Middle East Journal of Agriculture Research **Volume : 09 | Issue : 04| Oct.-Dec. | 2020**
EISSN: 2706-7955 ISSN: 2077-4605 **Pages:711-720**
DOI: 10.36632/mejar/2020.9.4.55

Effect of salinity stress on growth, chemical constituents and stem anatomy of *Duranta erecta* L. plants

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Received: 15 August 2020 / Accepted 10 Oct. 2020 / Publication date: 25 Oct. 2020

ABSTRACT
The present study was carried out at the Ornamental Horticulture Department, Faculty of Agriculture, Cairo University, Giza, during the two successive seasons of 2014 and 2015 in order to enhance the growth of duranta plants grown under different concentrations of salinity (2000, 4000, 8000 and 12000 ppm of salt mixture, NaCl: CaCl2, 1:1w/w) by foliar application of 200 and 400 ppm ascorbic acid. The results showed that, growing the plants under 2000 ppm salinity + 200 ppm ascorbic acid gave the highest values of number of branches, root length, fresh and dry weight of leaves, cl (a, b), N%, P% and K% concentrations in both seasons. While, growing the plants under 4000 ppm salinity + 200 ppm ascorbic acid gave the highest value of plant height in both seasons. Data also reveal that the application of 400 ppm ascorbic acid grown under stress of 8000 ppm salinity caused enhancement in stem structure of salinized plants. Such treatment caused recovery more than 80% of the reduction occurred in all included tissues of the main stem where their meanvalues were almost reached the level of the control.

***Keywords*:** *Duranta erecta*, Salinity, vegetative growth, chemical constituents and Anatomy

Introduction

Duranta erecta (Golden dewdrop) family Verbenaceae is a native of Mexico, Central America, South America to Argentina, southern Florida (possibly naturalized), Bermuda, the Bahamas, and the West Indies (Howard 1989; Liogier 1995; Little *et al*. 1974). The species is widely cultivated and escaped in the tropics and subtropics including Hawaii, American Samoa, and Guam (Pacific Islands Ecosystems at Risk 2002). *Duranta erecta* (Golden dewdrop) grows wild mostly in dry coastal areas (750 to 900 mm of annual precipitation in Puerto Rico) from near sea level to over 100 m in elevation (Little *et al*., 1974). It also grows in disturbed areas in moister habitat, especially along roads (Pacific Island Ecosystems at Risk 2002). Because it is moderately intolerant of shade and does not compete well with taller vegetation, golden dewdrop is usually found in rocky or sandy areas with low shrubs and sparse grass and herbs. Although it is more common on limestone, the shrub also grows in areas with igneous rocks. The species tolerates light to moderate salt spray. *Duranta erecta* (Golden dewdrop) forms a part of the coastal scrub community and contributes to soil and ecosystem stability. It is a popular ornamental used for accent plants and hedges in tropical and subtropical parts of the world because of its profuse displays of flowers and fruits (Floridata, 1999). Ethyl acetate and aqueous extracts of leaves showed significant antimalarial activity when administered to mice (Castro *et al.*, 1996). In small quantities, fruits are used to treat intestinal worms (Whistler, 2000).

Salinity is one of the world's most serious environmental problems in agriculture. It is estimated that about one-third of the world's cultivated land is affected by salinity (PerezAlfocea *et al.*, 1996). The National Academy of Sciences of the USA includes salinization of soils and waters as one of the leading processes contributing to a possible worldwide catastrophe (Francois and Maas, 1994). The increasing world population, especially in arid and semi-arid regions, food shortages, and land scarcity are compelling the use of lands not utilized because of salinity and other soil stresses. Salinity and sodality problems are characterized by an excess of inorganic salts and are common in the arid and semiarid lands (ASAL) where they have been naturally formed under the prevailing climatic conditions and due to the high rates of evapotranspiration and lack of leaching water (Mengel and Kirkby, 1982; Shannon *et al.*, 1994). In the arid and semiarid parts of Africa, for instance, salinity and alkalinity are

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major problems affecting about 24% of the continent (Reich *et al.*, 2004). Salinity of arable land is an increasing problem of many irrigated, arid and semi-arid areas of the world where rainfall is insufficient to leach salts from the root zone, and it is a significant factor in reducing crop productivity (Francois and Maas, 1994).

