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RESEARCH ON THE BEHAVIOR OF ORNAMENTAL SPECIES IN SALINE SOILS CONDITIONS

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Abstract

Although over the years, the cut flower industry has faced various challenges, it still remains an important sector of agriculture. Globally, in recent years, the production of cut flowers has increased. This can be associated on the one hand with the low impact on the environment, but also with their ecological effect. Apart from the traditional cut flowers that require large inputs of energy, there can be other ornamental species that can successfully fulfil multiple roles: improving ecosystem services as well-being through colour and attracting insects, economically easy to maintain and last but not least, bioremediation and implicitly, the valorisation of degraded land by natural or anthropogenic factors. Thus, the paper aims to present the behaviour of some ornamental species cultivated in different concentrations of salinity, as follows: S1 - 4,310, S2 - 12,330, S3 - 8,050, S4 - 5,760, S5 -18,630, S6 -24,600 mS/cm. As ornamental plant species were used Limonium sp., Celosia sp., Gypsophila sp., Amaranthus sp. During the experiment, seed germination and biometric measurements as plant height and number of leaves of the plant species were monitored. Also, before and after the experiment, for each variant of cultivation substrates, pH and electrical conductivity (EC) were registered. According to the obtained results, it was demonstrated that halophytic ornamental plants like Limonium sp. can adapt to soils with extreme salinity.

Key words*: cultivation substrates, halophytes, salinity, ornamental plant, cut flowers.*

INTRODUCTION

Agriculture plays an important role in the economy of the most countries of the world. Salinity, as an effect of the climate changes, is increasingly affecting agricultural areas by-9% globally and by 11-17% within Europe (Zhang & Cai, 2011), significantly diminishing production (Qados, 2011; Estrada et al., 2021), the income and implicitly the living standard of the population.

The increasing impact both of climate change and unsustainable irrigation practice (Stavridou et al., 2017) imposes challenges for the valorisation of such salt affected areas (Bimal and Harun, 2017).

One solution could be the use of ornamental plant species, halophytes or moderately halophytes, for soil remediation and ecosystem services quality improvement and, also for ornamental horticulture that require a large consumption of water, for flower production (Francisco et al., 2017; García-Caparrós & Lao, 2018).

Apart from the established ornamental plants, new ornamental crops for cut flowers are often introduced. Once they leave the natural environment, they become real trends on the international markets. Their migration from one country to the other begins as early as the 18^{th} century (Darras, 2021).

In the context of CO_2 footprint restrictions and global warming, the cut flowers production may be affected. At the same time, considering public demand for cleaner agricultural products, sustainable cultivation of ornamental plants species (cut flowers) can be an ecological alternative option. Considering these factors, it is useful to know which species are most suitable for cultivation on saline soils.

According to Bellache et al. (2022), *Amaranthus* species proved to be salt tolerant in all developmental stages. This ability being given by the stomatal morphology, respectively: low density, aperture, and basal conductance. In *Amaranthus tricolor* it was observed an increase of carotenoids and antioxidant enzymes, such as superoxide dismutase (SOD). *Limonium*

sinuatum also have been proofed to have salt tolerant ability, in the laboratory resisting up to a sodium chloride (NaCl) concentration of 400 mM (Guo et al., 2022).
In this context, the paper aims to present data related to the behaviour of ornamental plant species in order to state the hypothesis according to which they can growth on sever saline soil.

MATERIALS AND METHODS

The study was carried out in the Research Greenhouse and Research Center of Food Quality and Agricultural Products - USAMV of Bucharest, during the period January-July.

Plants varieties

The varieties and species used in this experiment were: *Celosia plumosa* 'Fresh look mix', *Celosia plumosa* 'Bombay Cherry', *Celosia plumosa* 'Ice Cream (Mix)', *Celosia plumosa* 'Glorious Red', *Limonium sinuatum* 'QIS mix', *Amaranthus* 'Autumn Palette', *Amaranthus caudatus*, and *Gypsophila elegans* 'Crimson'. The seeds were achieved from national market (Anthesis International S.R.L.).

Soil types

With regard to the cultivation substrates, six variants of cultivation were used as follows: S1, S2, S3, S4, S5, S6 having different electrical conductivity (EC) values (Table 2).

