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Physiological Studies on the Effect of Seaweed Extract and Potassium Humate on the Tolerance of Green Bean Plants to Saline Water Irrigation

Hayam A.A. Mahdy[1], M.F. Zaki[2], Abd El-Rheem Kh. M.[3] and Huda A. Ibrahim[2]

[1]Botany Department, National Research Center, Dokki, Giza, Egypt.
[2]Vegetable Research Department, National Research Center, Dokki, Giza, Egypt.
[3]Soil and Water Use Dept., National Research Center, Dokki, Giza, Egypt.

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ABSTRACT

Salinity, particularly in the region of arid and semi-arid regions, is a significant limiting factor for crop development and yield. The purpose of this study is to determine how potassium humate and seaweed extract can reduce the harmful effects of salinity on green beans (*Phaseolus vulgaris* var. Pulista). In pots with sandy soil and saline water that had an EC of 500, 1000, and 1500 ppm, seeds were sown in March 2020 and 2021. The concentrations of seaweed extract and potassium humate used were 0.25 g/l and 0.5 g/l for the former and 1 g/l and 2 g/l for the latter. At 3, 5, 7, and 9 weeks after cultivation, application occurred. Data indicated that all elements of plant growth, including plant height, leaf count, fresh and dry weights, were better when plants were treated with seaweed extract and potassium humate as opposed to untreated plants. Yield parameters followed also the same trend. The tallest green bean plants were estimated from that plants treated by seaweed extract at concentration of 0.25 g/l followed by the treatments of 0.5 g/l seaweed extract also while, the treatment of potassium humate at concentration of 2 g/l came in the third rank. It was determined that potassium humste and seaweed extract were superior at reducing the effects of salinity on green bean plants.

Keywords: Green bean, Salinity, seaweed extract, potassium humate, Total chlorophyll, N, P, K and Total Yield.

1. Introduction

Based on its geographic location and agroclimatic conditions, Egypt has a major comparative advantage in the production of horticulture commodities for export, especially green beans. According to reports, Egypt had an about 25% market share in the Netherlands, and was the top exporter of green beans there, just ahead of Spain (24%) and Kenya (20%). (HEIA, 2003). According to estimates, half of the global rise in green bean production occurs each year in Egypt (Wijnands, 2004). However, because the majority of the new recovered areas are where green bean agriculture is expanding, this expansion is constrained by some limiting factors such as salinity. Not only in the new land but also in the old valley where a considerable areas has become salt affected soils. According to Gehad (2003), some 90 thousands hectares of Nile Valley and Delta region are salinity affected soil. The problem is aggregated more when over withdraw is carried out from underground water wells and/or inefficient drain system is installed in the cultivated soil. This leads either to crop failure or at least to a significant reduction in yield and quality. Many trails have been carried out in order to help the grower to overcome those negative effects and increase his alternatives in the growing patterns and quantity and quality of his production. Among those trails, modification of greenhouse climate (Abdel-Mawgoud *et al*., 2004); application of organic matter such as humate (Abdel-Mawgoud *et al.* , 2007 and 2010); application of specific nutrients such as amino acids or growth regulators (El-Abd *et al*., 2005; Tantawy *et al*., 2009; 2013) and minerals i.e. calcium and silicon. Seaweed extract and humic acid have been reported to

Corresponding Author: Hayam A.A. Mahdy, Botany Department, National Research Center, Dokki, Giza, Egypt.

alleviate salinity stress and improve plant performance and production (Abdel-Mawgoud *et al.*, 2007 and 2010).

Therefore, this study is aiming at investigating the effect of applying seaweed extract and potassium humate separately in different concentrations on alleviating the negative effects of salinity on green bean plants.