Vitamins are considered as the accessory nutrients, required in minute quantities. Most of the vitamins are involved in enzyme systems. Vitamin contents of plants are also known to show altered metabolism under the influence of salinity (Anjali and Aruna, 2013).

Ascorbic acid (vitamin C) is a familiar molecule because of its dietary significance, most aspects of its metabolism and some aspects of its function in plants are very poorly understood. For example, its biosynthetic pathway has not been firmly established even though it reaches mill molar concentrations in most tissues. Humans and some other animals (including other primates and guinea pigs) depend on ascorbate in their diet because of loss of a functional form of the last enzyme (l-gulono-1,4-lactone oxidase) of the biosynthesis pathway. Ascorbate is best known for its function as an antioxidant and for its role in collagen synthesis. Collagen deficiency results in the symptoms of scurvy (Nicholas 1996). Ascorbic acid has effects on many physiological processes including the regulation of growth and metabolism of plants under saline conditions and increasing physiological availability of water and nutrient (Barakat, 2003). In addition, ascorbic acid protects metabolic processes against H_2O_2 and other toxic derivatives of oxygen affecting many enzyme activities, minimizes the damage caused by oxidative processes through synergistic function with other antioxidants and stabilize membranes (Shao *et al.*, 2008).

Materials and Methods

This study was carried out at the Ornamental Horticulture Department, Faculty of Agriculture, Cairo University, Giza. during the two successive seasons 2014 and 2015 to investigate the effect of ascorbic acid under salinity stress conditions on growth and chemical constituents of *Duranta erecta* seedlings. The liberality work on ornamental and woody trees department - National Research Centre. Seedlings of *Duranta erecta* were obtained from (private farm) (six months old, 20cm height) were used as a plant material. The experiment was under open field conditions through the two seasons. The seedlings of *Duranta erecta* were cultivated (20 cm length) in the first week of March in both seasons, and transported in 30 cm pots during the second week of March 2014 and 2015. The soil use was a combine with sand and compost 2:1 (V: V). All agricultural operations procedure fertilized all plants with Kristalon (NPK 19:19:19), produced by Phayzon Company, Holland at the rate of 5 gm/pot used in three times through the growth season; The plants were located under open field condition and irrigation was done according to the plants need. The physical and chemical analysis of these growing media presented in Table (1).

Table 1: Physical and chemical analysis of the growing media used in the experiment.

A. Physical analysis.

Medium material	SP	F.C		W.P %	A.W %
	%	0.1	0.33		
Virgin sandy sample	35.9	7.7	6.2	2.2	5.5
Mixed (sand + compost) sample	49.8	33.7	24.8	9.5	24.2
Compost sample	75.3	56.1	48.3	16.3	39.8

EC	PH	Ions (meq/L)						
(dS/m)		Ca++	Mg++	Na+	K+	(CO_3--+HCO_3-)	Cl-	SO_4^{--}
0.54	7.65	0.5	1.4	3.5	0.5	1.7	0.6	3.2

After three weeks from transplanting the plants received the first application of salinity treatments (0, 2000, 4000, 8000, 12000 ppm). Ascorbic acid Commercial vitamin, Ascorbic acid was used. The plants sprayed with ascorbic acid concentration at (0, 200, 400 ppm) received the first application after two weeks from salinity and the second application after two weeks from the first application. The experiment was made in a randomized complete block design with15 treatments, each treatment included three replicates. The treatments as follows: 1. Control, plants were irrigated with tap water. 2. Four levels of salinity in irrigation water; namely, 2000, 4000, 8000 and 12000 ppm of salt mixture

