Bionatura
Latin American Journal of Biotechnology and Life Sciences

Article

Effect of humic and fulvic acid treatment on the anatomical traits of the leaves of two genera of seedlings of ornamental palm Washingtonia filifera and Phoenix canariensis

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Available from. http://dx.doi.org/10.21931/RB/2023.08.04.46

ABSTRACT

This study was conducted in the growing season 2021 at the Agricultural Research Facility Station, University of Basrah. Start with seedlings of two genera of ornamental palm trees: *Washingtonia filifera* and *Phoenix canariensis*. Were given dosages of humic acid as treatment (0, 10, and 15 ml.L^{-1}). And fulvic acid by ground addition at concentrations of (0, 5, and 10 g.L^{-1}). The findings revealed that humic acids significantly impacted the anatomical traits and caused the improvement of those traits. The Humic acid content of (15 ml.L^{-1}) caused an increase in the thickness of epidermal cells, the length of columnar cells, the diameter of large and small vascular bundles, and the diameter of the fibrous bundles.

Additionally, a level of fulvic acid (10 g.L^{-1})caused a similar increase in those anatomical traits. The triple interaction significantly impacted the qualities under study. The interaction between the Washington type, the (15 ml.L^{-1}) of humic acid, and the (10 g.L^{-1}) of fulvic acid provided the highest values. For the anatomical traits, the thickness of epidermal cells, length of Columnar epithelial cells, the diameter of large and small vascular bundles, and diameter of large and small vascular bundles. And the diameter of the fibrous bundles. Washingtonia palm was significantly higher than the canary palm and had the highest values for epidermal cell thickness, columnar cell length, large and small vascular bundle diameter, and fibrous bundle diameter**.**

Keywords: ornamental trees; humic substances;leaves; anatomical; fulvic acid; seedling

INTRODUCTION

Palm trees are frequently employed in landscape home and building interior design. It is easy to recognize palm trees by their consistent shape, and they are typically planted either alone or in naturally formed groups in the green space on either side of the garden gates [1]. The *Washingtonia filifera* belongs to the Arecaceae family and the genus Washington. It is one of the most widespread palm trees in the world and Iraq. The original country of this tree is the desert oases southwest of Arizona to the American continent and southern Nevada [2]. The Washington palm is monocotyledon (Monoecious) and bisexual, bearing male and female flowering inflorescences on one tree and small, spherical fruits unfit for human consumption [3]. The Canary Islands in the Atlantic Ocean inspire the name of the Canary Palm, *Phoenix canariens*i. Its cultivation is spread in hot and semi-hot regions of the world. It belongs to the Aceraceae family, and the genus Phoenix is the hallmark of this type of palm. It has a giant stem, smooth cylindrical, with a large head and dense fronds. Canary palms are monocotyledons (Dioecious) and monosexual (Unisexual), bearing male flowering inflorescences on a

male tree and female flowering inflorescences on a female tree. They reproduce by seeds or Off-shoot, and their growth is prolonged [4]. The most significant nutrients in humic acid are nitrogen, carbon, oxygen, hydrogen, sulfur, phosphorus, plus additional mineral elements, whereas fulvic acid is a group of substances having high molecular weights that are comparable in structurally similar; fulvic acid differs from humic acid in that it has a different chemical structure and includes fewer carbon and nitrogen.
Nonetheless, it had more hydrogen and oxygen [5]. Adding humic and fulvic acids increases the number of nutrients absorbed by the plant, transporting nutrients to the plant. It also causes an increase in the root system's growth and germination rate and improves the plant's anatomical traits [6-9]. Since the ornamental palm suffers from a significant problem, which is the slow growth of seedlings resulting from the seeds, this study was conducted to improve the anatomical characteristics of the seedlings, which are related to the growth indicators of the plant, by treating them with humic and fulvic organic acids.

