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Research Paper

Seed germination of some endemic *Sideritis* species under different treatments

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Abstract. Plant material was represented by: *Sideritis congesta* P.H. Davis et Hub.-Mor.*, Sideritis condensata* Boiss. et Heldr.*, Sideritis leptoclada* O. Schwarz et. P.H. Davis*, Sideritis tmolea* P.H. Davis and *Sideritis libanotica* Labill. ssp. *linearis*. All of these plant materials are endemic to Turkey. Generally, *Sideritis* species has problems in seed germination. Therefore, the research on the cultivation of such species via seeds has difficulties. For this reason, some treatments were used to solve this problem, such as different gibberellic acid doses, stratification and hot water applications. The gibberellic acid doses were used 100, 250, 500, 750 and 1000 ppm, at room temperature and 8 h light, 16 h of darkness in the laboratory conditions. According to the results, the best germination rate was determined by control group of *Sideritis congesta* species between stratification and hot water applications, while those the best result was 100 and 750 ppm gibberellic acid doses by *Sideritis condensata* species among different doses.

Keywords: *Sideritis, Lamiaceae*, germination, gibberellic acid, seed applications, endemic.

INTRODUCTION

The Turkish Flora has about 10000 plant species, approximative 3000 are endemic and 1000 to 2000 of them are medicinal plant species (Arslan et al., 2002). Lamiaceae is a characteristic plant family of the Mediterranean Region with high diversified ecology (Estrelles et al., 2004). The family includes 546 species, 45 genera and totally 731 taxa and the endemic ratio is 44.2%. In Turkey *Sideritis* genus has 46 species and 53 taxa. 40 of *Sideritis* taxa are endemic. The genus *Sideritis* is natural in the western Anatolia. *Sideritis* species are annual or perennial, herbaceous or little bushy plants. The importance of the genus is represented by its export capacity. Some *Sideritis* species in Turkey were used as tonic, carminative, antispasmodic, diuretic. The plants were used commonly as herbal tea, especially Mediterranean and Aegean regions (Uçar and Turgut, 2009).

Lamiaceae is a characteristic plant family of the Mediterranean region, with highly diversified ecology (Estrelles et al., 2004).

One of the most difficult problems is to control and stop the extensive collection of vulnerable medicinal plants. One possible solution is to cultivate them and for some plants this is already a well established practice.

The seed germination process on the *Sideritis* species was analyzed. Seed germination is a critical phase in the reproductive cycle of great importance for species fitness and the variation in germination percentage has been interpreted as an adaptation to ecological conditions (Escriba et al., 2004).

Some characteristics and habitat properties of the studied *Sideritis* species are presented in Table 1.

The aims of this study are to ascertain the seed germination characteristics of some endemic *Sideritis* species, an economic asset to Turkey, and to investigate the effects of different concentrations of gibberellic acid (GA_3) and other treatments such as stratification and hot water applications.

MATERIALS AND METHODS

This study was carried out at the laboratories of the Selcuk University, Cumra High Educational College, Konya,

Table 1. The studied species, their habitat and characteristics.

Species	Characteristics	Altitudes
S. condensata Boiss. & Heldr.	branched and adpressed white-silky greyish tomentose perennial herb, up to 100 cm, growing on the pine forest and roadsides of Akseki (Antalya)	up to 1600 m
S. tmolea P.H. Davis	little-branched and shortly adpressed-tomentose perennial herb, up to 55 cm, growing on the rocky slopes of Bozdag (Izmir)	up to 1900 m
S. congesta P.H. Davis & Hub. –Mor.	simple or little-branched and densely adpressed white-tomentose perennial herb, up to 75 cm, growing on the open Pinus brutia forest and oak scrub of Antalya	up to 1000 m
S. leptoclada O. Schwarz & P.H. Davis	simple or little branched and densely adpressed white tomentose perennial herb, up to 60 cm, growing on the Pinus brutia forest and serpentine rocks of Mugla	up to 800m
S. libanotica Labill. ssp. *linearis*	simple or branched and adpressed white-tomentose perennial herb, up to 100 cm, growing Bozkır (Konya)	up to 1500 m

Table 2. The studied species, seed collection dates and locations.