(NaCl: CaCl2, 1:1 w/w). 3 Three levels of ascorbic acid were applied (0,200 and 400 ppm) on each of the tested four levels of salinity. The pots were located under open field conditions. Each level of salinity in irrigation water was added regularly (750ml/pot/week) during the whole period of the experiment (nine months from transplanting). Irrigation treatments were applied four times with salinized water followed by one irrigation with tap water (for leaching the accumulated salts) and then repeated in the same manner till the end of the experiment. In order to improve the growth of duranta plants grown under stress of salinity in irrigation water, ascorbic acid concentrations were sprayed twice. The first spray was done after one month from transplanting and the second one was applied two months from the first spray. Tween-20 was added as a spreading agent for tested treatments. The recorded data includes: 1. Plant height (cm). 2. Number of leaves/ plant. 3. Root length (cm). 4. Fresh and dry weight of leaves (g/plant). Meanwhile, fresh leaves (g/plant) were collected to determine photosynthetic pigments (chlorophyll a, b and carotenoids), according to Nornai (1982).Total carbohydrates % were determined according to Dubois *et al.* (1956). Furthermore, leave samples were collected and were oven dried at 70°C for the determination of nitrogen according to Cottenie *et al.,* (1982), phosphorus were determined according to Snell and Snell (1949) and potassium contents were determined according to Chapman and Pratt (1978).

Statistical analysis:

A randomize complete block design with two factor was used for analysis vegetative growth with three replications for each parameter. The treatment means were compared by least significant difference (L.S.D.) test as given by Snedecor and Cochran (1976) by used Assistat program.

Results and Discussion

1. Vegetative growth:

Data presented in Table (2) showed that the effect of saline water irrigation, ascorbic acid and their interaction on vegetative parameters of *Doranta erecta* plants. The results demonstrated clearly that the concentration of salinity at 12000 ppm significantly decreased plant height, No. of leaves, root length, fresh and dry of leaves compared with control plants in both seasons. The decrements in the first season were (21.60, 33.81, 10.13, 63.28 and 66.94%), respectively, and in the second season were (22.0, 27.86, 11.72, 64.11 and 67.39 %), respectively, compared with control plants. These results are in agreement with those obtained by Arafa *et al.* (2009) on sorghum plant, Farahat, (2013) on *Grevillea robusta* plant, Amirjani, (2015) on periwinkle plants and Hashish *et al.* (2015) on gladiolus plants, they reported that application of saline water alone led to significant reduction in all growth parameters. The reduction in plant growth due to the effect of salinity on many metabolic processes including enzyme activity, the activity of the mitochondria and chloroplasts and protein synthesis, these attributed by Mengel and Kirkby (1982). Concerning the effect of ascorbic acid on vegetative parameters, data in Table (2) revealed that application of ascorbic acid at 200 ppm had a significant favorable effect on plant height and number of leaves/plant in both seasons. The increments were (14.53% and 10.24%) for plant height and (27.32% and 34.30%) for number of leaves in the first and second seasons, respectively, compared with control plants. Increasing the concentrations of ascorbic acid from 200 to 400 ppm led to an increase in root length, fresh and dry weight of leaves in both seasons. The increments were (7.64% and 17.44%) for root length, (25.98% and 24.47%) for fresh weight of leaves and (32.56% and 30.34%) for dry weight of leaves in both seasons, respectively, compared with control plants. These results are in agreement with those obtained by Abdel-Aziz *et al.* (2009) on gladiolus plants, Badran *et al.* (2013) on *Khya sengalensis* seedlings, Khafagy *et al.* (2013) on *Hibiscus rosa-sinensis* plants and Nikee *et al.* (2014) on *Satureja hortensis* L. plants, they found that application of ascorbic acid increased all plant parameters. The effect of ascorbic acid treatments may be due to the substantial role of ASc in many metabolic and physiological processes, these attributed to the postulation of Shaddad *et al.,* 1990, and may be attributed to the biochemical functions of ascorbate which can be divided into four categories; enzyme cofactor, electron transport and antioxidant (Smirnoff, 1996).Regarding the effect of interaction between saline water irrigation and ascorbic acid application, data presented in Table (2) mentioned that the highest values of plant height were obtained when plants treated with ascorbic acid at 200 ppm combined with non-saline water (129.33 and 139.67 cm), respectively, in both season compared with other treatments. It is clear from data in the first and second seasons that the combined

Table 2: Effect of ascorbic acid on vegetative growth of *Duranta erecta* plants, aged 9 months, grown under salinity conditions in 2014 and 2015 seasons.