MATERIALS AND METHODS

A pot with a 25 cm diameter was used to grow the seeds of the ornamental palm trees Washington (W) and Canary (C), containing a soil river and peat moss at a ratio of (1:1) with fulvic acid (F) at concentrations (0, 5 and 10 $g.L^{-1}$)and humic acid (H) at concentrations (0, 10 and 15 ml/L) as a soil drench at an average of once every two weeks within six months. Leaf samples from all treatments were gathered. Furthermore, it was fixed in the F.A.A. solution for 48 hours. The cut sections were passed with ascending concentrations of ethyl alcohol, and then the samples were embedded with paraffin wax at 58 °C. A Rotary Microtome cut the samples with a thickness of 10 µm. The slides were conducted on slides, stained with Safranin pigment, placed in Fast green pigment, loaded with drops of D.P.X., and covered with the slide cover. Then, the slides were studied. The measurements were taken by micrometer (µm) by an ocular micrometer in an Olympus-type optical microscope equipped with a camera attached to the calculator [10]. Statistical analysis The data were analyzed with the statistical tool GeenStat Ver.13 utilizing the variance analysis for the anatomical structure of the research components. Additionally, the averages were examined, and significance was determined using the least significant difference test (L.S.D.) with a 0.05 probability level [11].

RESULTS

The thickness of the cuticle layer

The results in Table (1) and Figure (1-a,b,c) demonstrated the considerable impact of palm type on the cuticle layer's thickness, where *P. canarie*s outperformed *W. filifera* substantially and received the maximum score of 6.51 µm. In comparison, Washington's palm recorded the lowest average of 5.29 µm. Regarding humic acid's impact, the level of (15 $ml.L^{-1}$) recorded the lowest average cuticle thickness of 4.75 µm compared to the control treatment, which recorded the highest average of 7.51 µm. The cuticle layer's thickness was impacted by fulvic acid. The level of($10g.L^{-1}$)gave the lowest average cuticle thickness, which was 4.98 µm, compared to the control treatment, which had an average of 7.31 µm, the highest. The thickness of the cuticle layer was significantly influenced by the interference between two palm and humic acid genera. The contact of the canary palm with the concentration of (0 $ml.L^{-1}$) yielded the highest value of 7.99 µm, while the *W. filifera* interfered with the level of (15 $ml.L^{-1}$) and recorded the lowest value of 4.06 µm. The W. filifera and a level(10 g.L-1) interacted regarding the relationship between the kind of palm and fulvic acid. 4.34 µm was the lowest mean cuticle thickness, significantly different from the other interactions. The thickness of the epidermal layer differed significantly from the other reactions at the concentrations of humic and fulvic acid (15 $ml.L^{-1}$, 10 $g.L^{-1}$), respectively, and the lowest value was 3.08 µm. This shows that the study components' triple interference had a significant effect.

Skin thickness

The findings in Table 2 and Figures 1-a,b, and c demonstrated the considerable impact of palm type on epidermal cell thickness. The *P. canariensi* reported the lowest average of 10.04 m, while Washington's palm recorded the highest Figure of 11.20 µm.*W. filifera* was much superior to the Canary palm. The most significant value for the thickness of epidermal cells was 11.74 µm compared to the control treatment, which recorded the lowest average of 9.01 µm in terms of humic acid action (15 ml.L^{-1}), topping the other doses significantly. The thickness of the epidermis was impacted by fulvic acid. Compared to the control treatment, which recorded the lowest average of 9.23 µm, the level of (10 g.L^{-1}) was noticeably superior, and the highest average was 11.50 µm. The interaction between palm and humic acid significantly influenced the thickness of the epidermal cells.

palm type	Humic acid ml/L	Fulvic acid g.L^{-1}			genera×humic	Species effect
		0	5	10		
Washington	0	8.34	6.69	6.07	7.03	5.29
	10	6.35	4.11	3.87	4.78	
	15	5.69	3.41	3.08	4.06	
canary	0	8.67	8.02	7.29	7.99	6.51
	10	7.75	5.38	5.13	6.09	
	15	7.07	4.81	4.45	5.44	
genera× fulvic	Washington	6.79	4.74	4.34	Humic effect average	Fulvic effect average
	canary	7.83	6.07	5.62		
humic × fulvic	0	8.50	7.35	6.68	7.51	7.31
	10	7.05	4.74	4.50	5.43	5.40
	15	6.38	4.11	3.76	4.75	4.98
L.S.D. 0.05						
genera = 0.438	humic = 0.536	fulvic = 0.536	interaction between species and humic = 0.758	interaction between species and fulvic = 0.758	interaction between humic and fulvic = 0.928	triple interaction= 1.313

Table 1. *W. filifera* and *P. canariensi* leaves' cuticle layer thickness following treatment with humic and fulvic acids.

