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RESPONSE OF EGGPLANT (*Solanum melongena* L.) TO POTASSIUM AND LIQUORICE EXTRACT APPLICATION UNDER SALINE CONDITIONS

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Abstract. Eggplant (*Solanum melongena* L.) is one of the important summer vegetable crops of the Solanaceae family due to its high content of carbohydrates, protein and minerals i.e. N, P, K and Fe as well as vitamin C. The performance of Eggplant (*Solanum melongena* L.) to foliar spray with potassium (0, 1, 2 and 3 $g \cdot l^{-1}$) and liquorice extract (0, 2, 4 and 6 $g \cdot l^{-1}$) were investigated in summer 2013 and 2014 seasons at Ras Sudr research station farm, South Sinai governorate on a salinity soil under drip irrigation system. The effects of the experimental factors on plant growth parameters (height, leaf number, branch number, fresh and dry weight), leaf chlorophyll content, leaf minerals (N, P and K), yield parameters such as, fruit number/plant, fruit weight, total yield per feddan (0.42 ha) were evaluated. The results proved that the foliar application with potassium and liquorice extract produce a significant increase in all parameters under study compared to the control. The foliar application of 2 $g \cdot l^{-1}$ potassium plus 6 $g \cdot l^{-1}$ liquorice extract gave the highest values of vegetative growth, mineral values of the leaves, yield and its components.

Key words: Foliar nutrition, plant growth, nutrients content, yield

INTRODUCTION

The use of plant biostimulators recently became more common in the modern agricultural production, these materials may be out of biological origin such as plant extracts, hormones, enzymes and marine algae or be manufactured compounds, such as different plant growth regulators, amino acids and vitamins, biostimulators are not a fertilizer or nutritional substances but rather its an innovative stimulators for the

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growth and development of plants. The effect of biostimulators on the plant is due to their direct impact on metabolic processes within the plant, may be changing the enzymatic activity and antioxidant synthesis or stimulate the synthesis of natural hormones or increasing their activity, improving root growth and facilitate the absorption of water and nutrients from the soil, and consequently increase the quantity and quality of crop yield. Furthermore, plant biostimulators increase the resistance of plants to various stress conditions [Basak 2008]. Among such plant stimulator substances the liquorice root extract, liquorice is one of the Fabaceae family plants, the chemical constituents of the liquorice roots includes several bioactive compounds such as glycyrrhizin (16%), different sugars (up to 18%) flavonoids, saponoids, sterols, starches, amino acids, gums and essential oils [Mukhopadhyay and Panja 2008], also liquorice extract contains sugary substances and many mineral compounds (K, Ca, Mg, and P), more importantly, contains mevalonic acid which is the initiator in the synthesis of GA_3 acid in plants [Saleh et al. 2013]. Many studies reported that the spraying with liquorice extract improving plant growth parameters such as height, leaf number, fresh and dry weight, consecutively, gave the highest fruit weight, fruits number and yield of bean [Khalel and Hado 2011], potato [Hamadah et al. 2012], lettuce [Marie and Al Allaf 2012], onion [Faraj and Ghaloom 2012] and Cucumber [El Sagan 2015]. In addition liquorice foliar applications increase the percentages of N, K in plant leaves [Hamadah et al. 2012, El Sagan 2015], and P [El Sagan 2015], chlorophyll content [Khalel and Hado 2011, El Sagan 2015]. As well as, El Marsoumy [1999] reported that the mechanism of action of liquorice extract in plants is similar to the gibberellic acid action in the stimulating of vegetative growth of plants. Moreover, the licorice extract is available, low cost and effective as well as easy to apply.

Potassium is an essential macro element required in large amounts for plant growth and development. When the potassium uptake from the soil is below than required, especially in the arid zone conditions this may have an adverse impact on the general nutritional status of the plant, the foliar nutrition is the perfect solution to provide potassium element in this condition. Potassium fertilization may facilitate osmotic adjustment which maintains of the turgor pressure in the plants at lower leaf water potentials, and thus may improve the ability of plants to tolerate the drought and salinity stress [Lindhauer 1985].

