The Effects of Various Stratification Durations on Germination and Seedling Emergence Rates of Apricot Seeds

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Abstract

The effects of several stratification durations (0, 30, 45 and 60 days) on the seedling emergences and germination of seeds and pits of 'Hacıhaliloğlu' apricot cultivars were studied. The first emergence rates and durations as well as the maximum emergence rates and durations were investigated. For both seeds and pits the earliest emergence (12 and 17 days, respectively) were recovered for 60 days stratification treatment. This duration was 63 days for untreated control. While the average first emergence rates for seed and pits were 24% for 60 days stratification, 12% was recorded for control. The maximum emergence rate (92 %) was determined for seeds stratified for 60 days at 33 days, whereas the highest emergence rate was 54% at 96th day for control treatment. As a result, when maximum emergence rate and duration were considered together, 45 and 60 days stratification yielded more favorable results than other treatments.

Key words: apricot, propagation, dormancy, stratification, germination

INTRODUCTION

Fruit trees exhibit heterozygous genetic structure and therefore they must be vegetatively propagated if cultivars are to be perpetuated. The most common method of fruit tree propagation is grafting, where rootstock utilization is an integral part [2]. The rootstocks for apricots in Turkey are usually seed-propagated. For rootstocks, a wild genotype of apricot (called 'zerdali' in Turkish) commonly used, but seeds of cultivars are also occasionally used. The desired characteristics of apricot rootstock seeds include high germination rate, homogeneity in seedling growth, and the ability to grow quickly so they are ready to be grafted sooner [3,10].

Seeds of most fruit trees, especially *Rosaceae*, will either not germinate or display very low germination rate, unless pretreated in some way [7], to overcome dormancy. Apricot seed dormancy includes both endogenous and exogenous types, which are caused by components of the seed itself and the endocarp, respectively.

Dormancy of temperate zone fruits is an undesirable characteristic for both growers and breeders. When the seeds are sowed without any pretreatment they do not demonstrate regular germination. Therefore, some pre-sowing treatments to facilitate dormancy release such as stratification, application of plant growth regulators and treatment with acid are often employed. For an optimal stratification, low temperature (0-10 ^{o}C), sufficient air flow, high humidity, and adequate length of time are required. By maintaining the seeds in cool and humid conditions for a certain length of time, the chilling requirements will be met, which will increase growth vigor.

Westwood [11] determined that chilling requirements of fruit tree seeds vary between species and cultivars; requirements vary between 45-100 days for peach, 60 days for apricot, 60-90 days for pear and 20-30 days for almond.

Previous studies conducted on 'zerdali' and apricot seeds demonstrated varying results [6, 7, 8], although all showed positive efffects of stratification and application of plant growth regulators on germination rate and vigor. However, these studies lack determinations of emergence-related characteristics such as emergence rates under field conditions. In this study, the effects of various stratification durations of apricot seeds and pits on germination under orchard conditions as well as seedling emergence were investigated.

MATERIAL AND METHODS

The study was conducted at Mustafa Kemal University, Agricultural Faculty, Horticulture Department, Antakya, Hatay, Turkey. The seeds and the pits of 'Hacıhaliloğlu' apricot cultivar were supplied by the Malatya Fruit Research Institute. This cultivar was chosen because it dominates dry-site apricot production in Malatya Region (73% of apricots in Malatya Region are 'Hacıhaliloğlu') [1]. Morever, 83% of dried apricot in the world markets are produced in Turkey. For rootstocks, a wild genotype of apricot (called 'zerdali' in Turkish) commonly used, but seeds of 'Hacıhaliloğlu' cultivar are also occasionally used.

Apricot pits were randomly divided into two groups. The first group was untreated, while the pits in the second group were cut open to obtain only the seed; the endocarp was discarded. Both whole pits and the seeds were sterilized for 5 min in 5% bleach. The seeds and pits were rinsed in sterile water for 20 min.

