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Response of Williams Banana Plants to Application of EM_1 and Yeast

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ABSTRACT

During 2012/ 2013 and 2013/ 2014 seasons, Williams banana plants were treated via soil with EM_1 at 100 to 400 ml / plant and/ or via foliage with yeast at 0.1 to 0.4% . Growth characters, leaf pigments, N, P, K, Mg and Ca in the leaves, yield and fruit quality in response to the present treatments were investigated. Soil addition of EM_1 at 100 to 400 ml plant and/ or foliar application of yeast at 0.1 to 0.4% was very effective in enhancing all growth aspects , leaf pigments, N, P, K, Mg and Ca in the leaves , yield as well as both physical and chemical characteristics of the fruits relative to the check treatment. Using EM_1 was materially superior to using yeast in enhancing all growth traits, leaf pigments, N, P, K, Mg and Ca in the leave s, yield as well as both physical and chemical characteristics of the fruits. The best results with regard yield and fruit quality were obtained due to supplying Williams banana plants with EM_1 at 200 ml / plant plus spraying yeast four times at 0.2%.

Key words: Williams banana, EM1, yeast and fruiting

Introduction

Biofertilization of Williams banana plants with EM_1 and yeast is beneficial for controlling growth, enhancing flowering and improving both yield and fruit quality.

Clean cultivation is greatly achieved by using yeast (*Saccarmyces cerevisae*). The higher positive action of yeast on growth and fruiting of fruit crops might be ascribed to its higher content of IAA, cytokinins, protein, amino acids fats, minerals, nucleic acid, glutathione, lecithine, enzymes, coenzymes and vitamins B. Also, it is essential for the synthesis of amino lenulinic acid (AA) and protoprophyrin the precursor of chlorophylls and in activating photosynthesis through enhancing the release of carbon dioxide (Abou-Zaid, 1984 and Barnett *et al.,* 1990).

Effective microorganisms which is known as EM_1 is a culture containing more than 60 microorganisms including lactic acid bacteria (*Lactobacillus plantary, lactobacillus casei and Streptocous lactis*, photosynthesis bacteria, yeast and algae. Also, EM_1 produces lactic acids (Higa, 1989 and Formowitz *et al.,* 2007).

Previous studies showed that biofertilization of fruit crops with effective microorganisms (Badran and Mohamed 2009; Roshdy *et al.,* 2011; Refaai *et al.,* 2012; Ibrahim , 2012; Ahmed *et al.,* (2014a) and (2014b); Hassan – Huda, 2014 and Saied, 2015) and yeast (Ebrahiem *et al.,* 2000 ; Ahmed, 2001 ; Moustafa and El-Hosseiny , 2001; Gobara , 2004 ; Mostafa , 2004 ; Badawi- Sabah , 2005; Zagzog, 2009; Abd El- Motty- Elham *et al.,* 2010; Ahmed- Saman, 2011; Abdelaal *et al.,* 2012; Mahmoud, 2012; Ahmed *et al.,* 2013 and Oraby , 2013) was very effective in stimulating growth, nutritional status of the plants, yield and fruit quality.

The target of this study was examining the effect of soil addition of EM_1, and/ or spraying yeast on fruiting of Williams banana plants grown under Qena environmental conditions.

Material and Methods

This study was carried out during 2012/ 2013 & 2013/ 2014 seasons (i.e. on third and fourth ratoons, respectively) on Williams banana plants. The selected plants are grown in a private orchard situated at Qena district, Qena Governorate. The plants are grown in silty clay soil under flood irrigation system and irrigated by Nile water. Thirty stools planted at 3.5 x 3.5 m apart, each containing three plants were selected as experimental plants. Regular orchard management was carried out as usual.

The experimental included the following ten treatments from EM and yeast applications.

1- Control.
2- Soil addition of EM_1 at 100 ml/ plant.
3- Soil addition of EM_1 at 200 ml/ plant.
4- Soil addition of EM_1 at 400 ml/ plant.

