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OBSERVATIONS ON THE INFLUENCE OF SALICYLIC ACID ON RESISTANCE OF *RAPHANUS SATIVUS* L. VARIETIES TO SALINITY

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***Key words**: Raphanus sativus L., varieties, salinity, salicylic acid*

INTRODUCTION

Radish (*Raphanus sativus L.*), belonging to the family of *Brasicaceae* (*Cruciferae)*, is a vegetable cultivated in temperate regions for its succulent and bulbous roots. Latins called it *radicula*, with soft varieties used for human consumption and large and fibrous varieties used as food for animals. Radishes are very popular vegetables on the European continent, especially in cold areas, because they can be kept for several months after harvesting.

The spring radish is an annual plant. The summer and the winter radish are biennial. At spring radishes, the edible part is a tuber grown from a section of the epicotyl and hypocotyl, at summer and winter radish, it is a tuber grown from the hypocotyl and the upper section of the pivoting root. The inside of the root is formed of parenchymal tissue, has very few wood vessels arranged radially, making young roots tender and turgid. As the roots grow old, they become spongy, hollow and without juiciness (Parvu C., 1991).

Radishes are cold-resistant plants. The seeds germinate at a minimum temperature of 4.4^{o}C with the optimum being 7.2-32^{o}C. High temperatures associated with drought favour the leavening of roots, whereas low temperatures generate premature floriferous stems. Radishes are long-day plants and, under these conditions, they grow floriferous stems to the detriment of tuberous root growth. Requirements of water and mineral food are high. At temperatures lower than 6-8^{o}C, the plants no longer grow. The spring radish is cultivated in spring and autumn, when days are shorter (Stan N., Munteanu, N., 2001).

Radishes contain: 5-11% dry matter (5-8% at the spring radish and 8-11% at the summer and winter radish), represented especially by carbohydrates (glucose, fructose and sucrose), ranging from 1.64 and 8.40 per 100 grams of fresh substance (f.s.) and protein (0.6 to 1.9% f.s.). Other components are lipids, in very small amounts (0.1% f.s.), mineral salts of K, Ca, P, Mg, Na, S, Fe, etc., vitamins C (36-48 mg / 100 g f.s.) B1, B2, B6, PP and pantothenic acid. The roots also contain sulphur compounds (thioglycol) which, by enzymatic hydrolysis, release pungent isothiocyanates and thiocyanates, characteristic of the radish flavour. High content of these volatile substances makes radish have diuretic, bactericidal and anthelmintic effects (Maacaroun A. E., 2008).

Physiological resistance represents the characteristics of organisms to survive the harmful influence of the environment and their ability to ensure normal development of vital processes. Various climatic factors with different intensities affect plants causing structural and functional disorders. Functional disorders disrupt the normal metabolic processes of plants with a detrimental effect on their development. Structural disorders affect the ultrastructure of living matter, thus causing plant death. In droughty geographical areas, water coming from rain and snow do not deeply wash all minerals resulting from alteration of rocks. As a result, the soil gradually accumulates various salts. Besides, through the phenomenon of secondary salinization, arid soils are enriched with salts brought to the surface by the upstream water current under the influence of evaporation (Rati I., 2008). Large quantities of mineral salts in the upper layers of salty soils are harmful for most crop plants or plants from the spontaneous flora in two ways: on the one hand, they increase the concentration of soil solution, which makes it difficult for the root to absorb water, on the other hand, excess salts in the soil is toxic to plants.

Excess sodium causes the destruction of soil structure, which, due to lack of oxygen, can maintain neither plant nor animal growth.

The high concentration of soil solution osmotically inhibits imbibing and seed germination, as well as growth of the root system of plantlets. High concentration of salts in cells exerts a toxic action on the protoplasm, inhibits synthetic processes, especially photosynthesis and protein synthesis.

Salicylic acid is a phytohormone that, in small doses, stimulates cell proliferation and inhibits their growth and, in high doses, induces the installation of cell death phenomena. It is involved in mediating the systemic resistance acquired by plants against phytopathogenic, viral, bacterial or fungal agents.

Salicylic acid is considered as an important "signal" molecule involved in developmental processes in plants, plant responses to stress, injury and attack of pathogens. Salicylic acid is a plant growth regulator that affects many physiological processes such as: germination, growth of embryo-generated plantlets, stomatal closure, membrane permeability, content of assimilatory pigment (Purcărea Cornelia, 2008).

