Improving of Eggplant tolerance to salt stress by application of Selenium

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Abstract:

The experiment was conducted during the autumn season 2020-2021 in one of the plastic houses belonging to the department of horticulture, College of Agriculture, Al-qasim Green University to study the effect of irrigation water salinity and soil application of selenium on some soil characteristics, growth and yield of Eggplant (Solanum melongena L.) under the covered agriculture system.Three irrigation water salinity levels 1.8, 4, 8 $ds.m^{-1}$ and five selenium levels 0, 10, 20, 40, 80 $gm.ha^{-1}$ in Factorial experiment in RCBD with three replicates were used. Increasing irrigation water salinity to 8 dsm^{-1} increased significantly the soil salinity and decreased soil reaction and most of plant growth parameters such as vegetative and root dry matter and the yield of Eggplants while the soil addition of selenium mitigate the effect of the salinity on the most plant growth parameters . Soil addition of selenium increased both total and available concentrations of selenium in soil and N,P,K,Se concentration in leaves.

Keywords: Eggplant tolerance, salt stress, Selenium

Introduction:

Eggplant (Solanum melongena L.) is a common vegetable crop grown in Iraq, tropical and subtropical regions, Egypt, India, the Middle East, France and the United States of America, and is considered as a national diet in most of these countries (Yousafi et al., 2013). The salinity threshold for eggplant is1.5 dsm-1 with a slope of 4.4% and the water consumption of the plant decreases due to the increase in soil salinity with a slope of 2.1% (Unlukara et.al.2010). Salt stress is a serious problem for plants because it reduces plant productivity and growth, as the change in salinity lowers plant metabolism and causes organ dysfunction by reducing water and nutrient absorption, inhibiting growth and photosynthesis, and this in turn greatly affects plant productivity (Abdelrahman et. al.2018). Selenium (Se) is an important element for humans, animals and many plants, and there is evidence that adding selenium in low concentrations leads to an increase in plants resistance to many different environmental stresses (Ghazi, 2018). Under the conditions of salt stress, the addition of selenium reduces the harmful effect of sodium ions on the absorption of potassium by the roots of the plant due to the increase of sodium in the soil solution as a result of the high salinity of the irrigation water, and this role enhances the plant tolerance to salinity and increases the absorption of elements (Astaneh et. al. 2018).

Materials and methods:

The experiment was carried out in the autumn season (2020-2021) in one of the greenhouses affiliated to the Department of Horticulture and Landscaping Engineering,

College of Agriculture, Al-Qasim Green University. The process of plowing the soil of plastic house was carried out, then it was leveled, and three terraces with a width of 1m were made for the terrace along the length of the plastic house, thus making the area of the experiment unit $2m^2$. The experimental unit included five eggplant plants, the distance between one plant and another was 40 cm, leaving a distance of 1 m between the experimental units using the RCBD design in , a split-factorial experiment. Table (1) represents some soil chemical and physical properties . Three Irrigation water salinities 1.8,4,8 $ds.m^{-1}$ were used. The seeds of eggplant, SAMARA F1 variety, were sown in the greenhouse on 10/15/2020, and after two months, the seedlings were transferred to the plastic house . Five plants were planted in the experimental unit and dab fertilizer was added after the transfer of seedlings at a rate of 150 kg.ha-1 for all treatments. Selenium was added to the soil in five concentrations, 0, 10, 20, 40 and 80 $gm.ha^{-1}$ after two weeks of transferring the seedling to the plastic house and with three replications, bringing the number of experimental units to 45 that were randomly distributed.

The drip irrigation method was used, and some chemical properties of irrigation water was illustrated in table 2.

Results and discussion:

1- Soil salinity

Increasing irrigation water salinity from 1.8 to 8 dsm^{-1} led to a significant increase in soil salinity from 5.05 to 14.2 dsm^{-1} (table 3). The reason for this may be due to the different concentrations in the used irrigation water (table 2).

