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REDUCE THE HURTFUL EFFECTS OF SEA WATER SALINITY ON GROWTH, SOME PHYSIOLOGICAL AND ANATOMICAL CHARACTERS AS WELL AS YIELD OF *Phaseolus vulgaris* L. BY USING HUMIC ACID, PROLINE AND NAPHTHALENE ACETIC ACID

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ABSTRACT: Pots experiment was designed in two summer successive seasons of 2017 and 2018 at the wire house of the Agric. Bot. Dept., Fac. Agric. Zagazig Univ., Sharkia Governorate, Egypt. Common bean plants cv. Giza 3 were foliar sprayed with different concentrations of humic acid, proline, naphthalene acetic acid and distilled water (as a control) under sea water salinity levels, *i.e.* 1000, 2000 and 3000 ppm and tap water (500 ppm) as a control, to examine its effects on growth, photosynthetic pigments, proline content, yield and leaf anatomy of common bean plants. Results revealed that most studied traits, *i.e.*, plant height, number of leaves/plant, leaf area, fresh weight of roots, stems and leaves, photosynthetic pigments (chlorophyll a, chlorophyll b, chlorophyll a+b and carotenoids) and yield expressed as number of pods/plant, number of seeds/pod, number of seeds/ plant, 100-seed weight and length of pod as well as leaf anatomical parameters. Most aforementioned features were significantly decreased with increasing sea water levels up to the highest level (3000 ppm) comparison with control (tap water). On the contrary, proline content in leaves was increased with increasing salinity levels up to 3000 ppm. On the other hand, spraying common bean plants with humic acid at 2 and 4g/L, proline at 50 and 100 ppm and naphthalene acetic acid at 25 and 50 ppm had a positive significant effect in most studied traits compared to control (distilled water). In general, the most favorable treatments were foliar spray common bean plants with humic acid at 2g/L followed by proline at 100 ppm then naphthalene acetic acid at 25 ppm, respectively compared to control (distilled water). It could be concluded that spraying of humic acid, proline and naphthalene acetic acid mitigate the harmful effect of sea water salinity on common bean plants and the best treatment was interaction between irrigation with tap water or sea water at 1000 ppm and spraying by humic acid at 2 g/L.

Key words: Common bean, humic acid, proline, naphthalene acetic acid, sea water, growth, yield, chemical contents, leaf anatomy.

INTRODUCTION

Common bean plants (*Phaseolus vulgaris* L.) is one of the most important legume vegetable crops grown in Egypt that occupies a great figure in local consumption and exportation **(Ramadan and Ibrahim, 2006)**. About 20 to 30% of the bean-production areas in the Middle East are affected by soil salinity **(Bayuelo-Jiménes *et al.,* 2002)**. Common bean plants are relatively sensitive under sandy soil conditions compared to most vegetable crops **(El-Zaher *et al.,* 2001).** *Phaseolus vulgaris* has its origin in Middle and South America. It is a major world crop with almost 23.1 million tons of seeds produced **(FAOSTAT, 2014)**.

Salt stress affects many physiological aspects of plant growth. Shoot growth and dry matter are reduced by increasing salinity (**Rahman *et al.*, 2008**). Salinity either of soil or irrigation water is a major problem affecting the productivity of bean and cause low growth, yield and poor quality **(Lovelli *et al.,* 2000).** In

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many areas, the availability of high-quality water is limited. The use of low-quality water results in an increase in soil salinity **(Incrocci *et al.,* 2006**)

Humic acid (HA) is a promising natural resource to be utilized as an alternative for increasing crop production. It is a naturally occurring polymeric organic compound and is produced by the decay of organic materials and is found in soil, peat and lignites. HA serves as a catalyst in promoting the activity of microorganisms, water holding capacity in soil and reduce watering requirements for plants **(Hynes and Naidu, 1998; Sharif *et al.,* 2002)**.

Abdel-Mawgoud *et al.* (2007) stated that humic acid increased plant growth through chelating different nutrients to overcome the lack of nutrients, and have useful effects on growth increment, production, and quality improvement of yield might be due to that humic acid contain hormonal compounds. Among legume family plants, humic acid foliar spray has remarkable effects on vegetative growth of plant and increasing photosynthetic activity as well as leaf area index.

Proline is known to induce expression of salt stress responsive genes, which possess proline responsive elements *e.g.* PRE (proline responsive elements) (ACTCAT) **(Chinnusamy *et al.,* 2005)**. Proline can also protect cell membranes from salt-induced oxidative stress by enhancing activities of various antioxidants **(Yan *et al.,* 2000).**

Application of Naphthalene acetic acid (NAA) increased yield and its components of Rice, NAA at 100 g ha^{-1} increased the number of grains per panicle, percentage of filled spikelets, 1000- grain weight and thus final yield **(Reddy *et al.,* 2009).** Foliar application of NAA at 100 ppm were significantly increased fruit yield, number of fruits, average fruit weight of bell pepper and total chlorophyll **(Sridhar *et al.,* 2009)**.

Therefore, the aim of this present work is to study the effect of sea water salinity stress, humic acid, proline and naphthalene acetic acid on growth, physiological characters, yield and its components as well as leaflet blade anatomical structure of common bean plants.

MATERIALS AND METHODS

The present work was carried out during the two summer successive growing seasons of 2017 and 2018 in the wire house of the Agricultural Botany Department, Faculty of Agriculture, Zagazig University, Sharkia Governorate, Egypt, to investigate the effects of sea water salinity levels, exogenous foliar application with humic acid, proline and naphthalene acetic acid on growth, some physiological and biochemical processes, leaflet blade anatomical structure as well as yield and its components of common bean plants (*Phaseolus vulgaris* L.) cv. Giza 3.

Common bean seeds were obtained from Vegetative Research Section, Horticulture Research Institute, Agricultural Research Center, Giza, Egypt. Seeds were sown on 26^{th} February in both seasons in plastic pots (40 cm inner diameter and 45 cm in depth) and pitted bottoms for easing drainage. Each pot contained 20 kg of air dried clay soil. Ten seeds/pot were sown at equal distances and depth. After 2 weeks from sowing, seedlings were thinned to 4 seedlings/ pot. The physical and chemical properties in clay soil were given in Table 1 according to **Black (1965)**.

The recommended agricultural practices of growing common bean plants were applied. Phosphorus fertilizer in the form of calcium superphosphate (15.5 % P_2O_5) was mixed with the soil before planting at the rate of 1.8 g P_2O_5/ pot. While, potassium and nitrogen fertilizers applied in the form of potassium sulphate (48-52% K_2O) and urea (46% N) with water irrigation after thinning at the rate of 1.3g/pot for each.

Experimental Design and Treatments

A factorial (4 × 7) experiment in randomized complete block design with three replicates was used. So, the experiment was included 28 treatments, which were the combinations between three sea water levels (1000, 2000 and 3000 ppm) and tap water which containing 500 ppm salinity (as control) and six concentrations of foliar spray, *i.e.,* humic acid at 2 and 4 g/l, proline at 50 and 100 ppm and naphthalene acetic acid at 25 and 50 ppm as well as the control (spraying with distilled water). Each replicate contained three pots.

