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Full Length Research Paper

Effects of cold stratification and sowing time on germination of almond (*Amygdalus communis* L.) and wild almond (*Amygdalus orientalis* L.) seeds

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The aim of this study was to determine the proper pretreatments on seeds of almond (*Amygdalus communis* L.) and wild almond (*Amygdalus orientalis* L.) to overcome their germination obstacles. For this purpose, the seeds were kept in 5000 ppm ashen-water for three days. Experiments were carried out consisting of eight sowing dates (from 1st October to 15th March with 15 days intervals), and 13 different cold stratification periods (at 6±1°C for 15 to 120 days) in the terms of both in 2004 to 2005 and 2005 to 2006. The seeds were sown in the open field conditions, and statistical approach was completely randomized blocks design with four replications. 100 seeds per replicate were used. Statistical analysis showed that the results from two terms did not vary for both species. Seeds stratified for 60 or fewer days did not show enough germination. As result of the study, it could be concluded that either seeds should be sown after early rainfall in autumn or cold stratification for 75 to 120 days could be applied for seeds of both almonds.

Key words: *Amygdalus*, germination, cold stratification, sowing time.

INTRODUCTION

Almond (*Amygdalus*) is one of the most important subgenera of *Prunus*. They are one of the oldest commercial nut crops of the world. From the Middle and West Asia, it has diffused to other regions and continents (Ladizinsky, 1999). Besides its commercial use as a nut crop, the almond can be used as an ornamental plant because it has beautiful flowers which are white or pale pink (Davis, 1978; Karataş, 2007; Işıkalan et al., 2008). In addition, the important rootstock species and their scion combinations include almond rootstock for almonds and plums. As they are known as drought-resistant, hardy and long-lived plants they are planted in the poorest and driest soils as the best way of using them (Grasselly, 1990).

Seeds of many woody plant species can not germinate even if they are sown in the proper moisture, oxygen and soil conditions (Ürgenç and Çepel, 2001). The reason of this is based on different sources. Some of the biological sources, listed by ISTA (1993) are hard and impermeable seed coat, immature or dormant embryo, absence of endosperm and fleshy part of fruit. The germination obstacles vary both among and within species.

There have been few studies using different methods and techniques to overcome the germination obstacles of almond species (Khalil and Al-Eisawi, 2000; Rouhi et al., 2005a; Rouhi et al., 2005b; Rahemi et al., 2009; Gholami et al., 2010). It is essential to understand the effect of stratification and sowing time on germination both for practical nursery applications and conservation, but the methods to stimulate germination for these species have not been studied enough. The aim of this study was to investigate the effect of cold stratification and sowing time on seed germination of *Amygdalus communis* and *Amygdalus orientalis*

MATERIALS AND METHODS

The fruits of almond were collected from Eğirdir (37° 48' N, 30° 50' E) and the fruits of wild almond from Şarkikaraağaç (38° 04' N, 31° 21' E) by hand-stripping in September 2004 and 2005. All the fruits were packed in plastic bags and transported to the laboratory. Seeds obtained by breaking fruits were sampled randomly for all

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Table 1. Results of statistical analyses showing the relationship of the germination percentage (GP) with different pretreatments in 2004-2005 and 2005-2006 years.

