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Effect of some Potassium Sources on Productivity and Quality of Pea under Conditions of Saline Soil

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ABSTRACT

This study was carried out during 2015 and 2016 seasons at a private Farm in Road Village in Sahl El-Husseiniya, Sharkia Governorate to study the influence of foliar spraying with three potassium sources at three concentrations from each of them i.e. potassium sulfate1,2 and 4 g/ L; potassium silicate at 1,2,and 4cm/L as well as potassium humate at 1,2 and 4 cm / L beside without foliar spraying (control) to reduce the bad effects salinity stress on growth, yield and quality of pea Master B cultivar under saline soil conditions. The experiment was carried out by using completely randomized blocks design with three replications. Spraying pea plants with potassium silicate (4 cm/L) significantly increased and created the maximum means of all studied traits (growth, yield and yield attributes and chemical constituents in the leaves and seeds) as compared to other studied treatment in the two seasons. Spraying with potassium silicate (2 cm/L) was the second best treatment, followed by potassium silicate at the rate of 1 cm/L, then potassium humate at the rate of 4 cm/L and 2 cm/L in the two seasons. Conversely, the lowest means of these traits resulted from control treatment in the two seasons. Overall, using potassium silicate at different rates as foliar application exceeded using potassium humate at different rates exceeded potassium sulfate at different rates in the two seasons. Concerning proline % in leaves, it had adverse trend comparing with other studied traits in the two seasons. Generally, it could be recommended that spraying pea plants through 4 cm potassium silicate/L to enhance growth, yield and yield components and chemical constituents of pea under the environmental conditions of same research.

Keywords: Pea, foliar spraying, potassium sources, potassium sulfate, potassium silicate, potassium humate.

INTRODUCTION

Pea (*Pisum sativum* L.) is one of most essential leguminous vegetable crops grown during winter season in Egypt. It can grow throughout different types of soils ranging from the light sandy loam to the heavy clay in texture. But peas are relatively sensitive to salinity (Munns *et al.*, 2003). Soil salinity, the presence of excessive salts in the soil, and salinity is a very serious problem for agricultural productivity (Munns, 2005).

Owing to supplementation and ensuring nutrients availability, the application of foliar nutrition is imperative to create it uncomplicated and fast consumption by piercing stomata or leaf cuticle and go into the cells as compared to soil nutrients applied to obtain the highest yields and minimum cost per unit area (Arif *et al.*, 2006).

Potassium (K) is involved in the merestimatic tissues and is indispensable to maintain the pressure of the cell turgur, which is required to expand the cell (Rogalski, 1994 and Defan *et al.*, 1999). Moreover, it have a main function in osmoregulation, photosynthesis, transpiration, open and closure of stomatal and protein synthesis (Cakmak, 2005 and Milford and Johnston, 2007), in addition translating of assimilates into sink organs and enzymes establishment (Mengel and Kirkby, 2001). One of the mechanisms for improving plant tolerance to salinity is to apply potassium, which seems to have beneficial effects potassium fertilization mitigates the adverse effects of salinity in plants by increasing translocation and maintaining water balance within plants (Greenwood and Karpinets, 1997). Hussein *et al.* (2012) found that spraying pepper plants with potassium (200 ppm) increased the plant growth, biomass production, and fruit yield. While, chlorophyll a content and total phenols significantly increased with foliar application with 100 ppm of potassium. Elsharkawy (2013) indicated that foliage fresh and dry weights, No. of pods per plant, weight of pods per plant, total yield/fed, N, protein and K content in green pea seeds were significantly and positively affected by increasing potassium levels and the maximum promotion was detected at 48 kg K_2O/fed. Behairy *et al.* (2015) showed that spraying onion plants by way of 2 L potassium thiosulfate\fed noticeably increased growth, yield, bulb quality and bulb chemical composition. Balpande *et al.* (2016) stated that significantly high seed yield and protein % of pigeon pea were observed due to application of 30 kg K_2O/ha.