2. Materials and Methods

Two pot experiments were carried out during two successive spring seasons of 2020 and 2021 in a private farm in 10th of Ramadan region, Sharkia governorate to investigate the effects of using seaweed extract (the commercial product Alge® extracts of *Ascophyllum nodosum*) in concentration of 0.25 and 0.5 g/l. and Potassium humate (the commercial product Vesco-Plus®) in concentrations of 1.0 and 2.0 g/l to alleviate the effect of different salinity levels on the growth and yield of green bean plants (*Phaseolus vulgaris*, L.) cv. Pulista under the new reclaimed land conditions. Green bean seeds were sown in pots (plastic bags with the dimensions of 30 cm diameter, 50 cm deep) filled with washed sandy soil. The pots were filled with 13 kg washed sand. Plants were irrigated from three concentrations of saline water 500 (control), 1000 and 1500 ppm which were obtained by Rachel salt soluble in fresh water. Salinity treatments started after three weeks from sowing. Pots were irrigated with saline water periodically every 2-3 days, with 1000 ml to keep the water content at field capacity. Plastic pots were perforated to allow drainage. Treatments of seaweed extract and potassium humate were applied four times through irrigation in the 3rd, 5th, 7th and 9th week after sawing. Chemical fertilizers were added as recommended by the Ministry of Agriculture for green bean crop.

2.1. Data recorded

Five plants were taken from each replicate for measuring the plant growth parameters as following:

1. Plant height (cm) was measured from cotyledons level to plant top by the end of the season.
2. Fresh weight / plant (stem and leaves) was determined in gm / plant by the end of the season.
3. Dry weight / plant (stem and leaves) was determined in gm / plant by the end of the season.
4. Leaf area (cm^2) was recorded in the fourth leaf from the apex by using leaf area meter machine model ADC Bioscientific Ltd., Japan.
5. Leaves number / plant were recorded in the end of season.

Total chlorophyll content, was measured in the leaves (the 4th leaf from the plant top) using Minolta SPAD 501 chlorophyll meter (Yadava, 1986). Minolta SPAD chlorophyll-Meter used light sources and detector to measure the light transmitted by a plant leaf at two different wave lengths (one in the red and other in the infrared region of the spectrum). The ratio of the light transmission at these two wave lengths, in addition to the ratio determined without sample (blank), is processed by the instrument to produce a reading shown on a digital display. This reading is in SPAD units, which are values by Minolta to indicate the relative amount of chlorophyll contained in plant intact leaves.

Macro elements in leaves, sample of fresh leaves (the 4th leaf from the plant top) were taken and considered the most representative ones for plant analysis. The leaves were oven dried at 70^{o} C till a constant weight. The dry matter was finely ground and wet digested with H_2O_2 and concentrated H_2SO_4 for the determination of nitrogen, phosphorus, potassium, according to the following methods:-

-Nitrogen was determined in the digestion product, using the Micro - Kjeldahl method (Piper, 1947).

-Phosphorus was determined colorimetrically in the above mentioned digestion product, Spectrophotometrically according to the method described by (King, 1951).

-Potassium was determined in the above mentioned digestion product, using the Flame photometer according to the method described by (Jackson, 1967).

Total yield (g/plant), was determined as total weight of pods during the harvesting period. Unmarketable yield (g/plant), this includes weight of crooked and rotted pods. Marketable yield (g/plant), was determined after excluding crooked and rotten pods.

Regarding sodium and fiber contents in the pods, sodium was also determined in the above mentioned digestion product, using the Flame photometer according to the method described by (Brown and Lilleland, 1946). While Fiber contents in the pods were determined according to Rai and Mndgal (1988).

2.3. Statistical analysis

All data collected were subjected to the statistical analysis according to Snedecor and Cochram (1968). The experimental treatments were arranged by applying the split plot design with three replicates where, salinity levels were arranged in the main plots and seaweed extract & potassium humate treatments were arranged in the sub plots. The data of treatments were compared, using least significant difference (LSD at 5 %) method as mentioned by Gomez and Gomez (1984).