Electrical conductivity (EC) assay

The EC was realised using an adapted method (Rayment and Higginson, 1992).

Cultivation substrates

The research activities started with the preparation of the cultivation substrates. Thus, the soil was deposited and exposed in a thin layer in order to dry, because it had a very high humidity and could not be manipulated. After drying at room temperature, the soil was crushed for optimal handling and last but not least, in order to establish conditions favourable to the development of seed germination and root system of the studied plants (Figure 1).

Figure 1. Shredding the soil for sowing

Also, dried roots of other species and stones were removed (Figure 2).

Figure 2. Sifting the soil for sowing

Cultivation substrates for germination test
Experimental variants

To study the behaviour of the seeds in the cultivation substrate, the following cultivation substrates were used (Figure 3).

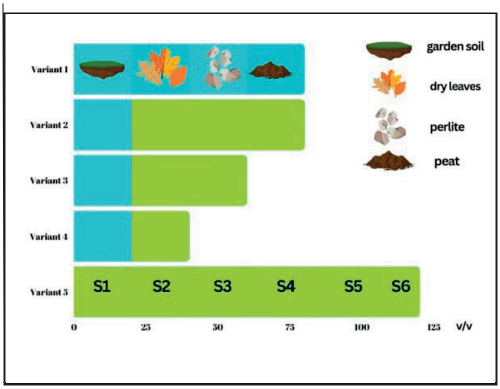

Figure 3. The composition of cultivation substrates (v/v)

Experimental variants for germination test

Experiment 1

To study the behaviour of the seeds in the cultivation substrate, the following cultivation variants were used (Figure 4).

The experiments started by sowing 50 seeds of each *Celosia plumosa* 'Fresh look mix', *Celosia plumosa* 'Bombay cherry', *Celosia plumosa* 'Ice Cream (Mix)', *Celosia plumosa* 'Glorious Red', *Limonium sinuatum* 'QIS mix' in V1 to V5 cultivation substrates.

In the climatic chamber, the trays with seeds were germinated at a temperature of 18-20°C for a period of 8-11 days, photoperiod 10/14 h depending on the indications of the seed manufacturer.

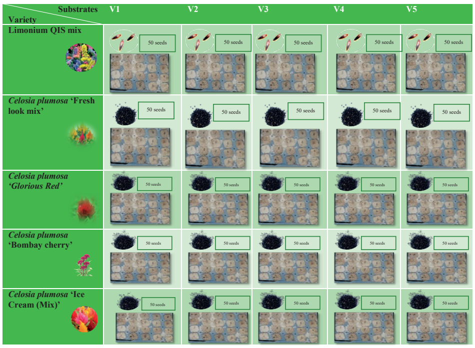

Figure 4. The experimental variants of seeds germination test

Experiment 2

Since the germination percentage of the seeds in the case of experiment I was much lower than that registered by the manufacturer, *Amaranthus* sp. 'Autumn Palette', *Amaranthus caudatus*, and *Gypsophila elegans* were tested within experiment 2.

Therefore, 3-4 seeds were placed in each peat pellet so that a minimum number of 20 plants could be covered per sampling substrate, in order to obtain the seedlings. After 20 days from sowing, having an average size of 2.5 cm, each seedling with a peat pellet was transferred to pots, containing saline soil (S1 to S6).

Thus, a total of 1200 seeds were sown in peat pellets in order to obtain seedlings. After obtaining them, they were transferred to the pots containing the soil of interest S1, S2, S3, S4, S5, S6, in the greenhouse, in an open system, with temperature, photoperiod controlled and irrigated daily. The experimental design is presented in Figure 5.

Figure 5. Experimental design for growth and development test of ornamental species

Statistical analysis

A general linear model, the Duncan test was used for the comparison of the data between groups, using Statistical Package for Social Science (SPSS version 21.0). Statistical processing was performed for a 95% probability. The results are expressed as the mean ± standard deviation (SD).

RESULTS AND DISCUSSIONS

Results regarding Experiment 1. As part of the experiment, we wanted to test the seeds germination on the cultivation substrates V1-V4. The following results were obtained, expressed as germination % (Table 1).