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5- Foliar application of yeast at 0.1%.
6- Foliar application of yeast at 0.2%.
7- Foliar application of yeast at 0.4%.
8- Using EM1 & Yeast at the low concentration.
9- Using EM1 & Yeast at the medium concentration.
10- Using EM1 & Yeast at the high concentration.

Each treatment was replicated three times, one stool per each. The pure yeast powder was activated by using sources of carbon and nitrogen with ratio of 6 : 1. This ratio is suitable to get about 12000 yeast cells. Such techniques for yeast preparation based on bringing glucose + casein as favourable sources of carbon and N and other essential elements (P, K, Mg, Fe, Mn, Cu, Na, B, Cl and Mo) in suitable balance, air pumping and adjusting incubation temperature. The media then subjected to two cycles of freezing and thawing for disruption of yeast tissues and releasing their bioconstituents directly before using (Barnett *et al.,* 1990).

Table 1: Analysis of the tested soil

Constituent	Values
Sand %	5.0
Silt %	56.0
Clay %	39.0
Texture	Silty clay
CaCO3 %	2.1
pH (1: 2.5 extract)	7.45
O.M. %	1.88
Total N %	0.09
Available P (ppm) Olsen method)	4.2
Available K (ppm) ammonium acetate)	410.0

Table 2: Chemical analysis of the used yeast extract (according to Abou- Zaid, 1984).

Characters	Values
Amino acids (mg / 1000 dry weight)	
Arginine	1.99
Histidine	2.63
Isoleucine	2.31
Leucine	3.09
Lycine	2.95
Methionine	0.72
Phenyl alanine	2.01
Threonine	2.09
Tyrptophan	0.45
Valine	2.19
Glutamic acid	2.00
Serine	1.59
Asparatic acid	1.33
Cystine	0.23
Proline	1.53
Tyrosine	1.49
N %	7.3
Fat %	3.5
Ash %	6.7
Carbohydrates %	23.2
Glucose %	13.33
Vitamins (mg / 100 g dry weight)	
B1	2.23
B2	1.33
B6	1.25
B12	0.15
Thamin	2.71
Riboflavin	4.96
Ensitol	0.26
Biotin	0.09
Nictotinic acid	39.88
Pantothenic acid	19.56
Pamino benzoic acid	9.23
Folic acid	4.36
Pyridoxine	2.90

Yeast were foliar applied four times started at the first week of April and at one month intervals. Effective microorganisms (EM_1) (each ml contain 0.6 x 10^7 microorganisms was soil applied once in holes 10 cm depth at the first week of April during both seasons. Triton B as a wetting agent was added at 0.05% to all the sprayed solutions of yeast. Spraying was done till all plants were completely covered with the yeast solutions. Randomized complete block design (RCBD) was adopted.

During both seasons, the following parameters were measured:

1- Pseudostem height (cm.) (from the soil surface up to the petiole of the last emerged leaf), pseudostem girth (cm.) in the base, middle and top of the pseudostem, then the average was calculated and number of green leaves/ plant were recorded after the emergence of the infloroscene (1st week of Sept).
2- Leaf samples were taken from the third upper leaf in the descending leaves from the top of the plant after bunch shooting (mid. of Sept). A sample of 10x 10 cm area from the middle part of the leaf blades (Summer, 1985) was taken for determining chlorophylls a & b , then total chlorophylls (as mg/ 100 g F.W.) (Von-Wettstein, 1957) and Hiscox and Isralstam, 1979) as well as percentages of N, P, Mg and Ca (according to Chapman and Pratt, 1975).
3- The bunches were picked at the last week of Oct., during both seasons, then bunch weight (kg.) was recorded. Six hands from the base, middle and distale end of the bunch were taken for measuring hand weight (kg) After artificial ripening finger weight (g) , T.S.S. %, total and reducing sugars % (Lane and Eynon, 1965) and total acidity %) as a malic acid / 100 g pulp) were recorded (A.O.A.C., 2000).