Treatments	Plant height (cm)		No. of leaves		Root length (cm)		F.W. of leaves (g/plant)		D.W. of leaves (g/plant)	
	2014	**2015**	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
Control	126.00	135.89	330.56	394.11	59.06	66.83	104.69	112.77	30.91	34.53
2000ppm S.	118.89	130.78	379.78	426.67	61.83	67.69	72.58	78.43	20.97	23.64
4000ppm S.	110.67	121.94	281.56	352.11	54.11	64.03	69.19	72.98	19.50	21.98
8000ppm S.	108.22	118.24	255.44	302.89	53.08	63.61	49.60	54.91	13.25	15.55
12000ppmS.	98.78	106.00	218.78	248.33	53.56	59.00	38.44	40.47	10.22	11.26
L.S.D. at 5%	3.29	3.71	14.89	21.98	2.54	2.65	4.76	4.90	2.27	2.47
Control	103.27	115.57	252.13	284.93	54.06	58.53	58.24	62.29	16.00	18.03
200ppm AS.	118.27	127.40	321.00	382.67	56.73	65.43	69.09	75.92	19.70	22.64
400ppm AS.	116.00	124.75	306.53	366.87	58.19	68.74	73.37	77.53	21.21	23.50
L.S.D. at 5%	2.55	2.87	11.53	17.03	1.96	2.05	3.68	3.79	1.76	1.91
Control	121.33	134.67	299.00	372.00	57.17	67.00	73.25	75.35	20.72	22.45
2000ppm S.	117.00	128.00	302.67	301.00	57.83	58.67	67.79	73.61	18.98	21.79
4000ppm S.	85.67	102.50	263.00	313.67	53.83	47.47	64.87	69.98	17.97	20.29
8000ppm S.	104.33	115.67	246.00	279.33	51.47	60.33	44.65	50.45	11.74	14.13
12000ppm S.	88.00	97.00	150.00	158.67	50.00	59.17	40.65	42.08	10.57	11.49
200ppm AS.	129.33	139.67	349.33	403.67	57.67	65.50	116.15	130.83	34.61	40.16
2000+200ppm AS.	120.00	130.67	424.33	513.67	63.00	70.67	73.84	79.42	21.48	24.06
4000+200ppm AS.	124.00	133.33	299.00	387.67	54.67	69.33	69.07	75.98	19.40	22.87
8000+200ppm AS.	112.33	122.33	269.00	314.33	53.50	63.17	49.73	54.35	13.32	15.33
12000+200ppm AS.	105.67	111.00	263.33	294.00	54.83	58.50	36.66	39.01	9.71	10.81
400ppm AS.	127.33	133.39	343.33	406.67	62.33	68.00	124.68	132.15	37.40	40.97
2000+400ppm AS.	119.67	133.67	412.33	465.33	64.67	73.73	76.10	82.26	22.45	25.08
4000+400ppm AS.	122.33	130.00	282.67	355.00	53.83	75.30	73.62	72.99	21.13	22.77
8000+400ppm AS.	108.00	116.73	251.33	315.00	54.27	67.33	54.42	59.94	14.69	17.20
12000+400ppm AS.	102.67	110.00	243.00	292.33	55.83	59.33	38.03	40.32	10.38	11.49
L.S.D. at 5%	5.71	6.43	25.79	38.09	4.40	4.59	8.25	8.48	3.93	4.27

effect between salinity level at 2000 ppm and ascorbic acid at 200 ppm significantly increased number of leaves (424.33 and 513.67), respectively, compared with other treatments. The combined effect between ascorbic acid at 400 ppm and salinity at 2000 ppm in the first season, and combined with salinity at 4000 ppm in the second season significantly increased root length compared with other treatments. Date in the same Table showed that the combination effect between ascorbic acid at 400 ppm with non- saline water treatment led to increase fresh and dry weight of leaves in the first season (124.68 and 37.40 gm/plant) and in the second season (132.15 and 40.97 gm/plant), respectively, compared with other treatments.

2. Chemical constituents

2.1. Pigments content

Data demonstrated in Table (3) showed the response of pigments content of *Duranta erecta* leaves to the salinity levels and foliar application of ascorbic acid concentration. In both seasons, the 0 ppm salinity treatment caused the highest values of chlorophyll (a), (b) and (carotenoids), and these contents were decreased gradually with increasing the level of salinity to reach the minimum values with the application of 12000 ppm salinity. These results are in agreement with the finding of Farahat *et al.* (2013) on *Grevillea robusta* plants, Ibrahem *et al.* (2013) on *Khaya sengalensis*, Sayed *et al.* (2014) on *Tagetes erecta* and Nisha (2015) on *Dalbergia sissoo,* they found that pigment contents(chlorophyll a, b and carotenoids) were decreased with increasing salinity levels.

