonstrated that the fruit quality properties were improved by the application of the bio-fertilizers. Bio-fertilizers treatments plus 75% NPK gave the highest values of fruit quality (pulp %). Also, Abd El-Aziz [17] demonstrated that fertilizing Williams banana with 450g N/plant as 50% via organic +50% via inorganic improved Pulp/peel.

Effect of Organic Fertilizers on Williams Banana Fruit Chemical Contents:

Tss (%): It was clearly, from data in Table 8, noticed that TSS% in banana fruit was significantly affected by different fertilization treatments during the two studied seasons and accumulation season. Organic dose as 1.5 strength of recommended chemical dose alone or reached by EM s howed the highest value of TSS% in banana

Table 9: Effect of different organic fertilization treatments on banana fruit of total acidity (%) during 2008, 2009 and accumulation 2009 seasons.

Organic fertilization treatments vs. mineral dose	Total Acidity (%)		
	2008 season	2009 season	2009 accumulation season
Control	0.355	0.362	0.362
0.5 fold	0.214	0.220	0.293
1.0 fold	0.212	0.240	0.288
1.5 fold	0.199	0.214	0.271
0.5 fold + EM	0.222	0.228	0.263
1.0 fold + EM	0.211	0.219	0.213
1.5 fold + EM	0.196	0.216	0.211
LSD at 5%	0.101	0.113	0.092

Table 10: Effect of different organic fertilization treatments on willams banana pulp fruit of nitrate (ppm) during 2008, 2009 and accumulation 2009 seasons.

Organic fertilization treatments vs. mineral dose	Nitrate (ppm)		
	2008 season	2009 season	2009 accumulation season
Control	18.65	19.69	19.69
0.5 fold	15.80	16.29	14.53
1.0 fold	16.07	17.69	16.97
1.5 fold	18.42	18.19	17.43
0.5 fold + EM	15.84	18.33	14.16
1.0 fold + EM	18.20	18.74	17.01
1.5 fold + EM	18.56	18.78	17.43
LSD at 5 %	0.38	0.45	0.44

fruits pulp in the 1st and 2nd seasons (25.59, 25.16%), respectively. Concerning the accumulation effect of organic fertilizers, organic dose at 1.5 strength of recommended chemical dose without EM recorded the highest TSS in fruits (26.92%).

Total Sugar: Concerning total sugar fruit content, the results in table 8 revealed that increasing the rate of organic fertilizers was significantly associated with a gradual increasing in total sugar of Williams Banana fruits. 1.5 fold of organic matter treatment plus EM were the superior treatment in both studied seasons. Also, in the accumulation season, the same treatment was the best even EM added or not.

Results in Table 8 were in agreement with those noted by Abd El-Naby and El-Sonbaty [18] recorded that Maghrabi banana plants supplied with mineral fertilizers combined with organic manure (Farm refuse compost at 25% + 75% and 50% + 50%, respectively) improved fruit chemical characteristics of finger (total soluble solids and total sugar). In addition, El-Shenawi and El-Sayed [23] recorded that contents of fingers (total soluble solids and total sugars) increased by increasing the rates of biofertilizers and farmyard manure of Grand Nain banana. Also, these result came in line with finding of Mahmoud [26] as they noticed a great effect on fruit chemical properties (total soluble solids and total sugar) with varying HA:K:Mg. The best results were obtained with using HA: K: Mg at 10: 300: 150 g/plant with all studied parameters.

Total Acidity: Data in Table 9 revealed that total acidity was significantly affected by different fertilization treatments. Control plants recorded the highest total acidity in fruits. But, all organic fertilizers treatments recorded the lowest total acidity in fruits than the control. The same findings of results were recorded during the accumulation season.