The interaction between the *W. filifera* and the level of(15 ml.L^{-1})recorded the most significant value of 12.37 µm, and the lowest value, 8.54 m, was reported for the interference between the *P. canariensi* and level (0 ml.L^{-1}). Regarding the interaction between fulvic acid concentration and palm type, the *W. filifera* interaction with the level (10g.L^{-1}) recorded the maximum average thickness of epidermal cells of 12.12 µm, significantly different from the other interactions. The interaction between concentrations of humic acid (15 ml.L^{-1}) and fulvic acid (10g/L) produced the greatest value for the thickness of epidermal cells, measuring 12.72 µm, significantly different from the other interactions. In the *W. filifera* tree, the level of (15 ml.L^{-1}) humic acid and the level of (10g.L^{-1}) fulvic acid exhibited the greatest interaction, which recorded the highest value for the thickness of epidermal cells at 13.34 µmandhad a substantial difference from the other interactions**.**

genera	Humic ml/L	The three-way interaction effect			genera×humic	Species effect
		Fulvic acid g.L^{-1}				
		0	5	10		
Washington	0	8.38	9.87	10.23	9.49	11.20
	10	10.03	12.41	12.79	11.74	
	15	10.76	13.01	13.34	12.37	
canary	0	7.89	8.61	9.11	8.54	10.04
	10	8.88	11.11	11.42	10.47	
	15	9.42	11.79	12.11	11.11	
genera× fulvic	Washington	9.72	11.76	12.12	Humic effect average	Fulvic effect average
	canary	8.73	10.50	10.88		
humic × fulvic	0	8.13	9.24	9.67	9.01	9.23
	10	9.45	11.76	12.10	11.11	11.13
	15	10.09	12.40	12.72	11.74	11.50
L.S.D. 0.05						
genera = 0.929	humic = **1.137**	fulvic = **1.137**	interaction between species and humic = **1.608**	interaction between species and fulvic = **1.608**	interaction between humic and fulvic = **1.970**	triple interaction= **2.786**

Table 2. The Effect of humic substances treatment on the epidermal cell thickness of W. filifera and P. canaries' leaves.

The length of the Columnar epithelial cells

The results in Table 3 and Figures 1-a,b,c indicated that the length of the columnar epithelial cells was considerably influenced by the kind of date palm, with the *W. filifera* significantly outperforming the canary palm and recording the most significant value of 16.46 µm, With a mean of 14.27 µm, the *P. canarie*s had the lowest average. The effect of humic was much more significant at a concentration of (15 ml.L^{-1}) compared to the other concentrations, and the columnar epithelial cells' maximum length was 17.47 µm, significantly longer than the average length of 12.54 µm for the control treatment. The length of the Columnar epithelial cells was impacted by fulvic acid. Compared to the control treatment, which recorded the lowest average of 12.81 µm, the level of (10 g.L^{-1}) was much superior, and the highest average was 17.08 m. The interplay of the type of palm and humic acid significantly influenced the length of the columnar cells. The canary palm's contact with the concentration (0 ml.L^{-1}) logs the lowest value of 11.89 µm, while the *W. filifera* interaction with the level (15 ml.L^{-1}) logs the greatest value of 18.79 µm.

Regarding the interaction between the type of palm and the concentration of fulvic acid, the Washington palm and the interaction with the level of (10 g.L^{-1}) logs the highest average length of the Columnar epithelial cells at 18.41 µm.and had a substantial difference from the other interactions. In terms of the effects of humic substances, the interference between the concentrations of humic acid (15 ml.L^{-1}) and fulvic acid (10 g.L^{-1}) recorded the highest value for the length of the Columnar epithelial cells at amounted to 19.65 µm with a significant difference from the other interactions. The *W. filifera*, concentrations of (15 ml.L^{-1}) humic and (10 g.L^{-1}) fulvic, and the triple interaction between the study factors all had a significant impact on the length of the columnar epithelial cells, with the Washington palm interaction recording the highest value at 21.32 µmand had a substantial difference from the other interactions.