Results obtained concerning the chlorophyll (a), (b) and (carotenoids) contents in response to foliar application of ascorbic acid treatment revealed that, in both seasons, pigments content were relatively higher in plants sprayed with 400 ppm ascorbic acid. While, reducing the concentration of ascorbic acid to 200 ppm gave lower value of pigments content in the first and second seasons, compared with high concentration treatment. Mosleh *et al.* (2014) on *Prunus armeniaca L.* Results indicated that total chlorophyll content in the apricot leaves significantly increased by increasing the application of ascorbic acid at both seasons. Also, Abdel-Aziz *et al.*, 2006 on *Khaya sengalensis* plants, Abdel-Aziz *et al.*, (2007) on *Syngonium podphyllum* L. plants, Mohamed and Mohamed (2015), on (*Helianthus annuus* var. Sakha 53), Hira *et al.,* (2016) on *Cucumis sativus* plant and Samin *et al.,* (2016), they showed that the plants grown under foliar application of ascorbic acid showed significant increase in total chlorophyll, compared to untreated plants. These increments in photosynethic pigments contents may be attributed to increase in photosynethic process efficiency, which led to increase net assimilation of Co_2 which is known as the basic unit of carbohydrate. The data obtained showed that in the first season, the combination between salinity at 0 ppm + foliar application of ascorbic acid at 400 ppm increased the chlorophyll (a), (b) and (carotenoids) content (0.70, 0.37and 0.36 mg/gm. F.W.), respectively. While, in the second season, decreasing the concentration of ascorbic acid to 200 ppm gave the highest values of Chl (a) and (b) content combined with the non-saline water treatments((0.85 and 0.44mg/gm. F.W.), respectively, although the combination between the non-saline water treatment plus foliar application of ascorbic acid at 4004200 ppm in the second season, there were a gradual increase in the carotenoids content (0.47 mg/gm. F.W.), followed by salinity at 2000 ppm plus ascorbic acid at 400 ppm (0.33 and 0.45 mg/gm. F.W.), respectively, in the first and second seasons.

2.2. Carbohydrates (%)

Data on the effect of different salinity levels and various ascorbic acid foliar applications on total carbohydrates percentages of *Duranta erecta* in leaves are presented in Table (3). It is clear from data that non-saline water treatment increased the total carbohydrates percentage in both seasons (32.82 and 36.75 %), respectively, in the first and second seasons, compared with salinity treatments. On the other hand, raising the level of salinity markedly decreased the total carbohydrates percentage from 8000 and 12000 ppm giving (27.47 and 27.70%) in the first season, and (32.37 and 24.65%) in the second season. The present findings are generally in accordance with those reported by Eid *et al.*,(2011) on *Tagetserecta*, Mazher *et al.*, (2012) on *Chrysanthemum indicum* and Farahat *et al*., (2013) on *Gerevillae robusta* plant , they found that , the highest concentrations of salinity decreased total carbohydrates. It is also clear from the data that spraying duranta plants with ascorbic acid treatments resulted highest value of percentage of total carbohydrates (31.24 %) when plants treated with ascorbic acid at 400 ppm in the first season, and 200 ppm in the second season which giving (33.65%).These results are agreement with Khafagy *et al.,* (2013) on *Hibiscus rosa-sinensis*, Samin *et al.*, (2016) on *Solanum*

melongena, they found that ascorbic acid at different concentrations caused significant increases in total carbohydrates contents in leaves as compared with untreated plants. According to the data, it is clearly noticed that the maximum total carbohydrates percentage was recorded with plants untreated with salinity at 0 ppm + ascorbic acid at 400 ppm giving (34.18 %) in the first season. Whereas, in the second season, salinity at 2000 ppm + ascorbic acid at 400 ppm gave the highest values of total carbohydrates percentage (38.31 %).

