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Williams Banana Growth, Nutritional Status, Yield and Fruit Quality as Influenced by Spraying Humic Acid and Seaweed Extract

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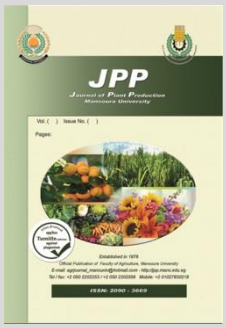

ABSTRACT

In order to study the response of Williams banana plant (*Musa spp*.) to spraying with humic acid (potassium humate) at 0.5%, 1% & 2% and seaweed at 0.25%, 0.50% & 0.75% three times yearly, a field experiment was conducted during 2018 and 2019 seasons at private orchard situated at Saft Al-Laban village El-Minia Governorate, Egypt, where the soil is silty clay loam. The obtained results confirmed that spraying Williams banana plants with humic acid at 0.5%, to 2.0% and seaweed at 0.25% to 0.75% significantly improved vegetative growth (in terms of pseudostem length, pseudostem girth, number of leaves/plant and leaf area), leaves chemical constituents (i.e. nitrogen%, phosphorus%, potassium%, and magnesium%), bunch weigh (kg)/plant, finger weight, as well as fruit physical and chemical properties (i.e. fruit weight, fruit dimension, pulp/peel ratio, TSS%, total sugars and total acidity%) compared to control plants. The combined spraying of humic acid and seaweed shows more effective in all studied characteristics than using each compound alone. The best results in the abovementioned parameters were observed in spraying humic acid and seaweed extract in combination at higher concentrations. However, non-significant differences were observed between the higher concentrations, neither for humic acid nor for seaweed extract. The results of the present study confirmed that important role of humic acid and seaweed extract in improving growth parameters, leaves chemical composition, yield, and fruit physical and chemical properties of Williams banana grown in silty clay loam soil under arid conditions.

Keywords: Musa spp., Williams banana, humic acid, seaweed extract.

INTRODUCTION

Botanical classification puts banana plant (*Musa spp*.) in Family Musacae. *Musa* species are native to tropical zone. Banana plants cultivate primarily for their fruit, and to a lesser extent to make fiber, banana wine, and banana. This prompted to expansion of its cultivation, and increasing in its cultivated area. Also, many good high-yielding varieties were introduced to Egypt, including the Williams variety subject of this research (Ibrahim, 2016).

The classification of cultivated bananas has long been a problematic issue for taxonomists. Linnaeus originally placed bananas into two species based only on their uses as food: *Musa sapientum* for dessert bananas and *Musa paradisiaca* for plantains. More species names were added, but this approach proved to be inadequate for the number of cultivars. Many of these cultivars were given names that were later discovered to be synonyms. Williams cultivar is one of *Cavendish* subgroup and considered as one of the most the main bananas varieties in terms of widespread and commerce. This cultivar characterized by a hardy pseudostem which has a good resistance to wind and cold, heavy weight of bunches and large heads, as well as fruit that are sweet (Ibrahim, 2016).

The link between food safety and human health is the major concern of the consumer. However, natural sources such as humic acid and seaweed extracts have an important role in this regard (Stevenson, 1982; Guiry & Blunden 1991; Kulk, 1995; Fornes *et al.*, 2002; Massie 2003; Fornes *et al.*, 2005; Laurence, 2006; Kuwada *et al.*, 2006; Gary-Wiiens & Reynold 2008; Murdinah & Hermant 2008; Mosa *et al.*, 2014; Battacharyya *et al., 2015;* Ibrahim & Gad El-Kareem, 2014: El-Boray *et al*., 2015; Doring *et al.*, 2015, and Omar *et al.*, 2017; Jindo *et al*., 2020). Humic acid acts as a soil conditioner and bio catalyzer, increases root development and colonization. Benefits of humic substances are addition of organic matter to soil, increasing root vitality, improving nutrient elements uptake, enhancing chlorophyll synthesis, increasing fertilizers retention, stimulating beneficial soil microbial activity, and producing healthy plants with good yield (Hewitt *et al.*, 1976; Stevenson, 1982; Ferrara and Brunetti, 2010; Abd El-Kareem 2014; Mayi *et al*., 2014; El-Boray *et al*., 2015; and De-Melo *et al.*, 2016). Seaweeds are potentially excellent sources of highly bioactive secondary metabolites that could represent useful leads in the development of new functional ingredients. Many reports have been published regarding isolated compounds from seaweeds with various biological activities, demonstrating their ability to produce important metabolites unlike those found in terrestrial species (Featonby-Smith, 1984; Fan *et al.*, 1993; Reitz & Trumble, 1996; Laurence, 2006; Zamani *et al.*, 2013; Ibrahim, 2017 and Ibrahim & Abo-Hessiba 2018).

Based on the abovementioned the target of this study was to examine the effect of spraying of humic substances and seaweed extract on growth, nutritional status, and yield as well as fruit physical and chemical characteristics of Wiliams banana plant grown under arid conditions of El-Minia Governorate, Egypt.