Table 1. The physical and chemical properties of the soil used

Physical property	Value	Chemical property (g/100 g soil)	Value
Sand (%)	61.38	Ca^{++} (mg/100 g soil)	8.18
Silt (%)	20.25	Mg^{++} (mg/100 g soil)	4.04
Clay (%)	18.69	Na^{+} (mg/100 g soil)	6.42
ECw (dSm-1) (mmhos/c)	2.05	K^{+} (mg/100 g soil)	1.93
pH	8.10	CO_3^{-} (mg/100 g soil)	0.00
		HCO_3^{-} (mg/100 g soil)	2.68
		Cl^{-} (mg/100g soil)	9.32
		SO_4^{--} (mg/100g soil)	8.52

In both seasons, foliar applications of humic acid, proline and naphthalene acetic acid were applied three times at 25, 35 and 45 days after sowing. Spray using a hand pressure sprayer and wetting agent in early morning, control plants was sprayed with distilled water and the spraying solution was maintained just to cover completely the plant foliage till drip.

Sea water

Sea water (EC 51.56 dSm^{-1}) was obtained from Suez Canal, Ismailia Governorate, Egypt. Dilute sea water to be contains 1000, 2000 and 3000 ppm salinity levels.

The Chemicals

Humic acid

HELP STAR WG was produced by Trade Corporation International Company, Madrid and imported by Samtrad Comp. Group, Cairo, Egypt. Proline and naphthalene acetic acid were obtained from Al-Gomhoria Company. Humic acid prepared by adding 2 g and 4 g to one liter distilled water. Proline and naphthalene acetic acid were prepared by adding one g to one liter distilled water.

Sampling

Three random samples from each treatment were taken after 55 days from sowing.

Preparation of samples for analysis

The chosen common bean plants at sampling dates were taken carefully from the soil of the pots using a stream of water to ensure minimal loss of root system and then each plant was separated into roots, stems and leaves and the following data were recorded:

The morphological characters

Plant height (cm), number of leaves/plant, leaf area (cm^2), fresh weight of roots, stems, and leaves/plant (g) were determined.

Physiological and Biochemical Characters

Photosynthetic pigments

The photosynthetic pigments (Chl. a, Chl. b, Chl. (a+b) and carotenoids) were extracted from fresh leaf sample by pure acetone according to Fadeel' s method **(Fadeel, 1962),** then calculated using the formula adapted by **(Von Wettestein, 1957)** as mg/g fresh weight.

Proline content

It was determined in fresh leaves of common bean using the method of **Bates *et al.* (1973).**

Leaflet Anatomy

The anatomical studies were carried out only in the second season (2018) to follow the changes occurring in common bean plants leaflet tissues as affected by both of sea water levels, foliar application with humic acid, proline, naphthalene acetic acid and their interaction treatments. Samples of all treatments were taken from the blade of terminal leaflet of compound medium leaf developed the main stem of the plant after 55 days of sowing.

Microtechnique procedures given by **Nassar and El-Sahhar (1998)** were followed. These specimens were killed and fixed for at least 48 hr. in FAA (10 ml formalin, 5 ml glacial acetic acid and 85 ml ethyl alcohol 70%). The selected materials were washed in 50% ethyl alcohol, dehydrated in normal butyl alcohol series, embedded in paraffin wax of 56°C melting point, sectioned to a thickness of 14 microns, double stained with safranin and light green, cleared in xylene and mounted in canada balsam. Sections were examined to detect histological manifestations of the chosen treatments and photomicrographed.

Yield and its Components

At harvesting stage (90 days after sowing), dry pods were harvested at proper maturity stage then counted and weighed. The following parameters were calculated: number of dry pods/ plant, number of seeds/plant, weight of seeds/ plant (g), dry weight of pods/plant (g) and 100-seed weight (g) and length of pod (cm).

Statistical Analysis

Data of the present work were statically analyzed and the differences between the means of the treatments were considered significant when they were more than the least significant differences (LSD) at the 5% level by using computer program of statistix version 9 **(Analytical Software, 2008)**.

RESULTS AND DISCUSSION

Plant Growth

Results in Table 2 show that plant height, number of leaves/plant, leaf area, fresh weight of roots, stems and leaves of common bean plants decreased with increasing irrigation water salinity levels up to the highest level at 3000 ppm in both growing seasons of study. In general, the best treatment for producing the maximum values of plant growth characters was control treatment followed by 1000 ppm sea water level. Results were previously reported by **Abdi *et al.* (2015)** on common bean. **Kamel (1989**) mentioned that the decreasing of plant height by salinity might be due to that salinity decreased cell division of plant or inhibited the meristematic activity and elongation. The decreased plant height under high salt stress as observed in this study suggests a toxic effect from high ion concentration in different plant tissues. Consistent with these results, previous studies have shown that plant height and dry matter yield in legumes such as *Phaseolus* or *Beta vulgaris* were reduced under salt stress **(Demir and Kocacaliskan, 2002). Zhu (2001)** reported that depressing effect of salinity on plant growth may be attributed to the effect of increasing soil soluble salt content in raising the osmotic pressure of the soil solution and as a result, less water flows from the soil into the plant **(Yurekli *et al*., 2004)**.

On the other hand, results presented in Table 2 show that plant height, number of leaves/plant, leaf area, fresh weight of roots, stems and leaves were increased significantly with foliar application of humic acids, proline and naphthalene acetic acid. Where, foliar application with humic acid at 2 and 4g/l were the best treatment followed by proline at 100 ppm for all above-mentioned characters in both growing seasons. These results are in line with those obtained by **Shehata *et al.* (2012)** as well as **Abdel-Razzak and El-Sharkawy (2013)**. Humic acids own to stimulate plant growth and consequently yield by acting on mechanisms involved in: cell respiration, photosynthesis, protein synthesis, water and nutrient uptake, enzyme activities **(Chen *et al*., 2004).** Humic acids can significantly reduce water evaporation and increase its use by plants in non-clay, arid, and sandy soils. Furthermore, they increase the water holding capacity of soils. Humic acids aid in correcting plant chlorosis, increase the permeability of the plant membranes and intensify enzyme systems of plants. They accelerate cell division, show greater root development, and decrease stress deterioration. Under the influence of humic acids, plants grow stronger and they better resist plant diseases **(Khaled and Fawy, 2011)**.

Gamal El-Din and Abd El-Wahed (2005) showed that a foliar application of 100 mg/l proline on chamomile increased plant height, number of branches, fresh and dry weight aerial vegetative parts.