palm type	Humic acid ml/L	three-way interaction effect			genera×humic	Species effect
		Fulvic acid g.L^{-1}				
		0	5	10		
Washington	0	11.37	13.67	14.49	13.18	16.46
	10	14.11	18.69	19.43	17.41	
	15	14.88	20.17	21.32	18.79	
canary	0	10.65	12.12	12.91	11.89	14.27
	10	12.48	15.46	16.36	14.77	
	15	13.36	17.12	17.98	16.15	
genera× fulvic	Washington	13.45	17.51	18.41	Humic effect average	Fulvic effect average
	canary	12.16	14.90	15.75		
humic × fulvic	0	11.01	12.90	13.70	12.54	12.81
	10	13.30	17.08	17.89	16.09	16.21
	15	14.12	18.64	19.65	17.47	17.08
L.S.D. 0.05						
genera = 1.796	humic = **2.200**	fulvic = **2.200**	interaction between species and humic = **3.111**	interaction between species and fulvic = **3.111**	interaction between humic and fulvic = **3.810**	triple interaction= **5.388**

Table 3. The effect of humic and fulvic acid treatment on the length of columnar cells in *W. filifera* and *P. canariensi* leaves.

Large vascular bundle diameter

The results in Table 4 and Figure 1-a,b,c demonstrated that date palm type significantly affected the diameter of the large vascular bundles, with *W. filifera* significantly outperforming *P. canariensi* and recording the highest value of 133.5 µm. In comparison, the *P. canariensi* recorded the lowest average of 97.5 µm. In terms of the humic acid effect, the concentration (15 ml.L^{-1}) was significantly superior to other concentrations, and the highest value of the diameter of the large vascular bundles was 149.4 µm compared to the control treatment, which recorded the lowest average of 76.9 µm. The diameter of the large vascular bundles was affected by fulvic acid, where the concentration was significantly exceeded (10 g.L^{-1}), and the highest rate was 140.8 µm compared to the control treatment, which recorded the lowest rate of 80.9 µm. The interaction between the type of palm and humic acid significantly affected the diameter of the large vascular bundles. The interaction between the *W. filifera* and the concentration (15 ml.L^{-1}) produced the highest value of 179.7 µm.

In contrast, the interaction between the *P. canarie*s and the concentration (0 ml.L^{-1}) produced the lowest value of 69.6 µm. In terms of the interaction between palm type and fulvic acid concentration, the interaction between the *W. filifera*and (10 g.L^{-1}) recorded the highest average diameter of the large vascular bundles, amounting to 167.4 µm, with a significant difference from other interaction values. In terms of the interaction between the effects of humic acid and fulvic acid, the interaction between the concentration (15 ml.L^{-1}) of humic acid and the concentration (10 g.L^{-1}) of fulvic acid recorded the highest value for the diameter of the large vascular bundles, 189.5 µm, with a significant difference from other interaction values. The interaction between the *W. filifera*and the concentrations (15 ml.L^{-1}) of humic acid and (10 g.L^{-1}) fulvic had the most significant effect on the diameter of the large vascular bundles, measuring 238.5 µm.

genera	**Humic ml/L**	**Fulvic acid g.L^{-1}**			**gen-era×hu-mic**	**genera effect**
		0	5	10		
Washing-ton	0	62.2	90.1	100.2	84.2	133.5
	10	95.4	151.3	163.4	136.7	
	15	108.3	192.4	238.5	179.7	
canary	0	60.0	69.0	80.0	69.6	97.5
	10	73.8	114.9	122.4	103.7	
	15	85.5	131.5	140.6	119.2	
genera× fulvic	Wash-ington	88.6	144.6	167.4	Humic effect average	Fulvic effect average
	canary	73.1	105.1	114.3		
humic × fulvic	0	61.1	79.5	90.1	76.9	80.9
	10	84.6	133.1	142.9	120.2	124.9
	15	96.9	161.9	189.5	149.4	140.8
L.S.D. 0.05						
genera = 13.72	humic = **16.81**	fulvic = **16.81**	interac-tion be-tween species and hu-mic = **23.77**	interac-tion be-tween species and fulvic = **23.77**	interac-tion be-tween humic and ful-vic = **29.11**	triple in-terac-tion= **41.17**

Table 4. The effect of humic and fulvic acid treatment on the diameter of the large vascular bundle of *W. filifera* and *P. canariensi* leaves.