Silicon (Si) is one of the popular often taking places in chemical elements in nature (Chen *et al.*, 2010) and micronutrient for plant development (Regina and Katarzyna, 2011). It is well known that Si participates in plant tolerance against many stress factors, among them silicon in soil assists plants to stay alive in water shortage conditions, and decrease transpiration in cells with high silicon concentration (Gao *et al.*, 2006), in addition increasing dry mass and yield besides improved pollination (Korndörfer and Lepsch, 2001). Silicon addition caused enhancing in chemical composition and productivity as well as fruit quality of several plants(Crusiol *et al* ,2009 on potato and Abou-Baker *et al.*, 2011 on Faba bean). and most commonly increased disease resistance (Rodrigues, 2004). The increase of tomato productivity due to using SiO could be attributed to the benefit effects of Si in the plant, as an progress of the architecture for performance more erect leaves, which intercept upper solar luminosity rising the photosynthetic effectiveness and higher chlorophyll content (Braga *et al.*, 2009). El-Hedek (2013) found that potassium silicate foliar application significantly improved yield components of wheat and also increased their contents of potassium, calcium and phosphorus percentages.

Humic acid have a lot of helpful effects on soil arrangement, soil microbial populations, augment adjust mechanisms concerned in plant growth encouragement, nutrients uptake and increment yield (Akinremi *et al.*, 2000). Faten *et al.* (2005) studied the effect of potassium humate (0, 3, 6 and 12 L/fed) of onion plants. They found that potassium humate (KH) had significant effects on growth characters, total yield and components as well as it was caused an increment in TSS, N, P, K and Fe in bulbs tissues. Dhanasekarm (2006) found that spraying tomato plants with humic acid as based substance improved total yield as compared to control treatment (without humic spraying). Gad El-Hak *et al.* (2012) found that foliar application with humic acid at 2g/L produced the highest plant dry weight, pod diameter, fresh seeds weight/pod, number of fresh seeds/pod, green pod yield, seeds weight/dry pod, dry seed yield and phosphorus percentages. Dawa *et al.* (2013) reported that spraying pea plants with a humic acid lead to obtain highest vegetative growth parameters, and yield and its components. Helmy (2013) found that spraying with humic acid increased height of plant, No. of branches per plant, No. of leaves per plant, photosynthetic pigments (chlorophyll a, b, total chlorophyll a + b and carotene), nitrogen, phosphorus and potassium in leaf tissues, dry weight/ plant, length of pod, diameter of pod, No. of seeds per pod, the weight of 100 seeds, green pods yield/plant and green pods yield/fed. Khan *et al.* (2013) evaluated the effects of humic acid practical as soil or foliar addition at 15, 30 and 45 ppm on pea growth, nutrient concentrations and yield. Plant growth and seed yield were increased by soil or foliar application of humic acid. Fahramand *et al.* (2014) revealed that humic acids are heterogeneous, which include in the same macromolecule, hydrophilic acidic functional groups and hydrophobic groups. Under water stress, foliar fertilization with humic molecules increased leaf water retention and the photosynthetic and antioxidant metabolism. Kandil (2014) found that dry weight, weight of 100 seeds and yield of pea were significantly increased by increasing of humic acid levels. Humic acid decreased soil pH and increased the availability of phosphors and micronutrients.

Hence, this investigation aimed to study the influence of foliar spraying with some potassium sources on growth, yield and quality of pea Master B cultivar under saline soil conditions in Road Village, El-Husseiniya Center, Sharkia Governorate.

MATERIALS AND METHODS

These field experiments carried out during the two winter seasons of 2015/2016 and 2016/2017 at private farm in Road Village in Sahl El –Husseiniya, Sharkia Governorate , Egypt. The objectives of this investigation to study the reduction of the adverse effect saline soil stress on growth and yield in'Master B cultivars peas by foliar spraying with some potassium sources .