Table (3) Effect of adding selenium on the electrical conductivity of soil $ds.m^{-1}$ after harvest under salt stress

Irrigation Water Salinity ($ds.m^{-1}$)	**Selenuim Concentration ($gm.ha^{-1}$)**					**Mean**
	Se1 (0)	**Se2 (10)**	**Se3 (20)**	**Se4 (40)**	**Se5 80))**	
1.8	4.92	4.96	5.01	5.09	5.27	5.05
4	8.61	8.83	9.27	9.26	9.29	9.05
8	14.32	14.45	14.21	14.17	14.11	14.25
Mean	9.28	9.41	9.50	9.51	9.56	9.45
L.S.D0.05	**Irrigation Water Salinity**		**Selenuim Concentration**		**Interaction**	
	0.19		**0.24**		**0.42**	

2- Soil reaction.

Increasing irrigation water salinity from 1.8 to 8 dsm^{-1} caused a decrease in soil reaction from 7.54 to 7.47 (table 4) and this is may be due to the accumulation of chloride and sulfate salts of calcium and magnesium as well as sodium .

Table (4) Effect of adding selenium on the soil reaction after harvesting under salt stress

Irrigation Water Salinity ($ds.m^{-1}$)	**Selenuim Concentration ($gm.ha^{-1}$)**					**Mean**
	Se1 (0)	**Se2 (10)**	**Se3 (20)**	**Se4 (40)**	**Se5 80))**	
1.8	7.56	7.55	7.54	7.52	7.52	7.54
4	7.58	7.53	7.47	7.48	7.47	7.50
8	7.50	7.49	7.46	7.46	7.42	7.47
Mean	7.54	7.52	7.49	7.49	7.47	7.50
L.S.D0.05	**Irrigation Water Salinity**		**Selenuim Concentration**		**Interaction**	
	0.02		**0.03**		**0.05**	

3- Total selenium concentration

The total soil selenium concentration was increased by 25% with increasing irrigation water salinity from 1.8 to 8 dsm^{-1} and this may be attributed to the increase in the selenium concentration in saline water (table2). Also the high addition of selenium 80 $gm.ha^{-1}$ caused a high total selenium concentration in soil (table 5).

Table (5) Effect of adding selenium on the total selenium concentration in soil $mg.kg^{-1}$ after harvest under salt stress

Irrigation Water Salinity ($ds.m^{-1}$)	**Selenuim Concentration ($gm.ha^{-1}$)**					**Mean**
	Se1 (0)	**Se2 (10)**	**Se3 (20)**	**Se4 (40)**	**Se5 80))**	
1.8	5.02	8.32	15.20	27.12	45.12	20.16
4	7.62	10.96	18.64	30.12	50.13	23.49
8	6.00	11.35	19.19	34.50	55.05	25.22
Mean	6.21	10.21	17.68	30.58	50.10	22.95
L.S.D0.05	**Irrigation Water Salinity**		**Selenuim Concentration**		**Interaction**	

	1.31	**1.69**	**2.93**

4- Available selenium concentration :

The available selenium concentration was decreased from 2.04 to 0.72 $mgkg^{-1}$ with increasing soil salinity from 1.8 to8 dsm^{-1} and this may be due to the association of selenium ions with some ions existed in soil solution making a precipitated complexes which increase the total selenium concentration (table 5). The addition of selenium significantly increased the available selenium concentration(table 6)

Table (6) Effect of adding selenium on the concentration of available selenium in soil $mg.kg^{-1}$ after harvest under salt stress

Irrigation Water Salinity ($ds.m^{-1}$)	**Selenuim Concentration ($gm.ha^{-1}$)**					**Mean**
	Se1 (0)	**Se2 (10)**	**Se3 (20)**	**Se4 (40)**	**Se5 80))**	
1.8	1.54	1.90	2.01	2.28	2.49	2.04
4	1.07	1.28	1.31	1.42	1.50	1.32
8	0.23	0.40	0.62	1.05	1.28	0.72
Mean	0.94	1.19	1.32	1.58	1.75	1.35
L.S.D0.05	**Irrigation Water Salinity**		**Selenuim Concentration**		**Interaction**	
	0.04		**0.05**		**0.08**	

5- Vegetative, root dry weights and yield of eggplant:

The vegetative and root dry weights and the yield of eggplant (tables7,8,9) decreased significantly with increasing irrigation water salinity and this may be attributed to the accumulation of toxic ions in plant cells which caused a decrease in the activity of plant tissues, cell division and elongation .