Table 3: Effect of ascorbic acid on pigment content (mg/g F.W.) and total carbohydrates (%) of *Duranta erecta* plants, aged 9 months grown under salinity conditions in the two seasons 2014 and 2015.

Treatments	Pigments content mg/g F.W.			Pigments content mg/g F.W.			Total carbohydrates (%)	
	2014			2015			2014	2015
	Chl. a	Chl.b	carotenoids	Chl.a	Chl.b	Carotenoids		
Control	0.68	0.32	0.33	0.82	0.39	0.41	32.82	36.75
2000ppm S.	0.65	0.27	0.31	0.73	0.35	0.38	29.82	34.57
4000ppmS.	0.60	0.26	0.30	0.70	0.35	0.36	28.01	32.60
8000ppmS.	0.54	0.23	0.29	0.64	0.33	0.35	27.47	32.37
12000ppmS.	0.46	0.21	0.23	0.57	0.28	0.27	27.70	24.65
Control	0.54	0.23	0.26	0.63	0.30	0.28	27.10	30.24
200ppmAS.	0.59	0.26	0.30	0.71	0.35	0.37	28.78	33.65
400ppmAS.	0.63	0.28	0.31	0.74	0.37	0.40	31.24	32.68
Control	0.65	0.28	0.30	0.79	0.32	0.32	30.84	35.43
2000ppmS.	0.60	0.24	0.29	0.65	0.33	0.30	2791	30.20
4000ppmS.	0.53	0.23	0.28	0.62	0.32	0.27	26.19	30.80
8000ppmS.	0.45	0.20	0.23	0.54	0.30	0.28	23.01	31.16
12000ppmS.	0.45	0.18	0.21	0.53	0.23	0.24	27.51	23.59
200ppmAS.	0.69	0.32	0.32	0.85	0.44	0.44	33.44	37.38
2000+200AS.	0.66	0.26	0.31	0.76	0.34	0.40	28.46	35.19
4000+200AS.	0.59	0.26	0.30	0.71	0.35	0.40	26.98	31.56
8000+200AS.	0.55	0.25	0.32	0.67	0.33	0.37	27.60	36.62
12000+200AS>	0.45	0.22	0.25	0.57	0.29	0.26	27.44	27.48
400ppmAS.	0.70	0.37	0.36	0.82	0.41	0.47	34.18	37.44
2000+400AS.	0.68	0.30	0.33	0.79	0.38	0.45	31.24	38.31
4000+400AS.	0.67	0.29	0.32	0.77	0.37	0.41	30.85	35.45
8000+400AS.	0.63	0.23	0.32	0.70	0.36	0.39	31.80	29.34
12000+400AS.	0.47	0.23	0.22	0.60	0.31	0.30	28.15	22.88

2.3. Mineral content in leaves (N, P and K %)

Data of (N, P and K) percentage in the leaves of *Duranta erecta* plants as affected by different levels of salinity and various concentrations of ascorbic acid in both seasons are presented in Table (4). As regards the effect of salinity levels, it is clear from data in Table (4) that salinity at 2000 ppm increased (N, P and K% D.W.) in the leaves by (1.23, 0.19 and 0.80 % D.W.) in the first season, while, in the second season by(1.30, 0.20 and 0.85% D.W.), respectively. Whereas, the lowest values of mineral content in *Duranta erecta* leaves when plants treated with salinity at 12000 ppm in both seasons.

Farahat *et al.*, (2013) on *Grevillea robusta* plant and Ibrahem *et al.*, (2013) on *Khaya sengalensis*, they found that N, P and K % were decreased with increasing the salinity levels. Concerning the effect of ascorbic acid on (N and P%D.W.) in leaves, it was increased by (1.16 and 0.17% D.W.) in the first season, and by (1.23 and 0.18% D.W.) in the second season, respectively, in response to foliar application at 400 ppm, followed by application of 200 ppm which led to increase (K%) by (0.74 and 0.80 % D.W.) in the first and second seasons, respectively. These results are agreement with Eid *et al.,* (2011) on *Tagetes erecta* L., Badran *et al.*, (2013) on *Khaya senegalinsis* plant and Nisha 2015 on *Dalbergia sissoo* plants, they showed that ascorbic acid improved content of N, P and K % in leaves.

