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GERMINATION SPECIALITIES OF SOME SALINE PLANT SPECIES

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ABSTRACT
Seeds of *Achillea aspleniifolia*, *Artemisia santonicum*, *Aster tripolium* subsp. *pannonicum*, *Inula britannica*, *Limonium gmellinii* subsp. *hungaricum* and *Podospermum canum* were collected from five different sodic habitats in Hungary: Apajpuszta, Cegléd, Dinnyés, Farmos and Fülöpszállás. We compared the germination percentage and rate among the populations and determined the optimal sowing depth and substrate preference. We observed big differences among the species and even the habitats. Outstanding dynamics was measured for *Achillea aspleniifolia* and *Artemisia santonicum* species. Highest germination percentage was reached by *Podospermum canum*. Germination stress-tolerance index was the highest for *Podospermum canum*, while the lowest was determined for *Inula britannica.* The germination rate of the species did not reach the volumes reported in the publications. The majority of species germinated in light, optimal substrate was seedling growing medium. *Podospermum canum* proved to be a highly stress-tolerant species.

Keywords: sodic, saline, promptness index, germination stress-tolerance index

INTRODUCTION

More than 12,000 km^2 of different types of sodic soil surfaces are present in Hungary (TÓTH AND SZENDREI, 2006). Their flora is excessively rich in perennial species that even have ornamental value. This ornamental treasure of us is largely untapped. Most of the sodic perennial species tolerate well but do not demand obligatorily the high salinity concentration and bad structure of the soil, intensive insolation and dryness (BORHIDI, 2007). The selection for salinity tolerance and examination of salinity tolerance of ornamental plants is going on in other countries as well (KRATSCH ET AL., 2008).
The first step in selection is collecting data and samples *in situ,* and the examination of generative propagation organs. LUDEWIG ET AL. (2014) reported high (76-94%) viability and germination ability of *Inula britannica*. The germination percentage of *Achillea millefolium* ssp. *elburensis* was over 60% between 15 °C and 30 °C, BANNAJAN ET AL. (2006) found 20 °C optimal. Based on publication data, *Aster tripolium* seeds germinate over 90% on 25/15 °C (BAKKER AND DE VRIES 1992). WANG AND LI (2012) measured 98% germination percentage for *Limonium gmellinii*. PETI ET AL. (2015) reported 85% germination rate of *Podospermum canum*.
During our experiment, we examined the germination ability of some saline perennial species derived from different habitats. Furthermore, we determined the effect of sowing depth and sowing substrate on germination.

MATERIAL AND METHOD

Comparison of populations based on germination parameters

We collected seeds of *Achillea aspleniifolia, Artemisia santonicum, Aster tripolium* ssp. *pannonicum, Inula britannica, Limonium gmellinii* ssp. *hungaricum* and *Podospermum*

canum species from five different salty-sodic habitats in Hungary in October-November 2017: Apajpuszta, border of Cegléd, region of Dinnyés, region of Farmos railway station, and region of Fülöpszállás (Not all species were found in all habitats). Seeds were stored at room temperature. We sowed the seeds on 05.01.2018 in the greenhouse of the Szent István University, Buda Campus into 0.7 litre plastic boxes. Sowing substrate was the mixture of Klassmann peat TS-3 and 2 g/l Futor (carbonated lime). Fifty-five seeds were put into each box that was covered with a clear topper. Boxes were put on basic heating (6-8 °C higher than air temperature) tables till the start of germination. We counted the seedlings every 3-4 days. We considered the germination as finished on 12.02.2018. We want to repeat the experiment at the end of 2019.

Examination of optimal sowing depth

In this experiment, we used seed mixtures of propagules derived from different salty-sodic habitats, stored on room temperature. Every mixture contained 50 seeds. *Podospermum canum* mixture contained 10 seeds. They were sown into 750 ml Swedish boxes half filled with Klassmann TS-3 peat on 24.01.2018. We sowed the seeds of all the six taxa at three different depths:

- on the surface of the substrate (examination of germination on light)
- 1 mm cover with substrate
- 5 mm cover with substrate

Covering material was also sifted Klassmann substrate. After humidifying, sowing boxes were closed and labelled and were placed on rolling tables in a plastic tunnel. Air temperature was 20 °C, heating tubes were located 20 cm under the table. During evaluation scot-free, healthy, two cotyledon-containing seedlings were counted two times weekly, during 3-4 weeks.

Substrate preference examination

Substrate mixtures were:

1. Substrate (TS-3 Klassmann standard peat 100 %),
2. Substrate (TS-3 Klassmann standard peat and perlite 50:50%),
3. Substrate (Oasis seedling substrate), that is a peat-based mixture containing more components.

From all the six examined taxa, we sowed 50 seeds into 750 ml Swedish boxes. Based on the results of the previous sowing depth experiment, *Posdospermum* seeds got 1 mm cover with sifted Klassmann peat. Other taxa were sown on the surface of the substrates. We evaluated the experiment three times per week with counting the healthy, scot-free, two cotyledon-containing seedlings.

