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EFFECT OF INCREASING DOSES OF SODIUM CHLORIDE AND SODIUM SULPHATE ON THE YIELD OF DRY SUBSTANCE AND CONTENT OF SOME ELEMENTS IN OPIUM POPPY *(Papaver somniferum L.)*

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Abstract

The effect of higher salinity with sodium chloride and sodium sulphate in the soil on the yeald of dry substance, osmotic pressure and distribution of some elements in different organs of poppy plant and in different stages of development was examined. The salinity of soil has various influence on the amounts and distribution of some macroelements in different organs and in different stages of development, but yield of dry substance is lower and osmotic pressure becomes higher compared with the control samples.

Introduction

Every soil contains a mixture of soluble salts, some of which are essential for growth. But salinity, defined simply as the presence of excessive concentrations of soluble salts suppresses plant growth. The supression increases as the salt concentration increases (Bernstein and Hayward, 1958; Gauch and Eaton, 1942; Hayward and Long, 1941) until the plant dies. Tolerance to salinity varies among different species.

The ion species present in excess in soil have specific effects on some plants. For example, certain injury sings can be atributed to Na^+ or Cl^- toxicity, Na^+ or SO_4^- induce K-deficiency (Bernstein, 1964; 1975). But such specific ion-effects seem to be limited to certain susceptible plant species or varieties and rarely are a major cause of growth suppression.

Salts like sodium chloride and sodium sulphate are present in exess in saline soils (Gauch and Eaton, 1942; Hayward and Long, 1941). These soilts affect the general nutritional status as well as the metabolism of plants. Salinity suppresses growth of many plant species more under arid than under humid conditions (Hofman *et al.*, 1971a; 1971b; Neiman and Poulsen, 1967). Soils with higher percentage of sodium chloride and sodium sulphate in Macedonia are about 11 000 ha in arid and semiarid zones.

Our research is directed towards finding the kind of influence salinity of soil on the growth of the poppy plant. Continuing our investigation on the effect of soil salting on behaviour of plants (Georgiev and Spasenoski, 1977) in this paper we investigate the effects of soil salting with sodium chloride and sodium sulphate in different quantities on the production of dry substance, osmotic pressure in cell sap and content and distribution of macroelements: sodium, potassium, calcium, magnesium and phosphorus in different phases of development.

Material and methods

Opium poppy plants were planted in Micherlih pots with 5 kg of cinnamon-forest soil. Three plants were planted in every pot. At the sowing time, water solution of 2.012 g of ammonium nitricum, 1.387 g of potassium dihidrogenphosphatum and 0.925 g of potassium sulphatum were added. During the vegetation the humidity of soil was kept at 70% of retention capacity of soil and 22 mg of ammonium nitricum, 5 mg od potassium dihidrogenphosphatum, 7.7 mg magnesium nitricum and 7.3 mg of calcium nitricum were added in six portions.

Sodium chloride and sodium sulphate were added in pot at the beginning of vegetation of the plants in quantities of 0.025, 0.05, 0.1 and 0.2% of soil in ten parallel samples for every concentration. Control samples were without soil salting of sodium chloride and sodium sulphate.

The contents of sodium, potassium, calcium, magnesium and phosphorus were determined in the plants in a phase of rossette and in different organs, root, stem, leaves, blossom and capsule in phase of blossom and of ripe capsule. The above elements, except for phosphorus, were determined atomicabsorption-spectrophotometrically. Phosphorus was determined spectrophotometrically as yellow complex with ammonium molibdate.

For determination of osmotic pressure Karl Kolb Apparatus was used (Walter, 1931, 1933).

Results and discussion

The effect of soil salting on yield of dry substance in grammes per three plants is given in Table 1. As can be seen, with the increase of sodium chloride concentration, the amount of dry substance is diminished compared with control samples, but concentration of sodium sulphate has not remarcable influence in both stages of development.

Table 1. Effect of the increased sodium chloride and sodium sulphate concentration in the soil on the yield of dry substance in the diferent organs of the poppy plant, g/3 plants

Concentr. of: in %	Stem	Leaf	Blossom — Capsule	Total
	In a blossom stage		In a stage of ripe capsule	
Control	7.90—9.80	6.23—6.22	0.96—11.06	15.09—27.08
0.025 NaCl	7.33—9.03	5.53—4.60	0.78— 9.46	13.64—23.09
0.050 "	6.46—9.10	4.69—5.03	1.00—10.80	12.06—24.93
0.100 "	5.60—7.63	5.46—4.96	0.76— 8.66	11.82—21.25
0.200 "	3.13—4.15	2.91—3.63	0.55— 4.13	6.59—11.91
0.025 Na_2SO_4	6.76—8.63	3.70—4.20	0.85— 9.36	11.31—22.19
0.050 "	6.46—8.93	4.23—4.86	0.83— 9.43	11.52—23.22
0.100 "	6.40—8.56	4.70—4.34	0.83—11.03	11.93—23.93
0.200 "	6.03—8.50	4.40—4.32	1.18—11.00	11.61—23.82

The determination of stem's length (Table 2) shows that in the presence of sodium chloride, it diminished compared with the conrol samples, but sodium sulphate has not significant influence.