MATERIALS AND METHODS

This study was carried out during two successive seasons of 2018 and 2019 on second and third ratoons of

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Williams banana plants grown in a private orchard situated at Saft Al-Laban village El-Minia Governorate, Egypt, where the soil is loamy clay and well drained. The plants are planted at 3 x 3.5 m apart and irrigated with Nile water using surface irrigation system. Other horticultural practices such as fertilization, hoeing as well as training, and pest control was carried out as usual as recommended (Ibrahim, 2016).

Soil analysis: Analysis of the orchard soil at 0.0 to 60.0 cm depth was carried out according to Wilde *et al.*, (1985) and Walsh & Beaton (1986). The obtained data are shown in Table (1).

Table 1. physical and chemical properties of the tested soil.

Soil Property	Values
Sand %	6.4
Silt %	56.2
Clay %	37.4
Texture	Silty clay loam
pH (1: 2.5 extract)	7.82
E.C. (1:5 extract) (d Sm^{-1})	1.66
O.M %	1.92
$CaCO_3$%	2.13
Total N %	0.11
Available P (ppm, Olsen)	6.1
Available K (ppm, ammonium acetate)	433.6

Experimental procedures: This study included sixteen treatments with two factors (A & B), each treatment was replicated three times making up 48 experimental stools. The first factor (A) comprised of four humic acid concentrations namely: 0.0, 0.5%, 1% and 2%. The second factor (B) contained the following four seaweed extract concentrations namely: 0.0%, 0.25%, 0.50% and 0.75%. Stool of each treatment was containing three Williams banana plants. Potassium humate as the salt of humic acid and seaweed extract were sprayed three times at the second week of April and at one-month intervals. Triton B as a wetting agent was added to all spraying solutions.

Experimental design: This experiment was set up in a randomized complete Block design (RCBD) in split plot arrangement which the humic acid concentration occupied the main plots and seaweed extract occupied the sub- plots according to **Snedecor** & Cochran 1990. The main Chemical analyses of seaweed extract are shown in table (2) according to El-Said and El-Sikaily 2013.

Table 2. Chemical analyses of seaweed extract used in this experiment.

Compound	Concentration
Organic Matter	45 ~ 50% w/w
Total Nitrogen	0.5 ~ 1.5% w/w
Phosphorus (P_2O_5)	6 % w/w
Potassium	18 ~ 22% w/w
Magnesium	0.42 ~ 0.6% w/w
Calcium	0.40 ~ 1.60 % w/w
Iron	0.15 ~ 0.30 % w/w
Copper	25 ppm ~ 45 ppm w/w
Sulfur	1.4 ~ 2.6 % w/w
pH value	8 ≈ 8.5
Moisture	≤ 5 %
Alginic acid	10 – 13% w/w
Soluble in water	100decreases% w/w
Appearance	Black Flake / powder

Measurement of vegetative growth: After the flowering inflorescence emerges from the top of plant at July for both the second and third ratoons, the following vegetative characteristics were measured: Pseudostem height in (m), girth of pseudostem (cm) at the height of 1 meter from the soil surface, number of green leaves per plant, Leaf area (cm^2) according to the following equation:

Leaf area = 0.67 (L x W) + 107.15 (Ahmed and Morsy, 1999)
Where: L= leaf length (cm) and W = leaf width (cm).

Leaf mineral contents: Leaf samples were taken from the third upper leaf of the plant after bunch shooting in September in both seasons. A sample of 10x 10 (cm) area from the middle part of the leaf blades as recommended by Martin-Préval *et al.,* (1984). Leaf samples were washed with tap water then with distilled water, and then the samples were oven dried at 60- 70ºC until a constant weight and ground. The following mineral elements were determined: Total nitrogen%, using micro- Kjeldahl method (Wilde *et al.*, 1985). Phosphorus%, by using the Olsen method as (Martin-Préval *et al.*, 1984). Potassium%, by using Flame photometric, (Martin-Préval *et al.*, 1984). Magnesium%, using versene method (Martin-Préval *et al.*, 1984).

Measurement of yield and fruit quality: The bunches were picked at the last week of November in both 2018 and 2019 seasons when the fingers reached three quarter stage. Bunch weight (kg), average hand weight (g) and finger weight (g) were recoded. Three hands from the base middle and distal end of the bunch (as a composite sample) were taken for the physical and chemical determination. Then, the hands were wrapped with newspaper and enclosed in wooden boxes with a glass surface to achieve artificial ripening. After the fingers ripened, the following physical parameters were determined: Average weight of the finger (g); Average finger dimensions (diameter and length cm); Average ratio between pulp and peel. A composite sample was taken from the fruit pulp and mixed using an electric blender, and then the following chemical parameters were determined: percentage of total soluble solids by using a handy refractometer; percentage of reducing and total sugars by using methods of Lane and Eynon (1965) that outlined in Rangana (1985); percentage of total acidity (g malic acid per 100 g fresh pulp) according to A.O.A.C., (2000).

Statistical analysis: The obtained data were analyzed and the differences between the means were compared by using L.S.D. test at the probability level of 5% according to (Snedecor & Cochran 1990 and Gomez & Gomez, 1984).