Table 1. Germination test on V1-V5 substrates

Plant	V1	V2-V5
Celosia plumosa 'Fresh Look Mix'	84%	*nd*
Celosia plumosa 'Bombay cherry'	22%	*nd*
Celosia plumosa 'Ice Cream (Mix)'	32%	*nd*
Celosia plumosa 'Glorious Red'	42%	*nd*
Limonium sinuatum 'QIS mix'	42%.	*nd*

Although ornamental plants may represent a solution for many fields of interest, the specialized scientific literature is scarce, within the article it was difficult to associate the data obtained with other related studies.

Positive results were obtained only for cultivation V1, the other variants (V2-V5) being negative. Thus, the varieties with the best results were *Celosia plumosa* 'Fresh look mixi' 84%, and *Limonium sinuatum* 'Qis mix' 42% germination percent and were subjected to further studies in the sense of behaviour on the soil with different salinity.

With regard to the germination percentage, there are studies explaining that salinity may influence the process (Yildirim et al., 2002) either by creating an osmotic potential, or the toxic effects of sodium (Na^+) and chlorine (Cl^-) ions (Khajeh-Hosseini et al., 2003). Salinity can inhibit or delay seed germination (Almansouri et al., 2001) and reduces the growth of seedling depending on cultivar.
So obtained, the seedlings were transferred to 10 cm diameter pots, containing soil with a known salinity. The plants were monitored for a period of 4 months.
The impact of plant cultivation on soil EC value is presented in Table 2. Soil salinity level is site specific and based on electrical conductivity value (Bimal and Harun, 2017). From the results presented in Table 2 it can be seen that for each type of plant, a decrease in the electrical conductivity value.

Table 2. Initial and final electrical conductivity (EC) of the soil

Soil samples	Initial EC/ (mS/cm)	Plant name	Final EC (mS/cm)
S1	4,310	*Amaranthus* sp. 'Autum Palette'	4,080
		Limonium sinuatum 'QIS mix'	2,710
		Amaranthus caudatus	2,560
		Reference (Without plant)	2,540
S2	12,330	*Amaranthus* sp. 'Autum Palette'	13,410
		Limonium sinuatum 'QIS mix'	11,730
		Amaranthus caudatus	11,230
		Reference	15,900
S3	8,050	*Amaranthus* sp. 'Autum Palette'	10,430
		Limonium sinuatum 'QIS mix'	3,270
		Amaranthus caudatus	7,010
		Reference	4,500
S4	5,760	*Amaranthus* sp. 'Autum Palette'	12,240
		Limonium sinuatum 'QIS mix'	12,280
		Amaranthus sp. *caudatus*	10,500
		Reference	7,280
S5	18,630	*Amaranthus* sp. 'Autum Palette'	23,800
		Limonium sinuatum 'QIS mix'	16,900
		Amaranthus caudatus	18,310
		Reference	21,720
S6	24,600	*Amaranthus* sp. 'Autum Palette'	21,190
		Limonium sinuatum 'QIS mix'	19,190
		Amaranthus caudatus	20,490
		Reference	21,810

In the case of S1, the lowest electrical conductivity was recorded after cultivation of *Amaranthus caudatus*, followed by *Limonium sinuatum* 'QIS mix' and *Amaranthus* sp. 'Autum Palette'. In the case of S2, where the salinity was higher than S1, the decrease of electrical conductivity was in the following order: *Amaranthus* sp 'Autum Palette' > *Amaranthus caudatus* > *Limonium sinuatum* 'QIS mix'.
Considering the best-performing species, it can be argued that both *Amaranthus caudatus* and *Limonium sinuatum* 'QIS mix' were positive in terms of diminishing salinity. However, by comparing the species in the same sample (S1 or S2), there are no differences, both of them may be recommended for this purpose.
Also, in the experiment, the influence of plant growth on the change of soil pH value was observed.
Thus, the initial and final (after plant cultivation) pH value for S1-S6 soils were recorded.
The results are shown in Table 3.

Table 3. Soil characterization (pH)

Soil sample	pH(i)	pH(f)	t°C
S1	8.73	8.73	22.3
S2	8.47	8.23	22.2
S3	8.72	8.72	22
S4	8.82	8.66	22.2
S5	8.13	8.07	22.7
S6	8.22	7.98	22.3

According to the results presented above, it can be seen that the pH value was not altered, the soil remaining slightly alkaline.
In order to see if plants can adapt to soil with the salinity shown above, the plants have been

monitored, meaning that biometric measurements have been performed. Thus, the height of each plant type was monitored for a period of 4 months.

