Effect of Temperature, Light, Seed Weight and GA$_3$ on the Germination of
Verbascum bithynicum, Verbascum wiedemannianum and Salvia dicroanthera

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Abstract: S. dicroanthera, (Stapf in Denkseehr) Verbascum bithynicum and V. wiedemannianum are (Bios.) endemic and medicinal potential plants disturbed in Turkey. V. wiedemannianum is different from the other Verbascum species in red-purple flowers and as a threatened plant. Seed germination strategies of these species were studied with the aim of producing appropriate germination protocols for use ex situ conservation. The optimum temperature for seed germination of S. dicroanthera, V. bithynicum and V. wiedemannianum was 20°C and darkness. The seeds of V. bithynicum and V. wiedemannianum incubated in darkness showed higher germination percentages than the seeds incubated with a 16:8 h photoperiod or continuous light, but the effect of application of darkness, photoperiod (16:8 h) or continuous light on the germination percentage of the seeds of S. dicroanthera was not significant. In the case of S. dicroanthera, seed weight significantly affected germination percentage, but not significant in the case of V. bithynicum and V. wiedemannianum. Exogenous GA$_3$ (20, 100, 200 mg L$^{-1}$) was completely prevented germination the seeds of these species.

Key words: Verbascum bithynicum, Verbascum wiedemannianum, Salvia dicroanthera, seed germination

INTRODUCTION

Salvia dicroanthera, Verbascum bithynicum and V. wiedemannianum are endemic and medical plants disturbed in Turkey. V. wiedemannianum is different from the other Verbascum species in red-dark purple flowers and it has been listed in threatened species list (Ekim et al., 2000). It was known that the various parts of several Verbascum and Salvia species (leaves, stem, flowers etc.) had antioxidative and antimicrobial activity (Uçar et al., 2002, Tadeg et al., 2005, Tepe et al., 2006 a, b, c).

Detailed information on the different stages in the reproductive cycle of endemic, threatened and at the same time medicinal species may contribute to improved understanding of the phenomenon of endemism and at the same time assist conservation management decisions for the species under study (Navarro et al., 2003).

Each species has particular requirements for seed germination and germination requirements for native species are often unknown, particularly for rare or endemic species of which material is more difficult to obtain (Navarro et al., 2003; Cerabolini et al., 2004).

Temperature, light and gibberellic acid are the most important factors influencing the induction of seed germination (Baskin et al., 1998). In addition to these traits seed weight is an important factor for successful germination (Malcolm et al., 2003; Kambizi et al., 2006; Pérez-García et al., 2006).

In this study, we report on the effects of temperature, light, GA$_3$, and seed weight on the germination of the seeds of these species.

MATERIALS AND METHODS

Seed collection: The capsules V. bithynicum and V. wiedemannianum and the nuts of S. dicroanthera used for this study were harvested from their natural populations within Adana, Çorum and Samsun from Turkey, respectively in July-August of 2003. The seeds were removed from capsules and parts of perianths, air dried and stored in brown bottle at room temperature (18-25°C) until using time.

Germination tests: Seeds were soaked for 15 min in 1% NaOCl, washed with distilled water for three times and then placed in 9 cm petri dishes containing cotton and filter paper and moisturized with 10 mL distilled water.

Temperature: The effect of temperatures on the germination were determined at 5, 10, 15, 20, 25 and 30°C.
Light exposure: Seeds were incubated at 20°C in continuous dark (petri dishes were covered with aluminum foil) continuous light and 16:8 h (light:dark) photoperiod.

GA₃: Seeds were wetted with GA₃ in petri dishes (20, 100, 200 mg L⁻¹, it concentrations) and then incubated at 20°C in continuous dark.

Seed weight: For each species 300 seeds were chosen at randomly. Each seed was weighed with a precision balance, and assigned to two groups the seeds of *V. wiedemannianum* and *V. bithynicum* and three groups of *S. dicroantha* (Table 1).

Data analysis: Statistics: For evaluation of seed germination General Linear Model ANOVA procedure was used (SPSS 10.0 for Windows).

RESULTS

The results of this research showed that temperature and continuous dark affected the germination rate of *S. dicroantha*, *V. bithynicum* and *V. wiedemannianum* (Fig. 1).

The optimum temperatures for germination of the seeds of these species are 15-30°C.

The maximum germination percentage obtained at 20°C and continuous dark for *S. dicroantha*, *V. bithynicum* and *V. wiedemannianum* (49.44, 86.11, 86.69%, respectively).

For the seeds of *V. bithynicum*, the highest germination rate was obtained at 20-25°C and no significant difference (p<0.01) in germination rate was observed between seeds incubated at 20-25°C, but at 5°C the seeds weren't germinated (Table 2).

The highest germination rate was observed at 20°C in *V. wiedemannianum* seeds at 5 and 10°C was not germination. There were statistically significant differences between studied temperatures (p<0.01). Also in the seeds of *S. dicroantha*, the highest germination rate was observed at 20°C, at 5°C no germination and the least germination rate was observed at 10°C (p<0.05) (Table 2).

Continuous light and photoperiod (16:8 h) were decreased the germination rate of the seeds of *V. bithynicum* and *V. wiedemannianum*. The highest germination rate was occurred in continuous dark (Fig. 2). There were statistically significant differences between studied temperatures (p<0.05). It was determined that the effects of continuous light, continuous dark and photoperiod were not significant on the germination of the seeds of *S. dicroantha* (Table 3).