Small vascular bundle diameter

The results in Table (5) and Figure (1-a,b,c) demonstrated that date palm type significantly affected the small vascular bundles, where the *W. filifera*was was significantly Superior to the *P. canarie*s and logs the highest value of 94.8 µm. In comparison, the *P. canariensi*logs have the lowest average of 61.8µm. In terms of humic effect, the level of (15 ml.L^{-1}) significantly excelled the other concentrations, and the highest value of the diameter of the small vascular bundles was 110.0 µm compared to the control treatment, which recorded the lowest rate of 41.4 µm. Fulvic had an apparent effect on the diameter of the small vascular bundles, where the concentration was significantly excellent(10 g.L^{-1}), and the highest average was 100.8 µm compared to the control treatment, which recorded the lowest average of 44.9 µm. The interaction between the type of palm and humic acid significantly affected the diameter of the small vascular bundles. The interaction between the *W. filifera*and level(15 ml.L^{-1}) produced the greatest worth of 136.7 µm, while the interference between the *P. canariensi*and concentration (0 ml.L^{-1}) produced the lowest value of 34.1 µm.

Regarding the interface between palm type and fulvic level, the interaction between the *W. filifera*and the level of (10 g.L^{-1}) logs the highest average diameter of the small vascular bundles at 122.9 µm, significantly different from the other interactions. In terms of the interaction between the effects of humic acid and fulvic acid, the interference between the level of (15 ml.L^{-1}) humic and (10 g.L^{-1}) fulvic logs the highest value for the diameter of the small vascular bundles, 144.2 µm, with a significant difference from the other interactions. The triple interaction between the study's factors had a significant effect, with the interaction between the *W. filifera*and the level (15 ml.L^{-1}) humic and (10 g.L^{-1}) fulvic recording the highest value for the diameter of the small vascular bundles amounted to 183.1 µm, and had a substantial difference from the other interactions.

genera	**Humic ml/L**	**Fulvic acid g.L^{-1}**			**genera×humic**	**genera effect**
		0	5	10		
Washington	0	25.4	55.7	65.4	48.8	94.8
	10	60.4	115.7	120.3	98.8	
	15	71.5	155.4	183.1	136.7	
canary	0	24.4	33.4	44.3	34.1	61.8
	10	38.5	79.5	86.3	68.1	
	15	49.5	95.3	105.3	83.4	
genera× fulvic	Washington	52.4	108.9	122.9	Humic effect average	Fulvic effect average
	canary	37.5	69.4	78.6		
humic × fulvic	0	24.9	44.5	54.9	41.4	44.9
	10	49.4	97.6	103.3	83.4	89.2
	15	60.5	125.4	144.2	110.0	100.8
L.S.D. 0.05						
genera = 15.34	humic = **18.79**	fulvic = **18.79**	interaction between species and humic = **26.57**	interaction between species and fulvic = **26.57**	interaction between humic and fulvic = **32.54**	triple interaction= **46.02**

Table 5. The Effect of humic substances treatment on the diameter of the small vascular bundle of *W. filifera*and *P. canariensi* leaves.

Diameter of fibrous bundles

The findings in Table 6 and Figures 1-a,b, and c demonstrated the palm type's considerable impact on the diameter of the fiber bundles. The *P. canariensi* fared much worse than *W. filifera*, scoring the lowest value of 33.6 µm, while *W. filifera* received the best value of 44.8 µm. The greatest value of the diameter of the fiber bundles was 49.6 µm, compared to the control treatment, which recorded the lowest average of 25.6 µm. Regarding humic acid's impact, a level of (15 ml.L^{-1}) significantly outperformed the other concentrations. The diameter of the fiber bundles was affected by fulvic acid, where the concentration was significantly above (10 g.L^{-1}), and the most significant average was recorded at 47.3 µm compared to the control treatment, which recorded the lowest average of 26.7 µm. The interplay between palm type and humic acid significantly impacted the diameter of the fiber bundles. The *W. filifera*and level (15 ml.L^{-1}) interaction produced the maximum value of 57.5 µm, while the *P. canariensi*and level (0 ml/L) interaction produced the lowest value of 23.7 µm. The *W. filifera* with the level of (10 g.L^{-1}) of fulvic had the strongest interaction, with the *W. filifera* recording the maximum average diameter of the fiber bundles at 55.0 µm, with a significant difference

