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Effects of Scarification and Temperature on Germination of Licorice *(Glycyrrhiza glabra* L.*)* Seeds.

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ABSTRACT

Laboratory experiments were performed to determine the effect of various scarification treatments at four temperature regimes on germination of licorice seeds . A randomized complete block design with four replications was used. Germination counts were made every day for 2 weeks. At 5^{0}C, none of the chemically and mechanically scarified and non scarified seeds germinated. At 15, 25, and 35^{0}C, mechanical scarification increased seed germination to 94-98%. However, at these temperatures, velocity of germination of mechanically scarified seeds were lowest among all treatments. Chemical scarification also increased germination percentage significantly to 90-95% with 45 min soaking. At 15 and 25^{0}C, seed germination percentage and velocity of germination increased as the soaking time in sulfuric acid increased from 5 to 30, 45, or 60 min. However, at 35^{0}C, there was no difference in germination percentage between soaking times of 5 and 60 min. It appears that soaking for 45 min provides full germination at 25 and 35^{0}C.

Keywords: Licorice dormancy, Weed biology, Weed seed germination.

INTRODUCTION

Licorice *(Glycyrrhiza glabra* L.) is a perennial weed in most dryland and some irrigated fields of Fars province, its natural population having been reported in rangelands and many other parts of Iran (Kamali, 1990). Licorice reproduces by rhizome and seed. The seed is round, flat (lens shaped) which has shining chestnut-brown color. In natural stands, seed germination is very low, due to dormancy caused by hard seed coat (Boe and Wynia, 1985). At present, in Iran, due to the extensive harvest of licorice roots from the rangelands and croplands, both soil and licorice plants are subjected to destruction. Licorice as a native legume offers tremendous potential for enhancing the productivity of pastures and rangelands where introducing species are not adapted or desired (Davis, 1982). Before any native legume is accurrately evaluated for cultivation or soil conservation purposes, the best condition for its seed germination must be identified, but the present knowledge in this regard is rather limited.

Experiments have been conducted to break licorice seed dormancy by chemical and mechanical scarification treatments. *G. glabra* L. seeds soaked in sulfuric acid for 10 to 60 min germinated at 19 to 20°C (Shunkurullaev and Khamdamov, 1976). Maximum germination (98.3%) was obtained with seeds treated for 40 min. Only 7% of control treatment seeds germinated. Khudahibergenov and Mikhahilova (1972) showed that untreated seeds of *G. uralensis* L. have 11% germination in the laboratory and 9% in the field. Treatment in concentrated sulfuric acid increased germination from 60 to 94%. Seeds germinated most vigorously at 40 to 50°C. Badalov and Pauzner (1979) showed that treatment of licorice seeds in 25 to 50

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mg l^{-1} succinic acid combined with scarification in sand increased laboratory and field germination. Soaking scarified seeds in 35 mg l^{-1} succinic acid for 24 hr increased laboratory germination to 98.7%.

In laboratory tests conducted by Gaganidze (1985), seeds of *G. uralensis* germinated comparatively better at a maximum temperature of 25°C and maximum moisture of 80%. Sharp temperature change from 10 to 35°C proved to be more effective than moderate change from 10 to 15°C or 15 to 35°C. The objective of this research was to evaluate the effect of seed scarification and constant temperature regimes on licorice seed germination.

MATERIALS AND METHODS

Bulk pod collections were obtained from natural stands of *Glycyrrhiza glabra* L. in the experiment station of the college of agriculture of Shiraz University. Pods were carefully threshed in bulk on a rubber threshing board. Seeds were stored at 3 to 5°C for 2 months.

Laboratory experiments were performed to determine the effect of scarification methods on licorice seed germination at different constant temperatures. In the chemical scarification method, seeds were soaked in sulfuric acid (70% concentration) solution for 5, 15, 30, 45, and 60 minutes. The scarified seeds were then washed under running water for 15 min. In mechanical scarification, seeds were scarified with hand rotary scarifier model M-4. Scarified seeds were checked for fractured seed coat by wild stereo microscope (X10). Treated and sterilized seeds were placed in 9-cm sterilized petri dishes on one sheet of Whatman no.2 filter paper. Petri dishes were then placed at four constant temperature regimes (5, 15, 25, and 35°C) in germinator under dark conditions with 80% relative humidity. The experiment was factorial with a randomized complete block design using four replications. Each replicate consisted of 100 seeds (4 petri dishes of 25 seeds each). Germination counts were made every day for 2 weeks.

Coefficient of velocity (*CV*), a unitless parameter determined by a mathematical manipulation that incorporates the number of seeds germinated and the velocity of germination, was calculated using the following formula:

$$CV = 100\left[\frac{\Sigma N_i}{\Sigma N_i T_i}\right] \qquad (1)$$

where N is the number of seeds germinated on day i and T is the number of days from sowing (Scott, Jones and Williams, 1984). In general, a higher *CV* value reflects increased germination and shorter germination time. Data were analyzed and means were compared using Duncan's new multiple range test.