On pepper plant, **Al Sahli *et al.* (2013)** found that the enhancing effect of naphthalene acetic acid (NAA) treatment on fresh and dry weight may be due to the increasing palisade tissues of leaf and this in turn enhance the photosynthesis

Table 2. Effect of irrigation with different sea water levels, foliar application with different concentrations of humic acid (HA), proline (pro) and naphthalene acetic acid (NAA) on vegetative growth characters of common bean plants during 2017 and 2018 seasons

Character / Treatment	Plant height (cm)		No. of leaves/ plant		Leaf area/ plant (cm^2)		Roots FW/ plant (g)		Stems FW/ plant (g)		Leaves FW/ plant (g)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Salinity level												
Tap water (Control)	26.63	30.40	5.37	6.86	95.03	97.38	5.43	6.562	5.69	6.02	7.00	7.24
1000 (ppm)	24.17	26.59	4.75	6.33	83.77	86.18	4.76	5.82	4.76	4.88	6.09	6.30
2000 (ppm)	9.571	19.85	3.39	5.27	63.44	65.81	4.21	5.04	3.93	4.05	5.09	5.24
3000 (ppm)	14.94	15.10	2.44	4.39	49.18	51.56	3.06	4.11	2.77	3.04	3.86	4.20
LSD at 0.05	0.658	0.534	0.235	0.151	0.227	0.240	0.128	0.183	0.160	0.070	0.157	0.384
Foliar spray application												
Distilled water (Control)	17.78	19.11	3.29	5.12	61.14	63.48	3.63	4.678	3.26	3.63	4.12	4.34
HA at 2g/l	26.12	28.78	4.87	6.51	90.28	92.66	5.24	6.320	5.51	5.62	7.31	8.09
HA at 4g/l	24.31	25.99	4.54	6.20	81.87	84.21	4.89	5.87	4.88	5.10	6.52	6.68
Pro at 50 ppm	20.45	22.38	3.90	5.91	74.15	76.58	4.30	5.35	4.12	4.42	5.49	5.55
Pro at 100ppm	22.40	23.40	4.11	5.60	70.99	73.45	4.63	5.54	4.65	4.71	5.741	5.85
NAA at 25 ppm	19.46	21.24	3.67	5.41	67.66	70.01	4.06	5.02	3.94	4.14	4.82	4.99
NAA at 50 ppm	18.77	19.99	3.55	5.22	63.91	66.25	3.81	4.90	3.66	3.86	4.58	4.70
LSD at 0.05	0.870	0.706	0.311	0.200	0.300	0.317	0.169	0.242	0.211	0.461	0.207	0.508

process and translocation of photosynthesis assimilates rate and consequently increased vegetative growth and this reflected on increasing dry weight of plant.

Results in Table 3 illustrate that the interactions between sea water salinity levels and foliar application with HA, pro and NAA had significant effects on plant height, number of leaves/plant, leaf area, roots, stems and leaves fresh weight of common bean plants in both seasons. The best interaction treatment in this respect was tap water (control) and humic acid at 2g/l. While, the interaction between salinity levels at 3000 ppm and spraying with distilled water (control) gave the lowest value for each of plant growth characters in the two growing seasons. Similar findings were obtained by **Dawood *et al.* (2014**) who found that exogenous application of proline at 25 mM partially alleviated the harmful effect of diluted sea water (3.13 dS/m^{-1} and 6.25 dS/m^{-1}) on faba bean plants. It is probable that proline would have been `absorbed by the developing seedlings, where it maintained water status by increasing the influx of water and reducing the efflux of water under salt-induced water-limiting conditions (**Chen and Murata, 2008)**. Proline might have protected cell membranes against ion toxicity and salt-induced oxidative stress, increased cellular growth **(Banu *et al*., 2009)**. Naphthalene acetic acid (NAA) belongs to the kinetin class of plant growth regulators and has been well known to enhance cell division in the presence of auxin **(Cleland, 1996)**.

Table 3. Effect of the interaction between irrigation with different sea water levels and foliar application with different concentrations of humic acid (HA), proline (pro) and naphthalene acetic acid (NAA) on vegetative growth characters of common bean plants during 2017 and 2018 seasons

Treatment	Character	Plant height (cm)		No. leaves/ plant		leaf area (cm^2)		Leaves FW / plant (g)		Stems FW/ plant (g)		Roots FW/ plant (g)	
Salinity level	Foliar spray application	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Tap water (Control)	Distilled water (Control)	24.00	27.64	6.00	6.22	86.59	89.01	4.89	5.80	4.20	4.83	5.11	5.21
	HA at 2g/l	30.00	35.89	7.77	8.68	111.40	113.73	6.15	7.68	7.51	7.67	9.18	10.04
	HA at 4g/l	29.33	32.94	7.49	8.11	102.83	105.12	5.68	6.84	6.31	7.03	8.07	8.11
	Pro at 50 ppm	25.79	29.39	6.67	7.29	91.67	94.14	5.53	6.78	5.50	5.96	7.49	7.50
	Pro at 100ppm	28.00	30.06	7.51	7.61	93.97	96.27	5.63	6.50	6.18	6.28	7.51	7.69
	NAA at 25 ppm	24.64	28.89	6.40	6.94	90.74	93.03	5.18	6.30	5.22	5.38	5.94	6.33
	NAA at 50 ppm	24.66	28.00	6.19	6.79	88.06	90.39	5.01	6.06	4.96	5.02	5.74	5.80
1000 (ppm)	Distilled water (Control)	20.22	21.71	5.82	6.15	69.07	71.4	4.06	5.11	3.85	4.07	4.70	4.87
	HA at 2g/l	28.84	33.09	7.04	7.26	103.24	105. 66	5.89	6.83	5.97	6.00	8.12	9.16
	HA at 4g/l	27.28	30.16	6.78	7.22	94.42	96.78	5.66	6.52	5.42	5.44	6.97	7.00
	Pro at 50 ppm	23.45	26.05	6.26	6.78	82.28	84.84	4.33	5.69	4.55	4.79	5.88	5.94
	Pro at 100ppm	25.11	27.39	6.42	7.04	86.47	88.98	5.16	6.14	4.96	5.00	6.17	6.22
	NAA at 25 ppm	22.51	24.88	6.08	6.45	78.45	80.79	4.26	5.12	4.35	4.55	5.53	5.58
	NAA at 50 ppm	21.80	22.89	5.94	6.38	72.47	74.85	3.96	5.35	4.25	4.34	5.29	5.33
2000 (ppm)	Distilled water (Control)	15.66	15.81	4.69	4.76	51.38	53.73	3.36	4.29	3.04	3.16	3.98	4.01
	HA at 2g/l	25.57	25.90	6.27	6.55	81.69	84.03	5.27	6.03	4.79	4.85	6.62	7.45
	HA at 4g/l	22.66	22.75	5.96	6.13	72.21	74.49	4.66	5.47	4.53	4.60	6.12	6.15
	Pro at 50 ppm	18.56	19.60	5.09	5.13	62.46	64.77	4.05	4.95	3.97	4.05	4.92	4.95
	Pro at 100ppm	20.40	20.12	5.20	5.30	64.17	66.69	4.31	5.15	4.38	4.40	5.21	5.23
	NAA at 25 ppm	17.67	17.96	4.97	5.02	57.78	60.24	3.94	4.80	3.69	3.85	4.60	4.66
	NAA at 50 ppm	16.50	16.84	4.72	4.88	54.44	56.76	3.89	4.60	3.12	3.46	4.24	4.26
3000 (ppm)	Distilled water (Control)	11.23	11.28	4.00	4.03	37.52	39.81	2.23	3.51	1.98	2.46	2.71	3.30
	HA at 2g/l	20.10	20.26	4.99	4.02	64.82	67.17	3.68	4.75	3.78	4.00	5.34	5.71
	HA at 4g/l	18.00	18.14	4.58	4.72	58.02	60.48	3.56	4.65	3.26	3.33	4.95	5.50
	Pro at 50 ppm	14.01	14.49	4.40	4.41	47.57	50.04	3.31	4.02	2.48	2.91	3.70	3.82
	Pro at 100ppm	16.11	16.06	4.54	4.51	51.99	54.42	3.44	4.37	3.11	3.16	4.08	4.29
	NAA at 25 ppm	13.03	13.27	4.23	4.30	43.67	45.99	2.86	3.88	2.52	2.78	3.23	3.42
	NAA at 50 ppm	12.14	12.22	4.06	4.15	40.70	43.02	2.41	3.64	2.32	2.66	3.07	3.43
LSD at 0.05		**1.741**	**1.413**	**0.400**	**0.622**	**0.600**	**0.627**	**0.339**	**0.484**	**0.423**	**0.922**	**0.415**	**1.017**

