The Effect of Flowering Time on Seed Dormancy Breaking of Almond

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Abstract

Seed's dormancy is considered as one of the effective factors in seeds germination and consequently in the growth of seeds of many plant species. Shortening the dormancy period and enhancing the germination percentage in fruit types could be a valuable strategy for the seed researchers and plant nurseries. In this research the seeds of mature fruits of different almond cultivars including late-very late flowering (Sahand), mid-late flowering (Touno) and early-very early flowering (Najafabad)cultivars with hard shells after being collected and prepared, were separated from the hull and were preserved under 18% dry moisture till the beginning of the experiment in a proper place. Seeds were disinfected with 2%TMTD® (Tetramethyl thiuram disulphide) fungicide solution for 30 minutes. Treated seeds, with and without endocarp, were stratified at 4 ◦C for 1–15 weeks. The numbers of germinated seeds were recorded weekly for each cultivar. The seeds were examined during cold stratification 4°C due with a view to the germination once a week. The results showed that different treatments have significant effect on the decrease of the time of different cultivars' seed germination; in other words, on the decrease of the chilling requirement in them. In hard shell seeds of Touno, Sahand and Najafabad cultivars with different flowering time had higher germination rate and uniformity, respectively.

Keywords: flowering time, seed dormancy, seed germination, almond

Introduction

Seed dormancy is an adoptive mechanism in *Prunus* species to protect temperate fruit trees from freeze damage during the winter (Martynez-Gomez and Dicenta, 2001). A seed which is dormant will not germinate even when the environment (e.g. water, oxygen, temperature) is adequate for germination (Bewley and Black, 1994; Hartmann *et al*., 1997; Nikolaeva, 1997). Various methods have been used by seed scientists and technologists to break seed dormancy (Diaz and Martin, 1972; Bewly and Black, 1994; Hartmann *et al.,* 1997). In order to accelerate seed germination, this method can be combined with some treatments such as chemical applications or mechanical seed coat removal (Du Toit *et al.,* 1979; Mehanna *et al.,* 1985; Garci a-Gusano *et al.,* 2004). Many researchers have examined the effects of chemical material on seed germination. According to report gibberllic acid eliminated the chilling requirement of peach and almond seeds and increased their germination (Mehanna *et al.,* 1985; Frisby and

Seely, 1993). But the effects of some endogenous and exogenous growth regulators on plum seed dormancy were reported differently (Lin and Boea, 1972). Among other chemicals, potassium nitrate and thiourea are widely used to break dormancy, but their role is not clear (Mehanna *etl.,* 1985; Agrawal and Dadlani, 1995). Rouhi *et al.*, (2006) studied the effects of gibberellic acid and cold temperature on seed of wild almond species. They obtained significant differences between the control and 500 ppm gibberellic acid. The highest seed germination percentage was observed with 125 ppm gibberellic acid at 7°C. Cetinbas and Koyuncu, (2006) showed that the effect of the treatment of gibberellic acid, potassium nitrate, and thiourea on cherry seeds has been positive in the improvement of germination. Some have given attention to the role of flowering time (Garcia-Gusano,, 2004) and the others to the role of seed coat (Grisez, 1974; Chang and Warner, 1984; Suszka *et al.*, 1996). According to a report, the elimination of seed coat (Lema Paleo) in Arabidopsis has resulted into its faster germination (Debeaujon *et al.*, 2000). Eira and Caldas, (2000) indicated that seed coat remove, after stratification and chemical treatments, has positive effect on seed germination.

In almond, studies about seed dormancy are very rare. Grigorian, (1972), Kester *et al.*, (1977) and Garcı´a-Gusano *et al.*, (2004) have indicated an optimum period for stratification of 8-12 weeks in almond cultivars. Therefore, seed dormancy breaking and shortening the germination period especially in the species with hard seeds could be a valuable strategy for the researchers and plant propagators. So for this purpose the effect of the flowering time of different cultivars of almond with hard shell on seed dormancy breaking time and germination has been examined in the present study.

Materials and Methods

This experiment was done in Seed and Plant Improvement Institute (SPII) of Karaj and in Agriculture Faculty of Tehran University in 2009. The seeds of different almond cultivars including 3 almond cultivars (Sahand, Touno, Najafabad) after being collected and prepared were separated from the hull and were preserved under 18% dry moisture till the beginning of the experiment in a proper place. At the time of the experiment the seed samplings after being disinfected with 2%TMTD® (Tetramethyl thiuram disulphide) fungicide solution for 30 minutes were exposed to the running water for 24 to 48 hours. Treated seeds, with and without endocarp, were stratified at 4 ◦C for 1–15 weeks. The numbers of germinated seeds were recorded weekly for each cultivar. The germinated seeds were considered that their root had grown 0.5 mm. In this experiment 540 seeds were used, and each cultivar's seeds were divided into 2 groups and each group counting 2 sections with 90 seeds (with shell and without shell) in a completely random design. The measurement of germination percentage was done for each treatment separately. For each cultivar in every treatment 30 seeds with 3 repetitions were used. Values were calculated including; Percentage of germination ((n/N) 100, n= the total number of seeds germinated and N number of seeds were used at the beginning of experiment), Germination start (the long time between seed sowing and beginning of germination), Time to

50% final germination (T50, of each treatment was determined as week that took place 50% of final germination) and germination speed (or germination mean (Agrawal and Dadlani, 1995).The statistical analysis was performed using Microsoft Excel (2007) and SPSS (14.0) Statistical Software.