The data also showed the interaction between salinity levels and ascorbic acid application, it can be noticed that salinity at 2000 ppm combined with foliar application of ascorbic acid at 400 ppm gave the highest percentage of (N and P%) were (1.29 and 0.20% D.W.), in the first season, while in the second season by (1.35 and 0.22% D.W.), respectively. The plants were treated with salinity at 2000

ppm combined with 200 ppm ascorbic acid gave the highest value of (K%) in both seasons were (0.84 and 0.89% D.W.), respectively.

Table 4: Effect of ascorbic acid on N, P and K % of *Duranta erecta* plants, aged 9 months grown under salinity conditions in the two seasons 2014 and 2015.

Treatments \ Characters	Mineral of content in leaves					
	2014			2015		
	N%	P%	K%	N%	P%	K%
Control	1.13	0.18	0.73	1.26	0.17	0.80
2000ppmS.	1.23	0.19	0.80	1.30	0.20	0.85
4000ppmS.	1.10	0.16	0.68	1.18	0.18	0.72
8000ppmS.	0.99	0.15	0.65	1.11	0.16	0.70
12000ppmS.	0.87	0.13	0.63	1.04	0.14	0.65
Control	0.92	0.15	0.66	1.11	0.16	0.67
200ppmAS.	1.10	0.16	0.74	1.21	0.17	0.80
400ppmAS.	1.16	0.17	0.69	1.23	0.18	0.76
Control	1.04	0.17	0.73	1.19	0.15	0.72
2000ppmS.	1.14	0.18	0.82	1.24	0.19	0.80
4000ppmS.	1.05	0.14	0.60	1.11	0.17	0.64
8000ppmS.	0.88	0.16	0.58	1.09	0.16	0.62
12000ppmS.	0.53	0.11	0.60	0.92	0.13	0.59
200ppmAS.	1.15	0.18	0.75	1.29	0.17	0.90
2000+200AS.	1.26	0.19	0.84	1.32	0.19	0.89
4000+200AS.	1.10	0.16	0.78	1.24	0.18	0.82
8000+200AS.	1.02	0.15	0.70	1.10	0.16	0.68
12000+200AS.	1.01	0.13	0.65	1.09	0.14	0.71
400ppmAS.	1.22	0.19	0.71	1.32	0.19	0.77
2000+400AS.	1.29	0.20	0.74	1.35	0.22	0.86
4000+400AS.	1.17	0.17	0.66	1.21	0.18	0.70
8000+400AS.	1.07	0.15	0.67	1.15	0.15	0.80
12000+400AS.	1.08	0.15	0.65	1.12	0.14	0.66

3. Anatomical studies

3.1. Stem anatomy

Microscopica measurements of certain histological characters in transverse sections through the median portion of the main stem of normal *Duranta erecta* plants and of those grown under salinity stress of 8000 ppm as well as of those salinized by 8000 ppm and affected by foliar spray with 400 ppm ascorbic acid are presented in Table (5). Likewise, microphotographs illustrating these treatments are shown in Figure (1). It obvious from Table (5) and Figure (1) that the salinity level of 8000 ppm reduced the diameter of the main stem by 35.8% less than the control. The decrease in stem diameter, due to salinity stress, could be attributed mainly to the prominent decrease in all included tissues except that of pith diameter which showed prominent increase of 28.6% over the control. It is clear that salinity stress decreased the thickness of periderm, cortex, phloem tissue and xylem tissue as well as mean diameter of vessel by 23.3, 16.1, 39.9, 58.2 and 5.3% less than those of the control; respectively. The present findings are generally in accordance with those reported by Reda *et al.* (2000) and by Nassar *et al.* (2016) on Leucaena as well as by Reda (2007) on *coffee senna*. Data also reveal that the application of 400 ppm ascorbic acid on *Duranta erecta* plants grown under stress of 8000 ppm salinity caused enhancement in stem structure of salinized plants. Such treatment caused recovery more than 80% of the reduction occurred in all included tissues of the main stem where their mean values were almost reached the level of the control. Thus, it could be stated that ascorbic acid had the ability to minimize the harmful effect of salinity on anatomical structure of *Duranta erecta* stem. Such treatment induced small decrease in stem diameter of salinized plant by 16.1% below the control due to decrements in thickness of all included tissues in spite of negligible increase of 3.1% in mean diameter of vessel over the control. Thickness of periderm, cortex, phloem tissue, xylem tissue and diameter of pith were decreased by 9.9, 11.3, 10.5, 18.2 and 14.2% less than those of the control; respectively. Worthy to note that the mean values of all tissues in stems of salinized plants which were sprayed with ascorbic acid, except that of pith diameter, were decidedly higher over those of salinized plants. The main stem