The main role of potassium is the activation of many enzymes that involved in the structure of organic substances as well as building up many of compounds such as starch and protein also it has a role in the enlargement and triggering of cells in the meristematic tissues, also, promotes the photosynthesis and transport of carbohydrate to the storage organs [Marschner 1995]. The potassium foliar application improved the vegetative growth parameters of tomato [Chapagain and Wiesman 2004], sweet pepper [El Bassiony et al. 2010], potato [Dkhil et al. 2011, Salim et al. 2014], eggplant [Jaafer 2012], cucumber [Kazemi 2013], tomato [Kazemi 2014]. Chlorophyll, N, P and K values of plant leaves increased with potassium foliar application to tomato [Kazemi 2014] and potato [Salim et al. 2014]. Furthermore, the total yield, fruit number and weight were significantly increased by potassium foliar application to eggplant [Jaafer 2012], tomato [Kazemi 2014] and potato [Salim et al. 2014].

The aim of this study was to investigate the response of eggplant to foliar application of potassium and liquorice extract under saline conditions.

MATERIAL AND METHODS

The research was conducted in summer 2013 and 2014 seasons at Ras Sudr Research Station, Desert Research Center, at the South Sinai Governorate, Egypt to study the effect of potassium and liquorice extract on vegetative growth, chemical composition and yield of eggplant (*Solanum melongena* L.) El Balady (black) cultivar. The soil of the location was highly calcareous and saline. The mechanical and chemical analyses of the experimental soil are presented in Table 1. The soil analysis was carried out according to Golcz [2011], Black and Editor [1965] and Jackson [1967].

Table 1. Mechanical and chemical properties of the experimental soil

Depth (cm)	pH	EC mS·cm^{-1}	$CaCO_3$%	Silt %	Sand %	Clay %	Class texture
0–30	7.7	8.65	56.99	8.05	81.28	10.67	sandy loam
30–60	7.4	7.90	52.48	7.59	86.08	6.33	
	soluble anions (mg·100 g^{-1})				soluble cations (mg·100 g^{-1})		
	CO^{-2}_3	HCO^-_3	SO^{-2}_4	Cl^-	Ca^{+2}	Mg^{+2}	Na^+	K^+
0–30	0.00	105	2832	2276	767	335	1353	79
30–60	0.00	61	3133	1828	618	268	1513	4

Eggplant seeds were sown on February 1 under greenhouse conditions. When they had three real uniform leaves (in appearance) they were transferred to the sustainable agriculture place on March 15 in both seasons. The experimental unit area was 12.8 m^2 containing 4 rows each with 4 m length and 80 cm width. The distance between plants was 50 cm. Plants were irrigated with saline water (4500 ppm), at 3-days intervals. The analysis of irrigation water is given in Table 2 and Table 3 for the meteorological data at the experimente site [Central Lab. for Agricultural Climate, Agricultural Research Center, Ministry of agriculture & Land Reclamation, Egypt].

Table 2. Chemical analysis of the irrigation water

pH	EC mS·cm^{-1}	Soluble anions (mg·dm^{-3})				Soluble cations (mg·dm^{-3})		
		CO_3^{-2}	HCO^{-3}	SO_4^{-2}	Cl^-	Ca^{2+}/Mg^{2+}	Na^+	K^+
8.6	7.03	0.00	135	1403	1737	42.50	921	3

The experiment was set up as a split plot design with three replications. Every replicate included 16 treatments which were the combinations between four levels of both potassium and liquorice extract. The main plots were devoted to the potassium, while the sub plots were occupied with the liquorice extract.

Table 3. Meteorological data at Ras Sudr site during 2013 and 2014 seasons

Year	Month	Temperature (°C)		SRAD	RH	R.F.
		max	min	(MJ/m^2/day)	(%)	(mm)
2013	March	26.3	13.6	22.19	43.80	1.40
	April	28.1	15.9	25.33	44.52	1.60
	May	34.2	20.7	28.15	37.75	1.50
	Jun	35.9	23.0	30.20	40.61	0.0
	July	35.5	23.5	29.65	48.45	0.0
	August	36.6	24.5	27.67	50.43	0.0
2014	March	25.4	14.4	20.69	49.39	6.0
	April	30.0	16.9	24.83	42.76	1.50
	May	32.4	20.6	27.00	42.82	9.20
	Jun	35.6	22.8	29.91	41.25	0.0
	July	37.0	23.6	29.74	46.33	0.0
	August	37.1	25.5	27.69	48.21	0.0

* – SRAD = solar radiation; RH = relative humidity; RF = rainfall

The experimental treatments. A. Potassium: four potassium (K_2SO_4) levels were used, namely 0, 1, 2 and 3 g·dm^{-3}. Spraying treatments were started after 20 days of transplanting, at four times with 10-days intervals.