These results are in agreement with those of Hammam *et al.* [16] as they found that plants received 80 g N/plant/year Agrolig plus 370 g N/plant/year in mineral N source significantly decreasing total acidity compared with using N in mineral source alone. In addition, Abd El-Aziz [17] showed that fertilizing Williams banana with 450 g N/plant as 50 % via organic plus 50 % via inorganic decreased total acidity of fruit content.

On the other hand, Abd El-Naby and El-Sonbaty [18] recorded that Maghrabi banana plants supplied with mineral fertilizers combined with organic manure (Farm refuse compost at 25% + 75% and 50% + 50%, respectively) improved fruit chemical characteristics of finger (total soluble solids and total acidity).

Nitrate (ppm): Data in Table 10 revealed that fruit content of nitrate was significantly affected by different fertilization treatments. Mineral fertilizer (control plants) resulted in highest values of residues nitrate in pulp of banana fingers (18.65, 19.69 and 19.69 in the 1st, 2nd and accumulation seasons, respectively) comparing with the other treatments used. Organic seasonally application of organic fertilizers is important to reduce the nitrate residues in pulp fingers.

In this respect, Hosam El-Dien and Boshra [19] found that the highest nitrate residues in the finger pulp were observed in mineral N treatments alone, whereas the lowest values were gained from compost treatments (organic manure).

It is well known that nitrate is easily formed from mineral nitrogen whereas; it is slowly formed from organic fertilizers [32].

CONCLUSION

From this study it could be concluded that organic fertilization during January with T_5 (1.0 fold of organic: 27.3 Kg Compost + 399 g rock phosphate +7.48 Kg feldspar vs. 400N + 250P + 900K unit + 360 ml EM /plant / year, or T_6 (1.5 fold of organic: 40.95 Kg Compost + 598 g rock phosphate +11.21 Kg feldspar vs. 600N + 375P + 1350K unit) + 360 ml EM /plant / year enhanced the most studied characters. In addition, using organic fertilizers at 1.5 fold improved the banana bunch weight, fruit quality. Also, continuous addition of organic fertilizers (accumulation effect) was superior to that fertilized once by using 1.0 fold of organic fertilizers.