The experiment was set up in a factorial design with five replications, with each consisting of 10 seeds. The data were analyzed according to Factorial experiment in a Completely Randomized Blocks Design and the mean comparisons were made by Tukey's HSD test [9]. The percent values

were transformed ($\sqrt{\arcsin}$) to increase normality. The two treatments, pit and seed, were separated and plotted on the stratification duration expressed by days. Regression analyses were carried out and the equations and relevant R^2 values were determined.

Both the pits and seeds were directly sowed without any treatment for control. Half of the stratified seeds were stratified as seed and the other half as pits. Pits and seeds were placed in plastic bags filled with perlite that had been sterilized at 121 ^{o}C for 20 minutes. The plastic bags were placed in pots and the pots were placed in refrigerators (7 ^{o}C). Separate bags were used for each stratification duration treatment (30, 45, 60 days). At the end of the stratification duration, seeds and pits were removed from the perlite and were sowed in the seed beds in the Mustafa Kemal University, Horticultural Research Station. The seed beds were prepared as raised beds that were 100 cm wide and 20-25 cm tall, with 15-20 cm between rows and 10 cm within rows. The seeds and pits were sowed at the depth that was twice as their length (approximately 1.5-2.0 cm).

The observations of seeds and pits on field conditions for several traits were observed from the day of sowing until the period where germination and seedling emergence follow a steady trend. After the sowing, the seed beds were observed every two days for germination and seedling emergence. For seedling emergence criteria appearances of the epicotyl on the soil survey were utilized. Cultural practices such as irrigation and pest control were carried out as needed.

Variables studied included: 1) days to first emergence, 2) first emergence rate (%), 3) days required for seeds to maximum emergence and 4) maximum emergence rate (%). Emergence duration was determined by following the seeds and pits form the day of sowing to the days when the first or maximum emergence was observed. Emerge rates were determined by dividing the number of plant emerged on the relevant days by the total seeds or pits sowed.

RESULTS

The effects of different stratification intervals on the number days to first emergence and percentage of seeds that had emerged by that date are given in Tables 1 and 2. The percent emergence of seed and pits showed significant differences for stratification durations. The highest percent emergence (24%) was observed for the 60 day stratification treatment while the percent emergence was lowest (12%) in the control treatment (Table 1). The number of days to first emergence was 14 days for 60 day stratification and 63 days for the control treatment (Table 2).

In general, percent emergence was higher in seeds than pits, but the difference was not significant. The seed exhibited 20% emergence on 32nd day, while the pit was only at 15.8% emergence (Tables 1 and 2). Conversely, the difference on

Table 1. The effects of stratification durations on first emergence rates for apricot seed and pits.

Type	Stratification duration (day)				Mean (%)
	0	30	45	60	
Pit	12 b[3]	12 b	14 ab	25 ab	15.8 NS[1]
Seed	12 b	32 a	12 ab	22 ab	20.0
Mean (%)	12 b[2]	22 ab	13 ab	24 a	

[1] NS: Not significant.

[2] Means followed by different letters for average stratification duration are significantly different at 1% by Tukey test.

[3] Means followed by different letters for average type x stratification duration interactions are significantly different at 5% by Tukey test.

Table 2. The effects of stratification durations on the time required to reach first emergence for apricot seed and pits.

Type	Stratification duration (day)				Mean (day)
	0	30	45	60	
Pit	64 a[3]	32 b	18 cd	12 d	31 NS[1]
Seed	62 a	30 b	19 c	17 cd	32
Mean (day)	63 a[2]	31 b	19 c	14 d	

[1] NS: Not significant.

[2, 3:] Means followed by different letters for each of Average stratification duration and type x stratification duration interactions are significantly different at 1% by Tukey test.

both the date of first emergence and percent emergence for the stratification durations caused by the material type was statistically significant. The percent emergence for pits gradually increased depending upon the stratification duration, whereas different results were obtained for seeds.

