Liquid Sorting and Film Coating: Techniques for Improving Tree Seed Performance©

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INTRODUCTION

Tree seed performance has benefited considerably from the development of controlled methods to overcome dormancy. Traditionally tree seeds have often been stratified outdoors. Depending on the types of dormancy, stratification starts before or during summer and continues during winter, or it starts before winter. Seeds become ready to germinate during winter, and they may start to germinate before sowing. Reducing the water content of the seeds during pre-treatment can prevent this premature germination.

If premature germination is prevented, treatments at slightly reduced and controlled moisture content (MC) can be prolonged. As a result, percentage, rate, and uniformity of germination increase. Moreover germination proceeds over a wider range of seedbed conditions. So far, controlled MC treatment has been developed for about 20 species, both broad leaved and conifers.

Seed quality is often a limiting factor in tree seeds, which are often collected from the ground. The prevention of premature germination during controlled MC treatment leads to new possibilities for seed enhancement techniques, including liquid sorting and film coating. Both techniques have been proven successful in agricultural and horticultural seeds. Liquid sorting is a technique that aims to remove poor quality seeds by sorting on specific gravity. Temperature and water potential can be controlled to provide conditions which are optimal for the species. Film coating with fungicides aims to protect the seed against soil-borne diseases, thereby increasing the percentage of usable plants.

The aim of the present study was to investigate effects of liquid sorting and film coating with fungicides in some tree species.

MATERIALS AND METHODS

Dormancy Breaking. To overcome dormancy, seeds were pre-treated in a controlled way. Cold pre-treatment at 3 °C occurred at controlled MC without medium in plastic bags. Warm pre-treatment of fully hydrated seeds was in a sphagnum peat and sand (1 : 1, v/v) mixture in plastic boxes. Three volume parts of medium were mixed with one volume part of seeds. Moisture content of *Larix kaempferi* seeds was not controlled, as premature germination is not possible during the relatively short cold pre-treatment of this species. Pre-treatments of the different species are shown in Table 1.

Germination and Sowing Conditions. Four replicates of 50 seeds were sown in plastic boxes or Petri dishes on one layer of wet thick paper or wet filter paper. Germination of *L. kaempferi* was tested at 15 °C. Germination of the other species in the liquid sorting experiments was tested at 10 °C. Germination in the film coating experiments was determined at 17 °C. Germination tests were finished

Table 1. Treatments to overcome dormancy in the different species.

Species	Pre-treatment
Acer palmatum	12 w 3 °C, 37% MC
Acer pseudoplatanus	15 w 3 °C, 46% MC
Carpinus betulus	6 w 20 °C in sphagnum peat/sand followed by 16 w 3 °C, 28% MC
Crataegus monogyna	10 w 25 °C in sphagnum peat/sand followed by 24 w 3 °C, 22% MC
Fagus sylvatica	20 w 3 °C, 30% MC
Larix kaempferi	10 or 6 w 3 °C, fully hydrated
Prunus avium	8 w 20 °C in sphagnum peat/sand followed by 18 w 3 °C, 28% MC (liquid sorting)
	Or 2 w 20 °C, 6 w 3 °C, 2 w 20 °C, 2 w 3 °C, 2 w 20 °C, 14 w 3 °C, 28% MC (film coating)
Tilia cordata	8 w 20 °C in sphagnum peat/sand followed by 24 w 3 °C, 43% MC

Note: Abbreviations: w = weeks, MC = moisture content.

after 4 weeks. Field emergence was determined at an experimental field or at commercial nurseries.

Liquid Sorting. In the first experiment seeds were sorted either before or after dormancy breaking; in the second experiment seeds were only sorted before dormancy breaking. Before liquid sorting, using liquids with different specific densities, air was removed from the seeds.

Film Coating with Fungicides. Different film coatings with fungicides were applied after dormancy breaking. The fungicides used were a combination of fosetyl-aluminium (Aliette, 3 or 6 $g \cdot kg^{-1}$ seed) and iprodione (Rovral Aquaflo, 3 or 6 $ml \cdot kg^{-1}$ seed); and a combination of propamocarb hydrochloride (Previcur, 6 or 12 $ml \cdot kg^{-1}$ seed) and thiophonate-methyl (Topsin M) (4 or 8 $ml \cdot kg^{-1}$ seed). In *Fagus sylvatica* these fungicides were also applied individually.

