Effect of physical treatments on germination of *Ginkgo biloba* L.

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Summary: In our country the maindenhair tree (*Ginkgo biloba* L.) is raised mainly from seeds, so the aim of our experiments was to determine the most useful generative propagation method. However, some experiments have been conducted earlier connected to the germination of the species, but the comparative control of physical seed treatment was done first time by the authors.

After the statistical evaluation of the results it can be stated that the percentage of germination has significantly increased if the seeds received physical treatment (scalding, mechanical scouring). Hereby the pericarp is getting soft or growing thinner, so the germination of the seed is easier. These treatments are extraordinarily simple, easy to carry out and their effect is very favourable, that is why their use is strongly advised.

Comparing the seeds collected at different times was found that the ability of germination is decreasing proportionally with the time spent in the open field. On the basis of our experiments and of earlier practice in Hungarian tree nurseries, our opinion is that the stratification of seeds is not necessary.

Introduction

The *Ginkgo biloba* L. is one of the most intriguing species of the world of plants. As the only representative of the *Ginkgoaceae* family, it has often been called a "living fossil". It has been faithful to the ancient features and some of its other characteristics are also unique on Earth (*Gencsi & Vancsura*, 1992; *Huh & Staba*, 1992). In the past few years, this species became the centre of attention in Hungarian researches. Because of its appearance, it has become a popular ornamental tree. It is highly tolerant towards environmental contamination, and due to this, it adorns several parks and streets in growing numbers all over the world (*Michel*, 1986). The ginkgo tree is dioecious, sexual maturity is reached only at the age of 20-30 years. The outer fleshy layer that covers the seeds contains – among others – butyric acid, which has a rather unpleasant smell during autolysis. This is the reason why only male individuals are planted along the streets (*Schmid & Schmoll*, 1994; *Schütt* et al., 1984).

In West-Europe and in North America, it is being grown in great quantities. Vegetative propagation is the most widely used method thus the problem of sexual differentiation is solved (*Israelsen*, 1993; *McClintock*, 1989).

Since in Hungary researches concerning this plant have only recently began, the simplest and cheapest way of propagation is used: sexual. The goal of our experiments was to determine the most effective way of using seeds for propagation. Our primary aim was to decide about the optimal time to collect the seeds and to investigate the effects of the collecting time and the physical treatments before planting on the ability of germination.

Opinions concerning the propagation of the maidenhair tree differ greatly. Most literatures agree in one aspect: the

stratification of seeds is always suggested. For optimal germination, some authors advice one year (*Probocskai*, 1969; *Szűcs*, 1977; *Melzheimer*, 1992), others two years long (*Bärtels*, 1989) stratification in a mixture of sand and peat. According to *Dirr & Heuser* (1987) the proportion of germinated seeds is 29% in the case of fresh seeds and 62% in the case of stratificated seeds. Based on domestic growers' practical experiences, the need for stratification is doubted. It is important though, to store the seeds in a damp and cool place otherwise they tend to stay dormant (*Schmidt*, 1996). Seed viability declines rapidly under dry conditions and with time (*Browse*, 1979). The adjudgement of the results of scalding before planting is very different. According to *Melzheimer* (1992) this does not result a better germination. *Probocskai*'s experiments showed that the soaking of seeds in hot water for a few hours before planting is advisable to soften the pericarp. According to *Bärtels* (1989) the most effective method to reach the same result is a few seconds long scalding.

Material and methods

The seeds for the experiments were taken from an about 100 years old *Ginkgo biloba* L., found in the Botanical Garden of the Szent István University, Faculty of Horticultural Sciences, Budapest. Seeds were collected three times. First, in the beginning of November, this is also the start of the falling of seeds. The second collection was in January (next year). (Between the two occasions snow covered the seeds.) Thirdly seeds were gathered right before sowing, that is at the end of March.

After collection, the fleshy layer was removed from the seed. The cleaning happened in water, along with slight scouring. In the first two cases the seeds were dried for two days at room temperature, then were put in paper boxes, and stored until sowing, without stratification, at 10 °C.

Two types of seeds were collected in the third group: both that have overwintered, with and without seed sarcotesta.

Sowing took place at the end of March, 4–5 cm deep into potting soil. Seeds were bated in Zineb 80. 100 seeds were used for each treatment. The appropriate dampness of the soil was assured by regular watering. The experiments were set up parallel on two sites: in Budapest and in Szeged.

Budapest. The seeds were placed in a 10x10x20 cm large flowerpots (10 seeds in each pot). 100 seeds were sowed for each treatment, groups of tens (n=10) made up ten repetitions in all cases. In the case of seeds collected the first two times, besides the control, there were two groups with different treatments. One of the treatments was a few seconds long scalding, the other was mechanical scouring. In the third group of seeds no mechanical treatment was applied, the separation of seeds in two groups was based on the way of overwintering. Thus, those seeds which spent the winter without the sarcotesta formed the control, and those formed the second group, where it was removed during picking.

Szeged. Only seeds from the first two pickings were part of the experiments. Besides the two treatments (scalding and mechanical scouring) there was 1–1 control group. Seeds were placed into 50x100x20 cm containers. The containers were divided into four parts, where the treatments were placed randomly. Thus there were four repetitions with n=25 number of elements.

During the experiments, there were three surveys: 7 and 10 weeks resp. after sowing, and at the end of September.

