Influence of different storage conditions on quality aspects of harvested seed material from an *Arrhenatherion* meadow

Haslgrübler P.[1], Krautzer B.[1], Graiss W.[1], Blaschka A.[1] and Pötsch E.M.[1]
[1]*AREC - Agricultural Research and Education Centre Raumberg-Gumpenstein, A-8952 Irdning, Raumberg 38, Austria*
Corresponding author: petrahaslgruebler@gmx.at

Abstract

No guidelines are available for quality criteria and storage conditions of harvested seed material coming from semi-natural grassland. The aim of this work was to find some methods which are practicable and recommendable to assess such quality aspects. The seed material from an *Arrhenatherion* meadow was harvested via on-site threshing in 2009. After the determination of purity and thousand seed weight, the germination capacity was tested in a greenhouse. The harvested seed material was stored under different conditions up to three years and tested once a year. A specific volume of seed material was sown on organic growing media. The results showed that storage under different conditions and the length of storage influenced the germination capacity significantly. Storage under cool and dry conditions revealed better results. There is a strong positive relationship (correlation) between the proportion of mature seed and germination percentage.

Keywords*:* on-site threshing, germination capacity, greenhouse, storage, *Arrhenatherion* meadow

Introduction

Until now there has been no prescribed method for determination of the germination capacity of seed mixtures harvested from *Arrhenatherion* meadows. Therefore, a method was developed to gain sufficiently valid information about the seed potential of a harvested donor site within a defined period of time, with as limited technical and personnel expenditure as possible. Contractors are interested in obtaining sufficient information about the quality of sowing material, especially in terms of seed proportion and germination capacity (GC). The seed production of plants and the biomass of a meadow stock are dependent on the course of precipitation and temperature during the year, and these differ from year to year (Scotton *et al.*, 2012). An especially high content of diverse seeds in the seed material is necessary for successful restoration. The share of mature seeds with high germination capacity in the harvested material is decisive for the transfer rate on the newly sown area. The main questions of this research work are: i) is there any influence on the seed material by storing it under different conditions and ii) is there a change of germination capacity over the course of time?

Materials and methods

The experimental site is an *Arrhenatherion* meadow and situated in the north-western part of Austria, the so called 'Welser Heide' (48°18'27" N, 14°03'98" E; 310 m a.s.l). During the year of harvest the mean annual air temperature was 9.6°C and annual precipitation was 1017 mm. The pH-value of the soil is neutral to alkaline (6.3-7.4). The seed material was harvested on 1 July 2009, using an on-site threshing (OST) with a plot combine thresher (Wintersteiger) that had a cutting width of 150 cm. After harvesting, the material was air dried, cleaned using a 6 mm sieve, and divided into three fractions. The material was stored over three years (2009-2012) under different conditions: i) room temperature (15-20°C) with 7-15 g m^{-3} of absolute humidity ('room'); ii) cooling chamber (2-5°C) with 3-4 g m^{-3} absolute humidity ('cool'); and iii) freezer (at -18°C) ('freeze'). A germination capacity (GC) test in the greenhouse was done every year. The experimental design for the greenhouse trials were designed after determination of the purity, the thousand seed weight (TSW) and following the results of pre-tests in the phytotron presented in Haslgruebler *et al.* (2011). For determination of the TSW a 100 g sample was taken and divided in subsamples and 8×100 randomly available full seeds were counted and weighed. For the purity assessments the samples were divided into chaff and full seeds. The TSW, purity and the GC is important to define the sowing density of the harvested material. Before the germination trial started, a 4×1.2 g sample was taken and divided into monocotyledons, dicotyledons and chaff. The seeds of every sample were counted and weighed. Afterwards, the samples were mixed again and sown in bulb trays (40 cm × 60 cm × 0.6 cm) on growing organic media (OGM) according to the International Seed Testing Association (ISTA, 2011). The duration of the trial was 4 weeks and the samples were counted once a week and divided into monocotyledon and dicotyledon seedlings. The statistical analyses were done with the statistics program R 2.15.1 (R Core Team, 2012). A Shapiro Wilk Test was done, testing the sample originating form a normally distribution of the data. Afterwards a two-way ANOVA was used to test for differences between the length of storage and the storage under different conditions. Finally, the Bonferroni post hoc test was used to test for significant differences between variants where necessary.