RESULTS AND DISCUSSION

Licorice Seed Germination Percentage

Since licorice seeds did not germinate at 5°C with different scarification methods, the data for this temperature regime were not included in calculations. Analysis of variance for data showed that temperature, scarification methods, and their interactions were significantly different.

Results of licorice seed germination as affected by various constant temperatures and different scarification treatments are shown in Table 1. At 5°C, neither of the chemically or mechanically scarified, nor nonscarified seeds (control) germinated. At 15, 25, and 35°C percent germination of nonscarified seeds was as low as 6, 11, and 14%, respectively. At these same temperatures, mechanical scarification promoted seed germination more than 15, 8, and 7 fold as compared with control, respectively. Chemical scarification also increased percent germination significantly. At 15°C , soaking times longer than 15 min did not affect percent germination. At 25°C, there was no difference in percent germination between soaking times of 30, 45, and 60 min. However,

Table1. Germination percentages of licorice seeds as affected by scarification methods and various constant temperatures.

	Time soaked in H_2SO_4 (min)					Mechanical scarification	Nonscarified seeds	Mean
	5	15	30	45	60			
Temperature (°C)					(%)			
5	0	0	0	0	0	0	0	0
15	55c [a]	69 bc	73 abc	82 ab	80 ab	94 a	6 d	66 B
25	58c	74b	83 ab	90 a	80 ab	94 a	11 d	70 AB
35	74d	81 cd	88 bc	95 ab	78 d	98 a	14 e	75A
Mean	62 c	75 b	81 ab	89 a	79 ab			

[a] Means within each row (small letters) or column (capital letter) with similar letters are not significantly different at 1% level according to Duncan's multiple range test.

germination percentage was significantly different between soaking times of 5 and 60 min.

At 35°C, no significant increase occurred in germination when seeds were chemically scarified with sulfuric acid for 5 to 15 min. There was no difference in germination percentage observed between soaking times of 15 and 30 min and also between soaking times of 30 and 45 min. However, germination percentage was significantly decreased when the soaking time increased from 45 to 60 min. Overall, maximum germination percentage was obtainted at 35°C and the soaking time of 45 min, although there was no significant difference between 30, 45, and 60 min soaking times (Table 1).

Regression equations (Figure 1.) where *y* is the germination percentage and *x* the scarification time in minutes provide satisfactory fit to the observed data for the chemical scarification treatments. From this formula the optimum scarification time for each temperature can be estimated by solving the equation $\frac{dy}{dx}=b+2$ cx when $\frac{dy}{dx}=0$. For the 15°C, maximum germination was estimated at 82% after 54.2 minutes of scarification ; for 25°C the estimate is 83% germination after 26.8 minutes; and for 35°C, maximum germination was estimated at 92% after 36.2 minutes. This indicates that as temperature increases, the germination percentage reaches its maximum rate within a shorter time when seeds are soaked in sulfuric acid.

Coefficient of Velocity of Germination

Effects of various constant temperature regimes and scarification on coefficient of velocity of germination are shown in Table 2. At 15, 25, and 35°C, velocities of germination of mechanically scarified seeds were the lowest among all treatments. Chemical scarification increased coefficient of velocity as the soaking time in sulfuric acid increased from 5 to 15 min and also from 15 to 30 min. However, at 15 and 25°C, no difference in coefficient of velocity was observed when the soaking time increased from 30 to 60 min. These results indicated that the optimum temperature for maximum coefficient of velocity was 25°C (Table 2). The coefficient of velocity was reduced either above or below this temperature. Maximum figure was obtained at the soaking time of 30 min or longer.

Seeds that are unable to imbibe water are commonly termed impermeable or "hard seeds". Impermeable seeds are common in many species of *Fabaceae, Chenopodiaceae, Convolvulaceae, Malvaceae,* and *Solanaceae* (Harrington, 1916). The testa and its structures, the hilum, micropyle, strophiole, and chalaza, have all been implicated as barriers to water penetration or as areas of

Table2. Effect of various constant temperatures and scarification on coefficient of velocity of germination of licorice seeds.

	Time soaked in H_2SO_4					Mechanical scarification	Nonscarified seeds	Mean
	5	15	30	45	60			
Temperature (^{0}C)								
15	45 c [a]	53 b	66 a	66 a	68 a	23 d	40 c	52 C
25	59 c	70 b	92 a	93 a	91 a	36 e	47 d	70 A
35	62 c	62 c	65bc	74 ab	76 a	47 d	47 d	62 B
Mean	55 b	62 b	74 a	78 a	78 a			

[a] Means within each row (small letters) or column (capital letter) with similar letters are not significantly different at 1% level according to Duncan's multiple range test.

weakness where imbibition does occur.