In this study we aimed to highlight the effect of different concentrations of sodium chloride on *Raphanus sativus L.* seed germination and growth of plantlets; the influence of different concentrations of sodium chloride on physiological processes at the *Raphanus sativus L.* species (dry matter and water content, assimilating pigments content); the influence of treatment with salicylic acid on the resistance to salinity of radish seeds and salinity tolerance of the species *Raphanus sativus L.*

MATERIALS AND METHODS

Our research was conducted on seeds and plantlets of the *Raphanus sativus L.* varieties of *Cherry Belle* (red radish) and *Icicle* (white radish). Throughout the paper, to avoid confusion, we shall consider the *Raphanus sativus L.* cultivar *Icicle* - R1 and the *Cherry belle* - R2.

The *Icicle* variety has a vegetation period of 30-35 days. The roots are long and sharp, white, fine and crisp. This variety is highly suitable for cultivation in open field. The *Cherry Belle* variety has a vegetation period of 28-30 days. Its round roots have a bright red colour. They do not become woody. The *Cherry Belle* variety is recommended for cultivation in open field, solarium and conservatory. The *Raphanus sativus L.* seeds were purchased from a store that sells seed material and seed authenticity is guaranteed by the manufacturer company.

To determine the germination capacity, the seeds were placed in disposable cups with distilled water for 24 hours in the dark, and the next day they were placed in Petri dishes on filter paper, 50 seeds/dish. Part of the seeds was treated with 0.001 ml solution of salicylic acid to observe its effect on the physiological process of germination (inhibition, stimulation or absence of any effect) under conditions of salinity.

The seeds were wetted daily with different concentrations of NaCl (0.65%, 1%, 1.5%, 2%, 2.5%, 3%, 3.5%), 3 ml / dish, except the seeds from the control sample that were wetted with distilled water.

The Petri dishes were subsequently introduced into the growth chamber where there were maintained constant the following factors: 20ºC temperature, the photoperiod of 16 hours of light – 8 hours of dark, light intensity of 22 lux. For each working version there were performed three repetitions.

Daily, there were numbered the germinated seeds / sample, in order to determine the yield of germination under salt stress and salicylic acid treatment.

I considered as germinated seed a seed whose small roots were equal in size to the length of the seed. The radish seeds were photographed, in a preliminary stage, with a Nikon digital camera.

The biometric study was conducted on *Raphanus sativus L.* plantlets, the varieties *Cherry Belle*, and *Icicle* respectively. Following seed germination, the Petri dishes were maintained in the growth chamber until plantlet development in the seed. The plantlets were watered daily with 3 ml of NaCl solution. After 20 days from starting the experiment, biometric measurements were performed on root and stem length, cotyledon width and green weight of plantlets. Root and stem length, cotyledon width were measured with a ruler in cm, the green plantlets weight in grams, using an analytical balance (ACCULAB).

The cotyledons, hypocotyl and leaves from the red and white radish plantlets were used for physiological investigations. The plantlets were placed in the ground in disposable cups and placed in the room for growth. The soil showed a 5.5-6.5 pH, a humidity of 60-70%, 410 ppm nitrogen, 192 ppm phosphorus, 1350 ppm potassium (chemical composition offered by the producing company). For 20 days, the plantlets were watered with distilled water to help them accommodate in the ground and become more vigorous. Then, for 5 subsequent days, the analysis samples were watered with different concentrations of sodium chloride in order to observe the effects of salt stress on the physiological processes of the plant.

The quantitative determination of the dry matter and water content in *Raphanus sativus L.* leaves was performed through the gravimetric method and dosage of assimilating pigments through the spectrophotometric Mayer-Bertenrath method with the changes made by tirban and Fărcuş.

RESULTS AND DISCUSSIONS

The percentage of germination varied within fairly wide limits (Table 1) as seen in the first germinated seeds 2-4 days after inoculation into the Petri dishes.

At the white radish, there was observed a high efficiency of seed germination of 56% at the control sample after 7 days from the inoculation into the Petri dish. The higher the salt concentration the lower the germination rate. At a concentration higher than 2%, white radish seed germination was inhibited. The seeds from the samples wetted with sodium chloride solution in concentrations higher than 2% did not germinate while also degenerating.