Photosynthetic Pigments and Proline Content in Leaves

Regarding the effect of salinity stress on photosynthetic pigments and proline content of common bean leaves, results in Table 4 indicate that Chl. a, Chl. b, Chl. a+b and carotenoids decreased with increasing irrigation water salinity levels up to the highest used level (3000 ppm) in both growing seasons of study. On the contrary, proline content in leaves increased by increasing irrigation water salinity levels in the two growing seasons. These results are in agreement with those obtained by **Abdelhamid *et al.* (2013)** on (*Phaseolus vulgaris* L.) and **Abo-El-Khier *et al.* (2001)** who mentioned that rape seed plants grown under different concentrations of salinity, negatively affected the photosynthetic pigments content in the leaves. Also, **Desingh and Kanagaraj (2007)** presumed that salinity stress might affect the biochemistry of photosynthesis by causing disorientation of the lamellar system of chloroplasts and loss of chloroplast integrity leading to a decrease in the activities of photo-systems.

Results in Table 4 show that foliar spray of common bean plants with humic acid, proline and naphthalene acetic acid were significantly increased the concentration of Chl. a, Chl. b, Chl. a+b as well as carotenoids and proline content in leaves in both seasons compared to control (spraying with distilled water). Where, the best treatments were foliar plants with humic acid at 2 g/l followed by 4g/l for photosynthetic pigments. While, the highest values of proline content were recorded with foliar spray by proline at 100 ppm followed by humic acid at 2 g/l in 1st and 2nd seasons. These results agree with those of **Senthil *et al.* (2003)** on soybean plant**, Butt *et al.* (2016)** on chilli and **Parveen *et al*. (2017)** on cotton plants. **Farouk *et al*. (2011)** reported that application of humic acid enhanced chlorophyll concentrations in radish plants.

Results in Table 5 reveal that the interaction between sea water salinity levels and foliar application with HA, Pro and NAA had significant effect on chlorophyll content of common bean plants in both seasons. The best interaction treatment in this respect was tap water (control) and humic acid at 2g/l followed by 1000 ppm salinity level and spray with humic acid at 2g/l. On the other hand, the interaction between irrigation with 2000 ppm or 3000 ppm of sea water and spraying with proline at 100 ppm significantly increased proline content in leaves in both seasons. Similar findings were obtained by **Aydin *et al.* (2012)** on bean plants and **Dawood *et al.* (2014)** on faba bean.

Yield and its Components

Results in Table 6 indicate that number of dry pods/plant, number of seeds/plant, weight of seeds/plant (g), dry weight of pods/plant (g), 100-seed weight (g) and length of pod of common bean plants decreased with increasing irrigation water salinity levels up to the highest used level (3000 ppm) in both growing seasons of study. In general, the best treatment for producing the maximum value for each of all above-mentioned traits was control treatment (tap water) followed by 1000 ppm salinity level. Similar stimulation effect was previously reported by **Ahamed *et al*. (2011)** on (*Vigna racliata*) and **Rada *et al*. (2012)** on (*Foeniculurn vulgar*e Mill). On snap bean, **Singer *et al*. (2001)** found that number of flowers, pod set percentage and pods yield and quality were decreased by increasing water-stress. Moreover, the decrease in photosynthesis in the salinity-stressed plants was further reflected in reduced vegetative growth. Therefore, the availability of photosynthesis decreased during the reproductive phase, which finally resulted in decreasing pod number and yield at harvest period.

Results presented in Table 6 show that spraying common bean plants with humic acid, proline and naphthalene acetic acid with different concentrations, significantly increased yield and its components compared to control (distilled water) in both seasons. Where, the best treatment was spraying with humic acid at 2and 4 g/l, respectively for number of pods/plant, number of seeds/plant, weight of seeds/plant, dry weight of pods/plant , 100-seed weight and length of pod compared to the other treatments in the two growing seasons.

Some studies reported that HA can be used as a growth regulator. Humic acid will causes noticeable increase of yield of plants using positive physiological effects such as effect of metabolism of plant cells and increased concentration of leaf chlorophyll **(Nardi *et al.*, 2002)**.

Table 4. Effect of irrigation with different sea water levels and foliar application with different concentrations of humic acid (HA), proline (pro) and naphthalene acetic acid (NAA) on chlorophyll a, chlorophyll b, total chlorophyll (a+b), carotenoids and proline of common bean plants during 2017 and 2018 seasons

Treatment / Measurement	Chlorophyll a (mg/g FW)		Chlorophyll b (mg/g FW)		Total chlorophyll (mg/g FW)		Carotenoids (mg/g FW)		Proline (µmol./g FW)	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Salinity level										
Tap water (Control)	0.805	0.842	0.420	0.441	1.222	1.283	0.588	0.653	7.244	7.923
1000 (ppm)	0.767	0.810	0.383	0.406	1.151	1.217	0.498	0.572	7.955	8.574
2000 (ppm)	0.583	0.613	0.283	0.301	0.867	0.914	0.3624	0.423	8.668	9.751
3000 (ppm)	0.491	0.515	0.234	0.241	0.726	0.756	0.294	0.342	9.586	10.75
LSD at 0.05	**0.015**	**0.0170**	**0.007**	**0.009**	**1.222**	**0.0209**	**0.0125**	**0.0161**	**0.348**	**0.377**
Foliar spray application										
Distilled water (Control)	0.432	0.440	0.203	0.223	0.635	0.664	0.196	0.252	4.511	4.743
HA at 2g/l	1.018	1.028	0.534	0.550	1.552	1.579	0.817	0.913	11.638	11.87
HA at 4g/l	0.815	0.820	0.448	0.466	1.263	1.287	0.632	0.720	10.264	10.89
Pro at 50 ppm	0.602	0.718	0.298	0.340	1.041	1.098	0.412	0.446	8.703	10.07
Pro at 100ppm	0.743	0.758	0.374	0.358	0.977	1.077	0.447	0.560	13.374	14.51
NAA at 25 ppm	0.542	0.579	0.248	0.267	0.790	0.847	0.313	0.341	5.155	6.822
NAA at 50 ppm	0.481	0.519	0.207	0.228	0.688	0.747	0.232	0.252	4.899	5.827
LSD at 0.05	**0.020**	**0.0225**	**0.009**	**0.0121**	**0.023**	**0.027**	**0.016**	**0.021**	**0.460**	**0.499**