RESULTS

Liquid Sorting. Germination often correlated with the specific density of the seeds (Fig. 1). In general, low-density fractions showed the poorest germination. Sometimes, the heaviest fraction showed poor germination too. By removing these fractions the performance of a seed lot can be improved. In most species liquid sorting was successful before and after dormancy breaking (data not shown). In *Prunus avium* and *Crataegus monogyna*, liquid sorting after dormancy breaking was disturbed by loose fruit parts. In 2005 complete fruits of *Acer pseudoplatanus* were sorted. Sorting in water allowed removal of the lightest fraction. However, this fraction still showed 70% germination (Fig. 1). In 2006 de-winged and winged fruits of *A. pseudoplatanus* were sorted. Results were comparable (Table 2). In contrast to 2005 liquids with a specific density higher than 1 were required to remove the heaviest fraction in *A. pseudoplatanus*, which showed poorer germination than the lighter fractions (data not shown).

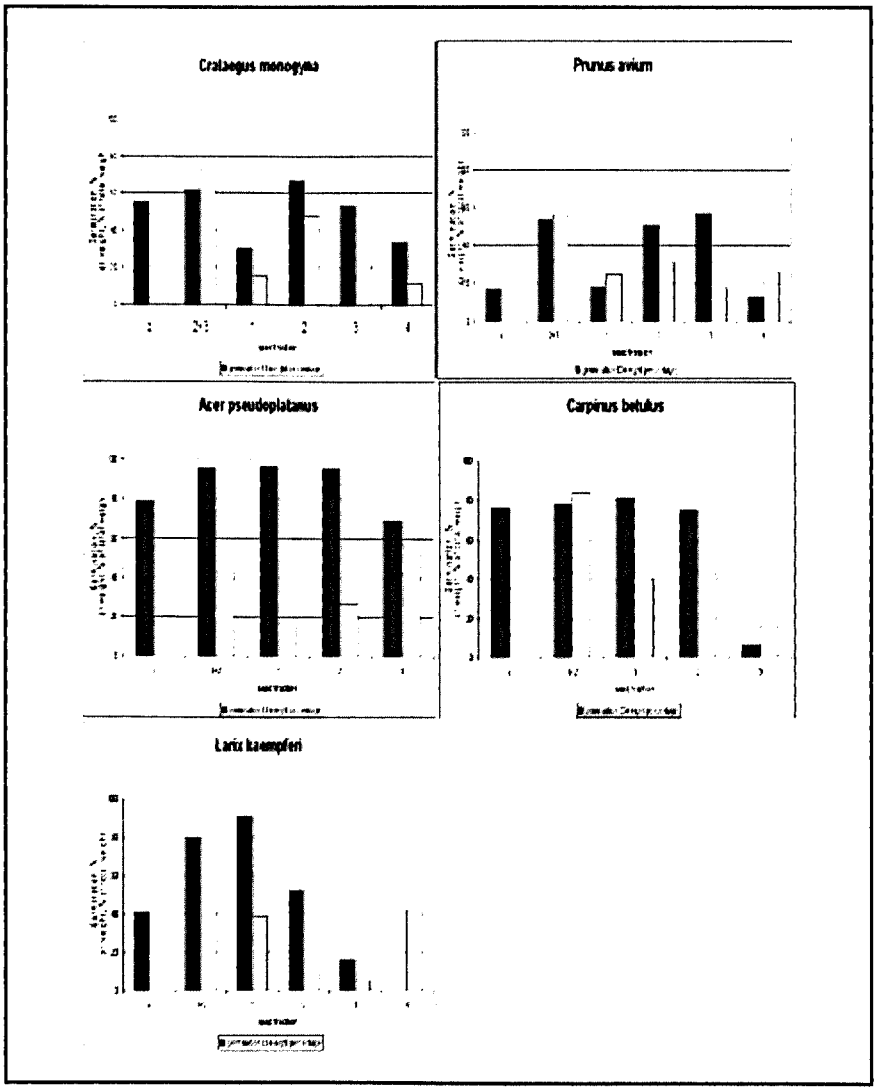

Figure 1. The effect of liquid sorting on germination of seeds of *Crataegus monogyna*, *Prunus avium*, *Acer pseudoplatanus*, *Carpinus betulus*, and *Larix kaempferi*. Before (*Crataegus*) or after (other species) dormancy breaking as indicated in Table 1 seeds were divided in different density fractions. c = nonsorted control. *C. monogyna*: 1 > 1.300, 2 = 1.260 – 1.300, 3 = 1.175 – 1.260, 4 < 1.175; *P. avium*: 1 > 1.220, 2 = 1.200 – 1.220, 3 = 1.155 – 1.200, 4 = 1.100 – 1.155; *A. pseudoplatanus*: 1 > 1.060, 2 = 1.000 – 1.060, 3 < 1.000; *C. betulus*: 1 > 1.225, 2 = 1.190 – 1.225, 3 < 1.190; *L. kaempferi*: 1 > 1.110, 2 = 1.075 – 1.110, 3 = 1.025 – 1.075, 4 < 1.025. Germination of all fractions was tested at 15 °C (*Larix*) or 10 °C (other species).