Table 1. Percentage of germination of *Raphanus sativus L.* seeds, the *Icicle* (white radish) and *Cherry Belle* (red radish) varieties

No	***Raphanus sativus***	Percentage of germination after 7 days (%)		Percentage of germination after (%) 20 days	
		Icicle varietie	Cherry Belle varietie	Icicle varietie	Cherry Belle varietie
1	Control sample	56	13	95	68
2	NaCl Solution 0,65%	51	9	89	53
3	NaCl Solution 1%	47	7	81	48
4	NaCl Solution 1,5%	39	6	76	46
5	NaCl Solution 2%	35	3	63	35
6	NaCl Solution 2,5%	3	-	-	-
7	NaCl Solution 3%	3	-	-	-
8	NaCl Solution 3,5%	1	-	-	-

The white radish seeds germinated in conditions of salinity for 20 days, recording values higher than 50% of the total yield of seed germination in all samples. The control sample showed a 95% germination of seeds, under conditions of wetting them with distilled water. Seed germination rate decreased concomitantly with the increase of NaCl concentration, the sample with 0.65% saline solution yielding a 89% of seed germination after 20 days, and at a concentration of 1% the germination rate was 81%. Similar values were recorded at NaCl concentrations of 1% - 1.5% with over 75%.

The *Cherry Belle* variety (red radish), 7 days after inoculation into the Petri dishes, has recorded, for the control sample, a low percentage of germination (13%), the yielded evidence of others being below 10%. After 20 days from inoculation of the seeds into the Petri dishes, the maximum efficiency was found at the control sample (68%) and the minimum at the sample with 2% NaCl solution (35%). Of the samples subjected to salt treatment, high values, above 50%, were recorded by the sample with 0.65% NaCl solution (53% germinated seeds). Comparable values were observed at samples with 1 and 1.5% saline solution (48%, respectively 46%) (Table 1).

After the treatment with salicylic acid, the white radish seed germination was delayed in the first 7 days from the inoculation of the seeds into the Petri dishes. Thus, the sample AS 0.65% NaCl showed a maximum germination (33%) and the AS 2% NaCl sample a minimum germination (14%), compared with the control sample (Table 2).

Table 2. Seed germination percentage at the *Raphanus sativus L. Icicle* (white radish) and *Cherry Belle* (red radish) varieties treated with salicylic acid

No	***Raphanus sativus***	Percentage of germination after 7 days (%)		Percentage of germination after (%) 20 days	
		Icicle varietie	Cherry Belle varietie	Icicle varietie	Cherry Belle varietie
1	NaCl Solution 0,65%	33	5	77	48
2	NaCl Solution 1%	24	5	74	43
3	NaCl Solution 1,5%	19	3	58	33
4	NaCl Solution 2%	14	-	51	28
5	NaCl Solution 2,5%	-	-	-	-
6	NaCl Solution 3%	-	-	-	-
7	NaCl Solution 3,5%	-	-	-	-

After 20 days from inoculation, the yield of white radish seed germination treated with salicylic acid decreased by 12% compared to the control sample. All the experimental samples recorded a yield of over 50% germinated seeds, showing a maximum value at the AS 0.65% NaCl sample (77%) and a minimum at the AS 2% NaCl sample (51%).

Comparing the yield of the *Raphanus sativus L.* control seed germination, the *Cherry Belle* variety with those treated and untreated with salicylic acid, there may be observed a downward curve, with maximum values recorded by the control sample and the samples with 0.65% NaCl solution and AS 0.65% NaCl, and the minimum values at concentrations of over 1.5% NaCl. Salicylic acid did not stimulate the germination process, the values recorded for the treated and untreated samples being close (89% for the 0.65% NaCl, 77% for the AS 0.65% NaCl) and in the first 7 days from the inoculation of the seeds into the Petri dishes, most samples showed 3-5% germinated seeds (Table 2).

The yield curve of red radish seed germination keeps decreasing even after 20 days from their inoculation into the Petri dishes. The maximum yield was found at the sample AS NaCl 0.65% (48%) and the minimum at the sample AS 2% NaCl (28%).

