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TADEUSZ TYLKOWSKI

Storing of Russian elm (*Ulmus laevis* Pall.) seed over many years

Abstract

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Samaras of Russian elm when collected fully ripe can be stored after partial drying to a moisture content of about 10%, in sealed containers at −1° to −3°C for a period of 5 years without loosing the initial high germination capacity (90%). After 6 years of storage the germinative capacity declined to 70%.

Additional key words: seed hydration, germination, seedling emergence.

Address: T. Tylkowski, Institute of Dendrology, 62-035 Kórnik, Poland.

INTRODUCTION

Russian elm belongs to the small group of woody plants in the Temperate climate which flower and produce fully ripe seeds in the spring of the same year. This phenological property results in that in natural conditions seeds of the species easily loose their viability if after falling they do not find favourable conditions for germination. Seeds of elm collected somewhat earlier, that is before full ripeness (collected green) and stored loose their viability already after a few weeks (Tyszkiewicz 1949).

Seeds of some elm species, such as *Ulmus americana* L. or *U. pumila* L. can be stored without loss of viability for several years in sealed containers at 2 - 5°C and with a low moisture content of 3 - 8% (Barton 1939, Heit 1967). Krstič (1950) stored seeds of *U. campestris* L. in sealed jars and in an exiccator over calcium chloride for 10 months at room temperature. The initial high germination capacity of fresh seeds declined after storage to 30% of the initial value. Seeds which were air dry and covered with paraffine have during the same time period lost their viability altogether.

Information concerning storage of Russian elm seeds is comparatively

small. Sus (1925) stored air dry seeds of this species at room temperature and found that after 6 months the seeds were still alive. Tyszkiewicz (1949) recomended that fully ripe seeds of this elm be stored dry and that three months before spring sowing they be subjected to a warm stratification.

The methods of storing seed of *Ulmus laevis* suggested so far (Tyszkiewicz 1949) are based on insufficient study and do not ensure the maintenance of seed viability longer than over the first winter after collection. From the studies of Vincent (1960) it appears however that seeds of Russian elm can be stored for 3 years without less of germination capacity. Thus it was considered of interest to study the conditions for satisfactory storing of these seeds for at least 5 - 6 years. The need for investigating long term storage of seeds of this elm are also associated with the considerable importance of this species in urban green areas in view of its considerable resistance to air pollution and the highest of all elms resistance to the Dutch elm disease (Bugała 1979).

MATERIALS AND METHODS

Samaras have been collected on June 9th 1980 during a dry and sunny weather from a single tree in Kórnik. At collection time the samaras contained 22.9% of water in their fresh weight (determined by weight after drying at 105°C for 24 h). After partial drying at room temperature to 14.1%, 11.8% and 9.8% the seeds were placed in seald bottles and stored at 3°C, −1°C and −3°C.

Seed germination tests (in whole samaras) were conducted on a Jacobsen's germinator at a temperature of 20°C in 4 replicates with 50 seeds each. This was done at the beginning of the experiment and after 4, 8 and 12 months of storage and thereafter till the end 3rd year at 6 months intervals and till the 60th month of storage every 12 months. The last lot was tested after 70 months of storage.

Initially the study was planned for 3 years, and thus for the seed testing, samples were taken from bottles which were not opened. After 3 years of storing for the consecutive germination tests seeds were taken from bottles from which already once, twice or three times seeds have been taken for testing. This was possible because the seeds partially dried to various levels of water content have been placed in the storage bottles in excessive quantities.

In the vear 1980 the germination was tested of both fresh and partially dried to 14.1% of moisture content. For these tests use was made of seeds extracted from the pericarp and of whole samaras, which have been chilled on moist filter paper for 0, 4, 6 and 8 weeks at 3°C prior to transfer to Jacobsen's germinators at 20°C. These expe-

riments were aimed at testing whether in the fully ripe seeds of Russian elm it is necessary to employ a cold stratification similarily as is practiced for other elm species e.g. *U. rubra* Muhl., or *U. serotina* Sarg. (Brinkman 1974).

In the spring of 1984 (after 48 months of storage), besides a laboratory germination test, the seeds were also subjected to a seedling emergence test in a nursery. The samaras were sown in a complete block design into furrows pressed into the soil to a depth of 0.5 cm and covered with sand, the sowing being shaded to prevent the drying of the soil (Bärtels 1982). For comparative purposes, together with seeds stored for 48 months, fresh seeds were sown (collected in 1984 from the same tree), partially dried to 10.2% of water content. It needs to be mentioned that 1984 was not a good seed year for *Ulmus laevis*.