2004-2005			2005-2006		
Pretreatments	**F-ratio**	**GP (%)***	**Pretreatments**	**F-ratio**	**GP (%)**
Amygdalus communis			***Amygdalus communis***		
Sowing (S) in 15 March 2005	867.826***	0.00^{a}	S in 15 March 2006	230.688***	0.00^{a}
Control		0.00^{a}	Control		17.38^{b}
S in 1 March 2005		1.44^{a}	S in 1 March 2006		17.63^{b}
Cold stratification (CS) for 15 days		25.45^{b}	CS for 15 days		36.11^{c}
S in 15 february 2005		32.03^{c}	S in 15 February 2006		40.53^{d}
CS for 30 days		45.14^{d}	CS for 30 days		52.85^{e}
S in 1 February 2005		51.06^{e}	S in 1 February 2006		53.76^{e}
S in 15 January 2005		59.37^{f}	S in 15 January 2006		58.54^{f}
S in 1 January 2005		65.28^{g}	CS for 45 days		65.49^{g}
CS for 45 days		65.30^{g}	S in 15 October 2005		69.38^{gh}
S in 15 November2004		65.31^{g}	CS for 120 days		69.97^{hj}
CS for 120 days		65.67^{g}	CS for 60 days		70.44^{hj}
CS for 105 days		65.68^{g}	CS for 105 days		71.81^{hjk}
S in 1 December 2004		65.84^{g}	CS for 75 days		71.82^{hjk}
S in 15 October 2004		65.88^{g}	CS for 90 days		71.84^{hjk}
S in 1 November 2004		65.89^{g}	S in 1 January 2006		72.35^{hjk}
S in 1 October 2004		66.08^{g}	S in 15 November2005		74.06^{hjk}
S in 15 December 2004		66.44^{g}	S in 1 December 2005		74.28^{hjk}
CS for 75 days		66.62^{g}	S in 1 October 2005		74.29^{hjk}
CS for 90 days		66.84^{g}	S in 15 December 2005		74.46^{kl}
CS for 60 days		67.03^{g}	S in 1 November 2005		75.67^{m}
Amygdalus orientalis			***Amygdalus orientalis***		
S in 1 March 2005	760.986***	0.00^{a}	S in 1 March 2006	1008.429***	0.00^{a}
S in 15 march 2005		0.00^{a}	S in 15 March 2006		0.00^{a}
Control		0.00^{a}	Control		19.78^{b}
CS for 15 days		5.96^{b}	CS for 15 days		22.15^{c}
S in 15 February 2005		10.65^{c}	S in 15 February 2006		25.82^{d}
CS for 30 days		17.89^{d}	CS for 30 days		39.52^{e}
S in 1 February 2005		22.27^{e}	S in 1 February 2006		41.84^{f}
CS for 45 days		37.01^{f}	S in 15 January 2006		46.01^{g}
S in 15 January 2005		40.38^{g}	CS for 45 days		49.61^{h}
CS for 60 days		59.84^{h}	CS for 60 days		63.99^{j}
S in 1 January 2005		60.58^{h}	S in 1 January 2006		70.75^{k}
S in 15 December 2004		64.55^{j}	S in 15 December 2005		71.10^{kl}
S in 1 December 2004		67.24^{j}	CS for 120 days		71.34^{kl}
S in 15 November2004		68.46^{k}	CS for 105 days		72.06^{klm}
S in 1 November 2004		68.91^{k}	CS for 90 days		72.11^{klm}
CS for 75 days		68.92^{k}	S in 1 December 2005		72.46^{klm}
CS for 90 days		72.13^{m}	CS for 75 days		72.63^{klm}
CS for 120 days		72.81^{m}	S in 1 November 2005		73.33^{klm}
CS for 105 days		72.88^{m}	S in 15 November2005		73.48^{mn}
S in 15 October 2004		73.65^{m}	S in 15 October 2005		73.65^{mn}
S in 1 October 2004		74.58^{m}	S in 1 October 2005		74.68^{n}

Means in column with the same letter are not significantly different at α=0.05.

the experiments. Initial viability was obtained using the cutting method.

Freshly harvested seeds were stored in opened-mouth jams at room temperature before stratification and sowing time treatments were applied. Seeds selected for pretreatments were soaked in 5000 ppm ashed-water for three days. Ashed-water was replaced on a daily basis. An important point to be indicated here is that the ratio of ashed-water is five times more (1:5) than weight of seeds to be used. For both stratification and sowing time treatments, damaged and unusually small seeds were eliminated and the remaining seeds were soaked for 24 h in room conditions (at about 20°C) in running water.

For stratification treatments, fruits were mixed with moistened sand. Afterwards they were subjected to varying periods of stratification. Seeds were stratified in pots of 30 × 40 cm. Stratified seeds were regularly irrigated once per week. To prevent the water loss during stratification upper surface of pots was covered by a sack. The following stratification and sowing time pretreatments (total of 42 pretreatments) were applied for each species: Cold stratification (CS) for 15, 30, 45, 60, 75, 90, 105 and 120 days in 2004 to 2005 and 2005 to 2006 years (total of 16 pretreatments). Sowing time (ST) in 1st and 15th October, 1st and 15th November, 1st and 15th December, 1st and 15th January, 1st and 15th February, 1st and 15th March of 2004 to 2005 and 2005 to 2006 years (total of 24 pretreatments). Control (without pretreatment).

Experiments applied for these pretreatments were arranged in a completely randomized design with four replications at the Eğirdir Forest Nursery, Turkey (37°53́ N, 30°52́ E, 926 m asl). Sowing depths used for wild almond and almond was 10 and 20 mm, respectively. In both species, seeds were sown in lines. 100 seeds per replicate were used. After sowing, mulching was applied on the sowing lines in 0.5 cm by means of the scales of Cedar. After this process, upper surface of sowing lines was covered by a sack until germination started. These experiments were intensively watered after sowing. But it was watered once in week commencing the seed sowing during terms not raining.

Germination percentages were calculated for each experiment. Data was transformed by using arcsin square root and the significance of mean was tested by ANOVA. Means were tested by Duncan's multiple range tests when significant differences were identified. A significance level of 5% was used for all the statistical analysis and the results obtained from experiments were separately analyzed. SPSS program was used for statistical analysis (SPSS Inc., 2002).

RESULTS AND DISCUSSION

Statistical analysis showed that the germination percentage (GP) was significantly affected by sowing times and cold stratification for both species ($p<0.001$). There were significant differences among both sowing times and cold stratification pretreatments (Table 1).