from the other interactions. The interaction between the effects of humic and fulvic logs the highest value for the diameter of the fiber bundles at 61.5 m, significantly different from the other interactions. This interaction was between the levels of (15 ml.L^{-1}) humic and (10 g.L^{-1}) fulvic. In *W. filifera*, the level of (15 ml.L^{-1}) humic acid and the concentration of (10 g.L^{-1}) fulvic acid had an interaction that recorded the highest value of the diameter of the fiber bundles at 71.6 µmand had a substantial difference from the other interactions, indicating that three-way interaction effect between the search factors had a significant impact.

7. tannin cell diameter.

The results in Table (7) and Figure (1-a,b,c) revealed a significant relationship between the type of date palm and the diameter of the tannin cells, with the canary palm significantly outperforming *W. filifera*and recording the highest value of 20.18 µm while recording the lowest average of 18.73 µm. Regarding the impact of humic acid, the control treatment, which had the highest average tannin cell diameter of 21.54 µm, recorded the lowest average tannin cell diameter of 18.04 µm at a concentration of (15 ml.L^{-1}). In contrast to the control treatment, which recorded a maximum rate of 21.26 µm, fulvic acid impacted tannin cell diameter, as the concentration (10 g.L^{-1}) recorded the lowest average for tannin cell diameter of 18.30 µm.

genera	**Humic ml/L**	**Fulvic acid g.L^{-1}**			**genera×humic**	**Species effect**
		0	5	10		
Washington	0	23.2	26.7	32.3	27.4	44.8
	10	29.4	57.7	61.1	49.4	
	15	35.3	65.5	71.6	57.5	
canary	0	22.2	24.1	24.9	23.7	33.6
	10	24.4	39.4	42.3	35.4	
	15	25.3	48.4	51.3	41.7	
genera× fulvic	Washington	29.3	50.0	55.0	Humic effect average	Fulvic effect average
	canary	24.0	37.3	39.5		
humic × fulvic	0	22.7	25.4	28.6	25.6	26.7
	10	26.9	48.6	51.7	42.4	43.7
	15	30.3	57.0	61.5	49.6	47.3
L.S.D. 0.05						
genera = 6.79	humic = **8.32**	fulvic = **8.32**	interaction between species and humic = **11.77**	interaction between species and fulvic = **11.77**	interaction between humic and fulvic = **14.41**	triple interaction= **20.38**

Table 6. *W. filifera* and *P. canariensi* leaves fiber bundles diameter after humic and fulvic acid treatment.

The interplay between palm type and humic significantly impacted the diameter of the cells. The *W. filifera* level interferes (15 ml.L^{-1}) recorded the lowest value in the second year at 17.29 µm, while the *P. canariensi* level interferes (0 ml.L^{-1}) recorded the most significant value at 22.15 µm. Regarding the relationship between fulvic content and palm type, a relationship between *W. filifera* and the concentration of (10 g.L^{-1}) was observed. The tannin cells' lowest average diameter, which differed significantly from the other interfere, was 17.55 µm.In terms of the interference between humic and fulvic, the interference between the level of humic (15 ml.L^{-1}) and fulvic (10 g.L^{-1}) was noted. Compared to the other interactions, the lowest result for the diameter of tannin cells was 16.85 µm. The triple interaction of the study variables had a significant impact, as the *W. filifera* interaction with the concentrations of humic acid (15 ml.L^{-1}) and fulvic acid (10 g.L^{-1}) recorded the lowest value for the diameter of the tannin cells at 16.11 µm, significantly different from the other interfere.