Table 5. Effect of the interaction between irrigation with different sea water levels and foliar application with different concentrations of humic acid (HA), proline (pro) and naphthalene acetic acid (NAA) on chlorophyll a, b, total chlorophyll (a+b), carotenoids and proline of common bean plants during 2017 and 2018 growing seasons

Treatment	Measurement	Chlorophyll a (mg/g FW)		Chlorophyll b (mg/g FW)		Total chlorophyll (mg/g FW)		Carotenoids (mg/g FW)		Proline (μmol./g FW)	
Salinity level	Foliar spray application	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season
Tap water (Control)	Distilled water (Control)	0.524	0.528	0.28	0.298	0.804	0.826	0.254	0.329	3.76	3.93
	HA at 2g/l	1.23	1.258	0.693	0.711	1.923	1.969	1.007	1.111	10.47	10.80
	HA at 4g/l	0.976	0.995	0.54	0.561	1.516	1.556	0.908	0.966	8.68	10.10
	Pro at 50 ppm	0.885	0.895	0.373	0.396	1.258	1.291	0.623	0.705	7.93	8.67
	Pro at 100ppm	0.715	0.876	0.453	0.473	1.168	1.349	0.583	0.668	11.20	12.77
	NAA at 25 ppm	0.695	0.721	0.338	0.361	1.033	1.082	0.391	0.423	4.39	4.87
	NAA at 50 ppm	0.616	0.620	0.265	0.29	0.881	0.910	0.353	0.381	4.27	4.32
1000 (ppm)	Distilled water (Control)	0.494	0.51 1	0.23	0.255	0.724	0.766	0.225	0.315	4.16	4.16
	HA at 2g/l	1.174	1.182	0.646	0.663	1.820	1.845	0.972	1.073	10.84	11.27
	HA at 4g/l	0.93	0.935	0.519	0.54	1.450	1.475	0.694	0.807	10.11	10.42
	Pro at 50 ppm	0.869	0.885	0.357	0.38	1.226	1.265	0.465	0.597	8.01	9.40
	Pro at 100ppm	0.702	0.843	0.413	0.441	1.115	1.284	0.502	0.48	13.20	13.75
	NAA at 25 ppm	0.624	0.718	0.277	0.301	0.901	1.019	0.363	0.416	4.75	6.00
	NAA at 50 ppm	0.581	0.599	0.243	0.268	0.824	0.867	0.26	0.255	4.62	5.02
2000 (ppm)	Distilled water (Control)	0.382	0.391	0.177	0.197	0.559	0.588	0.15	0.219	4.70	4.85
	HA at 2g/l	0.909	0.932	0.443	0.458	1.352	1.390	0.723	0.825	11.90	12.03
	HA at 4g/l	0.738	0.73	0.394	0.419	1.132	1.148	0.518	0.605	10.83	11.05
	Pro at 50 ppm	0.662	0.679	0.258	0.286	0.920	0.965	0.272	0.512	8.77	10.74
	Pro at 100ppm	0.538	0.622	0.346	0.338	0.884	0.960	0.39	0.34	14.10	14.68
	NAA at 25 ppm	0.46	0.474	0.201	0.225	0.661	0.699	0.263	0.271	5.47	7.88
	NAA at 50 ppm	0.394	0.465	0.167	0.186	0.561	0.651	0.18	0.195	4.91	7.03
3000 (ppm)	Distilled water (Control)	0.328	0.332	0.125	0.144	0.453	0.476	0.137	0.148	5.42	6.03
	HA at 2g/l	0.759	0.743	0.356	0.369	1.115	1.112	0.568	0.643	13.35	13.40
	HA at 4g/l	0.616	0.623	0.339	0.346	0.955	0.969	0.409	0.503	11.43	12.00
	Pro at 50 ppm	0.557	0.575	0.204	0.299	0.761	0.874	0.256	0.429	10.11	11.49
	Pro at 100ppm	0.456	0.534	0.286	0.182	0.742	0.716	0.316	0.27	15.00	16.84
	NAA at 25 ppm	0.389	0.405	0.179	0.184	0.568	0.589	0.237	0.255	6.00	8.54
	NAA at 50 ppm	0.335	0.393	0.154	0.168	0.489	0.561	0.141	0.148	5.79	6.94
LSD at 0.05		**0.041**	**0.045**	**0.013**	**0.024**	**0.046**	**0.055**	**0.033**	**0.043**	**0.92**	**0.99**

Table 6. Effect of irrigation with different sea water levels and foliar application with different concentrations of humic acid (HA), proline (pro) and naphthalene acetic acid (NAA) on yield and its components of common bean plants during 2017 and 2018 seasons

Character / Treatment	No. dry pods/plant		No. seeds/plant		Seed weight /plant (g)		Dry pods weight/plant (g)		100-seed weight (g)		Length of pod (cm)	
	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season
Salinity level												
Tap water (Control)	3.41	3.86	9.54	9.88	3.41	3.33	4.03	4.30	32.79	33.03	9.62	10.34
1000 (ppm)	2.58	3.44	7.54	9.42	2.58	2.58	3.52	3.74	25.78	26.12	9.07	8.75
2000 (ppm)	1.72	1.81	5.33	8.40	1.46	1.34	2.31	2.60	18.30	18.51	8.20	5.79
3000 (ppm)	1.28	1.45	3.16	6.35	0.90	0.74	1.34	1.52	10.87	11.18	6.11	3.70
LSD at 0.05	**0.079**	**0.165**	**0.232**	**0.357**	**0.191**	**0.118**	**0.11 9**	**0.204**	**0.201**	**0.159**	**0.417**	**0.313**
Foliar spray application												
Distilled water (Control)	1.68	1.92	4.29	6.15	1.51	1.30	2.08	2.33	14.68	15.02	6.07	4.93
HA at 2g/L	3.24	3.59	8.96	11.13	2.93	2.76	3.68	3.87	30.69	30.98	10.98	9.79
HA at 4g/L	2.56	3.17	7.78	9.94	2.67	2.49	3.31	3.32	26.73	27.04	9.52	8.82
Pro at 50 ppm	2.04	2.57	6.23	8.42	1.97	1.95	2.81	3.09	22.64	22.81	8.26	6.87
Pro at 100 ppm	2.33	2.85	6.66	9.20	2.28	2.19	3.00	3.22	21.51	21.83	8.49	7.92
NAA at 25 ppm	2.02	2.30	5.66	7.84	1.69	1.70	2.53	2.84	19.49	19.77	7.74	6.30
NAA at 50 ppm	1.87	2.08	5.18	6.90	1.58	1.58	2.19	2.63	17.80	18.00	6.67	5.38
LSD at 0.05	**0.105**	**0.218**	**0.306**	**0.472**	**0.252**	**0.156**	**0.158**	**0.270**	**0.266**	**0.210**	**0.552**	**0.415**

Zaky *et al.* (2006) found that foliar application with humic acids at (1g/l) gave a significant superior effect over non-treated plant on number of pods/plant, total pod yield/plant and average pod fresh weight of common bean. **El-Bassiony *et al.* (2010)** stated that green pod yield of snap bean plants (*Phaseolus vulgaris* L.) grown under sandy soil conditions significantly increased by increasing the spray of humic acid at 2 g/l. On Peas, **Gad El-Hak *et al.* (2012)** found that the dry seed yield and its components *e.g.*, seed weight/pod, 1000-seed weight and dry seed yield were significantly increased by foliar application with humic acid during the two growing seasons compared to the control treatment. The highest mean values were obtained from plants foliar sprayed with humic acid at the concentration of 1 g/l. Exogenous protectants such as osmoprotectant (proline, glycinebetaine, trehalose, *etc.*) have been found effective in mitigating the stress induced damage effect in plant cells **(Hasanuzzaman *et al.*, 2013)**. **Osman (2015)** reported that exogenous application of proline might be not only accelerate the translocation process of amino acids from source to sink, but also suppress the conversion process from amino acids to proteins.

