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Effects of Different Alkaline Metal Salts (NaCl, KNO_3), Acid Concentrations (H_2SO_4) and Growth Regulator (GA_3) on the Germination of *Salvia cyanescens* Boiss. & Bal. Seeds

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ABSTRACT

In this study, the seed germination characteristics of *Salvia cyanescens* a plant which is endemic for Turkey and the effects on germination rates of such factors as temperature, alkaline metal salt (NaCl, KNO_3) and acid (H_2SO_4) concentrations and growth-regulating (GA_3) substances are examined. At the end of the study, it was observed that the seed was not dormant; germination was promoted by cold-wet process at -5ºC; low concentrations of NaCl and KNO_3 (0.5%, 1%) brought up high germination percentage, but higher concentrations (2%>) inhibited the germination; all of the H_2SO_4 concentrations (0.5%-3%) inhibited the germination completely; at 1% GA_3 application in different media (Jacobsen and Rodewald apparatus, Plant Growth Chamber, Room conditions) the highest germination percentage occurred in the Jacobsen apparatus and the lowest in the plant growth chamber.

Key Words: Endemic, Germination, Labiatae, Salinity-Acid Stress, Salvia cyanescens, Seed.

1. INTRODUCTION

There are 92 *Salvia* taxa distributed naturally in Turkey, almost 50% of which are endemic. *Salvia* species have been used as folk medicine for their diuretic, antiseptic, haemostatic, antibacterial, spasmolitic, carminative and wound-healing effects [1]. In recent years, antitumor effects have been attributed to some diterpenoids obtained from *Salvia* species, and they are also used in the treatment of some heart failure [2, 3].

An element of Irano-Turanian, *Salvia cyanescens* shows a natural distribution, as a plant endemic for Turkey, in the provinces of Bolu, Çankırı, Kastamonu, Sivas, Eskişehir, Ankara, Yozgat, Konya and Niğde [4]. It is a decorative plant of 25-70 cm, perennial, with purple flowers. It contains 0.43% essential oil and borneol+isoborneol 10% [5]. Borneol esters, being possessed of a typical needle-pine scent, are used in the perfumes of bornil acetate soaps, inhalers, room sprays and medical preparations [6].

The aim of this study is to ascertain the seed germination characteristics of *Salvia cyanescens*, an economic asset to Turkey as an endemic plant, and to investigate the effects of different concentrations of NaCl and H_2SO_4, as well as various growth regulators and germination-stimulating substances, on its seed germination.

2. MATERIALS AND METHODS

The materials selected for this study are *Salvia cyanescens* seeds. Samples of plants, the seeds of which had been collected, were identified and placed in the Herbarium of the Department of Biology, Faculty of Science, Anadolu University (ANES 4471).

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Each germination experiment comprised experimental series of 3x100 seeds. The experiments were carried out in five different media: climate chamber, Jacobson apparatus, Rodewald apparatus, germination chamber and normal room conditions. In the climate chamber, sand and filter-paper were used, a constant temperature (+25ºC) was maintained throughout the experiment and a photoperiod of 8 hours light and 16 hours darkness was applied. One group of seeds was pre-treated for 5 minutes at -5ºC, another for 210 minutes at +105ºC. The effects of NaCl, H_2SO_4 and growth regulators at rates of 0.5%, 1%, 2% and 3% on the seeds constituting the experimental series were examined. For the experiments carried out in the Jacobson and Rodewald apparatus, the germination chamber and normal room conditions, the seeds were subjected to a pre-treatment in 1% GA_3 before being put to germination. While the fundamental procedural principles of the apparatus were adhered to in the experiments conducted in the Jacobson and Rodewald apparatus, a constant temperature of +25ºC and photoperiod of 8 hours light and 16 hours darkness were applied in the germination chamber. For the 'room conditions' experiments sand was used as the germination bed in uncontrolled room conditions. All procedures were applied equally and at the same time to each of the series throughout the germination period, which was terminated on the 60th day. It was accepted as sufficient for a seed to be considered germinated if the radicle emerging from the tip of the seed was touching top of paper or sand.

4. RESULTS

The weight of 1000 seeds is 2.048 g (of which 8.2% is moisture). At the germination experiments, the seeds were determined not to show dormancy; the results are given in their entirety in Table 1.

3.1. Effects of Germination Top of Sand or Paper on Germination

In the control series with a germination bed of sand and paper, prepared with distilled water and without any kind of pre-treatment, germination rates were ascertained to be high. The highest germination rate (76%) was observed in the series with a germination top of paper, 2% the lowest rate was found on that of sand (Figure 1).

3.2. Effects of Cold/Hot Pre-Treatment (-5ºC, +105ºC) on Germination

The highest germination rate (78%) was found in the series with a germination top of paper which had been pre-treated for a period of five minutes at a temperature of -5ºC (Figure 1). In the series subjected to a pre-treatment temperature of +105ºC for a period of 210 minutes, 5% germination rate was observed.