The number of days to final emergence and percent of seeds that had emerged by that date for seeds and pits varied statistically depending on the stratification duration (Table 3 and 4). As shown in Table 3 and 4, for the control treatment, the seeds only reached 54% emergence in 96 days, while pit showed 80% emergence in 100 days. On the other hand, in the 60 day stratification treatment, seeds and pits exhibited 92% and 70% emergence, respectively, on the day 33. Therefore, the highest percent emergence in the seeds was reached in the 60 day stratification treatment, while in the pits the highest percent emergence (80%) was observed in control treatment,

and it took 3.5 months to reach this rate. However, for the 45 day stratification treatment 78% emergence was achieved by 44 days for pits.

Regression analyses demonstrated that better fits expressed by higher R^2 values are obtained for days required to reach first and maximum emergence rates when compared to emerge rates plotted on the stratification duration for both pit and seed treatments (Figure 1). In fact, for days required to reach first and maximum emergence rates the R^2 values were all higher than 90% and having similar results for pit and seed treatments (Figure 1, Plate A and B). However, for the first and maximum emerge rates the lower R^2 values were recovered. In particular, fit was observed on first emerge rate for seed were the lowest ($R^2 = 0.06$).

Table 3. The maximum emergence rates of apricot seed and pits for various stratification durations.

Type	Stratification duration (day)				Mean (%)
	0	30	45	60	
Pit	80 ab [3]	74 ab	78 ab	70 ab	75.50 NS[1]
Seed	54 b	84 ab	72 ab	92 a	75.75
Mean (%)	67 NS[2]	79	75	81	

[1, 2]NS: Not significant.

[3]: Means followed by different letters for Average type x stratification duration interactions are significantly different at 1% by Tukey test.

Table 4. The time required to reach maximum emergence rates of apricot seed and pits for various stratification durations.

Type	Stratification duration(day)				Mean (day)
	0	30	45	60	
Pit	100 a[3]	60 b	44 bc	23 c	57 NS[1]
Seeds	96 a	56 bc	32 bc	33 bc	55
Mean (day)	98 a [2]	58 b	38 bc	28 c	

[1] NS : Not significant.

[2, 3:] Means followed by different letters for each of Average stratification duration and type x stratification interactions duration are significantly different at 1% by Tukey test.