The experiment was carried out by using completely randomized blocks design with three replications. The experimental unit area was (10.5 m2) and included 5ridges each of (0.6 m) width and (3.5 m) length. The studied treatments (foliar spraying with some potassium sources, in addition recommended NPK rate) were as follows;

1- Without foliar spraying (control treatment).
2- Foliar spray with potassium sulfate 1 g/L.
3- Foliar spray with potassium sulfate 2 g/L.
4- Foliar spray with potassium sulfate 4 g/L.
5- Foliar spray with potassium silicate 1 cm/L.
6- Foliar spray with potassium silicate 2 cm/L.
7- Foliar spray with potassium silicate 4 cm/L.
8- Foliar spray with potassium humate 1cm/L.
9- Foliar spray with potassium humate 2 cm/L.
10- Foliar spray with potassium humate 4 cm/L.

The foliar solution volume was 200 Liter/fed and spraying by hand sprayer (for experimental plots) until saturation point. Foliar spraying with some potassium sources was carried out three times at aforesaid levels after 30, 37 and 44 days from sowing (DFS).

The farm soil type was clay loam soil and Table 1 shows the physical and chemical properties of the experimental soil.

A sample of irrigation water was collected and analyzed for the saline content as revealed in Table 2.

Table 1. Soil characteristics of the experimental sites in the two growing seasons.

Soil analyses		2015	2016
A: Mechanical analysis:			
Clay (%)		48.00	52.0
Silt (%)		31.40	28.4
Fine sand (%)		19.70	14.7
Coarse sand (%)		1.90	2.89
Texture class		Clay	Clay
Organic matter (%)		1.14	2.91
B: Chemical analyses:			
pH (1 : 2.5)		7.89	8.11
E.C. ds m^{-1} (1 : 5)		4.07	3.90
Saturation percentage (SP %)		72.00	71.50
Available N (ppm)		46.50	48.1
Available P (ppm)		4.30	4.70
Exchangeable K (ppm)		375	226
Cations (meq/100 g soil)	Ca^{++}	3.25	4.25
	Mg^{++}	0.67	2.41
	Na^{+}	4.25	2.93
	K^{+}	0.31	0.16
Anions (meq/100 g soil)	CO_3^{--}	-	-
	HCo_3^{-}	0.94	4.61
	Cl^{-}	2.66	2.73
	So_4^{--}	1.88	2.39

Table 2. Chemical analysis of the irrigation water of El-Salam Canal used in the experimental field during the two growing seasons.

Properties		2015	2016
pH		8.22	8.12
E.C. dS m^{-1}		1.28	1.26
Anions (meq L^{-1})	CO_3^{--}	-	-
	HCo_3^{-}	2.30	2.40
	Cl^{-}	7.61	7.56
	So_4^{--}	2.89	2.87
Cations (meq L^{-1})	Ca^{++}	3.38	3.36
	Mg^{++}	2.98	2.99
	Na^{+}	6.30	6.40
	K^{+}	0.14	0.15
SAR		3.53	3.54

Pea seeds of Master B cultivar were immediately sown in the moderately moist soil on 20th and 25th November in 1st and 2nd seasons, respectively. Seeds were sown in hills (3 seeds / hill) by hand at 10 cm apart on 2 rows of each ridge. The common recommended rates of chemical fertilizers (N, P and K) were added. Where, 200 kg calcium super phosphate (15.5 % P2O5)/fed was applied during preparation of soil. Potassium fertilizer (potassium sulphate "48.0 % K2O") at 75 kg/fed and nitrogen fertilizer (ammonium sulfate "20.5 % N") at 150 kg/fed were used in two equal doses, the first one was added before the first irrigation and the second one was before the following irrigation. According to Ministry of Agriculture and Land Reclamation recommendations, all other agricultural practices were done, excluding studied factors.