RESULTS AND DISCUSSION

1- Effect of humic acid and seaweed on vegetative growth:

It is obvious from the obtained data (Table 3) that using humic acid and seaweed extract significantly was accompanied with enhancing pseudo stem height, pseudo stem girth, number of leaves/plant and leaf area, during both experimental seasons. Using humic acid had announced effect on these characters than using seaweed extract, especially with the higher concentrations. The highest values of pseudo stem length and girth as well as number of leaves/plant and average leaf area were observed with using humic acid at 2% accompanied with seaweed at 0.75% followed by 2% humic acid accompanied with 0.5% seaweed extract. However, during both experimental seasons, non-significant differences were observed in all vegetative growth parameters between the higher concentrations of either humic acid or for seaweed extract. On the other side, untreated plants present the lowest pseud stem height, pseudo stem girth, number of leaves/plant and leaf area, during both experimental seasons.

It is well known that humic acid and seaweed extract had a many functions in plant nutrition and growth that influence vegetative growth. These included enhancing of metabolic processes such as photosynthesis; activation of carbohydrate metabolized for synthesis of amino acids and proteins; main role of cell division and root colonization and distribution in soil. The aforementioned roles of both compounds could be explaining its effect on improving growth parameters (Doring *et al.,* 2015, and Omar *et al.,* 2017; Jindo *et al*., 2020).

It is well documented that humic acid enhances the production of growth promoting substances i.e. IAA, GA3, and cytokinin (Mouftah 2007; Al-Wasfy and El-hawaga 2008; Mohamed 2017). Moreover, previous investigations recommended the use of humic acid to enhance growth, nutrients availability and uptake, nutrient transport, photosynthesis process, water use efficiency, vitamins B and resistant to draught (Senn & Kingman 2000; Mansour *et al*., 2004; Al-Wasfy & El-Khawage 2008 and El-Khawga & Meklad 2013). However, seaweed components such as macro- and microelement nutrients, amino acids, vitamins, cytokinin, auxins, and abscisic acid (ABA)-like growth substances affect cellular metabolism in treated plants leading to enhanced vegetative growth of fruit trees (Tay *et al.,* 1985; Crouch 1990; Gandhiyappan & Perumal 2001 and Ali & Mohamed 2016). Seaweed extracts are bioactive at low concentrations, although many of the various chemical components of seaweed extracts and their modes of action remain unknown, it is plausible that these components exhibit synergistic activity (Fornes *et al.,* 2002; Vernieri *et al.,* 2005; Doring 2015 and El-Boray *et al.,* 2015). This brief description of the most important roles of humic acid and seaweed extract in enhancing plants growth can clearly explain the remarkable improvements in all vegetative growth of Williams banana that were found in this study.

Table 3. Effects of spraying humic acid (HA) and seaweed extract (SW) on vegetative growth of Wiliams banana plants, during 2018 and 2019 seasons.

Treatments	Pseudo stem height (m)									
	2018					2019				
	HA 0.0%	**HA 0.5%**	**HA 1%**	**HA 2%**	**Mean B**	**HA 0.0%**	**HA 0.5%**	**HA 1%**	**HA 2%**	**Mean B**
SW 0.0 %	1.63	1.88	1.95	2.10	1.89	1.66	1.89	2.09	2.19	1.88
SW 0.25%	1.77	1.93	2.17	2.28	2.04	1.81	1.93	2.19	2.28	2.05
SW 0.50%	1.89	2.27	2.35	2.41	2.23	1.96	2.26	2.39	2.44	2.26
SW 0.75%	1.92	2.33	2.39	2.43	2.27	2.05	2.29	2.43	2.49	2.32
Mean A	1.80	2.10	2.22	2.31		1.87	2.09	2.28	2.35	
LSD 5%		A= 0.18 ;	B= 0.15	; AB= 0.22			A= 0.18 ;	B= 0.17	; AB= 0.25	
	pseudo stem girth (cm)									
Treatments	2018					2019				
	HA 0.0%	HA 0.5%	HA 1%	HA 2%	Mean B	HA 0.0%	HA 0.5%	HA 1%	HA 2%	Mean B
SW 0.0 %	72.5	75.2	77.5	79.0	76.1	71.1	76.6	79.8	81.4	77.2
SW 0.25%	75.8	79.8	82.1	82.9	80.2	76.9	77.9	82.7	83.8	80.3
SW 0.50%	78.7	81.6	83.9	84.2	82.1	79.5	82.4	84.2	85.5	82.9
SW 0.75%	79.3	82.5	84.4	84.3	82.6	80.1	83.9	85.1	86.4	83.9
Mean A	76.6	79. 8	81.9	82.6		76.9	80.2	83.0	84.3	
LSD 5%		A= 2.70 ;	B= 2.11	; AB= 3.02			A= 2.82 ;	B= 2.91	; AB= 4.26	
	Number of green leaves / plant									
Treatments	2018					2019				
	HA 0.0%	HA 0.5%	HA 1%	HA 2%	Mean B	HA 0.0%	HA 0.5%	HA 1%	HA 2%	Mean B
SW 0.0 %	11.0	15.0	17.0	19.0	15.5	12.0	17.0	20.0	21.0	17.5
SW 0.25%	14.0	17.0	19.0	21.0	17.8	17.0	19.0	21.0	22.0	19.8
SW 0.50%	17.0	19.0	20.0	22.0	19.5	19.0	22.0	23.0	23.0	21.8
SW 0.75%	18.0	20.0	22.0	22.0	20.5	20.0	23.0	23.0	24.0	22.5
Mean A	15.0	17.8	19.5	21.0		17.0	20.3	21.8	22.5	
LSD 5%		A= 1.5 ;	B=1.6	; AB=2.3			A=1.8 ;	B= 1.9	; AB= 2.7	
	Leaf area (m^2)									
Treatments	2018					2019				
	HA 0.0%	HA 0.5%	HA 1%	HA 2%	Mean B	HA 0.0%	HA 0.5%	HA 1%	HA 2%	Mean B
SW 0.0 %	0.87	1.01	1.18	1.21	1.10	0.89	1.01	1.21	1.29	1.10
SW 0.25%	1.03	1.19	1.25	1.29	1.19	1.11	1.22	1.29	1.32	1.26
SW 0.50%	1.16	1.21	1.28	1.36	1.25	1.18	1.25	1.37	1.41	1.30
SW 0.75%	1.19	1.28	1.32	1.39	1.29	1.21	1.32	1.41	1.45	1.35
Mean A	1.06	1.17	1.26	1.31		1.09	1.20	1.32	1.37	
LSD 5%		A=0.11 ;	B=0.13	; AB= 0.19			A=0.09	; B=0.12	; AB= 0.18	