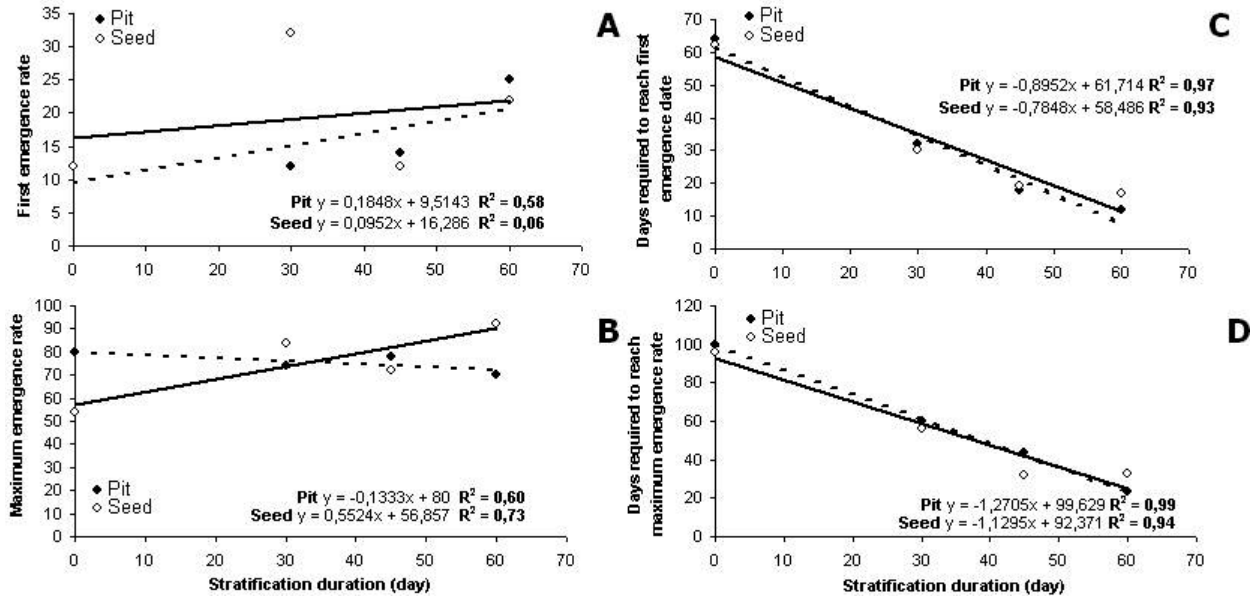

Figure 1. The equations and R2 values for the effects of stratification durations on first (A) and maximum (B) emergence rates the time required to reach first (C) and maximum (D) emergence for apricot seed and pits.

DISCUSSION

Apricot seeds, like all other temperate zone fruits trees, require a dormancy period. Both seeds and pits need to be cold stratified for a period of time for homogenous germination and a regular growth. Seeds and pits are usually kept in a humid substrate at 0-10 ^{o}C during the treatment.

We studied the effects of stratification on the number of days required for emergence duration and rate for apricot seeds and pits; and, observed positive effects of stratification. In present study, the earliest emergence was recorded in the 60 days stratification treatment for both seeds and pits. However, this duration was observed as 63 days for non-stratified seeds and pits. In general, as stratification durations increased, the number of days to first emergence decreased both in seeds and pits. In control treatment, for both seeds and pits, only 12% of the seeds had emerged on the days to first emergence; this value was nearly doubled with 60 days of stratification.

Seeds gave more promising results for both days to emergence and percent emergence when compared to pits. The highest emergence rate for seeds (33 days) was observed in 60 day stratification. On the other hand, the maximum for 96 days was only 54% in the control treatment. Conversely, the highest emergence percentage (80%) was in control treatment, yet 100 days were required to reach this percentage. While the 45-day stratification treatment resulted in 78% emergence rate in 44 days, the 60-day stratification resulted in 70% emergence in 23 days. Therefore, although the 60-day stratification treatment resulted in 10% less emergence when compared to control, the overall results were still more favorable for 60 day stratification as the number of days to emergence was significantly lower for these treatments.

The different germination rates were observed in this study carried out on both apricot seeds and pits, and similar findings have been reported. For example, Kara [6] studied the effects of different stratification durations on two zerdali types, and found the highest percent germination at 49 and 63 days stratification treatment for Zerdali-1 and Zerdali-2, respectively. The maximum germination days was reported to be reached at 72 days of stratification duration for 'Fajoumi' apricot cultivar Fadl et al. [5]; 63 days for Zerdali-A type 42, 'Hasanbey' Kuden and Kaska [8]; and 42 days for 'Kabaaşı' 'Zerdali' and 63 days for 'Çöloğlu', 'Çataloğlu', 'H. Haliloğlu', 'Hasanbey', 'Şekerpare' and 'Tebereze' Güleryüz and Ercişli [4]. In none of these studies, no information regarding days to first and last emergence and percent seeds emerged by these dates for seed and/or pits were reported. It is likely that these studies were conducted in the laboratory conditions; therefore, we are unable to compare our results which are directly related with nursery production with this literature.

It is well-known that most fruit species, especially Prunus genus do not germinate or germinate poorly without pre-germination treatments. Stratification is one of the most common methods applied in *Prunus* species. Several hypotheses were proposed for beneficial effect of stratification including one suggesting that stratification allows the embryo to synthesize increased levels of adenosine phosphates. In another one suggest that stratification increases the level of plants growth regulators necessary for active cell growth and division while it decreases the level of some inhibitors like abscisic acid. Our study was not designed to determine factors influencing the stratification progress. However, it is clear that we recovered beneficial effect by our treatments. Also, when maximum percent emergence and fewest days to emergence were considered together, 45 and 60 days stratification yielded more favorable results than other treatments.

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