3. Results

Data in Table (1) shows the effects of various salinity levels, potassium humate, seaweed extract, and treatments on plant height, number of leaves, and leaf area, respectively. Plant height, leaf area, and leaf number all significantly decreased with increasing saline levels. These patterns persisted throughout the experiment's two growing seasons. Meanwhile, the application of seaweed extract followed by potassium humate improved plant performance compared to control, with the concentrations of seaweed extract (0.25g/l) and potassium humate (2 g/l) recording the highest positive effects. However, in all salinity levels, seaweed extract showed superiority in the positive effect compared to potassium humate and this difference was significant.

Table 1: Effect of different salinity levels, seaweed extract, potassium humate and interaction on plant height, number of leaves and leaf area of green bean plants in 2020 and 2021 seasons.

Salinity levels	Treatments	Plant height (cm)		Number of leaves		Leaf area (cm^2)	
		1st season	2nd season	1st season	2nd season	1st season	2nd season
500 ppm	Control	26.00	29.44	16.78	16.00	406.44	404.24
	*S.E. (0.25 gm / L)	40.63	47.22	23.00	22.78	542.44	537.34
	*S.E. (0.5 gm / L)	30.78	41.22	19.39	18.78	428.67	424.67
	**P.H. (1 gm / L)	31.22	40.00	19.14	18.00	413.78	408.48
	**P.H. (2 gm / L)	34.44	42.78	21.78	20.78	535.45	529.95
Mean		32.61	40.13	20.02	19.27	465.36	460.94
1000 ppm	Control	22.78	27.95	13.33	12.67	312.78	308.58
	*S.E. (0.25 gm / L)	35.44	41.78	18.78	16.78	474.78	468.46
	*S.E. (0.5 gm / L)	28.44	36.44	15.44	15.78	382.78	377.44
	**P.H. (1 gm / L)	25.94	33.75	13.78	14.78	352.63	346.38
	**P.H. (2 gm / L)	29.44	38.44	17.78	15.56	436.44	431.23
Mean		28.41	35.67	15.82	15.11	391.88	386.42
1500 ppm	Control	20.28	22.44	10.44	10.44	280.34	274.34
	*S.E. (0.25 gm / L)	30.44	34.78	15.44	14.13	384.43	378.49
	*S.E. (0.5 gm / L)	26.78	30.44	11.78	12.44	308.78	305.48
	**P.H. (1 gm / L)	23.44	28.44	10.65	11.99	289.45	279.49
	**P.H. (2 gm / L)	27.78	30.44	14.78	13.33	345.44	335.54
Mean		25.74	29.31	12.62	12.46	321.69	314.67
Mean of Treatments	Control	23.02	26.61	13.51	13.04	333.19	329.05
	*S.E. (0.25 gm / L)	35.50	41.26	19.07	17.9	467.22	461.43
	*S.E. (0.5 gm / L)	28.67	36.03	15.54	15.67	373.41	369.20
	**P.H. (1 gm / L)	26.87	34.06	14.52	14.92	351.95	344.78
	**P.H. (2 gm / L)	30.55	37.22	18.12	16.56	439.11	432.24
L.S.D. at 5%	Salinity	1.14	1.32	0.94	0.86	31.20	25.17
	Treatments	1.70	1.24	1.55	1.59	11.18	16.46
	Interaction	2.23	2.15	2.17	2.13	20.73	29.12

*S.E. ------- Seaweed extract **P.H. ------------- Potassium humate

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Although the applied seaweed extract and potassium humate mitigated the negative effect of salinity within each salinity level significantly. The interaction effect showed clearly that, the best values of plant height, number of leaves and leaf area for green bean plants was showed with that plants which irrigated with the lowest salinity level (500 ppm) and treated with seaweed extract (0.25g/l). While the lowest values were noticed with that plants irrigated with the highest salinity level (1500 ppm) and no treatments reserved (control). These results findings were completely similar in seasons of 2020 and 2021.