Species	Collection date	Collection location
Sideritis congesta	September 2008-2009	The road Akseki-Antalya altitude of 480 m
Sideritis condensata	September 2008-2009	Murtici and Cevizli, Akseki- Antalya altitude of 1225 m
Sideritis leptoclada	July 2009	The road Fethiye-Dalaman, Mugla altitude of 100 m
Sideritis tmolea	September 2009	Bozdag, Izmir altitude of 1590 m
Sideritis libanotica ssp. *linearis*	September 2008-2009	Bozkır, southwest Konya altitude of 1320 m

in 2009. Seeds of *Sideritis* species were collected from the wild populations at various locations, central, southwest and western Anatolia, Turkey. The seed collection dates and locations of the studied *Sideritis* species are presented in Table 2.

Seed weight was determined for each species in year 2008: *S. congesta*, 0.3 g; *S. condensata*, 1.5 g; *S. leptoclada*, 11.2 g; *S. tmolea*, 0.6 g and *S. libanotica* ssp. *linearis*, 6.8 g. In year 2009, these values were: 6.85, 21.94, 8.51, 9.80 and 24.70 g, respectively. The untreated seeds were sown in different petri dishes and evaluated as control. These control seeds were commonly used for treatment of stratification and were kept in hot water.

Germination conditions

The experiments were performed both at constant temperatures and darkness as well as under constant temperatures and light conditions. The seeds were placed on petri dishes placed in germination cabin and set up at 8 h light and 16 h darkness conditions. The temperature and humidity in germination cabin were remained stable as 25°C and 70%, respectively.

Seed germination was carried out with nutlets (hereafter called seeds for simplicity) manually; extracted from their calyces; the calyces were carefully rubbed and the seeds carefully cleaned from calyx fragments. The seeds were treated with different doses of gibberellic acid (with 100, 250, 500, 750 and 1000 ppm). The seeds treated with gibberellic acid for 6 h were washed with water. Four replicates of 100 seeds were sown on moistened filter paper disks in petri dishes. The criterion of germination was visible radicle protrusion. After each count, the germinated seeds were discarded, and the tests were considered finished when no additional seeds germinated.

Stratification was performed through keeping seeds at +4°C for one week and then placed in germination cabin. The seeds treated with hot water were kept in 60 to 70°C in various times such as 30, 60 and 90 s.

Table 3. The mean values of seed treatments and their statistical groups.

	Control	Stratification	Hot water	Mean values
Sideritis congesta	28^{A}*	24^{AB}	12^{DE}	21.3
Sideritis condensata	24^{AB}	12^{DE}	12^{DE}	16.0
Sideritis leptoclada	8^{F}	0^{G}	12^{DE}	6.7
Sideritis tmolea	20^{BC}	20^{BC}	8^{F}	16.0
Sideritis libanotica	8^{F}	16^{CD}	8^{F}	10.7
Mean values	17.6	14.4	10.4	
$LSD_{0.05}$ = 2.171				
CV: %10.53				

*Mean values followed by the different letters are significant at the 0.05 level

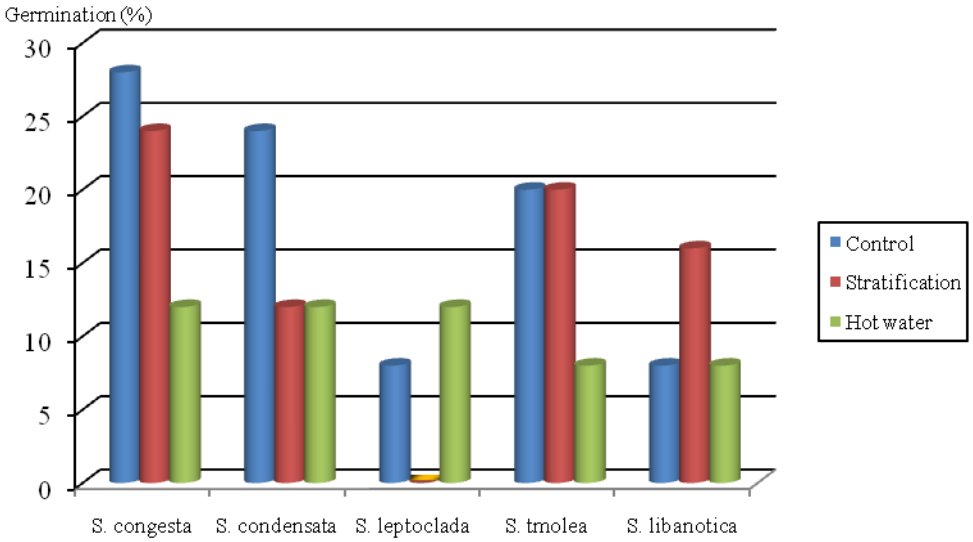

Figure 1. The germination values of treated and untreated seeds.