The following parameters were determined during the evaluation:

PI (promptness index): $PI=nd_2\times(1{,}00)+nd_4\times(0{,}75)+nd_6\times(0{,}50)+nd_8\times(0{,}25)$, where and means the number of germinated seedlings on the 2., 4., 6., and 8. day after sowing (HARTMANN ET AL., 1997).

MGT (mean germination time): $MGT= (\sum ni \times ti)/\sum n$, means the sum of multiplication of the given day (ti) and germinated seed (ni) / number of germinated seeds in the end of the experiment (n).

Germination rate, germination percentage at the end of the experiment.

G start: number of days from sowing till the appearance of the first seedlings.

G power: number of seedlings from the sowing till the 7. day (PEKARSKAS AND SINKEVIČIENĖ, 2011).

GSTI: Germination stress-tolerance index: (PI stress-conditioned seeds / PI control seeds)×100 (ASHRAF ET AL., 2006). We considered seeds as stress-conditioned that were covered with peat while control the uncovered seeds.

RESULTS

Comparison of populations based on germination parameters

The germination of the seeds derived from different populations can be read in *Table 1*. Except for *Aster tripolium* subsp. *pannonicum*, there was a big difference among the populations that determines the later seed collection. The single population of *Achillea aspleniifolia* germinated rather quickly, the achenes started to develop already on the second day after sowing (*Table 1*). We did not observe mentionable differences in the final number of seedlings among the populations of *Aster tripolium* subsp. *pannonicum*, however, the slowest seedling development was measured in the population of Fülöpszállás. Comparing the propagules of *Artemisia* from Apajpuszta and Farmos, we measured big differences in germination percentage and germination start. Propagules from Farmos germinated very badly but high mean germination time could be observed for the propagules from Apajpuszta as well. The parameters of *Inula britannica* were also diverse according to the different habitats. Best germinating rate could be measured in the Cegléd population. *Limonium gmellinii* subsp. *hungaricum* propagules derived from Apajpuszta had the best germinating parameters while seeds collected in Cegléd had the worst. Achenes of *Podospermum canum* from Dinnyés germinated the most quickly and those from Apajpuszta showed the worst results (*Table 1*).

Table 1. Germination rate of different populations

TAXON	HABITAT	PI	MGT	G rate	G %	G start	G power
Achillea	Dinnyés	35	1.12	0.45	45	2	28
Aster	Apajpuszta	5.4	12.83	0.33	33	7	7
	Cegléd	3.5	17.00	0.35	35	4	7
	Dinnyés	1.25	14.74	0.35	35	7	3
	Fülöpszállás	0.75	22.22	0.42	42	11	0
Artemisia	Apajpuszta	1.75	23.93	0.49	49	6	5
	Farmos	0	32.00	0.02	2	32	0
Inula	Apajpuszta	0	29.21	0.25	25	18	0
	Cegléd	2.25	22.58	0.56	56	7	7
	Dinnyés	3.25	10.00	0.18	18	7	7
	Farmos	0	26.00	0.04	2	24	0
Limonium	Apajpuszta	1.5	16.14	0.40	40	11	0
	Cegléd	0	27.33	0.05	5	21	0
	Fülöpszállás	1.75	16.25	0.29	29	7	5
Podospermum	Apajpuszta	0	27.60	0.18	18	14	0
	Dinnyés	18	7.39	0.69	69	7	38
	Farmos	3	15.24	0.55	55	7	8
	Fülöpszállás	3.25	19.55	0.73	73	7	11

Legend: PI – promptness index, MGT – mean germination time, G start – first day of germination, G power – number of seedlings in the first 7 days.

Examination of the effect of sowing depth on the germination of saline perennial species

In all examined parameters *Achillea aspleniifolia* proved to be the best among the six taxa, its stress tolerance was moderate. Both covering thickness values retarded all germination parameters (*Table 2*). *Aster tripolium* subsp. *pannonicum* had outstandingly high stress tolerance. Thin cover during germination favourably influenced promptness index (PI), mean germination time (MGT) and the number of seedlings till the 7th day (G power). The germination dynamics parameters of *Artemisia santonicum* were moderate but this species had the highest germinating percentage during the experiment. Stress tolerance index of the species proved to be low, it reacted badly for the treatments. This species was sensitive to covering. The time parameters (*Table 2*, 1. and 2. columns) of *Inula britannica* were good/moderate comparing to the other plant taxa, however its stress-tolerance index was the lowest and germination percentage was also very low. It reacted to the seed cover especially sensitive. Worst results were evaluated for *Limonium gmellinii* subsp. *hungaricum* in all examined parameters. Its stress-tolerance index was medium/low. The seeds germinated on light, did not tolerate any covering. *Podospermum canum* proved to be a highly stress-tolerant species. All germination parameters could be considered good although ten seeds were examined only in each treatment. Thin covering increased all the examined parameters, even 5 mm was more advantageous comparing to the uncovered control (*Table 2*).