B. Liquorice extract: four liquorice extract rates were tested, i.e., 0 (untreated), 2, 4 and 6 g·dm^{-3}. Spraying treatments were started after 20 days of transplanting at four times with 15-days intervals.

For the method of preparation of licorice extract, appropriate weight of grinded dry roots according to the concentrations which listed in the experimental treatments (2, 4 and 6 g·l^{-1}) was macerated in covered flask containing hot distilled water at temperature of 40°C for 24 hours then the solution was filtered through a piece of fabric to get rid of the large impurities, the obtained extract re-filtered through No. 2 Whatman filter paper for small suspended particles which might impede the foliar spraying process, the output licorice leachate extract was diluted with distilled water to reach the required size then the solution is ready to spray [El Marsoumy 1999].

All foliar spray applications were made early in the morning or late in the afternoon to avoid the rapid drought of solution droplets by the sun's heat, therefore remain the solution as long as possible on leaf surfaces.

All agricultural practices were carried out according to the recommendations of the Egyptian Ministry of Agriculture for eggplant production, fertilization was 30 m^3 farmyard, 200 kg calcium super phosphate (15.5% P_2O_5), 200 kg ammonium sulfate

(20.5% N) per feddan were added during soil preparation, after transplanting, 200 kg ammonium sulfate were added with irrigation water at weekly intervals during the cultivation season until harvest period.

Data recorded. Plant growth. Random samples of four plants were taken after 75 days from transplanting from each plot to measure plant growth parameters, i.e. height, leaf number, branch number, fresh and dry weight per plant.

Measuring Leaf Chlorophyll Content. It was determined by Spad meter [Inada 1985] in samples taken randomly from the fourth true upper leaf

Leaf mineral percent. Determination of N, P and K in the leaves. Nitrogen was determined using the modified "microkjeldahl" method as described by Jackson [1973]. Phosphorus was colorimetrically estimated by using chlorostannous reduced molybdophosphoric blue color method according to Jackson [1973]. Potassium was determined using the flame photometer as described by Irri [1976].

Yield and its components. Determine eggplant yield characters, i.e. fruit number per plant, the average of fresh fruit weight and total yield per feddan.

Statistical analysis. All data were processed by analysis of variance according to the method described by Steel and Torrie [1960] and the means were compared using the least significant difference test (L.S.D.) at $P \leq 0.05$ [Snedecor and Cochran 1980].

RESULTS AND DISCUSSION

Growth parameters and leaf chlorophyll content. Plant growth parameters, i.e. height, leaf number, branch number, fresh and dry weight per plant as well as leaf chlorophyll content, responded positively to the increasing of potassium foliar application compared with control (tabs 4 and 5). The highest values of the growth parameters and leaf chlorophyll content were obtained from the foliar application of 2 $g \cdot l^{-1}$ potassium, but the lowest values were obtained with no foliar application (control) in two growing seasons. The same trend was reported by Jaafer [2012] and Kazemi [2014]. This result may be due to the potassium role in the activation of many enzymes that has the responsibility of regularity of various metabolic processes within plants, as well as, the construction of vital compounds such as starch and protein, as well, stimulating the growth of meristematic tissue, also promote the photosynthesis and transport of the carbohydrates to the storage organs [Marschner 1995]. Substantially, potassium is one of the building blocks in plant physiology.

Concerning to liquorice extract there was a gradual increment in plant growth parameters (height, leaf number, branch number, fresh and dry weight per plant) and leaf chlorophyll content with increasing of liquorice extract levels in both seasons. The results agree with those of Khalel and Hado [2011] and El Sagan [2015]. The positive influence of liquorice extract may be due to its similar to the behavior of gibberellic acid and working to increase the elongation and cell division because of its impact on the special enzymes to convert complex compounds into simple compounds utilized in the construction of the plant required for the growth [El Marsoumy 1999], also, Gordon and An [1995] showed that the liquorice extract contains flavonoids and isoflavonoids, these compounds have antioxidant activity, therefore they concluded that the liquorice plant extract possesses antioxidant activity. Likewise, Treutter [2006] indicated that the antioxidant flavonoids have a protective function during the environmental stresses that protect plants and improve the growth under these conditions. Also Haraguchi et al. [1998] demonstrated that the phenolic compounds such as Licochalcones, echinatin and retrochalcones in liquorice extract were shown to be effective in protecting biological systems against various oxidative stresses.