After 50 days of the sowing, samples of 5 plants were randomly taken from each experimental unit to measure vegetative growth traits as follows:

1- Height of plant (cm).
2- No. of leaves per plant.
3. Total chlorophylls (SPAD): Leaf chlorophylls content was assessed by SPAD-502 (Minolta Co. Ltd., Osaka, Japan).
4. Plant fresh weight (g).
5. Plant dry weight (g): The plant samples were weighed and oven dried at 70 °C until constant weight was reached then, dry matter calculated in expression of g/plant.

Green pods of each plot were harvested at the proper maturity stage, and then the following parameters were recorded:

1- Average length of pod (cm).
2- Green seeds number per pod.
3- The weight of 100 green seeds (g).
4- Total yield: It was calculated as the total weight of pods (t/fed).

A representative samples of 100 g from pea leaves after 50 days from sowing and green pods at proper maturity stage were dried in the oven at 70°C until constant weigh. For determination of macro elements in the leaves and seeds; 0.2 g crude dried kept powder from each sample was wet digested with a mixture of concentrated sulphuric and perchloric acid (Peterburgski, 1968).

1-Nitrogen content (N %) was determined using Keldahl methods described by Jackson (1967).
2-Phosphorus content (P%) was determined colouremitricaly using the chlorostannus reduce molybdo phosphoric blue colours method in sulphoric system (Jackson 1967)
3-Potassium content (K %) was determined in the digested plant materials using a flame photometer according to Black (1965).
4-Total carbohydrates percentage was determined according to Somogy (1952).
5- Crude protein was calculated by multiplying the total nitrogen by the factor 6.25.
6-Proline percentage in leaves was determined according to AOAC (1990).

All obtained data statistically analyzed as technique of analysis of variance for the completely randomized blocks design (Gomez and Gomez, 1984) using "MSTAT-C" computer software package. LSD method was used to compare differences among means of treatments at 5 % level of probability (Snedecor and Cochran, 1980).

RESULTS AND DISCUSSION

1- Vegetative growth characters:

Data presented in Table 2 show that foliar spraying with some potassium sources *i.e.* potassium sulfate, potassium silicate and potassium humate at various rates in addition control treatment (without foliar spraying) caused significant effects on vegetative growth traits *i.e.* plant height, number of leaves/plant, total chlorophylls, fresh and dry weights of plant . The best treatments were spraying with 4 cm potassium silicate/ L, followed by spraying with the same source with rates of 2 and 1 cm / L as well as sprayed with potassium at 4 cm / L respectively. Generally, spraying pea plants with potassium silicate at different rates surpassed foliar spraying with potassium humate at different rates and followed by foliar spraying with potassium sulfate at different rates in the two seasons. While, the lowest values of vegetative growth traits were obtained from control treatment in the two growing seasons.

The enhancing effect of potassium silicate or potassium humate at various rates on vegetative growth traits may be due to come together the favourable effect of potassium and silicon or potassium and humic acid. Where, potassium acting important function in osmoregulation, photosynthesis, transpiration, open and closure of stomatal, protein synthesis, translating of assimilates into sink organs and enzymes establishment (Mengel and Kirkby, 2001 ; Cakmak, 2005 and Milford and Johnston, 2007). In addition, the effective role of silicon in the plant, as an improve of the architecture for showing more erect leaves, which intercept higher solar luminosity increasing the photosynthetic efficiency and higher chlorophyll content (Braga *et al.*, 2009), besides its role in plant forbearance adjacent to many stress factors. The enhancing effect of humic acid on vegetative growth of pea may be due to induce plant hormones which play a beneficial effect on nutrition of plants (Martinez *et al.*, 1983) and enhance the uptake of minerals through the stimulation of microbiological activity (Akinremi *et al.*, 2000). The obtained results are in harmony with those reported by Dawa *et al.* (2013), Elsharkawy (2013), Helmy (2013), Kandil (2014) and Balpande *et al.* (2016).