Results and Discussion

The gained results of examining the effect of flowering time of Almond's different cultivars including Sahand (late-very late flowering and hard shell), Tuono (mid-late flowering and hard shell) and Najafabad (early-very early flowering and hard shell) on their seed's dormancy breaking and germination showed that different treatments had a significant effect on the decrease of germination time of different cultivar's seed (i.e. the decrease of chilling requirement). In addition, in Najafabad cultivar (early-very early flowering and hard shell), a longer duration with regard to the germination percentage was observed as compared to other cultivars. On the whole the gained results of germination percentage of every cultivar's seeds affected by two treatments, with shell and without shell in every experiment, are presented in Table 1.

Sahand (late-very late flowering and hard shell)

The germination percentage of seeds of Sahand (late-very late flowering and hard shell) cultivar affected by treatments, without shell and with shell, was different in a way that if the 6th week be considered as a criterion for examining the germination percentage, it was observed that the treatment without shell has the cumulative germination percentage with 17% in contrast to the 9% cumulative germination of shelled seeds in the same week (Table1). As it is seen in the Table 1, no germination was observed in the treatment, without shell and with shell, till the 5th week and 6th week, respectively. The highest germination percentage in the treatment without shell 40% with 55% cumulative germination percentage and in the treatment with shell 20% with 47% cumulative germination was observed in the 11th week. The highest germination speed (or germination mean) in the treatment without shell was 10.22 (in 9th week), while this value was 5.22 for the treatment with shell in the same week.

Tuono (mid-late flowering and hard shell)

In the experiment, also seeds of Tuono (mid-late flowering and hard shell) affected by treatments of seeds with shell and without shell were different and had various germination percentage in different times; if the 7th week be considered as a criterion for examining the germination percentage, it would be observed that germination in seeds without shell and with shell it was 13%and 0%. The highest germination percentage in the treatment without shell 52% with 65% cumulative germination in the 8th week, but this value in the treatment with shell 32% with 32% cumulative germination was observed. Time to 50% final germination and start germination in the treatment without shell was 8th and 7th week respectively. This time for the seeds with shell was 9th and 8th week respectively. The highest germination speed (or germination mean) in the treatment without shell was 9.44 (in 9th week), while this value was 5.88 for the treatment with shell in the same week.

Najafabad (early -very early flowering and hard shell)

In examining the germination of with shell and without shell seeds of Najafabad (early-very early flowering and hard shell) affected, it is finely obvious that if the 7th week be considered as a criterion for examining the germination percentage, the cumulative percentage affected by the treatment of without shell seeds would be 4% while in the same week the germination was 0% in the treatment of shelled seeds (Table 1). The highest germination percentage was observed in the 11th week in the treatment without shell 20% with 55% cumulative germination in compare to the treatment with shell 28% with 67% cumulative germination. Time to 50% final germination and start germination in the treatment without shell was 11th and 7th week, respectively. This time for the seeds with shell was 11th and 8th week respectively. Germination speed (or germination mean) in the treatment without shell was 3.22 in 9th week, while this value was 2.22 for the treatment with shell in the same week.

As it is seen in the Table 1, the germination between seed of the cultivars is different after dormancy breaking. For example, after dormancy breaking, germination speed (or germination mean) of the without shell seeds of Touno (mid-late flowering and hard shell) cultivar from 1.85 in the 7th week gets to 9.44 in the 9th week, during 3 weeks; whereas germination speed (or germination mean in with shell seeds same duration (from 8th to 10th week), from 4 to7 acquires (Table 1). If such a state be examined in Sahand (late-very late flowering and hard shell) cultivar, it would be specified that such duration is different in this cultivar. As during 4 weeks the cumulative germination percentage of shelled seeds of Sahand cultivar after dormancy breaking from 9% in the 6th week gets to 47% in the 9th week with germination speed from 1.50 to 5.22 (Table 1); in contrast, in the without shell seeds, in the same duration, the cumulative germination percentage from 4% to 52% has been attained since the 5th week to the 8th week with germination speed from 0.8 to 6.5 (Table 1).