For each species, 20 pots were monitored. The same varieties and number of plants for S1 to S6 soil types were used.

For S1 variant, the results obtained are presented in Table 4.

Table 4. Plant monitoring for soil type S1

Soil sample	Plants	Plant height (cm) during four months (M)			
		M1	M2	M3	M4
S1	*Amaranthus sp.* 'Autum Palette'	4.16 ± 0.61[a]	9.36 ± 1.38[b]	14.02 ± 1.96[c]	20.64 ± 2.45[d]
	Limonium sinuatum 'QIS mix'	3.02 ± 0.68[a]	6.58 ± 1.55[b]	11.62 ± 2.21[c]	11.46 ± 1.79[c]
	Amaranthus caudatus	1.48 ± 0.31[a]	3.02 ± 0.55[b]	7.4 ± 2.18[c]	14.4 ± 3.7[d]
	Gypsophila elegans 'Crimson'	1.99 ± 0.39[a]	3.9 ± 0.82[b]	6.92 ± 1.28[c]	10.1 ± 2.07[d]
	Celosia plumosa 'Glorious red'	0.55 ± 0.13[a]	1.14 ± 0.13[a]	1.72 ± 0.64[b]	3.23 ± 1.12[c]

*The values are expressed as mean ± standard deviation.

According to the results obtained on the cultivation soil S1, it can be observed that for the species *Amaranthus* sp. 'Autumn Palette' the plant height changed by approximately 5 cm per month, up to a maximum of 20.64 cm.

Also on the same substrate, it can be observed that for the species *Limonium sinuatum* 'QIS mix', the plant height changed on average by 3 cm per month, up to a maximum of 11.62 cm. Regarding this species, similar values (because in month4 some of the plants were affected by salinity) were recorded in months 3 and 4, a sign that the plant has stagnated in development. Regarding the species *Amaranthus caudatus*, the plant height varied throughout the experiment, reaching a maximum value of 14.4 cm. Regarding the species *Gypsophila elegans* 'Crimson', the plant height varied from one month to another, with the plant growing up to 10 cm. Last but not least, *Celosia plumosa* 'Glorious red' recorded changes in height growth, reaching a maximum value of 3.23 cm.

In the experiment carried out on the S1 substrate, the lowest values were recorded in the case of the *Celosia plumosa* 'Glorious red', while the highest plant height values were recorded in the case of the *Amaranthus* sp. 'Autum Palette'.

For S2 variant, the results obtained are presented in Table 5.

Table 5. Plant monitoring for soil type S2

Soil sample	Plants	Plant height (cm) during four months (M)			
		M1	M2	M3	M4
S2	*Amaranthus* sp. 'Autum Palette'	1.00 ± 0.12[a]	2.00 ± 0.46[b]	nd	nd
	Limonium sinuatum 'QIS mix'	1.54 ± 0.36[a]	3.18 ± 0.62[b]	3.03 ± 0.55[b]	nd
	Amaranthus caudatus	0.68 ± 0.22[a]	1.06 ± 0.5[a]	4.22 ± 0.76[b]	4.7 ± 0.58[b]
	Gypsophila elegans 'Crimson'	0.9 ± 0.26[a]	1.87 ± 1.00[b]	2.50 ± 0.0[c]	nd
	Celosia plumosa 'Glorious red'	0.5 ± 0.0[a]	1.00 ± 0.0[a]	2.13 ± 0.0[b]	nd

*The values are expressed as mean ± standard deviation.