RESULTS

The germinative capacity of freshly collected Russian elm seeds left in whole samaras was high, amounting to 84.5 - 91.0%, while the seeds taken out of the samaras germinated 99.5%. The remaining seeds dacay-

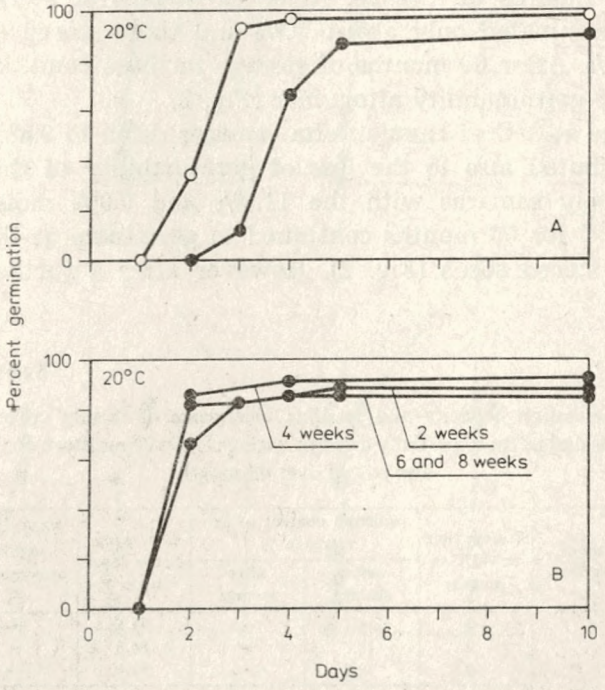

Fig. 1. Course of germination of freshly collected *Ulmus laevis* L. seeds (A) removed from samaras (open circle) or left in samaras (black circle) and of seeds left in samaras and chilled on moist filter paper at 3°C (B) for 2, 4, 6 and 8 weeks

ed during the germination tests. Seeds deprived of the pericarps germinated already in the first day of the test while for seeds left in the samaras the onset of germination occured during the second day after being sown on filter paper.

Samaras sown on moist filter paper and maintained for 2, 4, 6 or 8 weeks at 3°C did not germinate in that temperature. After transfer to 20°C they germinated as early and as fast as fresh seeds extracted from the samaras. (Fig. 1). Thus it appears that subjecting of *U. laevis* seeds to any kind of stratification is pointless.

After 4 months of storage of whole samaras at the three levels of initial water content in sealed bottles and at three different storage temperatures no loss of seed germination capacity was observed. Also the germination capacity did not decline over 24 months for the seed stored at −1° and −3°C. Those stored at 3°C have had the first signs of loss of germinability already after 8 months and much more clearly after 12 months of storage of samaras with the highest initial moisture content (14.1%). Seeds in samaras with a lower water content germinated after 12 months of storage at that temperature still at an unchanged level. A slow and systematic lowering of seed germinability of the seeds with highest hydration (14.1%) stored at −1° and −3°C was observed only after 18 months of storage. After 42 months of storage at −1°C these seeds germinated only about 10% and those stored 48 months at −3°C only 7%. After 60 months of storage in these conditions the seeds have lost their germinability altogether (Fig. 2).

The storage at 3°C of Russian elm samaras dried to 9.8% of moisture content contributed also to the loss of germinability of the seeds after 60 months. Only samaras with the 11.8% and 9.8% moisture content stored at −3°C for 60 months continued to germinate at the same level as fresh, not stored seeds (Fig. 2). However after a further 10 months

Table 1

Germination capacity and seedling emergence of freshly collected seeds and of those partially dried to various levels of moisture content and stored over 48 months

Year of collection	Storage time at −3°C in months	Moisture content of samaras in %		Lab. germinative capacity in %	Field (1984) seedling emergence in %
		before storage	after storage		
1980	0	14.1	–	88.5	–
	0	11.8	–	84.5	–
	0	9.8	–	91.0	–
	48	14.1	12.9	7.0	1.0
	48	11.8	12.3	79.5	12.0
	48	9.8	9.8	84.0	10.8
1984	0	10.2	–	87.5	16.5