2- Yield and its components:

The data presented in Table 3 show that foliar spraying pea plants with some potassium sources *i.e.* potassium sulfate at the rates of 1, 2 and 4 g/L, potassium silicate at the rates of 1, 2 and 4 cm/L and potassium humate at the rates of 1, 2 and 4 cm/L compared with control treatment (without foliar spraying) caused significant increases in yield and its components (length of pod, No. of green seeds per pod, the weight of 100 green seeds and total yield/fed) in the two seasons of this study.

Spraying pea plants by 4 cm potassium silicate/L significantly increased and produced highest mean values of all studied yield and its components as compared other studied treatment in the two seasons of this study. The second best treatment was spraying with potassium silicate at the rate of 2 cm/L, followed by spraying with 1 cm potassium silicate/L, potassium humate at the rate of 4 cm/L, potassium humate at the rate of 2 cm/L, potassium humate at the rate of 1 cm/L, potassium sulfate at the rate of 4 g/L, then potassium sulfate at the rate of 2 g/L and spraying with potassium sulfate at the rate of 1 g/L. In contrast, the lowest mean values of all studied yield and its components were obtained from control treatment in both growing seasons. Overall, using potassium silicate at different rates as foliar application exceeded using potassium humate at different rates and potassium humate at different rates exceeded potassium sulfate at different rates in the two seasons.

The enhancing effect of potassium silicate treatments may be due to the role of potassium in osmoregulation, photosynthesis, transpiration, opening and closing of stomatal, synthesis of protein, translocation of assimilates and activation of enzymes (Mengel and Kirkby, 2001 ; Cakmak, 2005 and Milford and Johnston, 2007). Additionally, the benefit effects of silicon in facilitates plants live on the conditions of water shortage, decreasing transpiration, plant development, healthy and competitive growth and productivity (Gao *et al.*, 2006 ; Brunings *et al.*, 2009 and Regina and Katarzyna, 2011). Obtained findings are in compliance by those reported by Elsharkawy (2013), El- Hedek (2013) and Balpande *et al.* (2016).

The enhancing effect of potassium humate treatments might be payable to the beneficial function of potassium in plant growth, development and productivity as formerly mentioned, besides the distinction effects of humic acid should be made between indirect and direct effects on plants growth. In addition, foliar spraying with humic molecules increased leaf water retention and the photosynthetic and antioxidant metabolism (Fahramand *et al.*, 2014). Obtained findings are in conformity by those of Gad El-Hak *et al.* (2012), Dawa *et al.* (2013), Helmy (2013), Khan *et al.* (2013) and Kandil (2014).

Table 3. Plant height, number of leaves/plant, total chlorophylls, fresh and dry weights of plant after 50 days after sowing as affected by foliar spraying with some potassium sources during 2015 and 2016 seasons.

Characters	Plant height (cm)		Number of leaves/plant		Total chlorophylls (SPAD)		Fresh weight of plant (g)		Dry weight of plant (g)	
Treatments	**2015**	**2016**	**2015**	**2016**	**2015**	**2016**	**2015**	**2016**	**2015**	**2016**
Without	44.16	45.32	19.13	20.22	73.13	73.24	47.31	50.60	1.780	1.875
Potassium sulfate 1 g/L	46.71	48.16	20.41	21.23	73.74	73.24	50.42	52.51	1.875	1.968
Potassium sulfate 2 g/L	49.52	51.33	21.62	22.32	73.83	73.91	52.23	55.72	1.950	2.063
Potassium sulfate 4 g/L	53.43	54.41	22.53	23.52	74.21	74.41	55.15	57.52	2.062	2.156
Potassium silicate 1 cm/L	56.46	57.61	26.72	27.71	75.12	75.31	65.56	67.51	2.531	2.641
Potassium silicate 2 cm/L	58.62	59.72	28.81	29.92	75.55	75.74	70.71	72.53	2.652	2.717
Potassium silicate 4 cm/L	60.71	61.54	30.63	31.82	75.85	75.98	75.78	77.78	2.813	2.906
Potassium humate 1 cm/L	53.82	54.63	23.52	24.64	74.38	74.51	57.50	60.32	2.156	2.250
Potassium humate 2 cm/L	54.73	55.73	24.42	25.78	74.58	74.81	60.71	62.53	2.250	2.341
Potassium humate 4 cm/L	55.82	56.46	25.63	26.41	74.91	75.01	62.61	65.43	2.343	2.437
F. test	*	*	*	*	*	*	*	*	*	*
LSD at 5%	3.32	3.47	3.59	2.92	80.31	0.157	3.67	3.75	0.245	0.212