At the *Raphanus sativus L.* samples, the *Icicle* variety, the control sample recorded, for root length, values between 0.7 and 2.1 cm. This biometric feature highlighted growing values in parallel with exposure of seeds to different concentrations of NaCl, salinity positively influencing root growth. Similar root length values recorded at the white radish control sample were found at the seeds germinated under 0.65% NaCl saline solution (0.8 to 2.5 cm) (Table 3).

Table 3. Variation of *Raphanus sativus L.* morphological traits at the *Icicle* and *Cherry belle* varieties under salinity and treatment with salicylic acid

Raphanus sativus	**Root length (cm)**	**Hypocotyl length (cm)**	**Cotyledon width (cm)**	**Green biomass (g)**
Soi Icicle				
Control sample	0,7 – 2,1	0,5 – 1,3	0,4 – 1,0	1,652
NaCl Solution 0,65%	0,8 – 2,5	0,7 - 1,3	0,4 – 0,9	1,455
NaCl Solution 1%	1,0 – 2,5	0,7 – 1,3	0,4 – 0,9	1,432
NaCl Solution 1,5%	1,0 – 2,5	0,7 – 1,2	0,4 – 0,9	1,429
NaCl Solution 2%	1,0 – 2,6	0,8 – 1,2	0,4 – 0,9	1,403
***Soi Icicle* SA**				
Soluție NaCl 0,65%	0,7 – 2,1	0,7 – 1,3	0,4 – 0,9	1,420
Soluție NaCl 1%	0,7 – 2,2	0,7 – 1,3	0,4 – 0,9	1,402
Soluție NaCl 1,5%	0,9 – 2,2	0,7 – 1,2	0,4 – 0,8	1,399
Soluție NaCl 2%	0,9 – 2,2	0,7 – 1,2	0,4 – 0,8	1,387
Soi Cherry belle				
Control sample	1,0 – 3,0	0,6 – 2,2	0,5 – 1,1	1,565
NaCl Solution 0,65%	1,0 – 3,1	0,8 – 2,1	0,4 – 0,9	1,535
NaCl Solution 1%	1,0 – 3,2	0,8 – 2,2	0,4 – 0,9	1,513
NaCl Solution 1,5%	1,0 – 3,2	0,8 – 2,2	0,4 – 0,9	1,510
NaCl Solution 2%	1,0 - 3,3	0,8 – 2,2	0,4 – 0,9	1,499
***Soi Cherry belle* SA**				
NaCl Solution 0,65%	1,0 – 3,0	0,8 – 1,9	0,4 – 0,9	1,502
NaCl Solution 1%	0,9 – 2,8	0,8 – 1,9	0,4 – 0,9	1,489
NaCl Solution 1,5%	0,8 – 2,6	0,7 – 1,8	0,4 – 0,8	1,467
NaCl Solution 2%	**0,8 – 2,6**	**0,7 – 1,8**	**0,4 – 0,8**	1,452

The average hypocotyl length value at the white radish control sample was 0.9 cm. It was observed that the size, respectively hypocotyl growth was not influenced at low concentrations of NaCl solution (0.65%), but decreased slightly under higher concentrations. Thus, at a concentration of 2% NaCl, the hypocotyl size has values between 0.8 and 1.2 cm.

The cotyledon registered biometric values between 0.4 and 1.0 cm (control sample) and 0.4 to 0.9 cm (other samples). There was observed the negative influence on the growth of the aerial part of the white radish plantlet caused by soil salinity with NaCl concentration above 0.65%.

The average weight of white radish plantlets recorded maximum values at the control sample (1.652 g) and minimum values at the 2% saline sample (1.403 g). The green biomass decreases simultaneously with the increase of soil salts.

At white radish samples treated with salicylic acid, the control sample recorded root length values between 0.7 to 2.1 cm. Along with increased salinity, root sizes also grow, reaching, on the soil moistened with 2% NaCl solution sizes between 0.9 - 2.2 cm (Table 3). Similar values of root length recorded at the white radish control sample were highlighted at seeds germinated under 0.65% NaCl saline solution (0.7 - 2.1 cm) and 1% NaCl solution (0.7 - 2.2 cm) (Table 3).

With respect to hypocotyl length, the sample treated with salicylic acid and wetted with NaCl solution showed, at the white radish, sizes between 0.7 and 1.3 cm. We note the negative influence of high concentrations of NaCl on hypocotyl growth. Thus, at concentrations of 1.5% and 2% NaCl, hypocotyl size values are between 0.7 and 1.2 cm.