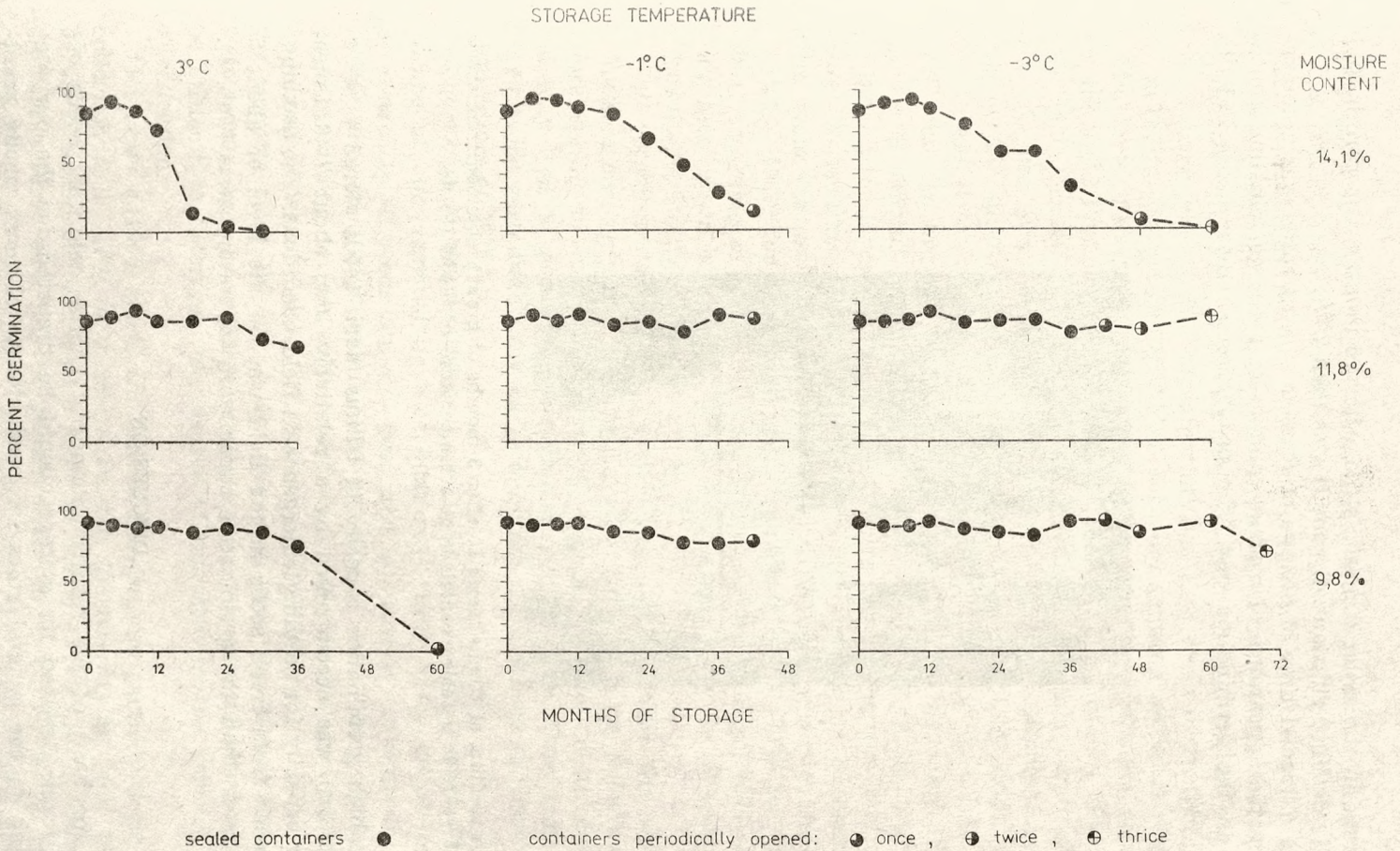

Fig. 2. Germination capacity of *Ulmus laevis* L. seeds stored after collection in whole samaras in a partially dried state to 14.1%, 11.8% and 9.8% of moisture content at a temperature of 3°, −1° and −3°C in sealed containers, or in periodically opened ones once, twice or thrice in order to take seed samples

of storage in the latter conditions (i.e. after 70 months) the germinative capacity declined substantially and it was then 70%.

The extended time of storage of Russian elm samaras was accompanied by the appearance of a small number of seeds germinating abnormally in the germination test. The proportion of these seeds did not exceed 5%.

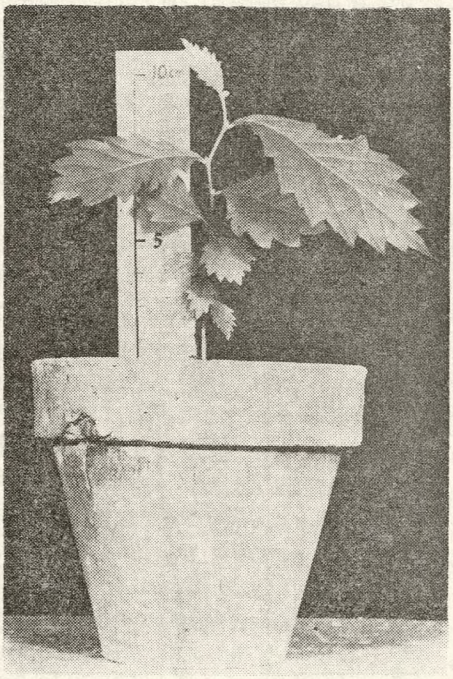

Fig. 3. A seedling of *Ulmus laevis* L. after 3 months of growth obtained from seeds stored 3 years in a sealed container at a temperature of −3°C (Photo T. Tylkowski)

The high germination capacity of *Ulmus laevis* seeds stored 4 years (48 months) was accompanied by a relatively low, about 7 - 8 times smaller capacity for seedling emergence in field conditions. The seedling emergence from fresh seeds in the field was on the level of about 5 times lower than the germinative capacity in laboratory tests (Tab. 1).