3- Chemical constituents in the leaves and seeds:

Foliar spraying pea plants with some potassium sources (potassium sulfate potassium silicate at the rates and potassium humate at different rates), besides control treatment (without foliar spraying) significantly affected chemical constituents in the leaves and seeds (N, P and K % in pea leaves after 50 days after sowing, N, P and K % in green seeds at harvesting as well as total carbohydrates and crude protein % in green seeds at harvesting and proline % in leaves after 50 days after sowing) in the two seasons of this study as shown in Table 4, 5 and.

The highest mean values of studied chemical constituents in the leaves and seeds, except proline % in leaves were obtained due to spraying pea plants with potassium silicate (4 cm/L) in the two seasons of this study. The descending order of other studied treatments was; 2 cm potassium silicate /L, 1 cm potassium silicate/L, 4 cm potassium humate/L, 2 cm potassium humate/L, 1 cm potassium humate /L, 4 g potassium sulfate/L, 2 g potassium sulfate/L and 1 g potassium sulfate/L. Conversely, the lowest mean values of all studied chemical constituents in the leaves and seeds, except proline % in leaves resulted from control treatment in both growing seasons. In general, the arrangement of potassium sources regardless its rates was as follows; potassium silicate, then potassium humate and potassium humate concerning its effect on chemical constituents in the leaves and seeds, except proline % in leaves in the two seasons. Regarding proline % in leaves, it had adverse trend comparing with other chemical constituents in the leaves and seeds in the two seasons.

Table 4. Pod length, number of green seeds/pod, weight of 100 green seeds and total yield/fed as affected by foliar spraying with some potassium sources during 2015 and 2016 seasons.

Characters Treatments	Pod length (cm)		Number of green seeds/pod		Weight of 100 green seeds (g)		Total yield (t/fed)	
	2015	**2016**	**2015**	**2016**	**2015**	**2016**	**2015**	**2016**
Without	7.83	8.02	6.14	5.62	36.26	38.30	2.12	2.24
Potassium sulfate 1 g/L	8.45	8.54	6.35	6.13	40.37	41.53	2.34	2.36
Potassium sulfate 2 g/L	8.84	8.97	6.86	6.64	43.23	44.67	2.56	2.43
Potassium sulfate 4 g/L	9.35	9.51	7.37	7.13	46.42	47.42	2.67	2.67
Potassium silicate 1 cm/L	10.89	11.03	8.92	8.73	54.52	53.14	3.31	3.43
Potassium silicate 2 cm/L	11.32	11.43	9.63	9.34	56.63	57.36	3.53	3.65
Potassium silicate 4 cm/L	11.69	11.92	10.03	9.89	58.14	59.42	3.72	3.87
Potassium humate 1 cm/L	9.46	9.72	7.75	7.42	49.31	48.56	2.73	2.84
Potassium humate 2 cm/L	10.21	10.43	8.14	7.85	51.63	50.34	2.96	3.01
Potassium humate 4 cm/L	10.46	10.57	8.45	8.26	53.41	52.67	3.17	3.23
F. test	*	*	*	*	*	*	*	*
LSD at 5%	0.19	0.21	0.222	0.210	3.374	3.456	0.34	0.29

Table 5. Nitrogen, phosphorus and potassium percentages in pea leaves after 50 days after sowing as affected by foliar spraying with some potassium sources during 2015 and 2016 seasons.