The effects of the applied treatments are shown in Table (2) along with the interaction effects on the bean plants' fresh and dry weights and total chlorophyll content. The detrimental impact of salinity on chlorophyll content, which was considerable when compared to control, was clearly visible in the recorded data. Even while potassium humate and applied seaweed extract lessened the adverse effects of salinity, seaweed extract (0.25 g/l) had a clearly superior effect when compared to the other treatments. Similar to how increasing salinity level dramatically decreased the plant's fresh and dry weights. Meanwhile, seaweed extract and potassium humate mitigated that negative effect compared to control of each salinity level. Seaweed extract at concentration of 0.25 g/l showed superiority in its effect compared to all other applied concentrations of seaweed extract and potassium humate.

Table 2: Effect of different salinity levels, seaweed extract, potassium humate and interaction on on plant fresh & dry weight and total chlorophyll of green bean plants in 2013 and 2014 seasons.

Salinity levels	Treatments	Plant fresh weight (g / plant)		Plant dry weight (g / plant)		Total Chlorophyll (SPAD)	
		1st season	2nd season	1st season	2nd season	1st season	2nd season
500 ppm	Control	50.93	50.78	7.98	11.40	39.44	41.69
	*S.E. (0.25 gm / L)	91.47	96.44	11.19	15.14	48.93	53.45
	*S.E. (0.5 gm / L)	67.97	62.22	9.25	13.39	41.53	43.78
	**P.H. (1 gm / L)	57.32	59.00	8.96	12.44	41.00	43.39
	**P.H. (2 gm / L)	80.99	78.78	10.24	14.15	43.69	46.65
Mean		69.74	69.44	9.52	13.30	42.92	45.79
1000 ppm	Control	45.66	48.44	5.45	8.47	30.47	29.34
	*S.E. (0.25 gm / L)	87.37	89.78	8.32	12.99	42.78	41.43
	*S.E. (0.5 gm / L)	63.66	59.44	7.64	11.36	36.44	35.69
	**P.H. (1 gm / L)	55.30	54.00	5.67	9.43	36.49	35.57
	**P.H. (2 gm / L)	73.67	96.65	7.93	11.05	38.44	37.53
Mean		65.13	69.66	7.00	10.86	36.92	35.91
1500 ppm	Control	38.36	39.44	3.32	7.43	22.65	21.47
	*S.E. (0.25 gm / L)	80.59	81.44	6.96	10.70	34.78	33.93
	*S.E. (0.5 gm / L)	58.94	57.00	5.67	9.49	30.44	29.35
	**P.H. (1 gm / L)	49.80	51.00	4.93	8.12	31.44	30.53
	**P.H. (2 gm / L)	66.59	67.00	5.99	9.42	33.56	33.88
Mean		58.86	59.18	5.37	9.03	30.75	29.8
Mean of Treatments	Control	44.98	46.22	5.58	9.10	30.85	30.83
	*S.E. (0.25 gm / L)	86.48	89.22	8.82	12.94	42.16	42.94
	*S.E. (0.5 gm / L)	63.52	59.55	7.52	11.41	36.14	36.27
	**P.H. (1 gm / L)	54.14	54.67	6.52	9.99	36.31	36.49
	**P.H. (2 gm / L)	73.75	80.81	8.05	11.54	38.56	39.35
L.S.D. at 5%	Salinity	1.25	1.22	0.78	0.74	1.75	1.64
	Treatments	2.31	2.20	1.01	0.85	2.10	1.93
	Interaction	3.01	3.09	1.17	1.26	2.11	2.29

*S.E. ------- Seaweed extract **P.H. ------------- Potassium humate

The yield and its constituent parts were calculated using the observed data for vegetative growth. As salt level rose, total yield drastically decreased (Table 3). Meanwhile, the administration of potassium humate and seaweed extract considerably reduced those adverse effects, improving the overall output. Seaweed extract at a dosage of 0.25 g/l demonstrated the strongest mitigating impact on total yield across all salinity levels among applications of potassium humate and seaweed extract. Similar to this, marketable yield drastically decreased as salt level rose. The use of potassium humate and seaweed extract considerably lessened the detrimental effects of salinity while improving the marketable output. Seaweed extract at 0.25 g/l recorded the highest effect in improving marketable yield compared to all other treatments. On the contrary of the all above results, only unmarketable yield is the parameter which showed an opposite trend where salinity increment increased the unmarketable yield. The application of seaweed extract and potassium humate reduced that parameter, with seaweed extract at 0.25 g/l recorded the highest effects however, potassium humate at 2 g/l came in the second rank.