The obtained data were tabulated and subjected to the proper statistical analysis and the differences between different treatment means were compared using new L.S.D. at 5% (Mead *et al.,* 1993).

Results and Discussion

Growth characters:

It is clear from the obtained data in Table (3) that single and combined applications of EM_1 at 100 to 400 ml/ plant and yeast at 0.1 to 0.4% significantly stimulated height and girth of pseudostem and number of green leaves/ plant relative to the check treatment. The stimulation on these growth characters was associated with increasing levels of EM_1 from 100 to 400 ml / plant and concentrations of yeast from 0.1 to 0.4%. Using EM_1 was significantly superior to using yeast in this respect. Combined application of EM and yeast significantly surpassed the application of each alone in this connection. Increasing levels of EM, from 200 to 400 ml/ plant as well as concentrations of yeast from 0.2 to 0.4% failed significantly to show any promotion on these growth characters. The maximum values of height (225.7 & 227.4 cm), girth (83.6 & 85.3 cm) of pseudostem and number of green leaves / palm (31.0 & 31.0) were recorded on the plants that soil fertilized with EM_1 at 400 ml / plant besides foliage application of yeast at 0.4 % during both seasons respectively. Untreated plants produced the minimum values. These results were true during both seasons.

Table 3: Effect of EM_1 and yeast application on some growth characters, chlorophylls a &b and total chlorophylls in the leaves of Williams banana plants during 2012/ 2013 and 2013/ 2014 seasons.

Treatments	Pseudostem height (cm.)		Pseudostem girth (cm)		No. of green leaves / plant		Chlorophylls a (mg / 100 g F.W.)		Chlorophyll b (mg / 100 g F.W.)		Total chlorophylls (mg / 100 g F.W.)	
	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14
Control	205.0	206.0	71.0	71.5	23.0	22.0	4.1	3.9	1.9	2.0	6.0	5.9
EM1(100ml/ plant)	214.9	216.0	76.3	76.8	27.0	27.0	5.5	5.6	3.1	3.1	8.6	8.7
EM1 (200ml/ plant)	217.0	218.1	79.0	79.6	29.0	28.0	6.0	6.2	3.6	3.6	9.6	9.8
EM1 (400 ml/ plant	217.7	219.4	79.4	80.0	29.0	28.0	6.1	6.3	3.7	3.7	9.8	7.4
Yeast (0.1 %)	208.9	210.0	73.0	73.6	24.0	25.0	4.5	4.7	2.3	2.4	6.8	7.1
Yeast (0.2%)	211.0	212.3	75.0	75.7	26.0	27.0	4.9	5.2	2.6	2.7	7.5	7.9
Yeast (0.4%	211.6	213.0	75.6	76.0	26.0	27.0	5.0	5.7	2.7	2.8	7.7	8.5
EM1 & Yeast at the low con.	220.0	221.8	81.9	82.9	29.0	30.0	6.5	6.8	4.2	4.3	10.7	11.1
EM1 & Yeast at the med. con.	225.0	227.0	82.3	85.0	31.0	31.0	6.9	7.3	4.7	4.8	11.6	12.1
EM1 & Yeast at the high con.	225.7	227.4	83.6	85.3	31.0	31.0	7.6	7.6	4.8	4.9	11.8	12.5
L.S.D. at 5 %	1.5	1.6	1.0	1.0	1.0	1.0	0.3	0.3	0.2	0.2	0.3	0.3

EM= Effective microorganisms

Leaf chemical composition:

Data in Tables (3 & 4) clearly show that application of EM_1 at 100 to 400 ml/ plant and / or yeast at 0.1 to 0.4% significantly was accompanied with stimulating chlorophylls a , b , total chlorophylls , N, P, K, Mg and Ca in the leaves rather than non application. Using EM_1 at 100 to 400 ml/ plant was significantly superior in improving these nutrients than using yeast at 0.1 to 0.4%. Combined application of EM_1 and yeast was significantly preferable than using each alone in this respect. No significant differences on these nutrients were observed among the higher two levels of EM_1 (200 and 400 ml / plant) and concentrations of yeast (0.2 and

0.4%). The maximum values were recorded on the plant that received EM_1 and yeast together each at the higher levels. The untreated plants gave the minimum values. These results were true during both seasons.