2- Effect of humic acid and seaweed on leaf mineral contents:

Table (4) show the effect of single and combined spraying of humic acid and seaweed extract on Wiliams banana leaf mineral contents. It is worth to mention that application of humic acid and seaweed extract was significantly followed by great promotion on leaf N, P, K, and Mg% relative to untreated plants. The same Table shows that increasing the humic acid and/or seaweed extract concentration was associated with significant increasing in leaf mineral contents. Regarding the interactions between the examined compounds, increasing humic acid concentration accompanied with seaweed extract enhanced leaf mineral % significantly during both seasons. However, the highest N%, P%, K% and Mg% were obtained from the plants received 2% humic acid accompanied with seaweed extract at 0.75% in both experimental seasons. On the other hand, unfavorable effects on leaf mineral contents, during both experimental seasons, were produced by untreated plants.

These results are in accordance with those obtained by Gandhiyappan & Perumal, (2001); Fornes *et al.,* (2002);

Vernieri *et al., (*2005); Doring (2015) and El-Boray *et al.,* (2015); Ali & Mohamed (2016) and Ibrahim & Abo-Hessiba (2018); whereas, their results proved that application of humic acid or seaweed extract improved nutritional status of fruit trees.

Table 4. Effects of spraying humic acid (HA) and seaweed extract (SW) on leaves N, P, K and Mg content (%) of Wiliams banana plants, during 2018 and 2019 seasons.

Leaf N%

Treatments	2018					2019				
	HA 0.0%	**HA 0.5%**	**HA 1%**	**HA 2%**	**Mean B**	**HA 0.0%**	**HA 0.5%**	**HA 1%**	**HA 2%**	**Mean B**
SW 0.0 %	1.72	1.92	2.12	2.19	2.02	1.80	2.12	2.22	2.23	2.11
SW 0.25%	1.95	2.11	2.23	2.27	2.14	2.05	2.17	2.29	2.30	2.20
SW 0.50%	2.24	2.22	2.29	2.30	2.26	2.19	2.23	2.32	2.36	2.28
SW 0.75%	2.28	2.24	2.31	2.32	2.29	2.21	2.29	2.35	2.38	2.31
Mean A	2.04	2.12	2.24	2.27		2.07	2.20	2.30	2.32	
LSD 5%		A=0.09	; B=0.11	; AB=0.16			A= 0.11	; B= 0.09	; AB=0.13	

Leaf P%

Treatments	2018					2019				
	HA 0.0%	HA 0.5%	HA 1%	HA 2%	Mean B	HA 0.0%	HA 0.5%	HA 1%	HA 2%	Mean B
SW 0.0 %	0.39	0.42	0.45	0.45	0.43	0.38	0.42	0.45	0.46	0.43
SW 0.25%	0.42	0.46	0.47	0.48	0.46	0.44	0.47	0.49	0.50	0.48
SW 0.50%	0.44	0.48	0.48	0.48	0.47	0.47	0.51	0.53	0.53	0.51
SW 0.75%	0.44	0.47	0.48	0.49	0.47	0.49	0.53	0.54	0.55	0.53
Mean A	0.42	0.46	0.47	0.48		0.45	0.48	0.50	0.51	
LSD 5%		A= 0.03	; B= 0.03	; AB=0.04			A= 0.02	; B=0.04	; AB=0.06	

Leaf K%

Treatments	2018					2019				
	HA 0.0%	HA 0.5%	HA 1%	HA 2%	Mean B	HA 0.0%	HA 0.5%	HA 1%	HA 2%	Mean B
SW 0.0 %	1.94	2.22	2.33	2.37	2.22	2.09	2.19	2.28	2.33	2.22
SW 0.25%	2.31	2.33	2.41	2.42	2.37	2.21	2.27	2.37	2.41	2.32
SW 0.50%	2.39	2.37	2.44	2.46	2.42	2.30	2.39	2.41	2.51	2.40
SW 0.75%	2.39	2.43	2.45	2.47	2.44	2.33	2.44	2.44	2.54	2.44
Mean A	2.26	2.34	2.41	2.43		2.23	2.33	2.38	2.44	
LSD 5%		A= 0.12	; B= 0.11	; AB= 0.16			A=0.11	; B= 0.12	; AB= 0.18	