Characters	N (%) in leaves		P (%) in leaves		K (%) in leaves	
Treatments	**2015**	**2016**	**2015**	**2016**	**2015**	**2016**
Without	2.61	22.63	0.301	0.303	2.95	2.97
Potassium sulfate 1 g/L	2.82	22.74	0.310	0.315	2.98	3.01
Potassium sulfate 2 g/L	2.96	22.89	0.315	0.320	3.10	3.12
Potassium sulfate 4 g/L	3.02	22.95	0.319	0.323	3.19	3.21
Potassium silicate 1 cm/L	3.32	33.36	0.343	0.346	3.31	3.37
Potassium silicate 2 cm/L	3.39	33.40	0.354	0.352	3.38	3.42
Potassium silicate 4 cm/L	3.41	33.43	0.367	0.365	3.44	3.46
Potassium humate 1 cm/L	3.13	33.19	0.323	0.328	3.21	3.24
Potassium humate 2 cm/L	3.19	33.23	0.329	0.334	3.24	3.28
Potassium humate 4 cm/L	3.22	33.34	0.339	0.338	3.29	3.32
F. test	*	*	*	*	*	*
LSD at 5%	0.03	0.03	0.140	0.139	0.3	0.3

The attractive effect of potassium silicate at various rates on chemical constituents in the leaves and seeds may be due to the role of potassium and silicon in activation of vegetative growth, yields and its components as mentioned formerly, consequently enhancement chemical constituents in the leaves and seeds. These results are in conformity with those reported by Elsharkawy (2013) and Balpande *et al.* (2016).

The favourable effect of potassium humate at various rates on chemical constituents in the leaves and seeds may be due to the same factors that activated vegetative growth, yields and its components as mentioned previously. These findings are in harmony with those of Faten *et al* . (2005), Helmy (2013) and Khan *et al.* (2013).

Table 6. Nitrogen, phosphorus and potassium percentages in green seeds at harvesting time as affected by foliar spraying with some potassium sources during 2015 and 2016 seasons.

Characters	N (%) in seeds		P (%) in seeds		K (%) in seeds	
Treatments	**2015**	**2016**	**2015**	**2016**	**2015**	**2016**
Without	2.65	2.53	0.345	0.339	1.44	1.51
Potassium sulfate 1 g/L	2.71	2.61	0.351	0.343	1.51	1.57
Potassium sulfate 2 g/L	2.75	2.68	0.372	0.367	1.56	1.61
Potassium sulfate 4 g/L	2.82	2.77	0.380	0.375	1.63	1.65
Potassium silicate 1 cm/L	3.16	3.25	0.395	0.411	1.85	1.87
Potassium silicate 2 cm/L	3.27	3.34	0.413	0.425	1.91	1.94
Potassium silicate 4 cm/L	3.38	3.46	0.426	0.433	1.93	2.01
Potassium humate 1 cm/L	2.87	2.83	0.382	0.383	1.66	1.69
Potassium humate 2 cm/L	2.93	2.89	0.387	0.388	1.73	1.75
Potassium humate 4 cm/L	3.05	2.96	0.391	0.397	1.79	1.82
F. test	*	*	*	*	*	*
LSD at 5%	0.16	0.17	0.016	0.017	0.16	0.10

Table 7. Total carbohydrates and crude protein in green seeds at harvesting time and proline (%) in leaves after 50 days after sowing as affected by foliar spraying with some potassium sources during 2015 and 2016 seasons.