The cotyledon, at the samples mentioned above, recorded biometric values between 0.4 -0.9 cm (control sample and the solution 0.65% NaCl sample) and 0.4 - 0.8 cm (other samples). The average weight of white radish plantlets recorded maximum values at the control sample (1.625 g) and minimum values at the 2% saline solution sample (1.387 g). The green biomass concentration decreased simultaneously with the increase of soil salts.

At the *Raphanus sativus L.* samples of the *Cherry Belle* variety, the control sample recorded root length values between 1.0 and 3.0 cm. This feature showed increased values in parallel with seed exposure to different concentrations of NaCl, salinity positively influencing root growth. Similar values to the root length recorded at the red radish control sample were highlighted for the seeds germinated under the 0.65% NaCl saline solution (1.0 - 3.1 cm) (Table 3).

Regarding hypocotyl length, the average value recorded at the red radish control sample was 1.4 cm. Growth of hypocotyl length was not affected by low concentrations of NaCl solution (0.65%), but decreased slightly under higher concentrations.

Thus, at a concentration of 2% NaCl, the hypocotyl size has values between 0.8 and 2.2 cm.

The cotyledon recorded biometric values between 0.5 and 1.1 cm (control sample) and 0.4 to 0.9 cm (other samples). There may be observed the negative influence on the growth of the aerial part of red radish plantlets caused by soil salinity under NaCl concentration above 0.65%.

The average weight of red radish plantlets recorded maximum values at the control sample (1.565 g) and minimum values at the 2% saline sample (1.499 g).

At the red radish samples treated with salicylic acid, the control sample recorded root length values between 1.0 - 3.0 cm. Along with increased salinity there also grew root sizes, reaching, on the soil wetted with 2% NaCl solution, sizes between 0.8 and 2.6 cm (Table 3).

Values similar to root length found at the red radish control sample were also found at the seeds germinated under the 0.65% NaCl saline solution (1.0 - 3.0 cm) and 1% NaCl solution (0.9 to 2.8 cm) (Table 3).

Regarding hypocotyl length, the red radish samples treated with salicylic acid and wetted with NaCl solution showed sizes between 0.8 and 1.9 cm. We note the negative influence of high concentrations of NaCl on hypocotyl growth. Thus, at concentrations of 1.5% and 2% NaCl, hypocotyl size values are between 0.7 and 1.8 cm.

The cotyledon, for the samples mentioned above, recorded biometric values between 0.4 - 0.9 cm (the control sample and the 0.65% NaCl solution sample) and 0.4 - 0.8 cm (other samples). The average weight of white radish plantlets recorded maximum values for the control sample (1.565 g) and minimum values for the 2% saline solution sample (1,452 g). The green biomass decreased simultaneously with the increase of soil salts.

Wide variations between samples treated and untreated with salicylic acid, for both varieties studied, were found only in root length, root dimensions being reduced at the seeds subjected to the action of salicylic acid (0.7 - 2.1 cm at the control sample; 1.0 - 2.6 cm at the 2% NaCl solution sample; 0.9 - 2.2 cm at the AS 2% NaCl solution sample). The traits of hypocotyl length, average cotyledon width and weight for fresh substance showed little variation.

The water content of white radish leaves and cotyledons was between 83.89 g% (control sample) and 78.92 g% (2% NaCl solution sample) (Table 4).

All the samples showed a high water content (over 70 g%), with similar values found at the 0.65% and 1% NaCl solution samples of 83.02 g%, 82.68 g%, respectively. Water content decreased simultaneously with increased concentration of the NaCl solution, the 2% NaCl solution sample recording a minimum of 78.92 g% water content, but a maximum of 21.08% g dry matter content.

Obviously, as these two traits are interconnected to each other, the white radish samples that showed a high content of water had a low dry matter content, and vice versa.

The white radish dry mater parameter recorded values between 16.11 - 21.08 g%. Also, there was observed an increase in the dry matter content simultaneously with increased concentration of salt, dry mater values above 17 g% being found at the 1%, 1.5% and 2% NaCl solution samples (17.32 g%, 20.84 g%, 21.08 g%, respectively).