REFERENCES

1. FAO, 2009. FAO STAT, http://faostat. fao. org/default. aspx.
2. Mayaz, M. and M. Salem, 1992. Effect of some nitrogen fertilizers treatments on the growth and productivity of banana (*Musa cavendisii* lambert) in sandy soils. Egypt. J. Appl. Sci., 7: 439-448.
3. Bationo, A., F. Lompo and S. Koala, 1998. Research on Nutrient Flows and Balance in West Africa: State-of-the-art. Agriculture, Ecosystem and Environ., 71: 19-35.
4. Bekunda, M.A., A. Bationo and H. Sail, 1997. Soil Fertility Management in Africa: A Review of Selected Research Trials , In: Buresh, R.J. P.A. Sanchez and F. Calhoun (eds.) Replinishing soil fertility in Africa. SSSA.Special publication,soil science society of America, Madison, Wisconsin, USA, 51: 63-79.
5. Buresh, R., 1999. Agroforestry Strategies for Increasing the Efficiency of Phosphorus Use in Tropical Uplands. Agroforestry Forum, 9: 8-13.
6. Hartz, T.K., 2003. The assessment of soil and crop nutrients status in th development of efficient fertilizer recomedations. Acta. Hort., 627: 231-240.
7. Rizk, F.A. and M.R. Shafeek, 2000. Response of growth and yield of Vicia faba plants to foliar and bio-fertilizers. Egypt J. Appl. Sci., 15: 131-136.
8. Montaser, A.S., N. El-Shahat, G.F. Ghobrial and M.Z. Abd-El Wadoud, 2003. Residual effect of nitrogen fertilization on leaves and fruits of Thompson seedless grabes. J. Environ. Sci., 6: 465-484.
9. Pham, D.T., 2004. FNCA Biofertilizer Newsletter. Japan Atomic Industrial Forum, Inc., 4: 1-8.
10. Higa, T., 2010. Effective microorganisms as a commercial product. http://econature. wordpress. com/2010/04/15/effective-microorganisms-em/
11. Hemeng, O.B., J.S. Asante and R.S.B. Ferris, 1995. Influence of poultry manure and inorganic fertilizer on plantain growth and yield. Musa Africa, 6: 2.
12. Bose, T.K. and S.K. Mitra, 1996. Tropical and subtropical fruits. Depatmet of Horticulture, Bidhan Chandra Krishi Viswavidyalaya Kalyani 741235, India Reprinted, pp: 838.
13. Lescot, T., 1997. Plantain production and sustainable production systems. Culture du bananier plantain et durabilite des systemes de production. Fruits, 52: 233-245.
14. Shintani, M., P. tabora, T. Alfoldi, W. Lockeretz and U. Niggli, 2000. Organic fertilizer: managing banana residues with effective microorganism (EM). The World Grows Organic Proceedings 13th International Federation of Organic Agriculture Movements (IFOAM) Scientific Conference, Basel, Switzerland CH, 28-31 August, 2000. Vdf Hochschulverlag AG an der ETH Zurich, Switzerland, pp: 260-269.
15. Geetha, K. and R.R. Nair, 2000. Integrated plant nutrition system (IPNS) for banana. Ann. Agric. Res., (India), 21: 499-503.
16. Hammam, M.S., E.G. Ibrahim and A.E.M. Mansour, 2003. Response of Williams banana to some organic nitrogen fertilizers. Egypt J. Hort., 30: 51-65.
17. Abd El-Aziz, K.A.K., 2004. Effect of Some Organic Nitrogen Fertilizers on Growth and Fruiting of Williams banana. Ph. D. Thesis, Fac. Agric. ,Minia Univ. Egypt, pp: 85.
18. Abd El-Naby, S.K.M. and M.R. El-Sonbaty, 2005. Effect of partial replacement of chemical fertilizers by organic manures in banana production and fruit quality. Assiut J. Agric. Sci., 36: 107-122.