As regards to the effect of interaction between potassium and liquorice extract, it was a significant effect on all growth parameters and leaf chlorophyll content except plant height in the first season and branch number per plant in both seasons. Plants sprayed with 2 $g \cdot l^{-1}$ potassium combined with 6 $g \cdot l^{-1}$ liquorice extract gave the highest values in the two seasons of study (tabs 4 and 5).

Table 4. Effect of potassium and liquorice extract application on plant height, leaf number and branch number of eggplant in 2013 and 2014 seasons

	Treatments	First season (2013)					Second season (2014)				
	potassium ($g \cdot l^{-1}$)	liquorice extract ($g \cdot l^{-1}$)					liquorice extract ($g \cdot l^{-1}$)				
		0	2	4	6	mean	0	2	4	6	mean
Plant height (cm)	0	32.62	34.00	36.33	38.67	35.42	33.33	35.00	38.33	39.67	36.58
	1	34.67	36.33	37.33	41.00	37.33	34.33	36.67	38.33	43.33	38.17
	2	37.00	39.33	44.00	46.00	41.58	37.33	42.00	46.67	47.33	43.33
	3	36.33	38.00	43.33	44.67	40.58	36.00	38.67	43.67	46.33	41.17
	mean	35.16	36.92	40.25	42.59		35.25	38.09	41.75	44.17	
	L.S.D at P ≤ 0.05 for										
	potassium			1.09					0.84		
	liquorice extract			1.12					0.75		
	interaction			N.S					1.50		
Leaf number per plant	0	19.33	24.00	27.00	34.00	26.08	20.67	24.00	28.00	35.33	27.00
	1	24.00	27.67	32.23	35.67	29.89	24.67	29.00	33.33	36.67	30.92
	2	27.00	35.00	38.33	39.67	35.00	28.33	35.00	38.67	41.67	35.92
	3	28.33	34.33	36.67	38.33	34.42	29.00	33.00	37.33	41.00	35.08
	mean	24.67	30.25	33.56	36.92		25.67	30.25	34.33	38.67	
	L.S.D at P ≤ 0.05 for										
	potassium			0.79					1.82		
	liquorice extract			1.03					0.54		
	interaction			2.05					1.09		
Branch number per plant	0	3.67	4.33	5.33	6.67	5.00	3.33	4.00	5.67	6.00	4.75
	1	4.33	5.67	6.67	7.33	6.00	3.67	5.33	6.33	6.67	5.50
	2	5.00	6.33	7.67	8.00	6.75	4.67	5.67	7.00	7.33	6.17
	3	4.67	6.33	7.33	8.00	6.58	4.33	5.33	6.67	7.33	5.92
	mean	4.42	5.67	6.75	7.50		4.00	5.08	6.42	6.83	
	L.S.D at P ≤ 0.05 for										
	potassium			0.56					0.61		
	liquorice extract			0.52					0.49		
	interaction			N.S					N.S		

Table 5. Effect of potassium and liquorice extract application on fresh weight, dry weight per plant and leaf chlorophyll content of eggplant in 2013 and 2014 seasons