Results in Table 7 show that the interactions between sea water salinity levels and foliar application with HA, pro and NAA had significant effects on yield and its components of bean plants in both seasons. The best interaction treatment in this respect was humic acid at 2g/l and control water salinity (tap water) followed by the interaction between tap water control and spraying with humic acid at 4g/l. Similar findings were obtained by **Ashraf and Foolad (2007)**. On cowpea, **El-Hefny (2010)** pointed out that humic acid application was significantly increased number of seeds/pod, seed pod weight (g), weight of 100 seeds and seed plant weight (g)

Table 7. Effect of the Interaction between irrigation with different sea water levels and foliar application with different concentrations of humic acid (HA), proline (pro) and naphthalene acetic acid (NAA) on yield and its components of common bean plants during 2017 and 2018 seasons

Treatment / Character		No. dry pods/ plant		No. seeds/ plant		Seed weight /plant (g)		Dry weight of pods/ plant (g)		100-seed weight (g)		Length of pod (cm)	
Salinity level	Foliar spray Application	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Tap water (Control)	Distilled water (Control)	2.53	3.06	6.54	7.39	2.24	2.39	3.18	3.46	22.50	22.62	7.23	7.73
	HA at 2g/l	4.76	4.93	12.91	13.42	4.44	4.46	5.03	5.73	44.29	44.39	13.21	13.39
	HA at 4g/l	3.46	4.54	11.27	11.61	4.05	3.95	4.75	4.85	38.68	38.81	11.57	12.04
	Pro at 50 ppm	3.28	3.83	9.36	9.63	3.40	3.29	4.10	4.17	32.14	32.24	9.55	10.04
	Pro at 100ppm	3.50	4.03	9.92	10.55	3.66	3.73	4.25	4.40	34.05	34.27	9.60	11.44
	NAA at 25 ppm	3.33	3.48	8.50	8.57	3.17	2.92	3.68	3.84	29.20	29.46	8.45	9.43
	NAA at 50 ppm	3.03	3.17	8.35	7.99	2.95	2.56	3.25	3.68	28.69	28.76	7.58	8.56
1000 (ppm)	Distilled water (Control)	2.05	2.59	5.30	6.74	2.10	1.74	2.48	2.81	18.25	18.46	6.70	5.69
	HA at 2g/l	3.74	4.48	10.11	12.16	3.25	3.40	4.66	4.77	34.71	34.89	12.15	11.92
	HA at 4g/l	2.95	4.13	9.17	11.10	3.01	2.92	4.19	4.21	31.50	31.70	10.13	10.87
	Pro at 50 ppm	2.44	3.22	7.40	9.37	2.41	2.48	3.55	3.73	25.43	25.55	8.88	8.70
	Pro at 100ppm	2.60	3.95	8.24	10.12	2.76	2.79	3.71	4.09	28.31	28.46	9.28	9.56
	NAA at 25 ppm	2.20	3.05	6.73	8.71	2.37	2.41	3.25	3.49	23.14	23.38	8.64	7.74
	NAA at 50 ppm	2.10	2.72	5.87	7.80	2.22	2.36	2.81	3.14	20.20	20.42	7.73	6.77
2000 (ppm)	Distilled water (Control)	1.30	1.10	3.21	5.76	1.29	0.63	1.65	1.85	11.10	11.28	5.66	3.56
	HA at 2g/l	2.46	2.66	8.31	10.49	2.36	2.10	2.97	3.04	28.55	28.68	10.38	8.97
	HA at 4g/l	2.28	2.25	7.06	9.62	2.22	2.06	2.67	2.54	24.27	24.44	9.00	7.70
	Pro at 50 ppm	1.41	1.89	5.22	8.49	1.39	1.36	2.40	2.88	17.98	18.05	8.46	5 07
	Pro at 100ppm	1.89	2.01	4.88	9.19	1.66	1.41	2.61	2.82	16.82	16.99	8.94	6.65
	NAA at 25 ppm	1.43	1.48	4.55	8.25	0.69	0.98	2.11	2.67	15 69	15.83	8.14	4.66
	NAA at 50 ppm	1.34	1.30	4.09	7.01	0.67	0.88	1.80	2.44	14.11	14.16	6.85	3.93
3000 (ppm)	Distilled water (Control)	0.85	0.95	2.14	4.75	0.42	0.45	1.01	1.20	7.45	7.61	4.71	2.76
	HA at 2g/l	2.02	2.32	4.52	8.47	1.69	1.10	2.09	1.96	15.59	15.8	8.04	5.07
	HA at 4g/l	1.58	1.80	3.62	7.43	1.41	1.05	1.66	1.69	12.5	12.68	7.42	4.67
	Pro at 50 ppm	1.04	1.35	3.28	6.21	0.69	0.69	1.20	1.59	11.35	11.51	6.17	3.71
	Pro at 100ppm	1.34	1.42	3.30	6.96	1.04	0.86	1.43	1.60	11.41	11.54	6.15	4.06
	NAA at 25 ppm	1.13	1.21	2.87	5.85	0.56	0.51	1.10	1.39	9.94	10.10	5.75	3.38
	NAA at 50 ppm	1.03	1.62	2.44	4.82	0.49	0.53	0.93	1.27	22.50	22 62	4.54	2.28
LSD at 0.05		**0.211**	**0.437**	**0.631**	**0.954**	**0.505**	**0.313**	**0.316**	**0.541**	**0.532**	**0.241**	**1.103**	**0.803**

grown under salinity stress. **(Frances *et al*., 2006; Khan *et al*., 2009)** concluded that accumulation of proline increased significantly under stress which helps in the maintenance of physiological traits and it optimized the grain yield by maintaining leaf water potential.

Leaflet Anatomy

Microscopical counts and measurements of certain histological characters in transverse section through the blade of terminal leaflet compound medium leaf developed the main stem of common bean (*Phaseolus vulgaris* L.) plants c.v. Giza 3 grown under salinity stress of 3000 ppm and sprayed with 2g/l humic acid, 100 ppm proline and 25 ppm NAA in (Table 8) and (Fig. 1).