Comparing the amount of dry matter for the 2% NaCl solution sample with the control sample, there was found an increase of approximately 5 g% dry matter in the leaves treated with sodium chloride during the growing season of the plant. There was found a positive effect of soil salinity on dry matter accumulation in plant material (white radish).

Table 4. Water content / dry matter (%) content in red and white radish leaves under salinity

Physiological parameter	Control sample	NaCl Solution 0,65%	NaCl Solution 1%	NaCl Solution 1,5%	NaCl Solution 2%
Soiul *Icicle* (R1)					
g % water	83,89	83,02	82,68	79,16	78,92
g % dry matter	16,11	16,98	17,32	20,84	21,08
Soiul *Icicle* (R1 - SA)					
g % water	83,89	80,99	89,77	88,82	90,17
g % dry matter	16,11	19,01	10,23	11,18	9,83
Soiul Cherry Belle (R2)					
g % water	83,97	82,38	82,07	81,98	80,67
g % dry matter	16,03	17,62	17,93	18,02	19,33
Soiul Cherry Belle (R2 - SA)					
g % water	83,97	86,95	87,62	87,97	89,13
g % dry matter	16,03	13,05	12,38	12,03	10,87

SA: salicylic acid

The differences between white radish seeds treated and untreated with salicylic acid regarding water content and dry matter were of 2g% increase at the untreated samples.

The plantlets grown from white radish seeds treated with salicylic acid showed high water content and low dry matter content, the AS 2% NaCl sample showing a minimum of 9.83g% dry matter and lower values compared with the samples treated only with sodium chloride.

The red radish water content varied between 83.97 g% (control sample) and 80.67 g% (2% NaCl solution sample), which resulted in a dry matter content of 16.03 g%, respectively 19 33 g%.

With increasing salt concentrations, it was found that red radish water content in the leaves and cotyledons was reduced and dry matter content increased.

The amount of dry matter increased simultaneously with the increase in sodium chloride concentration of the solution, so that the 2% NaCl sample recorded increased dry matter content of 3.30 g% in the leaves compared to the control sample.

The differences between red radish seeds treated and untreated with salicylic acid in water content and dry matter increased by 5 g% in untreated samples.

The plantlets grown from red radish seeds treated with salicylic acid showed high water content values at the expense of dry matter content, the AS 2% NaCl sample showing a minimum of 10.87 g% dry matter and lower values compared with samples treated only with sodium chloride.

If we consider the average value of the two parameters throughout the experiment, we find that the highest dry matter content in leaves (about 17 g%) and lowest water content (about 80 g%) was recorded in the leaves of the white radish variety, compared to those of red radish.

The measurements of assimilating pigments content conducted after plantlet soil treatment for 5 days with different concentrations of NaCl showed a downward dynamic process of biosynthesis of chlorophyll a and b (Table 5).

The chlorophyll content ranged between 0.270 - 0.038 mg / g at the white radish and between 0.030 - 0.014 mg / g at the samples treated with salicylic acid.

Chlorophyll b also decreased, with the exception of the 1% NaCl sample that recorded 0.015 mg / g chlorophyll-b, a value higher than that at the other samples treated with salicylic acid and sodium chloride, but lower than that of the control sample. Chlorophyll b showed values between 0.012 and 0.008 mg / g.

The assimilating pigments from the plant material treated with salicylic acid showed lower values than those found at the samples subjected only to treatment with sodium chloride.

Table 5. Content of chlorophyll a and b (mg / g fresh substance) of *Raphanus sativus L.* leaves

***Raphanus sativus* L.**	chlorophyll a (mg/g)	chlorophyl b (mg/g)	Carotenoid pigments (mg/g)
R1 Control sample	0,270	0,19	0,00008
R1 NaCl 0,65%	0,060	0,025	0,00002
R1 NaCl 1%	0,054	0,026	0,00003
R1 NaCl 1,5%	0,040	0,028	0,00002
R1 NaCl 2%	0,038	0,032	0,00003
R1-SA NaCl 0,65%	0,030	0,012	0,00001
R1–SA NaCl 1%	0,033	0,015	0,00001
R1-SA NaCl 1 ,5%	0,030	0,012	0,00001
R1–SA NaCl 2%	0,014	0,008	0,00002
R2 Control sample	0,060	0,024	0,00005
R2 NaCl 0,65%	0,054	0,022	0,00001
R2 NaCl 1%	0,048	0,021	0,00001
R2 NaCl 1,5%	0,043	0,018	0,00004
R2 NaCl 2%	0,039	0,018	0,00003
R2-SA NaCl 0,65%	0,028	0,010	0,00001
R2–SA NaCl 1%	0,023	0,008	0,00002
R2-SA NaCl 1,5%	0,018	0,007	0,00001
R2–SA NaCl 2%	0,016	0,007	0,00001

At the red radish, chlorophyll content recorded values above 0.35 mg / g, similar to those found at all the white radish samples analysed.