Table 2. Effect of the increased sodium shloride and sodium sulphate in the soil on the stem's length ($\bar{x}$), in cm

Concentr. of: in %	In a blossom stage	In a stage of ripe capsule
Control	66.80	74.16
0.025 NaCl	63.73	83.53
0.050 "	56.93	80.26
0.100 "	54.93	71.60
0.200 "	37.60	56.60
0.025 Na_2SO_4	56.93	70.20
0.050 "	59.26	79.33
0.100 "	59.26	78.60
0.200 "	60.00	79.33

Osmotic pressure in cells increases with the increase of concentration of sodium chloride, but concentration of sodium sulphate has no influence (Table 3).

Table 3. Effect of the increased NaCl and Na_2SO_4 concentration in the soil on the osmotic pressure of cell sap of poppy plant, in kPa

Concent. of: in %	In the rosette stage	In the blossom stage
Control	1013	1215
0.025 NaCl	1114	1215
0.050 "	1114	1317
0.100 "	1216	1317
0.200 "	1317	1418
0.025 Na_2SO_4	1014	1215
0.050 "	1015	1115
0.100 "	1015	1115
0.200 "	1114	1215

As seen from (Table 4), the increase of sodium chloride and sodium sulphate amounts in soil has no effect on the quantities of potassium, calcium and magnezium, while contents of sodium tend to be larger. The amount of potassium unregularly varies from 93.8 to 132.9. The amount of sodium increases from 0.83 to 4.9 depending upon the concentration of sodium chloride and from 1.2 to 2.44 mg/g dry material in the case of sodium sulphate. The content of calcium varies from 9.5 to 18.6 and amounts of magnesium from 4.9 to 6.6 mg.

Table 4. Effect of soil salting with sodium chloride and sodium sulphate on the content of potassium, sodium, calcium and magnesium in a rosette stage of poppy plant

Concentr. of: in %	Content in mg/g dry material of: K	Na	Ca	Mg
Control	105.60	0.82	13.07	5.03
0.025 NaCl	132.90	1.50	17.23	6.66
0.050 "	121.20	1.90	12.82	6.03
0.100 "	125.10	3.20	18.60	6.59
0.200 "	93.80	4.90	11.98	4.91
0.025 Na_2SO_4	109.50	1.20	9.50	5.06
0.050 "	113.40	1.45	13.63	5.62
0.100 "	101.70	1.84	10.46	4.98
0.200 "	105.60	2.44	10.62	4.91

The content of the elements: potassium, sodium, calcium, magnesium and phosphorus, in the root, stem, leaf, blossom and capsule is not the same due to their different physiological function (Table 5).

Table 5. Effect of soil salting with sodium chloride and sodium sulphate on the content of: potassium, sodium, calcium, magnesium and phosphorus in mg/g dry material of different parts of poppy in a blossom stage — in a stage of ripe capsule