	Treatments	First season (2013)					Second season (2014)				
	potassium ($g \cdot l^{-1}$)	liquorice extract ($g \cdot l^{-1}$)					liquorice extract ($g \cdot l^{-1}$)				
		0	2	4	6	mean	0	2	4	6	mean
Fresh weight per plant (g)	0	123.67	141.00	157.33	173.67	148.92	119.33	134.33	14867	167.33	142.42
	1	137.00	173.00	184.00	202.00	174.00	136.67	163.33	177.33	194.67	168.00
	2	148.67	181.33	223.33	239.67	198.25	142.67	176.67	217.00	229.00	191.34
	3	150.00	172.67	214.00	227.67	191.09	146.00	170.00	208.33	221.33	186.42
	mean	139.84	167.00	194.67	210.75		136.17	161.08	187.83	203.08	
	L.S.D at P ≤ 0.05 for										
	potassium			3.84					2.89		
	liquorice extract			4.09					2.97		
	interaction			8.17					5.93		
Dry weight per plant (g)	0	20.48	24.99	28.47	32.45	26.60	18.63	22.17	26.11	30.08	24.25
	1	23.47	29.53	33.12	37.49	30.90	21.74	27.77	30.57	34.36	28.61
	2	25.34	32.67	41.42	43.90	35.83	24.44	31.71	38.37	41.53	34.01
	3	24.25	32.01	38.23	41.81	34.08	22.39	30.63	37.31	39.66	32.50
	mean	23.39	29.80	35.31	38.91		21.80	28.07	33.09	36.41	
	L.S.D at P ≤ 0.05 for										
	potassium			0.94					1.53		
	liquorice extract			0.98					0.94		
	interaction			1.96					1.88		
Leaf chlo-rophyll content (SPAD)	0	44.23	48.24	52.65	55.69	50.20	46.06	47.10	48.50	50.70	48.09
	1	51.31	53.53	55.83	58.52	54.80	47.59	49.46	50.94	52.17	50.04
	2	52.15	55.18	62.10	63.47	58.23	49.62	52.57	54.02	55.09	52.83
	3	52.33	55.20	59.17	62.33	57.26	49.11	51.95	53.64	55.07	52.44
	mean	50.01	53.04	57.44	60.00		48.10	50.27	51.78	53.26	
	L.S.D at P ≤ 0.05 for										
	potassium			0.73					0.28		
	liquorice extract			0.92					0.37		
	interaction			1.84					0.75		

Leaf mineral percent. Data in table 6 revealed that the application of different potassium treatments significantly influences on leaves percentages of N, P and K. The maximum leaf percentage of N (3.30 in the 1st and 3.47 in the 2nd season) and K (1.68 in the 1st and 1.65 in the 2nd season) were observed in the treatment of 2 $g \cdot l^{-1}$ potassium in both seasons. The highest P values (0.74 in the 1st and 0.79 in the 2nd season) were recorded by the highest rate of potassium in both seasons. The minimum leaf percentage of N (2.68 in the 1st and 2.72 in the 2nd season), P (0.55 in the 1st and 0.56 in the 2nd season) and K (1.31 in the 1st and 1.27 in the 2nd season) were recorded by no potassium application in both seasons. Similar results were found by Kazemi [2014] and Salim et al. [2014]. It may be due to the important roles of potassium in plants such as the osmotic adjustment [Lindhauer 1985], enzyme activation, cell turgor maintenance, ion homeostasis, photosynthesis and transport of outputs to the storage organs [Marschner 1995] which led to increased mineral values of the leaves.

Table 6. Effect of potassium and liquorice extract application on N, P and K percentages of eggplant leaves in 2013 and 2014 seasons

	Treatments	First season (2013)					Second season (2014)				
	Potassium ($g \cdot l^{-1}$)	Liquorice extract ($g \cdot l^{-1}$)					Liquorice extract ($g \cdot l^{-1}$)				
		0	2	4	6	mean	0	2	4	6	mean
N (%)	0	2.25	2.57	2.83	3.05	2.68	2.28	2.53	2.81	3.25	2.72
	1	2.51	2.64	3.02	3.40	2.89	2.47	2.71	3.01	3.60	2.95
	2	2.70	3.16	3.57	3.75	3.30	2.86	3.37	3.74	3.91	3.47
	3	2.76	3.12	3.37	3.72	3.24	2.80	3.27	3.48	3.86	3.35
	mean	2.56	2.87	3.20	3.48		2.60	2.97	3.26	3.66	
	L.S.D at $P \leq 0.05$ for										
	potassium			0.12					0.05		
	liquorice extract			0.06					0.05		
	interaction			011					0.10		
P (%)	0	0.42	0.48	0.58	0.70	0.55	0.41	0.52	0.61	0.70	0.56
	1	0.45	0.57	0.73	0.81	0.64	0.54	0.61	0.73	0.78	0.67
	2	0.48	0.62	0.86	0.93	0.72	0.58	0.69	0.82	0.94	0.76
	3	0.52	0.68	0.84	0.90	0.74	0.65	0.74	0.86	0.92	0.79
	mean	0.47	0.59	0.75	0.84		0.55	0.64	0.76	0.84	
	L.S.D at $P \leq 0.05$ for										
	potassium			0.02					0.01		
	liquorice extract			0.02					0.02		
	interaction			N.S.					0.02		
K (%)	0	1.09	1.27	1.41	1.48	1.31	1.12	1.18	1.37	1.41	1.27
	1	1.11	1.32	1.48	1.65	1.39	1.11	1.29	1.45	1.62	1.37
	2	1.46	1.58	1.77	1.89	1.68	1.39	1.53	1.82	1.85	1.65
	3	1.36	1.53	1.72	1.82	1.61	1.36	1.53	1.73	1.82	1.61
	mean	1.26	1.43	1.60	1.71		1.25	1.38	1.59	1.68	
	L.S.D at $P \leq 0.05$ for										
	potassium			0.02					0.04		
	liquorice extract			0.04					0.03		
	interaction			0.05					0.05		