According to the results obtained on the cultivation soil S2 (Table 5), it can be observed that *Amaranthus* sp. 'Autum Palette' species developed in the first two months of cultivation at the pot level. Also, on the same substrate, it can be observed that for *Limonium sinuatum* 'QIS mix' the height of the plant changed on average by 2 cm per month, up to a maximum of 3.18 cm. Regarding this species, similar values were recorded in months 2 and 3 (due to the appearance of some affected plants). The growth and development of the plant took place until the 3rd month. Also in this sense, *Amaranthus caudatus* developed throughout the experiment, reaching a maximum value of 4.7 cm, the values being similar in the last two months. Regarding *Gypsophila elegans* 'Crimson', the plant height varied until the third month, with the plant growing up to 2.5 cm. *Celosia plumosa* 'Glorious red' registered slight changes in height growth, reaching a maximum value of 2.13 cm, similar to those of the *Gypsophila elegans* 'Crimson'. Both *Gypsophila elegans* 'Crimson' and *Celosia plumosa* 'Glorious red' grown until the third month of the experiment.

In the experiment carried out on the S2 substrate, all species recorded lower values than those obtained on S1, *Amaranthus caudatus* being present during the 4 months.

For S3 variant, the results obtained are presented in Table 6.

Table 6. Plant monitoring for soil type S3

Soil sample	Plants	Plant height (cm) during four months (M)			
		M1	M2	M3	M4
S3	*Amaranthus* sp. 'Autum Palette'	3.34 ± 0.44^{a}	7.38 ± 1.15^{b}	10.24 ±1.15^{c}	13.60 ± 1.13^{d}
	Limonium sinuatum 'QIS mix'	3.94 ± 0.09^{a}	8.72 ± 0.24^{b}	11.34 ± 0.79^{c}	11.06 ± 0.78^{c}
	Amaranthus caudatus	2.64 ± 0.84^{a}	5.78 ± 2.11^{b}	9.18 ± 3.54^{c}	14.10 ± 5.35^{d}
	Gypsophila elegans 'Crimson'	1.70 ± 0.29^{a}	3.84 ± 0.35^{ab}	5.78 ± 0.91^{b}	8.08 ± 1.04^{c}
	Celosia plumosa 'Glorious red'	0.86 ± 0.24^{a}	0.98 ± 0.11^{a}	2.68 ± 0.43^{b}	4.14 ± 0.54^{c}

*The values are expressed as mean ± standard deviation

From the results obtained on the cultivation soil S3, it can be seen that for *Amaranthus* sp. 'Autum Palette' the height of the plant changed by approximately 3 cm per month, up to a maximum of 13.6 cm. Also, on the same substrate, it can be observed that for *Limonium sinuatum* 'QIS mix', the height of the plant changed on average by 4 cm per month, up to a maximum of 11.34 cm. Regarding this species, in months 3 and 4, the height recorded similar values (the small differences come from the plants affected in the last month). In a similar manner to the S1 substrate, the *Amaranthus caudatus* developed progressively throughout the experiment, reaching a maximum value of 14.10 cm. Regarding *Gypsophila elegans* 'Crimson', the plant height varied up to the fourth month, with the plant growing up to 8 cm. *Celosia plumosa* 'Glorious red' registered slight changes in height growth, reaching a maximum value of 4.14 cm in the fourth month of the experiment.

In the experiment carried out on the S3 substrate, all species developed during the four months, *Amaranthus caudatus* standing out with the highest values.

For S4 variant, the results obtained are presented in Table 7.

Table 7. Plant monitoring for soil type S4

Soil sample	Plants	Plant height (cm) during four months (M)			
		M1	M2	M3	M4
S4	*Amaranthus* sp. 'Autum Palette'	2.55 ± 0.71^{a}	5.24 ± 1.55^{b}	8.00 ± 1.47^{c}	11.16 ± 1.51^{d}
	Limonium sinuatum 'QIS mix'	2.52 ± 0.44^{a}	5.16 ± 0.73^{b}	8.24 ± 1.84^{c}	8.78 ± 1.68^{c}
	Amaranthus caudatus	0.57 ± 0.10^{a}	0.98 ± 0.31^{a}	3.94 ± 0.84^{b}	5.43 ± 1.27^{c}
	Gypsophila elegans 'Crimson'	0.52 ± 0.19^{a}	0.24 ± 0.15^{a}	1.68 ± 1.09^{b}	2.88 ± 0.63^{c}
	Celosia plumosa 'Glorious red'	0.85 ± 0.05^{a}	1.58 ± 0.13^{a}	4.27 ± 0.67^{b}	nd

*The values are expressed as mean ± standard deviation.