genera	Humic ml/L	Fulvic acid g.L^{-1}			genera×humic	generaeffect
		0	5	10		
Washington	0	22.79	20.34	19.66	20.93	18.73
	10	19.91	17.11	16.89	17.97	
	15	19.23	16.53	16.11	17.29	
canary	0	23.14	21.98	21.34	22.15	20.18
	10	21.69	18.87	18.22	19.59	
	15	20.78	17.98	17.59	18.78	
genera× fulvic	Washington	20.64	17.99	17.55	Humic effect average	Fulvic effect average
	canary	21.87	19.61	19.05		
humic × fulvic	0	22.97	21.16	20.50	21.54	21.26
	10	20.80	17.99	17.56	18.78	18.80
	15	20.01	17.26	16.85	18.04	18.30
L.S.D. 0.05						
genera = 1.143	humic = **1.399**	fulvic = **1.399**	interaction between species and humic = **1.979**	interaction between species and fulvic = **1.979**	interaction between humic and fulvic = **2.424**	triple interaction= **3.428**

Table 7. The Effect of treatment with humic and fulvic acids on the diameter of tannin cells of leaves of *W. filifera* and *P. canariensi*.

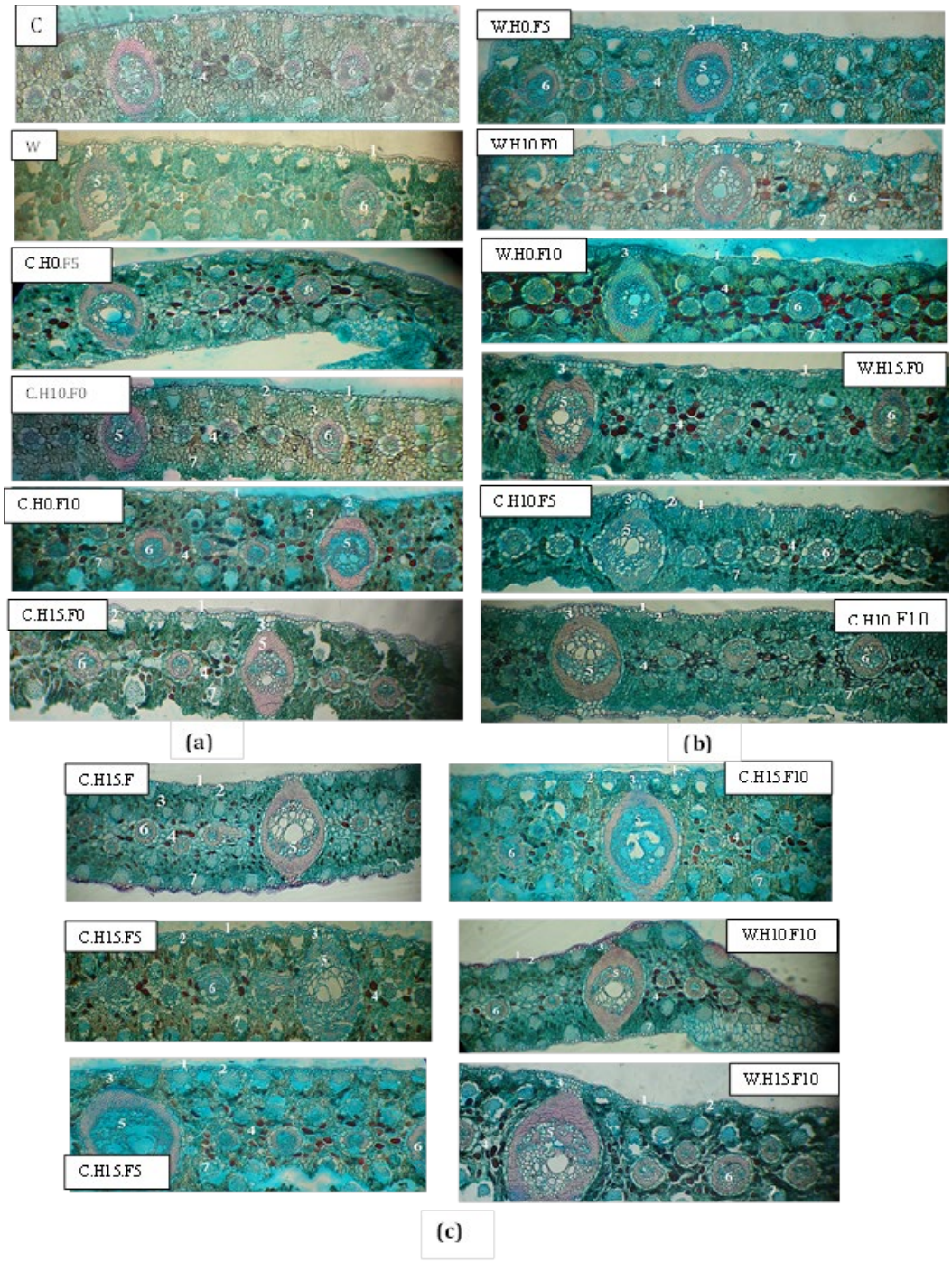

Figure 1. (a) Effect of humic and fulvic acid treatment on the morphological features of Washington and Canary palm leaves (1-cuticle 2- epidermis 3- columnar cells 4- tannin cells 5- macrovascular bundle 6- small vascular bundle 7- fibrous bundle; (b)The effect of humic and fulvic acid treatment on the morphological properties of Washington and Canary palm leaves (1-cuticle 2- epidermis 3- columnar cells 4- tannins 5- macrovascular bundle 6- small vascular bundle 7- fibrous bundle; (c)Effect of treatment with humic and fulvic acids on the anatomical characteristics of leaves of Washington and Canary palms (1-cuticle 2- epidermis 3- columnar cells 4- tannin cells 5- macrovascular bundle 6- small vascular bundle 7- fibrous bundle.

DISCUSSION

Several types of indicators can be used to describe the types of changes that the plant undergoes, such as anatomical indicators, where the plants growing in areas that suffer from fluctuations in environmental and

natural factors such as lack of water and lack of nutrients, and these conditions are determinants of plant growth and development, Despite the harsh conditions, plants have developed some anatomical characteristics that enabled them to survive under these conditions[12,13]. It is noted from the results of the current study that the palm and humic substances significantly improve the anatomical traits of the leaves of the seedlings of the *W. filifera* and *P. canariensi* for