Leaf Mg %

Treatments	2018					2019				
	HA 0.0%	HA 0.5%	HA 1%	HA 2%	Mean B	HA 0.0%	HA 0.5%	HA 1%	HA 2%	Mean B
SW 0.0 %	0.57	0.66	0.68	0.68	0.65	0.59	0.64	0.70	0.72	0.66
SW 0.25%	0.65	0.67	0.69	0.70	0.68	0.63	0.69	0.74	0.77	0.71
SW 0.50%	0.67	0.68	0.71	0.72	0.70	0.65	0.71	0.74	0.78	0.72
SW 0.75%	0.68	0.70	0.71	0.72	0.70	0.66	0.72	0.75	0.79	0.73
Mean A	0.64	0.68	0.70	0.71		0.63	0.69	0.73	0.77	
LSD 5%		A=0.02	; B = 0.03	; AB=0.04			A=0.03	; B= 0.03	; AB=0.04	

3- Effect of humic acid and seaweed on bunch and hand weight:

Effect of humic acid and seaweed on bunch (kg) / plant weight and hand weight (kg) are illustrated in Table (5). It is obvious from this Table that foliar application of humic acid and seaweed significantly was very effective in improving yield and its components. This promotion was associated with increasing humic acid concentration from 0.0% to 2% and seaweed from 0.0% to 0.75%.

The interaction between humic acid and seaweed extract had significant effect on bunch weight/plant (kg) and hand weight (kg) of Williams banana plant. Spraying Williams banana with Humic acid at 2% and seaweed extract at 0.75% gave the maximum values of bunch weight and hand weight, compared to untreated plants or other treatments. On the side, control plants presented the lowest bunch and hand weights during both experimental seasons.

The improving effect of humic acid and seaweed extract on enhancing leaf area (cm^2) and assimilation area (m^2) which observed in this study could explain the present results concerning the positive effect on bunch weight (kg)/plant, hand weight (kg) and finger weight (g). In addition, humic acid and seaweed extract leads to enhance the biosynthesis of carbohydrate and other organic foods and stimulate nutritional status, of plants which could result in enhancing the uptake of the essential elements and producing different assimilation during plant metabolism. The obtained results are in harmony with those obtained by Tay *et al.*, (1985); Vaughan & Malcolm, (1985); Crouch (1990); Gandhiyappan & Perumal (2001); Mayi *et al.*, (2014); Ali & Mohamed (2016) and Ibrahim (2017).

4- Effect of humic acid and seaweed on fruit physical properties:

Data concerning the effect of humic acid and seaweed extract on physical properties of Williams banana during 2018 and 2019 seasons are illustrated in Table (6). It is noticed from the obtained data that, during both experimental seasons, the fruit weight, fruit length, fruit diameter and pulp/peel ratio of Williams banana plant were improved significantly as a result to spraying humic acid and/or seaweed extract at different concentrations. However, during first season all humic acid and seaweed concentrations failed to significantly affect fruit length (cm). Except the case of combined application of both compounds at higher concentrations, that was capable to improve fruit length significantly. In relation to humic acid and seaweed extract application, the promotion effect on fruit physical properties were stronger in the second seasons than those obtained during the first season.

It is noticed from the obtained data that, during both experimental seasons, the interactions between humic acid and seaweed extract treatments were significant on all fruit physical properties. The plants received the highest

concentrations from the examined compounds in combination present the highest fruit weight (97.8 & 99.3 g), fruit length (15.9 & 16.5 cm), fruit diameter (7.3 & 7.8 cm) and fruit pulp/peel ratio (76.5 and 78.1%). on the other side, untreated plants presented the lowest values of fruit physical properties (84.4 & 85.6 g for fruit weight; 14.6 & 14.1 cm for fruit length; 5.5 & 5.0 cm for fruit diameter and 73.8 & 72.2% for fruit pulp/peel ratio).

Table 5. Effects of spraying humic acid (HA) and seaweed extract (SW) on bunch weight (kg) and hand weight (kg) of Wiliams banana plants, during 2018 and 2019 seasons.

Bunch weight (kg)										
Treatments	**2018**					**2019**				
	HA 0.0%	**HA 0.5%**	**HA 1%**	**HA 2%**	**Mean B**	**HA 0.0%**	**HA 0.5%**	**HA 1%**	**HA 2%**	**Mean B**
SW 0.0 %	22.3	24.5	25.5	28.4	25.2	21.8	25.5	27.1	28,9	25.8
SW 0.25%	24.3	26.7	25.7	29.2	26.5	24.9	26.5	28.5	29.9	27.5
SW 0.50%	25.6	28.3	29.9	30.1	28.5	26.8	28.1	30.3	31.7	29.2
SW 0.75%	25.5	28.5	30.3	30.9	28.8	27.1	28.8	31.6	32.3	29.6
Mean A	24.4	27.0	27.9	29.7		25.2	27.2	29.4	30.7	
LSD 5%		A= 1.9 ; B=1.3 : AB= 1.9					A=1.7 ; B=1.6 ; AB= 2.34			
Hand weight (kg)										
Treatments	2018					2019				
	HA 0.0%	HA 0.5%	HA 1%	HA 2%	Mean B	HA 0.0%	HA 0.5%	HA 1%	HA 2%	Mean B
SW 0.0 %	1.42	1.74	1.95	2.09	1.80	1.54	1.88	2.09	2.21	1.93
SW 0.25%	1.88	1.97	2.11	2.20	2.04	1.68	2.12	2.25	2.34	2.09
SW 0.50%	1.93	2.11	2.25	2.29	2.15	1.99	2.21	2.31	2.40	2.23
SW 0.75%	2.03	2.13	2.29	2.32	2.19	2.11	2.29	2.39	2.44	2.31
Mean A	1.82	1.99	2.08	2.22		1.81	2.13	2.26	2.35	
LSD 5%		A= 0.07 ; B= 0.07 ; AB= 0.10					A=0.09 ; B=0.8 ; AB=0.12			