Table 4: Effect of EM_1 and yeast application on the leaf chemical composition and bunch weight (kg.) per plant of Williams banana plants during 2012/ 2013 and 2013/ 2014 seasons.

Treatments	N %		P %		K %		Mg %		Ca %		Bunch weight/ plant (kg.)	
	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14
Control	2.11	2.18	0.16	0.14	1.50	1.46	0.49	0.47	2.41	2.31	16.3	16.5
EM1(100ml/ plant)	2.41	2.49	0.29	0.29	1.71	1.72	0.51	0.50	0.67	2.67	19.9	19.7
EM1 (200ml/ plant)	2.55	2.63	0.33	0.33	1.80	1.81	0.55	0.54	0.75	2.76	21.0	20.8
EM1 (400 ml/ plant	2.56	2.64	0.34	0.34	1.81	1.82	0.56	0.55	0.76	2.77	21.3	21.1
Yeast (0.1 %)	2.21	2.31	0.20	0.21	1.56	1.58	0.43	0.43	0.51	2.52	17.5	17.3
Yeast (0.2%)	2.29	2.41	0.23	0.24	1.62	1.64	0.46	0.47	0.59	2.60	18.6	18.4
Yeast (0.4%	2.30	2.42	0.24	0.24	1.63	1.65	0.47	0.48	0.60	2.61	18.8	18.5
EM1 & Yeast at the low con.	2.74	2.81	0.37	0.39	1.86	1.87	0.66	0.66	0.84	2.87	22.9	22.5
EM1 & Yeast at the med. con.	2.85	2.92	0.40	0.43	1.92	1.92	0.70	0.71	0.91	2.95	24.0	23.6
EM1 & Yeast at the high con.	2.86	2.93	0.41	0.44	1.93	1.93	0.71	0.72	0.92	2.96	24.3	24.0
L.S.D. at 5 %	0.06	2.05	0.03	0.03	0.05	0.04	0.03	0.03	0.06	0.06	0.8	0.9

EM= Effective microorganisms

Weights of bunch and hand:

It is obvious from the data in Tables (4 & 5) that weights of bunch and hand were significantly improved in response to application of EM_1 and/ or yeast comparing to the check treatment. A significant promotion on weights of bunch and hand was observed due to using EM_1 rather than spraying yeast. Combined application was favourable in improving weights of bunch and hand of Williams banana plants comparing with using each material alone. Increasing levels of EM_1 from 200 to 400 ml/ plant and yeast from 0.2 to 0.4% failed significantly to promote the yield (bunch weight) and hand weight. Economically point of view, it is advised to use a mixture of EM_1 at 200 ml/ plant plus yeast at 0.2% for producing good yield Under such promised treatment , yield per plant reached 24.0 and 23.6 kg / plant of comparing with the yield of untreated plants that reached 16.3 and 16.5 kg during both seasons, respectively. The percentage of increase on the yield due to using the promised treatment over the check treatment reached 47.2 and 43.0 % during both seasons, respectively. Similar results were announced during 2012/ 2013 and 2013/ 2014 seasons.

Table 5: Effect of EM_1 and yeast application on some physical and chemical characteristics of the fruits of Williams banana plants during 2012/ 2013 and 2013/ 2014 seasons.