19. Hosam El-Dein, A.S. and E.S. Boshra, 2008. Effect of Different Sources of Organic fertilizers As A Patrial Substitute For Mineral Nitrogen Fertilizers of Williams Banana. J. Agric. Sci. Mansoura Univ., 33: 143-149.
20. Smith, B.L., 1998. Micro-organisms in soil benefit growth and yield of banana. Netropika Bulletin, 299: 22-25. Cited from Hort. Abstract, 10034: 1998.
21. Gomes, J.A., A.C. Nobrega, J.S. Salgado and A.C. Da-Rocha, 1988. Utilization of organic matter in banana cultivar Prata in the state of Espirito Santo. www. bdpa. cnptia.embrapa.br/busca.jsp.
22. Khandare, V.S., B.A. Kadam, P.J.G. Wakle and B.B. Badgire, 1999. Effects of fertilizer dose on yield of banana ratoon crop cv. Ardhapuri. J. Maharashtra Agric. Univ., 23: 314-315.
23. El-Shenawi, M.R. and S.A.M. El-sayed, 2005. Effect of bio and organic fertilization on growth, productivity, fruit quality and leaf mineral content of Grand Nain banana. J. Adv. Agric. Res., 10: 779-789.
24. Kamel, A.B., 2002. Physical studies on Biofertilization of Banana Plants cv. Williams. Ph.D. Thesis, Fac. Agric., Minia. Univ. Egypt, pp: 127.
25. Abd El-Aziz, A.B.K., 2002. Physiological Studies on Biofertilizers of Banana Plants cv. Williams. Ph.D. Thesis, Fac. Agric., Minia Univ. Egypt, pp: 112.
26. Mahmoud, S.M., 2009. Effect of Organic and Bio-fertilization on Growth and Productivity of Williams Banana. Ph.D. Thesis, Fac. Agric, Cairo Univ. Egypt, pp: 96.
27. Jeeva, S., M. kulasekaran, K.G. Shanmugavelu and G. Obilisami, 1988. Effect of *Azospirillum* on growth and development of banana cv. Poovan (AAB). South Indian Horticulture, Cited from Hort. Abstract, 2102: 1990. 36: 1-4.
28. Dibut Alvares, B., A. Rodriguez Nodals, A. Perez and R. Martinez Viera, 1996. The effect of Azctoryzas double function on banana (*Musa* spp.) . Experimental conditions. Infomusa, 5: 20-23.
29. Tiwary, D.K., M.A. Hasan and P.K. Chattopadhyay, 1998. Studies on the effect of inoculation with *Azotobacter* and *Azosprillium* on growth, yield and quality of banana. Indian Agric., 42: 235-240.
30. Abd El-Moniem, E.A.A. and S.M.A. Radwan, 2003. Response of Williams banana plants to biofertilization in relation to growth, productivity and fruit quality. Arab Univ. J. Agric. Sci. Ain Shams Univ., 11: 751-763.
31. Mai, M.A.B., Z.H. Shamsuddin, W. Zakaria and M. Mahmoud, 2005. High yielding and quality banana production through plant growth promoting rhizobacterial (PGPR) inoculation. Fruits Paris, 60: 179-185.
32. Ibrahim, T., 1994. Water pollution. Series of science and life. Egypt organization for books, Cairo, Egypt,
33. Kader, A.A., 2005. Banana-recommendations for maintaining postharvest quality. http://postharvest. ucdavis. edu/Produce/ProduceFacts/Fruit/full banana ripening chart.shtml; 1 August, 2009.
34. Smith, F., M.A. Gilles, J.K. Hamilton and P.A. Godess, 1956. Colorimetric method for determination of sugars related substances. Anal. Chem., 28: 350-356.
35. A.O.A.C. (Association of Official Agricultural Chemists), 1985. Official Methods of Analysis, 13 th Ed. A.O.A.C. Int. Virginia, U.S.A.
36. Singh, J.P., 1988. A rapid method for determination of nitrate in soil and plant extract. Plant and Soil, 110: 137-139.
37. Snedecor, G.W. and W.G. Cochran, 1990. Statistical methods. Iowa St. Univ. Press. , 7th Ed. , Iowa, U.S.A. pp: 365-372.
38. Steel, R.G.D. and G.H. Torrie, 1982. Principles and procedures of Statistics. A biometrical Approach. McGraw-Hill Book Co., pp: 625.
39. Zake, Y.K., D.P. Bwamiki and C. Nkwiine, 2000. Soil management requirements for banana production on the heavy soils around Lake Victoria in Uganda. Proceeding of the first International Symposium on Banana and plantain for Africa, Kampala, pp: 14-18.
40. Lie, X.J., S.F. Dona and Y.S. Liu, 1998. Determination of IAA and Cytokines in the soil with different organic manure for pot cultured apple. Plant Physiology Communications, 34: 183-185.
41. Saber, M.S.M. and A.M.H. Gomaa, 1993. Associative action of multi-strain bio-fertilizer on tomato plants grow in a newly reclaimed soil. 6th inter. symp. on nitrogen fixation with non-regimes, Ismailia, Egypt, 6-10. Sept. pp: 495-583.
42. Nijjar, G.S.,1985. Nutrition of fruit trees. Kanylyani publishers, New Delhi, India, pp: 306-308.
43. Abd El-Naby, S.K.M., 2000. Effect of banana compost as organic manure on growth, nutrients status, yield and fruit quality of Maghrabi banana. Assiut J. Agric. Sci., 3: 101-114.
44. El-Shenawi, M.R. and M.G. Hassouna, 2004. Impact of biofertilizer on growth and yield of banana Williams in the study soil at Nubaria region. J. Agric. Sci. Mansoura Univ., 29: 6527-6535.