Regarding the behaviour of the plants on the S4 cultivation soil, it can be observed that for *Amaranthus* sp. 'Autumn Palette' the plant height changed on average by 3 cm per month, up to a maximum of 11.16 cm. Also, on the same substrate, it can be observed that for *Limonium sinuatum* 'QIS mix', the plant height changed on average by 3 cm per month, up to a maximum of 8.78 cm. Regarding this species, in months 3 and 4, the plant height recorded similar values. In a manner similar to S2, *Amaranthus caudatus* developed progressively throughout the experiment, reaching small values, up to 5 cm in height. Regarding *Gypsophila elegans* 'Crimson', the plant height varied up to the fourth month, with values up to 3 cm. *Celosia plumosa* 'Glorious red' recorded slight changes in height growth, reaching a maximum value of 4.14 cm in the third month of the experiment.

In the experiment carried out on the S4 substrate, all species developed during the four months, the *Celosia plumosa* species being an exception.

For S5 variant, the results obtained are presented in Table 8.

Table 8. Plant monitoring for soil type S5

Soil sample	Plants	Plant height (cm) during four months (M)			
		M1	M2	M3	M4
S5	*Amaranthus* sp. 'Autum Palette'	0.70 ± 0.10[a]	0.57 ± 0.29[a]	nd	nd
	Limonium sinuatum 'QIS mix'	1.36 ± 0.39[a]	2.82 ± 0.65[ab]	4.08 ± 1.19[c]	4.48 ± 1.42[c]
	Amaranthus caudatus	0.88 ± 0.13[a]	1.52 ± 0.16[b]	2.25 ± 0.78[c]	nd
	Gypsophila elegans 'Crimson'	0.75 ± 0.35[a]	1.40 ± 0.57[a]	nd	nd
	Celosia plumosa 'Glorious red'	0.48 ± 0.04[a]	0.74 ± 0.39[a]	nd	nd

*The values are expressed as mean ± standard deviation

In the same way, the results obtained on the cultivation soil S5 (Table 7), can be observed that the species *Amaranthus* sp. 'Autumn Palette' did not develop after the first month of cultivation, the average for the second month is small due to the fact that part of the plants taken in the study stopped growing. Also, it can be observed that for the species *Limonium sinuatum* 'QIS mix' the plant height changed on average by 1.5 cm per month, up to a maximum of 4.48 cm. Regarding this species, in months 3 and 4, the height recorded similar values. In the case of S5, *Amaranthus caudatus* developed reaching small values up to 2 cm in height. In the last month no measurements could be made, due to plant growth stopping.

Regarding *Gypsophila elegans* 'Crimson' and *Celosia plumosa* 'Glorious red', they developed only during the first 2 months of the experiment.

In the experiment carried out on the S5 soil, the only adapted species was *Limonium sinuatum* 'QIS mix'.

For S6 variant, the results obtained are presented in Table 9.

Table 9. Plant monitoring for soil type S6

Soil sample	Plants	Plant height (cm) during four months (M)			
		M1	M2	M3	M4
S6	*Amaranthus* sp. 'Autum Palette'	1.00 ± 0.12[ab]	2.00 ± 0.46[b]	3.03 ± 0.55[b]	nd
	Limonium sinuatum 'QIS mix'	1.54 ± 0.36[a]	3.18 ± 0.62[b]	4.22 ± 076[c]	4.70 ± 0.58[c]
	Amaranthus caudatus	0.68 ± 0.22[a]	1.06 ± 0.50[a]	2.25 ± 0.78[b]	nd
	Gypsophila elegans 'Crimson'	0.90 ± 0.26[a]	1.87 ± 1.00[a]	nd	nd
	Celosia plumosa 'Glorious red'	0.50 ± 0.00[a]	1.00 ± 0.00[a]	nd	nd

*The values are expressed as mean ± standard deviation.

Last but not least, according to the results obtained on the cultivation soil S6, it can be observed that for the species *Amaranthus* sp. 'Autum Palette' the plant height changed on average by 1 cm per month, until the third month, reaching a maximum of 3,03 cm. Also, on the same soil, it can be observed that for the species *Limonium sinuatum* 'QIS mix' the results obtained are similar to those of the S5 substrate. In a similar manner to S5, *Amaranthus caudatus* slowly grew, reaching values of up to 2 cm, in the last month the plant did not survive. Regarding *Gypsophila elegans* 'Crimson' and *Celosia plumosa* 'Glorious red', developed only in the first 2 months of the experiment. Similar to the results obtained on the S5 soil, the only adapted was *Limonium sinuatum* 'QIS mix'.