Table 2. The effect of liquid sorting on laboratory germination and field emergence of different seed lots of different species. Dormancy breaking and germination as in Figure 1.

Species	Provenance/seed lot	Year	Germination			Field emergence		
			Non-sorted	Sorted	Benefit	Non-sorted	Sorted	Benefit
Acer pseudoplatanus	Eastern Europe	2005	89	94	5			
	Vaartbos (NL)	2005	83	98	15			
	Zeewolde (NL)	2005	71	98	27	44	58	14
	Vaartbos de-wing	2006	33	55	22	31	25	-6
	Vaartbos wing	2006	31	52	21	21	19	-2
Carpinus betulus	Hilversum (NL)	2005	76	80	4	68	74	6
	Eastern Europe	2005	22	29	7			
	Hilversum (NL)	2006	3	52	49			
	Eastern Europe	2006	17	14	-3			
Crataegus monogyna	Italy	2005	42	57	15			
	Italy	2005	55	62	7			
	Romania	2005	47	49	2			
	Italy	2006	34	45	11	47	69	22
	Eastern Europe	2006	19	20	1			
Larix kaempferi	China	2005	45	84	39			
	DK Sostrup 2000	2006	61	89	28	43	57	14
	DK Sostrup 2002	2006	48	55	7	32	36	4
Prunus avium	Eastern Europe	2005	15	37	22	52	73	21
	Vaartbos (NL)	2005	8	23	15			

Table 2 shows that the benefit of liquid sorting on laboratory germination differs from seed lot to seed lot.

Some seed lots were sown outdoors. The results in Table 2 show that liquid sorting improved field performance in several seed lots. In 2006 field performance of *A. pseudoplatanus* did not benefit from liquid sorting, whereas laboratory germination did.

Film Coating With Fungicides. The combination of Aliette and Rovral Aquaflo and that of Previcur and Topsin M had no phytotoxic effect on seeds of *A. palmatum* and *Tilia cordata*. On *P. avium* phytotoxic effects were found in laboratory tests, on *Fagus sylvatica* phytotoxic effects were seen both in laboratory and field emergence tests. Single fungicides also produced phytotoxic effects in laboratory tests of *F. sylvatica*.

In the field only Aliette was phytotoxic. Positive effects of Previcur on reduction of damping-off were seen in *F. sylvatica*; positive effects also resulted from both tested combinations on *A. palmatum* (data not shown). In general, there were only low levels of damping-off on the untreated plots in our trials, so it was not possible to draw final conclusions about the effectiveness of the film coatings against damping-off.

Prunus avium seeds with a film coating of Aliette and Rovral Aquaflo were also sown at two nurseries. In one nursery film-coated seeds gave significantly better field emergence (Table 3). Only a few seedlings showed damping-off.

Table 3. The effect of a film coating with Aliette (6 $g \cdot kg^{-1}$ seed) and Rovral Aquaflo (6 $ml \cdot kg^{-1}$ seed) on laboratory germination and field emergence of *Prunus avium* seeds.

Treatment	Laboratory germination	Field emergence		Damping-off
		Nursery 1	Nursery 2	Nursery 2
Control	89	53	49	6
Film coating	90	52	73	1

DISCUSSION

Liquid sorting resulted in seed fractions with different specific densities (Fig. 1). By removing fractions with poor germination, the performance of a seed lot can be significantly improved (Fig. 1, Table 2). The benefit of liquid sorting varied from seed lot to seed lot and depended on the initial quality of the seed lot and the dormancy-breaking pretreatment.

A safe film coating with fungicides has been developed for *A. palmatum*, *P. avium*, and *T. cordata*, but not yet for *F. sylvatica*. So far, few conclusions can be drawn about the effectiveness against damping-off. In one nursery, field performance of film-coated seeds of *P. avium* was better than that of control seeds (Table 3). Further research is required to develop a safe film coating for *F. sylvatica* and to confirm effects against damping-off.