For almond, the highest germination percentage from 2005 to 2006 years was higher than that from 2004 to 2005, but for wild almond there was not much difference between the highest germination percentages from both terms. According to the results of both terms, the proper sowing time for almond and wild almond was the period between 1st October and 15th December, and also suitable duration of cold stratification for them was 75 to 120 days. Gültekin (2007) emphasized that the sowing time of these species was in the autumn and the early winter. Whereas, Rouhi et al. (2005) reported that the highest germination percentage was obtained from cold treatment for 90 days. Our findings from the present study support those mentioned above by both researches

According to the results of all the experiments, almond seeds sown on 15th March and wild almond seeds sown on 1st and 15th March had no germination. Besides, for both species only a low germination was obtained from control treatment in 2005 to 2006 years but no germination from that in 2004 to 2005 years (Table 1).

For almond there was significant difference between the highest germination percentages from the experiments in 2004 to 2005 and 2005 to 2006 years. It was considered that the cause of this difference between both terms was not only the variation in climate conditions, but also endosperm lack of the seeds. In this context, Gezer and Yücedağ (2006) explained that the seed needed adequate humidity, temperature and light to germinate.

When the results from this study were evaluated in practical terms, *Amygdalus* seeds should be sown either as soon as they are collected in autumn or after applying cold stratification for 75 days in late sowing to obtain high germination rate. As result, it is necessary to investigate ecological demands, relations with associated species and the principles of seed and seedling production with regard to these species to ensure economic, social and collective-cultural benefits expected from them. The findings from the present study are suitable for Eğirdir Forest Nursery and the other nurseries having similar habitat conditions.

REFERENCES

Davis PH (1978). Flora of Turkey and the East Aegean Islands. Edinburgh, 4: 21-28.

Gezer A, Yücedağ C (2006). Forest Tree Seeds and Techniques of Seedling Production by Sowing, Süleyman Demirel University, Publication Nr. 57, Isparta.

Gholami M, Rahemi M, Kholdebarin B (2010). Effect of Drought Stress Induced by Polyethylene Glycol on Seed Germination of Four Wild Almond Species. Austr. J. Basic Appl. Sci., 4(5): 785-791.

Grasselly C (1990). Almond production and industry in Europe, North Africa and the Middle East. In: Nut Production and Industry in Europe, Near East and North Africa. FAO, REUR Technical Series, 13: 95-105.

Gültekin HC (2007). Gültekin HC (2007). Tree Species with Wild Fruit and Techniques of Seedling Production. Republic of Turkey, Ministry of Environment and Forest, Ankara, pp. 35-36.

ISTA (1993). Rules for testing seeds. Seed Sci. Technol., 21: 1-259.

Işıkalan Ç, Adıyaman Akbaş F, Namlı S, Tilkat E, Başaran D (2008). In vitro micropropagation of almond (*Amygdalus communis* L. cv. Nonpareil). Afr. J. Biotechnol., 7(12): 1875-1880.

Karataş S (2007). Karataş S (2007). Ecological, morphological and anatomical properties of *Amygdalus* . (Rosaceae) species in the border of Şanlıurfa. Harran University, Institute of Natural and Applied Sciences, Master Thesis, Şanlıurfa, p. 99.

Khalil RY, Al-Eisawi DM (2000). Seed germination of - *Amygdalus arabica* Oliv.-as influenced by stratification and certain plant bioregulators. Acta Hortic., 517: 21-30

Ladizinsky G (1999). On the origin of almond Genetic Resources and Crop Evolution, 46: 143-147.

Rahemi A, Fatahi R, Ebadi A, Hasani D, Chaparro J (2009). The study of seed stratification and germination in *Amygdalus* species of Iran. 5th International Symposium on Pistachios and Almonds-ISHS-Şanlıurfa-Turkey, Oct.06-10, 2009, p. 180.

Rouhi V, Uddin MR, Damme P van (2005a). Germination, growth and dry matter accumulation of wild almond seedlings from stratified and scarified seeds. Commun. Agric. Appl. Biol. Sci., 70(2): 235-240.
Rouhi V, Ranjbarfardooei A, Damme P van (2005b). Effects of gibberellic acid and temperature on germination of *Amygdalus scoparia* Spech seeds. Options Mediterraneennes. Serie A, Seminaires Mediterraneens, 63: 397-401.
SPSS Inc. (2002). SPSS 11.0 Guide to Data Analysis, Published by Prentice Hall, Upper Saddle River, p. 637 New Jersey 07458.
Ürgenc S, Çepel N (2001). The Practical Principles of Species Selection, Seed Sowing and Seedling Planting for Afforestations. The Turkish Foundation for Combating Soil Erosion for Reforestation and the Protection of Natural Habitats (TEMA), No. 33, İstanbul.