In Figure 6 are presented the results related to the number of leaves according to the species and soil.

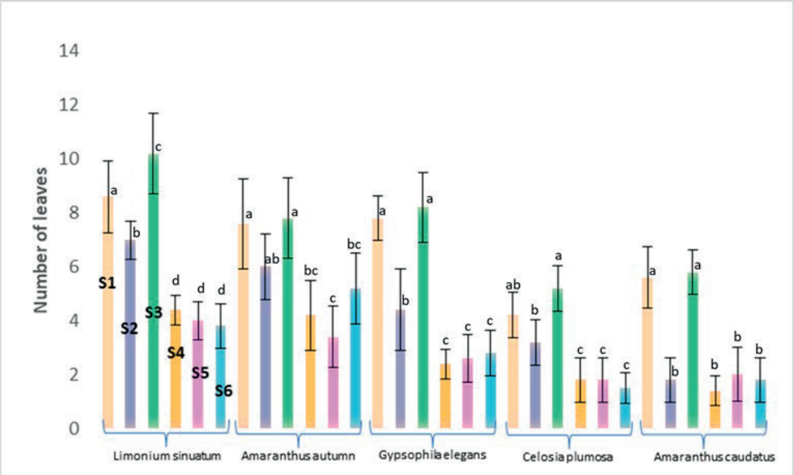

Figure 6. The number of leaves depending on the species and the type of soil
*The values are expressed as mean of five plants ± standard deviation

Regarding *Limonium sinuatum* 'QIS mix', the number of leaves was high in the case of S3, S1 and S2. The other species followed the same pattern, the difference between them being consisted of the smaller number of leaves.

Also, another very important aspect is related to the survival rate of the plants, namely: on the S1 soil, all the plants survived until the fourth month, except the *Amaranthus caudatus* species (month three); on the S2 soil, all the plants survived until month three, with the exception of *Amaranthus caudatus* (month four). On the substrates S3, S4, S5 and S6 both *Amaranthus* sp, and *Limonium sinuatum* 'Qis mix' developed leaves until the fourth month. As for the *Gypsophila elegans* 'Crimson', developed well until the fourth month on S3, S4 and until second month on S5 and S6. *Celosia plumosa* 'Glorious red' developed until month four on S3 and month three on S4 and stopped evolving on S5 and S6.

In the figures below (Figures 7-12), the behaviour of the studied species on each cultivation substrate (S1, S2, S3, S4, S5, S6) is showed.

As can be seen, they are in accordance with the results presented in the tables, being of increased visual impact. Thus, we demonstrated the hypothesis according to which saline substrates can be utilized for cultivation of ornamental plants.