DISCUSSION

On the basis of the results obtained it can be said that seeds of *Ulmus laevis* destined for storage should be prepared for the purpose according to the general rules for seed storage of most woody plant species (S t e i n et al. 1974). The most favourable storage conditions for

these seeds proved to be when after drying whole samaras after collection to 11.8% or 9.8% of moisture content in the fresh weight they were placed in sealed containers at a temperature of −3°C. After 5 years of storage in the above mentioned conditions (after 3 years the further germination tests were made on material held in bottles that were 1-, 2- or 3-times opened) the seeds germinated at a level unchanged relative to the initial one and provided normally growing seedlings (Fig. 3).

The large discrepancy between the laboratory germination capacity and the field seedling emergence for Russian elm seeds in 1984 was probably associated with the very unfavourable weather conditions in June of that year. The recommended germination temperature for seeds of this species is within the range 20 - 30°C (ISTA 1976), while the average daily maximum temperature for June of that year was 19.3°C and the average daily minimum temperature was only 10.4°C. The use of shading of nursery beds probably resulted in the soil temperature at the level of the seeds being even several degrees lower. The results of seedling emergence in the nursery (Table 1) substantially differ from the seedling yield reported by Tyszkiewicz and Obmiński (1963) for field conditions, amounting to 40 - 70% for *Ulmus laevis*. According to the USDA Forest Service (Stein et al. 1974) out of living seeds sown into the ground one can expect only 5 - 12% of seedlings suitable for transplanting.

The recommendation of Tyszkiewicz (1949) that the samaras of Russian elm be placed in a pit in a „warm" condition three months before spring sowing in the nursery does not appear to be justified and may lead to premature germination of the seeds. Both fresh and stored seeds germinate very early and fast when placed on Jacobsen's germinators at 20°C.

The range of temperatures of −4°C to −10°C recomended for the storage of elm samaras by Schönborn (1964) fully maintains the germinability of seeds for one year and is justified economically. The maintenance of a high germination capacity of seeds after storage requires according to that author that seeds used for storage be partially dried and collected before full maturity. Tyszkiewicz (1949) is of the opposite view. He claims that the seeds used for storage should be fully mature because in the case of collection of green material it would be difficult to determine the degree of maturity in the various years of collection.

Vincent (1960) stored samaras of Russian elm partially dried after collection to 9 - 11% of moisture content (partial drying took 48 h at 30°C) in sealed containers at a temperature of 2 - 4°C for 3 years. He did not observe any loss of germinability of so stored seeds. In the conditions of the experiment described here the regime most close to the conditions Vincent (1969) had I have found a 10% loss of ger-

minative capacity (9.8% of moisture content and 3 years of storage at 3°C). Longer storage of samaras of this elm in such conditions led to a complete loss of germinative capacity (Fig. 2).

The most favourable conditions for the storage of Russian elm samaras appear to be: partial drying to 10% of moisture content and storage in sealed containers at −3°C. These conditions ensured that germination capacity was maintained over 5 years at a level equal to that for fresh seeds. Longer storage, beyond 5 years, contributed to the lowering of the germination capacity of the seeds.

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Wieloletnie przechowywanie nasion wiązu szypułkowego (*Ulmus laevis* Pall.)

Streszczenie

Skrzydlaki wiązu szypułkowego zebrane w stanie pełnej dojrzałości z drzew, podsuszone do 14,1%, 11,8% i 9,8% wilgotności, przechowywano w szczelnie zamkniętych pojemnikach w 3°, −1° i −3°C. Najdłużej, bo przez 5 lat bez spadku początkowo wysokiej zdolności kiełkowania (90%) przechowywano nasiona w −3°C podsuszone do 9,8%. Po 6 latach przechowywania zdolność kiełkowania tych nasion obniżyła się do 70%.

Многолетнее хранение семян вяза гладкого (*Ulmus laevis* Pall.)*

Резюме

Крылатки вяза гладкого собрано с деревьев в состоянии полной спелости, подсушено до 14,1%, 11,8% и 9,8% влажнсти и хранили в плотно закрытых емкостях в 3°, −1° и −3°C. Дольше всего (5 лет) хранили без потери первоначально высокой способности прорастания (90%), семена в −3°C, подсушенные до 9,8%. Через 6 лет хранения способность этих семян к прорастанию понизилась до 70%.

* Автор: T. Тыльковски.