Also increasing salinity caused an increase is osmotic pressure and adepression in cells volumes , photosynthesis process efficiency (Alsultani,2020).The addition of selenium decrease the negative effects of salinity due its ability to bind Seleno- methionine amino acid with selono cestien and other aminoacids which as a result increase DNA and RNA neuclic acids activity and through this activity increases cell expansion division and cell differentiation (castello- Godina et.al.2016)

Table (7) Effect of adding selenium on vegetative dry weight gm after harvest under salt stress

Irrigation Water Salinity ($ds.m^{-1}$)	**Selenuim Concentration ($gm.ha^{-1}$)**					**Mean**
	Se1 (0)	**Se2 (10)**	**Se3 (20)**	**Se4 (40)**	**Se5 80))**	
1.8	138.53	139.17	140.57	150.20	168.57	147.41
4	104.43	118.00	118.27	125.87	129.23	119.16
8	104.00	110.43	112.93	115.73	120.53	112.73
Mean	115.66	122.53	123.92	130.60	139.44	126.43
L.S.D0.05	**Irrigation Water Salinity**		**Selenuim Concentration**		**Interaction**	
	2.61		**3.37**		**5.83**	

Table (8) Effect of adding selenium on the root dry weight gm after harvest under salt stress

Irrigation Water Salinity ($ds.m^{-1}$)	**Selenuim Concentration ($gm.ha^{-1}$)**					**Mean**
	Se1 (0)	**Se2 (10)**	**Se3 (20)**	**Se4 (40)**	**Se5 80))**	
1.8	44.43	49.18	53.80	55.70	57.00	52.02
4	40.44	41.11	42.38	42.90	43.74	42.11
8	38.32	39.38	40.58	41.60	42.49	40.47
Mean	41.07	43.22	45.59	46.73	47.74	44.87
L.S.D0.05	**Irrigation Water Salinity**		**Selenuim Concentration**		**Interaction**	
	1.31		**1.69**		**2.93**	

Table (9) Effect of adding selenium on eggplant yield $ton.ha^{-1}$ after harvest under salt stress

Irrigation Water Salinity ($ds.m^{-1}$)	**Selenuim Concentration ($gm.ha^{-1}$)**					**Mean**
	Se1 (0)	**Se2 (10)**	**Se3 (20)**	**Se4 (40)**	**Se5 80))**	

1.8	49.98	55.83	59.40	64.27	69.55	59.81
4	40.60	43.38	48.27	51.17	53.93	47.47
8	37.17	40.50	42.27	45.73	41.53	41.44
Mean	42.58	46.57	49.98	53.72	55.01	49.57
L.S.D0.05	**Irrigation Water Salinity**		**Selenuim Concentration**		**Interaction**	
	2.51		**3.24**		**5.61**	

6- N, P, K, Se concentrations in leaves:

Increasing irrigation water salinity caused a significant decrease in N, P, K, Se concentrations in leaves (tables 10,11,12,13) and this may be attributed to the competition between Cl^- and other ions such as No_3^-,$H_2po_4^-$, $SeO_4^=$,on the absorbing sights in the roots (Al-taey et.al.2017).In addition the reduced volume of roots due to increasing salinity caused a decrease in plant absorbing ability to these ions (par dossi et.al.1999). The addition of selenium caused a significant increase in the concentration of these ions due to its role in many physiological , chemical and biological mechanisms that mitigate the effects of salinity (Djanaguiraman et.al.2005) in addition to the role it plays as an antioxidant.

Table (10) Effect of adding selenium on N% in leaves after harvest under salt stress

Irrigation Water Salinity ($ds.m^{-1}$)	**Selenuim Concentration ($gm.ha^{-1}$)**					**Mean**
	Se1 (0)	**Se2 (10)**	**Se3 (20)**	**Se4 (40)**	**Se5 80))**	
1.8	1.83	1.96	2.27	1.91	1.88	1.97
4	1.82	1.87	1.72	1.83	1.67	1.78
8	1.67	1.53	1.46	1.74	1.97	1.67
Mean	1.77	1.78	1.82	1.83	1.84	1.80
L.S.D0.05	**Irrigation Water Salinity**		**Selenuim Concentration**		**Interaction**	
	0.09		**0.11**		**0.19**	

Table (11) Effect of adding selenium on P% in leaves after harvest under salt stress