The content of chlorophyll b showed values above 0.18 mg / g at the red radish, lower than those obtained at the white radish of over 0.25 mg / g.

The red radish samples treated with salicylic acid recorded the lowest content of chlorophyll a and chlorophyll b among the analysed samples: above 0,015 mg / g for chlorophyll a and above 0.015 mg / g for chlorophyll b.

CONCLUSIONS

The physiological investigations on *Raphanus sativus L.* under saline stress and treatment with salicylic acid led to the following conclusions:

• Seed germination of white and red radish spans a period of 20 days and the seed germination percentage varies depending on the germination conditions:

- 95% for the white radish control sample, 68% for the red radish control sample;
- for the samples germinated in conditions of salinity above 60% at the white radish and above 40% at the red radish samples;
- for the samples treated with salicylic acid above 50% at the white radish and above 25% at the red radish samples;
- at seeds treated with salicylic acid the germination was delayed in the first 7 days (3-5 germinated seeds / Petri dish) compared with the control samples.

• Along with increased concentrations of salt, there was found that in the leaves of red and white radish the water content decreased whereas the dry matter content increased, compared with the control sample.
• The dry matter and water content values were lower in samples treated with salicylic acid compared to the untreated samples.
• Soil salinity showed a positive effect on the accumulation of dry matter in the leaves of the *Raphanus sativus L.* varieties, but a negative effect on the biosynthesis of assimilating pigments.
• Soil salinity positively influenced root growth of white and red radish and negatively influenced hypocotyl growth and fresh biomass accumulation.
• The red radish variety recorded higher values of root and hypocotyl length, fresh plant biomass at all the studied samples, compared with the white radish variety.
• Salinity soil and seed treatment with salicylic acid negatively influenced the biosynthesis of assimilating pigments, the content of chlorophyll a and b being reduced with increased concentration of sodium chloride. It was found that the red radish *Cherry belle* variety was less resistant to NaCl in soil compared with the white radish *Icicle* variety.
• After completing the analyses, we categorized the red radish *Cherry Belle* variety as less resistant to soil salinity, and the white radish *Icicle* variety as having medium resistance to salinity; and treatment with salicylic acid did not stimulate resistance to salinity of the two varieties.
• Salicylic acid did not stimulate seed germination and growth of *Raphanus sativus L.* plantlets, the effect being adverse or absent.
• Salinity and seed treatment with salicylic acid negatively influenced some physiological processes (germination, assimilating pigments biosynthesis).

ABSTRACT

Salicylic acid is a phytohormone which stimulates cell proliferation in small amounts and in large quantities it induces cell death phenomena. Salicylic acid is involved in mediating systemic resistance in plants against phytopathogenic agents, viral, bacterial or fungal; it is an important "signal" molecule involved in developmental processes in plants, in plant stress reactions. As growth and development of plants are strongly affected by environmental factors (heavy metals, salinity, water scarcity, cold, UV radiation, etc.), in this study we aimed to test the influence of the treatment with salicylic acid (0,001mM) on the *Raphanus sativus* L. varieties at different concentrations of sodium chloride (0.65%, 1%, 1.5%, 2%). The samples of seeds were divided into three groups: control, the group wetted with solutions of sodium chloride and the group treated with solution of salicylic acid and wetted with various concentrations of sodium chloride. After the germination of seeds the following physiological measurements were carried out: germination rate, biometric measurements (root length, hypocotyl length, width cotyledon, fresh medium weight), dry substance and water content, assimilating pigments content. The varieties of radish, Cherry belle (red radish) and Icicle (white radish), showed small to medium resistance to the action of sodium chloride; treatment with salicylic acid did not stimulate seed germination, plantlets growth or assimilating pigment biosynthesis, exhibiting a mild inhibitor of physiological processes in conditions of salinity.

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