The biometrical analysis of data was based on a series of statistical tests, developed by *Vargha* (1999). The standard deviations were compared to each other with the help of the following tests: Fisher's F-test, Bartlett-test, O'Brian-test and the Levene-test. If the standard deviations happened to be the same, then the levels were compared by the two sample t-test or F-test. If standard deviations differed then, the James-test, the Welch-test or the Brown-Forsythe-test was used. The treatment levels were compared to each other by the Tukey-Kramer-test. Since the conditions of the variance analysis were not given, the SD results were not displayed as usual. The tests in Ministat 2.4 were mathematically described in a book by *Sokal & Rohlf* (1995).

Results and discussion

Seeds began germination after 5–6 weeks. The results displayed in *Table 1–2* are separated according to the two sites.

Table 1 The results of germination experiments of *Ginkgo biloba* L. in Budapest (%)

Observation	1 collecting (November)			2. collecting (January)			3. collecting (March)	
	Control	Scalding	Scouring	Control	Scalding	Scouring	Control	"Fresh"
May	22	28	46	7	26	34	0	0
June	31	43	52	14	42	43	6	2
September	37	58	67	29	49	58	25	27

Table 2 The results of germination experiments of *Ginkgo biloba* L. in Szeged (%)

Observation	1. collecting (November)			2. collecting (January)		
	Control	Scalding	Scouring	Control	Scalding	Scouring
May	22	25	36	15	21	19
June	37	54	51	26	33	30
September	42	67	70	34	48	51

The effect of site

The first question was whether the results from the two sites differ from each other. After the surveys it was obvious, that the group in Szeged was more evenly developing and was more vigorous. But this may be owed to the fact, that a higher number of elements was involved in one repetition.

The statistical tests have supported this observation. According to the analysis of variance, there was a great difference between the two sites. (The standard deviation of the experiment in Budapest was 23.95, in Szeged it was just 18.03.) A significant difference was found between the two places with the help of the Welch-test.

The effect of the timing of seed collection

Only the controls were involved in this examination, since these were the only groups where elements were present from all three pickings. Significantly more seeds germinated from the first collection (*Figure 1*).

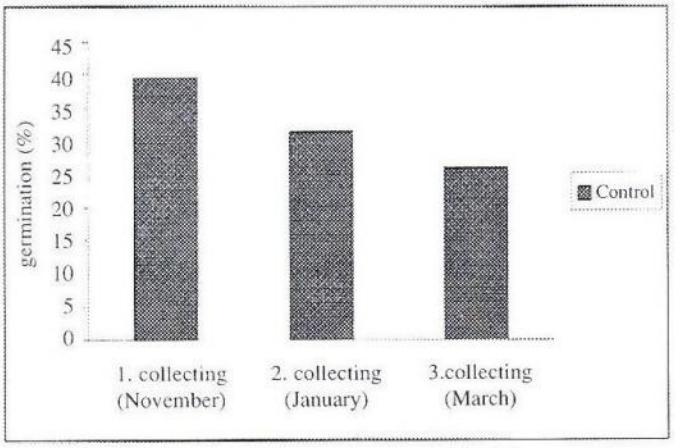

Figure 1 Germination of Ginkgo biloba L. at different collecting times

Seed viability declines with the time spent outdoors. The effect of timing was significant regarding all three pickings at all treatments. This result is in accordance with other studies.

Among the treated groups the proportion of germinated seeds was much higher in the first group than in the second group, taking into consideration both the site and the timing of seed collection.

Thus it is best to collect seeds right after their falling down (October-November), since later the germination potential decreases. Seeds collected in the spring germinate weakly.

The effect of treatment

The two sites were compared to each other by the time of collection of seeds (*Figure 2*). There was a significant difference between the first two groups and the control groups. The fewest seeds germinated in the controls. Significantly more seeds germinated in the case of both

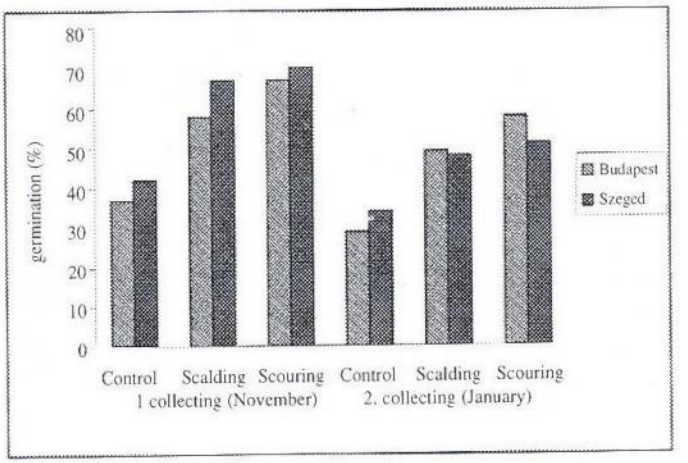

Figure 2 Germination of *Ginkgo biloba* L. at different treatments on two sites (in Budapest and in Szeged)

treated groups (scalded and mechanically scoured seeds). There is a slight difference between the two treated groups (the scoured seeds germinated more vigorously), but this result can not be supported statistically. The above listed results are in accordance with the observations of *Bärtels* (1989).

Based on our results it is advisable to treat seeds physically before sowing. The few seconds long bath in hot water softens the testa of the seeds and the scouring makes the shells thinner, thus helping the process of germination.

No treatment was applied to the seeds of the third picking. No difference was found in the percentage of germination between the control and the seeds freshly separated from the fleshy covering. Thus it was not important whether seeds overwintered with or without the outer layer.

It needs to be emphasised that in our experiments seeds were not stratificated. The results of germination are much better even in the case of the control than that cited in the literature found on the subject. This observation, thus supports the practical experiences in Hungary: stratification is not necessary. On the other hand it is important to store seeds in a cool and damp place.

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