Table 3: Effect of different salinity levels, seaweed extract, potassium humate and interaction on total yield (g/ plant), marketable yield (g/ plant) and unmarketable yield (g/ plant) of green bean plants in 2020 and 2021 seasons.

Salinity levels	Treatments	Total yield (g/ plant)		Marketable yield (g/ plant)		Unmarketable yield (g/ plant)	
		1st season	2nd season	1st season	2nd season	1st season	2nd season
500 ppm	Control	62.16	64.11	50.66	51.13	11.50	12.98
	*S.E. (0.25 gm / L)	83.71	82.32	81.47	77.34	2.24	4.98
	*S.E. (0.5 gm / L)	74.72	69.72	68.94	58.58	5.78	11.14
	**P.H. (1 gm / L)	65.32	66.31	56.54	54.73	8.78	11.58
	**P.H. (2 gm / L)	78.22	74.90	73.54	64.50	4.68	10.40
Mean		72.83	71.47	66.23	61.26	6.59	10.22
1000 ppm	Control	49.46	52.72	30.76	33.44	18.70	19.28
	*S.E. (0.25 gm / L)	73.42	76.66	67.12	70.92	6.30	5.74
	*S.E. (0.5 gm / L)	64.47	64.20	53.93	53.00	10.54	11.20
	**P.H. (1 gm / L)	58.60	53.61	41.7	35.97	16.90	17.64
	**P.H. (2 gm / L)	65.35	68.32	56.19	58.84	9.16	9.48
Mean		62.26	63.10	49.94	50.43	12.32	12.67
1500 ppm	Control	45.87	44.61	24.59	22.97	21.28	21.64
	*S.E. (0.25 gm / L)	65.39	73.62	56.69	64.24	8.70	9.38
	*S.E. (0.5 gm / L)	59.22	59.37	47.48	48.13	11.74	11.24
	**P.H. (1 gm / L)	57.61	57.90	39.83	44.36	17.78	13.54
	**P.H. (2 gm / L)	62.22	63.12	51.64	52.38	10.58	10.74
Mean		58.01	59.72	44.05	46.42	14.01	13.31
Mean of Treatments	Control	52.49	53.81	35.34	35.85	17.16	17.97
	*S.E. (0.25 gm / L)	74.17	77.53	68.43	70.83	5.75	6.70
	*S.E. (0.5 gm / L)	66.14	64.43	56.78	53.24	9.53	11.19
	**P.H. (1 gm / L)	60.51	59.27	46.02	45.02	14.49	14.25
	**P.H. (2 gm / L)	68.59	68.78	60.46	58.57	8.14	10.21
L.S.D. at 5%	Salinity	3.20	2.11	0.80	0.79	1.99	2.22
	Treatments	1.83	0.90	0.48	0.39	1.02	1.72
	Interaction	1.01	1.60	1.09	0.95	1.72	2.88

*S.E. ------- Seaweed extract **P.H. ------------- Potassium humate

Similarly, % of nutrients such as N, P and K showed a reduction as salinity level increased (Table 4), these reductions were mitigated by the application of seaweed extract and potassium humate, but with seaweed extract recording the highest positive effect at concentration of 0.25 g/l. All seaweed extract and potassium humate applications effects were significantly higher compared to control under each salinity level.

As it was expected, Na % increased in pods as salinity level increased (Table 5). Meanwhile the application of seaweed extract or potassium humate reduced significantly that % and the lowest % recorded under the treatment of seaweed extract 0.25 g/l.