The increasing of liquorice extract rates from 2 to 6 $g \cdot l^{-1}$ led to a significant increase in N, P and K values in leaves (table 6). In general, the highest and the lowest leaf mineral values were obtained by the application of liquorice extract at the rate of 6 $g \cdot l^{-1}$ and no application, respectively, in both seasons. Similar finding were reported by Hamadah et al. [2012] and El Sagan [2015]. This result could be due to that liquorice contains many minerals such as potassium, phosphorus [Saleh et al. 2013]. Indirectly, Dhak et al. [2010] found that the addition of saponins or the liquorice extract to solutions leads to suppression of surface tension for it, therefore, the saponins compound in liquorice extract may reduce the surface tension of the plant sap which increases the efficiency of sap transition through plant's vascular using the capillary motion according to cohesion-tension theory of Dixon and Joly [1894] as a consequence, it works on energy saving which exploits it in the growth and other construction operations within plant, this is particularly important under various stress conditions.The effect of interaction between potassium and liquorice extract level, indicated that the highest values of a mineral percent of leaves (N, P and K) were obtained from the 2 g·l^{-1} potassium combined with 6 g·l^{-1} liquorice, in both seasons. The differences among treatments were significant in both growing seasons except the phosphorus percent in the first season.

Yield and its components. Potassium application improved significantly fruits number per plant, fruit weight, total yield (table 7). The effect was more pronounced with the application of potassium at rate 2 g·l^{-1} in both seasons. These results are similar to those of Jaafer [2012] and Kazemi [2014].

Table 7. Effect of potassium and liquorice extract application on fruit number per plant, average fruit fresh weight and total yield of eggplant in 2013 and 2014 seasons

	Treatments	First season (2013)					Second season (2014)				
	Potassium (g·l^{-1})	liquorice extract (g·l^{-1})					liquorice extract (g·l^{-1})				
		0	2	4	6	mean	0	2	4	6	mean
Fruit number per plant	0	5.05	5.55	6.54	7.72	6.22	5.24	5.72	6.71	7.91	6.40
	1	5.56	6.34	7.62	8.54	7.02	5.75	6.52	7.82	8.77	7.22
	2	6.92	7.98	9.16	10.02	8.52	7.12	8.18	9.37	10.26	8.73
	3	6.77	7.87	9.01	9.50	8.29	6.96	8.07	9.22	9.72	8.49
	mean	6.08	6.94	8.08	8.95		6.27	7.12	8.28	9.17	
	L.S.D at P ≤ 0.05 for										
	potassium			0.13					0.21		
	liquorice extract			0.17					0.20		
	interaction			0.34					0.40		
Average fruit weight (g)	0	55.43	63.07	70.40	71.15	65.01	53.14	65.37	69.62	74.00	65.53
	1	60.52	65.43	73.78	77.68	69.35	60.94	69.05	75.62	78.67	71.07
	2	67.56	73.87	84.63	87.92	78.50	67.76	75.43	84.74	89.10	79.26
	3	64.88	74.45	83.54	84.77	76.91	66.26	72.66	84.93	86.59	77.61
	mean	62.10	69.21	78.09	80.38		62.03	70.63	78.73	82.09	
	L.S.D at P ≤ 0.05 for										
	potassium			0.72					1.80		
	liquorice extract			0.65					1.26		
	interaction			1.31					2.53		
Total yield (ton per feddan*)	0	4.45	5.65	6.28	7.13	5.88	4.95	5.46	6.44	7.57	6.11
	1	4.80	6.00	6.81	7.54	6.29	5.46	6.37	7.48	8.37	6.92
	2	6.18	7.22	8.25	8.63	7.57	6.92	8.08	9.03	9.90	8.48
	3	6.07	6.95	7.87	8.37	7.32	6.73	7.67	8.89	9.36	8.16
	mean	5.38	6.46	7.30	7.92		6.02	6.90	7.96	8.80	
	L.S.D at P ≤ 0.05 for										
	potassium			0.12					0.07		
	liquorice extract			0.09					0.11		
	interaction			0.17					0.21		