Table 6. Effects of spraying humic acid (HA) and seaweed extract (SW) on fruit physical characteristics of Wiliams banana plants, during 2018 and 2019 seasons.

Fruit weight (g)										
Treatments	**2018**					**2019**				
	HA 0.0%	**HA 0.5%**	**HA 1%**	**HA 2%**	**Mean B**	**HA 0.0%**	**HA 0.5%**	**HA 1%**	**HA 2%**	**Mean B**
SW 0.0 %	84.5	91.2	93.3	94.7	90.9	85.6	90.3	94.1	95.7	91.4
SW 0.25%	88.3	93.3	94.7	96.1	93.1	88.6	91.5	94.7	97.2	93.0
SW 0.50%	89.7	95.1	96.0	97.1	94.5	90.9	92.8	96.7	98.3	94.7
SW 0.75%	90.3	95.5	96.3	97.8	94.9	92.7	95.3	97.8	99.3	96.3
Mean A	88.2	93.8	95.1	96.4		89.5	92.5	95.4	97.6	
LSD 5%		A=4.1 : B= 3.6 ; AB= 5.3					A= 4.3 B= 3.2 ; AB= 4.7			
Fruit Length (cm)										
Treatments	2018					2019				
	HA 0.0%	HA 0.5%	HA 1%	HA 2%	Mean B	HA 0.0%	HA 0.5%	HA 1%	HA 2%	Mean B
SW 0.0 %	14.6	14.8	14.9	15.3	15.0	14.1	14.9	15.5	15.6	15.0
SW 0.25%	14.9	14.9	15.1	15.7	15.2	14.8	15.2	16.1	15.9	15.5
SW 0.50%	15.4	15.6	15.6	15.7	15.6	15.5	15.9	16.3	16.4	16.1
SW 0.75%	15.5	15.7	15.8	15.9	15.7	15.8	16.2	16.3	16.5	16.3
Mean A	15.3	15.3	15.4	15.6		15.1	15.3	16.1	16.1	
LSD 5%		A= NS ; B= NS ; AB= 1.3					A=1.0 ; B=1.1 ; AB=1.6			
Fruit width (cm)										
Treatments	2018					2019				
	HA 0.0%	HA 0.5%	HA 1%	HA 2%	Mean B	HA 0.0%	HA 0.5%	HA 1%	HA 2%	Mean B
SW 0.0 %	5.5	6.3	6.7	6.9	6.4	5.8	6.2	6.8	7.0	6.5
SW 0.25%	5.9	6.6	7.0	7.1	6.7	6.1	6.6	7.1	7.4	6.8
SW 0.50%	6.2	6.8	7.0	7.2	6.8	6.5	7.1	7.5	7.7	7.2
SW 0.75%	6.4	6.9	7.1	7.3	6.9	6.8	7.4	7.6	7.8	7.4
Mean A	6.0	6.7	7.0	7.1		6.3	6.8	7.3	7.5	
LSD 5%		A=0.58 ; B =0.42 ; AB=0.62					A=0.49 ; B=0.67 ; AB=0.98			
Fruit Pulp/peel ratio										
Treatments	2018					2019				
	HA 0.0%	HA 0.5%	HA 1%	HA 2%	Mean B	HA 0.0%	HA 0.5%	HA 1%	HA 2%	Mean B
SW 0.0 %	73.8	74.4	74.8	74.9	74.5	72.2	74.2	76.9	77.1	75.1
SW 0.25%	74.9	75.1	75.3	75.5	75.2	74.3	75.1	76.9	77.5	75.9
SW 0.50%	75.1	75.8	75.9	76.1	75.7	75.0	76.2	77.1	77.9	76.6
SW 0.75%	75.5	75.9	76.3	76.5	76.1	75.5	76.7	77.3	78.1	76.9
Mean A	74.7	75.3	75.6	75.8		74.3	75.6	77.1	78.2	
LSD 5%		A= 0.8 ; B=1.1 ; AB=1.6					A=1.3 ; B=0.9 ; AB=1.3			

It's well known that; seaweed extract is potentially excellent source of highly bioactive secondary metabolites that could represent useful leads in the development of new functional ingredients. Many reports have been published regarding seaweed extracts with various biological activities, demonstrating their ability to produce important metabolites unlike those found in terrestrial species (Featonby-Smith 1984; Fan *et al.*, 1993; Laurence, 2006 and Zamani *et al.*, 2013 and El-Boray *et al*., 2015). It is may be logical that The Improving effect of seaweed extract on physical properties of Williams banana fruits might be explained by its high content of macro and micro nutrients, its content of vitamins and hormones such as gibberellins and cytokinin.