Treatments	Av. Hand weight (kg.)		Av. Finger weight (g.)		T.S.S. %		Total sugars %		Reducing sugars %		Total acidity %	
	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14
Control	1.63	1.65	81.5	82.6	17.7	17.5	14.7	14.8	7.1	6.9	0.344	0.341
EM1(100ml/ plant)	1.99	1.97	99.5	98.5	19.0	19.0	15.7	16.0	8.1	8.0	0.274	0.275
EM1 (200ml/ plant)	2.10	2.08	105.0	104.0	19.4	19.5	16.0	16.4	8.4	8.3	0.251	0.250
EM1 (400 ml/ plant	2.13	2.11	106.5	105.5	19.5	19.6	16.1	16.5	8.5	8.4	0.250	0.249
Yeast (0.1 %)	1.75	1.73	87.5	86.5	18.1	18.0	15.0	15.1	7.4	7.3	0.320	0.319
Yeast (0.2%)	1.86	1.84	93.0	92.0	18.5	18.6	15.3	15.4	7.7	7.6	0.296	0.294
Yeast (0.4%	1.88	1.85	94.0	92.5	18.6	18.7	15.4	15.6	7.8	7.7	0.295	0.293
EM1 & Yeast at the low con.	2.29	2.25	114.5	112.5	20.0	20.1	16.5	16.7	8.8	8.7	0.230	0.229
EM1 & Yeast at the med. con.	2.40	2.36	120.0	118.0	20.6	20.4	16.9	17.0	9.0	9.0	0.210	0.209
EM1 & Yeast at the high con.	2.43	2.40	121.5	120.0	20.7	20.5	17.0	17.1	9.0	9.1	0.209	0.208
L.S.D. at 5 %	0.10	0.10	2.6	2.4	0.3	0.3	0.2	0.2	0.2	0.2	0.020	0.19

EM1= Effective microorganisms

Fruit quality:

Table (5) shows that single and combined applications of EM_1 at 100 to 400 ml/ plant and yeast at 0.1 to 0.4% was significantly very effective in improving fruit quality in terms increasing finger weight, T.S.S. % and total and reducing sugars % and decreasing total acidity % relative to the control treatment The promotion was significantly associated with increasing of EM_1 levels and yeast concentrations without significant effect between the higher two levels of any one. Combined application was significantly superior than using each alone in this respect. Combined application of EM1 at 200 ml/ plant plus yeast at 0.1 % gave the best results from economical point of view. Unfavourable effects on fruit quality were observed on untreated plants. These results were true during both seasons.

Discussion

The best results with regard to yield and fruit quality of Williams banana due to using EM_1 were attributed to positive action of EM_1 on enhancing soil fertility , the availability of nutrients, organic matter, root development, activity of organisms and N fixation (Higa, 1989 and Formowitz *et al.,* 2007).

These results with regard to the promoting effect of EM_1 on fruiting of Williams banana are in harmony with those obtained by Badran and Ahmed (2009); Roshdy *et al.,* (2011); Refaai *et al.,* (2013); Ibrahim (2012); Ahmed *et al.*, (2014a) and (2014b) , Hassan- Huda (2014) and Saied (2015).

The beneficial effects of yeast on fruiting of Williams banana plants might be ascribed to its higher content of IAA, cytokinins, proteins , amino acid, fats, minerals nucleic acid, glutathione, lecithine, enzymes, coenzymees and vitamins B. Also, yeast is essential for the synthesis of amino lenulinic acid and protoprophyrin the precursor of chlorophylls and in activating photosynthesis through enhancing the release of CO_2 (Abou – Zaid , 1984 and Barnett *et al.,* 1990).

The promoting effect of yeast on growth and yield of Williams banana was confirmed by the results of Ebrahiem *et al.,* (200), Ahmed (2011); Moustafa and El- Hosseiny (2001); Gobara (2004); Mostafa (2004); Badawi – Sabah (2005), Zagzog (2009); Abd El- Motty- Elham *et al.,* (2010); Ahmed – Samah (2011); Abdelaal *et al.,* (2012) ; Mahmoud (2012) ; Ahmed *et al.,* (2013) and Oraby (2013).

Conclusion

The best results with regard to yield and fruit quality of Williams banana were observed due to treating the plants with EM_1 at 200 ml plant plus yeast four times at 0.2%.

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