The interaction effect showed clearly that, the highest Na % was noticed with that plants which irrigated with the highest salinity levels, i.e. 1500 ppm and without supplied seaweed extract and / or potassium humate (control). While the lowest Na values were recorded with that plants irrigated with the lowest salinity levels, i.e. 500 ppm and treated with seaweed extract 0.25 g/l. These findings are completely similar in the two seasons.

Fibers percentage was positively affected by increasing salinity level significantly which indicates by a lower fruit quality (Table 5). The application of seaweed extract and / or potassium humate reduced this effect significantly. Using seaweed extract at concentration 0.25 g/l recorded the highest effect compared to all the other treatments. The interaction effect showed clearly that, the highest fibers % was noticed with that plants which irrigated with the highest salinity levels, i.e. 1500 ppm and without supplied seaweed extract and / or potassium humate (control). While the lowest fibers values were recorded with that plants irrigated with the lowest salinity levels, i.e. 500 ppm and treated with seaweed extract 0.25 g/l. These findings are completely similar in the two seasons of study.

Table 4: Effect of different salinity levels, seaweed extract, potassium humate and interaction on nitrogen, phosphorus and potassium percentages (%) of green bean leaves in 2020 and 2021 seasons.

Salinity levels	Treatments	N (%)		P (%)		K (%)	
		1st season	2nd season	1st season	2nd season	1st season	2nd season
500 ppm	Control	1.73	1.68	0.37	0.38	2.00	2.07
	*S.E. (0.25 gm / L)	2.70	2.68	0.42	0.44	2.52	2.48
	*S.E. (0.5 gm / L)	2.12	2.25	0.40	0.42	2.25	2.22
	**P.H. (1 gm / L)	2.01	2.11	0.41	0.40	2.01	2.12
	**P.H. (2 gm / L)	2.31	2.33	0.41	0.40	2.37	2.24
Mean		2.17	2.21	0.40	0.41	2.23	2.23
1000 ppm	Control	1.62	1.73	0.33	0.32	1.68	1.73
	S.E. (0.25 gm / L)	2.62	2.58	0.36	0.37	2.22	2.35
	S.E. (0.5 gm / L)	2.01	2.20	0.35	0.35	1.88	1.76
	P.H. (1 gm / L)	1.81	1.87	0.34	0.33	2.02	2.08
	P.H. (2 gm / L)	2.21	2.37	0.37	0.35	1.74	1.83
Mean		2.05	2.15	0.35	0.34	1.91	1.95
1500 ppm	Control	1.31	1.51	0.28	0.30	1.38	1.40
	*S.E. (0.25 gm / L)	2.34	2.35	0.35	0.34	1.68	1.72
	*S.E. (0.5 gm / L)	1.72	1.78	0.32	0.33	1.55	1.43
	**P.H. (1 gm / L)	1.53	1.60	0.30	0.31	1.42	1.50
	**P.H. (2 gm / L)	2.03	2.08	0.33	0.33	1.58	1.60
Mean		1.79	1.86	0.32	0.32	1.52	1.53
Mean of Treatments	Control	1.55	1.64	0.32	0.33	1.69	1.73
	*S.E. (0.25 gm / L)	2.55	2.54	0.38	0.38	2.14	2.18
	*S.E. (0.5 gm / L)	1.95	2.08	0.36	0.37	1.89	1.80
	**P.H. (1 gm / L)	1.78	1.86	0.35	0.35	1.82	1.90
	**P.H. (2 gm / L)	2.18	2.26	0.37	0.36	1.89	1.89
L.S.D. at 5%	Salinity	0.12	0.03	0.06	0.04	0.17	0.20
	Treatments	0.07	0.05	0.04	0.02	0.09	0.07
	Interaction	0.14	0.10	0.06	0.02	0.15	0.13

*S.E. ------- Seaweed extract **P.H. ------------- Potassium humate

Table 5: Effect of different salinity levels, seaweed extract, potassium humate and interaction on sodium (%) and fibers (%) in pods of green bean plants in 2020 and 2021 seasons.