It's also clear that plants grown under salinity stress of 3000 ppm and sprayed with distilled water induced a prominent decrease in thickness of both medvein and lamina of leaflet blades by 18.86 and 33.19% less than control, respectively. The decrease in lamina thickness was accompanied with 40.00 and 32.14% decrements in thickness of palisade and spongy tissues, respectively. Meanwhile, upper and lower epidermis not affected. Plants under salinity stress showed decrement in medvein bundle by 21.88 and 20.33% for length and width, respectively. But, xylem vessels diameter decrement by 11.54% and xylem vessels row number not affected. The inhibition effect of high salinity level on leaf structure may be due to the inhibition of growth vascular elements **(Rashid *et al*., 2004)** and/or correlation with an inhibition of the procambial activity which form, primary vascular tissues and/or decrease in the number and size of mesophyll cells

It's obvious from Table 8 and Fig. 1 that spraying with humic acid (HA) at 2 g/l and irrigated with tap water induced a prominent increase in medvein and lamina thickness by 4.00 and 7.30% more than plants sprayed with distilled water (control), respectively. It is clear that the increase in lamina thickness was accompanied with 66.67, 33.33 and 7.14% increments in thickness of upper epidermis, lower epidermis and spongy tissue meanwhile, palisade tissue not affected compared to control. The length of medvein bundle and xylem vessels row number increased by 31.25 and 25%, while the width of medvein bundle and xylem vessels diameter decreased by 3.65 and 15.38% compared to control, respectively.

Çavuşoğlu and Ergin (2015) reported that HA 28 mg/l pretreatment greatly affected the leaf anatomical structure of (*Hordeum vulgare*) seedlings grown under normal conditions. In distilled water medium, HA increased the epidermis cell number and cell width in comparison at the control seedlings. Results in Table 8 and illustrated in Fig. 1 indicate the interaction between water salinity (3000 ppm) and spraying plants with humic acid at 2g/l, proline at 100 ppm and NAA at 25 ppm. It is evident from results in Table 8 and illustrated in Fig. 1 that humic acid 2 g/l or proline 100 ppm as well as NAA 25 ppm recorded result near to values of control plants. Be attention that the best treatment was humic acid compared to proline or NAA it could be concluded that the use of humic acid 2 g/l partially mitigate that negative effects of water salinity stress on anatomical features of common bean plants leaf let blade. Generally, humic acid treatments help to partially compensate the reduction in leaflet parameters of common bean plants caused by water salinity. Similar findings were reported by **Osman (2005)** who found that after salinity treatment (8000-10000 ppm) thickness of spongy cells tissues and depth of palisade layers were increased in tolerant olive variety. Picual variety was adapted trough change in number of palisade cell layers from 8 to 3 layers, both of spongy cells and air space among spongy cell has been decreased. Also, **Boghdady (2009)** stated that salinity at 3000 or 4000 ppm reduced the thickness of midvein; lamina, upper and lower epidermis and palisade and spongy tissues as well as dimensions of midvein bundle, number of vessels per midvein bundle and vessel diameter. **Khafagy *et al*. (2009)** reported that the leaf blade anatomical characters decreased with increasing salinity levels. In addition, **El-Saadony *et al*. (2011)** on pea plants observed inhibition in differentiation and change in diameter and number of xylem vessels, reduction in leaf anatomy characters with increasing salinity concentration up to the highest tested level of 6000 ppm.

Also, **Dawood *et al*. (2014)** came to similar results by anatomical structure of the faba bean leaf. **Akram *et al*. (2016)** reported that water stress caused a significant reduction in the leaf vascular bundle area, leaf midrib thickness, leaf parenchyma cell area and the number of vascular bundles while water stress increased leaf epidermis thickness of radish (*Raphanus sativus* L.) plants.

Table 8. Effect of irrigation by sea water salinity levels and foliar spray with humic acid (HA), proline (pro), naphthalene acetic acid (NAA) and their interactions on counts and measurements of certain anatomical features in transverse sections through the leaflet blade of common bean plants during the second growing season 2018

Leaflet parameter	Treatment									
	Tap water (500 ppm)			Sea water salinity (3000 ppm)						
	Distilled water	HA 2g/l	±% to control	Distilled water	±% to control	HA 2g/l	±% to control	pro 100 ppm	±% to control	NAA 25ppm	±% to control
Midvein thick. (μ)	1732.50	1801.80	+4.00	1405.80	-18.86	1534.50	-11.43	1524.60	-12.00	1435.50	-17.14
Lamina thick. (μ)	212.4	227.9	+7.30	141.90	-33.19	186.4	-12.24	199	-6.31	182	-14.31
Upper epidermis thick.(μ)	9.9	16.5	+66.67	9.90	0.00	16.5	+66.67	14.85	+50.00	19.8	+100.00
Lower epidermis thick. (μ)	9.9	13.2	+33.33	9.90	0.00	11.55	+16.67	11.55	+16.67	13.2	+33.33
Palisade tissue thick. (μ)	99	99	0.00	59.40	-40.00	74.25	-25.00	69.3	-30.00	66	-33.33
Spongy tissue thick. (μ)	92.4	99	+7.14	62.70	-32.14	82.5	-10.71	102.3	+10.71	85.8	-7.14
Midvein bundle length (μ)	316.8	415.8	+31.25	247.50	-21.88	297	-6.25	247.5	-21.88	247.5	-21.88
Midvein bundle width (μ)	534.3	514.8	-3.65	425.70	-20.33	475.2	-11.06	475.2	-11.06	326.7	-38.85
Number of xylem rows in midvein bundle (μ)	4.00	5.00	+25.00	4.00	0.00	4.00	0.00	4.00	0.00	4.00	0.00
Number of xylem vessels in midvein bundle (μ)	20.00	13.00	-35.00	12.00	-40.00	18.00	-10.00	12	-26.44	8	-73.47
Average of xylem vessels diameters (μ)	42.9	36.3	-15.38	37.95	-11.54	34.65	-19.23	36.3	-15.38	28.05	-34.62