* – 1 feddan = 0.42 hectares

Concerning to the effect of liquorice extract, all liquorice extract rates significantly increased the eggplant yield parameters such as fruit number per plant, fruit weight and total yield per feddan compared to control. Liquorice extract at a rate 6 g·l^{-1} gave the superior values of eggplant yield parameters compared to the control treatment. It is evident that liquorice extract at rate 6 g·l^{-1} increased fruit number per plant (47.2% in the 1st and 46.3% in the 2nd season), fruit weight (29.4% in the 1st and 32.3% in the 2nd season) and total yield per feddan (47.2% in the 1st and 46.2% on the 1nd season). Similar results were also obtained by Hamadah et al. [2012] and El Sagan [2015].

Regarding to the interaction effect between potassium and liquorice extract level on fruits number per plant, fruit weight and total yield per feddan, the foliar spraying by 2 g·l^{-1} potassium along with the 6 g·l^{-1} liquorice extract recorded the highest values compared with other treatments in both seasons.

The satisfactory influence of using the potassium and liquorice extract on yield and its components may be due its favorable effect on plant growth (tabs 4 and 5) and leaf percentages of N, P and K (tab. 6). The yield per feddan reached 4.45 and 4.95 tons with untreated by potassium and liquorice extract and obtained 8.63 and 9.90 tons by using the 2 g·l^{-1} potassium combined with the 6 g·l^{-1} liquorice extract in the first and second seasons, respectively.

CONCLUSION

Both potassium and liquorice extract, in particular, potassium at 2 g·l^{-1} and liquorice extract at 6 g·l^{-1} increase the growth, percentage mineral content of the leaves (N, P and K) and yield of eggplant under saline conditions due to improving the ability of plants to tolerate salinity stress.

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REAKCJA BAKŁAŻANA (*Solanum melongena* L.) NA POTAS I EKSTRAKT Z LUKRECJI W WARUNKACH ZASOLENIA

Streszczenie. Bakłażan (*Solanum melongena* L.) jest jedną z najważniejszych roślin letnich z rodziny Solanaceae ze względu na wysoką zawartość węglowodanów, protein i związków mineralnych, tzn. N, P, K i Fe oraz witaminy C. Latem 2013 i 2014 w gospodarstwie doświadczalnym na glebie zasolonej w warunkach systemu nawadniania w okręgu południowego Synaju badano zachowanie bakłażana (*Solanum melongena* L.) w reakcji na spryskiwanie potasem (0, 1, 2 i 3 $g \cdot l^{-1}$) i wyciągiem z lukrecji (0, 2, 4 i 6 $g \cdot l^{-1}$). Oceniono wpływ czynników doświadczenia na parametry wzrostu roślin (wysokość, liczba liści, liczba pędów, świeża i sucha masa), zawartość chlorofilu, związków mineralnych w liściach (N, P i K), parametry plonu, takie jak liczba owoców na roślinie, masa owocu, całkowity plon w przeliczeniu na feddan (0.42 ha). Rezultaty wykazały, że dolistne stosowanie potasu i wyciągu z lukrecji powoduje istotny wzrost wszystkich badanych parametrów w porównaniu z kontrolą. Dolistne łączne zastosowanie 2 $g \cdot l^{-1}$ potasu oraz 6 $g \cdot l^{-1}$ wyciągu z lukrecji dało największe wartości wzrostu wegetatywnego, zawartości związków mineralnych w liściach, plonu i jego składników.

Słowa kluczowe: dokarmianie dolistne, wzrost roślin, zwartość składników odżywczych, plon

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