Characters	Total carbohydrates (%)		Crude protein (%)		Proline (%) in leaves	
Treatments	**2015**	**2016**	**2015**	**2016**	**2015**	**2016**
Without	46.53	47.13	15.61	16.37	11.24	11.16
Potassium sulfate 1 g/L	47.25	47.89	16.23	17.25	10.92	10.75
Potassium sulfate 2 g/L	47.86	48.52	16.84	17.73	10.25	10.16
Potassium sulfate 4 g/L	48.25	49.11	17.55	18.36	10.01	9.51
Potassium silicate 1 cm/L	49.75	50.61	20.12	21.42	7.91	7.86
Potassium silicate 2 cm/L	50.56	51.42	21.35	22.61	7.52	7.42
Potassium silicate 4 cm/L	51.37	52.13	22.42	23.38	7.23	7.13
Potassium humate 1 cm/L	48.27	49.22	18.15	18.76	9.13	9.02
Potassium humate 2 cm/L	48.94	49.83	18.92	19.65	8.97	8.51
Potassium humate 4 cm/L	49.46	50.31	19.75	20.32	8.06	8.11
F. test	*	*	*	*		*
LSD at 5%	1.77	1.79	1.87	1.88	0.031	0.033

CONCLUSION

From obtained results of this study, it could be recommended that spraying pea plants through 4 cm potassium silicate/L to enhance growth, yield and its components and chemical constituents of pea under the environmental conditions of same research.

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تأثير بعض مصادر البوتاسيوم على النمو والمحصول وجودة البسلة تحت ظروف الأراضى الملحية

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أجريت هذه الدراسة خلال موسمي 2015 و 2016 في مزرعة خاصة بقرية الرواد بسهل الحسينية ، محافظة الشرقية . وكان الهدف من هذا البحث هو دراسة تأثير الرش الورقي بثلاثة مصادر للبوتاسيوم وبثلاثة تركيزات من كل منها، وهى كبريتات البوتاسيوم 4 و2 و1 جم / لتر؛ و سيليكات البوتاسيوم 4 و 2 و1سم / لاس وكذلك هيومات البوتاسيوم بتركيز 4 و2 و1 سم / لتر باضافة الى معاملة المقارنة بدون رش للحد من الآثار الضارة للإجهاد الملوحى على النمو والمحصول ومكوناته الصنف البسلة ماستر ب تحت ظروف التربة المالحة نفذت التجربة باستخدام تصميم القطاعات كاملة العشوائية في ثلاثة مكررات. أدى الرش الورقى لنباتات البسلة بالبوتاسيوم في صورة سيليكات البوتاسيوم بمعدل 4 سم / لتر للزيادة المعنوية والحصول على أعلى القيم لجميع صفات النمو الخضري والمحصول ومكوناته والمكونات الكيميائية في الأوراق والبذور بالمقارنة بالمعاملات الأخرى المدروسة في كلا الموسمين. أما ثاني أفضل معاملة فكانت الرش الورقى لنباتات البسلة بالبوتاسيوم في صورة سيليكات البوتاسيوم بمعدل 2 سم / لتر، يليها سيليكات البوتاسيوم بمعدل 1 سم / لتر، ثم هيومات البوتاسيوم بمعدل 4 سم / لتر وهيومات البوتاسيوم بمعدل 2 سم / لتر في كلا الموسمين. من ناحية أخرى، كانت أقل القيم لجميع الصفات تحت الدراسة من معاملة المقارنة (بدون رش ورقى) في كلا الموسمين. بصفة عامة، تفوق البوتاسيوم في صورة سيليكات البوتاسيوم بالمعدلات المختلفة على هيومات البوتاسيوم بالمعدلات المختلفة يليه سلفات البوتاسيوم بالمعدلات المختلفة في كلا الموسمين. وفيما يتعلق بالنسبة المئوية للبرولين في الأوراق، فقد كان لها اتجاه عكسى بالمقارنة بجميع الصفات المدروسة في كلا الموسمين. وبصفة عامة، يمكن التوصية بالرش الورقى لنباتات البسلة بالبوتاسيوم في صورة سيليكات البوتاسيوم بمعدل 4 سم / لتر للحصول على أقصى نمو وإنتاجية وجودة للبذور تحت الظروف البيئية لهذا البحث.