Data analysis

The data obtained from stratification, hot water and gibberellic acid treatments were analysed by MSTAT computer program. The data obtained from stratification and hot water treatment were evaluated separately from gibberellic acid application data. All the differences were analysed statistically. Firstly, the germination ratio values were converted arcsinx values; then the variance analysis was done according to the arcsinx values. But, only the mean values of all treatments were represented as percentage of germination in tables.

RESULTS AND DISCUSSION

Seed germination

Sideritis species seeds were sown on moistened filter paper disks in petri dishes to rise of the seed germination ratio. The germination values of stratificated and hot water soaked seeds are represented in Table 3 and Figure 1. The differences between values of control and other groups were statistically significant. Also, the germination ratio mean values of seeds treated with different doses of GA_3 were represented in Table 4 and Figure 2.

As shown in Table 3, the germination ratio of *Sideritis* seeds did not increase significantly after stratification comparing with the control group. *Sideritis leptoclada* seeds not germinated. A miserable increasing on the germination rate was observed only in the case of *Sideritis condensata* seeds. At *Sideritis scardica* and *Sideritis recta* seeds a good germination rate was obtained after a treatment with gibberellic acid while stratification was not so effective (Kozuharova, 2009). In 2008, the seeds of *S. scardica* treated with stratification but no gibberellic acid had poor germination (10.6%), as well as those left with no treatment (control) (16.3%).

Figure 1 shows the germination rate of *Sideritis* species seeds in the case of stratification and hot water treatments. Estrelles et al. (2004) recorded that the seed

Table 4. The germination ratio mean values of seeds treated with different doses of GA_3 and Duncan groups.

GA_3 doses	*S. congesta*	*S. condensata*	*S. leptoclada*	*S. tmolea*	*S. libanotica* ssp. *linearis*	Mean values
100	48^{B}*	52^{A}	40^{D}	40^{D}	36^{E}	43.2^{a}***
250	40^{D}	48^{B}	12^{IJ}	32^{F}	26^{G}	31.6^{d}
500	48^{B}	36^{E}	54^{A}	40^{D}	34^{EF}	42.4^{a}
750	44^{C}	52^{A}	40^{D}	44^{C}	16^{H}	39.2^{b}
1000	36^{E}	44^{C}	46^{BC}	32^{F}	15^{HI}	34.6^{c}
Control	14^{HIJ}	12^{IJ}	4^{K}	10^{J}	2^{K}	8.5^{e}
Mean values	38.3^{b}**	40.7^{a}	32.7^{c}	33.1^{c}	21.5^{d}	

*CV: % 6.76 ** $LSD_{0.05}$ = 1.802 (species) *** $LSD_{0.05}$ = 1.828 (doses)
$LSD_{0.05}$ = 3.317 (interaction)