Figure 7. Growth and development of plant species on S1

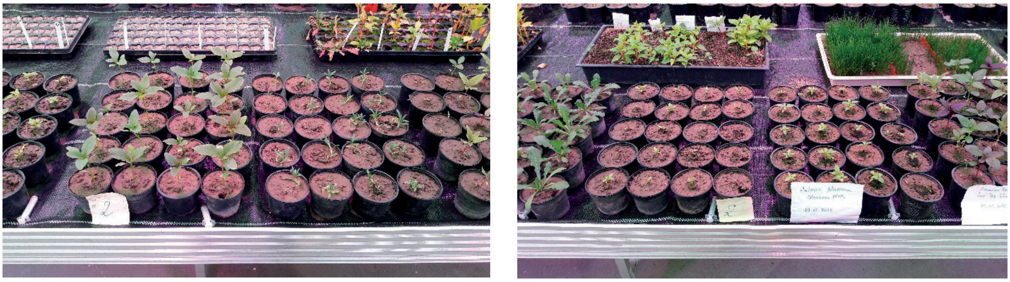

Figure 8. Growth and development of plant species on S2

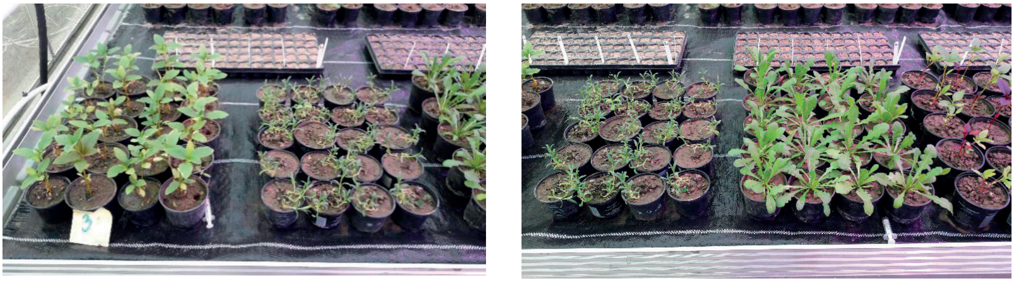

Figure 9. Growth and development of plant species on S3

Figure 10. Growth and development of plant species on S4

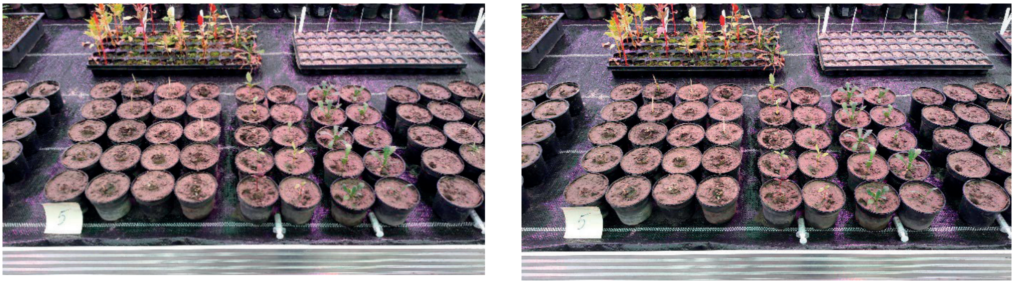

Figure 11. Growth and development of plant species on S5

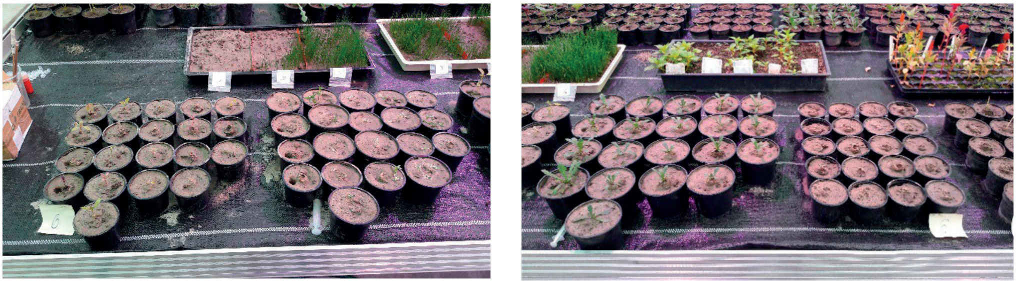

Figure 12. Growth and development of plant species on S6

Although the literature is scarce in this domain, there were several studies referring on the impact of substrate on plant architecture in roses bushes in order to improve the visual impact (Garbez et al., 2018). Other research focuses on the pharmacological part of ornamental plants such as *Celosia cristata* and *Celosia argentea* (Tang et al., 2016).

CONCLUSIONS

Regarding seed germination of studied species, high values were recorded for *Celosia plumosa* and *Limonium sinuatum* 'QIS mix'. With regard to the obtained results, it was demonstrated that halophytic ornamental plants can adapt to soils with extreme salinity, provided that they have been cultivated starting from seedlings. Also, in the same sense, the extraction role of the plants was demonstrated, through the changes made on the electrical conductivity. In terms of electrical conductivity, it has revealed *Amaranthus caudatus* and *Limonium sinuatum* 'QIS mix'. species.

As far as the value of pH is concerned, apparently there may not be a linkage between it and the cultivation of the species used in this experiment.

Through the research carried out, we enhance the studies related to ornamental halophytic species. Also, from the obtained results we may say that ornamental species can be used successfully in the valorisation of non-agricultural soils.

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