Concentr. of: in %	Root	Stem	Leaf	Bloss. — Cap.
		K		
Control	58.7—19.9	77.4—48.1	97.8—29..3	9.0—30.1
0.025 NaCl	50.8—14.9	73.9—46.9	101.7—73.5	8.6—25.8
0.050 "	40.7— 5.1	64.1—46.9	105.6—46.4	8.6—29.3
0.100 "	36.0— 2.3	63.3—24.2	105.6—16.8	8.6—34.4
0.200 "	27.4— 3.1	62.3—30.1	106.5—17.6	9.4—37.1
0.025 Na_2SO_4	50.1— 6.6	66.9—48.9	105.6—25.8	6.7—24.4
0.050 "	47.3— 6.6	67.3—39.5	101.7—27.8	7.8—28.5
0.100 "	41.8— 2.3	66.5—42.2	101.7—35.2	8.2—28.5
0.200 "	32.8— 5.9	65.3—48.9	109.5—23.5	8.6—27.0
		Na		
Control	4.1—1.0	1.0— 2.0	0.7—0.3	0.2—0.2
0.025 NaCl	6.9—2.3	1.5— 4.2	0.7—0.3	0.1—0.3
0.050 "	10.9—5.0	2.4— 7.8	1.1—0.4	0.1—0.7
0.100 "	14.4—4.1	3.7—10.7	1.7—0.4	0.1—2.3
0.200 "	22.6—3.2	6.5—28.4	3.7—1.2	0.2—7.6
0.025 Na_2SO_4	4.5—1.8	1.2— 3.6	0.7—0.3	0.1—0.3
0.050 "	7.4—2.8	1.6— 4.7	0.7—0.7	0.1—0.3
0.100 "	9.0—3.3	2.0— 7.2	1.1—0.6	0.1—0.4
0.200 "	12.5—5.2	3.3—10.2	1.5—0.6	0.1—0.4
		Ca		
Control	3.3—6.0	8.3—7.3	3.9—26.5	0.4—12.3
0.025 NaCl	3.0—6.7	8.4—7.3	2.9—27.9	0.6—14.5
0.050 "	4.0—5.1	9.5—7.1	3.4—24.4	0.6—14.5
0.100 "	4.4—1.2	9.3—6.9	3.7—23.7	0.5—11.9
0.200 "	2.5—1.6	9.6—8.4	2.7—25.1	0.8—13.4
0.025 Na_2SO_4	2.5—2.4	8.1—6.8	2.7—23.8	0.5— 8.6
0.050 "	4.1—6.1	7.6—7.1	3.1—23.1	0.6—11.7
0.100 "	5.0—3.2	8.5—7.6	3.2—21.0	0.6—11.7
0.200 "	3.7—6.6	7.5—3.6	2.3—23.8	1.0—11.7
		Mg		
Control	2.1—1.5	3.7—3.4	10.3—5.4	0.8—5.4
0.025 NaCl	2.0—1.8	3.8—3.1	11.6—6.4	0.8—5.3
0.050 "	2.7—1.0	3.9—2.7	11.1—6.4	0.8—4.7
0.100 "	2.3—0.8	4.1—2.4	12.1—5.1	0.8—4.7
0.200 "	2.2—0.9	3.9—2.7	11.6—5.7	0.9—5.4
0.025 Na_2SO_4	2.0—1.0	3.4—2.7	9.6—5.3	0.7—5.0
0.050 "	2.5—1.4	3.7—2.6	9.3—5.8	0.7—5.2
0.100 "	2.4—0.7	3.7—2.8	10.3—6.4	0.7—5.2
0.200 "	2.1—1.2	3.9—2.5	9.6—6.1	0.8—5.4
		P		
Control	6.9—2.5	5.7—1.9	6.8—4.2	6.1—6.4
0.025 NaCl	4.9—2.0	5.1—2.0	6.5—4.4	8.1—6.3
0.050 "	4.5—2.1	4.6—1.1	6.4—4.3	6.4—6.7
0.100 "	5.5—2.7	7.8—1.9	5.7—5.0	5.1—7.0
0.200 "	3.7—2.7	8.1—2.1	6.3—4.2	6.4—8.2
0.025 Na_2SO_4	6.0—3.2	6.1—1.9	5.3—3.9	7.5—6.1
0.050 "	6.8—1.6	6.7—2.0	7.1—4.7	6.2—6.5
0.100 "	6.7—2.1	7.7—2.5	9.0—4.7	8.7—7.3
0.200 "	6.8—2.6	8.4—2.3	9.2—4.4	7.6—6.6

So, the amounts of potassium in the stage of blossom are from 7.8 in a bsollom to 106.5 in a leaf, but in the stage of ripe capsule from 2.3 in a root to 37.5 mg in a leaf. The amounts of potassium are generally larger in a stage of blossom than in a stage of ripe capsule in root, stem and leaves, but are larger in capsule than in blossom. The amounts of calcium are increased in the stage of dry capsule and are in a large range from 1.2 to 27.9 mg. The soil salting has no effect on the amounts of calcium (compare thecontrols with the other values). It is evident, that they are larger in a capsule than in a blossom, but in root, stem and leaves are larger in the stage of blossom. The amounts of phosphorus are independent of soil salting. These values are larger in the stage of blossom in root, stem and leaves than in the same parts in the stageof ripe capsule, but the amounts are similar in blossoms and in ripe capsules. The amounts of phosphorus vary from 3.7 to 9.2 in the stage of blossom and from 1.1 to 8.2 mg in a stage of ripe capsule.