Salinity levels	Treatments	Na (%)		Fibers (%)	
		1st season	2nd season	1st season	2nd season
500 ppm	Control	0.18	0.20	8.83	8.76
	*S.E. (0.25 gm / L)	0.12	0.11	7.02	7.87
	*S.E. (0.5 gm / L)	0.15	0.15	8.32	8.68
	**P.H. (1 gm / L)	0.16	0.16	8.77	8.31
	**P.H. (2 gm / L)	0.14	0.13	8.74	8.54
Mean		0.15	0.15	8.34	8.43
1000 ppm	Control	0.26	0.25	10.87	10.88
	*S.E. (0.25 gm / L)	0.14	0.15	9.08	9.02
	*S.E. (0.5 gm / L)	0.21	0.22	10.33	10.54
	**P.H. (1 gm / L)	0.23	0.24	10.73	10.62
	**P.H. (2 gm / L)	0.18	0.20	10.05	10.11
Mean		0.20	0.21	10.21	10.23
1500 ppm	Control	0.37	0.35	11.87	11.61
	*S.E. (0.25 gm / L)	0.17	0.18	10.77	10.71
	*S.E. (0.5 gm / L)	0.28	0.20	11.54	11.54
	**P.H. (1 gm / L)	0.30	0.17	11.68	11.64
	**P.H. (2 gm / L)	0.24	0.20	10.80	10.87
Mean		0.27	0.22	11.33	11.27
Mean of Treatments	Control	0.27	0.27	10.52	10.42
	*S.E. (0.25 gm / L)	0.14	0.15	8.96	9.20
	*S.E. (0.5 gm / L)	0.21	0.19	10.06	10.25
	**P.H. (1 gm / L)	0.23	0.19	10.39	10.19
	**P.H. (2 gm / L)	0.19	0.18	9.86	9.84
L.S.D. at 5%	Salinity	0.01	0.009	0.04	0.09
	Treatments	0.01	0.01	0.03	0.06
	Interaction	0.01	0.009	0.07	0.11

*S.E. ------- Seaweed extract **P.H. ------------- Potassium humate

4. Discussion

This study was carried out in order to investigate some possible alternatives that may alleviate the negative effect of salinity on a salt sensitive crop such as green bean. The results showed the common negative effects of salinity on allover plant growth parameters such as plant height, number of leaves and leaf area as well as fresh and dry weights of the plant. Salinity is well known to affect negatively plant water status (Livett, 1980) and the latter is reflecting on smaller elongation of plant cells hence shorter plants and smaller leaf areas. Smaller canopy (plant height and leaf area) means smaller light interception hence, lower photo assimilate production and ending with lower fruit yield which has been recorded in this study. Not only water status, salinity affects also nutrients uptake negatively (Grattana and Grieve, 1999) and which has been observed in this study as well. This also contributes to the negative effect of salinity on overall plant performance and production. On the other hand, all trails that have been carried out earlier (Haghighi *et al.*, 2012; Tantawy *et al.*, 2014 and 2015) as well as this study are attempting to improve these situations of plant water and nutritional status.