Irrigation Water Salinity ($ds.m^{-1}$)	**Selenuim Concentration ($gm.ha^{-1}$)**					**Mean**
	Se1 (0)	**Se2 (10)**	**Se3 (20)**	**Se4 (40)**	**Se5 80))**	
1.8	0.44	0.46	0.37	0.41	0.40	0.42
4	0.27	0.30	0.29	0.32	0.33	0.30
8	0.24	0.23	0.32	0.29	0.32	0.28
Mean	0.32	0.33	0.33	0.34	0.35	0.33
L.S.D0.05	**Irrigation Water Salinity**		**Selenuim Concentration**		**Interaction**	
	0.02		**0.02**		**0.04**	

Table (12) Effect of adding selenium on K% in leaves after harvest under salt stress

Irrigation Water Salinity ($ds.m^{-1}$)	**Selenuim Concentration ($gm.ha^{-1}$)**					**Mean**
	Se1 (0)	**Se2 (10)**	**Se3 (20)**	**Se4 (40)**	**Se5 80))**	
1.8	1.71	1.76	1.91	2.44	2.77	2.12
4	1.43	1.55	1.75	1.87	2.34	1.79
8	1.36	1.44	1.61	1.78	2.19	1.68
Mean	1.50	1.58	1.76	2.03	2.43	1.86
L.S.D0.05	**Irrigation Water Salinity**		**Selenuim Concentration**		**Interaction**	
	0.03		**0.04**		**0.07**	

Table (13) Effect of adding selenium on selenium concentration in leaves mg.kg^{-1}after harvest under salt stress

Irrigation Water Salinity (ds.m^{-1})	**Selenuim Concentration (gm.ha^{-1})**					**Mean**
	Se1 (0)	**Se2 (10)**	**Se3 (20)**	**Se4 (40)**	**Se5 80))**	
1.8	3.28	5.66	11.99	21.35	27.22	13.90
4	1.60	3.57	9.02	17.55	22.45	10.84
8	0.51	2.36	7.65	12.85	18.63	8.40
Mean	1.80	3.87	9.55	17.25	22.77	11.04
L.S.D0.05	**Irrigation Water Salinity**		**Selenuim Concentration**		**Interaction**	
	0.81		**1.05**		**1.82**	

Table 1 Some chemical and physical properties of soil

Property	**Unit**	Value
(EC_e)	**ds.m^{-1}**	**5.08**
(PH)		**7.75**
Dissolved ions		
Ca^{++}	**mmol.L^{-1}**	**10.89**
Mg^{++}		**7.53**
Na^{+}		**10.75**
K^{+}		**0.81**
Cl^{-}		**16.12**
So_4^{-2}		**12.26**
Hco_3^{-}		**5.05**
CO_3^{-2}		**0.00**
SAR	**(mmol.L^{-1})$^{1/2}$**	**2.44**
CEC	**Cmmol.kg^{-1}**	**15.43**
$CaCO_3$	**gm.kg^{-1}**	**259**

$CaSO_4$		**0.79**
Bluk density	**Megagram.m^{-3}**	**1.31**
Porosity	**(%)**	**50%**
O.M	**gm.kg^{-1}**	**6.51**
N	**Mg.Kg^{-1}**	**31**
P		**20**
K		**201**
Se total		**9.25**
Se available		**1.81**
Sand	**Mg.Kg^{-1}**	**904.3**
Silt		**76.8**
Clay		**18.5**
Soil Texture	**Sandy Loam**	

Table No. 2 Some chemical properties of the irrigation water used in the experiment

Property	**Unit**	**Value**		
		E1	**E2**	**E3**
Ec	**ds.m^{-1}**	1.8	4	8
PH	-	7.50	7.85	7.83
Ca	**mmol.L^{-1}**	3.77	5.6	8.7
Mg	**mmol.L^{-1}**	1.61	4.8	9.6
Na	**mmol.L^{-1}**	3.13	11.15	19.4
K	**mmol.L^{-1}**	0.14	0.22	0.28
Cl	**mmol.L^{-1}**	3.87	11.7	23.2
So_4	**mmol.L^{-1}**	4.46	9.2	18.40

Hco_3	**$mmol.L^{-1}$**	2.14	2.73	4.21
Se	$mg.L^{-1}$	1.73	2.64	3.56
(SAR)	**$(mmol.L^{-1})^{1/2}$**	1.34	3.45	4.56
water class	-	C_3S_1	C_4S_1	C_5S_1

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