The highest content of potassium have the plants in a stage of rosette. With age the amounts of potassium decrease in all organs of the plant especially in the root, stem and leaves. The amounts of potassium are larger in leavel in the stage of blossom.

The amounts of calcium are independent of soil salting.

The soil salting increases the concentration of magnesium in the stage of blossom in the leaves, stem and root, but at the end of vegetation it decreases in the stem, and root and increases in ripe capsule.

The presenece of sodium chloride in soil diminishes the content of phosphorus in the root and increases the concentration of sodium in root and stem in the stage of blossom. With age potassium and phosphorus translocate from vegetative organs to capsule.

The contents of magnesium are larger in vegetative organs in the stage of blossom than at the end of vegetation.

Similar results concerning the effect of soil-salting are obtained with other kinds of plants[9,10].

Soil salting with sodium chloride and sodium sulphate in concentration of 0.025, 0.050, 0.100 and 0.200% has the following effects:

Sodium chloride decreases dry substance production.

Sodium chloride and sodium sulphate increases the amount of phosphorus in leaves and stem in a stage of blossom.

Sodium chloride decreases the amounts of potassium in root and stem in the stage of blossom.

At the end of vegetation the capsule has larger quantity of phosphorus than leaves.

The presence of sodium chloride and sodium sulphate in soil has direct influence of the amounts of sodium in leaves, stem and especially in root. With age the concentration of sodium in stem becomes higher but in the root becomes lower.

Sodium chloride and sodium sulphate influence a decrease the amounts of magnesium in root and stem at the end of vegetation.

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Rezime

NDIKIMI I PËRQENDRIMIT TË SHTUAR TË KLORURIT TË NATIUMIT DHE SULFATIT TË NATRIUMIT NË TOKË NË SHTIMIN E MASËS SË THATË DHE NË PËRMBAJTJEN E DISA MAKROELEMENTEVE TEK HASHASHI *(Papaver somniferum L.)*

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Është hulumtuar ndikimi i përqendrimit të shtuar të klorurit të natriumit dhe sulfatit të natriumit në tokë në produktivitetin (shtimin) e materies së thatë, presionit osmotik të lëngut qelizor dhe gjetjes së disa makroelementeve në organe të ndryshme bimore gjatë zhvillimit të hashashit (Papaver somniferum L.).

Mostrat për hulumtim janë kolektuar në fazën e rozetës, lulëzimit dhe kapsollës së pjekur. Makroelementet e hulumtuara: natriumi, kaliumi, kalciumi dhe magnezi zanë përcaktuar me absorber atomik, kurse fosfori është përcaktuar me metodën standarde spektrometrike, metodën molibdate. Përqendrimi i shtuar i kripave të përmendura të natriumit në tokë, kanë ndikuar në pakësimin e materies së terur te hashashi, ndërsa në lëngun qelizor vërehet shtim i presionit osmotik. Pasurimi i dheut me kripra të natriumit ndikon në shtimin e përqendrimit të natriumit në rrënjë dhe në pjesë të tjera të bimës, ndërsa ndikon ndryshe në përqendrimin dhe distribuimin e makroelementeve të tjera në faza të ndryshme të zhvillimit të hashashit.

Izvod

UTICAJ POVEĆANE KONCENTRACIJE NATRIUM HLORIDA I NATRIUM SULFATA U ZEMLJIŠTU NA PRINOS SUVE MASE I SADRŽAJ NEKIH MAKOELEMENATA U MAKU

(Papaver somniferum L.)

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Proučavan je uticaj povećane koncentracije natrium hlorida i natrium sulfata u zemljištu na prinos suve supstance, na osmotski pritisak ćelijskog soka i distribucije nekih makroelemenata u različitim biljnim organima u toku razvoja maka (Papaver somniferum L.).

Uzorci za istraživanje uzimani su u fazi rozeta, cvetanja i zrele čaure. Ispitivani makroelementi: natrium, kalium, kalcium i magnezium su određeni atomsko-apsorpcionom spektrometrijom, dok je fosfor određen standardnom spektrometriskom, molibdatnom metodom.

Povećane koncentracije navedenih natriumovih soli u zemljištu uticali su na smanjenje suve supstance u maku, dok u ćeliskom soku vidljivo je povećanje osmotskog pritiska.

Zasoljavanje zemljišta natriumovim solima utiče na povećanje koncentracije natrijuma u korenu i ostalih delova biljke u odnosu na kontrolne, dok različito utiče na koncentraciju i raspored ostalih makroelemenata u pojedinim fazama razvitka maka.