diameter was increased by 30.7% over stem diameter of salinized plant due to increments in most of included tissues by 17.4, 5.7, 49.1 and 95.7% for thickness of periderm, cortex, phloem tissue and xylem tissue; respectively. As far as the author is aware, information about the effect of foliar spray with ascorbic acid on the anatomical structure of the main stem of duranta plants, grown under salinity stress are not available.

Table 5: Measurements in micrometers (Mm) of some histological characters in cross sections through the median portion of the main stem, at the age of five months from transplanting, of normal *Duranta erecta* plants and those grown under stress of 8000 ppm salinity as well as of those salinized and affected by foliar spray with 400 ppm ascorbic acid (Means of three sections from three different specimens)

Treatments Histological characters	Control	8000ppm salinity	± % to control	8000ppm 400ppm Salinity + Ascorbic acid	± % to control	± % to 8000ppm salinity
Stem diameter	3839.5	2463.7	-35.8	3220.9	-16.1	+30.7
Thickness of periderm	63.6	48.8	-23.3	57.3	-9.9	+17.4
Thickness of cortex	106.2	89.1	-16.1	94.2	-11.3	+5.7
Thickness of phloem tissue	211.8	127.2	-39.9	189.6	-10.5	+49.1
Thickness of xylem tissue	1165.9	487.5	-58.2	954.2	-18.2	+95.7
Mean diameter of vessel	22.6	21.4	-5.3	23.3	+3.1	+8.9
Diameter of pith	742.2	954.8	+28.6	636.5	-14.2	-33.3

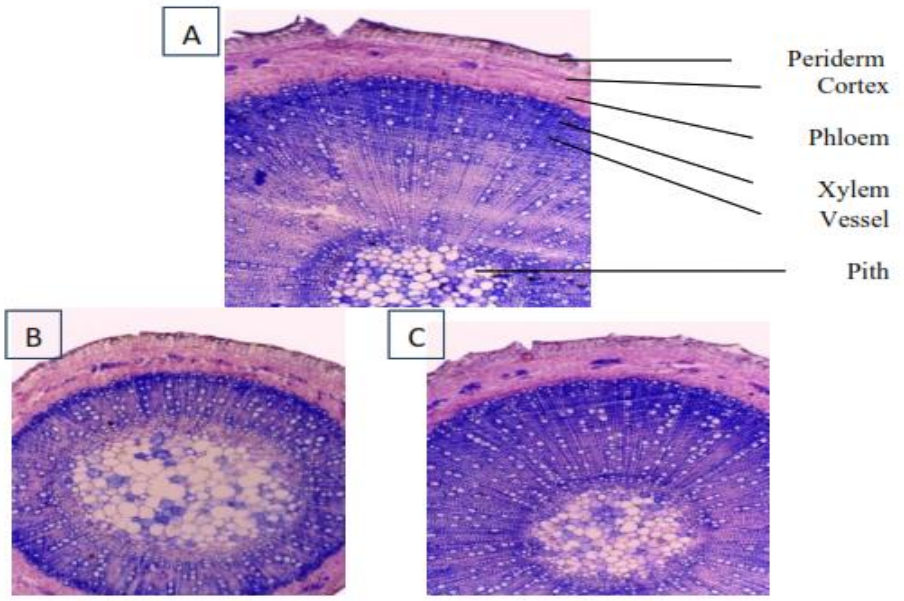

Fig. 1: Transverse sections through the median portion of the main stem of *Duranta erecta* plants, at the age of five months from transplanting, as affected by salinity stress and sprayed with ascorbic acid. (X 60).

A- From untreated plant (control).
B- From plant grown under salinity stress of 8000 ppm.
C- From plant grown under salinity stress of 8000 ppm and sprayed with 400 ppm ascorbic acid.

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