5- Effect of humic acid and seaweed on fruit chemical properties:

Data concerning the effect of humic acid and seaweed extract on total soluble solids%, total sugars% and total acidity of Williams banana plants during 2018 and 2019 seasons are illustrated in Tables (7). It is clear from these results that both humic acid and seaweed were capable of causing significant promotion in TSS% and total sugars% in Willimas banana fruits over the control plants, during both experimental seasons. On the other hand, gradual and significant decreases in the total acidity% in both experimental seasons were observed as a result of increasing the concentration used from the examined compounds (from 0.5% to 2% for humic acid and from 0.25% to 0.75% for seaweed extract) compared with control plants (Table 7). The promotion effect on T.S.S% and total sugars% of the Williams fruit was associated with increasing the concentration of humic acid and seaweed extract. However, no-significant promotion was attributed neither for the increasing humic acid concentration from 1% to 2% nor increasing seaweed extract concentration from 0.50% to 0.75%. Therefore, the recommend treatment in this respect was the application of humic acid at 1% and seaweed extract at 0.50% in combination. However, unfavorable effects on fruit chemical parameters were recorded on untreated plants during both seasons.

The promotion effect of spraying humic acid and seaweed extract on total soluble solids and sugars content and decreasing total acidity were reported by Qasim, (1991); Abd El-Wahab, (2015); Seleem & Ahmed (2008), Kok *et al*., (2010); Khan *et al*., 2012; Abd El-Wahab (2015) and Ali & Mohamed (2016) for seaweed extract, and Tay *et al.,* (1985); Crouch (1990); Gandhiyappan & Perumal (2001); El-Boray, *et al*., (2015) and Ali & Mohamed (2016) for the physiological effect of humic acid on fruit chemical properties.

The interaction between humic acid concentrations and seaweed concentrations was significant in both experimental seasons (Table 7). It was clear that the plants received humic acid at 2% accompanied with seaweed extract at 0.75% present higher and significant TSS% (21.9 & 21.9), total sugars% (18.5 & 18.6) and lowest Total acidity (0.312 & 0.303) followed by those received 2% humic acid accompanied with 0.5% seaweed extract.

However, the lowest TSS% and total sugars% were obtained from untreated plants (17.2 & 17.4% for TSS; 14.9 & 14.8% for total sugars) and highest total acidity% (0.433 & 0.424), during both seasons, respectively.

Table 7. Effect of spraying humic acid (HA) and seaweed extract (SW) on fruit chemical characteristics of Wiliams banana plants, during 2018 and 2019 seasons.

TSS %										
Treatments	**2018**					**2019**				
	HA 0.0%	**HA 0.5%**	**HA 1%**	**HA 2%**	**Mean B**	**HA 0.0%**	**HA 0.5%**	**HA 1%**	**HA 2%**	**Mean B**
SW 0.0 %	17.2	18.0	18.8	19.2	18.3	17.4	18.2	18.9	19.5	18.50
SW 0.25%	19.1	19.6	19.9	20.3	19.73	18.9	19.3	19.6	20.7	19.63
SW 0.50%	19.9	20.3	21.4	21.8	20.85	19.9	20.5	20.9	21.4	20.68
SW 0.75%	20.3	20.5	21.7	21.9	21.10	20.5	20.7	21.7	21.9	21.20
Mean A	19.13	19.60	20.50	20.80		19.18	19..68	20.28	20.88	
LSD 5%	A= 0.52 ; B= 0.48 ; AB= 0.701					A= 0.61 ; B= 0.67 ; AB= 0.98				
Total sugars %										
	2018					2019				
	HA 0.0%	HA 0.5%	HA 1%	HA 2%	Mean B	HA 0.0%	HA 0.5%	HA 1%	HA 2%	Mean B
SW 0.0 %	14.9	15.1	15.9	16.2	15.52	14.8	15.5	16.2	16.6	15.78
SW 0.25%	16.7	16.8	16.9	17.2	16.90	15.9	17.1	17.3	17.5	16.95
SW 0.50%	17.5	17.8	17.9	18.2	17.85	16.6	18.0	18.4	18.5	17.88
SW 0.75%	17.8	18.0	18.3	18.5	18.15	16.9	18.4	18.5	18.6	18.08
Mean A	16.73	16.93	17.25	17.53		16.05	17.25	17.60	17.77	
LSD 5%	A= 0.38 ; B= 0.43 ; AB= 0.63					A= 0.41 ; B= 0.57 ; AB= 0.83				
Total Acidity %										
Treatments	2018					2019				
	HA 0.0%	HA 0.5%	HA 1%	HA 2%	Mean B	HA 0.0%	HA 0.5%	HA 1%	HA 2%	Mean B
SW 0.0 %	0.433	0.422	0.401	0.391	0.412	0.424	0.411	0.389	0.381	0.399
SW 0.25%	0.403	0.390	0.381	0.376	0.388	0.405	0.392	0.355	0.344	0.374
SW 0.50%	0.387	0.371	0.333	0.320	0.353	0.337	0.329	0.328	0.311	0.326
SW 0.75%	0.385	0.356	0.322	0.312	0.344	0.327	0.319	0.312	0.303	0.315
Mean A	0.402	0.385	0.359	0.349		0.373	0.363	0.346	0.335	
LSD 5%	A= 0.027 ; B= 0.033 : AB= 0.048					A= 0.028 ; B= 0.039 : AB= 0.057				