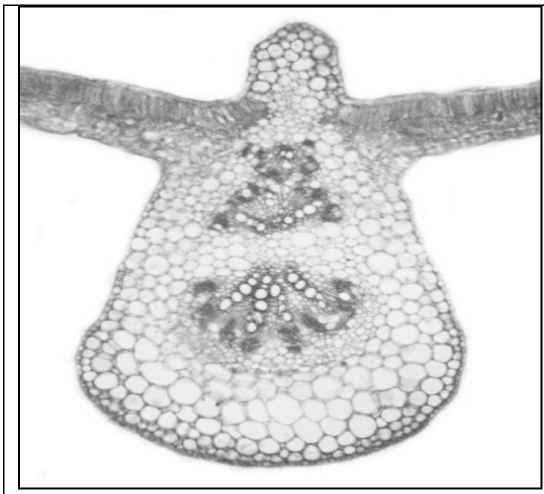
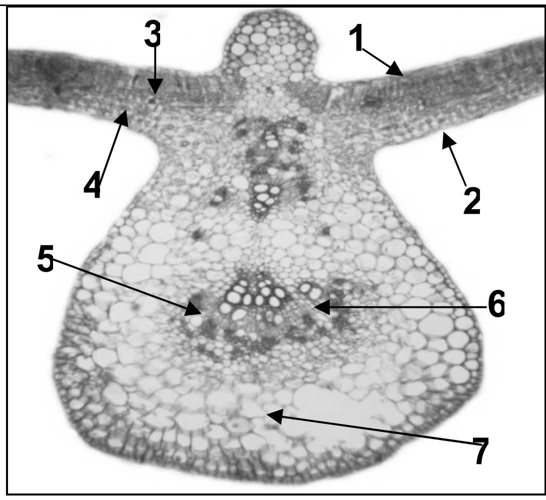
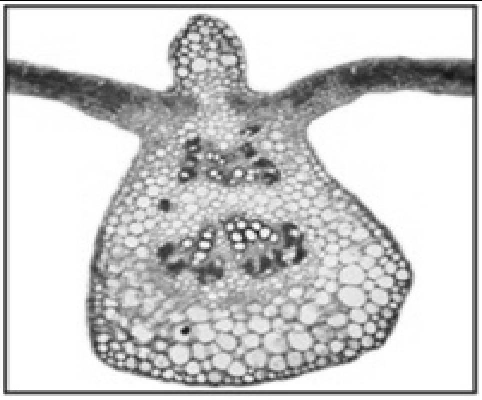
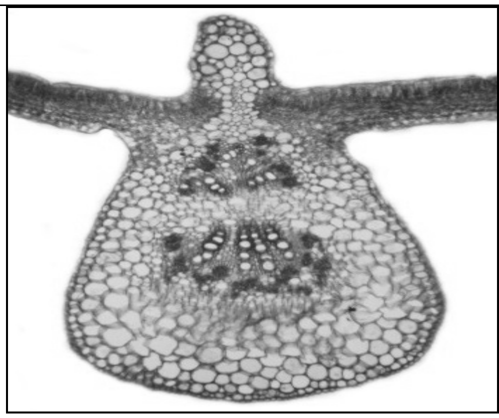
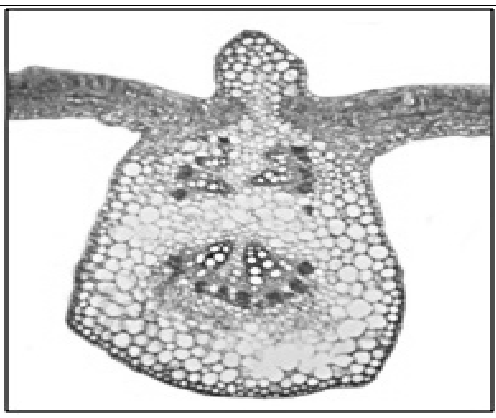
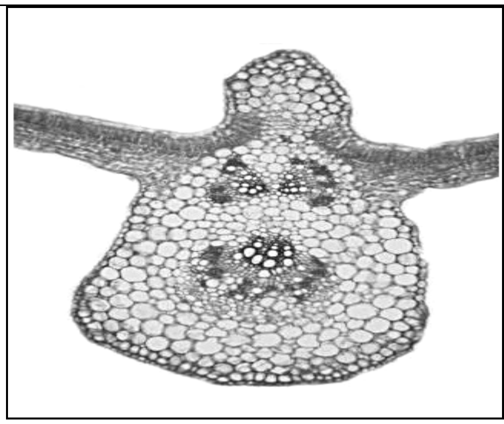
	
Tap water + distilled water (control)	**Tap water + HA 2g/l**
	
3000 ppm + distilled water	**3000 ppm + HA 2g/l**
	
3000 ppm + pro100 ppm	**3000 ppm + NAA 25 ppm**

Fig. 1. Transverse sections through the blade of terminal leaflet of the medium leaf compound leaf developed on the main stem of normal common bean plants grown under sea water salinity and sprayed with humic acid (HA), proline(pro) and naphthalene acetic acid (NAA) during the second growing season 2018. (×100)

1: Upper epidermis 2: Lower epidermis 3: Palisade tissue 4: Spongy tissue
5: Midvein bundle 6: Xylem vessels 7: Midvein region

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تقليل التأثيرات الضارة لملوحة مياه البحر على النمو، بعض الصفات الفسيولوجية، والتشريحية، والمحصول لنباتات الفاصوليا باستخدام حمض الهيوميك، البرولين وحمض نفثالين أسيتك

مؤمن محمد فهيم - السيد محمود مقيبل - فتحي محمد السعدوني - سهام عبد العال إبراهيم

قسم النبات الزراعي - كلية الزراعة - جامعة الزقازيق - مصر

صممت تجربة اصص خلال موسمي النمو الصيفى ٢٠١٧، ٢٠١٨ بالصوبة السلكية لقسم النبات الزراعي، كلية الزراعة، جامعة الزقازيق، محافظة الشرقية، مصر، حيث تم رش نباتات الفاصوليا صنف جيزة ٣ بتركيزات مختلفة من حمض الهيوميك، البرولين، وحمض نفثالين أسيتك والماء المقطر (كنترول) تحت مستويات مختلفة من مياه البحر مثل ١٠٠٠، ٢٠٠٠، ٣٠٠٠ جزء في المليون بالإضافة إلى الكنترول (مياه الصنبور ٥٠٠ جزء فى المليون)، وذلك لدراسة تأثير تلك المعاملات على النمو، صبغات التمثيل الضوئي، محتوي البرولين، المحصول والتركيب التشريحي لوريقة نبات الفاصوليا، أظهرت النتائج أن معظم الصفات تحت الدراسة مثل: إرتفاع النبات، عدد الأوراق/النبات، مساحة الورقة، الوزن الطازج لكل من الجذور، السوق، الأوراق، صبغات التمثيل الضوئي (كلوروفيل أ، كلوروفيل ب كلوروفيل أ+ ب والكاروتينويدات) والمحصول متمثلاً في عدد القرون/نبات، عدد البذور/قرن، وزن الـ ١٠٠ بذرة وطول القرن بالإضافة إلى الصفات التشريحية للورقة حدث لها نقص معنوي مع زيادة نسبة ملوحة مياه البحر حتى أعلى مستوى (٣٠٠٠ جزء في المليون)، وعلى العكس تماما، فإن نسبة البرولين في الأوراق زادت مع زيادة ملوحة مياه البحر حتى ٣٠٠٠ جزء في المليون، على الجانب الأخر، أدى رش نباتات الفاصوليا بحمض الهيوميك بتركيز ٢ أو ٤ جرام/لتر، البرولين بتركيز ٥٠ أو ١٠٠ جزء في المليون وحمض النفثالين أسيتك بتركيز ٢٥ أو ٥٠ جزء في المليون إلى زيادة معنوية في معظم الصفات تحت الدراسة بالمقارنة بمعاملة الكنترول (الرش بالماء المقطر)، وبصفة عامة، كانت أفضل المعاملات والتي أعطت أعلى القيم للصفات تحت الدراسة عند رش نباتات الفاصوليا بحمض الهيوميك بمعدل ٢جرام/لتر يليها البرولين بمعدل ١٠٠ جزء في المليون يليها حمض النفثالين أسيتك بمعدل ٢٥ جزء في المليون على التوالي مقارنة بالكنترول (الرش بالماء المقطر)، ونستنتج من كل النتائج السابقة أن رش نباتات الفاصوليا بحمض الهيوميك، البرولين وحمض النفثالين اسيتك خفف التاثيرات الضارة للرى بملوحة مياه البحر وكانت أفضل المعاملات هي الري بماء الصنبور أو بماء البحر بتركيز ١٠٠٠ جزء فى المليون مع الرش بحض الهيوميك بتركيز ٢ جرام فى اللتر.

المحكمـــــون:

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