3.3. Effects of Different Salinity (NaCl) Concentrations on Germination

In the series subjected to different salinity concentrations (0.5-3%), germination rates at the lower concentrations (0.5%, 1%), while 20-22% lower than those of the control series, were observed being high (56-58%) (Figure 2); in the 0.5% NaCl series the germination rate was high on day 5, at the end of day 5 the germination rate for the 2% series had fallen and in the case of 3%, germination was totally inhibited; in this light, salt, while clearly inhibiting to germination at a concentration of 2%, becomes a growth inhibitor at concentration of 3% [7].

3.4. Effects of Different Concentrations of Sulfuric Acid (H_2SO_4)

No germination was observed at any concentration of H_2SO_4; thus, H_2SO_4 inhibits germination [7].

3.5. Effects of Different Concentrations of Potassium Nitrate (KNO_3)

KNO_3 inhibit germination at low concentrations, the optimum germination rate (66%) was in the 1% concentration series (Figure 3); in the 2-3% KNO_3 series, germination was determined to decrease and its rate to have fallen (24%, 16%); thus when KNO_3 exceeds 2% in concentration, it becomes a germination inhibitor [7].

3.6. Effects of Gibberellic Acid (GA_3) on Germination Applied in Different Media (Jacobson Apparatus, Rodewald Apparatus, Germination Chamber and Room Conditions)

While the highest germination in the 1% GA_3 series was observed in the Jacobson apparatus (74%) and the lowest was observed in the Germination chamber (51%) (Figure 4). Despite the differences in medium, accelerated germination was observed during the first days in all series of 1% GA_3.

4. DISCUSSION

Protection of natural habitats and gene pools and meeting the growing demand for plant-based products is now only possible by cultivating natural plant species. For this purpose it is necessary first to ascertain seed-germination behavior. In this study, in an examination of the characteristics of seed germination of one of Turkey's economically valuable endemic plants, *Salvia cyanescens*, the effects on germination of various concentrations of NaCl and H_2SO_4 and of various growth regulators and germination-promoting substances are investigated. It was affirmed on completion of the study that no germination inhibitor exists.

It is known that a cold/hot pre-treatment applied to seeds has an effect on germination, and, in particular, that cold pre-treatment stimulates it. In *Sideritis germanicopolitana* ssp. *germanicopolitana* seeds a five-minute cold pre-treatment of -5ºC to -80ºC was stimulating to germination, while a hot pre-treatment inhibited it [8]. For the *Salvia cyanescens* series subjected to a five-minute cold pre-treatment at -5ºC, a high germination rate was ascertained.

Table 1. Results of *Salvia cyanescens* germination experiments

Prescription for:		Germination (Mean)					
		Substrate	Temp. (°C)	FC Days	NC Days	FG %	NG %
Plant Growth Cabinet	Control group	TP	25	3	28	31	76
	PT, -5°C	TP	25	3	38	18	78
	Sand	TS	25	3	24	2	74
	PT, -5° C	TS	25	3	26	23	73
	PT, +105°C	TP	25	9	13	4	5
	0.5 % NaCl	TP	25	2	5	29	56
	1 % NaCl	TP	25	2	29	1	58
	2 % NaCl	TP	25	3	9	2	23
	3 % NaCl	TP	25	0	0	0	0
	0.5 % H_2SO_4	TP	25	0	0	0	0
	1 % H_2SO_4	TP	25	0	0	0	0
	2 % H_2SO_4	TP	25	0	0	0	0
	3 % H_2SO_4	TP	25	0	0	0	0
	0.5 % KNO_3	TP	25	2	5	50	58
	1 % KNO_3	TP	25	2	14	47	66
	2 % KNO_3	TP	25	2	6	3	24
	3 % KNO_3	TP	25	4	9	4	16
Jacobsen, 1 % GA_3		TP	12-25	1	11	53	74
Rodewald, 1 % GA_3		TP	12-25	1	18	28	63
GC, 1 % GA_3		BP	25	1	5	35	51
GR, 1 % GA_3		TS	22-28	1	8	7	66

(Temp.) temperature; (FC) first count; (NC) final count; (FG) first germination; (NG) final germination; (TP) top of paper; (TS) top of sand; (BP) between of paper; (PT, -5ºC) pre-treated for 5 minutes at -5ºC; (PT, +105ºC) pre-treated for 210 minutes at +105ºC; (GC) germination cabinet; (GR) room conditions; (GA_3) gibberellic acid.