Table 2. The effect of sowing depth on the germination dynamics of examined species

TAXON	TREATMENT	PI	MGT	GSTI	G rate	G %	G start	G power
Achillea	light	55.5	5	81.53	0.74	74	4	74
	1 mm	40.5	5.28		0.58	58	4	58
	5 mm	4.75	17.42		0.38	38	4	8
Aster	light	6.75	13	191.59	0.52	52	4	10
	1 mm	8.75	12.96		0.52	52	4	14
	5 mm	4.25	14.52		0.42	42	7	10
Artemisia	light	27.5	8.41	18.18	0.82	82	4	56
	1 mm	4	9.25		0.16	16	7	10
	5 mm	1	14		0.18	18	9	0
Inula	light	8.25	7.69	6.06	0.26	26	4	18
	1 mm	0.5	7.5		0.08	8	9	0
	5 mm	0	-		0	0	0	0
Limonium	light	1.25	14.88	20	0.16	16	7	2
	1 mm	0.25	17		0.12	12	9	0
	5 mm	0	-		0	0	0	0
Podospermum	light	1.75	10.5	528.57	0.4	40	7	20
	1 mm	6.75	7.63		0.8	80	4	70
	5 mm	2.5	9		0.6	60	7	30

Legend: PI – promptness index, MGT – mean germination time, GSTI – Germination stress-tolerance index, G start – first day of germination, G power – number of seedlings in the first 7 days.

Examination of substrate preference

Peat + perlite mixture had positive effect on germination rapidity of *Achillea aspleniifolia* while highest number of seedlings appeared in germination substrate. Germination dynamics was similar in the case of *Aster tripolium* subsp. *pannonicum* as well. Highest

germination percentage was observed in germinating substrate. *Artemisia santonicum* had the best germinating parameters, most of the seedlings appeared within 4 days after sowing (*Table 3*, last two columns). Dynamic germination was going on in *Inula britannica* nonetheless germination percentage was the lowest among the six examined saline perennial taxa. The PI values of *Limonium gmellinii* subsp. *hungaricum* were favourable. Though germinating time was between 8-13 days (depending on treatment), germinating rate was high, mainly in peat and peat + perlite mixture. Germination of *Podospermum canum* proved to be slow. Highest numbers of seedlings were counted in germination substrate until the last evaluation time (*Table 3*).

Table 3. Effect of different substrates on the germination dynamics of examined saline perennial taxa

TAXON	TREATMENT	PI	MGT	G rate	G %	G start	G power
Achillea	1. Substrate	2.25	15.67	0.24	24	7	4
	2. Substrate	6.75	6.78	0.18	18	4	12
	3. Substrate	1.5	13.9	0.4	40	7	2
Aster	1. Substrate	4.5	10.39	0.36	36	7	6
	2. Substrate	4.75	11.79	0.48	48	4	6
	3. Substrate	1	14.41	0.64	64	9	0
Artemisia	1. Substrate	38.75	5.48	0.58	58	4	52
	2. Substrate	29.25	4.88	0.48	48	4	44
	3. Substrate	6.5	10.57	0.6	60	4	10
Inula	1. Substrate	5.25	7.88	0.16	16	4	8
	2. Substrate	14.5	6.46	0.26	26	4	22
	3. Substrate	8.5	4	0.22	22	7	22
Limonium	1. Substrate	6.25	11.43	0.6	60	7	8
	2. Substrate	14.5	8.26	0.54	54	4	24
	3. Substrate	2.75	13.13	0.3	30	7	4
Podospermum	1. Substrate	0.5	16.67	0.36	36	9	0
	2. Substrate	0	19.45	0.4	40	12	0
	3. Substrate	0	19.04	0.5	50	14	0

Legend: PI – promptness index, MGT – mean germination time, G start – first day of germination, G power – number of seedlings in the first 7 days.

CONCLUSIONS

Summarizing the three experiments, we can conclude that there are very big differences among the Hungarian saline habitats. The best habitat was Fülöpszállás in case of *Aster tripolium* subsp. *pannonicum,* but the germination time was the highest. However *Artemisia* and *Limonium* seeds from Apajpuszta germinated the best. The highest germination rate was detected in the Cegléd population in case of *Inula*, and in the Fülöpszállás population in case of *Podospermum*. Most of the examined plants germinated on light without substrate cover, only achenes of *Podospermum* need shallow covering. The seeds germinated well in germinating substrate, but the highest germination rate of *Limonium* was measured in 100 % standard peat. According to the germinating dynamics and speed, *Achillea aspleniifolia* and *Artemisia santonicum* germinated very quick and well, while the other taxa germinated much slower and in low amount (e.g. *Limonium,*

Inula). Concerning germination percentage, best results were obtained with *Podospermum canum* in all the three experiments. However, in the case of *Inula britannica* and *Limonium gmellinii* subsp. *hungaricum* only every fourth – fifth seed developed to an intact seedling.

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