Results and discussion

The TSW of the harvested OST material was 1.057 g with a purity of 63.05% pure seeds. The length of storage (P<0.001, Eta Sq = 0.95) and the different storage conditions (P<0.001, Eta Sq=0.46) showed a highly significant impact on the germination capacity of the tested OST material but there was no significant interaction between duration and storage method (see Table 1).

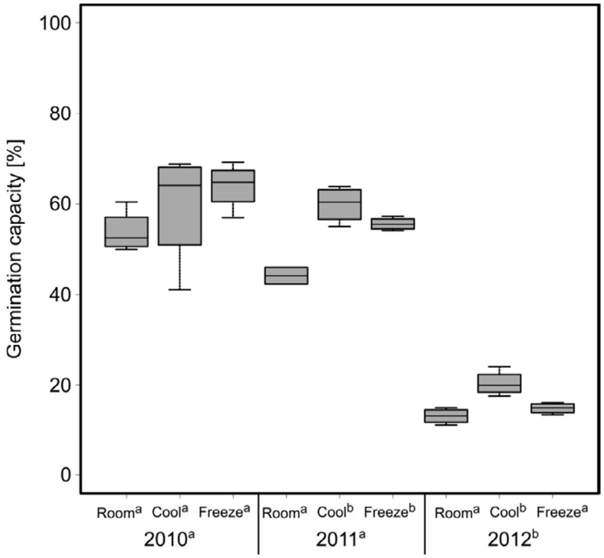
Table 1. Results of the two-way ANOVA of the greenhouse germination trial from seed material harvested with on-site threshing, stored under different conditions over three years.

	Df	Sum Sq	Mean Sq	F-value	*P*-value	Partial Eta Sq
Year	2	13038.3	6519.2	237.99	<0.001***	0.95
Storage	2	618.7	309.4	112.94	<0.001***	0.46
Year × Storage	4	232.1	58.0	21.18	0.106	0.24
Residuals	27	739.6	27.4			

R^2: 0.95: Adjusted R^2: 0.93

Significance level: P (*P<0.05, **P<0.01, ***P<0.001)

A minimum germination capacity threshold at 50% is shown in Figure 1, and this is the level that should be shown by the harvested material if it is to guarantee sufficient quality for restoration success (Krautzer and Hacker, 2006). After one year of storage, the germination capacity (Figure 1) of the OST material partly reached 70%. In the second year the samples stored under 'room' temperature declined to 40%, but the samples of the 'cool' and 'freeze' treatments still obtained a high result, ranging between 55 and 65%. After three years of storage all three treatments (room, cool and freeze) showed a significant reduction of the germination capacity to below 20%. In general, samples stored under cool and dry conditions revealed higher germination rates than the samples stored under room temperature. Variance of all treatments strongly declined over the years. This could be explained by the fact that seeds of single species have different germination strategies and, after storage over the years, some species loose vitality earlier than others (Grime *et al.*, 1981; Haslgruebler *et al.*, 2011).



a, b – different letters indicate significant differences

Figure 1. Germination capacity of stripped seeds from an *Arrhenatherion* meadow stored under different temperature and humidity conditions over three years (2010, 2011, 2012).

Conclusion

To obtain satisfactory quality results, seed material should be stored under cool and dry conditions. To avoid rapid decrease of germination capacity, the storage of seed material should not exceed two years. The presented method for testing seed material harvested from an *Arrhenatherion* meadow can be recommended to practitioners because it is easy to apply in practice and it gives sufficient information about the quality of seed material.

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