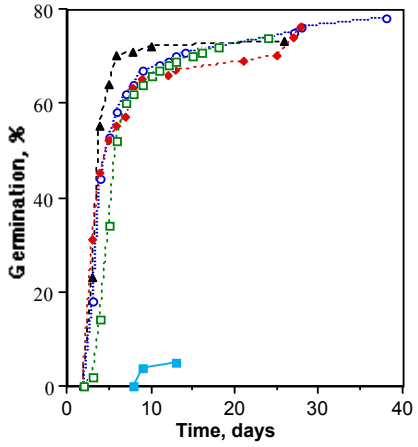

Figure 1. Effects of germination hot/cold pre-treatment on seed germination of *Salvia cyanescens* [(o) pre-treated for 5 minutes at -5ºC top of paper, (u) top of paper, (o) top of sand, (s) pre-treated for 5 minutes at -5ºC top of sand, (n) pre-treated for 210 minutes at +105ºC top of paper].

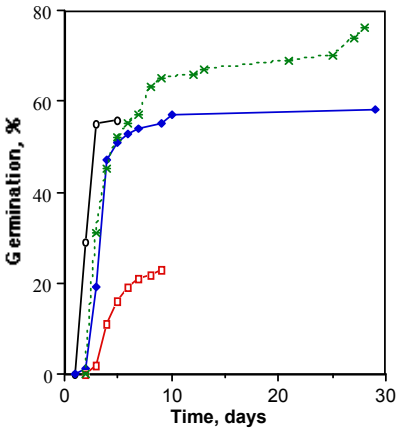

Figure 2. Effects of different concentrations of NaCl on seed germination of *Salvia cyanescens* [(x) control group, (u) 1% NaCl, (O) 0.5% NaCl, (o) 2% NaCl].

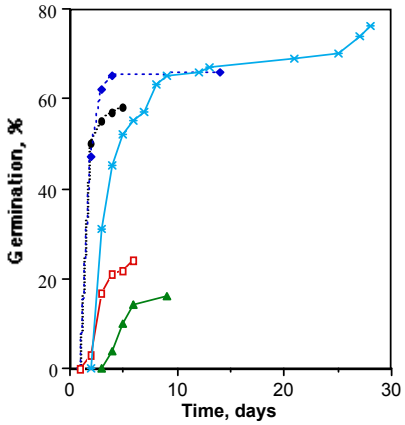

Figure 3. Effects of different concentrations of KNO_3 on seed germination of *Salvia cyanescens* [(x) control group, (u) 1% KNO_3, (l) 0.5% KNO_3, (o) 2% KNO_3, (s) 3% KNO_3].

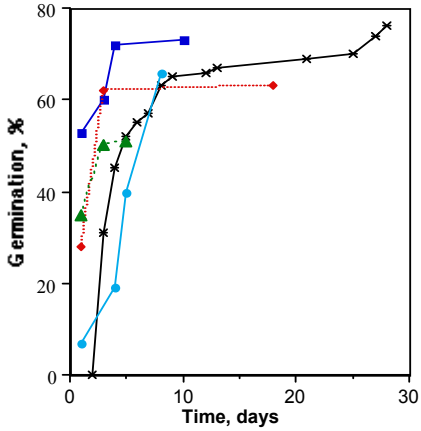

Figure 4. Effects of GA_3 on seed germination of *Salvia cyanescens* in different media [(x) control group, (n) Jacobson apparatus, (l) room conditions, (u) Rodewald apparatus, (s) germination cabinet].

The dark-colored seeds of *Pinus nigra* ssp. *pallasiana* var. *şeneriana* (Saatçi.) Yalt. were determined to germinate at a rate of 62.1%, albeit lower than the control group, when subjected to a hot pre-treatment of 100ºC at 210 minutes [9]. Hot pre-treatment of +105ºC, applied to *Salvia cyanescens* for 210 minutes was determined to inhibit germination (5%) and the seed to be sensitive to hot pre-treatment.

Germination is delayed and inhibited in relation to salinity concentrations [10]. The findings obtained in this study show partial discrepancies with other studies conducted, as high germination was determined at low NaCl concentrations (0.5%, 1%), while a 2-3% concentration was seen to delay and inhibit germination [7].

H_2SO_4, known to be a germination inhibitor, inhibits germination completely even at low concentrations (0.5%) [7].

KNO_3 has been stated as being a growth-regulating substance by a number of researchers. In this study, KNO_3 is determined to delay and inhibit germination [7].

GA_3 is known to be a growth regulator and is used frequently in overcoming obstructions to germination. Kabar and Baltepe, 1990 [11], for example, state that GA_3 was effective in removing heat and salinity stress on the germination of lettuce and barley seeds. In this study, GA_3 wasn't seen to be particularly effective on the speed of germination in *Salvia cyanescens* seeds.

Salvia cyanescens, as a decorative evergreen, perennial plant with its own special aromatic scent, can be used in park and garden designs. In addition, while it can be cultivated for medicinal purposes, it can also be used as a principle plant in erosion-control efforts. There was no inhibitor on its germination process; it can be produced from both seed and stem separation.

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