*Mean values followed by the different letters are significant at the 0.05 level

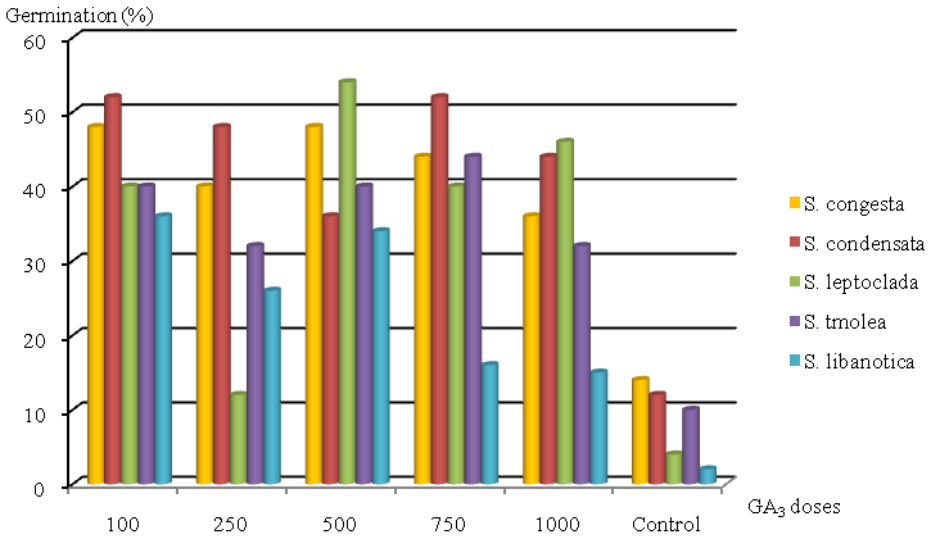

Figure 2. The germination ratio mean values of seeds treated with different doses of GA_3.

germination process on *Sideritis spinulosa* ssp. *subspinosa* on conditions of constant and alternant temperature regimes was analysed and obtained the germination ratio as 20% in 15°C, 15% in 20°C and 30% in 25°C at constant temperature in darkness; in light conditions the germination rates are 45% in 15°C, 25% in 20°C and 27% in 25°C at constant temperature. At 35°C, the seeds had not germinated both at constant and alternant temperatures. The germination ratio was 60% in 25/15°C and 20% in 35/15°C at alternant temperatures in darkness. In light conditions, the germination rates are 35% in 25/15°C and 33% in 35/15°C at alternant temperatures.

Thanos and Doussi (1995) recorded that 60 to 70% of the seeds of *Sideritis syriaca* ssp. *syriaca* germinated only in the dark at a warmer temperature range (20 to 25°C). At 30°C, only 40% seeds germinated.

There was no increase in the germination ratio of *Sideritis* seeds treated with hot water. No literature could be found concerning the hot water treatment.

As can be seen in Table 4, the high germination rate was determined on the *Sideritis* seeds after treatment with gibberellic acid. But, it was conspicuous that the different doses of gibberellic acid affected *Sideritis* species differently. The highest germination rate was determined at 100 ppm dose for *Sideritis congesta, S. condensata* and *S. libanotica ssp. linearis*; at 500 ppm dose for *S. leptoclada* and at 750 ppm for *S. tmolea* and *S. condensata*.

Kozuharova (2009) showed that *S. scardica* seeds treated with gibberellic acid germinated in 80.9% comparing with no treatment.

Uçar and Turgut (2009) recorded that *Sideritis stricta*, *S. perfoliata* and *S. erythratha* seeds treated with different doses of gibberellic acid had germinated very poorly, as 0% in *S. stricta*, 33% *S. perfoliata* and 33% *S. erythrantha* in 5 mg/L gibberellic acid solution. Other doses (10 and 15 mg/L gibberellic acid solutions) had not

obtained germination.

Yücel and Yılmaz (2009) recorded that Salvia cyanescens seeds were not dormant and germination was promoted by cold-wet process at -5ºC; low concentrations of NaCl and KNO3 (0.5%, 1%) brought up high germination percentage, but higher concentrations (2%>) inhibited the germination; also, all of the H2SO4 concentrations (0.5%-3%) inhibited the germination completely; at 1% GA3 application in different media, the highest germination percentage occurred in the Jacobsen apparatus and the lowest in the plant growth chamber.

CONCLUSION

After all treatments, it could be said that the GA_3 application gave the best results. The treatments of stratification and hot water did not give good results concerning *Sideritis* seed treatments. The germination ratios were maximal after stratification, 12, 6, 0, 10 and 8%, *Sideritis congesta*, *S. condensata*, *S. leptoclada*, *S. tmolea* and *S. libanotica* ssp. linearis, respectively. After the hot water application, the germination ratios of the seeds were 6, 6, 6, 4 and 4, *S. congesta*, *S. condensata*, *S. leptoclada*, *S. tmolea* and *S. libanotica* ssp. linearis, respectively. But, after the GA_3 application, the germination ratios were maximum of all doses used 48, 52, 54, 44 and 36%, *S. congesta*, *S. condensata*, *S. leptoclada*, *S. tmolea* and *S. libanotica* ssp. linearis, respectively. According to these results, the GA_3 application was the best treatment for the germination of the *Sideritis* seeds. For the cultivation, it can be recommended that the seeds must be treated with different doses of GA_3 (especially 500 ppm).

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