cells compared with those developing in control conditions. This, in turn, may lead to an increase in cell division activity and an improvement in the growth conditions of the seedlings represented in the anatomical characteristics of the leaves. The effect of humic organic acids in improving vegetative growth had an apparent effect in reducing the thickness of the cuticle layer, where it was observed through the results of the current study that there was a significant increase in the averages of the thickness of the epidermal cells and the length of the Columnar epithelial cells, which means that there was an expansion in the surface area of the leaf that led to an increase in the spread of the waxy layer The covering of the upper epidermis and consequently the decrease in its thickness, in addition to the humic function organic acids in increasing the absorption of water, which increases the filling and expansion of cells, including the cells of the epidermis of the leaf, which reduces the thickness of the cuticle layer that covers it. Humic and fulvic acids also have a hormonal effect as they affect the cell's protoplasm and the cell wall, leading to the rapid division and growth of cells [14].

Furthermore, this improves the plant's anatomical traits. It also stimulates the enzymes needed to convert complex compounds into simple compounds and exploits them to provide the plant with energy. Necessary for its growth, all these effects were positively reflected in the studied anatomical traits[15].

CONCLUSIONS

Treatment with organic materials (humic and fulvic acid) as a ground addition to the seedlings of both *W. filifera* and *P. canariensi* ornamental palms led to an improvement in their anatomical characteristics, which led to an increase in the growth of seedlings of both genera.

Funding: This research received no external funding.

Conflicts of Interest: The authors declare no conflict of interest.

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Received: 26 September 2023 / Accepted: 15 April 2023 / Published:15 December 2023

Citation: Alpresem, W.; Abdulameer, M.; Ahmed R. Effect of humic and fulvic acid treatment on the anatomical traits of the leaves of two genera of seedlings of ornamental palm Washingtonia filifera and Phoenix canariensis). Revis Bionatura 2023;8 (4) 46. http://dx.doi.org/10.21931/RB/2023.08.04.46