The role of spraying humic acid on improving fruit chemical characteristics was also observed by Gandhiyappan & Perumal (2001); El-Boray, *et al*., (2015) and Ali & Mohamed (2016). Furthermore, the positive effect of spraying seaweed extract in increase the T.S.S% and sugar % as well as decreasing the total acidity of Williams banana fruit was observed on other fruit trees by: Koo (1988), Kok & Mayo (1994); Hegab *et al.,* (2005); Abd El-Wahab (2007), Seleem & Ahmed (2008); Spinelli *et al.,* (2009); Kok *et al.,* (2010); El-Saman, A.Y.E. (2010); Elham *et al.,* (2010) Gad El-Kareem & Abd El-Rahman (2013), Abd El-Wahab (2015), and Ali & Mohamed (2016).

CONCLUSION

From the obtained results It cloud be concluded that spraying Williams banana plants cv. with humic acid at 0.5% to 2% and/or seaweed extract at 0.25% to 0.57% was remarkably improved vegetative growth parameters, nutritional status, yield and fruit quality. However, in most studied characters non-significant differences were observed between the higher concentrations. The accompanied treatments of humic acid and seaweed extract were more effective than the individual treatment of each one. Generally, it is recommended that spraying Williams banana plants grown under silty clay loam soil by humic acid at 1% and

seaweed at 0.50% three times is effective in order to enhance banana growth, yield and fruit quality.

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النمو والحالة الغذائية والمحصول وجودة الثمار لنبات الموز الوليامز ومدى تأثرها برش حامض الهيومك ومستخلص الأعشاب البحرية

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لدراسة استجابة نباتات الموز الوليامز النامية تحت ظروف الأراضى الطينية "بقرية صفط اللبن بمركز المنيا - محافظة المنيا" لرش حامض الهيومك بتركيز 0,5% و 1,0% و 2,0% ومستخلص الأعشاب البحرية بتركيز 0,25% و 0,50% و 0,75% ثلاث مرات فى العام، خلال عامين متتاليين هما 2018 و 2019. وكانت النباتات المختارة لهذه الدراسة هى الخلفات الثانية والثالثة لنباتات الموز الوليامز النامية فى مزرعة خاصة بقرية صفط اللبن – محافظة المنيا تروى بالغمر بمياه النيل والتربة النامية بها سلتيه طينية طمبية جيدة الصرف ومستوى الماء الأرضى بها لايقل عن 2 متر. وقد أوضحت النتائج المتحصل عليها خلال هذه الدراسة أن رش نباتات الموز الوليامز ثلاثة مرات فى العام بالتركيزات المختلفة من حامض الهيومك (0,0% و 0,5% و 1,0% و 2,0%) ومستخلص الأعشاب البحرية (0,0% و 0,25% و 0,50% و 0,75%) أدى لحدوث تحسن معنوى فى الصفات الخضرية للنبات (متمثلة فى ارتفاع الساق الكاذبة، محيط الساق الكاذبة، عدد الأوراق الخضراء/النبات و مساحة سطح الورقة) والحالة الغذائية للنبات (متمثلة فى زيادة محتوى الأوراق من النيتروجين والفوسفور والبوتاسيوم والماغنسيوم) وكذلك كمية المحصول معبراً عنها بمتوسط وزن السوباطة ومتوسط وزن الكف. كما ادت هذه المعاملات الى تحسين المواصفات الفيزيائية والكيميائية للثمار (متمثلة فى زيادة وزن الثمرة، زيادة أبعاد الثمرة، زيادة نسبة اللب الى القشرة، زيادة نسبة المواد الصلبة الذائبة فى لب الثمرة، زيادة نسبة السكريات الكلية فى لب الثمرة، وانخفاض نسبة الحموضة الكلية فى لب الثمرة)، وذلك كله مقارنة بالنباتات الغير معاملة. وقد اظهرت المعاملة المشتركة بكلا المركبين (حامض الهيومك ومستخلص الأعشاب البحرية) تفوقا على استخدام كل مركب بمفردة وذلك على كل الصفات محل الدراسة. وأفضل نتائج الصفات الخضرية والثمرية لنبات الموز تحت الدراسة تم الحصول عليها عند رش النباتات بالتركيز الأعلى من كلا المركبين معاً، وذلك خلال موسمى الدراسة. فى حين أنه لم تكن الفروق جوهرية بين التركيزين الأعلى من كلا المركبين. إجمالا فأنه من خلال نتائج هذه الدراسة نجد أن رش حامض الهيومك ومستخلص الأعشاب البحرية بالتركيزات سالفة الذكر قد أدى لتحسين النمو الخضرى والأثمار وكمية وجودة الثمار للخلفات لنباتات الموز صنف الوليامز النامية في الأراضي السلتية الطينية الطميية تحت ظروف المناطق الجافة.