Two different groups were formed according to seed weight from 300 random individuals of *V. bithynicum*, *V. wiedemannianum*. There were no significant differences between groups in terms of germination rate. Seeds of *S. dicroantha* were separated into

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Table 1: The seeds groups according to seed weight. Seeds assigned to two groups the seeds of *V. wiedemannianum* and *V. bithynicum* and three groups those of *S. dicroantha* (Table 1).

<table>
<thead>
<tr>
<th>Species</th>
<th>Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I (mg)</td>
</tr>
<tr>
<td><em>V. bithynicum</em></td>
<td>0.1-0.4</td>
</tr>
<tr>
<td><em>V. wiedemannianum</em></td>
<td>0.1-0.3</td>
</tr>
<tr>
<td><em>S. dicroantha</em></td>
<td>0.9-1.9</td>
</tr>
</tbody>
</table>

Table 2: The effect of temperature on the germination of *V. wiedemannianum*, *V. bithynicum* and *S. dicroantha*

<table>
<thead>
<tr>
<th>Temp. (°C)</th>
<th><em>V. wiedemannianum</em></th>
<th><em>V. bithynicum</em></th>
<th><em>S. dicroantha</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>0.00±0.00d</td>
<td>0.00±0.00d</td>
<td>0.00±0.00e</td>
</tr>
<tr>
<td>10</td>
<td>0.00±0.00d</td>
<td>0.10±0.00d</td>
<td>0.11±0.00d</td>
</tr>
<tr>
<td>15</td>
<td>0.44±0.13d</td>
<td>0.16±0.11d</td>
<td>2.33±3.61d</td>
</tr>
<tr>
<td>20</td>
<td>8.66±3.43a</td>
<td>8.61±3.20a</td>
<td>49.44±5.67a</td>
</tr>
<tr>
<td>25</td>
<td>52.77±4.23b</td>
<td>78.33±2.88a</td>
<td>32.77±2.51b</td>
</tr>
<tr>
<td>30</td>
<td>20.00±2.63c</td>
<td>46.11±1.61b</td>
<td>16.11±2.32c</td>
</tr>
</tbody>
</table>

*p<0.01, **p<0.05*. Each value represents germination percentage with standard error in parenthesis. Mean followed by the same letter are not significantly different at the 0.05 or 0.01 level.

Table 3: The effect of continuous light, dark and photoperiod on germination

<table>
<thead>
<tr>
<th>Parameters</th>
<th><em>V. wiedemannianum</em></th>
<th><em>V. bithynicum</em></th>
<th><em>S. dicroantha</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Light</td>
<td>68.50±3.59b</td>
<td>66.16±4.24a</td>
<td>43.33±3.57a</td>
</tr>
<tr>
<td>Photoperiod</td>
<td>64.16±8.30b</td>
<td>68.33±4.94a</td>
<td>45.00±3.65a</td>
</tr>
<tr>
<td>Dark</td>
<td>89.16±3.74a</td>
<td>90.00±2.58a</td>
<td>44.16±2.38a</td>
</tr>
</tbody>
</table>

*Not Significant, **p<0.05. Mean followed by the same letter are not significantly different at the 0.05 level.

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Fig. 1: The effect of temperature on the germination percentage

Fig. 2: The effect of light and dark on germination percentage
DISCUSSION

The result of this research were indicated that conditions of temperature and light were affected germination of the seeds of three endemic species (V. bithynicum, V. wiedemannianum and S. dicroantha). At the lower of 20°C and the upper of 25°C, the germination percentage was reduced. The effect of temperature on the germination percentage was varied according to plant species (Leite et al., 2001).

Also in an other research the seeds of V. olypicum, V. vombycisferum and V. prasianum were germinated at 4-7 °C (Saribayir, 2001).

The application of continuous light, dark and photoperiod (16:8 h light:dark) were affected germination of the seeds of three species in different level.

The germination percentage of the seeds of V. bithynicum, V. wiedemannianum was decreased in continuous light and photoperiod, however in the S. dicroantha was not observed significant difference between the light applications. It was determined that seeds of some species germinated to similar rates at light or dark, but those of other some species germinated to higher rates at dark than light. The seeds of C. decida, P. arabic and S. aegyptica needed to light for germination (Huang et al., 2003), in S. pomifera white light increased to germination (Thanos et al., 1995), in Cecropia hololeuca increased to germination only at dark (Godoi et al., 2004). In P. juliflora germination in light was significantly greater than in the dark at high temperature (El-Keblawy et al., 2005). Also P. grandiflora and P. viscosa seeds germination to higher rate at dark than 12:12 photoperiod (Navarro et al., 2003).

The results of this research and other researches were indicated that the effect of application light varied according to plant species. It is very important to determine appropriate temperature and light conditions for the best germination.

The application of GA, completely inhibited to germination in the research seeds. In the seeds of E. hyemalis, GA, not affected at 23°C, but at 4°C, GA application stimulated germination (Tipirgiz et al., 2000). The stimulating effect of GA, not universal and this effect varied according to germination conditions and plant species (Greipsson, 2001).

The seeds of V. bithynicum and V. wiedemannianum separated into two groups according to seed weight and no significant differences between groups in terms of germination rate. But S. dicroantha seeds separated into three groups and significant differences were found between groups (p<0.01).

It was determined that seed weight affected on the germination percentage and seedling growth (Arunachalam et al., 2003). Navarro et al. (2003) suggest that the poorer performance of lighter seeds is due to their lower endosperm content. Our results from S. dicroantha are in accordance with this hypothesis. The heavier seeds of S. dicroantha showed significantly greater germination rate than lighter seeds.

REFERENCES