In our investigation Seaweed extract application promoting bean vegetative growth, yield and its components under saline water irrigation, these enrichment in the previous characters due to seaweed extract content with high levels of organic matter, microelements (Fe, Cu, Zn, Co, Mo and Mn), vitamins and amino acids and also, is being rich in growth regulators such as auxins, cytokinins and gibberellins (Khan *et al.*, 2009). Exogenous application of seaweed extract has already been shown to enhance plant growth, yield and its quality, as well (Abdel-Mawgoud *et al.*, (2010) on watermelon; Shehata *et al.*, (2011) on Celeriac plant. Biostimulants seaweed extract can promote plant growth may be due to, activate root cells at the same time stimulate biosynthesis of endogenous cytokinins from roots (Schmidt 2005), enhancing leaf water status (Demir *et al.* 2004), altering hormonal balances and favor cytokinins and auxins production (Schmidt 2005), enhancement of antioxidant enzymes (SOD, GR, ASP) for protection against adverse environmental conditions (Schmidt 2005), stimulation the biosynthesis of Tocopherol, ascorbic acid and carotenoids in chloroplast which protect photosynthetic apparatus of PSII (Zhang and Schmidt 2000), protection of plant cells from lipid peroxidation and in activation of enzymes that occur under stress (Smirnoff 1995)., stimulation stem elongation and exhibits auxin-like activity. (Crouch and Staden 1993), reduced uptake of NaCl (Nabati 1994) while increased K and Ca content in the leaves (Demir *et al.* 2004), stimulation of chlorophyls biosynthesis (Garbay and Churin 1996), regulation cell membrane components under drought stress (Yan 1993), inhibits activity of free radical groups which are major elements for chlorophyll degradation (Fletcher *et al.,* 1988), stimulation the uptake of N, P, K, Mg, Ca, Zn, Fe and Cu by the plants that alleviate the inhibitory effect of Na toxicity and restored growth (Nelson and Van-Staden 1984), promoted the accumulation of reducing sugars which increased wilting resistance through enhancing osmotic pressure inside plant and stimulation of chloroplast development and enhancing phloem loading and delay senescence (Demir, *et al.,* 2004).

Meanwhile potassium humate has positive effects on salt tolerance based on the plant growth parameters, nutrient contents, yield and fruit quality in this study, this due to humic acid has an essential role in agricultural processes. It increases cation exchange capacity and enhances soil fertility, converting the mineral elements into forms available to plants (Stevenson, 1994). Humic substances lead to a greater uptake of nutrients into the plant root and through the cell membrane (Yilmaz, 2007; Kulikova *et al*., 2005). Humic acids show a sponge like tampon character in the wide pH scale, its activity may be changed by various pH levels but neutralizes soil pH, and so many trace elements become available to the plant (Yilmaz, 2007). Humic substances can break the bonds between phosphate and the iron ions in between acid soils and in calcium and iron ions in alkaline soils (Stevenson, 1994). Also, humic acids have increased root development and growth in broad bean (Akinci *et al*., 2009). Additionally Kulikova *et al*., (2005) reported that humic substances might show anti-stress effects under a biotic stress conditions such as, unfavorable temperature, pH, salinity etc. Humic substance could improve plant growth under soil condition by enhancing the uptake of nutrients such as N, P, K, Ca, Mg, S and Mn) and reducing the uptake of some toxic elements such as Na^+ (Cimrin *et al*., 2010). Also, humic acid increased total chlorophyll content in tomato plants under saline water irrigation conditions (Salama, 2009).

The effect of these two organic materials must have been reflected on plant water status and the ability of the plant to uptake nutrients and this was reflected on higher nutrient contents in plant tissues. These also reflected on higher assimilate production which was interpreted in the form of higher dry weight of the plant. Higher dry matter production and better plant water status means higher fresh weight of the plant and this is what was recorded in this study. As yield is a fraction of total plant fresh weight, it must improve as the latter improves. Furthermore, fruit quality expressed as fiber content has improved probably due to alleviating the stress load on the plant. This is supported by the proline content which is an indicator for plant stress.

5. Conclusion

Although applied seaweed extract and potassium humate improved plant performance and production in this study, the effect of salinity was dominant specially with higher levels. This is due to either specific ion effect of Na and/or the level of salinity is beyond the maximum level that can be hold by the bean plants. There is nothing without a limit and that limit must have been crossed by increasing the high salinity level for bean plants. However, the application of seaweed extract and potassium humate reduced the negative effects of each salinity level which gives the grower an opportunity to grow bean under similar circumstances in case if the market price is attractive.

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