Results of these scarification studies indicated that seed coat was the major barrier to licorice seed germination. Seed coat hardness of this type is also common among perennial plants including common milkweed *(Asclepias syriaca* L.), field bindweed *(Convolvulus arvensis* L.) and others (Brown and Porter, 1942; Evetts and Burnside, 1972; Hackett and Murray, 1987). Low CV values for the control seed indicate that germination events are less frequent and the speed of germination is lower than with chemically scarified seed. A hard seed coat allows seed to survive and later germinate over a number of seasons, enhancing species survival. Coat-imposed seed dormancy also may explain why few seedlings are observed at any one time throughout the season.

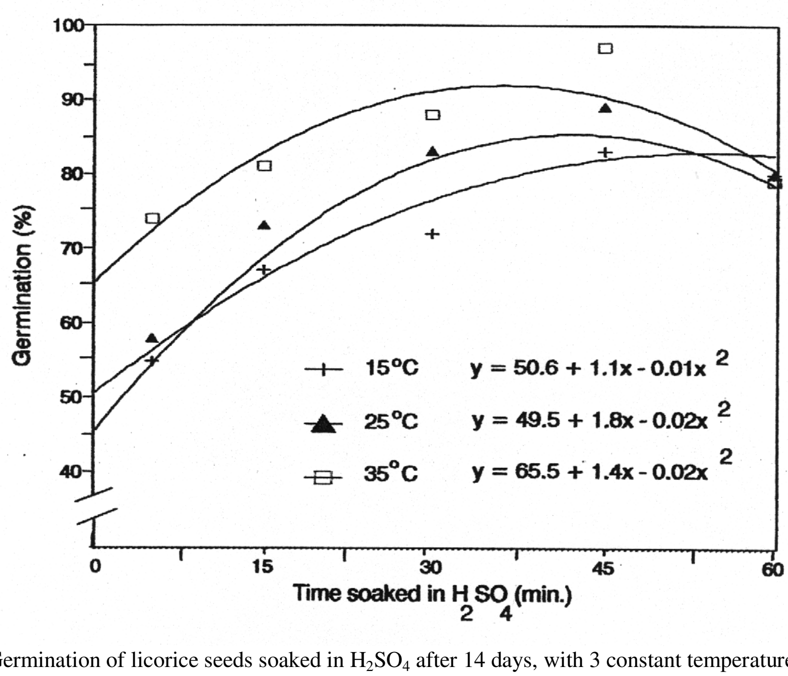

Figure 1. Germination of licorice seeds soaked in H_2SO_4 after 14 days, with 3 constant temperature regimes.

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اثر خراش دهی و دما بر جوانه زنی بذر شیرین بیان (*Glycyrrhiza glabra* L.)

چکیده

آزمایش هایی برای تعیین اثر تیمارهای مختلف خراش دهی در چهار رژیم دمایی روی جوانه زنی بذر شیرین بیان انجام گرفت. طرح مورد استفاده بلوک های کامل تصادفی با چهار تکرار بود. شمارش بذرهای جوانه زده هر روز به مدت دو هفته انجام شد. در ۵ درجه سانتی گراد، هیچیک از بذرهایی که به طور شیمیایی و مکانیکی خراش دهی شده بودند و بذرهای خراش داده نشده جوانه نزدند. در ۱۵، ۲۵ و ۳۵ درجه سانتی گراد، خراش دهی مکانیکی جوانه زنی بذر شیرین بیان را به ۹٤ تا ۹۸٪ افزایش داد. اما، در این دماها، سرعت جوانه زنی بذرهایی که به طور مکانیکی خراش داده شده بودند در پایین ترین میزان بود. همچنین خراش دهی شیمیایی با ٤٥ دقیقه خیس کردن در سولفوریک اسید باعث افزایش معنی دار جوانه زنی به ۹۰ تا ۹۵٪ شد. در ۱۵ و ۲۵ درجه سانتی گراد، درصد و سرعت جوانه زنی بذر، با افزایش زمان خیس کردن بذرها در سولفوریک اسید از ۵ دقیقه به ۳۰، ٤٥ و یا ٦۰ دقیقه، افزایش یافت. اما در ۳۵ درجه سانتی گراد، هیچ تفاوتی در درصد جوانه زنی بین زمان خیس کردن بذر در سولفوریک اسید به مدت ۵ و ٦۰ دقیقه ملاحظه نشد. به نظر می رسد که خیس کردن بذر شیرین بیان به مدت ٤٥ دقیقه بیشترین جوانه زنی را در دماهای ۲۵ و

۳۵ درجه سانتی گراد ایجاد می نماید.