The germination period Najafabad (early-very early flowering and hard shell) cultivar from its beginning to the end was different among the seeds with shell and without shell. the germination of without shell seeds begun in the 7th week with 5% and ended in the 14th week with 100% cumulative germination; though, the germination of shell seeds initiated in the 8th week with 9% and ended in the 14th week with 100% cumulative germination during 8 weeks. Therefore, in this experiment the beginning time and germination period of without shell and with shell seeds of Sahand (late-very late flowering and hard shell), Touno (mid-late flowering and hard shell) and Najafabad (early-very early flowering and hard shell) cultivars were different. For example, the beginning time of germination of with shell seeds of Sahand (late-very late flowering and hard shell), Touno (mid-late flowering and hard shell) and Najafabad (early - very early flowering and hard shell) cultivars (Table1) were the 6th, and 7th and 8th, respectively. Therefore, it could be said that Touno (mid-late flowering and hard shell), Sahand (late-very late flowering and hard shell) cultivars and Najafabad (early-very early flowering and hard shell), respectively do have the higher speed growth and higher germination monotony (Table 3).

By the general results of these experiments, the difference between the germination of with shell and without shell seeds of one cultivar and also the difference between several cultivars with the same nut shell can be noticed (Table 1); in other words, there was no such a difference between dormancy breaking of cultivars seeds of with the different flowering time. It can't be true that the seeds of late flowering cultivars delay germination than early flowering cultivars seeds. Also, in this experiment, it was determined that almond's nut shell did not have a significant role in creating and controlling the dormancy and it seems that the main factor is in the internal parts of almond seed; after being under cold and moist conditions and the elimination of controlling internal factors of dormancy, the seeds with shell and the seeds without shell with a little difference do germinate. Such a state has been in the gained results of this experiment. Grigorian, (1972) and Kester *et al.*, (1977) studied that the demanded period for the stratification of almond seeds has been 8 to 12 weeks. Such a condition has been reported in the results of Cetinbas and Koyuncu, (2006) experiment which was about the improvement of the germination of cherry seeds affected by the treatment of gibberellic acid, potassium nitrate, and thiourea under shell's effects. Although there was a significant difference between seed's germination speed in the shelled ones and the unshelled, but in the treatment of the seeds with shell, the germinated seeds had the least loss percentage. In this experiment it was specified that the main controlling factor in almond seed dormancy was physiologic and was related to internal factors of the seed (embryo and the surrounding texture), and the nut covers and flowering time did not have such a role in this phenomenon. We think that a practical application of these findings in managing the nursery would have economical effects by the increase of seedlings uniformity and by the decrease of seed's loss percentage, and would be a valuable strategy for the costly amendment.

Table 1. Percentage cumulative germination, mean of cumulative germination(%), , weekly germination speed (or mean germination) of seeds of different cultivars of almonds after 1 to 15 weeks at 4°C in dark environment conditions with different treatments.

	Treatment*																	
	Sahand			Sahand			Touno			Touno			Bomi1			Bomi 1		
	Without shell			With shell			Without shell			With shell			Without shell			With shell		
Weeks since sowing	weekly Germination Percent	Cumulative Germination Percente	weekly Germination Speed (or Mean Germination	weekly Germination Percent	Cumulative Germination Percente	weekly Germination Speed (or Mean Germination	weekly Germination Percent	Cumulative Germination Percente	weekly Germination Speed (or Mean Germination	weekly Germination Percent	Cumulative Germination Percente	weekly Germination Speed (or Mean Germination	weekly Germination Percent	Cumulative GerminationPercente	weekly Germination Speed (or Mean Germination	weekly Germination Percent	Cumulative Germination Percente	weekly Germination Speed (or Mean Germination
1	0	0a		0	0a		0	0a		0	0a		0	0a		0	0a	
2	0	0a		0	0a		0	0a		0	0a		0	0a		0	0a	
3	0	0a		0	0a		0	0a		0	0a		0	0a		0	0a	
4	0	0a		0	0a		0	0a		0	0a		0	0a		0	0a	
5	4	4a	.80	0	0a		0	0a		0	0a		0	0a		0	0a	
6	13	17b	2.83	9	9a	1.50	0	0a		0	0a		0	0a		0	0a	
7	6	23b	3.28	5	14b	2.00	13	13b	1.85	0	0a		5	5a	071	0	0a	
8	29	52c	6.50	13	27b	3.37	52	65c	8,12	32	32b	4.00	18	23b	2.87	9	9a	1.25
9	40	92d	10.22	20	47b	5.22	20	85d	9.44	21	53c	5.88	6	29b	3.22	11	20b	2.22
10	2	94d	9.40	11	58c	5.80	7	92d	9.20	17	70d	7.00	6	35b	3.50	19	39c	3.90
11	1	95d	8.63	13	71d	6.45	8	100d	9.09	18	88e	8.00	20	55c	5.00	28	67c	6.09
12	5	100d	8. 33	12	83e	6.91	0	100d	8. 33	7	95e	7. 91	13	68c	5.41	17	84c	7.00
13	0	100d	7.69	12	95e	7.30	0	100d	7.69	5	100e	7.69	17	85d	6.53	10	94c	7.23
14	0	100d	7.14	5	100e	7.14	0	100d	7.14	0	100e	7.14	15	100d	7.14	6	100 d	7.14
15	0	100d	6.66	0	100e	6.66	0	100d	6.66	0	100e	6.66	0	100d	6.66	0	100 d	6.66

1. Means with similar letters there are no significant difference by Duncan test (P<0.05)